elevation at which the requirements for pavement subgrade materials and compaction shall fulfill.

(b) Under turfed and nontraffic areas:

Twelve-inch layers, to at least 85 percent CE 55 maximum density for cohesive material and 90 percent CE 55 maximum density for cohesionless material.

(2) Determination of density

Laboratory tests for moisture-density relations shall be made in accordance with Military Standard MIL-STD-621, Test Method 100, compaction effort designation CE 55, except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. The soil density shall be measured in the field in accordance with AASHO Standard T 147, except that the oil alternate shall not be used. Laboratory and field tests for each area shall be made in accordance with SECTION "TESTING OF MATERIALS AND CERTIFICATES". Areas with inadequate compaction shall be retested after corrective measures have been made.

19.8 EXCAVATION AND BACKFILLING FOR DRAINAGE STRUCTURES

Excavation and backfilling for drainage structures shall conform to the applicable requirements specified in paragraphs "ESCAVATION, TRENCHING, AND BEDDING FOR PIPE CULVERTS AND STORM DRAINS" and "BACKFILLING PIPE" herein.

19.9 DRAINAGE STRUCTURES

Drainage structures shall be of the following types and constructed of the materials specified for each type in accordance with the indicated details.

19.9.1 INLETS

Inlets shall be constructed of reinforced concrete, with frames and covers or gratings, and with fixed galvanized steel ladders where indicated.

19.9.2 WALLS AND HEADWALLS

Walls and headwalls shall be constructed of reinforce concrete or plain concrete, as indicated.

19.9.3 MORTAR-EMBEDDED-STONE STRUCTURES

Mortar embedded stone structures shall be as specified in paragraph "STONE PROTECTION".

19.10 MATERIALS FOR DRAINAGE STRUCTURES

19.10.1 CONCRETE

Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for Class A concrete in Clause 4 "CONCRETE WORK". The concrete covering over steel reinforcing shall be not less than 1 inch thick for covers and not less than 1-1/2 inches thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 3 inches between the steel and the ground. Expansion joint filler material shall conform to ASTM

Specification D 1751 or D 1752, or shall be resin-impregnated fiberboard conforming to the physical requirements of ASTM Specification D 1752.

19.10.2 MORTAR

Mortar for pipe joints and connections to other drainage structures shall be composed of one part by volume of Portland cement and two parts of sand. The cement and sand shall be as specified in Clause 4 "CONCRETE WORK". Hydrated lime may be added to the mixture of sand and cement in an amount equal to 20 per cent of the volume of cement used. Hydrated lime shall conform to Federal Specification SS-L-351, Type M, or ASTM Specification C 141, Type B. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar, but shall in no case exceed 6 gallons of water per sack of cement. Water shall be clean and free of harmful acids, alkalies and organic impurities. The mortar shall be used within 30 minutes from the time the ingredients are mixed with water. The inside of the joint shall be wiped clean and finished smooth. In pipe too small for a man to work inside, wiping may be done by dragging a suitable swab or long-handled brush through the pipe as work progresses. The mortar bead on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

19.10.3 MANHOLE FRAME AND COVER

Manhole frame and cover shall be cast iron conforming to Federal Specification QQ-I-652, with tensile-strength test not less than

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Class 25, and shall be of the shape and size shown.

19.10.4 INLET FRAME AND GRATINGS

Sizes and spacing of bearing and cross bars shall be as indicated. Materials, construction welding and workmanship shall be in accordance with Federal Specification RR-G-661. Frame shall be constructed of steel angles conforming to Federal Specification QQ-S-741 to the size and design shown. After fabrication, frame and gratings shall be hot-dip galvanized in accordance with ASTM Specification A 123 or A 153, as applicable, except that the weight of coating shall be not less than 2.0 ounces per square foot of surface. The frame and gratings shall be anchored to concrete as shown.

20. WATER SUPPLY, SEWAGE AND SANITARY EQUIPMENT WORK

20.1 GENERAL

20.1.1 SCOPE

This clause covers the performance of all water supply, sewage and sanitary equipment works to be executed according to the Drawings and these Specifications.

(1) Water supply equipment work

(2) Sewage and aeration equipment work

(3) Hot water supply equipment work

(4) Sanitary equipment work

(5) Clarification tank equipment work

The Contractor shall submit shop drawings of the fabricated items to the Engineer for approval. The shop drawings shall clearly shown the details of fabrication, installations, dimensions, sizes, operation, methods of anchoring and all other pertinent details required for satisfactory installation.

20.1.2 DESIGN BASIS OF WATER SUPPLY, SEWAGE AND SANITARY SYSTEM

(1) Design criteria

(a) Water supply system

. Water supply quantity: 120 lit./day.one person

(b) Hot water supply system

. Hot water supply quantity

: 0.4 lit./day.one person

(2) System description

(a) Substation

1. Sanitary and Sewage System

The sanitary and sewage system shall be installed in

the lavatory, etc.

1.1 System Description

(i) Potable water shall be supplied to the respective positions by direct water supply system from the plant side.

Potable water shall be supplied up to the position one (1) meter in front of the elevated water tank from the plant side.

The tie-in point shall be at the position of the gate valve.

(ii) Miscellaneous drainage and sewage shall be led outdoors through individual systems, joined into one system outdoors and sent to a clarification tank. After clarification, such drainage and sewage shall be emptied into the unit neutralizing pit.

The clarification tank shall be of a composite type, and the BOD of poured water shall be 90 ppm.

(iii) Water closets, urinals, lavatories and other sanitary fixtures shall be installed at all required positions.

20.2 EQUIPMENT AND MATERIALS

20.2.1 HOT WATER STORAGE HEATER

(1) Hot water storage heater

(a) Type

The hot water storage heater shall consist of a hot

water storage tank and an electric heater built in a wall hanging type casing made of stainless steel.

(b) Materials

The hot water storage tank and the casing shall be made of stainless steel.

(c) Power source

Single phase, 220 V, 50 Hz

(2) Accessories

The hot water storage heater shall be provided with the following accessories.

(a)	Ball tap (15 mm)	1 set
(b)	Drainage hole	1 set
(c)	Water level (Made of glass with protective metal)	1 set
(d)	Thermometer	1 set
(e)	Overflow hole	1 set
(f)	Thermostat	1 set

(3) Shapes, dimensions and performance

The shapes, dimensions and performance of the hot water storage heater shall be in accordance with the manufacturer's specifications.

20.2.2 SANITARY EQUIPMENT AND ACCESSORIES

(1) General

(a) All sanitary wares shall be of high quality and of a PAKISTAN manufacture, or equivalent to JIS A 5207.

(b) All fittings for sanitary wares shall be in accordance with JIS A 5514, or equivalent.

(c) All accessories and visible sanitary wares such as faucets, flush valves and flushing pipes shall be nickel-chromium-plated.

(2) Water closet

(a) Water closet

Vitreous china (V.C.), siphonic washdown.

(b) Flush valves

The flush valves shall be in accordance with JIS A 5521 "Flush Valves for Closet".

The diameter of the connection hole to the flushing pipe shall be 32 mm, and the flushing operation mechanism shall be of a handle type.

(c) Flushing pipe

The flushing pipe shall be made of brass with a minimum plate thickness of 0.6 mm.

(d) Accessories

(a)	Water closet seat and cover (Plastic)	1 set
(b)	Water closet floor flange	1 set
(c)	Seat bumper	1 set
(d)	Paper holder (Brass)	1 set

(3) Urinal

(a) Urinal

V.C., wall hanging type

(b) Flush valve

Push button type urinal (Brass)

(c) Accessories

(a) Urinal pad

(b) Wall flange

(4) Wash basin (for lavatory)

(a) Wash basin

V.C., 6.5 , wall hanging type

(b) Accessories

(a)	Pillar cock (13 mm)	1 pc
(b)	Angle type stop cock (13 mm) with water supply pipe	1 set
(c)	Washer basin trap	1 set
(d)	Back hanger	1 set
(e)	Liquid soap holder (Vertical type, 350 cc)	1 set

(5) Wash basin (for battery room)

(a) Wash basin

V.C., 9.5 , counter-top type

(b) Accessories

(a)	Pillar cock (13 mm)	1 pc
(b)	Eye bath (Vertical flexible type, 13 mm)	1 set
(c)	Angle type stop cock (13 mm) with water supply pipe	1 set
(d)	Wash basin trap	1 set
(e)	Back hanger	1 set
(f)	Liquid soap holder (Push button type, 360 cc)	1 set

(6) Janitor's sink

(a) Janitor's sink

V.C. with back

(b) Accessories

1)	Sink faucet (20 mm with feed seat)	1 pc

2)	Trap (S type)	1 pc
3)	Trap connection fixtures	1 set
4)	Chain and stopper	1 set
5)	Back hanger	1 set
6)	Rim cover	1 set

(7) Mirror

The mirror shall be frameless and moistureproof.

Glass for mirror shall be 5 mm thick and 360 x 455 mm in size, and in accordance with JIS R 3202 (Float, Polished Plate Glass).

(8) Shower set, water cock and similar items

The quality shall be in accordance with JIS A 5514, or equivalent.

20.2.3 SEPTIC TANK

The main structures constituting the septic tank shall be made of fiberglass reinforced plastic (F.R.P.) having appropriate shape, dimensions and capacity. The structures shall have sufficient strength against soil pressure, water pressure, load, etc., and shall be of a construction permitting easy inspection and cleaning. In the case of a building with an accommodation capacity of fifty (50) persons or less, an independent treatment septic tank capable of reducing BOD (biological oxygen demand) into 90 ppm shall be installed.

