8203. CONTROL CENTER COMPARTMENT

(1) Type of Equipment

a. Control center shall be built-in interchangeable type, and 200 mm or larger vertical modular height plug in units with hinged doors.

b. Control center shall be drawout type with drawout type of load and control connection.

c. Unless otherwise specified, starters shall be of circuit breaker combination, three poles full voltage magnetic type, and with three overload relays and external manual reset.

d. Control center shall be provided with external lockable handles and interlocks to prevent opening the door or drawing out the starter unless breaker is open.

e. Control center shall include wiring to terminal blocks for remote control of all the said units in addition to specified local controls.

(2) Magnetic Starters

a. Starter shall be of full voltage, nonreversing, or reversing with molded case circuit breaker as specified or as required.

b. Starter shall have either thermal relay or two elements relay to match motor specifications.

c. Starter shall be supplied with necessary auxiliary contacts as required by means of relays, and with one spare normal open and one spare normal close contacts respectively.

8204. MAJOR COMPONENTS OF THE FACILITIES

Major components for each unit shall be as follows:

- Power receiving unit or bus connecting unit	
Four pole, molded case circuit breaker	1 each
Green, red and orange lamps	1 set
- Power distributing unit	
Three or four pole, molded case circuit breaker	1 each
Green, red and orange lamps	1 set
- Non-reversing unit	
Three pole, molded case circuit breaker	1 each
Three pole, magnetic contactor	1 each
Thermal relay or two element relay	1 each
Current transformer (if necessary)	1 set
Ammeter (if necesary)	1 each

	Green, red and orange lamps	1 set
	Changeover switch	1 each
	Push button switch (start, stop)	1 set
-	Reversing unit	
	Three pole, molded case circuit breaker	1 each
	Three pole, magnetic contactor	2 each
	Thermal relay	1 each
	Green, red, white and orange lamps	1 set
	Changeover switch	1 each
	Push button switch (open, close and stop)	1 set

SECTION 8300. CONTROL PANEL

8301. GENERAL

Control panel shall be fabricated and tested at the shop and shall include all equipment and devices not specified and indicated but required to form the complete control system.

8302. TYPE OF THE PANEL

Control panel shall be of indoor use self standing, metal enclosed type and shall be dead front cubicle type of complete vermin proof.

8303. STRUCTURE

a. Control panel shall be made of rigid structural steel frame, and enclosure of adequate thick rolled steel plate.

b. Control panel shall be rigid and free from twist during handling and after installation and shall be free from magnetic vibration.

c. Control panel shall be furnished with lockable front door with chrome plated handles and either removable or fixed panels of adequate thickness on top, rear, bottom and sides in accordance with manufacturer's instructions.

d. The control switches, signal lights, etc. shall be mounted on a front door.

e. Control panel shall be provided with anti-condensation heater together with ON/OFF switch.

f. Other specifications shall be in accordance with those of specified on the predescribed switchboard section.

8304. REMOTE SUPERVISING CONTROL PANEL AND MEASURING INSTRUMENT PANEL

(1) Remote Supervising Control Panel

a. The panel shall be of steel sheet enclosed self-supported indoor-use tunnel type construction.

b. The panel shall have side doors and inner maintenance walk way.

c. The panel shall be of front operation and vertical supervising face type.

(2) Measuring Instrument Panel

a. The panel shall be of steel sheet enclosed self-supported indoor-use type construction.

b. The panel shall be of front operation and vertical supervising fact ype.

8305. SMALL WIRING

a. Control panel shall be wired complete at the shop. All small wiring shall be made with 600 V PVC insulated wire and sized 2 sq.mm or larger.

b. All small wiring shall be neatly run and securely fixed in the plastic duct with cover and the said wiring shall be able to be checked by wiring diagrams without removing bindings.

SECTION 8400. EQUIPMENTS FOR EMERGENCY

8401. UNINTERRUPTABLE POWER SOURCE

(1) General

This system shall supply the uninterruptable power to the following instrumentation, communications, emergency lightings, alarm annunciator circuit and control circuit for switchgears continuously. The system shall have not less than 30 minutes back-up capacity when commercial power failure.

(2) Construction

The uninterruptable power source shall be of indoor-use, self-standing, metal enclosed type. The panel shall be dead front cubicle type and complete vermin proof construction.

(3) Thyristor Rectifier with Automatic Voltage Regulation

The rectifier shall be designed as fully automatic. Float charging or recovery charging when commercial power supply recovered shall be automatically given by this rectifier. This system shall be of continuous rating type and shall have suitable current capacity for load plus charger. This system shall be of natural cooling or forced cooling type. The rectifier shall have over-current protection circuit.

(4) Battery

The battery shall be of Sinterd Type Alkaline Battery (SBA type AHH).
Final terminal voltage of cells shall be as follows;

1.1 V/cell x 96 cells = 105 V

The battery shall have not less than 30 minutes backed-up capacity.

(5) Inverter

The inverter shall be of continuous rating type and shall be able to switch to commercial line automatically in case of the inverter trouble and/or test. The inverter shall have suitable capacity for load current.

The following charasteristics shall be required.

a. Output performance (Transient voltage deviation)

Sudden input voltage change of ± 10%	:	within ± 5%
Sudden load change of 75% 100%	:	within ± 10%
AC failure or recovery	:	within ± 10%

b. Frequency variation : within ± 1%

c. Voltage accuracy : within ± 2%

d. Wave distortion : within ± 5%

e. Efficiency (DC AC) : 75% or more

8402. EMERGENCY DIESEL ENGINE DRIVEN GENERATOR SET

(1) General

This facility shall be used for emergency power supply system in case of commercial power failure. This facility shall supply as an emergency power to instrumentation, communication, emergency lighting, ventilation fan, etc. This system shall consist of the following units.

(2) Diesel Engine

Four-cycle, vertical type, water cooled, direct injection or precombustion chamber type diesel engine shall be required.

These ratings shall be as follows;

Revolutions : less than 1,500 r.p.m.

Starting method: electric motor

Cooling system : radiator with fan

Fuel : diesel oil

Number of Cylinder: two (2) or more

(3) Generator

The generator shall be of open, drip-proof, self-ventilated type.

(4) Fuel Oil Service Tank

The tank shall be made of 3.2 mm sheet steel with suitable reinforcement and shall be of self-standing with supporting structure. Level indicator and level controller for fuel transfer pump shall be required.

(5) Fuel Oil Transfer Pump

Contractor shall supply the suitable capacity of fuel oil transfer pump for feeding to the fuel oil reservoir. Pump capacity shall be determined by the Contractor.

(6) Fuel Oil Piping

Contractor shall furnish and install all the fuel oil pipings around the emergency diesel engine generator set.

(7) Special Requirement

In case of automatic operation mode, the system shall start-up and be able to supply the power within 40 seconds after commercial power failure.

SECTION 8500. INSTRUMENTATION

8501. GENERAL

(1) Contractor shall furnish all transmitters, sensing elements, measuring cells, receivers, transducers, signal converters, indicators, integrators, power supplies, etc., as specified and required for proper operation and complete functioning of the instrumentation system.

(2) Input voltage of power source for instrument shall be of single phase 110 V or 220 V, 50 Hz.

(3) Transmitter shall have shut-off valves in its primary measuring lines.

(4) Transmitter and sensor shall have an automatic temperature compensator if necessary.

(5) Contractor shall provide "Two years supply of charts, pens and ink" for each recorder.

(6) Contractor shall provide nameplates for all remote instruments similar to those specified for control cubicle and console.

(7) Signals transmitted shall be 4 to 20 mA DC or 1 to 5 V DC.

8502. EQUIPMENT

(1) Differential pressure Transmitter with thermal compensation

a. The transmitter shall be of the electronic type.

b. The transmitter shall have an indicator unless specified otherwise. The indicator shall be within a transmitter case.

c. The transmitter shall be wall or pipe mounted type.

d. The transmitter shall be within weatherproof case.

e. Bellows shall be made of 316 stainless steel or equal.

f. Transmitter shall be designed to be highly pressure resistant and vibration resistant.

g. Measuring range shall be easily adjustable in the field.

h. Transmitter shall have meter body with adjustable internal pulsation damping circuit.

i. Transmitter shall be calibrated to match flow tube or water level.

j. Accuracy shall be within ± 0.25% FS.

(2) Recorder

a. One-pen continuous writing recorder shall be used.

b. Recorder shall be automatic balance type with high and low alarm contacts.

c. Recorder shall be provided with a matching case.

d. Recorder shall be removable from the front of the panel.

e. Recorder shall have strip charts with speed of both 19 mm per hour and 19 mm per minute and indicating scales.

f. Accuracy shall be within ± 0.5% FS.

(3) Automatic Balance Type Indicator

a. Indicator shall be with ribbon scale.

b. Indicator shall have high and low alarm contacts.

c. Indicator shall be provided with a matching case.

d. Indicator shall be removable from the front of the panel

e. Accuracy shall be within ± 0.5% FS.

(4) Moving Coil Type Indicator

a. Indicator shall be of the rectangular shape.

b. Indicator shall have high and low alarm contacts as otherwise specified.

c. Accuracy shall be within ± 1.0% FS.

(5) Slidewire Resistance Current Converter

a. Slidewire resistance current converter shall convert the resistance according to the position of an oscillation slidewire resistance of valve.

b. Accuracy shall be within ± 0.5% FS.

(6) Integrator

a. Integrator shall have six digits with manual reset.

b. Integration range shall be 10 to 100% of flow rate.

c. Integration accuracy shall be within ± 0.5% FS.

d. Integrator shall be provided with a matching case.

(7) Flow Meter

a. Flow meter shall be of ultra-sonic two beam type.

b. Measuring accuracy with the transducer shall be within ± 1% FS.

c. Flow meter control units shall be of solid-state logic type and weatherproof style, suitable for wall mounting.
The unit shall contain digital flow display in cubic meters per minute (m^3/min).

d. Special executive transmission cable shall be supplied.

e. The transducers shall be of the clamp-on, waterproof style, mounted on the outside wall of the pipes.

(8) Alarm Point Setter

Alarm point setter shall be of flash panel mounting and face operation electronic type.

SECTION 8600. WIRES AND CABLES

8601. CONDUCTOR OF WIRES AND CABLES

a. Conductor of wires and cables shall be of annealed, 98% conductivity, soft drawn copper, and shall be stranded with size larger than 2 sq.mm.

b. The conductor of wires and cables shall be larger than 3.5 sq.mm and 2 sq.mm for power supply and control or signal respectively.

8602. WIRES AND CABLES

a. The cables for power supply voltage ranging 22 KV to 600 V shall be of crosslinked polyethylene insulated PVC sheathed cable or equal.

b. The cable for control or signal shall be of PVC insulated PVC sheathed cable or equal and/or city pair polyethylene insulated PVC sheathed cable or equal.

c. The power cables and control cables shall have sufficient cross sections for load current, interrupting current and small voltage drop.

d. Each of the parallel trunk cables for high and low tension power supply shall have sufficient cross sections to transmit the whole power required for all power equipment connected to the respective switchgears and motor control centers.

e. All cables shall be laid in the utility duct and on cable trays supplied by the Contractor.

f. Wiring design, wiring method and materials shall comply with all applicable provision of JEM or equal and all applicable codes and regulations.

8603. GROUNDING

a. Exposed metal frames of all electrical appratus and machinary not forming part of the electric circuit, neutral of transformers, etc. shall be grounded.

b. Ground plate shall be 90 cm square, 1.5 mm thick copper plate or the like. Grounding cable shall be copper and sized as required. Test terminal shall be provided to measure the grounding resistance.

6404. RACEWAY

a. Raceway system shall be electrically and mechanically completed before wires and cables are installed. Bends and offsets shall be smooth and symmetrical and shall be formed with tools designed for the purpose intended. Empty conduit, when not in pullboxes, shall be plugged. Exposed raceways shall be installed perpendicular or parallel to floor or wall. Conduit shall be supported by straps, cast clamps and the like. Conduit which pierces concrete slabs or walls shall be terminated with flush coupling. Conduit for equipment standing on floor shall be placed in strict accordance with approved shop drawings.

b. All non-metallic conduits where permitted or required, shall be PVC. Joints shall be solvent welded.

c. Steel conduit shall be mild steel hot dip galvanized inside and outside. All steel conduit buried in the ground shall be jacketed or coated with a polyvinyl chloride so that protected from corrosion. Any damage to the protection caused by bending and others shall be required. Corrosion proof conduit shall be exposed until inspected and approved by the Engineer.

d. Flexible conduit shall be used for the connection of equipment such as motors, instruments, valves level switches, and the like.

8605. CABLE TRAYS

The trays shall be of galvanized steel or aluminum. The trays shall have adequate depth and width for wiring. The trays shall be supported at intervals of 1.5 m. All necessary supports, hanger rods and brackets and the like shall be furnished with the trays. The trays shall be grounded.

8606. WIRES AND CABLES IDENTIFICATION

Wires and Cables shall be identified by means of labels attached to the conductor termination. All spare conductors shall be identified in the same manner as above.

SECTION 8700. ILLUMINATION SYSTEM

8701. MATERIALS

(1) General

a. All fixtures and materials shall be furnished by the Contractor and shall conform to applicable provisions of JIS, TIS or ASTM, and shall be approved by the Engineer prior to installation.

b. Lighting fixtures shall be furnished products; complete with socket, receptacles, choke coils, starter switches, power factor improvement condensers, discharge resistances, installation hardware and other technically required accessories and parts.

c. Appliances shall be of heavy-duty construction, shall not deteriorate in their function under prolonged use, shall be of construction easy to dismantle and to inspect, and shall be completely interchangeable as to common parts, including spare parts. Those items which are to be assembled at the site shall be accompanied by all bolts, nuts, and accessories necessary for assembly.

(2) Lighting Fixtures

a. Fixtures shall be of sturdy construction, easy to maintain and inspect, and shall not develop defects in any part thereof by continuous vibration. In particular, installation and connection leads shall be of sufficient strength.

a. Fixtures shall be free of light leakage, shall admit no dust, insects and other objectionable matter so far as possible, and shall be so constructed as to sufficiently withstand surrounding temperatures. Consideration shall be given so that any heat generated within the appliances shall be diffused completely.

c. Fixtures shall be warranted against defects of electrical parts or insulating materials by overheating, and against deterioration, deformation, discoloring, peeling of paint due to overheating, and poor material and workmanship, for a period of one year after acceptance of the work.

d. For wiring within fixtures, different colored vinyl insulated electric wires shall be used, and wiring diagram for each terminal shall be attached to each appliance.

(3) Tumbler Switches and Receptacles

a. The types and rating of tumbler switches and receptacles shall be in accordance with the descriptions on the Drawings. The standards are as set forth below:

Tumbler switch: 250V, 20A flush type, monopolar or three-way tumbler switch with plate

Receptacle: 250V, 20A flush type, single or duplex receptacle with plate

b. Tumbler switches shall be of the totally enclosed tumbler type. The terminals shall be of the side connecting screw type. The switch housing and operating lever shall be constructed of phenolic compound, brown in color. Switches with porcelain bases are not acceptable.

c. Receptacles shall be of 2-pole, 3-wire, ground and straight blade type. The receptacle body shall be brown phenolic and shall have screw terminals for side and back wiring. Copper or copper alloy shall be used for all current carrying and for wire-binding screws.

d. Device plates shall be stainless steel alloy of not less than 1.5 mm thick with beveled edges.

