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.

22.3.4 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

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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 23.3.4 (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 22.3.3 (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 22.3.4(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.

22.3.5 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 22.3.5(2)(b) in the above.

2) The thickness of insulation shall be in accordance with the table in 22.3.5(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 22.3.5(2)(b) in the above.

2) The thickness of the insulation shall be in accordance with the table in 22.3.6(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 22.3.5(2)(b) in the above.

2) The thickness of the insulation (coverings) shall be in accordance with the table in 22.3.5(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.

22.3.6 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.

22.3.7 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.

22.3.8 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 22.3.8(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 Second coating	1	The primer coat shall be anti-corrosive paint.
Lined steel pipes and coated steel pipes including joints	Exposed	Ready-mixed paint	2	1	1	The primer coating shall anti-corossive paint.
	Concealed	Anti-corrosive paint	1	-	1	Excluding resin-coated joints

23. AIR CONDITIONING AND VENTILATION EQUIPMENT WORK

23.1 GENERAL

23.1.1 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.

23.1.2 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
55±5%	Relative humidity

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(b) Ventilation system (change of air)

Turbine room	7	times/h
Battery room	10	"
Lavatory room	10	"
Storage room	5	"
Cable treatment area	5	"
Kitchen room	10	"
Shower room	10	"
Locker room	10	"
Machine shop	10	"
Electrical room	20	"
Water treatment equip. room	20	"
Cholorination equip. area	20	"

(c) Minimum Ventilation Air

25 m^3/h.person

(2) System Description

(a) Main powerhouse

1. Air conditioning system

The air conditioning system shall be intended to realize air conditioning of the control room, central control room, shift room, office rooms, etc. in the main powerhouse.

1.1 System description

The air conditioning system shall consist of air-cooled type chillers, and be designed to perform air conditioning by supplying chilled water into the air handling units. The air conditioning zones shall be divided into the following four areas.

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(i) System for Computer Room

a) Computer room

(ii) System for Control Equipment Rooms

a) Control equipment room

(iii) System for Central Control Room

a) Central control room

b) Shift room

c) Conference room

(iv) System for Labo Room

a) Labo room

2. Ventilation system

The following rooms will be ventilated.

(a) Battery room

(b) Storage room

(c) Lavatory

(d) Locker room

(e) Turbine room

(f) Analysis room

(g) Cable treatment area

(h) Air conditioning machine room

2.1 System Description

The battery room Cable treatment area shall be ventilated by forced air supply and forced exhausting systems, while other 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 except for T/G room.

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(b) Administration Building

1. Air Conditioning system

The air conditioning system shall be intended to perform air conditioning of the office rooms, conference rooms, canteen and other rooms in the administration building.

1.1 System description

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

2. Ventilation system

The following rooms shall be ventilated.

(a) Air conditioner machine room

(b) Electrical machine room

(c) Storage room

(d) Shower room

(e) Lavatory

(f) Canteen

2.1 System Description

The air conditioning machine room and electrical machine room, shall be ventilated by forced air supply and forced exhausting systems, while other rooms shall be ventilated by natural air supply and forced exhausting system.

Outdoor air shall be treated for removal of dust and other foreign matter before supply into the respective rooms.

(c) Water treatment equipment and control room

1. Air conditioning System

The air conditioning system shall be intended to realize air conditioning of the control room, in the water treatment equipment and control room.

1.2 System description

Air conditioning shall be performed by using air-cooled packaged air conditioners.

2. Ventilation system

The following rooms shall be ventilated.

(a) Storage room

(b) Lavatory

(c) Treatment 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.

(d) Guard house

1. Air Conditioning system

The air conditioning system shall be intended to perform air conditioning of the office rooms, conference rooms, canteen and other rooms in the guard house.

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) Kettle room

(b) Lavatory

(c) Equipment room

2.1 System description

The rooms shall be ventilated by natural air supply and forced exhausting systems.