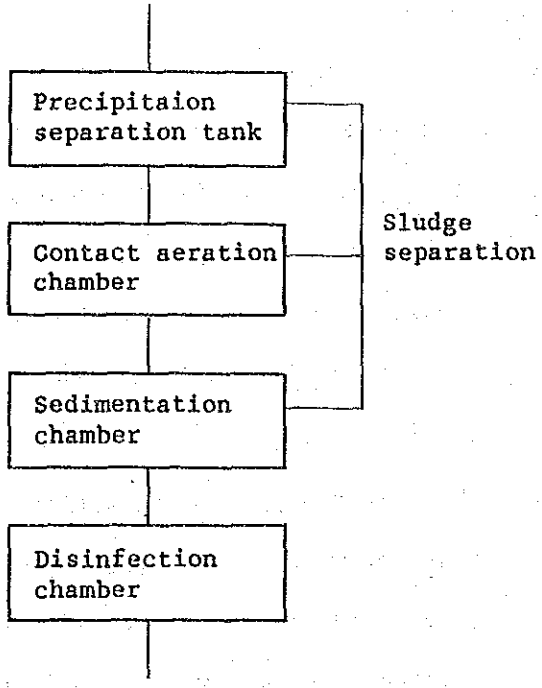
The treatment process flow diagrams of the respective types of septic tanks shall be as indicated below.

TREATMENT PROCESS

OF

SEPTIC TANK

(a) Independent treatment septic tank



20.2.4 PIPING MATERIALS AND PIPE FITTINGS

(1) Pipe

(a) Water supply pipes

The water supply pipe shall be galvanized steel pipe in accordance with JIS 3452.

(b) Hot water supply pipes

The hot water supply pipe shall be M-type copper seamless pipe in accordance with JBMA-0002 and JIS H 3300.

(c) Drainage and air vent pipes

The drainage and air vent pipes shall be the galvanized

steel pipe in accordance with JIS G 3452, rubber joint type cast iron pipe in accordance with JIS G 5525 and HASS-210, and the centrifugal reinforced concrete pipe as specified in JIS A 5303.

(2) Pipe joint

(a) Water supply pipe joints

The water supply pipe joints shall comprise screwed type pipe joints in accordance with JIS B 2301, and shall have flange type pipe joints. The flange type pipe joints shall be made by welding the flange to the end surface of the steel made joints as stipulated in JIS B 2211 or JIS B 2212.

(b) Hot water supply pipe joints

The hot water supply pipe joints shall be copper alloy steel pipe in accordance with JCDA-0001.

(c) Drainage and air vent pipe joints

The drainage and air vent pipe joints shall be malleable cast iron pipe joint in accordance with JIS B 2301 and screwed type drainage pipe joint in accordance with JIS B 2303.

(3) Gate valves

(a) The gate valves with a nominal diameter of 50 mm or less shall be the 10 kg/cm^2 bronze screwed type gate valve as stipulated in JIS B 2023.

(b) The gate valves with a nominal diameter of 65 mm or more shall be the 10 kg/cm^2 cast iron flanged gate valves (outside screw type) as stipulated in JIS B 2044.

(4) Pipe washer

The pipe washers shall be made of nickel chromium coated brass or stainless steel.

(5) Pipe sleeve

The pipe sleeves shall be made of steel pipe or steel plate with a thickness of 0.4 mm or over (0.7 mm or over in case the nominal diameter exceeds 200 mm). However, the non-water-proofed floor pipe sleeve to be used indoors shall be made of laminated cardboard.

(6) Pipe support fittings

(a) The pipe support fittings shall be resistant to contraction and expansion, rolling, etc., of pipe, and shall be of a construction having sufficient bearing strength against load of pipe when liquid is contained inside. The materials to be used shall be in accordance with JIS G 3101 (Rolled Steel for General Structure). All steel fittings shall be finished by galvanizing.

(b) The inserts shall have sufficient strength for supporting the pipe and shall have a construction suitable for connecting hangers, etc. All inserts shall be made of cast iron, press-formed malleable cast iron or steel plate.

(7) Cementing/bonding materials

(a) Thread sealing material

1) The thread sealing tapes shall be in accordance with JIS K 6885 (Unsintered Polytetrafluoroethylene Tapes for Thread Sealing (Raw Tapes)), and shall neither be hazardous to human health nor cause

adverse effects upon drinking water.

2) The paste sealing agent shall not be affected by the liquid in pipe, and shall consist of contents applicable to the purpose of use. In case an agent is used for sealing of piping for drinking water, it shall not be hazardous to health nor cause any adverse effect upon drinking water.

(b) Packing

The packing(s) shall be in accordance with JIS K 6353 (Rubber Goods for Water Works Service), JIS R 3433 (Compressed Asbestos Sheets), etc., and have sufficient durability applicable to the respective quality of water, water pressure, temperature, etc.

(c) Caulking lead

The caulking lead shall, in principle, be the 5th Class of those stipulated in JIS H 2110 (Pig Lead).

(d) Caulking hemp

The caulking hemp shall, in principle, be the jute of #130 single thread which, when tied in a bundle, has a diameter or about 25 mm.

20.2.5 DRAINAGE PIPE FITTINGS

(1) General

(a) The water sealing depth of trap shall be 50 mm or more, and the effective area of the drainage hole for strainer shall not be less than the sectional area of the drainage pipe.

(b) The materials for drainage pipe fittings shall be Grade

2 or higher as stipulated in JIS G 5501 (Grey Iron Castings) in case of cast iron materials. However, in case of brass casting, the materials shall be Grade 2 or higher as stipulated in JIS H 5101 (Brass Castings).

(c) All iron castings shall be cold-painted having a synthetic resin finish containing refined bituminous material.

(d) The nickel chromium plated section of the drainage pipe fittings shall be equivalent to or higher than Class 1 of Grade 2 in JIS H 8617 (Electroplated Coatings of Nickel and Chromium).

(2) Floor drain trap

The floor drain traps shall be made of cast iron, and the strainer shall be nickel chromium plated brass. The floor drain trap for asphalt waterproofed floor shall be of a waterproofing type, but that for other floors shall be of the standard type.

(3) Sink trap

The sink traps shall be made of cast iron and shall be furnished with an inside basket made of brass or stainless steel (SUS 304). The strainer shall be made of brass having a nickel chromium plating finish.

(4) Floor clean-out

The floor clean-out shall be of a screwed type made of brass having a nickel chromium plating finish. The floor clean-out for asphalt waterproofed floor shall be of a waterproofing type, but that for other types of floors shall be of the standard type.

(5) Under-floor clean-out

The under-floor clean-out shall be of a screwed type made of brass.

(6) Drainage pipe fittings

The drainage pipe fittings shall be made of brass having a nickel chromium plating finish, and the chain and stopper shall be made of stainless steel.

20.2.6 PIT AND PIT COVER

(1) General

(a) The materials for iron castings shall be equivalent to or higher than Grade 3 as stipulated in JIS G 5501 (Grey Iron Castings).

(b) The iron castings shall be baked with refined tars in accordance with JIS K 2439 (Processed Tars) to which more than 2% of linseed oil or drying oil is mixed, or shall be cold painted with refined bituminous materials to which synthetic resin finish is added.

(2) Invert pit

(a) The invert pit shall be of a concrete construction and all visible portions shall be finished by mortar coating. The pit shall be furnished with a cover, and an invert applicable to the pipe diameter shall be provided on the bottom of the pit.

(b) The cover shall be made of cast iron with chain, and shall be of an odorproof type able to withstand the weight of 2,500 kg.

(3) Storage pit

(a) The storage pit shall be of concrete construction, and all visible portions shall be finished by mortar coating. The pit shall be furnished with a cover.

(b) The cover shall be made of cast iron with chain, and shall be of an odorproof type able to withstand the weight of 2,500 kg.

(4) Valve box

The valve box shall be of a circular type made of cast iron with a cover.

20.3 EXECUTION

20.3.1 ERECTION WORKS

(1) Wall hanging type electric water heater

The wall hanging type electric water heater shall be set firmly on the wall by using expansion joints.

(2) Sanitary ware, accessories and fittings

(a) General

1) In case wall hanging fittings are fixed on a concrete wall or brick wall, expansion bolts shall, in principle, be used.

2) In case a metal panel or lightweight steel framed board wall is set, steel plate and worked angle materials or hardwood patch shall be fixed to the sanitary ware in advance.

3) In case a part of the sanitary ware is embedded in concrete, the portion of the sanitary ware that comes into contact with concrete or mortar shall

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be covered with asphalt having a thickness of 3 mm or more. However, the bottom contact surface of sanitary ware, such as that for standing type urinals, shall be filled with sand.

(b) Water closet

1) The upper end of the water closet shall be set horizontally in place in accordance with the precise setting position.

2) Prior to connecting the water closet to the drain lead pipe, the connecting end of the lead pipe shall be flared up to the diameter of the flange, and after inserting the non-drying sealing materials between the external surface of the flange and connecting end, the water closet shall be connected to the drain lead pipe by nuts and fastened from above by flange fittings and bolts. The plate thickness of the external end of the flared lead pipe shall be not less than 2 mm. The end of the flange for the lead pipe to be connected to the water closet shall be supported sufficiently with hangers, etc., so that no load of drain pipe, etc., will act directly on the water closet.

