

PREVIEW

SE00-02

Sales Engineer Handbook

“Application Course”



DAIKIN INDUSTRIES, LTD.

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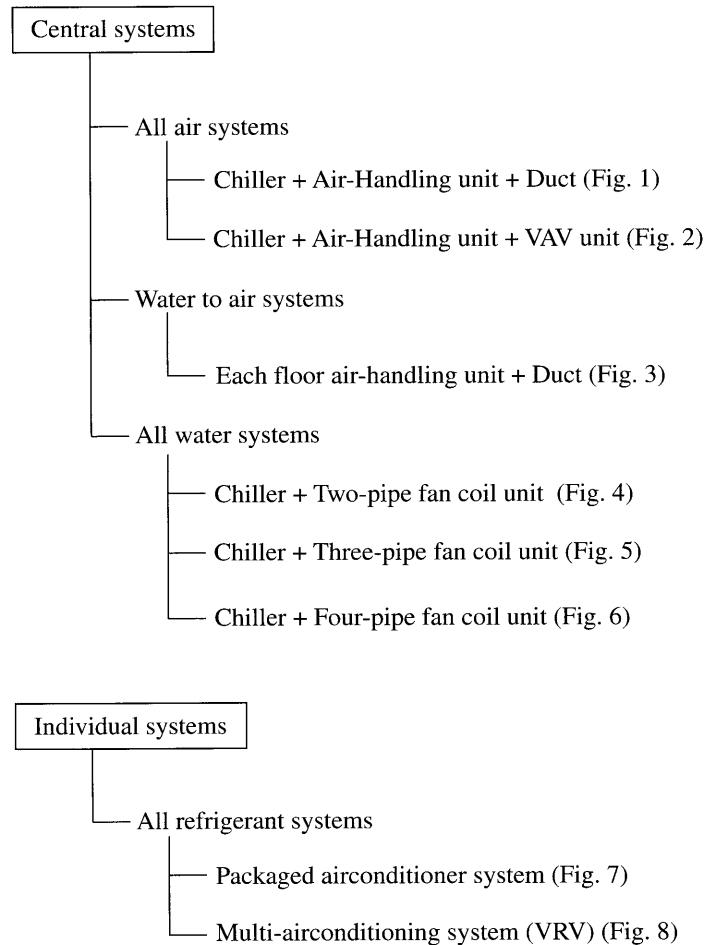


Features of Various Systems

1. Features of Various Systems

You must know various system except VRV for the sake of reaching the knowledge of VRV system design and the selection. Otherwise, you can't persuade estimated customers. This chapter takes up typical systems and the features with advantage/disadvantage will be roughly explained and discussed.

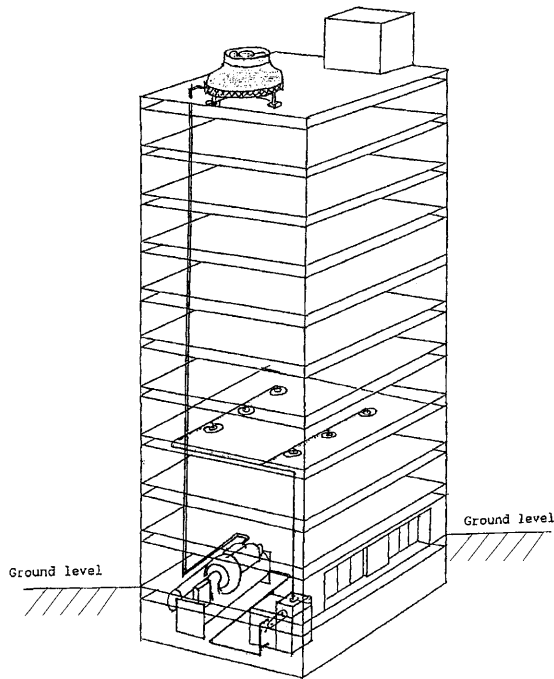
1-1 General Classifications



[Description]

- Above classification, All air system, All water system, and Water to air system, is a superficial one. On an actual job being progressed, we won't say "Let's adopt All air system!" Instead, it is very common to say "Let's use a combination of chiller, air-handling unit and duct system!" Here above, that is a only thing to classify several air conditioning systems from academic point of view.
- In this connection, this classification method specifies the heat transfer media supplying heat to the space to be air conditioned. An all air system supplies chilled or hot air from an air-handling unit to a space through ducts, and a water to air system once supplies chilled water or hot water to coils of an air handling unit on each floor, and converts the energy into chilled air or hot air and finally is sent to a room space, or like that.
- The advantages and disadvantages of each system are summarized on Table 1.

Fig. 1 Chiller + Air-Handling unit + Duct system

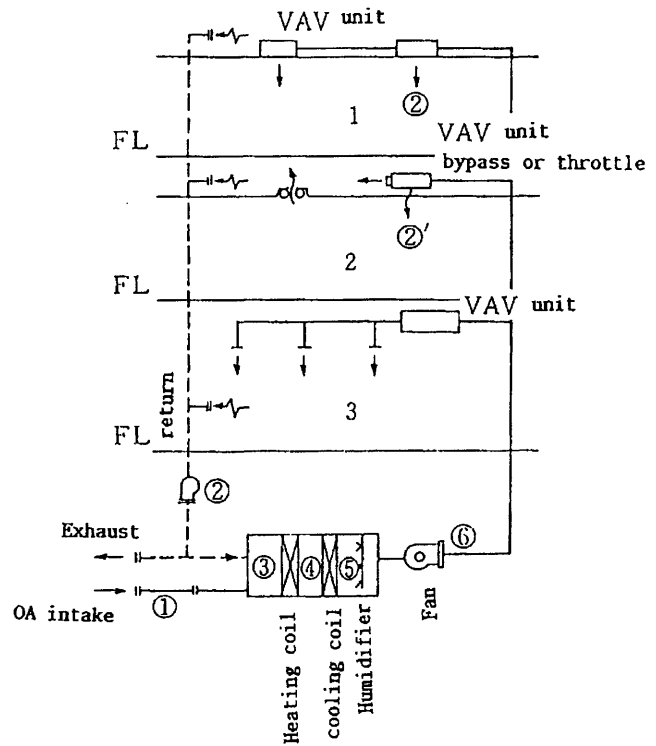


[Description]

Outline of system is to install heat source equipment like a water chiller and big sized air-handling unit in a machine room on a basement.

Chilled or hot air is delivered to each airconditioning space through a long distance duct.

Fig. 2 Chiller + Air-Handling unit + VAV unit

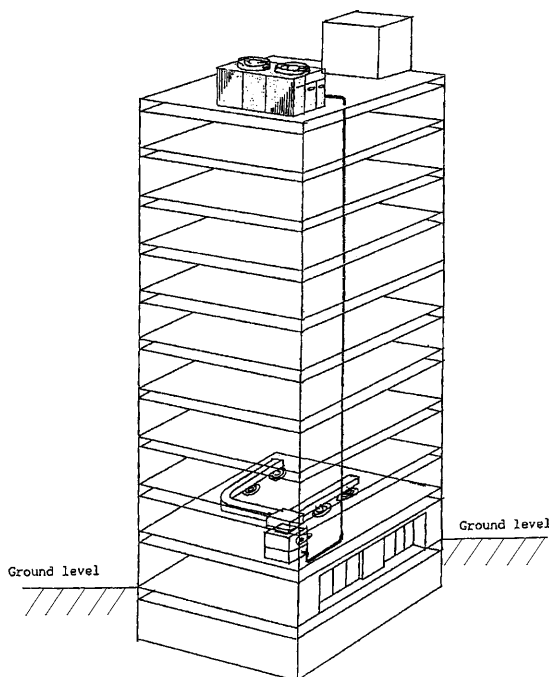


[Description]

Structured equipment till air-handling unit is the same to the system in Fig.1, but VAV unit is provided in the inlet duct connection on each floor.

VAV unit can throttle the air flow in a range of 30 ~ 100 % based on a room temperature before supplying to a room.