(e) Warehouse, chlorination equipment area and control room

1. Ventilation system

The following room shall be ventilated.

i) Warehouse

a) Stores room

ii) Chlorination equipment area an control room

a) Control room

b) Chlorination equipment area

1.1 System description

The control room shall be ventilated by forced air supply and forced exhausting systems, while other rooms shall be ventilated by natural air supply and forced exhausting systems.

23.2 EQUIPMENT AND MATERIALS

23.2.1 AIR COOLED CHILLER UNITS

(1) Configuration

The air-cooled chiller units shall consist of the compressors, motors, power transmission devices, air-cooled condensers, coolers, safety (protective) devices, accessory devices and so forth, and have a specified performance with minimal noise and vibration during operation.

(2) Compressors

a) Reciprocating compressor

The reciprocating compressor shall be of a totally closed or semi-closed type with perfect dynamic and static balance during operation, equipped with a sufficient lubrication device and shaft sealing device (except in the case of closed type), durable over a long period of operation and have a rigid construction and an exact function.

The capacity shall be controlled automatically by means of the suction gas pressure or temperature or chilled water temperature. Moreover, the capacity control system shall be equipped with a light load starting device.

b) Screw compressor

Although the relevant items pertaining to the reciprocating compressor shall be applied, the screw compressor shall moreover meet the following requirements:

(i) The compressor body shall be made of cast iron, equipped with an internal twisting rotor for rotary compression and a slide valve, and be of a construction convenient for overhaul and inspection of internals.

(ii) The capacity control system shall be capable of automatically controlling up to a low load by means of an exactly actuated slide valve system and be equipped combinedly with a light load starting device.

(iii) An oil separator shall be installed on the discharge side to provide compressor lubrication and cooling oil supply functions.

(3) Motor

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

(4) Power transmission device

The power transmission device of 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, belt-driven or V-belt driven type. Both of the power transmission devices shall be low in loss and designed to ensure safe transmission of power. In the case of the belt-driven type, a belt cover shall be provided as required.

(5) Condenser

The air-cooled type condenser shall consist of a coil with fin, blower and motor, and casing. The coil material shall be made of copper tube corresponding to C1020, C1202 or C1220 in JIS H-3300 (Copper and Copper Alloy Seamless Pipes and Tubes), while 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). Meanwhile the contact section between the tube and fin shall be so designed as to minimize the heat transfer resistance.

The fin shall undergo corrosionproof surface treatment by the chromate method, acrylic resin coating or other method. Meanwhile, a protective measure of fin shall be taken as appropriate in case the fin could possibly be damaged.

The casing shall be made of steel plate or glass fiber reinforced polyester resin and sufficiently be reinforced. Meanwhile, in the case where the 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	1.0 or more

(6) Chiller (Cooler)

The water-cooled cylinder multi-tube chiller (unit) shall be of a construction permitting easy cleaning of the tube, and consist of a body made of steel plate fabricated by welding or steel pipe/tube, and an edge part water box made of cast iron or steel plate fabricated by welding. The tube shall be the copper tube or copper fin tube according to C1020, C1201 or C1220 in JIS H-3300 (Copper and Copper Alloy Seamless Pipes and Tubes), and be fixed so tightly as to avoid leakage from the tube plate. Any rust on the internal surface of the body shall be removed by acid washing or other appropriate method.

This chiller unit shall be equipped with a safety valve (or soluble cock). Moreover, the chiller unit shall also be eqipped with the water drain (cock), air vent (valve), coolant liquid outlet stop valve, liquid level gauge, etc. as required.

Meanwhile, in case any receiver is not particularly installed, a sufficient capacity shall be provided as a coolant receiver.