(c) Urinal

1) The urinal shall be set precisely in place without misalignment.

2) Connection of urinal with drain pipe shall be carried out in accordance with the procedures for connecting the water closet in (b).

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3) The setting height of urinal shall be 530 mm from the floor surface to the upper front end of the urinal.

(d) Wash basin and hand wash basin

1) The bracket or back hanger/s shall be firmly set in place, and the wash basin shall be fixed carefully so that the upper surface of the basins will be kept horizontal without exhibiting looseness. To eliminate leakage of water, heat-resistant non-drying sealing materials shall be filled around drain holes of the basins and around openings between the drain pipe fittings.

2) The setting height of basins shall be 800 mm (approximate) from the floor surface to the upper front end of the basin.

(e) Slop sink

The trap shall be set in place without any misalignment, and the connection of slop sink to the drain pipe shall be carried out in accordance with the procedures for connection of water closet in (b). Setting of back hanger/s and connection between drain holes of the slop basin and drain pipe fittings shall be carried out in accordance with the procedures for the above wash basins in (d).

(f) Water cock

The water cock shall be fixed firmly after precise centering by fully taking into account the convenience of use and harmony with the surrounding facilities.

A sufficient space for the spout shall be provided between the end of the spout of water cock and the flood level rim of the drain receptacle.

(g) Mirror

The setting height of the upper end of the mirror shall be 1,800 mm from the floor surface.

(3) Septic tank

Reinforced concrete foundation shall be provided, and the tank shall be firmly fixed to the foundation so as to withstand upward water pressure.

20.3.2 CONNECTION OF PIPES

(1) General

(a) All pipes shall be carefully cut at a right angle against the axial center of the pipes so as to avoid any deformation of the sections, and the cut end shall be finished smoothly.

(b) Pipes shall be connected after removing all chips, dust and other foreign matter and after confirming that such foreign matter has been completely removed form inside the pipes.

(c) In case piping work is temporarily suspended, all pipes shall be sufficiently protected to avoid entry of any foreign matter.

(2) Water supply piping

(a) No water supply piping shall, in principle, be connected according to an insertion system, unless specified otherwise.

(3) Hot water supply piping

(a) No water supply piping shall be connected according to an insertion system. In the case of piping which is required to be removed, flare fittings shall be used having a normal diameter of 1-1/4 or less and flange couplings having a nominal diameter of 1-1/2 or more. Prior to connection of the piping, the external surface of all pipes and the internal surface of all joints shall be cleaned thoroughly. The pipe shall then be inserted properly into the joint while heating the pipes and joints to an appropriate temperature and applying soft solder alloy.

(4) Drainage and air vent piping

(a) Prior to connecting the galvanized steel pipes, the pipes shall be correctly threaded so that a slight clearance is provided between the end face of pipes and the recess of joints in order to obtain the tapered threaded pipe portion. The steel pipes shall then be screwed tightly into the joints.

(b) All cast iron pipes shall be connected by using rubber rings. In this case, the pipes shall be inserted into the rubber rings until the end of spigot comes into contact with the bottom of socket. The rubber rings that have been inserted into a position near the end of spigot in advance shall then be inserted into the pipes carefully so that no twisting will occur in the opening between the socket and spigot. Rubber rings shall be set in close contact with the pipes while uniformly fastening the tap bolts and nuts

using a junk ring.

(c) All centrifugal reinforced concrete pipes shall be connected by using collars.

After both ends of the pipes have achieved tight contact with each other at the central part of the collar and carefully set in place to ensure proper alignment in the surrounding opening, stiff consistency mortar shall be placed into the opening. In this case, all cement and water inside the pipes shall be throughly removed. In case one end of the pipe is made into socket form after connecting the collar to the end with mortar, mortar shall be applied about 10 mm away from the pipe end.

20.3.3 PIPING

(1) Water supply piping

(a) General

1) Prior to execution of piping work, detailed study shall be made on the relationship between other piping and equipment, and all positions for pipe laying shall be decided by taking into account the precise slope of the respective piping.

In the case where piping is laid inside a building, setting of the pipe support fittings and embedding of pipe sleeves shall be carried out without any delay and in accordance with progress of the work.

2) The flange joints shall be inserted for all main piping at appropriate intervals so as to ensure

easy removal of such piping.

3) In the case where any piping is branched from the main piping, T-joints shall be used.

4) An air release valve shall be provided at the dead air space portion in piping, and a mud discharge valve shall be provided at the portion where mud is collected. The size of the mud discharge valve shall be the diameter of the related pipe, provided that the size of the valve shall be 25 mm in case the nominal diameter of the pipe exceeds 25 mm.

5) In case no antisweat covering is provided for piping, pipe washers shall be fixed to all portions of piping that penetrate through ceilings, floors, walls, etc., and to items visible from the outside.

6) Any openings between the piping that penetrates through fire service areas, etc., shall be filled with rock wool heat insulation or other noncombustible material.

7) In the case where a pipe sleeve is used at a place requiring watertightness, lead caulking shall be provided in the opening between the sleeve and pipe.

8) In the case where any steel pipe and similar materials are laid under the ground, such pipe shall be protected against corrosion by either a double coating of coal tar or a double winding of

corrosionproof vinyl tapes (JIS Z 1901 "Protective Polyvinyl Chloride Tapes").

9) Repair of steel pipe, cast iron pipe and lead pipe with caulking shall be prohibited.

10) After completion of piping work, the inside of the piping shall be cleaned by water pressure on the occasion of hydrostatic test of the piping. In the case of piping for drinking water, the piping shall be sterilized until free residual chlorine of 0.2 ppm or more has been detected at the end of the piping.

(b) Gradient

In the case of horizontally running pipe, the upfeed pipe shall have an upward slope and the downfeed pipe shall have a downward slope. In principle, the gradient shall be 1/250.

(c) Support pitch

1) The support pitch of the horizontally running pipes shall, in principle, be in accordance with the values in the following table and, wherever necessary, all bent sections and branching sections shall be supported. In the case where steel pipes or similar pipes are supported with hangers, a stable rest shall be provided for each horizontally running pipe so as to avoid looseness of the pipe due to movement at the time of earthquake.

2) A stable rest shall be provided for indoor vertical pipe at at least one place on each floor.

MINIMUM SUPPORT PITCH OF WATER SUPPLY PIPE

(Unit: m)

Nominal pipe diameter	20 or less	25-40	50-80	100-150	200 or more
Support pitch	1.8	2.0	3.0	4.0	5.0

(2) Hot water piping

(a) General

1) All hot water piping shall be laid with uniform gradient so as to ensure proper function during contraction and expansion of piping. The piping shall be carefully laid to ensure smooth circulation of water and avoid reverse gradient, dead air space, etc.

2) In case a copper pipe is supported with steel fittings, such pipe shall be protected with rubber, etc.

Other general provisions other than those described above shall be in accordance with the general provisions in 23.3.3 (1).

(b) Gradient

Hot water supply pipes shall have an upward slope and hot water return pipes a downward slope. The gradient shall, in principle, be 1/250.

(c) Support pitch

1) The support pitch of horizontally running copper pipes shall, in principle, be as indicated in the table below. In the case where horizontally running main pipes are supported with hangers, a stable rest shall be provided at all required places.

SUPPORT PITCH OF STEEL PIPE

(Unit: m)

Nominal pipe diameter	20 or less	25-40	50	65-80	100 or more
Maximum pitch	1.0	1.5	2.0	2.5	3.0

(3) Drainage and air vent pipe

(a) General

1) All horizontally branched drainage pipes, etc., shall be combined as near horizontally as possible at an acute angle of less than 45^{o}.

2) In case bent lead pipe is used, the pipe shall be carefully fabricated so as not to impair its roundness, and no branch drainage pipe shall be connected to the bent section of the pipe.

3) No waste water shall be discharged directly from the following equipment.

o Air conditioners

o Elevated water tanks

o Pumps

4) Indirect drainage pipe shall be opened while maintaining a space of over twice the diameter of the pipe from the drain receptable and flood level rim. In case an obstacle is foreseen in providing the above opening, appropriate measures shall be taken for protection.

5) The lowest portion of the vertical drainage pipe shall be fixed with a support stand where required.

6) Air vent pipe shall be run out vertically or at an angle of less than 45^{o} from the horizontally branched drainage pipe, and in no case shall the pipe be run out horizontally.

7) In the case where air vent pipes on floors are connected to vertical air vent pipes, the said pipes shall be connected at the place over 150 mm from the flood level rim of the related equipment. Vertical air vent valves shall be connected to the stack vents in accordance with the above procedures.

8) In case a hume pipe is buried, a pit shall be excavated from the lower and of the pipe to a depth of about 100 mm in case the nominal diameter of the pipe is 300 mm or less, and about 150 mm in case the nominal diameter exceeds 300 mm. After unscreened crushed stone, unscreened gravel or pit sand has been laid and compacted, the pipe shall be laid. However, the portions where joints are provided shall be excavated further, if required.

Initial back filling of pipe shall be carried out up to the center line of the pipe to ensure immovability, and after sufficient compaction, the pipe shall finally be buried.

Provisions other than those described in this paragraph shall be in accordance with the general provisions in 20.3.2 (4).

(b) Gradient

The gradient of horizontally running drainage pipes laid inside a building shall be 1/100. All air vent pipes shall have un upward slope facing the vertical pipes, and shall be free from reverse slope and unevenness.