(4) Lighting Panel Board

a. Front of cases shall be so constructed as to be easily removable for inspection and repair of equipment mounted inside, and shall be equipped with a door to facilitate operation of the distribution circuit breaker. Surface of the board shall be painted in a color directed by the Engineer.

b. Panels shall be made of steel plate 1.6 mm minimum thickness, and provided with the required distribution circuit breakers and shall be connected with copper bars of adequate size.

c. Lighting panel boards shall be wall-mounted, be equipped with a 4-pole busbar system and be equipped circuit breaker to 20 amps for the individual lighting circuits.

(5) Conduit and Accessories

a. Unless otherwise specified, all conduits shall be rigid steel conduit, hot-dip galvanized in accordance with JIS C 8305 or equivalent standards.

b. Conduit accessories shall be galvanized and shall conform to the respective publications and other requirements of JIS C 8330, JIS C 8333, JIS C 8331, JIS C 8347, JIS C 8357 or other equivalent standards.

c. Suitable conduit accessories shall be selected. Outlet boxes for lighting fixtures, receptacles, local switches, etc., shall be made of metal. Wooden base, wooden box or the like shall not be substituted for metal products. Where 2 or more tumbler switches, receptacles or others are to be installed at the same place, a common box shall be provided together with proper common cover and plate. At places where heavy lighting fixtures are installed, stud bolts adequate to support the fixtures shall be provided in structures supporting such boxes.

(6) Electric Conductors

a. Electric wire for lighting branch circuits shall be 600 V PVC insulated single conductor. This insulating material shall be satisfactory for installation in wet or dry locations on AC and DC circuits and shall be suitable for use on a copper conductor with maximum operating temperature of not more than 60°C.

b. The size of conductors shall be as indicated on the Drawings and shall be not less than 3.14 mm^2 in minimum sectional area.

c. Cabling, fillers, binder and conductor indentifications for multi-conductor cables shall be in accordance with JIS C 3605. Individual conductors of 600 V multi-conductor cables shall be coded by the use of color jacket compound or colored insulation. Coding by printed number will not be accepted.

8702. INSTRUCTION BOOK

The Contractor shall furnish six (6) copies of instruction books on the operation and maintenance of principal equipment furnished and installed by him under this section, one month before he completes the installation work.

8703. PAINTING

All metal and wooden surfaces of fixtures shall be painted, except as listed below. Performance of painting work shall be as specified in Division 9 Painting:

- portions to be embedded in concrete
- plated surfaces other than zinc plating
- zinc plated portions to be left concealed
- surface treated with special decorative finish

SECTION 8800. INSTALLATION

8801. INSTALLATION OF SWITCHGEAR SWITCHBOARD AND CONTROL PANEL

(1) Conduit Work

a. Conduits and accessories of boards shall be laid in cable duct, unless otherwise specified shall be exposed. Exposed conduits shall be laid out in such an orderly manner as to match with the condition of surface for support.

b. All radii of conduit bends shall be 2 times or more than the inside diameter of conduit. The tube shall not have more than 4 rectangular bends or similar curve between any 2 fixtures.

c. Conduits shall be sufficiently protected so that no water, dust, or other objectionable matter shall enter the pipes. During the period from the laying of conduits up to installing conductors, adequate measures shall be taken to prevent entry of moisture, dust or other materials into conduits, and the inside of the conduits shall be cleaned by adequte means immediately prior to installing conductors.

d. Conduits and accessories shall be perfectly connected both mechanically and electrically by suitable means. A suitable metallic bond shall be provided where conductivity is feared to be obstructed. Wires for bonding shall be soft copper of a diameter of 2.0 mm or more by welding or other method approved by the Engineer.

All cables and conduits which enter a Main Switchgear and Switchboards and Control Panel shall be covered by a removable heavy gauge metal enclosure which extends from the floor to the boards.

(2) Cable Work

The installation shall be carried out with PVC insulated wires in galvanised steel troughing, PVC insulated PVC sheathed armoured cables shall be used for main and submains. The cable sizes for main and submains shall be as shown on the Drawing. Cables for final sub-circuits shall be adequate for the service conditions. Voltage drop of final sub-circuits shall not exceed 3 percent, when measured from the commencement of the circuit.

(3) Wiring Work

a. In installation conductors, substance harmful to conductor, such as oil, grease shall not be used. Splicing of conductors within the conduit shall be strictly prohibited.

b. No soldering shall be applied to the conductor joints as a rule. In case soldering is unavoidable, prior approval of the Engineer shall be required.

c. Insulation resistance against ground of each circuit shall be more than 1 meg ohm.

8802. Installation of Illumination System

(1) Installation of Fixtures

a. Wiring connections shall be made in outlet boxes. In case of installation on wooden structures, the outlet box shall be screwed on directly to such structure. In case of installing on reinforced concrete structure, the outlet box shall be screwed on concrete for exposed conduit piping, or shall be placed in concrete for embedded conduit piping. In case of installing a built-in type fixture on a ceiling, steel or timber furring shall be provided parallel with the longitudinal direction of the fixture, and the fringe of the reflecting shade or body shall be either supported by, or screwed on to, such steel or timber furring support. Concrete foundations shall be provided as shown on the Drawings for pole type outdoor lighting and the poles shall be firmly installed on such foundations by bolts or other fasteners, or embedded in concrete foundation.

b. Indoor illuminations shall be installed as soon as possible after control house, office and other building roof installation.

(2) Conduit Work

a. Conduit pipes and accessories of lighting fixtures, other than those which are indicated to be exposed shall, unless otherwise specified, be embedded. Exposed conduits shall be laid out in such a manner as to match with the condition of its supporting surface.

b. Except for risers of conduit, other wall surface conduit shall be generally supported along or suspended from the ceiling surface. Pull boxes shall be generally suspended from the ceiling or attached to walls. All radii of conduit bends shall be 6 times or more the inside diameter of conduit. The conduit shall not have more than four 90 degree bends, or equivalent, between any 2 fixtures or between any 2 boxes.

c. Conduits shall be sufficiently protected so that no water, dust, or other objectionable matter shall enter the conduit. During the period from the laying of conduit up to installation of conductors, adequate measures shall be taken to prevent entry of moisture, dust or other materials into conduits. The inside of

the conduit shall be cleaned by adequate means immediately prior to installing conductors.

d. Conduits and accessories shall be perfectly connected both mechanically and electrically by suitable means. A suitable metallic bond shall be provided where conductivity may be thought to be obstructed. Wires for bonding shall be soft copper of a diameter of 2.0 mm or more.

(3) Wiring Work

In installing conductors, substance harmful to conductor, such as oil or grease shall not be used. Splicing of conductors within the conduit shall be strictly prohibited.

As a rule, no soldering shall be applied to the conductor joints. In case soldering is unavoidable, prior approval of the Engineer shall be required.

Insulation resistance against ground of each circuit shall be more than 1 meg-ohm.

SECTION 8900. TESTING

8901. GENERAL

The Contractor shall perform following tests in accordance with the latest Standard specified in Division 1. "General Requirement" of this Specification.

8902. SHOP TEST

The following test shall be performed at shop by the Contractor.

(1) Main transformer

a. General inspection
b. Dielectric strength test by commercial frequency and full wave impulse
c. Measurement of temperature rise
d. Inspection of oil leakage
e. Characteristic test:

- Dielectric resistance measurement
- Transformation ratio measurement
- Winding resistance measurement
- Polarity and phase rotation check
- No load test:

  Including measurement of exciting current under 50% to 100% of the rated voltage

- Short-circuit test:

  Including measurement of copper loss

- Impendance measurement
- Calculation of efficiency
- Calculation of voltage regulation

(2) Low Tension Transformer

a. General inspection
b. Dielectric strength test by commercial frequency
c. Measurement of temperature rise
d. Characteristic test:
   - Dielectric resistance measurement
   - Transformation ratio measurement
   - Winding resistance measurement
   - Polarity and phase rotation check

- No load test:

  Including measurement of exciting current under 50% to 100% of the rated voltage.

  - Short-circuit test:

    Including measurement of copper loss

    - Impendance measurement
    - Calculation of efficiency
    - Calculation of voltage regulation

(3) Metal-Clad Switchgear, Motor Starter, Motor Control Center, and Switchboard

a. General inspection
b. Dielectric strength test
c. Dielectric resistance measurement
d. Performance test of relays
e. Error test of meters
f. Sequence test

(4) Circuit Breaker

a. General inspection
b. Dielectric resistance measurement
c. Operation test
d. Dielectric strength test

(5) Instrumentation

a. General inspection
b. Performance test

(6) Engine driven Generator Set

a. General inspection
b. Dielectric resistance measurement
c. Dielectric strength test
d. Combined operation test on full load and partial load
e. Fuel consumption measurement
f. Simulation test of protection relay and generator control sequence

(7) DC/AC Uninterruptable Power System

a. General inspection
b. Dielectric resistance measurement
c. Dielectric strength test
d. Temperature rise test
e. Voltage charasteristic test
f. Charger characteristic test

8703. SITE TEST

The following site test shall be performed by the Contractor after installation completed. All necessary materials and equipments for the site test shall be provided by the Contractor at his own expense.

a. Dielectric resistance measurement
b. Dielectric strength test
c. Grounding resistance measurement
d. Sequence test
e. Operating test on actual load
f. Vibration test
g. Other necessary tests and measurements directed by the Engineer.

DIVISION 9. BUILDING WORK

SECTION 9000. EARTH, CONCRETE AND BRICK WORKS

9001. EARTH WORK

(1) Land Grading

The Contractor shall make a topographical survey of the buildings area and shall then submit full details of the arrangement of the land in this area to the Engineer for his approval, prior to the commencement of the Work.

The details shall include the work of excavation, fill, drainage, masonry, road etc., which shall be executed in accordance with the General Specification "Earth Work" of Division 2.

(2) Excavation

The earthwork required for foundations and other parts of the buildings shall be carried out to the lines and levels as shown on the Drawings and/or as directed by the Engineer, in accordance with General Specification in Section 2000 "Excavation".

9002. CONCRETE WORK

The concrete work shall be performed in accordance with the applicable requirements of the General Specification of "Concrete" of Division 3. Providing no other kind of concrete is specified in the Drawings, Class D Concrete shall be used for the floors and low thickness parts and Class F Concrete shall be used for the reinforced concrete.

9003. BLOCK AND BRICK WORK

(1) General

The work shall include but not be limited to:

a. All solid and hollow brick walls including plastering
b. All concrete block
c. Brick work for setting manhole frames and miscellaneous purposes
d. Connecting wall anchors, ties, bolts and related embedment items
e. Installation only of frames for doors, windows and louvers, steel lintels, recessed fixtures and equipment

(2) Concrete Block Material

Concrete block shall conform to ASTM C90 "Hollow Load-Bearing Concrete Masonry Units", Grade N and shall be 19 cm x 39 cm nominal face size stretcher block and either 15 cm or 20 cm thick as noted on the Drawings. Ventilation and other special block shall be manufactured by an approved concrete block manufacturer.

Block shall be manufactured from Portland Cement conforming to ASTM C150 and/or JIS R5210 "Portland Cement".

Aggregate shall be crushed lime stone and sand and conform to the grading of Table 2, Grading Zone 1, B.S. 882 and for mortar Table 2 of B.S. 1200.

Block shall be furnished in stretcher, corner lintel and other types as required.

Block shall be free from substances that will cause staining or pop-outs, and shall be fine, even textured with straight and true edges. All blocks shall be wet stream cured for at least 18 hours and then air cured in covered storage for not less than 14 days before delivery.

(3) Hollow Brick

Brick used in non-load bearing walls shall be as shown on the Drawings.

(4) Brick Material

All brick shall be good, sound, hard and uniformly burned, solid, rectangular, regular and uniform in shape and size and of compact texture. The mean of five tests for absorption shall not exceed 7 percent and no test shall exceed 11 percent.

(5) Bonding Materials

a. Cement

Portland cement shall conform to ASTM C150. One color of cement shall be used throughout the Works. The brand of cement used shall be for the use intended and in accordance with the written approved recommendation of the manufacturer.

b. Hydrated Lime

Lime shall be hydrated, conforming to ASTM C 207, "Hydrated Lime for Masonry Purposes", Type N or S.

c. Sand for Mortar

Clean, durable particles, free from injurious amounts of organic matter shall be used for mortar. The sand shall conform to the limits of ASTM C 144, "Aggregate for Masonry Mortar".

d. Aggregate for Mortar

Aggregate for mortar shall conform to the requirements of Fine Aggregate as defined in ASTM C404, "Aggregate for Masonry Grout".

e. Water

Water shall be free from injurious amounts of oils, acids, alkalis, organic matter, or other deleterious substances.

Potable tap water will normally fulfill the above requirement.

(6) Expansion and Control Joints

Expansion and control joints shall be made with self expanding cork or premoulded joint filler and a two component synthetic rubber compound.

(7) Reinforcing and Anchors

All reinforcing bars shall conform to the General Specification in Section 3200 "Reinforced Steel". Metal tie bars shall be 4mm thick by 3 cm wide and 70 cm long and 4 cm right angle bends on each end. Metal lath, if used, shall be 6mm mesh galvanized. Dovetail type flat bars for use in embedded slots or inserts shall be 16 gage 3 cm wide.

(8) Sample Walls

Before commencing with the laying of any block that is to be exposed (not plastered) the Contractor shall construct a sample wall using the block and joint spacing proposed for the finished wall. The sample wall shall be 2 meters long and a meter high showing type and tooling of joint, color of mortar, bonding type and width of joints. Sample walls shall be left in place until completion of the work for which they were constructed and then shall be disposed of.

(9) Installation

a. Exposed Concrete Block

Concrete block shall be laid in "stack" bond, unless otherwise indicated, with joints not exceeding 1.0 cm and uniform throughout and finished slightly concave and smooth. All block shall be laid in a full bed of mortar applied to shells only. Apply mortar to the vertical joint of block already set in the wall and all contact faces of the unit to be set. Each unit shall be placed and shoved against the block previously laid so as to produce a well-compacted vertical mortar joint for the full shell thickness. Moisture content of block when laid shall not exceed 35 percent. Intersection bearing walls shall be tied together with metal ties at a meter vertical spacing. Bends of tie bars and reinforcing shall be embedded in cells filled with mortar. Where indicated, concrete block shall be reinforced and concrete block lintel types shall be built in.

Install all door, window and louver frames, set all blocks tightly against frames, build in all frame anchors, and fill metal frames with mortar.

Control joints shall be installed at the intersection of block walls with structural concrete and elsewhere as detailed on the Drawings. Joints not detailed otherwise shall be raked out to a depth of 2 cm for the full height of the wall and caulked. Maximum length between joints shall be 10 meters, if not shown on the Drawings or directed by the Engineer.