(7) Protective devices

The protective devices shall be equipped with the following 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) Temperature relay to be actuated due to overcooling of chilled water

(d) 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

(e) Protective thermostat shall be activated at the time of overheating of compressor exhaust gas (except in the case of open type compressor)

(8) Coolant

The coolant to be used shall be that designated in JIS K 1517 [Fluoromethanes: Trichloromonofluoromethane (FLON 11); Dichlorodifluoromethane FLON 12); Monochlorodifluoromethanes (FLON 22)] applicable to the refrigerator or equivalent.

(9) Hot and cold thermal insulation materials

These materials shall be according to the standard specifications of the manufacturer.

(10) Paint

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

(11) 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 : One (1) complete set

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

23.2.2 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 devices, accessories, etc., and have a specified function with less noise and vibration during operation. Moreover, this air conditioner shall be equipped with a heater (electric heater), humidifier, air filter and so forth as required.

(2) Compressor

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.

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Moreover, this compressor shall be of a rigid construction and have specified performance to withstand long time of operation. A capacity control system shall be provided to perform automatic control of the capacity by means of the suction gas pressure or temperature, or chilled water temperature, and combinedly 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 of the power transmission devices shall be low in 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. In addition, the packaging shall be provided with the mounting seats for prevention of overturning as necessary. Whereas, the casing of the outdoor unit shall be according to the relevant items on the condenser in Paragraph 23.2.1.

Meanwhile, 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 the 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 be treated by using non-flammable materials to prevent dispersion of fibrous materials.

Meanwhile, (the thiness 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 an 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) Air cooled condenser

Refer to Item (5) "Condenser" in Paragraph 23.2.1.

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(9) Cooler (Cooling unit)

Refer to Item (5) "Condenser" in Paragraph 23.2.1.

(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 23.2.1.

(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).

23.2.3 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 designed so as to ensure accurate function.

(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.

23.2.4 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 free from any trouble during long time continuous operation.

(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.)

23.2.5 PUMPS

(1) Chilled water pumps.

The chilled water pumps shall be the volute pumps coupled directly to motors with couplings and attached to the common bed made of iron casting. The pumps proper shall be made of

Class 2 or move in JIS G5501 (Grey Iron Castings), and the impellers of Class 2. The pump shafts shall be made of SUS403 or SUS420J1 in JIS G4303 (Stainless Steel Bars), or S30C or more in JIS G4051 (Carbon Steels for Machine Structural Use) only in case a sleeve is used. These pumps shall be of a construction so as to ensure smooth operation under service conditions, and shall be free from excessive noise with only slight vibration.

(2) Accessories

The following accessories shall be supplied, provided however that the non-return valve, foot valve, priming funnel (with cock) and suction cover shall be excluded in case these pumps are used for closed circuit or chilled water.

a. Gate valve (valve stem lifting type): One (1) pc.

b. Non-return valve (with bypass valve): One (1) pc.

In case the nominal diameter in 50 mm or less, bypass pipes (with a nominal diameter of 15 mm or more) shall be attached to the lifting pipe before and after the non-return valve.

c. Pressure gauges: Two (2) sets

d. Priming funnels and cocks: One (1) set

e. Air relief cock: One (1) pc.

f. Drain cocks: One (1) set

g. Suction cover (made of iron casting or steel plate): One (1) set

h. Shaft coupling protection cover: One (1) set

i. Companion flange (with bolt): One (1) set

j. Vibration-isolating coupling: Two (2) pcs

k. Foundation bolts, nuts and other required accessories: One (1) set

23.2.6 AIR HANDLING UNIT

(1) Configuration

The air handling unit shall consist of air heating and cooling coils, blower (fan), motor and other necessary components, and shall have a casing to house these components, and shall have a casing to house these components. The air cleaner, humidifier, eliminater, etc., shall be provided as required. The unit shall have the specified performance with low noise and vibration during operation.