(c) Support pitch

1) The support pitch of steel pipes shall be in accordance with the applicable provisions in 20.3.3(1),(c).

2) Horizontally running cast iron pipes shall be supported at a pitch of less than 1.6 m, and the deformed fittings to be connected shall be supported at a pitch of less than 0.6 m.
In case pipes are connected with rubber, each straight pipe and deformed fitting shall be supported at the connected portion. Vertical pipes shall be supported at least one place on each floor.

20.3.4 HEAT INSULATION WORK

(1) Materials

The heat insulation materials and exterior and auxiliary materials shall be as specified in the table below.

HEAT INSULATION MATERIALS, EXTERIOR AND AUXILIARY MATERIALS

Classification of materials	Specifications
Heat insulation materials	
Glass wool heat insulation material	The glass woold heat insulation tubes shall be in accordance with JIS A 9505 (Glass Wool Heat Insulating Material).
Exterior materials	
Galvanized sheets	The galvanized sheets shall be in accordance with Grade 2 in JIS G 3302 (Galvanized Sheets). The standard thickness of original sheet shall be 0.3 mm when the sheet is used for insulating pipes, valves, etc., and shall have an outside diameter of 250 mm or less. However, in other cases, the thickness shall be 0.4 mm.
Cotton cloth	The weight of cotton cloth shall be 115 g or more per 1 m^2. In case, the cloth is used for pipe, etc., it shall be cut into appropriate tape form width.
Glass cloth	The glass cloth shall be nonalkali plain glass cloth obtained by processing EP21C into a non-fraying type as stipulated in JIS R 3414 (Glass Cloth).

PVC tape (Vinyl tape)	The PVC tape shall be nontacky tape of medium gloss with a thickness of 0.2 mm, and shall be in accordance with JIS Z 1901 (Protective Polyvinyl Chloride Tapes).
Waterproofing temp. cloth (linen)	The waterproofing linen shall be Hessian cloth No. 7 as stipulated in JIS L 3405, over one side of which blown asphalt, as stipulated in JIS K 2207 (Petroleum Asphalt), has been coated. The linen shall be cut into tape form of appropriate widths in case it is used for waterproofing of pipes, etc.
Auxiliary materials	
Molding base paper	The base paper shall be molding base paper of 370 g or more per m^2.
Asphalt roofing	The asphalt roofing shall be the one manufactured in accordance with JIS A 6006 (Asphalt Roofing Felts (Fibre Base) (Self-Finished Bitumen Felts), and more than 17 kg per roll (21 m^2).
Iron wire	The iron wire shall be the one as stipulated in JIS G 3532 (Barbed Wires) which has been galvanized.
Steel frame	In principle, the steel frame shall be the one made of steel sheet with a standard thickness of the original sheet of 0.4 mm or more as stipulated in JIS G 3302 (Galvanized Sheets).

Adhesive PVC tape	The adhesive PVC tape shall be in accordance with JIS Z 1525 (Pressure Sensitive Adhesive Polyvinyl Chloride Tapes) with a thickness of 0.2 mm.
Band and toothed lock washer	The band and toothed lock washer shall have a thickness of 0.2 mm or more, and shall be made from the materials in accordance with JIS G 4305 (Cold Rolled Stainless Steel Sheets and Plates) and/or JIS G 4307 (Cold Rolled Stainless Steel Strips), or JIS H 3201 (Brass Plates). However, the ones made from brass shall be finished by nickel chromium plating. The width of band shall be 20 mm.
Adhesive	In principle, acrylic emulsion adhesive shall be used for adhesion of glass cloth, glass filament mat and aluminum glass cloth. Vinyl acetate adhesive shall be used for adhesion of foamed polystyrene heat insulation materials, and chloroprene rubber adhesive for adhesion of rivets.

(2) Execution

(a) General

1) The thickness of insulation shall be that of the main insulation material, and shall not include the thickness of exterior materials and auxiliary materials.

2) The clearance between mutual insulation materials shall be as small as possible, and in no case shall joints for overlapping sections be provided on the same line.

3) Band and tube shaped coverings shall be tightly bound with galvanized wire. Bands shall be bound at a 50 mm pitch, and tubes shall have two windings at least three places per tube. All overlapping portions and joints of tubes shall be joined together by using adhesive tape.

4) In principle, the width of tape winding shall be 15 mm or more, and that of other overlapping portions shall be 35 mm or more. In the case of waterproof linen wrapping, galvanized wire shall be wound twice over the wrapping at an interval of 2 m, then asphalt primer shall be coated twice over the windings.

5) Tapes shall be wounded starting form the lower part and then proceed to the upper part of piping. Should there be any possibility of deviation in case of polyvinyl chloride tape, etc., such deviation shall be eliminated by using adhesive tape, etc.

6) The lagging plate over the insulation of the pipe shall be carried out in a bend over form, and that of the vent section shall be carried out in fan form.

7) Shakeproof washers shall be attached to the ends of heat insulation sections for indoor piping, and

bands shall be attached to branch and bent sections of the piping.

8) The ends of heat insulation sections shall be protected as required depending upon the types and purposes of heat insulation materials to be used.

(b) Materials and sequence of works according to the types of heat insulation

The materials and the sequence of work according to the types of heat insulation shall be as indicated in the table below.

Type of covering work	Materials and sequence of work (i) Glass wool heat insulation materials	Remarks
a	1. Heat insulation tube 2. Galvanized wire 3. Rough paper 4. Cotton cloth	Outdoor exposed piping
b	1. Heat insulation tube 2. Galvanized wire 3. PVC tape	Inside ceiling and pipe shaft
c	1. Heat insulation tube 2. Galvanized wire 3. Aluminum glass cloth	Ditto
d	1. Heat insulation tube 2. Galvanized wire 3. Asphalt roofing tile 4. Galvanized iron plate	Outdoor exposed piping

(c) Thickness of heat insulation (coverings)

The thickness of insulation shall be as indicated in the table below.

THICKNESS OF INSULATION

(Unit: mm)

Type	Nominal diameter	10	20	25	32	40	50	65	80	100	Remarks
I	Water supply and drainage piping	20	20	20	20	20	20	20	20	25	Glass wool
II	Hot water supply piping	20	20	20	20	20	20	20	20	25	Glass wool

(d) Heat insulation (coverings) for water supply pipes including joints and valves.

1) The materials and sequence of works according to the types of work shall be in accordance with the table in 20.3.4(2)(b) in the above.

2) The thickness of insulation shall be in accordance with the table in 20.3.4(2)(c) in the above.

Place of application	Materials and sequence of work	Thickness of insulation
Indoor exposed piping	(a) - (1)	I
Piping inside ceilings and pipe shafts	(b) - (1)	I
Outdoor exposed piping	(d) - (1)	I

(e) Heat insulation for hot water supply piping including

joints and valves

1) The materials and sequence of work according to the types of work shall be in accordance with the table in 20.3.4(2)(b) in the above.

2) The thickness of the insulation shall be in accordance with the table in 20.3.4(2)(c).

Place of application	Materials and sequence of work	Thickness of insulation
Indoor exposed piping	(a) - (1)	II
Piping inside pipe shafts, ceilings and concrete	(c) - (1)	II

(f) Heat insulation for drainage and air vent pipes including joints.

1) The materials and the sequence of work according to the types of work shall be in accordance with the table in 20.3.4(2)(b) in the above.

2) The thickness of the insulation (coverings) shall be in accordance with the table in 20.3.4(2)(c) in the above.

Place of application	Materials and sequence of work	Thickness of insulation
Indoor exposed piping	(a) - (1)	I
Piping inside ceilings and pipe shafts	(b) - (1)	I

(g) No insulation shall be provided for the following pipes,

valves and flanges.

1) Devices and piping, including drainage pipe on the floor below sink, which are considered accessories for sanitary wares.
2) Piping for water supply and drainage underground or inside concrete.
3) Water supply piping laid indoors, excluding the piping to be laid inside ceilings and highly humid areas.
4) Hot water supply piping, valves and flanges
5) Outdoor exposed drainage piping
6) Air vent piping, excluding the portion of 100 mm from the branch point of drainage pipe.
7) Overflow pipes and drain pipes for various tanks and similar equipment.

20.3.5 PAINTING WORK

(1) General

All respective equipment and materials, except the followings, shall be painted.

Equipment and materials, except those requiring corrosionproof painting, to be buried

(2) Painting

The types of paints and frequency of painting of portions to be painted shall, in principle, be as specified in the table hereafter.

20.3.6 CIVIL WORKS

Items other than those specified in the following shall be in accordance with the specifications for "Architectural Works".

(1) The pit for piping under the ground shall be excavated so that the required gradient can be kept precisely and the piping can be connected easily.

(2) The foundation and pit for tanks, etc., shall be properly excavated by taking into account the space for assembly and removal of forms.

20.3.7 TEST

(1) Electric water heater

(a) The hydrostatic test shall be carried out for the instantaneous type electric water heater.

(b) The hydrostatic test pressure shall be 17.5 kg/cm^2 (Shop test).

(2) Water supply pipes

The hydrostatic test of water supply pipes shall be carried out prior to coating work during piping work, or prior to shielding and backfilling, or after completion of piping. The minimum pressure retention time shall be 60 minutes.

(a) The test pressure of piping below elevated water tanks shall be twice the pressure equivalent to the static head. However, the minimum pressure shall be 7.5 kg/cm^2.