Fig. 3 Each floor air-handling unit + Duct system

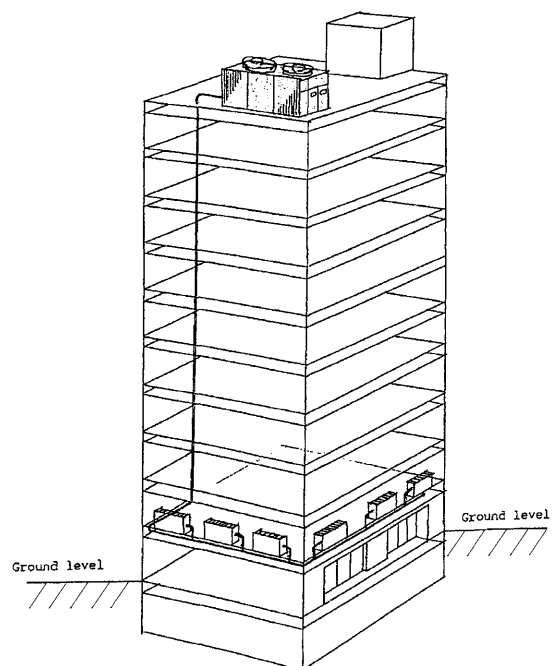


[Description]

Chilled or hot water is supplied to air handling units on each floor where converts energy to chilled air or hot air which delivered to a room space.

Many modern high-rise building adopt this type's central system.

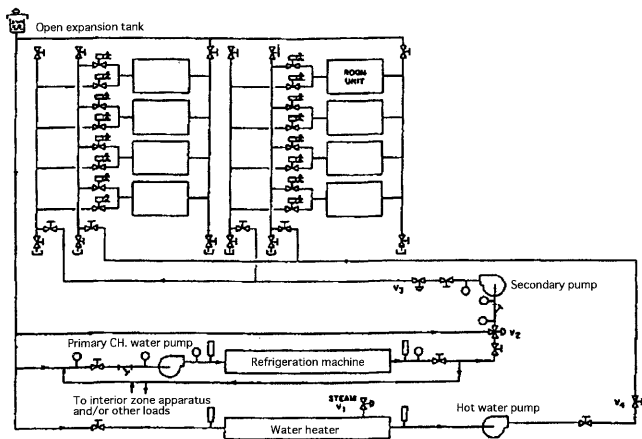
Fig. 4 Chiller + Two-pipe fan coil unit system



[Description]

Most popular fan coil unit system. Three-way valve controls the inlet chilled or hot water in by-pass circuit or another way uses a flow control valve to save energy.

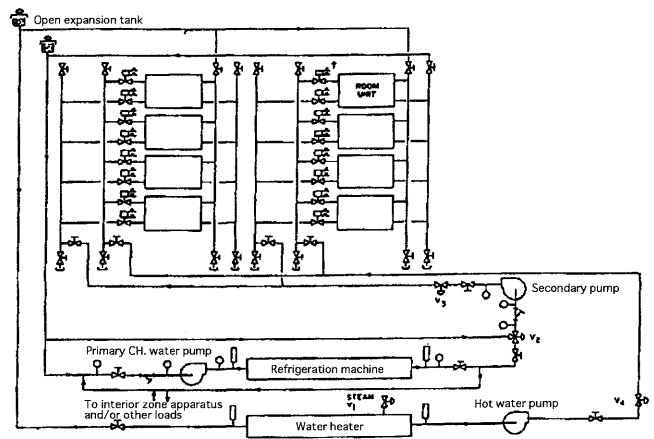
Fig. 5 Chiller + Three-pipe fan coil unit system



[Description]

A system that chilled or hot water is always supplied to a three-way valve at fan coil's inlet depending on a space temperature. On the return side, just one pipe is connected and mixture will take place at an outlet of fan coil unit, then returns to the heat source equipment.

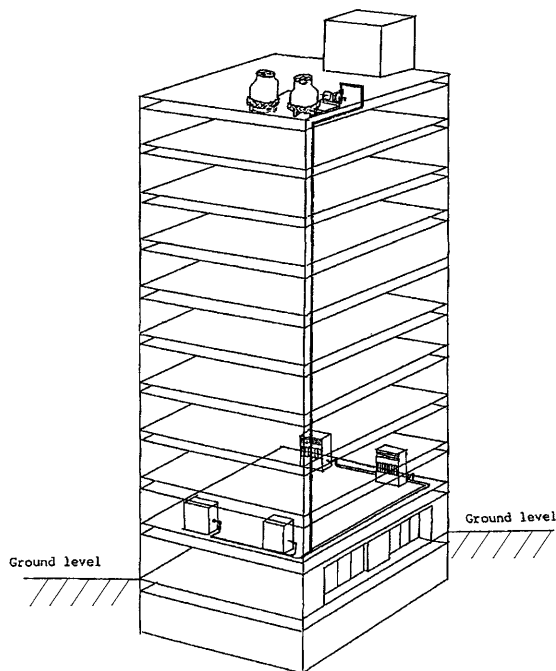
Fig. 6 Chiller + Four-pipe fan coil unit



[Description]

Two coils ; for chilled water and hot water individually, are mounted in fan coil unit, and each coil is connected to a line with a chilled or hot heat source. The change over between chilled and hot water is conducted by an inlet valve of fan coil unit.

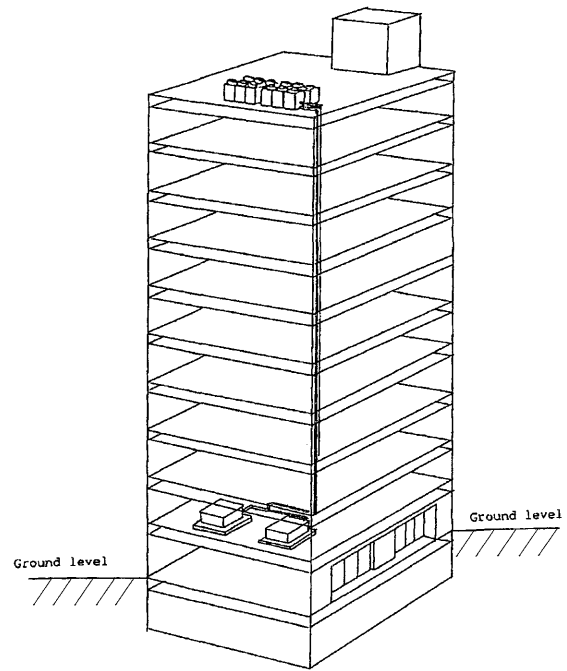
Fig. 7 Packaged air conditioner system



[Description]

System which has been used from old times. Packaged air conditioners are installed in a space and water piping are commonly connected to each packaged air conditioner. Units can operate individually.

Fig. 8 Multi-airconditioning system (VRV)



[Description]

Air cooled outdoor units are installed at top or in terrace of building, and favorite indoor units are placed on an indoor space, and then combine these two kinds units with refrigerant piping. Indoor units can be operated under a group control or one by one individual control.

1-2 Central system often used

The equipment, which will be explained in next chapter by using many pages, are fan coil unit, air-handling unit and heat pump unit as heat source because of the frequent use.

Here, let me show you two plan view, Fig. 10 and 11, about central systems often used. Besides, a schematic view is shown in Fig. 9 where an air-handling unit and a fan coil unit cover loads in perimeter and interior zones respectively.

Fig. 9

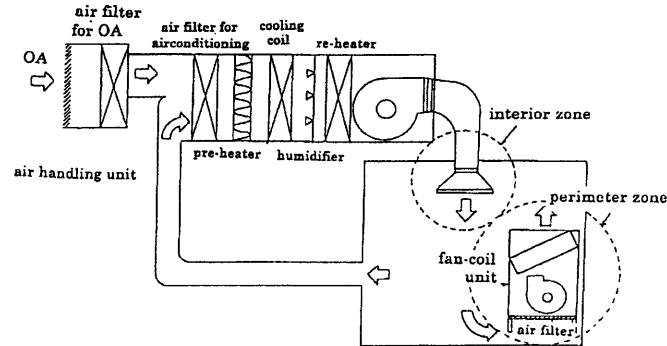


Fig. 10 : Each floor single duct VAV system

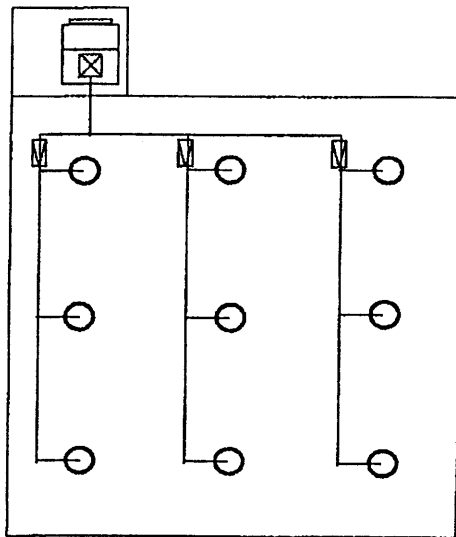
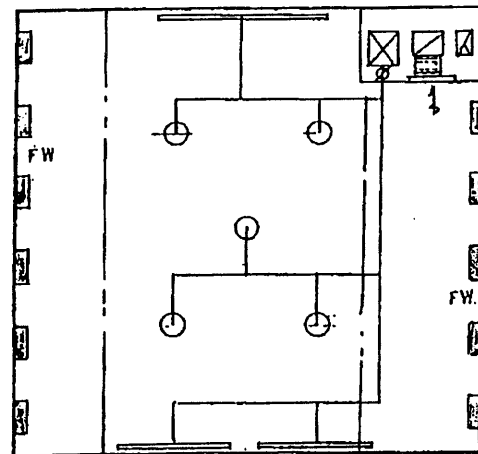


Fig. 11 : Simultaneous use of fan coil unit and air-handling unit



FW Fan coil unit

[Description]

Possible to save energy by every group with a VAV unit. But it has disadvantage that every time when the air flow rate changes, air distribution also varies and may give influence badly to the comfort.