Joints are to be examined to locate cracks, holes or other defects and all such defects shall be filled with mortar and pointed.

b. Concrete Block to be Plastered

Concrete block walls, to be plastered, may be laid with either running bond, or stack bond. Joints are to be left rough to assist in bonding of plaster. Otherwise concrete block masonry shall conform to previous paragraph "Exposed Concrete Block". Control joints in plastered block walls shall be carried through the plaster.

c. Brick Work

Hollow brick shall be laid in mortar with joints not exceeding 1.0 cm. Hollow brick work for walls is to be plastered on both sides. Solid brick shall be laid in common bond with all joints filled solidly with mortar and backs fully pargeted to form solid structures. Joints of walls to receive plaster shall be lightly raked to provide a bond for plaster. Solid brick shall be plastered only when so indicated on the Drawings or scheduled in Particular Specifications.

Hollow brick Works shall be constructed as specified herein before for concrete block to be plastered, including the installation of expansion and control joints.

(10) Lintels, Ties and Miscellaneous Items

The Contractor shall build in or provide all miscellaneous items to be set in structure including frames, lintels, reinforcing steel, electrical boxes and fixtures, sleeves, grilles, anchors and other miscellaneous items. All anchorage, attachments, and bonding devices shall be set so as to prevent slippage and shall be completely covered with mortar.

(11) Grouting

Grout and cement mortar for setting structural steel columns, railings, frames in walls and where otherwise required shall be done with mortar as hereinbefore specified. Before placing grout thoroughly clean all surfaces. Grout shall be tamped into place with a blunt tool to fill the entire void. In the event space does not permit tamping, the Contractor shall build the necessary forms and place grout by pouring from one side only. When grout is placed by pouring a head of grout shall be maintained in the form. Grout shall be kept wet for three days and after the temporary supports or adjusting wedges are removed the empty space shall be grouted and the surrounding grout pointed.

(12) Cleaning

Mortar smears and droppings on concrete block walls shall be dry before removal with a trowel. The work may be cleaned using a mild muriatic acid solution.

SECTION 9100. CARPENTRY

9101. MATERIALS

(1) General

All lumber to be incorporated into the permanent work shall be sound stock delivered dry and shall be fuliy protected at all times from injury and dampness. Kinked, knotted, broken, insect-bored, or otherwise damaged pieces will not be allowed in the Works.

Gradation shall be select grade which is defined as selected lumber, generally clear, high quality, of good appearance, and suitable for use without waste and for natural finish.

(2) Hardwood

Hardwood shall be heavy, and close-grained and shall be of the following species:

Botanical Name	Thai Name
Afzelia tylocarpa	Maka-mong
Xylia kerrii	Dang
Pterocarpus macrocarpus	Pradoo or Makushuah
Cotylelobium lanceolatum	Kiem
Chukrasia velutina	Yomhin
Pentacme siamensis	Rung

(3) Medium Wood

Midium wood shall be of following species:

Botanical Name	Thai Name
Sindora siamensis	Maka-tae
Dipterocarpus obtusifolins	Heang
Dipterocarpus tuberculatus	Pluang
Bouea micro phylla	Mapring
Maugifera spp.	Mamuang
Adina cordifolia	Takien-thong
Shorea obtusa	Teng

(4) Teak Wood

Teak wood shall be of the following species:

Botanical Name	Thai Name
Tectona grandis	Sak tong (grade 1)
Premna pyramidata	Sak khee khwai (grade 2)

(5) Soft Wood

Soft wood shall be of the following species; the wood shall be relatively light in texture and easily worked:

Botanical Name	Thai Name
Dipterocarpus pilosus	Yaeng dang
Amoora polystachya	Tah sua
Sandoricum indicum	Ka thon

9102. WORKMANSHIP

(1) Splicing

Framing members shall not be spliced between bearing points, and shall be free from pronounced defects. Joints and splices shall be bolted or spiked together, and shall occur over bearings only.

All carpentry and millwork shall be accurately cut, fitted and installed as detailed on the Drawings.

Anchors shall be installed, where indicated or required, to anchor carpentry, or other items securely to concrete.

(2) Miscellaneous Wood Form Work

Forms for structural concrete work are specified in the General Specification in Section 3100 "Form Work". Provide all other miscellaneous wood form work as may be required for the completion of the work.

All staging, exterior and interior, shall be erected by the Contractor and maintained in safe condition by him.

All edges of sills, projected courses, concrete steps and liable to be damaged during construction shall be protected with temporary wooden covers.

(3) Painting Woodwork

All wood work shall be painted in accordance with the Specifications in Section 9400 "Painting".

9103. WOOD CABINETS AND CLOSETS

Where wood cabinets, closets and other wood furniture are detailed on the Drawings they shall be constructed to the dimensions and details shown. Exterior grade teak plywood of sufficient thickness, and strength for the use intended shall be incorporated into the work. The frame shall be teak wood of size and details shown. Finished hardware is specified in this division.

9104. STOP LOGS

Wood stop logs of sizes, number and details indicated on the Drawings shall be furnished. Wood shall be sound stock, regular size, straight, dry and untreated wood equal to Takien Tong. Split or otherwise damaged pieces shall not be allowed in the work.

Galvanized steel lifting accessories and recesses shall be provided where indicated. Painting is not required.

9105. FINISHED CARPENTRY

Wood for blocking, cants, nailers, moulding, trim and miscellaneous wood to finish off opening shall be medium wood. Wood to be exposed in the finished work shall be accurately cut, fitted, sanded and painted to conform to adjoining surfaces.

9106. PLYWOOD

Plywood shall be the thickness indicated on the Drawings. Plywood 20 mm thick and thinner shall be at least three ply. All plies shall be bonded by the hot plate method with a urea (white) glue. Plywood specified to be marine plywood shall be bonded with a water resistant phenol (red) glue. Plywood shall be formed using presses which exert a minimum of 10 kg/cm^2 pressure. Plywood panels shall be prefinished on one side. The grade of finish shall be first grade according to local practice, unless otherwise noted. Local practice provides for three grades; special, first and medium. Special grade is the highest quality.

9107. WOOD FOR GLAZING

Wood beads and trim for glazing in wood doors and windows shall be the same type of wood as the door or window. Beads shall be neatly shaped to fit flush with the sash and support the glass. Wood setting blocks shall be teak installed at 40 cm intervals under glass and in from the edge 20 cm.

9108. ASBESTOS CEMENT FLAT SHEETING

Asbestos cement sheeting shall be flat sheet of asbestos cement manufactured to the Thai Industrial Standard. Sheet shall be compressed sheets 6 mm thick unless otherwise noted and shall be natural color. Sheeting shall be installed on a firm hard wood frame using corrosion resistant nails. Joints shall be sealed according to standard practice. Sheeting shall be installed to dimensions indicated on the Drawings. All holes in asbestos sheeting shall be predrilled.

9109. LAMINATED PLASTIC (FORMICA)

Where counter tops, doors and other surfaces are noted on the Drawings to have a Formica surface a laminated plastic surfacing shall be applied to a thickness of 1.6 mm. The surfacing shall be applied to 2 cm thick plywood unless otherwise noted. The materials, adhesives and method of fabrications shall all conform to General Purpose Grade as made by the Formica Corporation of U.S.A.

9110. PRESERVATIVE TREATMENT

Timbers indicated as "Treated Wood" on the Drawings and timbers which contact with concrete, hollow concrete block, cement mortar and metal shoes shall be treated with wood preservatives for the prevention and curative treatment of fungal and insect attack. Treatment shall be carried out after all cutting and shaping are completed and care shall be taken to avoid damage to surfaces of treated timber in subsequent handling.

If treated timber is unavoidably cut or damaged, liberal application of preservatives shall be made to cut or damaged surfaces. Material and treatment shall be in accordance with BS 144, BS 1282 and BS Code of Practice CP98. Creosote shall be applied on the surface of the timber to form an unbroken film. All treated timber shall be dry before incorporation in the works.

SECTION 9200. MOISTURE PROTECTION

9201. ROOFING

(1) General

Roof drains shall be furnished and installed as specified herein, all other work to be installed on roofs such as roof fans and pipe vents is to be furnished and installed as specified under other Sections. Roofing and flashing shall be done as specified herein. Steel purlins are specified in the General Specification in Section 6001 "Structural Steel Work".

The work included herein applies to roofing materials and installation of asbestos cement corrugated sheet and built up roofing to be applied to exposed concrete roof slabs where required on the Drawings.

(2) Corrugated Sheet Roofing Material

a. Sheets and Tile

Asbestos cement sheets and roman tile shall be asbestos cement corrugated sheet as made by the Siam Fibre Cement Co., Ltd. or Jalaprathan Cement Co., Ltd. Asbestos cement sheets shall be small or large corrugated sheet gray color and roman tile shall be gray color unless noted otherwise. Sheets shall be without holes, cracks or other defects and shall be dense and tough.

b. Accessories

Ridge pieces, valley flashings, soaker flanges, eave end plugs, closers, fillers and similar items required to assure a weatherproof and watertight installation shall be used with the sheets. Accessories shall be of the same basic material as the sheets. They shall be formed as recommended by the manufacturer of the sheets. Sheets shall be furnished with soaker flanges as required for vent stacks. Circular opening shall be 5 cm larger than the O.D. of the vent stack.

c. Fasteners

Fasteners for attaching sheets to wood purlins shall be galvanized steel hooked bolts with synthetic rubber gaskets, galvanized coach screws and galvanized nuts and washers all as supplied by the manufacturer of asbestos cement sheets. Fasteners to steel purlins shall be galvanized metal type or conventional fasteners with lead washer for weather seal.

(3) Installation

a. Built-Up Roofing

Roofing primer and material to be installed by authorized local distributor of roofing materials.

Roof slab surface shall be smooth and dry. Remove all loose materials, dust, grease and any bitumen. Spray on one coat of roofing primer. Apply PVC thickness 0.06 cm to 0.09 cm to form a homogeneous and tightly adhesive membrane. Ensure all exposed edges terminate in cove or at a protected face.

b. Asbestos Cement Corrugated Sheet Roof

All sheets, with all fasteners and accessories, shall be erected and installed in accordance with the manufacturer's instruction. Sheets shall be laid with corrugations in the direction of the roof slope, starting at the end of the building opposite the prevailing wind directions. End lap shall be not less than 20 cm. Side laps shall be not less than one corrugation. Accessories shall be used as required by the manufacturer to insure a weather proof installation. All laps and joints shall be caulked.

In order to avoid cracking of corrugated panels, the use of a punch is strictly prohibited. Twist drills shall be used for all drilling. Location and size of holes shall be as recommended by the manufacturer.

When asbestos cement sheets are cut in the field, a power driven carborundum wheel or saw properly guarded or hand-saw for cross cutting shall be used, with templates of approved type, as recommended by the manufacturer.

Asbestos cement roofing shall be joined into the concrete ridge beam as detailed on the Drawings. Class C concrete edge seal shall be placed where indicated. Where a recess is provided, the roofing sheet shall be formed with a ridge roll resting on a panel-end-closures as shown with a cement mortar filling composed of one part Portland cement and three parts sand and shall be caulked with a plastic sealer.

Valleys for asbestos cement roofing shall be formed using sheet metal gutter lined with asphalt felt set in a bituminous plastic cement. Where the asbestos cement roofing terminates at the valley the openings shall be caulked using loose oakum faced with bituminous plastic cement.

Ridge roll joints and spaces between overlaps of asbestos cement roof panels shall be caulked with application of compound by a caulking gun with a continuous bead from a 12 mm nozzle. Prior to application, joints and spaces to be caulked shall be thoroughly dry and shall be kept clean. Caulking shall be placed to a depth of 1.5

cm. Caulking shall be Asbestumen as made by Expandite or approved equal as furnished by W.R. Grace Co. or Loxley Co.

The roofing units shall be protected during the erection by the use of planks for walkways. Workmen shall use proper caution in the disposition of their own weight and shall not store material on any part of the roofing after erection.

9202. CAULKING

(1) General

The work shall include but not be limited to caulking for:

a. Wood doors, windows and louver frames
b. Control and expansion joints
c. Caulking for roof penetrations and wall openings
d. Expansion joints where caulking noted on Drawings and for mosaic and ceramic floor tile
e. Frames for ventilation equipment in wall openings

(2) Materials

a. Backing

Joint backing shall be polyethylene foam, neoprene or butyl rope. Oakum, bituminous or impregnated metals will not be permitted.

b. Caulking

Caulking material shall be elastic, non corrosive and water resistant polysulphide liquid polymers that when set shall be firm but not brittle. It shall be delivered in original sealed containers and applied in accordance with the manufacturer's directions. Color shall be gray. The material characteristics should permit concave tooling when in place.

(3) Installation

Installation of caulking shall be carried out according to the manufacturer's directions and the Contractor shall furnish the services of a person knowledgeable to instruct workmen in the application of caulking or apply the caulking material. All joints, reglets and openings to be caulked shall be clean, dry and free of dust and foreign matter. Where required, a joint cleaner shall be used. Deep joints shall be filled with joint backing to not less than 1 cm of the surface and not less than the thickness of the joint. Joint backing where used shall be furnished by the supplier of the caulking material. Joint primers shall be applied when required by manufacturer's instructions.

(4) Cleaning

Excess caulking material shall be cleaned immediately from surfaces of adjacent work.

9203. DAMPPROOFING

(1) Application Schedule

The exterior sides of all wall surfaces in contact with earth are to be dampproofed from 15 cm below finished ground elevation down to and including the top of footing. This applies to the exterior walls of pump rooms and other dry spaces below grade. The walls of manholes, underground vaults etc. not normally occupied are not to be dampproofed unless specifically required. Exterior walls and roofs of buried structures containing filtered water shall be waterproofed.

(2) Materials

Dampproofing shall be Bitumastic Black Solution locally provided.

(3) Application

Surfaces to be treated shall be free from oil and dirt and shall be in the proper condition as recommended by the manufacturer prior to the application of the dampproofing material. The concrete shall have been completely cured and the surface shall be dry.

Surfaces to be dampproofed shall receive two heavy coats, the first coat being carefully applied so that untreated air-bubble depressions in the surface shall be completely filled and the second coat shall guarantee 100 percent coating of the surface. The coating shall be applied at a coverage rate not in excess of manufacturer's recommendation for surface to be covered.

Particular care shall be given to the application of dampproofing at all construction joints which are encountered.

9204. WATERPROOFING

(1) General

It is not the purpose of this water proofing to repair leaks in concrete, but it is for insuring the moisture can not penetrate through.

Waterproofing materials are not to be applied until 30 days has elapsed since the concrete to be treated was placed or after hydrostatic test, whichever occurs later.

Adequate ventilation of areas where epoxy and tar base pitch containing solvents are being applied shall be provided. Interior areas shall have forced ventilation and face masks are recommended, as well as suitable protective clothing. The Contractor shall provide approved arrangements in order that the Engineer may inspect the work in progress.

(2) Materials

Waterproofing shall be either a cement based coating, tar base pitch or an epoxy coating.

a. Cement Based Coating

Waterproofing by the use of a cement based coating will be locally made and approved by the Engineer. An acrylic polymer shall be used as an admixture to improve adhesion, such as acryl 60. This is a three coat treatment consisting of a painted prime coat, steel trowel applied cement coating and sponged coating.

b. Tar Base Pitch

Waterproofing by the use of a tar base pitch will be locally made and approved by the Engineer. This is a four coat treatment consisting of two prime coats and two finish coats.

c. Epoxy Coating

Waterproofing by the use of an epoxy coating will be locally provided and approved by the Engineer. This is two component 100 percent solids epoxy-resin system applied in two coats.