(3) Hot water supply pipe

The hydrostatic test of the hot water supply pipes shall be carried out in accordance with the test procedures in

20.3.7(2).

(4) Drainage pipes

The water filling test of the drainage pipes shall be carried out prior to coating work during piping work, or prior to shielding and backfilling, or after completion of piping. The water passage test of sanitary drain pipes shall be carried out after sanitary wares, etc., have been attached. The minimum water retention time in case of water filling test shall be 30 minutes or more, and that in case of water passage test shall be 15 minutes or more.

TYPES OF PAINTS AND FREQUENCY OF PAINTING OF RESPECTIVE PORTIONS

Portions to be painted		Types of paints	Frequency of painting			Remarks
Equipment and menbers	Conditions		Primer painting	Inter-coating	Face coating	
Supports, racks and similar fittings (Other than galvanized materials)	Exposed	Ready-mixed paint or aluminum paint	2	1	1	The primer coating shall be anti-corrosive paint.
	Concealed	Anticorrosive paint	1	-	1	----------
Heat-insulated exterior (cotton and cloth)	Exposed	Ready-mixed paint	1	1	1	The primer coating shall be sealer coating.
	Concealed	Sealer coat	1	-	1	----------
Heat-insulated exterior (Glass cloth)		Synthetic resin emulsion paint	1	1	1	After the glass cloth has been precisely bonded and made sufficiently dry, synthetic resin emulsion paint as stipulated in JIS K5663 shall be used.
	Exposed	Polyvinyl chloride resin enamel	1	1	1	After the glass cloth has been precisely bonded and made sufficiently dry, emulsion putty shall be applied twice, and after surface finish with paper file, resin enamel shall be
Heat-insulated exterior (Galvanized iron plate/ board)	Exposed	Ready-mixed paint	1	1	1	The primer coat shall be anti-corrosive paint.
				Second coating		
Lined steel pipes and coated steel pipes including joints	Exposed	Ready-mixed paint	2	1	1	The primer coating shall anti-corrosive paint.
	Concealed	Anti-corrosive paint	1	-	1	Excluding resin-coated joints

21. AIR CONDITIONING AND VENTILATION EQUIPMENT WORK

21.1 GENERAL

21.1.1 SCOPE

This clause covers the performance of all air conditioning and ventilation equipment works in accordance with the Drawings and these Specifications.

(1) Air conditioning equipment work

(2) Ventilation equipment work

(3) Secondary electrical and automatic control work

The Contractor shall submit shop drawings of fabricated items to the Engineer for approval. The shop drawings shall clearly show the details of fabrication, installations, dimensions, sizes, operation, methods of anchoring and all pertinent details required for satisfactory installation.

21.1.2 DESIGN BASIS OF AIR CONDITIONING SYSTEM AND VENTILATION SYSTEM

(1) Design criteria

(a) Air conditioning system

Outdoor

42°C	Dry bulb
28.6°C	Wet bulb

Room

24±2	Dry bulb
50±5%	Relative humidity

(b) Ventilation system (change of air)

GIS room	5	times/h
Battery room	10	"

Lavatory room	10	"
Storage room	5	"
Baldia GIS Station	10	"
Shower room	10	"

(c) Minimum ventilation air

25 m^3/h.person

(2) System Description

(a) Baldia Gris Station

1. Ventilation System

The following rooms shall be ventilated.

(i) Baldia Grid Station

1.1 System Description

The rooms shall be ventilated by natural air supply and forced exhausting systems. Outdoor air shall be treated for removal of dust and other foreign matter before supply into the respective rooms.

(b) Substation

1. Air conditioning system

The air conditioning system shall be intended to perform air conditioning of the control rooms in the substation.

1.2 System description

The air conditioning system shall consist of air cooled packaged air conditioning.

2. Ventilation system

The following rooms shall be ventilated.

(a) Battery room

(b) Lavatory

(c) Locker room

2.1 System Description

The rooms shall be ventilated by natural air supply and forced exhausting systems. Outdoor air shall be treated for removal of dust and other foreign matter before supply into the respective rooms.

21.2 EQUIPMENT AND MATERIALS

21.2.1 Air Cooled Packaged Air Conditioner

(1) Configuration

The air cooled packaged air conditioner shall consist of the compressor, motor, blower, power transmission device, air-cooled condenser, cooler, casing, safety device, accessories, etc., and have a specified function with minimal noise and vibration during operation. The air conditioner shall be equipped with a heater (electric heater), humidifier, air filter and other necessary pertinents as required.

(2) Compressors

The compressor shall be of a totally closed or semi-closed type, perfect in dynamic and static balances during operation and equipped with a sufficient lubrication system and shaft sealing device (except in the case of closed type) free from leakage. The compressor shall be of a rigid construction and have specified performance to withstand long time operation.

A capacity control system shall be provided for automatic control of the capacity by means of suction gas pressure or temperature or chilled water temperature, and shall be equipped with a low load starting device.

(3) Motor

The motor to be used shall be according to the standard specifications of the manufacturer.

(4) Power transmission device

The power transmission device of the compressor shall be of a directly coupled to motor type, and that of the blower for air-cooled type condenser shall be of a directly coupled to motor type, or V-belt driven type. Both power transmission devices shall have minimal loss and designed to ensure safe transmission of power. In the case of the V-belt driven type, a belt cover shall be provided as required.

(5) Casing

The external packaging of the casing of indoor unit shall be according to JIS G 3141 (Cold Rolled Carbon Steel Sheets and Strip), galvanized steel plate or electro-galvanized steel plate, and be sufficiently reinforced. The packaging shall be provided with mounting seats for prevention of overturning as necessary. The casing of the outdoor unit shall be according to the relevant items for condenser in Paragraph 21.2.1.

The steel plate thickness of the casings for the indoor and outdoor units shall be as indicated in the table below.

Plate thickness of casing for indoor and outdoor units

(Unit: mm)

Total output of compressor	Plate thickness
7.5 kW or less	0.8 or more
Over 7.5 kW and less than 37 kW	1.0 or more

(6) Thermal insulation materials

The internal surface of the casing which comes into contact with conditioned air shall be lined with glass wool heat insulation material No. 2 40 K designated in JIS A 9505 (Heat Insulator Made of Grass Wool), or equivalent, and the surface shall be treated by using non-flammable materials to prevent dispersion of fibrous materials.

Thickness of the heat insulation materials shall be qualified through the dewing test designated in JIS B 8615 (Testing Methods for Unitary Air Conditioner).

(7) Drain pan

The drain pan shall be made of steel plate with a thickness of not less than 1.0 mm, or stainless steel plate with a thickness of not less than 0.6 mm, with perfect water tightness and sufficient gradient, and provided with a downstream side.

The external surface shall be provided with non-flammable heat insulation materials to prevent dewing. The internal surface of the drain pan made of steel plate shall be treated for rust prevention by using epoxy resin paint, etc.

(8) Condenser

The air-cooled type condenser shall consist of coil with fin, blower and motor, and casing. The coil material shall be made of copper tube corresponding to C1020, C1201 or C1220 in JIS H-3300 (Copper and Copper Alloy Seamless Pipes and Tubes).

The fin material shall consist of not less than 99% of aluminum content designated in JIS H-4000 (Aluminum and Aluminum Alloy Sheets and Plates, Strip and Coiled Sheets).

The contact section between the tube and fin shall be so

designed as to minimize heat transfer resistance.

The fin shall undergo corrosionproof surface treatment by the chromate method, acrylic resin coating or other suitable method. Protective measures against fin damage shall be taken, if required.

The casing shall be made of steel plate or glass fiber reinforced polyester resin with sufficient be reinforcment.

In the case where steel plate is used, the steel plate thickness shall be as indicated in the table below, and sufficient corrosionproof treatment shall be provided by acrylic resin coating, melamine baking finish, epoxy resin coating or other appropriate methods.

Steel plate thickness of casing

(Unit: mm)

Total output of compressor	Plate thickness
Less than 37 kW	1.0 or more
37 kW or more	1.2 or more

(9) Cooler (Cooling unit)

Refer to Item (8) "Condenser" in Paragraph 21.2.1.

(10) Air filter

The air filter to be used shall be according to the standard specifications of the manufacturer. In case the total output of the compressor is not smaller than 22 kW, the air filter shall meet the following requirements.

The filter material/medium shall be installed inside a frame made of rust-prevention treated steel plate, aluminum plate or extruded aluminum shape, and shall have a construction having

filter material holders on both surfaces of the filter material permitting easy mounting and dismounting. The filter material shall have the characteristics indicated for the filter material unit of panel type air filter. As a result of the Type 3 Test designated in JIS B 9908 (Air Filter Units for Ventilation), the collection efficiency at a planar wind velocity of 2.5 m/sec. and the dust retaining capacity shall, respectively, be not smaller than 25% and 410 g/m^2, and the initial resistance not higher than 5.5 mmH_2O.

(11) Protective/safety devices

In principle, the protective safety devices shall be equipped with the necessary relays, etc., as given below.

(a) The relays shall be activated when the condensate pressure becomes excessively high and when the steam/vapor pressure excessively drops (except in the case of using a totally closed compressor)

(b) Water supply suspension relays shall be activated at the time of excessive reduction of chilled water or suspension of water supply

(c) Hydraulic pressure (oil pressure) relays shall be activated at the time of drop of hydraulic pressure of compressor in case the hydraulic pressure of compressor has exceeded 1 kgf/cm^2)

(d) Protective thermostat shall be activated at the time of overheating of compressor motor coil and exhaust gas thermostat shall be activated due to overheat of compressor exhaust gas

(e) Excessive temperature rise preventive device and temperature

fuse (In case electric heater is installed)

(12) Coolant

Refer to relevant items in Paragraph 21.2.1.