(2) Casing

a. The casing shall be composed of a framework sufficiently reinforced with the steel section designated in JIS G3101 (Rolled Steel for General Structure) in compliance with JIS G3192 (Dimensions, Weight and Permissible Variations of Hot Rolled Steel Sections), and provided with an exterior steel plate with a thickness of 1.2 mm or more as designated in JIS G3141 (Cold Rolled Carbon Steel Sheets and Strip), JIS G3302 (Galvanized Sheets) or JIS G3313 (Electrolytic Zinc-Coated Steel Sheets).

b. In order to ensure uniform distribution of velocity of air passing in coil, the length from the rear surface of coil to the blower housing surface in the case of a horizontal

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air-conditioner and that from the rear surface of coil at the upper position of coil to the casing surface in the case of a vertical air-conditioner shall respectively be half the effective height of the corresponding coil. In the case of an air handling unit having an eliminater, the coil may be substituted for the eliminater.

c. Inspection holes with a width of 300 mm or more and a height of 500 mm or more shall be provided for the fan and other sections. The inspection holes shall be of a construction permitting easy opening and closing but free from air leakage when closed. The door of inspection hole that comes into contact with conditioned air shall be heat-insulated.

The holes for visual inspection of humidifying conditions shall be of a size so as to permit easy inspection of atomizing conditions of water, etc. from the humidifer.

d. Vibration of air conditioner shall be measured under the conditions where the air conditioner proper is placed on a rigid structure, and the total amplitude shall not be greater than 15 micron on the machine base in the vertical direction.

(3) Drain pan

The drain pan shall be made of steel plate in JIS G3141 (Cold Rolled Carbon steel Sheets and Strip) or SUS304 in JIS G4305 (Cold Rolled Stainless Steel Sheets and Plates) with a thickness of 1.5mm or more, and of a perfectly watertight construction with adequate slope. A drain pipe connection hole with a diameter of 32 mm or more shall be provided on the

downstream side of the pan. The internal surface of drain pan made of material other than SUS 304 shall undergo epoxy resin coating or equivalent corrosion-proof treatment.

(4) Coil

a. The coil shall be of a plate fin type, low in resistance to air flow and high in thermal efficiency.

b. The tube shall be as designated in JIS H3300 (Copper and Copper Alloy-Seamless Pipes and Tubes) with an outside diameter of 16 mm or more and a thickness of 0.5 mm or over, and shall have sufficient strength against internal pressure.

c. The fin shall be as designated in JIS H4000 (Aluminum and Aluminum Alloy Sheets and Plates, Strip and Coiled Sheets) or JIS H4160 (Aluminum and Aluminum Alloy Foils) with an Al content of 99% or over and a thickness of 0.15 mm or more. The heat transfer resistance shall be minimized at the contact part between fin and tube.
The fin shall undergo corrosion-proof surface treatment by chromate process or acrylic resin film coating, etc.

d. The header of coil shall, in principle, be of a tubular type, and provided on the inlet and outlet sides of water. A return vent made of steel tube shall be brazed or welded between each line. The header shall be provided with piping connection holes and air relief valves.

(5) Humidifier

a. In principle, the humidifier shall be of the nozzle atomizing type and have the specified humidifying capacity.

b. In the case of steam atomizing type, a steam atomizing

opening shall be attached to the tube designated in JIS G3448 (Light Gauge Stainless Steel Pipes for Ordinary Piping).

c. In the case of water atomizing type, a socket or extension tube shall be attached to the tube designated in JIS G3448 (Light Gauge Stainless Steel Pipes for Ordinary Piping). A water atomizing nozzle made of stainless steel or other corrosion-resistant material capable of uniformly atomizing fine water drops shall be attached to the socket or extension tube.

d. The water pressure atomizing type humidifier shall consist of a booster pump, discharge pipe (with header and water atomizing nozzle), strainer, solenoid valve for feedwater, pressure gauge, etc., and shall be of a construction capable of uniformly atomizing fine water drops. The booster pump shall be designed so that it will be shut down automatically whenever water supply is suspended.