[Description]

Fan coil unit and air handling unit cover load in perimeter and interior zones respectively. This layout is often found in large sized buildings.

Table 1: Each system's comparison (Merit/Demerit)

	System	Fig. referred to	Difficulty of individual operation control	Difficulty of fresh air intake	
All air system	Chiller + Air handling unit +Duct	Fig. 1	Impossible to control individual outlet.	Easy. Fresh air intake duct will be connected to air-handling unit. Free cooling is possible by outdoor air.	
	Chiller + Air handling unit + VAV unit	Fig. 2	Possible to control each group's air flow rate. Fan is controlled by means of revolution.	Ditto above	
Water to air system	Each floor air handling unit + Duct	Fig. 3	Possible to control by every floor	Either way is adopted, each floor intake style or central with distribution ducts.	
All water system	Chiller + Two-pipe fan coil unit	Fig. 4	Possible with bypass circuit or flow control valve	Needs independent ventilation system. Fan coil with fresh air intake mechanism is available. By digging hole on wall individually or centralized duct system, fan coil unit can intake fresh air.	
	Chiller +Three-pipe fan coil unit	Fig. 5	Possible with the same devices above but becomes complex.	Ditto above	
	Chiller + Four-pipe fan coil unit	Fig. 6	Ditto above	Ditto above	
Individual system	Packaged airconditioner system	Fig. 7	Possible to operate in style we want and whenever we want.	Generally, independent ventilation system is installed.	
	Multi-airconditioners (VRV) system	Fig. 8	Ditto above	Generally independent ventilation system is installed. To indoor units with fresh air intake hole, each floor central air ducts are combined. Sometimes requires auxiliary fan.	

	Occupied level in indoor space	Cost	
		Initial cost	Running cost
	Needs duct's shaft and space above ceiling. No need of space in room.	Comparatively simple control system just with fresh air intake control or so. Duct installation cost occupies most of initial cost. [MID]	Costs much for fan operation. Impossible to save energy. [HIGH]
	Ditto above	Cost much money for system and devices related to VAV. [HIGH]	Costs much lower than all air system. [MID]
	Needs a machine room on each floor. No need of space in room. Shaft space is only for water piping.	Costs much for installing many air-handling units. Enables shaft to be compact. [HIGH]	High saving energy because of individual operation of air-handling units on each floor. [MID]
	If indoor unit is mounted above ceiling, no extra space for room. Floor standing type requires corresponding floor space in room is needed.	If invests much to the control of fan coil unit, it results in power saving. Simple installation of fan coil units and power source equipment. [MID]	If saving energy control system is applied, it costs lower. [MID]
	Most of 3 or 4-pipe fan coil system apply floor standing unit which will take a corresponding space.	Water piping costs one and half times to 2-pipe system. [MID]	As return water from cooling coil and heating coil are mixed together, it results in energy loss on power source equipment. [HIGH]
	Ditto above	Water piping costs simply double. Fan coil unit itself is expensive with complexity. [HIGH]	Costs much for duplicate supply of chilled / hot water at all times. [HIGH]
	Takes large space to place units and provide pipings.	Possible to install standard units as they are, and very easy installation. [LOW]	COP of equipment itself directly affects running cost. No extra heat loss other than this. [LOW]
	Enables shaft to be small size compared to Water piping or duct system.If indoor unit is mounted above ceiling, no extra space for room is needed.	High unit cost because all necessary sophisticated devices were equipped in the factory. Costs lower than central system because of its simplicity. [MID]	High efficiency equipment itself. Least power consumption among all system expressed here. Same condition for ventilation system with other systems. [LOW]

1-3 In choosing system

Big difference of VRV to other system

Let's take up the example of airconditioning surroundings from Japan. Any building with 3,000 cm² or more floor area must be complied with Building Management Act (BMA). In planing airconditioning system, such a large building, the designer of the system is required at least a few years experience, sometimes ten years or more. Do you have ever visited any office where system engineers work? In such office, there are many bookshelves on which a lot of catalogues, technical handbooks of accessories, related to airconditioning systems, given by the manufacturers of the accessories. You may feel dizzy when you see handbooks as many as several ten's concerning valves, pumps, functional devises, electric components and so force are put on shelves. It should be one of the important technique charging for engineers to handle these handbooks easily.

Conversely, no need of bookshelves for VRV. Only one desk with deep drawer is enough. The latest several engineering handbooks might be stocked in the drawer. Thus, you can start system designing with VRV. Two or three years experience would be sufficient to handle the VRV system design. Moreover, some handbook of ventilation, for example HRV's engineering data, might be ready in your stock. It is another point of VRV's advantage that the short required time and no need of many years experience for the system designing, because almost required electronic or functional devices are inherently built in the unit.

System selection which every body will agree.

Now, next subject is concerned to the circumstances. No matter how you will become aware of advantage of VRV, you will not be able to expect that the estimated customer will willingly agree to apply VRV immediately because there is some other circumstances till to reach the assessment. Here, the summary of factors to reach a conclusion of adopting airconditioning systems might be described.

Take a look at Fig. 12 in next page. This is the chart which has been used in DAIKIN training center for a long time. Every year come many attendants to study from various countries in the world. There have been many experts who have been in charge of designing central airconditioning systems for many years so far. Those kinds of people have agreed upon the facts this chart describes, while saying "That's it!" Let's explain more about this.

1) How the related people are familiar to the system.

Owners, design consultants, design engineers, and workers are tend to like using the system to which they have been familiar for a long time.

2) What style does the building have?

What application does the building have? New building or retrofit? Is the power supply enough? Is sufficient space available? (for piping shaft, duct, space above ceiling, etc.)

3) What circumstances is the building in?

Is surrounding air clean or contaminated. Are there a lot of dust? Does salty air blow? Much noise is emitting?