(3) Application

Surface preparation of concrete shall conform to the manufacturer's recommendations. In general, concrete surface shall be free of deteriorated concrete laitance and contamination such as oil, grease, etc. All application work shall be in accordance with manufacturer's recommendation.

Concrete surface exposed to the sun shall be cooled by water and shaded during application.

a. Cement Based Coating

An initial prime coat of cement based coating and water shall be applied and allowed to cure. The material shall be troweled or followed by a sponge float to build up a layer not less than 3 mm thick. Where there are areas of uneven absorption an initial light trowel finish may be required before the finish covering.

To prevent too rapid drying the surface shall be shaded and kept moist until sunset.

b. Tar Base Pitch

Two coats of prime coat shall be applied on the concrete followed by two coats of tar base pitch. Each coat of the latter shall have a 13 to 18 millimeter thickness and the first coat shall be dry before the second is applied.

c. Epoxy Coating

Mix components thoroughly in accordance with manufacturer's recommendations Epoxy coating shall consist of a primer and final coat. Paint may be applied by brush spray, or rollers all in conformance with the manufacturer's recommendations.

SECTION 9300. DOORS, WINDOWS & GLASS

9301. WOOD DOORS, WINDOWS AND LOUVERS

(1) Materials

Wood for doors, windows and louvers shall be of sound stock, thoroughly seasoned dried and neatly and accurately framed. Wood shall conform to the applicable Sections under the General Specification in Section 9100 "Carpentry" and shall be the type of wood indicated on the Drawings.

All door and window frame joints shall be mortise and tenon and shall be joined with an approved type of glue. All wood work shall be sanded, filled resanded and painted as specified in the General Specification in Section 9400 "Painting".

Wood louvers shall be select grade hard wood with frame groved to receive slats of proper width and depth. Joints shall be nailed and glued. Insect screens shall be installed as shown in the Drawings.

Wood doors shall have a 12-cm-wide horizontal stiffening rod vertically centered or the lock or handle and latch assembly.

Frames for doors and windows shall have a drip. Jambs shall rest on sills and the head shall rest on the jambs.

Doors shall be made at a shop specializing in this type of work (not at the site). Doors shall be rigidly framed, smoothly finished and 3.5 cm thick unless otherwise specified.

Plywood doors shall have either a solid or hollow core, however, all exterior wood doors shall be solid core. Hollow core shall adequately support the outer plywood and afford strength and stability sufficient for the use intended. Stiles shall not be less than 2 cm and rails shall not be less than 7 cm. A lock block shall be provided 1.0 m from bottom, midway on stile, and shall be securely connected to the stile. Veneer for cross binding and faces shall be plywood of two or more plies with a combined minimum thickness of 7 mm before sanding. Face veneer shall be of plain sliced teak, laid with grain at right angles to cross binding, glued under pressure and heat and sanded smooth.

Flush doors shall be 3.75 mm thick with teak frame unless otherwise noted. Sash door shall be solid with standard rails and mullions.

(2) Finish

After fabrication and before installation wood doors, windows and louvers shall be given a coating of an approved synthetic resin clear sealer and protected from damage until installation.

(3) Installation

All wood windows, doors, and louvers shall be fitted plumb and square in the structural and wall openings with concrete nails, caulking, wood shims and appurtenances as indicated on the Drawings. Concrete nails 4.8 mm in dia. shall be through nailed to masonry at 40 cm intervals. Frames shall be set with double wedge blocking in back of butts and lock strikes.

9302. GLASS AND GLAZING

(1) Materials

Each piece of glass shall bear the manufacturer's label showing grade, thickness and type of glass and all labels shall remain until the glass has been set and inspected.

All clear glass shall be 6 mm thick, locally manufactured and approved by the Engineer.

(2) Installation

Clear sheet glass shall be used except where indicated otherwise. The glass shall be cut and installed with any visible lines or waves running horizontal.

Glazing in wood shall have rabbets and beads primed and painted. The glass shall be firmly seated into the previously bedded and back-bedded rabbet with glazing compound and secured in place with wood beads, attached with not less than 2.5 cm length finish nails, or flat headed screws, countersunk and set approximately 15 cm on center. Nails or screws, used in beads shall be of the corrosion resistant type.

(3) Clean Up

All glass shall be cleaned at the completion of construction and any broken glass replaced.

9303. ROLLING SHUTTER DOOR

(1) Materials

Rolling shutter door shall have a curtain of interlocking single face slats formed of rolled zinc galvanized steel.

The door shall be of the dimensions indicated and will be as supplied by the local manufacturer and approved by the Engineer.

Slats and slat lugs at guides shall be of sufficient section to give a curtain strength adequate to safely resist a 90.0 kg/m^2 wind load.

Galvanizing shall be of zinc applied by a hot-dipped process on both sides. Zinc shall be applied at not less than 0.04 gm/cm^2 of steel and in such a manner as to provide a ductile coating, tightly adherent to base metal and conforming to bend tests conducted in accordance with ASTM A525, "Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, General Requirements".

The counter balance, coil brackets, and hood shall be fabricated in accordance with the manufacturer's standard. The coil shall be housed in a sheet metal hood, galvanized and bonderized. Guides shall be fabricated of structural steel of sufficient depth to retain the curtains in the guides against the wind load specified. Guides shall be provided with anchors for wind locks.

Operation of the door shall be by a hand crank, shafting and reduction gearing. Crank hoist shall be suitable for face of wall mounting outside building, unless noted otherwise.

The door shall have a continuous rubber cushion along the bottom.

(2) Installation

Rolling shutter door shall be installed and adjusted to the manufacturer's instructions.

(3) Painting

All surfaces, not galvanized, shall be shop primed with a paint compatible with paint to be applied after installation as specified in Section 9400 "Painting" of the General Specifications.

9304. ALUMINUM FRAMING

(1) General

The work shall include:

a. Aluminum frames and sash for doors and windows
b. Aluminum framing for partitions
c. Glazing beads and weather stripping for glass in aluminum sash.

The Contractor shall furnish Shop Drawings of all aluminum framing. The Contractor shall verify all dimensions at the site for the fit of the materials. The Drawings shall show assembly and

installation details including anchoring and reinforcing. Samples of frames, sash, and glazing, and accessories shall be furnished. Frame samples shall be furnished. Frame samples shall show method of connections for various sections, and surface finish.

(2) Materials

The aluminum framing and accessories shall be as manufactured by the local manufacturer and approved by the Engineer.

Doors shall be of the top and bottom hung type, fabricated of hollow aluminum sections with no exposed seams. Mechanical joints shall be accurately milled to a hairline watertight joint. The minimum wall thickness of door members shall be not less than 3 mm. The doors shall be fabricated to the details indicated on the Drawings including steel tension rods, top and bottom, and wool pile weathering on the sides.

Glazing members for doors and windows shall be such design that they are snapped in, eliminating the use of exposed screws. Glass shall be seated in vinyl weather stripping as indicated on the Drawings using neoprene setting blocks.

Hardware reinforcement on doors and windows shall be fastened in place without the attaching method being visible.

Wall anchors shall be galvanized mild steel.

Sliding windows shall be fabricated of the shapes indicated on the Drawings.

Vinyl weather stripping shall be furnished to the contours indicated on the Drawings.

Neoprene setting blocks shall be closed cell neoprene 85 + 5 durometer hardness.

(3) Finishes

All exposed surfaces of aluminum doors and windows including sash, framing and partition framing shall be finished to a mirror like surface, free from defects or other surface blemishes. After anodizing the surface shall be coated with a lacquer, or oil for protection.

Edges of door handles and appurtenances shall be ground-off smooth to remove burrs.

(4) Installation

All structural openings shall be prepared plumb and square. Door and window frames shall be installed in the opening, plumb and

in true alignment. Frames shall be firmly secured to the floors, walls, heads, ceilings and support members by means of anchors.

(5) Protection and Cleaning

The Contractor shall protect all exposed surfaces of aluminum against damage from staining, abrasion or other injury and shall be responsible for final cleaning of the aluminum.

9305. STEEL DOORS

(1) General

The Contractor shall submit, for Engineer approval, the Shop Drawings showing location, size, and details of construction and erection of all steel doors frames and accessories.

(2) Materials

Steel plate doors and frames shall be installed to the dimensions indicated on the Drawings. Metal sizes shall be the sizes indicated with 6 mm minimum thickness.

Frames shall be set-up, all welds ground smooth with 3 jamb anchors each side into concrete and 3 strap anchors as indicated into concrete structure. Top of frame shall have a rain lip.

Doors shall be constructed of steel plate and frame as indicated.

SECTION 9400. PAINTING

9401. GENERAL

This Section covers the painting of all exposed and submerged metal, exposed masonry and concrete walls of buildings, exposed wood equipment, piping, frames and all other surfaces obviously required to be painted unless otherwise specified. The omission of minor items in the painting schedule shall not relieve the Contractor of his obligation to include such items where they come within the general intent of the Specifications as stated herein.

(1) Materials

Painting material will be supplied by the local manufacturer and approved by the Engineer.

All these materials shall be obtained from one manufacturer so that complete compatibility between successive coats may be achieved, unless specified hereunder.

Where shop priming must be done with primers other than specified herein, they shall be approved by the paint manufacturer of the finish coat(s) which must be field applied to them.

All materials shall be delivered in the shop or on the site in unbroken, sealed and labelled containers of the paint manufacturer, and shall be subject to inspection by the Engineer. Labels shall clearly state name of manufacturer, name of paint and type, color and date.

(2) Scaffolding

The Contractor shall supply, erect and afterwards remove all scaffolding, ladders, and temporary platforms, required for all painting work.

This scaffolding shall be permitted to be used by other trades for the hanging and replacing of fittings, fixtures,. and appurtenances which have been temporarily removed to allow for the proper proceeding of the painting work. The work of the other trades shall not interfere with or impede the painter's work.

The support or bracing of any part of any scaffolding from or to any wall, sill, or window frame is strictly prohibited. All scaffolding must be strongly and safely built as an independent structure supported only by the floor or ground.

9402. PREPARATION OF SURFACES

(1) General

All surfaces to be painted shall be thoroughly cleaned, by effective means, of all foreign substances. Cleaning shall be done with approved solvents, power wire brushing, scraping or sandblasting.

Hardware, electrical fixtures and similar accessories shall be removed or suitably masked during preparation and painting operations.

(2) Metal Surfaces

Metal surfaces shall be clean and free from flaking, bubbling, rust, loose scale and welding splatter. Sharp edges shall be dulled by grinding. Oil and grease shall be thoroughly removed by mineral spirits or solvents. Priming shall be done immediately after cleaning to prevent new rusting.

(3) Wood Surfaces

Wood surfaces shall be sanded to a smooth surface. No wood shall be painted or finished unless it is sufficiently dry. Excess natural resin shall be removed with a blow torch, scraper or solvent. The prime coat shall then be applied after which, when dry, nail and knot holes shall be filled with putty, allowed to dry, and sandpapered.

(4) Concrete Block and Brick Surfaces

Concrete block and brick surfaces shall be left at least one month before painting. All concrete surfaces shall be cleaned of all dust, form oil, curing compounds and other foreign matter. Efflorescence shall be removed using a 15 to 20 percent muriatic acid solution.

(5) Plastered Surfaces

Plastered surfaces shall be painted not less than 60 days after application. No efflorescence shall appear.

9403. WORKMANSHIP

All painting shall be done strictly in accordance with manufacturer's specifications, and recommendations.

Work areas will be designated by the Engineer for storage and mixing of all painting materials. Painting materials shall be stockpiled in a neat manner to facilitate finding them and preventing their loss or misuse. Painting wastes shall be disposed of promptly

in proper containers outside the building. No plumbing fixture of drainage system shall be used for disposal.

9404. APPLICATION OF PAINTS

(1) General

The Contractor shall apply each coating in quantities and thickness as indicated on the Drawings and approved by the Engineer. If paint has thickened or must be diluted for application by spray gun, the coating shall be built up to the same film thickness achieved with undiluted material. The coverage of paint must remain the same, whatever method of application shall be used. Each coat of paint shall be in a different tint to the succeeding one.

(2) Drying

Drying time shall be allowed before additional coats shall be applied. Where conditions are other than normal, because of weather, or where painting is done in confined areas, longer drying time will be necessary.

(3) Application

a. General

Paint shall be applied either with brushes, by means of rollers or spraying machines to obtain a uniform even coating.

Paint shall be approximately of the same temperature as that of the surface on which it shall be applied.

All surfaces shall be sanded lightly between coats and dusted before the succeeding coat shall be applied.

One gallon of paint as originally furnished by the manufacturer shall not cover a greater area when applied by spray gun than when applied unthinned by brush. Deficiencies in film thickness shall be corrected by the application of additional coat.

On concrete or brick, application rates will vary according to surface texture; however in no case shall the manufacturer's stated coverage rate be exceeded.

On porous surfaces it shall be the painter's responsibility to achieve a protective and decorative finish either by decreasing the coverage rate or by applying additional coats of paint.

b. Brush

The primary movement of the brush shall describe a series of small circles to thoroughly fill all irregularities in the surface after which the coating shall be smoothed and thinned by a series of parallel strokes.

c. Roller

This application shall be done by rolling the second coat at right angles to the first coat.

c. Sprayer

Spray painting shall only be permitted in areas approved by the Engineer. Any equipment located in such areas shall be completely enclosed in a manner satisfactory to the Engineer. Spray equipment shall be of ample capacity for the work and shall at all times be kept clean and in good working order. Spray guns shall be suited to the type of paint specified, and shall be operated with orifices, nozzles and air pressure adjusted to consistency. Spray painting shall be done by persons experienced with this type of equipment.

Paint pots shall be of ample capacity and shall be equipped with means of controlling air pressure on the pot, independently of the pressure on the gun.

Air lines shall be equipped with water traps to positively remove condensed moisture.

If satisfactory work with any one of the application methods is not expected or not obtained, the Engineer will decide which method shall be used. On surfaces inaccessible for brushes, and where spraying is not being employed, the paint shall be applied with sheepskin daubers specially constructed for the purpose.

9405. VENTILATION

In enclosed areas where painting systems using strong solvents are specified, a forced air ventilation system shall be provided.

All treatment shall be done in accordance with the manufacturer's instructions.

9406. APPLICATION OF SPECIAL ZINC COATING

The surfaces to be covered with a special zinc coating shall be thoroughly cleaned from grease, dirt and old paint. This coating shall be applied by brush or spray. The material shall be stirred before use and stirred occasionally during the painting operation. It shall cover 6-7 sq.m. per liter. Two coats shall be applied and

when dry, it shall receive finishing paint coats, as specified. The application shall be carried out in accordance with the manufacturer's instructions.

9407. APPLICATION OF SPECIAL EPOXY COATING

The water side of the common wall between pumping stations and drinking water storage shall be acid etched with muriatic or dilute hydrochloric acid rinsed with fresh water and allowed to dry.