(6) Eliminater

In the case where the water atomizing type or water pressure atomizing type humidifier is used, an eliminator shall be provided on the downstream side of the humidifier. The humidifier shall be made of three-folded galvanized sheet designated in JIS G3302 (Galvanized sheets) with a thickness of 0.5 mm or more, or 50 mm or thicker net made by forming of polyvinylidene chloride series fiber, and be of a construction so as to permit easy dismounting.

(7) Fan

The fan shall be as specified in paragraph 23.2.4 "Centrifugal

Fan" and provided with a mechanism for adjusting the air volume from outside the machine as well as an opening indicator.

(8) Motor

The motor for humidifier shall be as specified PART II.

(9) Heat insulation materials

The internal surface of casing that comes into contact with conditioned air and the external surface of drain pan shall be heat-insulated with the glass wool heat insulating boards No.2 K40 stipulated in JIS A9505 (Glass Wool Heat Insulating Material) or equivalent, and shall have a thickness of 15 mm or more. The surface treatment of heat insulating board shall be carried out with rivets or adhesive using fraying-proofed glass cloth designated in JIS R3414 (Glass Fabrics) in the case of the internal surface of casing. The external surface of drain pan shall further be treated to prevent dispersion of fibrous materials.

(10) Accessories

The following accessories shall be provided.

a. Vibration absorbing materials — One (1) set

b. Protection wire net (in case the duct is not connected to the suction side): — One (1) set

c. Companion Flange: — One (1) set

d. Foundation bolts and nuts: — One (1) set

e. Name plate (Indicating the name of manufacturer, type, model No., date of fabrication and performance flow rate, static pressure outside the machine, motor rating, blower, revolving speed, cooling and heating capacity.

23.2.7 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 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 a sufficient suction performance with low noise. The clamping frame and slit shall be made of aluminum

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(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.

23.2.8 MATERIALS AND ACCESSORIES FOR PIPING

(1) Pipes and Joints

The pipes and joints shall be as designated in the table below.

Designations		Standards		
		No.	Designations	Types
Pipe	Steel pipe	JIS G3452	Carbon Steel Pipes for Ordinary Piping	White pipe
Pipe	Copper pipe	JIS H3300	Copper Seamless piping	
Pipe Joints	Steel pipe joints	JIS B2301	Screwed Type Malleable Cast Iron Pipe Fittings	
		JIS B2302	Screwed Type Steel Pipe Fittings	
		JIS B2304	Butt-welded Type Steel Pipe Joint for General Piping	
		JIS B2211 - B2213	- Standard Dimensions for 5 - 16 kgf/cm^2 Iron and Steel Flanges	
		JIS B2221 - B2223	- 5 - 16 kgf/cm^2 Slip-on Welding Steel Flanges	
	Copper Pipe joints	JIS H3401 JCD A0001	Copper alloy steel pipe	

(2) Valves and Fittings

Designations	Classification by nominal diameter	Standards	
		No.	Designations
Screwed gate valves	50 mm or less	JIS B2023	5 kgf/cm^2 Bronze Screwed Gate Valves
		JIS B2023	10 kgf/cm^2 Bronze Screwed Gate Valves
		JIS B2028	10 kgf/cm^2 Bronze Flanged Gate Valves
		JIS B2052	10 kgf/cm^2 Malleable Iron Screwed Gate Valves
	65 mm or over	JIS B2031	5 kgf/cm^2 Cast Iron Flanged Gate Valves (Outside Screw Type)
		JIS B2044	10 kgf/cm^2 Cast Iron Flanged Gate Valves (Outside Screw Type)
Screwed globe valves	50 mm or less	JIS B2011	5 kgf/cm^2 Bronze Screwed Glove Valves
		JIS B2021	10 kgf/cm^2 Bronze Screwed Screwed Globe Valves
		JIS B2026	10 kgf/cm^2 Bronze Flanged Glove Valves
		JIS B2051	10 kgf/cm^2 Malleable Iron Screwed Glove Valves
	65 mm or over	JIS B2041	10 kgf/cm^2 Cast Iron Flanged Glove Valves
Check Valves	50 mm or less	JIS B2025	10 kgf/cm^2 Bronze Screwed Swing Check Valves
		JIS B2053	10 kgf/cm^2 Malleable Iron Screwed Lift Check Valves
	65 mm or over	JIS B2045	10 kgf/cm^2 Cast Iron Flanged Swing Check Valves
Cocks	50 mm or less	JIS B2192	Screwed Bronze Gland Cocks