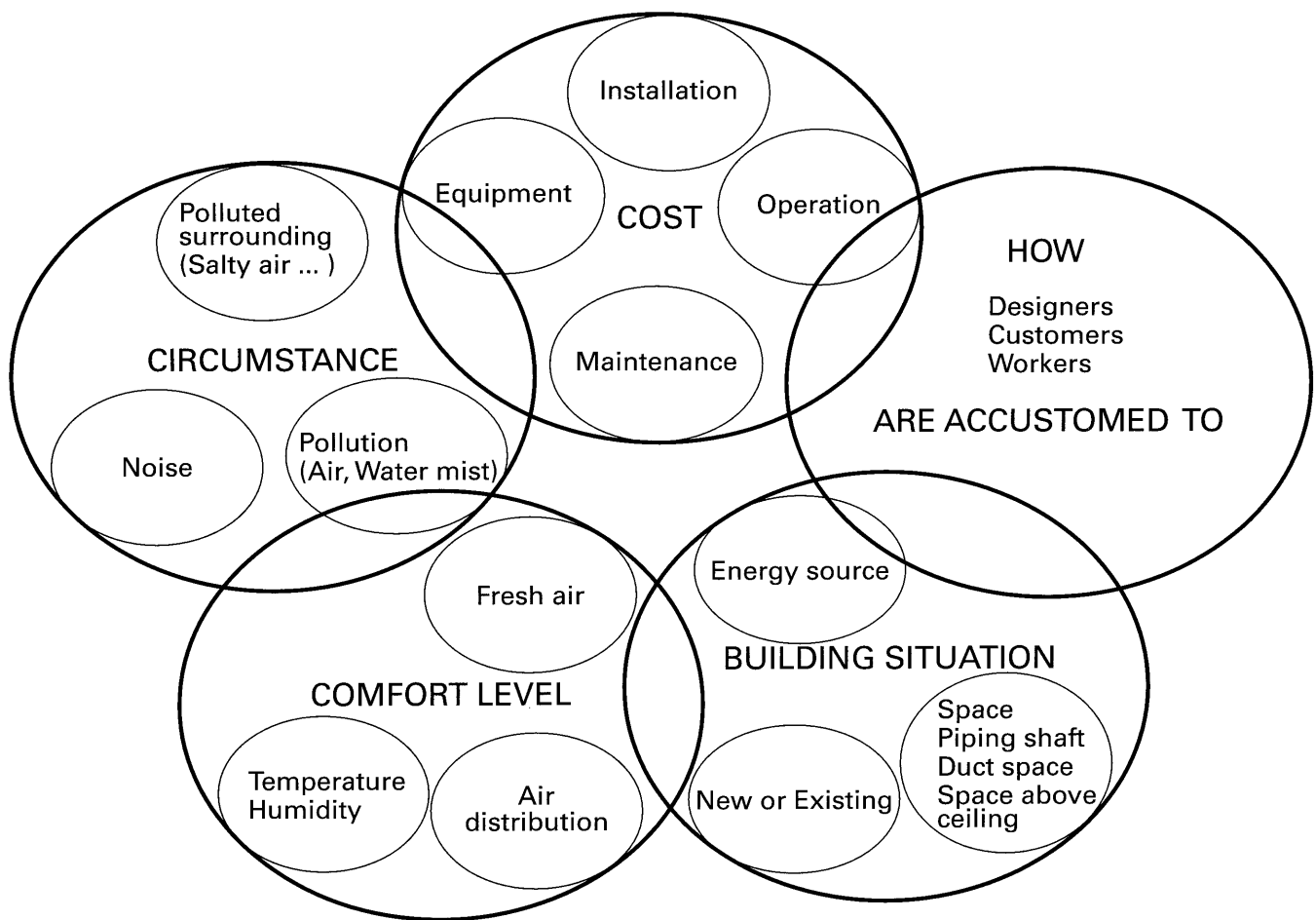
4) What comfort level is required.

Temperature, humidity and its range. Fresh air intake rate. Air distribution. Operation sound.

5) What's the cost to be able to extend.

For equipment, installation work, operation and maintenance.

Fig. 12 Big five factors before going into system design
 - Factors meshed with each other -





Central System Selection

2. Central System Selection

2-1 Planning method of airconditioning systems

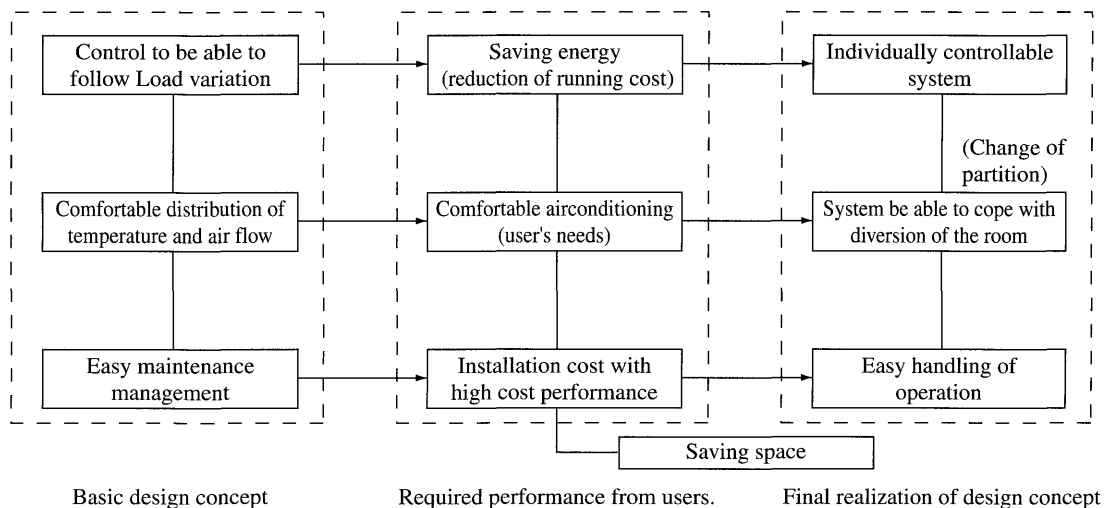
2-1-1 Planning concept of airconditioning systems

Main elements to decide airconditioning systems is to check and make sure a building grade, application, purpose, scale and an actual use of building, while checking up the owner's needs and a philosophy of the building designer.

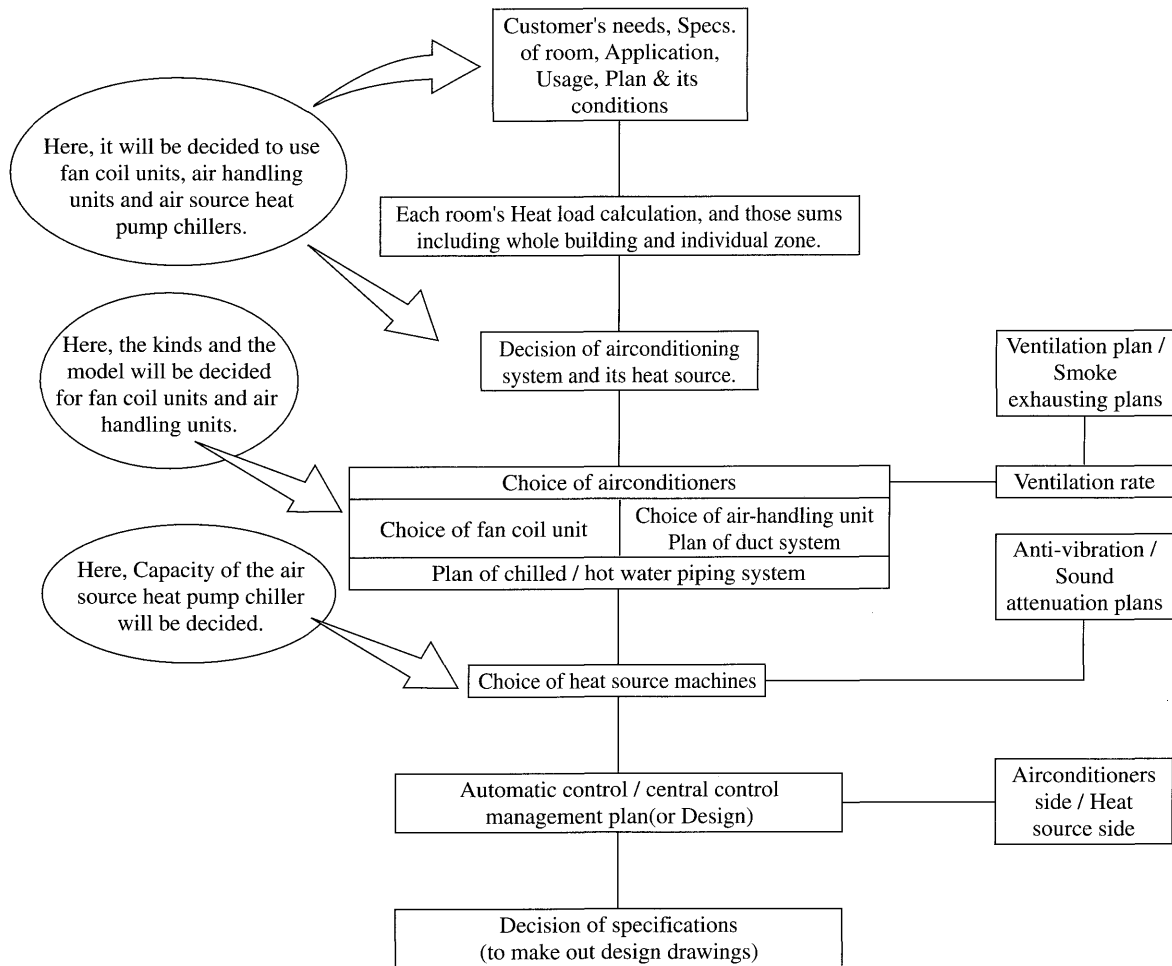
<<Elements and factors to decide>>

Elements	Factors (Examples)
Grade	High-class, Middle-class, Low-cost, Year-round airconditioning, Seasonal airconditioning
Purpose	Own office building, Rental office building
Application	Office, Hall, Hospital, Hotel
Airconditioning elements for applications	Operation hours, Heat source generated internally (Persons, illuminations, instruments), Future extension or alteration, Room temperature and humidity, Air cleanliness, Air distribution, Ventilation rate
Scale	Flat building, Multi-story building, Small scale, Middle scale, Large scale
Being in use	Automatic control, Manual control, Semi-automatic control, Each room control, Zone control, Central control, Remedy for saving energy.