9408. SHOP PAINTING

(1) General

Except for galvanized metal surfaces and other specified coatings. All mechanical and electrical equipment and ferrous metals are to be painted at the place of manufacture or fabrication. This shall be carried out to the extent and as required under the various other Sections of the Specifications. The Contractor shall be responsible for checking the compatibility of the shop paints with the field applied touch-up and finish paints. Items shop painted shall not be transported until adequate drying time has elapsed. Shop painting consists of either shop priming or shop applied finish coating.

(2) Shop Priming

All structural steel, miscellaneous ferrous metal and metal castings, shall be shop primed before delivery to the site. This prime coat is to be applied after fabrication and before exposure to the weather. This prime coat shall be the first coat as specified in the painting system.

(3) Shop Applied Finish Coating

All equipment which is customarily provided with a baked-on enamel finish or a standard factory finish shall be well painted to provide protection for ocean shipment and for possible extended storage period.

9409. FIELD PAINTING

(1) General

All painting at the site shall be designated field painting and shall consist of field priming and field painting to provide finish coating. The Engineer shall be advised of all painting work in advance so that surface preparation may be inspected and approved prior to application.

(2) Field Priming

Any structural steel, miscellaneous metal and other metals which arrive at the site unpainted shall be cleaned and field primed. Surfaces that have been shop primed and have been damaged in shipment and/or in installation or where shop prime has deteriorated shall be promptly cleaned and retouched before any successive painting is done in the field. Shop primed surfaces damaged by field welding shall be cleaned and field primed.

(3) Field Painting

Equipment which is customarily shipped with a baked-on enamel finish or with a standard factory finish shall not be field painted unless the finish has been damaged in transit or during installation.

Successive coats of paint shall be tinted so as to make each coat easily distinguishable from each other with the final undercoat tinted to the appropriate shade of the finished coat. Finish surfaces shall not show brush marks or other irregularities. Under coats of metal surfaces shall be sanded to remove defects and provide a smooth surface. Tops and bottoms of doors shall be painted.

Painting shall be continuous and shall be accomplished in an orderly manner so as to facilitate inspection. Surfaces of exposed members that will be inaccessible after erection shall be cleaned and painted before erection. Any defective paint changes in color or uncompatible paint with undercoat shall be scrapped off and repainted.

Any pipe or other metal surfaces to be painted a color other than black that have a coating of tar or asphalt-compound shall be painted with a paint specifically designed to isolate the finish paint from the tar surface.

9410. APPEARANCE

The finished surfaces shall be free from runs, drops and brush marks, exhibiting good hiding, spreading and leveling.

Only erection marks will be allowed. After the erection has been completed, the Contractor shall paint over all erection marks, areas left unpainted for erection purposes, and damaged spots. Toughing up shall be done with the same primers and finish coats as used originally on both shop and field painted surfaces.

9411. MIXING AND THINNING

Paints shall be thoroughly stirred, strained and kept at a uniform consistency during the application. Mixing of pigments to be added shall be done strictly as recommended by the manufacturer.

Where thinning is required, only the products of the manufacturer furnishing the paint and recommend for the particular purpose shall be allowed, according to instructions.

9412. COLORS

Colors of finish coats for machinery, control panels and other factory made equipment which have to be applied in the shop shall be indicated in the color schedule and approved by the Engineer.

9413. LETTERING AND NUMBERING

Equipment including valves and pipes shall be lettered according to the equipment identification list which will be furnished by the Engineer.

Arrows, where required, shall be painted or applied as tape on the pipes to indicate the direction of flow.

Letters, numbers and arrows shall be painted in black or white, by stencil or as tape, in type and size as directed by the Engineer.

9414. PROTECTION AND CLEANING

The Contractor shall protect all floors, walls and other adjacent areas and equipment from droppings by covering with tarpaulins, masking or otherwise. Dripped or spattered paint shall be promptly removed.

Painted surfaces shall be carefully protected upon completion of the Works.

9415. INSPECTION

All phases of the Works shall be subject to inspection by the Engineer to assure proper performance of the Specifications.

Prime coats and each succeeding coat shall be inspected and approved before additional coats shall be applied.

SECTION 9500. FINISHING

9501. TERRAZZO TILE

(1) Samples and Shop Drawings

Submit for approval samples of marble chips, divider strips, nosing, information on grinding stones, concrete mixes for under-bed and terrazzo topping, and an outline of the proposed program of work together with a Shop Drawing showing layout of divider strips.

No work shall start before the Engineer has approved the above and all work shall be carried out in accordance with approved samples and Drawings.

(2) Preparation of Surfaces

The surfaces of concrete to receive terrazzo shall be thoroughly cleaned of all plaster, oil, dirt and other deleterious material and well saturated with water.

(3) Materials

Cement shall conform to ASTM C150, "Portland Cement" Type 1 to match samples or colors specified. Color of cement shall be white.

Sand shall be clean, hard, natural or manufactured conforming with the General Specification in Division 3 "Concrete".

Marble chips shall be standard quarry products of sizes and colors necessary to match samples.

Mineral pigments (where approved) shall be lime proof, non-fading mineral or synthetic pigment.

Cleaner shall be a neutral liquid cleaner prepared for the terrazzo trade.

Sealer shall be penetrating type, free from harmfull alkali or acid contents. Sealer should be specially prepared for the terrazzo trade.

(5) Installation

Following the cleaning of floors and renoval of excess water the divider strips shall be set in concrete bern to an approved layout in approximately 1 meter squares and 15 cm border. The divider strips shall be set to the required grades for drainage as they are to serve as screeds for the placement of the topping. Following the brushing of the floor area with a neat cement paste, a cement under-bed in the

proportion of one part cement to four parts of sand shall be screeded and compacted to grade to within 1.5 cm of finished floor grade.

During installation no water shall be flushed into the waste water disposal or floor drainage systems. Water shall be discharged in an approved manner.

Unless otherwise indicated on the Drawings the floor terrazzo shall have a minimum thickness of 3 cm, consisting of 1.5 cm of topping and 1.5 of under-bed and on vertical surfaces 1.0 cm of topping.

The terrazzo topping shall be applied within 48 hours following the application of the setting bed, which shall be soaked with water and brushed with cement paste. The fresh topping surface shall be rolled with heavy rollers into a compact mass, extracting all excess water. The surface shall then be hand trowelled, disclosing the lines of the divider strips.

When the terrazzo has set sufficiently hard, it shall be machine rubbed using grit abrasive stones for initial grinding.

Immediately following initial grinding, the terrazzo surfaces shall be cleaned and all voids filled with grout composed of the same ingredients as used for the original material. The Contractor shall allow time for proper curing of grout fill before proceeding with final grinding. Final grinding (polishing) shall be carried out using a fine rubbing stone.

An excess amount of water shall be sprayed over the floor surface during this operation.

Terrazzo surfaces after polishing shall thoroughly be cleaned with soap and water, followed by thorough rinsing to remove all grinding and foreign material. This cleaning operation shall include walls, equipment, and appurtenances which have been splattered during the terrazzo installation. The floor shall then be allowed to dry and one coat of approved sealer shall be applied taking care to completely seal and fill the floor but not leave an excessive amount of sealer on the surface.

9502. CERAMIC WALL TILE

(1) General

Grounds, door bucks, plumbing fixtures, sleeves and all fittings shall be in place and other openings shall be properly closed before any tile is installed. All tile shall be delivered to the job site in original, unopened sealed packages unless otherwise permitted and cartons shall be kept dry until tiles are removed and checked.

Precautions shall be taken to protect tiles from breakage or staining.

(2) Materials

The Contractor shall submit samples of all tile proposed for approval. Glazed ceramic wall tile shall have square edges and nominal face sizes as noted on the Drawings. Trim shapes shall be of the sizes and shapes required and of the color and finish to match the wall tile unless otherwise indicated.

White wall tile shall be 10.8 cm by 10.8 cm by 0.55 cm and shall be made by the local manufacturer and approved by the Engineer.

Wall tile trim shapes and bases and other shapes shall be installed to produce a completely finished installation. Trim shapes shall be of the size and shapes indicated and of color and finish to match the wall tile.

Wall tiles indicated to be 0.15 m by 0.06 m by 0.01 m in size on the Drawings shall be glazed ceramic tile and manufactured by the local manufacturer and approved by the Engineer. Color shall be as selected by the Engineer unless noted otherwise.

a. Tile Accessories

Accessories shall be porcelain type tile and of color to match adjoining wall tile unless otherwise designated. The locations of tile accessories shall be as indicated on the Drawings. b. Backing and Grout

Tile backing on walls shall be a portland cement mortar not greater than 2 cm thick and mix shall be 1 part cement to 4 parts sand.

Grout for setting wall tiles shall be 1 part white cement and 1 part fine sand by volume with the addition of a bonding additive such as a water based polyvinyl acetate liquid. The mix proportion of admixture and grout coverage shall be in conformance with the recommendations of the admixture manufacturer.

(4) Installation

Ceramic tile shall be installed using the thin set method by experienced workmen skilled in the tile trade.

All surfaces to which wall tile is to be applied shall be even and true, free from dust and dirt and other foreign matter. A skin coat of grout shall first be applied with a flat trowel and allowed to dry. Openings around pipes and fixtures shall be sealed by packing with grout. Backs of tiles shall be spread with grout and set in place by a slight twisting motion to assure suitable contact.

Tiles shall be set to correct levels, true to line and perpendicular, and neatly cut around piping, fixtures and electrical receptacles. Excessive grout shall be removed and after tile has set joints shall be filled with grout to bottom edge of the bevel. Grout shall be forced into joints followed by sponging and tooling.

(5) Cleaning, Finishing and Protection

All tile work shall thoroughly be cleaned after completion and protected from damage. The Contractor shall close off work areas when necessary to avoid damage to finished surfaces before they are set up. The Contractor must remove all of his refuse and waste materials as they accumulate.

9503. VINYL ASBESTOS TILE

(1) Materials

The Contractor shall submit samples of materials to be installed showing size, color range and general characteristics for the Engineer's approval.

Materials shall be first quality only, as specified, delivered to the site in the original sealed packages of the manufacturer and labeled with brand name, size, color etc.

a. Vinyl Asbestos Tile

Tile shall be 23 cm by 23 cm square 3.2 mm thick. Colors to be selected by the Engineer.

b. Vinyl Base

Base shall be homogeneous type, 3.2 mm thick, first quality material, 10 cm high, preformed top set cove base with preformed end stops. All external corners and all internal corners shall be factory preformed. Color shall be black.

c. Adhesives

The adhesives to be used for the installation of vinyl asbestos tile shall be a water-proof adhesive as recommended by the tile manufacturer for installation on a concrete surface.

(2) Installation

Installation shall not commence until work of other trades, including painting has been substantially completed. All materials shall be installed by competent craftsman experienced in this type of work, and in strict accordance with the directions of the manufacturer whose materials are used. Flooring materials shall be

installed with an adhesive in such a manner as to produce smooth and even finished surfaces with tiles in a tight jointed, accurately aligned manner, and the upper surfaces smooth, clean and free from imperfections.

The concrete floor to receive vinyl asbestos tile flooring shall be finished, well cured (at least 28 days), dry broom cleaned, free from dirt, oil or grease and in proper condition, before floor tile is installed. Unevenness, spall or soft areas shall be properly repaired and made level before installation of the flooring.

The adhesive shall be spread over the surface as much as may be covered in 10 to 15 minutes in accordance with manufacturer's instructions.

Flooring shall be neatly scribed and cut to fit around all built-in fixtures, equipment, pipes, door jambs and other fixed vertical surfaces. Seams and joints shall be straight and true, parallel with walls unless otherwise indicated and shall be made with as inconspicuous joints as practicable.

Vinyl base shall be installed at all walls, partitions and other fixed vertical surfaces within the areas indicated on the room finish schedule. Adhesive shall be applied evenly to the back of the vinyl base so that no openings between the wall and the base shall be visible. Base shall be installed with joints butted as tightly and as inconspicuously as possible.

During and for at least 48 hours after installation, adequate ventilation shall be provided for removal of moisture and volatile fumes.

(4) Cleaning and Protection

As soon as practicable after the flooring has bonded firmly to the subfloor, flooring shall be washed with a neutral liquid or powder cleaner recommended by the manufacturer of the flooring material, rinse with clear water, let dry and thoroughly buff.

After the flooring had dried thoroughly, two thin coats of the manufacturer's standard wax shall be applied, with machine buffing and polishing after each coat.

Finished floors shall be covered with heavy, clean building paper and boards, or closed to traffic as required to adequately protect floors from damage due to subsequent building operations.

(5) Maintenance Tile

At the completion of the work deliver one unopened carton of each color of vinyl asbestos tile used and 3 meters of vinyl base to

the Employer for future maintenance. Cartons shall be plainly marked as to contents.

9504. HARDWARE

(1) General

Furnish all templates and schedules required by the manufacturers of the wood and metal doors, frames and other such work to enable the manufacturers to make proper provision in their work to receive the hardware. All locks, lock strikes, and flush bolts shall be made to ANSI standard dimensions.

Where a manufacturer's name or model number is mentioned it is to be considered as establishing type, quality and/or performance; equipment of other manufacturers of comparable specification may be offered provided the detailed requirements of these Specifications are met subject to the approval of the Engineer.

(2) Data to be Furnished

Submit for approval complete hardware Shop Drawings. No templates shall be distributed until the hardware has been approved.

(3) Packing and Marking

All hardware shall have the required screws, bolts, and fastenings necessary for proper installation, wrapped in paper and packed in the same package as the hardware. Each package shall be legibly labeled, indicating that portion of the work for which it is intended.

(4) Materials

All hardware shall be best grade, entirely free from imperfections in manufacture and finish. All hardware shall have a stainless steel finish and finish of all hardware shall be dull stainless steel, unless noted otherwise.

(5) Installation

Unless otherwise indicated, all hardware installation and hanging shall be done at the site. Doors shall swing as shown on the Drawings.

(6) Inspection

Upon completion of the hardware installation, all items shall be inspected for proper operation. All work shall be protected and any damage or incorrectness shall be repaired and left in perfect condition.

9505. IDENTIFICATION DEVICES

(1) General

The work included herein is as follows:

a. Equipment, valve and panel identification
b. Permanent exterior signs
c. High voltage and danger signs
d. Exterior door exit signs
e. Room identification
f. Traffic control sings
g. Entrance gate signs

(2) Equipment Marking

The Contractor shall provide equipment signs of lamacoid sheet, with engraved white letters on black background, secured to all pieces of equipment in a permanent manner. All markings shall be as approved by the Engineer. Identification shall be by a nameplate and/or an identifying number corresponding to the scheduled number.

This includes all equipment such as all pumps, motors, gears, and heisting equipment.

All valves shall be fitted with a numbered brass tag of 4 cm in diameter 22 gauge numbered as identified in the schedule. Valve operators shall similarly be identified.

All fans and other electric motors are to be identified in the same manner as on the motor control center or disconnect switch.