(13) Painting

Painting shall be accordance with the standard practices of the manufacturer.

(14) Accessories

a) Control panel : One (1)

b) Pressure gauge and hydraulic pressure gauge, as required : One (1) complete set

c) Necessary spare parts : One (1) complete set

d) Foundation bolt and fittings : One (1) complete set

e) Nameplate (Name of manufacturer, date of manufacture, performance, etc., shall be clearly indicated).

21.2.2 AIR FILTER

(1) Configuration

The air filter shall consist of a filter, automatic filter replacement mechanism, casing and control panel, and shall be of a construction so as to permit easy maintenance and inspection. Winding up of filter shall be performed automatically.

(2) Filter unit

The filter unit shall be housed inside a frame made of corrosion-proof treated steel plate (JIs G3141) or aluminum

plate (JIS H4000), and supported so that the filter will not be deformed due to strong wind. In principle, the size of the filter shall be 500 mm x 500 mm.

a. Flame retardant or incombustible.

b. Low moisture absorption.

c. Free from putrefacation and mold.

(3) Automatic filter replacement mechanism

The automatic filter replacement mechanism shall be activated by a filter winding-up control timer provided on the control panel, and shall be designed so as to ensure precise operation.

(4) Casing

The casing shall be made of steel plate (JIS G3141), reinforced as required, and of a construction so as to permit easy replacement of the filter.

21.2.3 CENTRIFUGAL FAN

(1) Centrifugal fan

The centrifugal fan shall have sufficient dynamic and static balance by adjustment with a balancing machine. The fan shall not produce excessive noise or vibration during operation, and shall have excellent performance.

Multiblade fans, if used, shall be as specified below or according to JIS B8331 (Forward-Curved Bladed Fans).

(2) Casing

The casing shall be made of steel plate specified in JIS G3101 (Rolled Steel for General Structure) or JIS G3141 (Cold Rolled Carbon Steel Sheets and Strip), and shall be

formed and reinforced rigidly by welding or riveting so as to prevent deformation, vibration and leakage of air from connected parts. The casing shall be of a construction permitting easy installation and smooth operation. Where required, a water relief shall be provided at the lower part of the casing.

(3) Blades

The blades shall be composed of steel plate or other materials having sufficient strength, formed and fabricated accurately into uniform profile, and attached firmly to the main plate and side plate which shall be clamped or joined to the impeller boss by welding, riveting or bolting. The blades shall have a sufficient strength so as not to be deformed during high speed operation. Where necessary, the side plate shall be reinforced by stay bolts.

(4) Shaft

The shaft shall be composed of material S30C in JIS G4051 (Carbon Steels for Machine Structural Use) or special steel. The bearing shall withstand radial and thrust loads, and shall be trouble-free operated under long time continuous use.

(5) Motor

The motor for the centrifugal fan shall be as specified in PART II.

(6) Accessories

The following accessories shall be provided.

a. V-belt wheel (in case of belt-driven): One (1) set

b. V-belt (same as above): One (1) set

c. V-belt protection cover
(Same as above): One (1) set

d. Companion flange: One (1) set

e. Common bed made of section
(where necessary): One (1) set

f. Suction hole wire net
(where necessary): One (1) set

g. Foundation bolt or clamping
bolt: One (1) set

h. Nameplate (indicating name of manufacturer, date of manufacture, model No., performance, etc.)

21.2.4 DUCT AND ACCESSORIES

(1) Materials for duct

(a) Galvanized sheet

The galvanized sheet shall be as designated in JIS G3302 (Galvanized Sheets).

(b) Steel

The steel to be used for duct shall be as designated in JIS G3101 (Rolled Steel for General Structure), and the dimensions, etc., of the duct shall be in compliance with JIS G3191 (Shape, Dimensions, Weight and Tolerance for Hot Rolled Steel Bars and Bar-in-Coil), JIS G3192 (Dimensions, Weight and Permissible Variations of Hot Rolled Steel Sections), and JIS G3193 (Dimensions, Weight and Permissible Variations of Hot Rolled Steel Plates, Sheets and Strip).

(c) Rivet

The rivet shall be as designated in JIS B1213 (Cold Headed Rivets).

(d) Bolts and nuts

The bolts and nuts shall be as designated in JIS G1180 (Hexagon Head Bolts) and JIS B1181 (Hexagon Nuts), respectively.

(e) Flange packing

The flange packing shall be asbestos tape having a thickness of 3 mm using JIS R 3450 (Asbestos Yarns and Twisted Ropes).

(2) Supply diffuser

The supply diffuser shall be designed so as to minimize noise and ensure adequate supply function, and shall be of a rigid construction so as to permit easy adjustment of the air volume. The damper and shutter behind the supply diffuser shall be made of steel plate (JIS G3141) with a thickness of 0.5 mm or more, or aluminum plate (JIS H4000) with a thickness of 1.0 mm or more (in case of a bag form, the thickness of a single face shall be 0.5 mm or more), or aluminum extruded shape (JIS H4100).

(a) The diffuser proper shall be made of aluminum (JIS H4000 or JIS H4100) or steel plate (JIS G3141) with a damper and rectifier. The thickness of external cone shall be 0.6 mm (0.8 mm or more in case aluminum made) or more in case the neck diameter is less than 250 mm, and 0.8 mm (1.0 mm in case of aluminum made) or more where the neck diameter is 250 mm or larger.

(b) The clamping frame and movable/adjustable blades for universal type supply opening shall be made of aluminum (JIS H4000 or JIS H4100) or steel plate (JIS G3141). The plate thickness of the frame shall be 1.0 mm or more. The packing for clamping shall be made of sponge rubber or felt with a thickness of 5 mm or more. The blades shall be of easily adjustable construction, and the shutter shall be of the double hinged type.

(3) Suction diffuser

The suction diffuser shall be of a rigid construction permitting easy adjustment of the air volume and shall have sufficient suction performance with low noise.
The clamping frame and slit shall be made of aluminum (JIS H4000 or JIS H4100) or steel plate (JIS G3141), and the plate thickness of frame shall be 1.2 mm or more. The shutter behind the suction diffuser shall be made of steel plate (JIS G3141) with a thickness of 1.0 mm or more, or aluminum (JIS H4000 or JIS H4100).

(4) Damper

The damper shall be composed of a casing and adjustable blades, and shall have adequate performance with minimum vibration and noise as well as minimum resistance to air flow.
The casing and adjustable blades shall be made of steel plate (JIS G3141) with a thickness of 1.2 mm or more.
In case two or more blades are used, opposed blades shall, in principle, be adopted.
The number of blades shall, in principle, be one (1) per

250 mm of duct height with overlapping portion of mutual blades being about 15 mm in the case of the rectangular type. In the case of the circular type, a single blade shall be used. A damper shaft of galvanized steel bar and a bearing of bronze or brass shall be attached to the casing. In case the damper is operated manually, a closing indicator of cast iron, steel plate or bronze shall be provided.

21.3 EXECUTION OF THE WORK

21.3.1 FOUNDATION AND INSTALLATION OF EQUIPMENT

(1) Foundation for equipment

The foundation for equipment shall be of a reinforced concrete or concrete construction withstanding the weight of the equipment and external forces and having a bearing surface sufficient for installation of equipment, and shall be built on the floor or ground of sufficient bearing capacity.
The surface of the foundation shall be finished by mortar coating, and the equipment installation surface shall be finished to a horizontal level.

(2) Installation of equipment

All equipment shall be installed and fixed firmly by using anchor bolts, etc., with sufficient strength in accordance with the drawings so that the equipment will be free from overturn, sliding or other trouble due to seismic force.

21.3.2 FABRICATION AND ERECTION OF DUCT

(1) General provisions

All ducts for air conditioning and ventilation systems shall be made of galvanized steel plates as specified below.

Unless set forth particularly in the special provisions, the rectangular duct shall be of the low velocity type.

a. The duct shall be of such a construction as to have minimal resistance to air flow, and minimum leakage, noize and vibration, and shall be free from deformation caused by differential pressures inside and outside the duct.

b. The inner radius of curved portion of duct shall not be smaller than the diameter of duct in the case of spiral duct, and not smaller than the width in the direction of radius in the case of rectangular duct. Should it be impossible to meet the dimensions mentioned above, guide vanes shall be provided as required.

c. Whenever the shape of cross-section of duct is changed, it shall be enlarged or decreased gradually without any sudden change, and the angle of inclination shall be within 15^{o}. However, should it be difficult to keep the angle within the above limit, the angle may be within 30^{o}.

(2) Plate thickness of duct

The thickness of plate for low velocity duct (with a maximum air velocity of 15m/sec. or less) shall be as specified in the table below.

In case the dimensions of duct vary at both ends of the duct, the maximum plate thickness shall be adopted.

Duct size	Metal Gauge	Thickness
Less than 450	#26	0.5 mm
455 - 750	#24	0.6
755 - 1500	#22	0.8
150 - 2250	#20	1.0
More than 2260	#18	1.2

(3) Connection of duct

a. Connection of duct shall be performed by using the joining materials specified in the table below.

b. Joining of duct with flanges shall be performed at four (4) corners, and the welds on the contact surface of duct with flanges shall be finished to a smooth and flat surface. The required number of holes shall then be drilled.

c. Joining of duct with flanges shall be carried out by using asbestos tape having the same width as that of the flanges, and the flanges shall be tightly clamped with bolts so as to prevent air leakage.