23.3 EXECUTION OF THE WORK

23.3.1 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.

overturn, sliding and other troubles due to seismic force.

23.3.2 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°. However, should it be difficult to keep the angle within the above limit, the angle may be within 30°.

(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 Steel	Max Pitch	Bolt		Rivet	
			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

(4) Support 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
0.5 mm	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

23.3.3 PIPING

(1) General Provisions

a. Prior to the commencement of piping, detailed study shall be performed with respect to each item related to other facilities and equipment, and the the pipe laying positions shall be determined exactly by taking into account the gradient.

b. In the case where piping which is not coated for heat insulation is laid at visible positions and penetrates through ceiling, floor, wall, etc., pipe washers shall be attached to such portions.

c. The piping required to prevent propagation of vibration shall be hung or supported with vibration absorbing metal hangers or supports.

d. The hanger bands and other supporting sections of piping shall be made of moistureproof-treated wood, or plastics.

e. For the piping with expansion joint, metal fixtures shall be provided at the positions effective as starting points of expansion and contraction, and a guide shall be

attached to such a joint as required.

f. subsequent to completion of piping, pipe internals shall be cleaned sufficiently.

(2) Joining of pipe

a. Joining of pipe shall be performed with flanges or screws, or by welding.

b. To prevent deformation of all cross sections of pipe, all pipes shall be cut at right angle to the axial center of the pipe and its cut portion shall be finished to a smooth and flat level. Prior to joining, the pipe internal shall be checked to confirm that it is free from any foreign matter, and chips or other foreign matter, if any, shall be completely removed prior to joining.

Whenever piping work is suspended temporarily, the piping shall be protected sufficiently to prevent inclusion of foreign matter into its internal.

(3) Support pitch

a. 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 steady rest shall be provided for each horizontally running pipe in order to avoid looseness of the pipe due to movement at the time of earthquake.

b. A steady rest shall be provided for indoor vertical pipe at least at one spot on every floor.

MAXIMUM SUPPORT PITCH OF CHILLED WATER 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

23.3.5 INSULATION WORK

23.3.4.1 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.

Classification of heat insulation coverings		Specifications
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.

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

Classification of insulation work	Order of insulation work
Insulation of exposed interiors	1. Rivetting 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.

(2) Piping work

(a) The Heat insulation materials of air conditioning pipes shall be in accordance with the applicable provisions in 22.3.5.

(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 are as indicated in 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. Asphalt felt 4. Melding base paper 5. Cotton cloth	Indoor exposed piping
b	1. Heat insulation tube 2. Galvanized wire 3. Asphalt felt 4. PVC tape	Inside ceiling and pipe shaft
c	1. Heat insulation tube 2. Galvanized wire 3. Asphalt felt 4. Aluminum glass cloth	Ditto
d	1. Heat insulation tube 2. Galvanized wire 3. Asphalt roofing tile 4. Galvanized iron plate	Outdoor exposed piping
e	1. Heat insulation tube 2. Galvanized wire 3. Asphalt roofing tile 4. Waterproofing temp cloth 5. Asphalt	Outdoor embeded piping

(c) Thickness of the heat insulation (coverings)

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

THICKNESS OF INSULATION

(Unit: mm)

Type	Nominal dia. - 25	32 - 200	250 -	Remarks
I Chilled Water piping	30	40	50	Glass wool
II Header		50		Glass wool

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

a. The materials and sequence of works according to the types of work shall be in accordance with Table in 23.3.4.1 (2) (b) in the above.

b. The thickness of insulation shall be in accordance with Table in 23.3.4.1(2)(C)

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

23.3.4.2 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.