(3) Exterior Devices

Exterior signs and letters to be mounted on the exterior walls of structures shall be fabricated from 16 gauge bronze sheet. Letter shall be 45 cm high with a stroke of 7 to 9 cm and a depth of 4.5 cm unless otherwise indicated. Letters shall be official (Rachakarn) design.

Letter shall have true edges and true flat faces, all exposed surface edges shall be ground smooth and have a gun metal finish.

Devices shall be mounted 3 cm off the wall and letters shall be provided with three 1/4" fully concealed, threaded stainless steel studs, lock-nuts and expansion anchors, mounted in a workmanlike manner in such a way as to permit ready removal, and/or replacement, without damaging the letters.

SECTION 9600. PLUMBING

9601. GENERAL

(1) General

This Section covers the following works:

1. Roof and floor drainage pipe systems
2. Sump pump discharge piping
3. Sanitary and waste drain and vent systems
4. Building water service systems including piping to equipment, plumbing fixture and faucets
5. Plumbing fixtures, hose faucets, and valves

(2) Piping

The general arrangement of the plumbing shall be as indicated. Detailed drawings of proposed departures due to actual field conditions or other causes shall be submitted for approval. The Contractor shall carefully examine the Drawings and shall be responsible for the proper fitting of materials and equipment in each building, as indicated, without substantial alteration. Material and equipment installed in the plumbing system shall be suitable for the pressures encountered.

Water piping shall start at the flanged tees on the main distribution header. Sanitary piping shall be extended outside the building to the septic tank, unless otherwise indicated. Sewer and water pipes shall be laid in separate trenches.

(3) Cross Connections and Interconnections

No plumbing fixture, device, equipment, or pipe connection shall be installed that will provide a cross connection or interconnection between a potable water supply and any source of non-potable water, such as a drainage system, a sanitary or waste water pipe.

(4) Connections to Equipment and Fixture

The Contractor shall provide all necessary material and labor to connect to the plumbing system all fixtures and equipment having plumbing connections, which are specified in other Sections of these Specifications. All connections to the sanitary drainage system shall be trapped. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with an integral stop, shall be equipped with a cut-off

valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures.

(5) Cutting and Repairing

The Works shall be carefully laid out in advance, and no excessive cutting of construction will be permitted. Damage to buildings, piping, wiring, equipment or appurtenances as a result of cutting for installation shall be repaired by mechanics skilled in the trade involved.

(6) Protection to Fixtures, Materials, and Equipment

Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical injury. Upon completion of all work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts located so that any person may come in close proximity thereto shall be fully enclosed or properly guarded.

9602. SANITARY AND WATER WASTE, DRAIN, AND VENT PIPING

(1) General

Pipe materials shall be polyvinyl Chloride (PVC) plastic drain, waste and vent pipe conforming to requirement of the General Specification "Pipe Work" of Division 5. Fittings shall be of the drainage-pattern type and shall be compatible with the pipe material. Fittings on dry vents shall be regular-pattern type. Fitting on PVC pipe shall be PVC socket type and shall be installed by solvent weld method using approved solvent cement.

(2) Installation

a. Drainage and Vent Pipes

Horizontal waste and drain pipes shall have a slope of 20 mm per meter. When authorized by the Engineer horizontal piping may be installed with a slope not less than 10 mm per meter. Vent pipes in roof spaces shall be run as close as possible to the underside of the roof without forming traps in pipes, using fittings are required. Vent and branch-vent pipes shall be so sloped and connected as to drip back to the vertical stack by gravity.

b. Fittings

Changes in pipe size, on sanitary and water waste and drain lines, shall be made with reducing fittings. Use of bushings will not be permitted. Changes in direction shall be made by the

appropriate use of 45 degree wyes, long or short-sweep 1/4, 1/6, 1/8, or 1/16 bends, or by a combination of these or equivalent fittings. Sanitary tees and 1/4 bends or elbows may be used in drainage lines only where the direction of flow is from horizontal to vertical, except elbows may be used in lines 50 mm or less in diameter. Short sweeps not less than 75 mm in diameter may be used where the change in direction of flow is either from horizontal to vertical or from vertical to horizontal, and may be used for making necessary offsets in vertical lines.

c. Union connections

Slip joints will be permitted only in trap seals or on the inlet side of the traps.

(3) Joints

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Threaded joints shall have British Stardard pipe threads with graphite or inert filler and oil, with an approved graphite compound, or with polytetrafluoroethylene tape applied to the male thread only.

9603. FLASHING

Pipes passing through roofs shall be flashed using lead or copper flashing with an adjustable integral flange of adequate size to extend not less than 200 mm from the pipe in all directions and flashed into the roofing to provide a watertight seal.

Sanitary vent stacks through corrugated asbestos roofing shall be installed to be watertight to the details shown on the Drawings with a PVC reducing socket, copper flashing and cement mortar. Asbestos cement roofing shall be with a soaker flange and be furnished and installed.

9604. TRAPS

Each fixture and piece of equipment, except fixtures or equipment having an integral trap or seal, requiring connections to the sanitary drainage system shall be equipped with a trap. Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on PVC pipe shall be PVC. Traps installed on lavatory wastes shall be brass recess-drainage pattern, or brass-tube type, chrome plated.

9605. FLOOR DRAINS

Floor drains shall have cast iron bodies with double drainage flange, weep holes and bottom outlet. Outlet shall be inside caulked or screwed.

(1) Lavatory Rooms

Shower and toilet room drains shall have adjustable chrome plated brass strainers with free strainer area equal to not less than one and one half times the connecting pipe size.

(2) Industrial Area

Pump room, equipment room and area drains shall have anti-tilting slotted cast iron grate of not less than 150 mm diameter.

9606. DOWN SPOUTS

Down spouts for roof drainage shall be the size indicated on the Drawings, fabricated of light gage galvanized steel, all offsets and bends shall be made with 1/8 bends and no skewed joints or bowed down spouts will be permitted. Down spouts shall be supported with galvanized steel straps as noted on the Drawings. Steel pipe level flows shall be installed as noted using galvanized medium class pipe.

9607. WATER PIPE, FITTINGS, AND CONNECTIONS

(1) Water Pipe

Water pipe to the structure and water piping within the structure shall be galvanized steel, ANSI schedule 40, for 100 mm and larger and PVC TIS category 13.5 for 75 mm and smaller. Exposed cold-and hot-water supply piping to fixtures shall be chrome-plated brass pipe, or chrome-plated copper tube.

(2) Fittings

Fittings for copper tubing shall be flared brass or solder-type bronze or wrought copper. Fittings for galvanized steel pipe shall be galvanized malleable iron. Fittings for brass pipe shall be brass. Fittings for PVC pipe shall be PVC socket type.

(3) Installation

The piping shall be extended to all fixtures, outlets, and equipment. The water piping system shall be installed so as to be drained. Drainage shall be accomplished using 12 mm plugged or capped fittings at each low point, except where drain valve or hose faucet is shown on the Drawings.

Pipe shall be cut accurately to measurements established at the building by the Contractor and shall be worked into place without springing or forcing. Care shall be taken not to weaken structural portions of the building. Exposed piping shall be run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using such crossover fittings as may be required by structural or installation conditions. Pipes, valves, and fittings shall be kept a sufficient distance from other work and other pipes to permit not less than 25 mm between pipes and other work and between pipes. No water pipe shall be buried in floors, cast in concrete walls, unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted. Change in direction shall be made with fittings.

a. Expansion and Contraction of Piping

Allowance shall be made throughout for expansion and contraction of pipe. Sufficient flexibility shall be provided on all branch runouts from mains to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that the piping will spring enough to allow for expansion without straining.

b. Joints

Joints in steel piping may be welded, screwed or flanged, except where flanged joint are indicated on the Drawings. Joints in PVC piping shall be socket type. Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for test will not be permitted. Threaded joints shall have British Standard pipe threads with graphite or inert filler and oil, with an approved graphite compound, or with polytetra-fluoroethylene tape applied to the male threads only. Unions shall be provided where required for disconnection.

9608. VALVES

Valves shall be provided on supplies to equipment and fixture. No valve shall be installed on any line with its stem below the horizontal. All valves shall be gate valves, unless otherwise specified or indicated.

9609. UNIONS

Unions on PVC pipe shall be PVC with socket type ends. Unions shall be installed in easily accessible locations. Gaskets for flanged unions shall be of the best quality fiber, plastic, or leather. Unions shall not be concealed in walls, ceilings, or partitions.

9610. HOSE FAUCETS

Hose faucets shall be brass with 1.27 cm inlet threads, hexagan shoulder, and 1.91 cm hose connection, unless otherwise indicated. Hose faucets installed on exterior walls of buildings shall have integral wall flange which shall be securely anchored to the wall to prevent any strain on the supply pipe when attaching or disconnecting hose. Anchors shall use brass or bronze bolts or screws with expansion shields in the concrete or masonry wall.

9611. PIPE SLEEVES, HANGERS, AND FIXTURE SUPPORTS

The material shall be furnished and set, and the Contractor shall be responsible for their proper and permanent location.

(1) Pipe Sleeves

Pipes passing through concrete or concrete floors shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be steel pipe. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush, except sleeves in toilet room floors shall extend 25 mm above the finished floor. Unless otherwise indicated, sleeves shall be of such size as to provide a minimum of 6.4 mm all around clearance between bare pipe and sleeves. The annular space between pipe and sleeves shall be packed and caulked water tight.

(2) Pipe Hangers, Inserts, and Supports

Material shall conform to General Specification in Section 5000 "Pipe Hangers and Supports". The location of hangers and supports shall be coordinated with the structural work to assure that the structural members will support the intended load.

(3) Fixture Supports

Wall-hung fixtures shall be fastened to the wall by 9.5 mm through-bolts where appearance of the bolts is not objectionable. Exposed bolt heads in finished areas shall be hexagonal and painted. Exposed nuts shall be chromium-plated hexagoral cap nuts. Washers shall be painted or chromium-plated to match bolt heads or nuts.

9612. TYPES OF FIXTURES AND FIXTURE TRIMMINGS

(1) General

Material specified herein shall be furnished and installed complete with all trimmings and fittings.

Generally, all fixtures, except water closets and urinals, shall have the water supply above the rim. Fixture with the supply discharge below the rim shall be equipped with backflow preventers. Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, loose-key pattern stops for supplies shall be furnished and installed with fixtures. Exposed traps and supply pipes for all fixtures and equipment shall be connected to the rough piping systems adjacent to the fixture where rough piping is exposed and at the wall where concealed. Floor and wall escutcheons shall be provided where pipes enter walls or floors. Exposed fixture trimmings and fittings shall be chromium-plated on nickel-plated brass with polished, bright surfaces.

(2) Fixture Connections

Where space conditions will not permit standard fittings in conjunction with the cast iron floor flange, special short-radius fittings shall be provided. Connections between earthenware fixtures and sanitary pipe shall be made absolutely gastight and watertight with a closet-setting compound or with a neoprene gasket and seal. Use of natural-rubber gaskets or putty will not be permitted for these connections. Bolts shall be not less than 6.4 mm in diameter and shall be equipped with chromium-plated nuts and washers. Fixture with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

(3) Flush Valves

Flush valves shall be of the non-hold-open type.

(4) Fixtures

The fixtures equipment will be provided by the local manufacturer.

9612. TESTS AND STERILIZATION

(1) Tests for Plumbing Systems

Sanitary, waste, vent, and water piping shall be tested by the Contractor and approved before acceptance. Underground sanitary and waste piping shall be tested before backfilling. Equipment required for test shall be furnished by the Contractor.

(2) Drainage and Venting System Piping

Piping shall be tested with water before the fixtures are installed. After the plumbing fixtures have been set and their traps filled with water, the entire drainage and venting system shall be submitted to a final test with smoke or peppermint.

(3) Water Test

Water testing shall be applied to the drainage and venting system either in its entirety or in sections. If the entire system is tested, all openings in the pipes shall be tightly closed except the highest opening, and the system shall be filled with water to the point of overflow. If the system is tested in sections, each opening except the highest opening of the section under test shall be tightly plugged, and each section shall be filled with water and tested with at least a 3 meters head of water. The water shall be kept in the system, or in the portion under test, for at least 15 minutes before the inspection starts; the system shall then be tight at all joints.

(4) Water System

When the roughing-in is completed and before fixtures are set, the entire water piping systems shall be tested at a hydrostatic pressure of not less than 7.0 kg/cm^2 (100 pounds per square inch) gage, and proved tight at this pressure for not less than 30 minutes in order to permit inspection of all joints. Where a portion of the water-piping system is to be concealed before completion, this portion shall be tested separately as specified for the entire system.

(5) Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests repeated. Repairs to piping shall be made with new materials. No caulking of screwed joints or holes will be acceptable.

(6) Cleaning and Adjusting

Equipment, pipes, valves, fittings, fixtures and appurtenances shall be cleaned of grease, metal cuttings, and sludge that may have accumulated from operation of the system during the test. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building, due to the Contractor's failure to properly clean the piping system, shall be repaired by the Contractor. Flush valves and automatic control devices shall be adjusted for proper operation.

SECTION 9700. AIR CONDITIONING SYSTEMS

9701. GENERAL

This Section covers all ductwork, piping, insulation and controls for the air conditioning systems as indicated on the Drawings.

Contractor shall submit the following for approval for all the equipment:

Shop Drawings describing the equipment in sufficient detail, including materials of construction, capacities, parts lists and dimensions to indicate conformance with the Drawings and Specifications.

The Shop Drawings indicate the extent and general arrangement of the airconditioning systems. Equipment, ductwork, and piping arrangements shall fit into space allotted and shall allow adequate acceptable clearance for installation, replacement entry, servicing, and maintenance.

(1) Capacities

Capacities of all equipment and material shall be not less than those indicated on the Drawings.

(2) Nameplates

Each major item of equipment shall have the manufacturer's name, address, serial and model numbers on a plate securely attached to the item.

(3) Safety Requirements

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

(4) Verification of Dimensions

The Contractor shall be responsible for the coordination and proper relation of his work to the building structure.

9702. MATERIALS AND EQUIPMENT

(1) General

Materials and equipment shall conform to the requirements specified herein and as shown on the Drawings and shall be the products of manufacturers regularly engaged in the manufacture of such products. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least 2 years and shall be supported by a service organization that is, in the opinion of the Engineer reasonably convenient to the site.

(2) Compressors

Air-conditioning compressors having less than the 2 years' service record specified above, will be acceptable when a certified record of satisfactory field operation under normal operating conditions for not less than 6,000 hours can be shown. Types that have been shown to have operated satisfactorily for these periods may have modifications; provided it can be clearly shown that the modifications will not increase maintenance and operating costs and will not decrease the life of the machine. Modifications of the following descriptions will definitely require compliance with the full 2-year or 6,000 hour satisfactory experience requirement.

a. Increase in rotative speeds in excess of 20 percent
b. Reduction in metal thickness in sections subject to high pressures or vacuum
c. Change of refrigerant
d. Change in lubricating system and bearings

(3) Insulation

a. Duct Insulation

Duct insulation shall be fiber glass block, board, blanket or felt with vapor barrier facing.

b. Pipe Insulation

Pipe insulation shall be styrofoam non-flame type with aluminum wrap.