Duct Flanges

Thickness	Shape	Max	Bolt		Rivet	
	Steel	Pitch	Dia.	Pitch	Dia.	Pitch
0.5 mm	25x25x3	1.8 m	8.0mm	100mm	4.5mm	65mm
0.6	25x25x3	1.8	8.0	100	4.5	65
0.8	30x30x3	1.8	8.0	100	4.5	65
1.0	40x40x3	1.8	8.0	100	4.5	65
1.2	40x40x5	1.8	8.0	100	4.5	65

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(4) Supports of duct

Metal hangers and supports for vertical duct shall be as specified in the table below, and vibration absorbing materials shall be attached, as required, to prevent propagation of vibration. The length of steel sections for hangers shall be the same as the lateral width of the flanges for joining.

Duct Hangers

Thickness	Shape Steel	Steel Rod Dia.	Max. Pitch
0.5mm	25 x 25 x 3	9 mm	3.6 m
0.6	25 x 25 x 3	9	3.6
0.8	30 x 30 x 3	9	3.6
1.0	40 x 40 x 3	9	3.6
1.2	40 x 40 x 5	9	3.6

21.3.3 INSULATION WORK

21.3.3.1 Materials

(1) Ductwork

(a) Specifications for heat insulation coverings.

Classification of heat insulation coverings		Specifications
Heat insulation materials	Glass wool heat insulation materials	Glass wool heat insulation board shall be No. 2 40K stipulated in JIS A 9505 (Glass Wool Heat Insulation Material).
Exterior materials	Glass cloth	Glass cloth shall be the non-alkali plain weave clothes as stipulated in EP21C in JIS R 3414 (Glass clothes) which have been made free from fraying.
	Aluminum glass cloth	Aluminum glass cloth shall be the flat weave cloth made of aluminum foil with a thickness of 0.02 mm or more as stipulated in JIS H 4160 (Aluminum and Aluminum Alloy Foils), to which the plain weave cloth made of 13 micron glass yarn and 200 single filament yarn according to JIS R 3414 with a unit weight of 85 g or more per m^2 are bonded with acrylic resin adhesive.
Auxiliary materials	Glass filament mat	Glass filament mat shall be made of glass yarn of 18 micron or less according to JIS R 3413 and shall have a unit weight of 45 g or more per m^2.
	Rivet	Rivet shall comprise a washer made of galvanized steel plate to which a nail with a length to be changed depending upon the thickness of heat insulation materials is built in, or the copper-plated nail for spot welding, and shall have a strength sufficient to bear the insulation materials.
	Steel frame	In principle, steel frame shall be made of steel plate with a standard plate thickness of 0.4 mm or more as stipulated in JIS G 3302 (Galvanized Sheets).
	Adhesive	In principle, acrylic emulsion adhesive shall be used for bonding of glass cloth, glass filament mat and aluminum glass cloth, and chloroprene rubber adhesive shall be used for bonding of rivet.

(b) Materials and procedures depending upon the types of heat insulation work.

Classification of insulation work	Order of insulation work
Insulation of exposed interiors	1. Rivet 2. Heat insulation board with a thickness of 50 mm 3. Corner patch and seal up 4. Adhesive 5. Glass clothes
Indoor, concealed	1. Rivet 2. Heat insulation board with a thickness of 25 mm 3. Adhesive 4. Aluminum glass cloth

Note: Galvanized steel plate with a thickness of 0.2 mm or more shall be used for corner patches, and glass filament mat shall be used for seal-up.

21.3.3.2 EXECUTION

(1) The thickness of coverings shall be that of the insulation materials, and shall not include the thickness of exterior materials or auxiliary materials.

(2) The mutual clearance between the respective insulation shall be as small as possible, and no overlapping joints shall be provided on the same line.

(3) In principle, two rivets shall be driven into the lower and side surfaces and one rivet into the upper surface of the air duct at intervals of 300 mm each.

(4) The portion or air duct penetrating through the floor shall be covered with stainless steel from the floor surface to a

height of up to 150 mm in order to protect the insulation.

(5) The outermost ends of the insulation shall be protected as required depending upon the materials and purpose of heat insulation.

(6) Heat insulation work for inspection doors, etc., of equipment requiring such insulation shall be carried out so as not to cause hindrance during opening and closing of such doors, etc. nor deterioration of the said heat insulation.

21.3.4 PAINTING WORK

21.3.4.1 GENERAL

a. All equipment and materials, except for the following, shall be painted.

i) Surfaces other than galvanized surfaces

ii) Galvanized portions which are normally concealed

b. All equipment and materials requiring inspection shall be painted after inspection.

21.3.4.2 PAINTING

a. The types of paints and frequency of painting of the respective portions shall, in principle, be as specified in Clause 20.3.5. Unless specified in this table, such painting shall be carried out according to similar items taking into account the work purposes, materials and other conditions.

21.3.5 TESTS

21.3.5.1 EQUIPMENTS

(1) The Contractor shall execute the following shop tests, and shall submit the test and inspection reports to the Engineer for approval.

(a) Material test

(b) Dimension check

(c) Performance test

(d) Vibration check

(e) Noise check

(2) The Contractor shall execute the following field tests, and shall submit the test and inspection reports to the Engineer for approval.

(a) Performance test

(b) Motor test (isolated)

(c) Vibration check

(d) Noise check

21.3.5.2 DUCT

The Contractor shall execute the following field tests, and shall submit the test and inspection reports to the Engineer for approval.

(a) Air flow test of each diffuser

21.3.5.3 TRIAL TEST

The Contractor shall execute the trial test for adjustment of each equipment in each building after installation of all equipment. The Contractor shall submit the test and inspection reports to the Engineer for approval.

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22. SECONDARY ELECTRICAL WORK

22.1 GENERAL

The Contractor shall perform all secondary electrical work as stipulated in the Specifications of PART II.

22.2 AUTOMATIC CONTROL FOR VENTILATION AND AIR CONDITIONING SYSTEMS

(1) The Contractor shall furnish and install a complete electric system of automatic temperature control as manufactured by Honeywell or equivalent.

(2) All wiring in connection with the control system shall be provided by the Contractor as stipulated in the Drawings.

(3) Wiring shall include furnishing of all wire and miscellaneous materials required for mounting and connecting the electrical control devices.

(4) After completion of installation, the Contractor shall adjust all thermostats and other equipment necessary for satisfactory completion of the work.

23. DISMANTLING WORKS

23.1 GENERAL

This clause covers all dismantling works of existing foundations, structures, pipings cables, etc., specified in the scope of work in accordance with the Drawings and these Specifications.

The Contractor shall furnish all materials, equipment and labor for the performance of the dismantling work, including temporarily used materials necessary for dismantling.

Temporary work and earth work in the dismantling works shall comply with clause 1. Temporary work and clause 2. Earth work of this Specifications, respectively.

23.2 CONCRETE BREAKING (DISMANTLING OF CONCRETE STRUCTURES)

For dismantling the concrete structures, the structural concrete shall be crushed into pieces within a 30 cm diameter and immediately be transported to and disposed of at a proper place outside the plant site. This crushing shall be carried out by using appropriate machines having low noise and vibration.

The machines to be selected for use shall be sufficient in capacity and quantity to complete the dismantling works within the work period, and the type of the machines to be used shall be approved by the Engineer.

23.3 ASPHALT BREAKING (DISMANTLING OF ASPHALT STRUCTURES)

For dismantling of asphalt structures, including dismantling of road bed, the portion of the pavement of road within the plant site and that on the slope of the foundation of fuel oil storage

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tanks shall be broken, and such broken asphalt shall immediately be transported to and disposed of at a proper place outside the plant site.

23.4 DISMANTLING WORK OF MISCELLANEOUS STEEL MATERIALS

This dismantling work is intended to dismantle the grating, girdrail, corner angle and other steel materials attached to the structures to be dismantled. Any steel materials dismantled by the Contractor shall immediately be transported to and disposed of at a proper location.

23.5 REMOVAL OF VEGETATION

This removal of vegetation covers the felling of trees sod, turf etc., and the complete removal of their roots within the site.

23.6 DISMANTLING OF STEEL STRUCTURE

The steel structure shall be dismantled successively by fusion-cutting of the beams after being brought down by a crane, with final dismantling of the columns. This work shall be repeated from dismantling of the lower columns and beams.

23.7 DISMANTLING OF SLAB, TRENCH AND FOUNDATION

The slab and foundation on the first floor shall be dismantled by combined use of the pressure crusher and crane, and openings formed by dismantling shall be backfilled with soil of appropriate quality.