<<Planning concept of airconditioning system>>



2-1-2 Procedure of airconditioning system planning



Structure of design drawings: External drawing of equipment
 Specifications (equipment itself, whole accessories)
 Equipment layout drawings (airconditioner, ventilator, water piping, duct layout, etc..)
 Wiring diagram (Internal wiring, external wiring, schematic control diagram)
 Exterior drawing of electric components (electric board, etc..)

2-2 Airconditioners

2-2-1 Fan coil unit

What a fan coil unit is.

A fan coil unit is composed of an air heat exchanger, a small fan, filter, and a casing. There are a variety of types such as floor standing type, concealed floor standing type, ceiling suspended type, ceiling mounted type, ceiling mounted cassette type, floor standing lowboy type, concealed floor standing lowboy type, and concealed wall mounted type, etc.

Fan coil unit has many applications and will be installed on a guest room of hotel, hospital, perimeter equipment in office building. Chilled water ($5\sim7^{\circ}\text{C}$) or hot water ($40\sim80^{\circ}\text{C}$) is supplied from heat source equipment such as a water chiller or so to fan coil units, and cool/dehumidify or heat room's air. Chilled/hot water piping and drain piping are connected to fan coil units.

① Heat exchanger

It consists of copper tubes with aluminum fins whose rows are two or three rows. In cooling mode, chilled water is supplied to the coil where air in a room is cooled down and dehumidified. Simultaneously, condensed water generated on surface of the heat exchanger drops on a drain pan and flows out through a drain pipe. In heating mode, hot water is supplied and heats up room air.

② Fan

Multi-blade centrifugal fan with both sides suction are often used. The numbers of fans used depend on the unit capacity and generally 1 ~ 4 fans are used. Flow control mechanism uses mainly the three steps change-over type and another type with linear change-over between high and low is available. High static pressure model of concealed duct connection type is available because duct connection arises extra pressure loss.

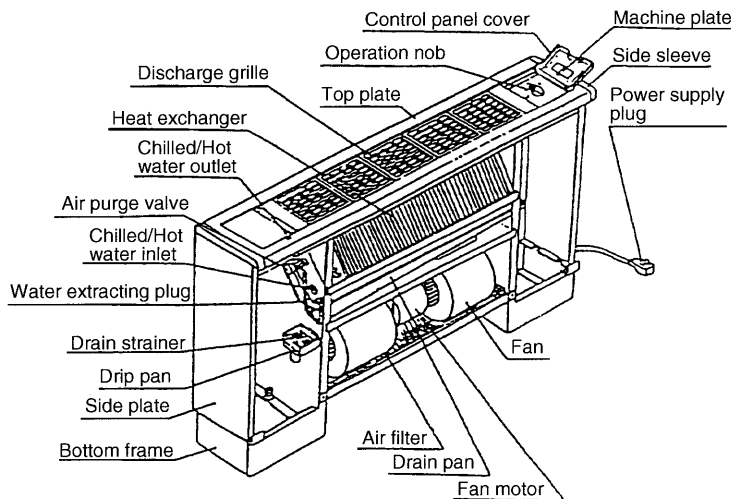
③ Filter

Filter generally uses materials washable like saran-net. Optional high efficiency filter coping with Building Management Act is available.

④ Casing

It is made of steel and lines a casing with glass wool with a finished surface as insulators on the necessary part.

Fig.3 Structure of floor standing type fan coil

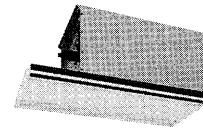


Various types of Fan coil unit

(1) Ceiling mounted cassette type

The adoption of new interior panel, with one to four selectable air outlets to realize the perfect comfort suitable for rooms, makes it possible to get comfort and increase the sense of interior. Further, quiet operation, top class in the industry, is designed. Wide variety of models are provided such as specified model for hotel, large sized four-way flow model for wide space or shopping center.

Ceiling mounted cassette two-way flow type



Two-way flow type: FWHC

(2) Ceiling mounted duct type

Ducting system covering small space to large space with various layout patterns allows the realization of high quality and quiet airconditioning. Many variety of models to suit installing conditions are available.

Ceiling mounted type



Ceiling mounted type: FWHM~

(3) Ceiling suspended type.

Easy installation work / ceiling suspended type.

No need to require wide space on a floor. Easily it can cope with the extension in the existing buildings or the replacement of the airconditioning systems.

Ceiling suspended type

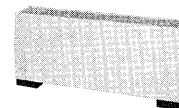


Ceiling suspended type: FWH~

(4) Floor standing type

The most suitable models for perimeter airconditioning with slim design as approx. 22cm depth. Lowboy type is available ready for a low projection wall (lowboy type's depth : approx. 35cm). Easy maintenance and quick adaptation to extension or replacement.

Floor standing type

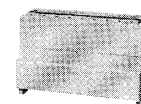


Floor standing type: FWV~

(5) Concealed floor standing type

Designed so slim that can be installed on the limited place beneath a window and to suit perimeter zone air conditioning.

Concealed floor standing type



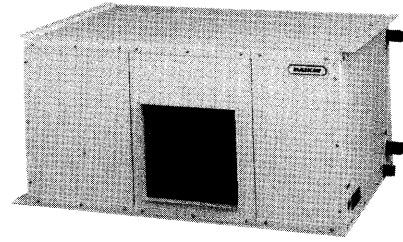
Concealed floor standing type: FWVM~

2-2-2 Packaged type air-handling unit (Possible to call large or middle sized fan coil unit)

(1) Ceiling suspended duct type

UAHM 90A(Z) ~ 450A(Z)

Main unit is hid out and possible to provide flexible duct distribution airconditioning to suit a room shape and conditions in use.

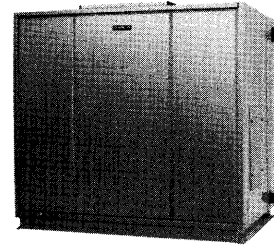


UAHM225A(Z)

(2) Floor standing duct type

UAVP 90A ~ 600A

Realized duct distribution airconditioning with easy installation floor standing type coping with diversity of airconditioning with a variety of models.



UAVP300A

2-2-3 Model selection

There are two cases ; Models have been decided, or Models will be decided through airconditioning system's planning.

(A) In case that models have been decided.

When equipment list is submitted from building designer's office, construction company, facilities engineering company or so, will proceed the selection work based on the list proposed.

(1) Example of a submitted equipment list and specifications.

On the list, specific conditions of required equipment in the plan of airconditioning systems for the building. Generally, these figures on the list (Specifications = required figure for the systems) are different from the figures shown in catalogue. It is needed to select the equipment based on the equivalent to or bigger values than the figures on the list proposed.

FCU: Fan coil unit's code

Code	Eq. name	Equipment specifications	Phase-volts (φ-V)	Power output (kW)	Q'y	Location	Remark
FCU-21	Fan coil unit	Type: #200 Concealed floor standing type Cooling capacity 1,150kcal/h (SH) 1,500kcal/h (TH) Heating capacity 2,730kcal/h C/H water flow rate 5.0L/min (7.0°C~12.0°C, 55.0°C~50.8°C) Air flow rate 310m³/h Filter Manufacturer's standard spec. Accessory Remote control switch (Linear air flow control) Flexible joint 2 pieces, Constant flow valve, two-way valve.	1-100	0.037	5	3rd-floor VIP meeting room	with connection duct
FCU-31	Fan coil unit	Type #300 Concealed floor standing type Cooling capacity 1,730 kcal/h (SH) 2,285kcal/h (TH) Heating capacity 3,880 kcal/h	1-100	0.051	5	4th-floor Small meeting room 4th-Manager's office	with connection duct

(2) Required conditions for model selection

Read the following conditions through an equipment list or airconditioning system's drawings.

- ① Model series (type)
- ② Air flow rate m³/min
- ③ External pressure loss mmH₂O
(for duct type only)
- ④ Cooling capacity kcal/h
total heat · sensible heat
- ⑤ Heating capacity kcal/h
- ⑥ Air conditions in cooling °CDB, °CWB
in heating °CDB
- ⑦ Chilled water conditions (Water temperature, water flow rate) °C, L/min
- ⑧ Hot water conditions (Water temperature, water flow rate) °C, L/min
- ⑨ Air filter's specifications
- ⑩ Humidifying method · humidified volume kg/h
- ⑪ Presence of special specifications

(3) Model selection

① Model series

Choose models which suits the airconditioning purpose and construction conditions.