23.3.5 PAINTING WORK

23.3.5.1 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.

23.3.5.2 PAINTING

a. The types of paints and frequency of painting of the respective portions shall, in principle, be as specified in Clause 12.3.6.2. 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.

23.3.6 TESTS

23.3.6.1 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

23.3.6.2 PIPE

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

(a) Hydrostatic test

The hydrostatic test of 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.

The hydrostatic test pressure shall be 17.5 kg/cm^2.

23.3.6.3 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

23.3.6.4 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.

24. SECONDARY ELECTRICAL WORK

24.1 GENERAL

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

24.2 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.

25. ELEVATOR FACILITIES

25.1 GENERAL

This clause covers the furnishing of all labor, equipment and materials for furnishing and installing automatic elevators for boiler and administration building as shown in the Drawings and in accordance with these Specifications.

The Contractor shall supply the elevator of reputable manufacturer.

25.2 DESIGN CONDITIONS

(1) The elevator shall be used principally for transportation of station personnel, but may be used for transportation of light freight.

(2) The elevators for boiler shall serve at least five (5) landings at all important operating floors and platforms.

The elevator for administration building shall serve four (4) landings.

(3) Elevator design data

Capacity	:	600 kg 9 persons
Speed	:	60 m/min.
Control	:	Collective control
Dimension	:	1,450 mm x 1,035 mm x 2,100 mm (height ofdoor)
Cage door	:	2 panel opening door
Hatch door	:	2 panel opening door
Travel	:	From Ground floor to platform at drum level of boiler structure
Motor	:	AC 5.5 kW 3ϕ 380V 50 Hz
Interphone	:	Connected to the central control room
Indicator	:	At each floor

(4) Car shall be automatically returned to the operating floor, for boiler and to the ground floor for administration building.

(5) A handset and speaker for paging system shall be provided.

25.3 TYPE OF EQUIPMENT

25.3.1 GENERAL

(1) The elevator shall be of the electric drive, fully automatic, pushbutton control and counterweighted traction type.

(2) Steel guide rails shall be provided for the car guides and counterweights.

(3) The elevator shall be equipped with roller guides for the car and counterweights.

(4) Oil type buffers shall be provided for the car and counterweights.

(5) Rail brackets, machine beams, required wiring, complete counterweights, counterweight screens, hoist and governor ropes and sound insulation for the machinery platform shall be included.

(6) The motor set shall be located in the overhead machine room and shall be isolated from the floor by suitable sound reducing materials, preferable rubber pads.

25.3.2 ELEVATOR CAR

(1) The car frame shall be constructed of structural steel.

(2) The car enclosure shall be of metal with vent perforation, and shall be equipped with an automatic sliding door, ceiling emergency exit, lighting fixture and an exhaust fan.

(3) The interior car lighting shall be connected to an independent electric circuit. The lighting circuit shall be connected to a 110 volt, single phase, 50 cycle source.

25.3.3 DOORS

(1) Doors shall be provided at all landings for the elevator. The doors shall be located on one side of the elevator.

(2) The doors shall be of the hollow steel, sliding type without windows, and shall close automatically.

(3) The doors in the open position shall be flush with the sides of the clear door openings.

(4) Doors shall be complete with all necessary hardware including frames, sills, hangers, covers, guards, strut angles, etc.

25.3.4 OPERATION

(1) The control system for the elevator shall be of selective and collective operation so as to allow the car to have intermediate stops in the direction of operation.

(2) The car shall be controlled so as to be self-leveling at all landings.