23.8 DISMANTLING OF DISCHARGE PIPES (CAST IRON PIPES) FROM "B" STATION

The dismantling work of discharge pipes for "B" station shall be executed by the Contractor as follows, and before the commencement of the dismantling work at each station, the Contractor shall submit the actual working plan and schedule table to the Engineer for approval.

i) At first, it is necessary for the dismantling work to execute the sheathing works (the driving work of the steel sheet piles, the setting work of the steel members for the sheathing, etc.) before the commencement of the excavation work.

ii) After the sheathing work, the excavation work shall be executed at the surroundings of the existing discharge pipes for exposing the full view of pipes.

iii) After the completion of the excavation work, the closing work of the existing discharge pipes shall be executed at the appropriate place, for example, the existing terminal pit under the Dockyard Road, in order to shut off the seawater from outlet, and after that, the dewatering work for the internal water of the existing discharge pipes, which are located from the terminal pit to "B" station, shall be executed before the commencement of the dismantling work.

iv) After the completion of the dewatering work, the dismantling work of the existing discharge pipes shall be executed at the inside of Plant, then the Contractor shall set up the temporary cut-off wall for the discharge pipes under the boundary line of Plant for the dismantling work of the

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discharge pipes (at the outside of Plant) due to the Lot I Contractor.

v) After the setting work of the cut-off wall for the existing discharge pipes, the backfilling work and the removal work for the sheathing wall (consists of the steel sheet piles, the steel members, etc.) at the excavation area shall be executed in accordance with the provisions of Clause 2.4 and 2.7 of the Specification.

# PLAN 19
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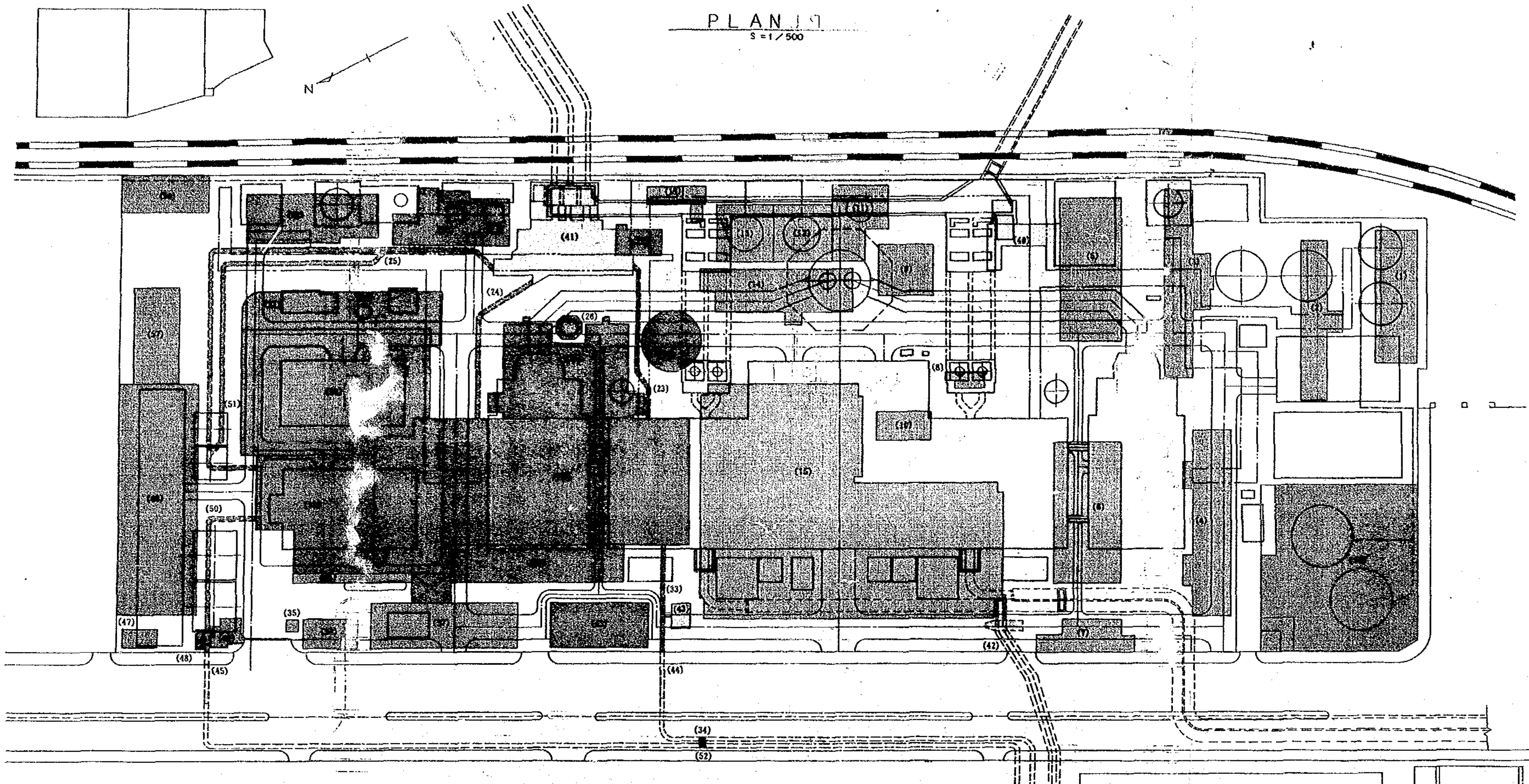

No. Name of facility and structure

1. Dismantling work inside Unit 1 construction area
   - (1) Staff Quaters No.1
   - (2) Staff Quaters No.2
   - (3) Officer's Flats
   - (4) Shift Engineer's Flat
   - (5) Store Shed No.1
   - (6) Store Shed No.2
   - (7) Canteen
   - (8) Underground Tank
   - (9) Ground Reservoir
   - (10) Wall
   - (11) Oil Tank No.1
   - (12) Oil Tank No.2
   - (13) Oil Tank No.3
   - (14) Instrument and Control Room
   - (15) A Station (Boiler and Turbine Room)
   - (16) Sanitary Block and Sewage Pump room
   - (17) Also, roads, trees, drainage facilities, cables and etc. Inside of Unit 1 area

2. Dismantling work inside of Unit 2 construction area

   Category B Station
   - (18) Boiler Room B Station Superstructure(Above ground floor level)
   - (19) Turbine Room B Station Including Transformer Bay(Above ground floor level)
   - (20) Stack B Station(Above ground floor level)
   - (21) Misc. Foundations and Wall(Above ground floor level)

   Category BX Station
   - (22) Switch Room
   - (23) Intake Water Pipe for BX Station No.1
   - (24) Intake Water Pipe for BX Station No.2
   - (25) Intake Water Pipe for B Station
   - (26) Stack BX Station(Above ground floor level)
   - (27) Boiler structures BX Station(Above ground floor level)
   - (28) Turbine Room BX Station(Above ground floor level)
   - (29) Transformer foundations for BX Station (Above ground floor level)
   - (30) Electric Shop, Raw Water Service Pump etc.
   - (31) Machine Shop and Store
   - (32) C.W.Tank
   - (33) Discharge Water Pipe for BX Station
   - (34) Closing work of C.W.Discharge Line for BX Station at Terminal Chamber

   Category Administration Building
   - (35) Guard house
   - (36) Car Parking
   - (37) Administration Building
   - (38) Cable Trench
   - (39) Also, roads, trees, drainage facilities, cables and etc. inside of Unit 2 area

3. Dismantling works to be carried out by Lot-I Contractor
   - (18) Boiler Room B Station Substructure(Below ground floor level)
   - (19) Turbine Room B Station Substucture including Transformer Bay(Below ground floor level)
   - (20) Stack B Station Substructure(Below ground floor level)
   - (21) Misc. Foundations and Wall(Below ground floor level)
   - (26) Stack BX Station Substructure(Below ground floor level)
   - (27) Boiler structures BX Station Substructure (Below ground floor level)
   - (28) Turbine Room BX Station Substructure (Below ground floor level)
   - (29) Transformer foundations for BX Station (Below ground floor level)
   - (40) C.W.Pump House for A Station
   - (41) C.W.Pump House and Screen for B, BX Stations
   - (42) Discharge Sump for B Station
   - (43) Sewer Sump and Pumping Station
   - (44) C.W.Discharge Pipe for BX Station (partial)
   - (45) C.W.Discharge Pipe for B Station (partial)

4. Dismantling works to be carried out by Lot-IIA Contractor
   - (46) 66kV Switchyard (outdoor)
   - (47) Pressure Tank
   - (48) City Water receiving Pit
   - (49) Dispensary
   - (50) Discharge Water Pipe for B Station (partial)
   - (51) Intake Water Pipe for B Station (partial)
   - (52) Closing work of C.W.Discharge Line for B Station at Terminal Chamber
   - (53) Also, roads, trees, drainage facilities, cables and etc. inside of Substation area and Transformer yard area

5) Structures not to be dismantled at this Project
   - (54) Fuel Oil Storage Tanks
   - (55) 11kV Switchgear Building
   - (56) Sui Gas Compound
   - (57) 66kV Switch Station Building

LEGEND :

Color	Structure No.	Area of Dismantle	Contractors
	(1) - (17)	Category "A" & Flats	Lot-II
	(18) - (21)	Category "B"	Lot-III
	(18) - (21)	Category "B" Substructure	Lot-I
	(22) - (34)	Category "BX"	Lot-III
	(26) - (29)	Category "BX" Substructure	Lot-I
	(35) - (39)	Category Adml.	Lot-III
	(40) - (45)		Lot-I
	(46) - (53)	Category Substation	Lot-IIA
	(54) - (57)	Not to be dismantled	

PAKISTAN

KARACHI ELECTRIC SUPPLY CORPORATION

WEST WHARF THERMAL POWER PLANT PROJECT

UNITS NO.1 AND NO.2

DISMANTLING WORKS
(Civil & Architectural)

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO JAPAN

APPROVED BY	REVIEWED BY	CHECKED BY	DRAWN BY

DRAWING NO.	SCALE	DATE
	1/500	