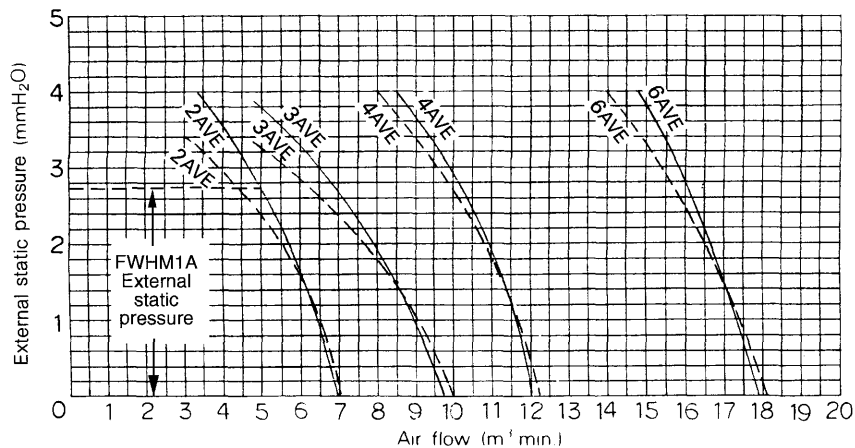
Since the types and air flow rate have been generally decided by building design office or construction company, select the models among models listed.

② External static pressure

When the ceiling mounted concealed duct type is used, some air pressure is required to send air forward to diffusers against resistance inside duct system proportional to the duct length. This pressure is called external static pressure and must be hold securely in the equipment side. As fan coil unit has its own fan motor inherently, check to make sure if the external static pressure of the fan coil unit you are going to use is in a permissible range or not.

Fig. 14: External static pressure chart Note) Use fan coil unit in this chart's range.

- FWHM1A(Z) · 2A(Z) · 3A(Z) · 4A(Z) · 6A(Z)
- FWMF1A(Z) · 2A(Z) · 3A(Z) · 4A(Z) · 6A(Z)
- FWMS2A · 3A · 4A · 6A



③ Capacity selection

Since the characteristics and air flow rate of fan coil unit are decided depending on the model, select the models in accordance with the customer's requirements. As the capacity and conditions the customer will propose are different in every object, be sure to check up the details according to the technical materials at every occasion. The capacities the customer offer us show "total heat" and "sensible heat", so choose the models so that these two capacities must be satisfied simultaneously.

For more information, the less the air flow rate, the less the capacity. Accordingly, pay attention to that fact for the duct connection type.

Key points to refer to technical documents

Classified by models and types

Representative air conditions are shown

Listed in both capacities of total heat and sensible heat

Representative inlet water temperatures are shown

Cooling capacity			are shown												are shown											
Unit Size	EnteringTemp. (°C)	EWT (°C)	26°CDB,18.6°CWB						27°CDB,19.0°CWB						27°CDB,19.5°CWB						28°CDB,22.0°CWB					
	Cooling Capacity (kcal/h)	Water Resistance WF (ℓ/min)	5		7		9		5		7		9		5		7		9		5		7		9	
	TC	SHC	TC	SHC	TC	SHC	TC	SHC	TC	SHC	TC	SHC	TC	SHC	TC	SHC	TC	SHC	TC	SHC	TC	SHC	TC	SHC	TC	SHC
2BVE	4.0	0.4	1,620	1,260	1,410	1,180	1,220	1,040	1,660	1,320	1,470	1,240	1,280	1,090	1,720	1,290	1,530	1,200	1,340	1,060	2,160	1,140	1,960	1,050	1,770	9,10
	5.6	0.7	1,840	1,410	1,620	1,310	1,390	1,150	1,910	1,480	1,690	1,370	1,460	1,210	1,980	1,450	1,760	1,340	1,540	1,180	2,480	1,340	2,260	1,230	2,030	1,080
	8.0	1.3	2,180	1,510	1,910	1,390	1,650	1,220	2,250	1,580	1,990	1,460	1,720	1,290	2,350	1,560	2,080	1,430	1,820	1,260	2,900	1,490	2,660	1,360	2,400	1,190
	10.0	1.9	2,390	1,560	2,120	1,420	1,850	1,240	2,480	1,630	2,180	1,500	1,910	1,310	2,570	1,610	2,300	1,470	2,000	1,290	3,210	1,550	2,930	1,420	2,630	1,240
	12.0	2.6	2,590	1,570	2,300	1,430	2,010	1,240	2,690	1,640	2,370	1,510	2,080	1,310	2,770	1,630	2,480	1,490	2,190	1,290	3,450	1,590	3,130	1,460	2,840	1,260
3BVE	4.0	0.4	1,810	1,570	1,590	1,490	1,380	1,340	1,870	1,650	1,650	1,570	1,440	1,420	1,950	1,600	1,740	1,520	1,520	1,380	2,410	1,450	2,190	1,370	1,980	1,230
	7.4	1.3	2,410	1,910	2,130	1,790	1,840	1,610	2,500	2,000	2,220	1,880	1,900	1,710	2,610	1,960	2,300	1,850	2,020	1,680	3,260	1,870	2,950	1,760	2,660	1,590
	8.0	1.5	2,490	1,950	2,180	1,830	1,870	1,650	2,590	2,040	2,270	1,920	1,960	1,750	2,680	2,010	2,400	1,890	2,080	1,710	3,360	1,930	3,040	1,810	2,730	1,640
	10.0	2.2	2,780	2,010	2,450	1,880	2,100	1,690	2,870	2,110	2,540	1,980	2,210	1,780	3,000	2,080	2,660	1,950	2,330	1,760	3,720	2,030	3,390	1,890	3,060	1,700
	14.0	4.1	3,230	2,090	2,850	1,940	2,470	1,730	3,350	2,180	2,980	2,040	2,600	1,830	3,480	2,160	3,100	2,020	2,720	1,810	4,280	2,150	3,900	2,000	3,520	1,790
4BVE	6.0	1.0	2,660	2,080	2,340	2,000	2,030	1,740	2,730	2,200	2,430	2,110	2,120	1,850	2,840	2,130	2,530	2,050	2,210	1,790	3,520	1,890	3,220	1,800	2,890	1,550
	8.0	1.7	3,070	2,320	2,680	2,230	2,320	1,940	3,160	2,440	2,800	2,330	2,420	2,060	3,280	2,390	2,920	2,280	2,540	2,000	4,080	2,190	3,720	2,090	3,360	1,800
	10.4	2.7	3,400	2,560	2,990	2,430	2,580	2,130	3,520	2,680	3,120	2,550	2,680	2,250	3,650	2,630	3,240	2,510	2,830	2,200	4,550	2,480	4,140	2,360	3,740	2,050
	12.0	3.5	3,630	2,640	3,200	2,500	2,740	2,190	3,740	2,770	3,310	2,630	2,870	2,310	3,920	2,710	3,450	2,590	3,020	2,270	4,860	2,600	4,420	2,460	3,990	2,140
	14.0	4.6	3,940	2,680	3,440	2,550	2,980	2,220	4,070	2,810	3,560	2,670	3,100	2,350	4,200	2,780	3,730	2,630	3,270	2,300	5,200	2,680	4,740	2,530	4,280	2,210
6BVE	8.0	0.8	3,740	3,090	3,260	3,010	2,880	2,710	3,860	3,300	3,380	3,210	3,000	2,920	4,030	3,210	3,550	3,130	3,160	2,830	4,990	2,980	4,530	2,890	4,150	2,590
	10.0	1.2	4,140	3,300	3,630	3,180	3,210	2,860	4,290	3,510	3,780	3,390	3,330	3,080	4,470	3,430	3,960	3,310	3,510	3,000	5,550	3,250	5,040	3,130	4,620	2,810
	14.6	2.4	4,810	3,610	4,200	3,450	3,670	3,110	4,940	3,840	4,380	3,670	3,850	3,320	5,160	3,780	4,550	3,620	4,070	3,260	6,480	3,670	5,820	3,530	5,340	3,170
	18.0	3.5	5,230	3,730	4,530	3,560	3,990	3,190	5,400	3,960	4,750	3,780	4,210	3,410	5,610	3,910	4,960	3,730	4,420	3,360	7,020	3,860	6,310	3,690	5,770	3,320
	20.0	4.2	5,450	3,780	4,730	3,600	4,190	3,220	5,630	4,010	4,910	3,830	4,370	3,450	5,870	3,960	5,150	3,780	4,610	3,400	7,320	3,930	6,600	3,750	6,060	3,370
8BVE	10.0	0.6	4,950	3,940	4,290	3,880	3,750	3,390	5,100	4,180	4,470	4,100	3,900	3,630	5,310	4,030	4,650	3,970	4,110	3,490	6,510	3,550	5,850	3,490	5,310	3,010
	16.0	1.4	6,240	4,630	5,420	4,470	4,700	3,920	6,430	4,910	5,610	4,740	4,890	4,200	6,720	4,800	5,850	4,660	5,130	4,110	8,250	4,400	7,440	4,240	6,720	3,690
	20.7	2.2	6,890	5,010	5,960	4,800	5,150	4,210	7,140	5,290	6,210	5,090	5,340	4,520	7,380	5,240	6,450	5,040	4,450	3,910	8,840	4,810	8,190	4,650	7,380	4,060
	25.0	3.1	7,500	5,220	6,440	5,000	5,560	4,380	7,720	5,540	6,740	5,290	5,840	4,680	8,020	5,500	7,040	5,250	4,640	4,640	9,970	5,090	8,920	4,870	8,020	4,260
	28.0	3.8	7,890	5,340	6,800	5,090	5,960	4,440	8,230	5,640	7,130	5,390	6,210	4,760	8,480	5,630	7,470	5,360	4,730	4,730	10,500	5,220	9,400	4,970	8,480	4,340
12BVE	15.0	0.8	7,020	5,730	6,030	5,380	5,310	4,840	7,290	6,130	6,300	5,790	5,530	5,280	7,600	5,920	6,570	5,610	5,850	5,070	9,130	5,460	8,140	5,120	7,380	4,610
	20.0	1.4	8,040	6,350	6,900	5,920	6,060	5,320	8,340	6,790	7,200	6,360	6,300	5,790	8,700	6,610	7,560	6,170	6,660	5,600	10,500	6,280	9,360	5,840	8,460	5,270
	26.7	2.4	9,050	6,930	7,680	6,430	6,720	5,770	9,370	7,400	8,010	6,900	7,040	6,240	9,770	7,250	8,410	6,750	7,440	6,090	11,770	7,070	10,490	6,540	9,450	5,910
	30.0	3.0	9,450	7,140	8,090	6,580	7,010	5,920	9,810	7,610	8,360	7,080	7,370	6,390	10,260	7,460	8,810	6,930	7,820	6,240	12,420	7,310	10,980	6,780	9,990	6,090
	35.0	3.9	10,180	7,340	8,710	6,750	7,580	6,050	10,600	7,810	9,130	7,220	7,970	6,530	11,720	7,690	9,550	7,090	8,390	6,400	13,330	7,600	11,860	7,010	10,710	6,320