(4) Pipe and Fittings

a. Water Piping

Chilled water piping shall be black steel pipe conforming to BS 1387, Class B. Fittings shall be malleable iron, screwed for sizes 38 mm and smaller and may be malleable iron screwed or steel, butt welded for sizes 50 mm and longer.

b. Refrigerant Piping

Refrigerant piping shall be annealed or hard drawn copper tubing of thickness required for the applicable pressures. Fittings for copper tubing shall be wrought copper or forged brass.

(5) Valves

Valves for water service shall be as specified under the General Specification Section titled "Valves" of Division 7.

Valves for refrigerant service shall be of the type and design suitable for the application.

9703. UNITARY SYSTEMS

(1) General

The air conditioner shall be a unitary type consisting of a completely self-contained, electrically operated unit, equipped with a factory assembled refrigeration system, air cooled condenser, evaporator, and fans ready for full capacity operation after connection to electric service. The unit shall be designed for supply and return air duct connections. The air conditioner shall consist of one or more compressors, fans, motors, evaporators, and all necessary valves, tubing, piping, safety devices, and accessories for a complete operating unit. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Where units are shipped with refrigerant holding charge, the system shall be completely charged in the field. The chassis and enclosure panels shall be fabricated of heavy zinc coated steel, bonderized and finished with baked-on enamel.

(2) Condenser and Evaporator Coils

Condenser and evaporator coils shall have 10 mm or 13 mm staggered seamless copper coil with mechanically bonded aluminum fins spaced approximately 12 per 25 mm.

(3) Compressor

Compressor shall be hermetically sealed and driven by a high torque motor.

(4) Fans

Supply fan shall be centrifugal type. Evaporator fan shall be propeller type.

(5) Controls

Controls shall be completely factory wired, except for the room thermostat, and shall include compressor contactor, motor protectors, starting and running capacitors, control relays, high and low pressure cutout, all pressure control, and low voltage room thermostat and transformer.

(6) Filters

Filters shall be 25 mm thick throwaway type with fiberboard frame, glass fiber media and metal grille faces. Resistance of clean filter at 91 m meters per minute velocity shall be approximately 2.16 mm water gage.

(7) Miscellaneous

Ductwork diffusers, grilles and insulation shall be as hereinafter specified.

9704. CHILLED WATER SYSTEM

(1) Water Chillers

The water chiller shall be air-cooled type completely factory assembled, piped and wired. The unit shall be complete with compressor, air cooled condenser, shell and tube type water cooler, motors, and controls in a weather protected housing ready for connection to electric service and chilled water lines. All necessary refrigerant piping, valves, safety devices and accessories shall be included and factory installed. Unit shall be provided with complete charge of refrigerant.

(2) Compressor

Compressors shall be semihermetic or hermetic industrial type, be capable of operating at partial load conditions, and shall be capable of continuous operation down to the lowest step of unloading as specified. Compressors shall be installed in a sound attenuating enclosure and provided with vibration isolators. Compressors shall be provided with capacity-reduction devices to produce automatic capacity reduction of at least 66 percent. Compressors shall start with capacity-reduction devices in the unloaded position. If standard with the manufacturer, two but not more than four compressors may be provided instead of a single compressor, in which case the compressors shall operate in sequence. Each compressor shall be provided with high-low-pressure safety cutoff. Compressors shall be equipped with suction and discharge valves. Motors shall be gas cooled and provided with thermal protectors.

(3) Cooler

Cooler shall be shell and tube type with copper tubes rolled into tube sheets. Shell shall be steel covered with 50 mm thickness of foam plastic vapor barrier insulation with suitable jacket. Tubes (refrigerant) side shall be designed for the applicable refrigerant pressure and the shell (water) side shall be designed for not less than 8.8 kg/cm^2 working pressure.

(4) Condenser

Condensers shall be constructed with non-ferrous tubes and mechanically bonded aluminum fins. Two or more axial flow direct drive fans shall circulate air through the condenser. Fan outlets shall be protected by a suitable heavy gauge galvanized wire screen.

(5) Controls

Controls shall be factory wired in a weatherproof box and shall include water temperature controller, unloading controls, and safety controls for low water temperature, high refrigerant pressure and low oil pressure plus any additional controls required for a fully automatic system as hereinafter specified.

9705. AIR HANDLING UNITS

(1) General

Air handling units shall be certified in accordance with the fabrication of the local manufacturer; draw through type, complete with air-tight enclosures, fans, motors, adjustable V-belt drive, belt guards,

chilled water coils, condensate pans, access doors, filter boxes, filters, vibration isolation bases and any other appurtenances necessary for satisfactory operation. Each air handling unit shall be of the type indicated on the Drawing and shall have physical dimensions suitable to fit the space allotted to the unit and shall have the capacity indicated.

(2) Enclosures

Enclosures shall be constructed of not lighter than 18 gage, 1.2 mm nominal thickness steel, hot-dip galvanized finished in accordance with the manufacturer's standard practice. Coil and filter section and bottom of the condensation pan shall be insulated and the fan enclosure shall be acoustically lined at the factory with not less than 1 inch thickness of fiber glass manufactured for duct liner materials, coating and adhesive shall conform to fire-hazard requirements hereinbefore specified for insulation under Materials and Equipment.

(3) Fans

Fans shall be double-inlet, centrifugal type with each fan in a separate scroll. Fans shall be statically and dynamically balanced at the factory in the air handling unit. Fans shall be driven by a unit-mounted motor connected to fans by V-belt drive complete with belt guard. Sheaves shall be adjustable to provide not less than 20 percent speed change and shall be selected to drive the fan at such a speed as to produce the specified capacity when set at the approximate midpoint of sheave adjustment. Fan motors shall have open drip proof enclosures. Motor shall be controlled by a remote manual switch with pilot light located near the room thermostat for the unit.

(4) Chilled Water Coils

Coils shall be fin-and-tube constructed of seamless copper tubes and aluminum fins mechanically bonded to tube. Tube support sheets shall be not less than 16 gage, nominal thickness, galvanized steel, formed to provide structural strength. Tubes shall be correctly circuited for proper water velocity without excessive pressure drop and they shall be drainable where required. Each coil shall be tested at the factory under water at not less than 18 kg/cm^2 air pressure and shall be suitable for 15 kg/cm^2 working pressure. Coils shall be mounted for counterflow service.

(5) Filters and Filter Boxes

Medium capacity (V-type) filter boxes shall be provided with permanent (cleanable) type, 50 mm thick, low velocity type filters. Filter velocity shall be approximately 91 meters per minute. Filter boxes shall have access doors on both sides. Filters shall fit snugly to prevent air bypass. Both sides of filter box shall be flanged for connection to coil casing and ductwork. Filter box shall be insulated. Viscous adhesive shall be furnished in 5-gallon containers in sufficient quantity for twelve cleaning operations, and not less than 1 quart shall be provided for each filter section.

(6) Miscellaneous

Chilled water pumps, piping, ductwork, diffusers, grilles, louvers, insulation and controller shall be as hereinafter specified.

9706. CHILLED WATER CIRCULATING PUMPS

Chilled water circulating pumps shall be electrically driven, single stage, centrifugal, enclosed impeller type suitable for the intended service and having capacity as shown. Pumps shall be end suction with overhung impeller and shall be directly connected to the motor through flexible coupling. Pump casing shall be close-grain cast iron. Impeller and gland shall be cast iron or bronze and shaft shall be one-piece, heat-treated steel. Pump shall be hydraulically balanced and shall conform to the applicable provisions of the Standards of the American Hydraulic Insutitute. Pump and motor shall be factory mounted on a cast iron or steel base. Motor shall have sufficient horse-power to operate the pump at any point on its curve. Motor shall be of the totally enclosed type.

9707. CHILLED WATER PIPING, VALVES AND ACCESSORIES

(1) Pipe and Fittings

a. Installation

Pipe shall be cut accurately to measurements established at the jobsite and worked into place without springing or forcing, properly clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval.

Supports shall be attached only to structural framing members, or concrete. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided. Pipes shall have burrs removed by reaming and shall be installed to permit free expansion and contraction without damage to joints or hangers. Changes in direction shall be made with fittings. All piping shall be installed with sufficient pitch to insure adequate drainage and venting. Piping connections to equipment shall be provided with unions or flanges. Open ends of pipelines or equipment shall be properly capped or plugged during installation to keep dirt and other foreign material out of the system.

b. Screw joints

Screw joints shall be made with tapered threads properly cut conforming to British Standard. Joints shall be made tight with a stiff mixture of litharge and glycerin, or polytetrafluoroethylene tape, or other approved thread joint compound applied to the male threads only. Not more than three threads shall show after the joint is made up.

c. Flanges and Unions

Flanges and unions shall be faced true. Flanges shall be provided with 1.6 mm asbestos or rubber gasket, and made square and tight. Union or flange joints shall be provided in each line immediately preceding the

connection to each piece of equipment or material requiring maintenance such as pumps, control valves, and other similar items.

(2) Valves

a. Gate, Check and Globe Valves

Valves shall conform to requirements of the General Specification titled "Valves" of Division 7.

b. Balancing Cocks

Balancing cocks shall be bronze, plug type, threaded end, designed or not less than 8.8 kg/cm^2 service. Cocks shall have square head or similar device and indicator with stops for full open and full closed.

c. Expansion Tank

Expansion tank of size indicated shall be provided and installed on an angle iron frame. Tank shall be equipped with gauge glass, airtrol fitting and drain valve. Tank shall be shop painted with red-lead-base paint.

d. Flow Indicator

Flow indicator shall be Bell & Gossett, Honeywell or equal, of proper size for the flow required by the respective air handling unit.

e. Automatic Air Vents

Air vents shall be float type which shall close when water rises in the float chamber.

f. Pressure Reducing and Relief Valves

Pressure reducing and relief valves on water supply to the chilled water system shall be a dual control unit which shall maintain water pressure in the system at the set pressure regardless of the service pressure and the relief valve shall release water when the pressure rises above its set pressure. Both valves shall be brass, adjustable and relief valve shall have a manual operating lever.

g. Thermometers

Thermometers shall be mercury column type with separable wells. Range shall be approximately 0 to 50°C.

h. Pressure Gauges

Pressure gauges shall have bronze Bourdon tubes, brass cock, brass case and ring finished black and approximately 75 mm aluminum dials graduated 0 to 5 kg/cm^2.

9708. DIFFUSERS AND GRILLES

(1) Diffusers

Diffusers shall be factory-fabricated steel or aluminum and shall distribute the quantity of air specified evenly over space intended without causing noticeable drafts over 15 m/min. in occupied zone, or dead spots anywhere in the conditioned area. The Contractor shall be responsible for diffusion, spread, drop, and throw. The units shall be selected in accordance with published data of the manufacturer of the proposed units. The units shall be selected to perform quietly and effectively. A schedule of all air outlets indicating location, types, specified air quantity, neck or face velocity, sound power level values, pressure drop, throw and drop, and maximum and minimum diffusion range shall be submitted for approval. Diffusers shall be provided with volume control and accessible operator. After the system is in operation, if excessive noise, drafts, or dead spots, are noticeable in the conditioned spaces due to improper selection of type and size of diffuser, the unit shall be changed to the proper size and type without additional cost. Diffusers shall be square type, with fixed or adjustable air discharge pattern. Diffusers shall be furnished with antismudge device, unless the diffuser unit minimizes ceiling smudging through design features. Sponge rubber gasket shall be provided between ceiling and diffuser or antismudge ring. Duct collar connecting the duct to diffuser shall be airtight and shall not interfere with volume controller.

(2) Grilles

Grilles shall be factory-fabricated steel or aluminum of fixed horizontal louver type. Each grille shall be provided with a face-operated, volume-control damper. Grilles shall be provided with sponge rubber gasket between flange and wall or ceiling.

9709. LOUVERS

Louvers provided under this Section shall include only those in exterior walls which are directly connected by ductwork to air handling units. Louver blades shall be fabricated from extruded aluminum or aluminum sheets, and shall be provided with frame of extruded aluminum or aluminum structural shapes. Sheet metal thickness shall be not less than 2.0 mm extruded aluminum and 1.6 mm formed aluminum. Louver shall be 100 mm thick with blades set at 45 angle and spaced at not more than 100 mm intervals. Blades shall be accurately fitted and firmly secured to frames. Edges of louver blades shall be folded or beaded for rigidity and baffled to exclude driving rain. Louvers shall be provided with bird screen of 12 mm mesh and 14 guage, 1.6 mm aluminum wire.

9710. DUCT INSULATION AND VAPOR BARRIER

(1) General

All supply and return ducts shall be covered with fiber glass insulation with factory-applied or field-applied vapor barrier. The vapor

barrier shall consist of a lamination of a aluminum foil, reinforcing scrim, and kraft paper. Insulation shall be flexible type where concealed of 1 pound per cubic-foot nominal density and, where exposed, rigid type of 3 pound per-cubic-foot nominal density as minimum requirements. Insulation of outside air ducts is not required. The insulation thickness shall be at least 25 mm on all air ducts. Where acoustical duct lining is installed, duct covering may be omitted or reduced in thickness, provided the thermal insulating value of the combination is equal to or exceeds that for duct covering alone.

(2) Application

The insulation shall be fixed to the metal surface with fire-resistant adhesive applied to the entire surface of the duct. Insulation on ducts over 75 cm in width and/or depth, shall be additionally secured at the sides and/or bottom surface of the duct with welded pins, or anchor clips of metal, nylon or high impact plastic, and speed washers, or cup-head pins, on maximum 30 cm centers. The pins used for impaling the insulation shall not distort the duct, burn through or mar the finish or the surface of the duct. The factory applied vapor-barrier facing on flexible type insulation shall overlap not less than 50 mm at all longitudinal and butt joints. All overlaps shall be cemented with fire-resistant adhesive and then secured with noncorrosive outward clinching staples applied on 100 mm centers. All staples shall then be coated with fire-resistant vapor-barrier coating. For rigid-type insulation with factory-applied vapor-barrier facing, all joints shall be butted tightly and sealed with a 100 mm wide tape of the same material as the factory-applied barrier. The tape shall be cemented and stapled on and staples shall be coated with fire-resistant vapor-barrier coating. All breaks and punctures in the vapor-barrier jacket shall be sealed with two coats of fire-resistant vapor-barrier coating with glass cloth applied between coats. All patches shall not be less than 100 mm in width and fire-resistant vapor-barrier coating shall be applied to a minimum dry film thickness of 1.6 mm. Field applied vapor-barrier shall be adhered to the insulation with fire-resistant adhesive, and all operations requried for the factory-applied vapor-barrier lap cementing and finishing, shall be performed. Duct insulation shall be continuous through wall and ceiling openings. The vapor-barrier shall be sealed to the duct at all projections through the insulation and where the insulation terminates at equipment, diffusers, grilles or similar terminating points with fire-resistant vapor barrier coating. the coating shall be applied in two coats, with a glass cloth, imbedded between coats. The coating shall be applied to a minimum thickness of 1.6 mm dry film and minimum overlap of 50 mm over adjoining vapor-barrier jacket and uninsulated surface.