(3) The elevator shall be equipped with a fully automatic pushbutton control system.

(4) The elevator machinery shall be suitable for use with 440 volts, 3 phase, 50 cycle power.

(5) Mechanical and electrical interlocks shall be provided for elevator to keep the landing doors securely close and locked when the car is not stopped at the landing and to prevent any movement of the car from the landing until the

doors are in the closed position and locked.

(6) The elevator shall be equipped with electromagnetic brakes to stop and hold the elevator at full load, and shall be designed for fail-safe provision in case of power failure.

(7) The elevator machinery motor circuits, where applicable, shall be equipped with overload, reverse-phase and open-phase relay protection.

(8) A car position indicator shall be installed in the car.

25.3.5 EMERGENCY CONTROL

(1) The elevator shall be provided with approved safety devices to grip the guide rails and stop the car in case of excessive speed or cable breakage.

(2) The door operator shall be arranged so that, in case of interruption or failure of electric power, the doors can be readily operated by hand from within the car. The Contractor shall also provide emergency devices and keys for opening the doors from the landing.

25.4 CONSTRUCTION

The construction shall comply with all items given in Section 3 "Elevator" in Chapter 5.3 of Building Standard Law Enforcement Ordinance of Japan, Japanese Electric Code requirement, and the local safety code requirements.

25.5 TESTS

(1) The Contractor shall make all tests necessary to demonstrate that the equipment furnished will perform as specified and as guaranteed.

(2) In case these tests demonstrate that the equipment does not meet the guaranteed performance, the Contractor shall correct the unsatisfactory condition at his own expense, and shall assume the costs of additional tests to demonstrate that the equipment complies with the guarantee.

25.6 ERECTION

Elevator erection shall be performed by qualified elevator erectors. All workmanship shall be excellent in every respect. Structural and miscellaneous steel shall be provided and shall be in accordance with clause 5 "STRUCTURAL STEEL WORK" in the Specifications.

26. DISMANTLING WORKS

26.1 GENERAL

This clause covers all dismantling works of existing foundations, structures, pipings, 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.

26.2 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.

26.3 DISMANTLING OF SLAB AND FOUNDATION

The slab and foundation 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.

Reinforced concrete piles provided under the turbine house/boiler foundation and stack foundation of "B" and "BX" Stations shall be

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dismantled by carefully taking into account the subsequent pile dismantling work.

The locations of all existing piles shall be marked with temporary wood piles in order to confirm their locations after backfilling.

26.4 PULLOUT OF EXISTING PILES

(1) Prior to starting the pile pullout work, Detailed pile pullout plan shall be submitted to and approved by the Engineer.

(2) As the length of the existing piles is unknown at present, the pile length shall be confirmed by core boring before pullout of the piles. Machinery and equipment having a sufficient length and reach shall be used for this work. The number of core borings shall not be smaller than the following:

		Number
"BX" Station	T/G pedestal	1
	Turbine house	1
	Stack	1
"B" Station	T/G pedestal	1
	Turbine house	1
	Stack	1

(3) Number of existing piles to be pulled out

Subsequent to completing marking of existing piles, the positions of new piles shall be marked based on the approved new pile arrangement diagram to be provided by the Lot I Contractor. The piles to be pulled out shall be determined in the presence of the Engineer, and shall be limited to those located within a radius of 75 cm from the center of a new pile. However, any pile outside this radius shall be pulled out if the Engineer deems it necessary.

(4) Pull-out method of existing piles

A friction-cut method for pulling out of cast-in-situ reinforced concrete piles shall be employed with casing auger having the water jet nozzle. Piles shall be pulled out using a crane having sufficient capacity, and the piles shall be dismantled and disposed of in a proper location. As the ground will be disturbed after pulling out of the piles, backfilling of the hole with sandy soil shall be immediately carried out. The Contractor shall submit the pile pull-out plan along with the Tender.