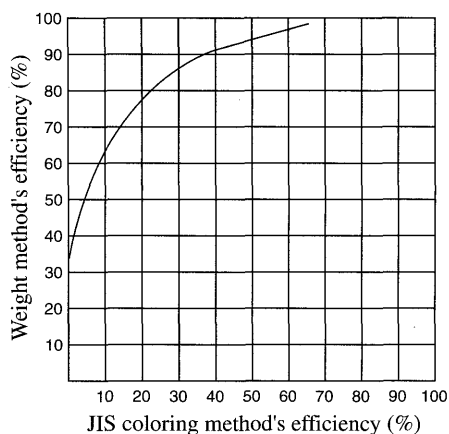
④ Air filter

The applied conditions for air filter are decided depending on the application of rooms, applied purpose and the size of the buildings, etc..

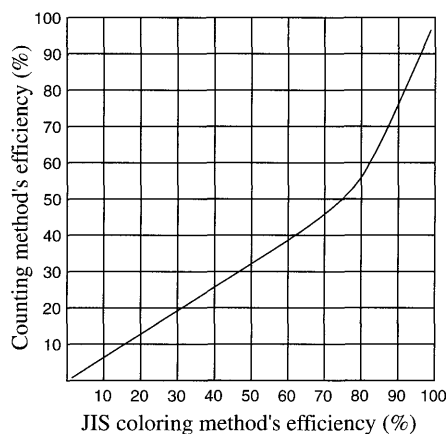
Air filter is evaluated by the dust collection efficiency and there are three methods to measure this efficiency; 1) Weight method 2) Coloring method 3) Counting method. These value of efficiencies are listed on a table of specifications.

No clear co-relations are available for the dust collection efficiency by this measuring method. But, for a simple guideline, the following charts show the co-relation in approximation.

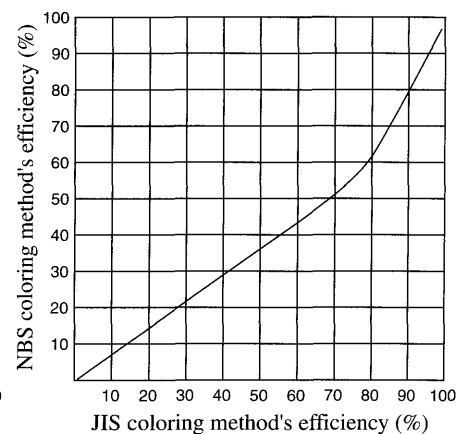
• Weight-method-JIS Coloring method



• Counting method-JIS Coloring method



• NBS method-JIS Coloring method



On the following table, the dust collection efficiencies, of the standard accessory's filters, the optional accessories filter are shown.

[FW series]

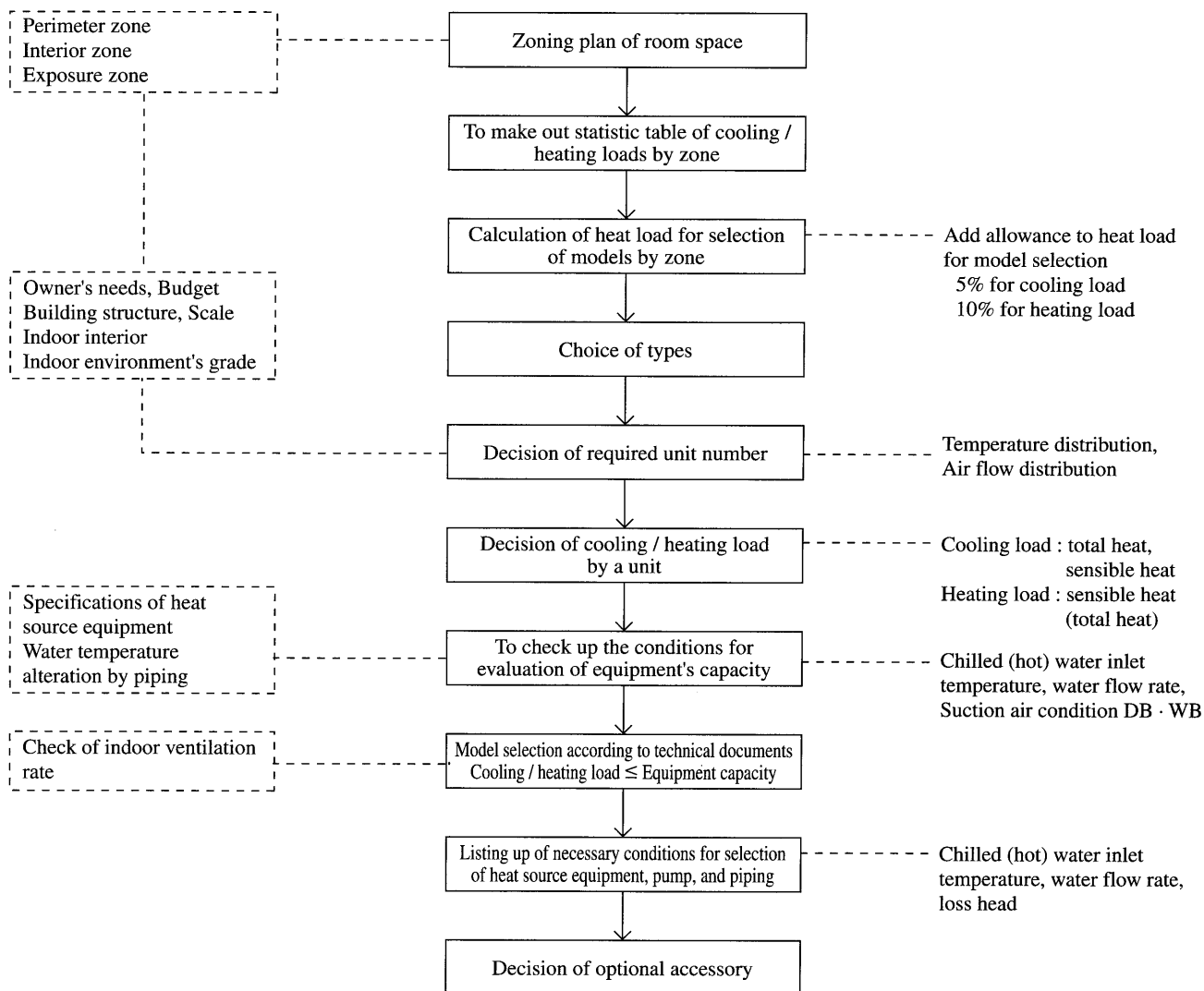
STD: Standard ○: Order-made products

Models	Kinds	Chemical texture net	Non woven chemical texture
	Efficiency	Weight method Approx.18%	Weight method Approx.70%
FWHC		○	—
FWHM		—	—
FWH		STD	○
FWV		STD	○
FWVM		STD	○

(B) Model selection from airconditioning system plan

The procedure for progressing the selection of fan coil units is available as mentioned below. "Planing method of airconditioning systems" described in chapter 2-1 must go forward definitely in order to decide the conditions of the model selection.