9711. PIPL INSULATION AND VAPOR BARRIER

(1) General

Chilled water lines shall be insulated with fiber glass insulation conforming to requirement in paragraph Material and Equipment. The insulation thickness shall be 25 mm. Insulation shall be provided with a factory applied, noncombustible vapor-barrier jacket consisting of a

lamination of aluminum foil, glass fiber reinforcing and a light color kraft paper.

(2) Application

After pressure tests have been completed in the piping systems, insulation shall be applied to the pipe with end joints tightly butted and the vapor-barrier jacket lapped not less than 38 mm at longitudinal joints and adhered with fire-resistant adhesive. At circumferential laps, 75 mm wide strip of jacketing material shall be applied and adhered with the same adhesive as above. The longitudinal laps of the vapor-barrier jacket shall be secured in place with noncorrosive outward clinching staples on 100 mm centers after which the staples and all seams shall be sealed with a brush coat of light color vapor-barrier coating. The insulation shall also be banded on 450 mm centers with 19 mm wide aluminum bands snugly fitted around the jacket. Ends of the sections of insulation that butt against flanges, unions and equipment shall be coated with a fire-resistant vapor-barrier coating and the vapor barrier shall be sealed to the pipe.

(3) Valves and Fittings

Valves and fittings shall be insulated with factory premolded, prefabricated or field fabricated segments of insulation of the same material and thickness as the adjoining pipe insulation. The segments of insulation shall be joined together with adhesive and shall be covered with glass tape. The glass tape shall be applied to the insulation with fire-resistant vapor-barrier coating applied in two coats, with the glass tape imbedded between coats.

(4) Insulation Through Hangers and Sleeves

Insulation shall be continuous through pipe sleeves, and pipe hangers. At hangers, where the pipe is supported by the insulation, protection shields shall be provided.

(5) Piping Exposed to Weather

Piping exposed to weather shall be insulated as specified above. The insulation shall be additionally finished with 0.4 mm minimum thick, corrugated, smooth or embossed aluminum sheet with joints lapped not less than 50 mm . The metal jackets shall be secured with aluminum lock-type bands not less than 19 mm by 0.5 mm thick applied directly over butt overlaps and on maximum 300 mm centers. Horizontal joints shall lap downward to shed water. Longitudinal joints and circumferential joints on vertical sections of the jackets shall be sealed, as necessary, to shed water. Where jacketing abuts an uninsulated surface the joint shall be sealed with glass tape and a vapor-barrier coating.

Fittings and other irregular surfaces shall be protected with two coats of vapor barrier coating material, with glass tape imbedded between coats. The total thickness of the dry film shall be 3.1 mm minimum. In lieu of glass tape covering for elbows, factory-fabricated aluminum sheet-metal elbows may be provided. The metal thickness shall be not less than 0.4 mm.

9712. EQUIPMENT INSTALLATION

Necessary supports shall be provided for equipment, appurtenances, pipe, and ductwork as required; these include frames or supports for air handling unit, expansion tank and other similar items requiring supports. All floor-mounted equipment shall be set on not less than 100 mm concrete pad doweled in place, unless otherwise indicated. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished for all equipment indicated or required to have concrete foundations.

9713. CONTROLS

(1) General

Controls shall be electric, or electronic type, or a combination thereof that will provide the required sequence of operation for the specified control. A schematic diagram of each automatic control system shall be submitted by the equipment or controls manufacturer, showing relays, control valves, malfunction alarm, safety shut-downs, switches, wiring, or other items necessary to perform the functions specified hereinafter.

(2) Unitary System

Unitary system control is specified under paragraph Unitary Systems.

(3) Chilled Water System Controls

a. Water Chiller Controls

Controls for each water chiller shall be furnished and wired at the factory and shall include return water temperature controller and flow switch. The flow switch shall prevent operation of the chiller unless water is flowing through the unit. The return water controller shall cause the compressor capacity to modulate, match the load and maintain return water temperature at the set point. When the load is less than the minimum capacity of both chillers, one chiller shall shut down and remain shut-down until the load exceeds the capacity of one chiller, the operating chiller shall automatically increase its capacity to pick up the load of the shut-down chiller. When the load exceeds the capacity of the operating chiller, the second chiller shall automatically restart and each shall adjust its output to handle approximately one half of the total load. The controllers shall be adjustable with a low limit setting of 48 degrees F. The chilled water pumps shall be energized manually and shall operate continuously.

b. Air Handling Unit

* Control

Each air handling unit shall be energized by a manual switch located adjacent to its room thermostat and shall operate continuously. Space temperature shall be controlled by a full proportioning type room thermostat which shall modulate the three-way mixing valve on the chilled

water return line from the air handling unit, varying the amount of chilled water passing through the coil. Thermostats shall be adjustable with appropriate range and shall be equipped with thermometer and locking cover. Thermostats shall control within plus or minus 1 degree F of the temperature setting at the thermostat location.

* Fan-safety Cutoff

The fan-safety cutoff with manual reset shall be provided in the return air duct connection ahead of the outside air connection for each air handling unit and shall be set to stop the fan if the return air temperature exceeds 125 degrees F.

9714. CLEANING, TESTING AND BALANCING

(1) Cleaning and Adjusting

Pipes shall be cleaned free of scale and thoroughly flushed of all foreign matter. Temporary bypass shall be provided for all water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Ducts, plenums, and casings shall be thoroughly cleaned of all debris and blown free of all small particles of rubbish and dust before installing outlet faces. Equipment shall be wiped clear, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction and after all construction dirt has been removed from the building, new filters shall be installed. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. All control valves and other miscellaneous equipment requiring adjustment shall be adjusted. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

(2) Pressure Tests

a. Water Piping

After cleaning and before applying insulation, water piping shall be hydrostatically tested at a pressure 7.0 kg/cm^2 for a period of time sufficient to inspect every joint in the system and in no case less than 2 hours. No loss of pressure will be allowed. Leaks found during tests shall be repaired by rewelding or replacing pipe or fittings.

b. Ductwork

Ducts, plenums, and casings shall be tested and made substantially airtight at static pressure indicated for the system before covering with insulation. The term, substantially airtight, shall be construed to mean that no air leakage is noticeable through the senses of feeling or hearing.

(3) Balancing

a. Water-piping system

Water piping system shall be balanced to produce water quantities as indicated with all automatic-control valves open.

b. Duct Systems

Duct systems shall be balanced to produce air quantities within 5 percent of that indicated.

(4) Performance Test

After cleaning, testing, insulating and balancing operations have been completed, as hereinbefore specified, the system shall be tested as a whole to see that all items perform as an integral part of the system, and have the capacity to produce the water and air entering and leaving conditions specified. Performance test shall be continuous 24 hours.

9715. PAINTING AND FINISHING

(1) Factory Coating

Equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish except that items located outside the buildings shall have weather resistant finishes.

(2) Finish Painting

Finish painting is covered under another General Specification titled Painting of Division 9.

9716. FIELD INSTRUCTIONS

Upon completion of the work and at a time designed by the Engineer, the services of one or more qualified engineers shall be provided by the Contractor for a period of not less than four (4) days to instruct the representative of the Authority in the operation and maintenance of the air conditioning systems. These field instructions shall cover all the items of equipment.

SECTION 9800. VENTILATION SYSTEMS

9801. GENERAL

(1) Data to be submitted

Literature and Shop Drawings, describing each item of equipment, shall be submitted to the Engineer for approval. The literature and Shop Drawings shall include sufficient descriptive materials such as catalogs, cuts, diagrams and other data published by the manufacturer.

a. Capacities

Capacities of equipment and materials shall be not less than those indicated.

b. Nameplates

Each major item of equipment shall have the manufacturer's name, address, serial and model number on a plate securely attached to the item.

c. Safety Requirements

Belts, pulleys, chains, gears, couplings, projecting set-screws, keys, and other rotating parts, so located that personnel can come in close proximity thereto, shall be fully enclosed or properly guarded.

d. Verification of dimensions

The Contractor shall visit the premises to thoroughly familiarize himself with all details of the work and working conditions and verify all dimensions in the field. The Contractor shall be specifically responsible for the coordination and proper relation of his work to the building structure and to the work of all trades.

9802. MATERIALS AND EQUIPMENT

Materials and equipment shall conform to the requirements specified herein and as shown on the Drawings and shall be the products of manufacturers regularly engaged in the manufacture of such products. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least two years. Where more than one unit of same capacity is required they shall be the same model with all parts interchangeable.

9803. SUPPLY FANS

(1) Cabinet Type

Cabinet type supply fans shall be factory fabricated complete with enclosures, fan wheels, motors, adjustable V-belt drives, belt guards, vibration isolation supports and only other appurtenances necessary for

satisfactory operation. Fan wheel shall be double inlet, non-overloading, centrifugal type with each wheel in a separate scroll. Each unit may have one or more fan wheels on the same shaft. Each unit shall have the physical dimensions to fit the allotted space and shall be the capacity indicated.

Enclosure shall be constructed of not lighter than 18 gage, (1.2 mm) nominal thickness, with shop finish suitable for field thickness, with shop finish suitable for field painting. Fans shall be statically and dynamically balanced at the factory in the air handling unit. Fans shall be mounted on steel shafts accurately finished and provided with key and key slots for the fan wheel hubs and pulleys and supported in ball-type bearings provided with lubrication facilities outside of the unit, or permanently lubricated sleeve-type or ball-type bearings. Fans shall be driven by a unit-mounted motor connected to fans by V-belt drive complete with belt guard. Sheaves shall be adjustable to provide not less than 20 percent speed change and shall be selected to drive the fan at such a speed as to produce the specified capacity when set at the approximate mid-point of sheave adjustment. Fan outlets shall be provided with horizontal and vertical deflection louvers.

(2) Vane Axial Type

Vane axial fans shall have welded tubular steel casing with stationary outlet vanes. Rotating element shall have radial projected blades with aerodynamic cone or centrifugal backward inclined blades. Fans shall be V-belt driven with adjustable motor sheaves, adjustable motor mounts, and belt guards. Air shall enter and leave the fan axially. Inlets shall be streamline with conversion vanes to eliminate turbulance and provide smooth discharge air flow. Fan bearings and drive shafts shall be enclosed and isolated from the air stream. Fan bearings shall be sealed against dust and dirt and shall be permanently lubricated. Unit shall be provided with vibration isolation mounts.

9804. EXHAUST FANS

Propeller fans and motors shall be supported on heavy metal frames designed for wall opening and mounting. Fan wheels less than 600 mm diameter shall be directly connected to the motor, and fans 600 mm diameter or larger shall be connected to the motor by V-belt drive. Fan discharges shall be provided with gravity operated shutter.

9805. GRAVITY SHUTTERS (AUTOMATIC LOUVERS)

Gravity shutters for exhaust and radiator fans shall be factory fabricated, parallel-blade type with delicately balanced blades that open automatically when the fan starts and close by gravity when the fan stops. The blades shall be constructed of aluminum sheets or extrusions with interlocking edges, with a maximum width of 130 millimeter. the edges of the blades shall be provided with felt or rubber strips to prevent rattling. Blade shall be connected to a vertical bar so all blades open equally. Damper blades shall be supported on aluminum frames.

9806. AIR FILTERS

Air filters shall be sectional, cleanable type, 25 millimeters thick and of the size required. The holding frame shall be galvanized steel with suitable cell-holding devices. Viscous adhesive shall be provided in 18.9 liters containers in sufficient quantity for twelve cleaning operations and not less than 0.95 liters for each filter section. One washing and charging tank shall be provided. The drain rack shall be provided with dividers and partition to properly support the filters in the draining position.

9807. DUCTWORK

(1) General

Duct work shall be constructed of aluminum sheets. Ducts, unless otherwise approved, shall conform to the dimensions indicated and shall be straight and smooth on the inside, with joints neatly finished. All edges and slips shall be hammered down to leave a smooth interior duct finish. Ducts shall be so constructed and installed as to be completely free from vibration under all conditions of operation. Joints shall be made substantially air-tight, and no dust marks from air leaks shall show at connections, grilles, register, or diffusers. Ducts shall be hung from or anchored securely to the concrete, masonry, or framing in the structures and the method of anchoring and/or fastening shall be as detailed on the Drawings. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided and detailed. All ducts shall be cross braked of sufficient center height to assure rigidity in the duct section.

(2) Turning Vanes

Square elbows shall be provided with curved turning vanes.

(3) Manual Dampers and Splitters

Manual dampers with locking quadrants, multiple-blade dampers, and splitter dampers shall be installed where indicated or necessary for proper control and balancing of air distribution. All dampers shall have an accessible operating mechanism. Slitter dampers shall be operated by a 4.8 mm rod brought through the side of the duct and locked with a set screw and bushing. Two rods shall be provided for splitter dampers over 30 cm in width. Dampers and splitters shall be constructed of material two gages heavier than the duct. Multiple blade dampers shall be parallel-blade type, except where opposed-blade is indicated, with a maximum blade with of 250 mm. Two or more blades shall be used when the blade width is more than 250 mm. Splitter dampers shall be of sufficient length to close off entire branch duct.

(4) Apparatus Connections

Where sheet metal connections are made to fans, or where ducts of dissimilar metals are connected, a noncombustible flexible connection shall be provided of 0.68 kg/m^2 neoprene coated fiber glass fabric and securely fastened by zinc-coated steelclinch-type draw bands for round

ducts. For rectangular ducts, the flexible connections, locked to metal collars, shall be installed using normal duct construction methods.

9808. ALUMINUM LOUVERS

Where indicated on the Drawings, louvers fabricated from aluminum sheets or extrusions shall be provided. Frames shall be fabricated of aluminum. Blade shall be accurately fitted and firmly secured. Edges of blades shall be folded or beaded for rigidity and shall be baffled to exclude driving rain. Metal thickness as indicated on the Drawings. Bird screens in removable aluminum frames shall be provided where indicated. Bird screen shall be 12 mm x 12 mm mesh of 1.5 mm diameter aluminum wire.

9809. PAINTING AND FINISHING

(1) Factory Coating

Equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish except that items located outside of buildings shall have weather resistant finishes.

(2) Finish Painting

Finish painting shall be in accordance with the General Specification in Section 9400 "Painting".

9810. TESTS

(1) General

Each supply and exhaust air system shall be balanced to produce the indicated air quantities at the conditions shown. Bearing shall be lubricated, and the speed and direction or rotation of each fan shall be checked. The running current of each motor shall be checked.

(2) Test Report

Report of test data, indicating the following in typed tabulation form, shall be submitted to the Engineer not less than 2 days before the final test of the system.

1. Fans:

    a. Specified air quantity and static pressure
    b. Installed motor horsepower

2. Air outlets and inlets:

   a. Specified size and air quantity
   b. Installed size
   c. Measured air velocity
   d. Computed air quantity

(3) Final Tests

Upon completion, and prior to acceptance of the installation, the Contractor shall subject the ventilating systems to such operating tests as may be required by the Engineer to demonstrate satisfactory functional and operating efficiency. Operating tests shall cover a period of not less than 6 hours for each system, and all tests shall be conducted at such times as the Engineer may direct. If tests do not demonstrate satisfactory operation of the ventilating systems, deficiencies shall be corrected and tested. All instruments, facilities, and labor required to properly conduct the tests shall be provided by the Contractor.