<<Fan coil unit Outline of model selection procedure>>



2-2-4 Air-Handling unit

(A) What air-handling unit is.

➤ Equipment to make cooling air or heating air and to supply clean air with controlled temperature and humidity.

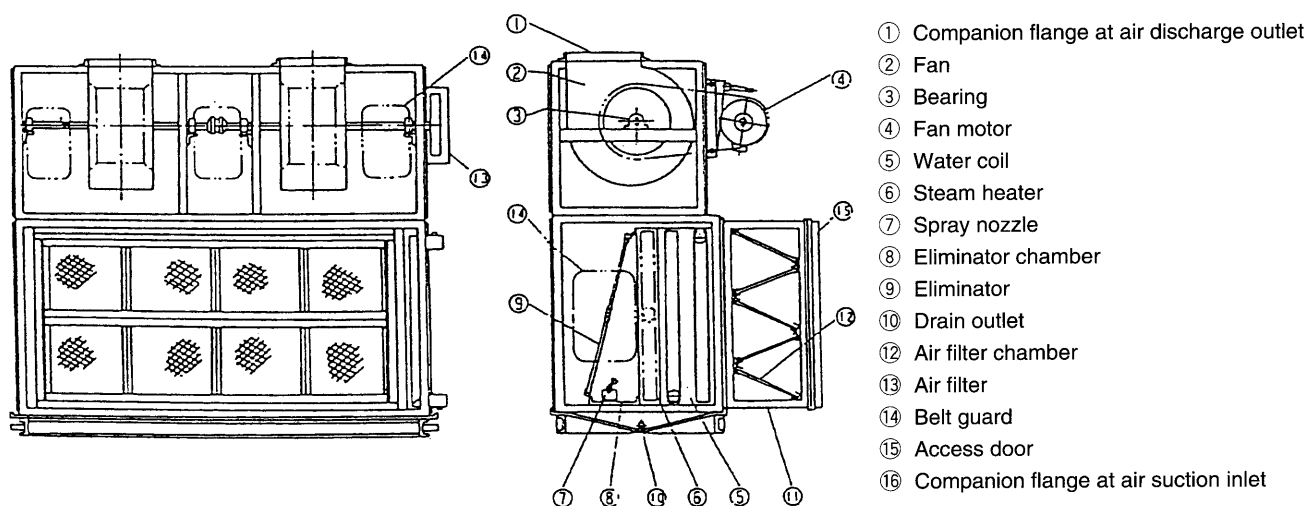
Basic structure

Air handling unit consists of ;

- | | |
|---|--------------------------|
| (a) Fan to supply air | (Fan, Fan motor) |
| (b) Chilled water (hot water coil) | (Water coil) |
| (c) Steam coil to make hot air | (Steam coil) |
| (d) Humidifier to add moisture to the air | (Humidifier, Eliminator) |
| (e) Air filter to clean up the air | (Air filter) |

and so forth. All these components are built in the casing of one package.

Fig. 15 : Basic structure (Example: standard vertical type)



Note) This figure shows the case of AV(K) 43EA, 51EA, 66EA, 75EA

(B) Selection order

Flow chart

Required conditions for selection

1. Air flow

2. External static pressure

3. Cooling capacity

4. Heating capacity

5. Air conditions

6. Chilled water conditions
(Water temp., water flow)

7. Hot water conditions
(Water temp., water flow)

8. Steam conditions
(Pressure, temperature)

9. Air filter specifications

10. Humidifying capacity

11. Humidifying method and conditions (pressure)

12. Installation conditions
- m³/min

mmH₂O

kcal/h

kcal/h

°CD.B, °CW.B

°C, ℓ /min

°C, ℓ /min

kg/cm²G, °C

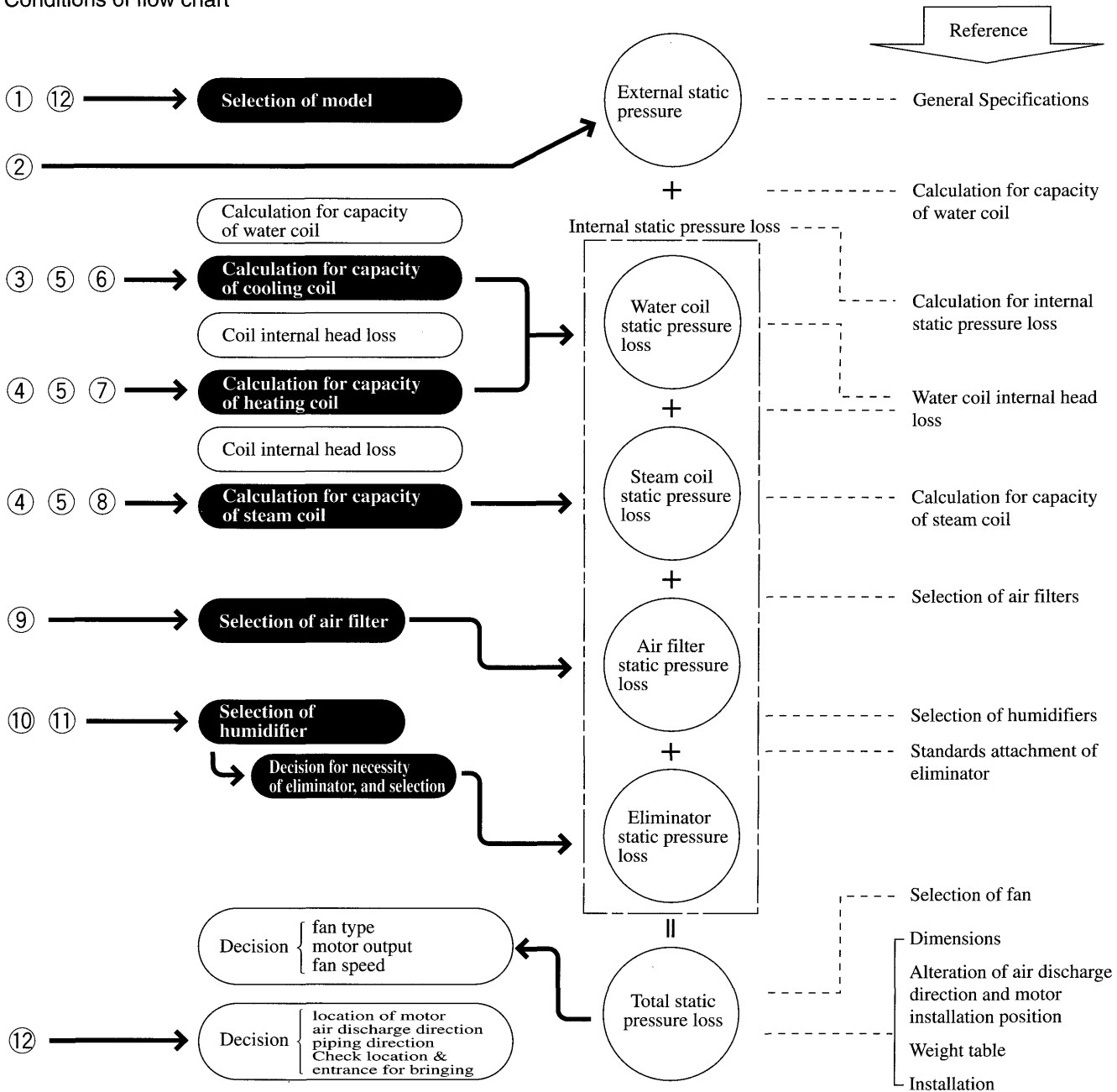
kg/h

kg/cm²G

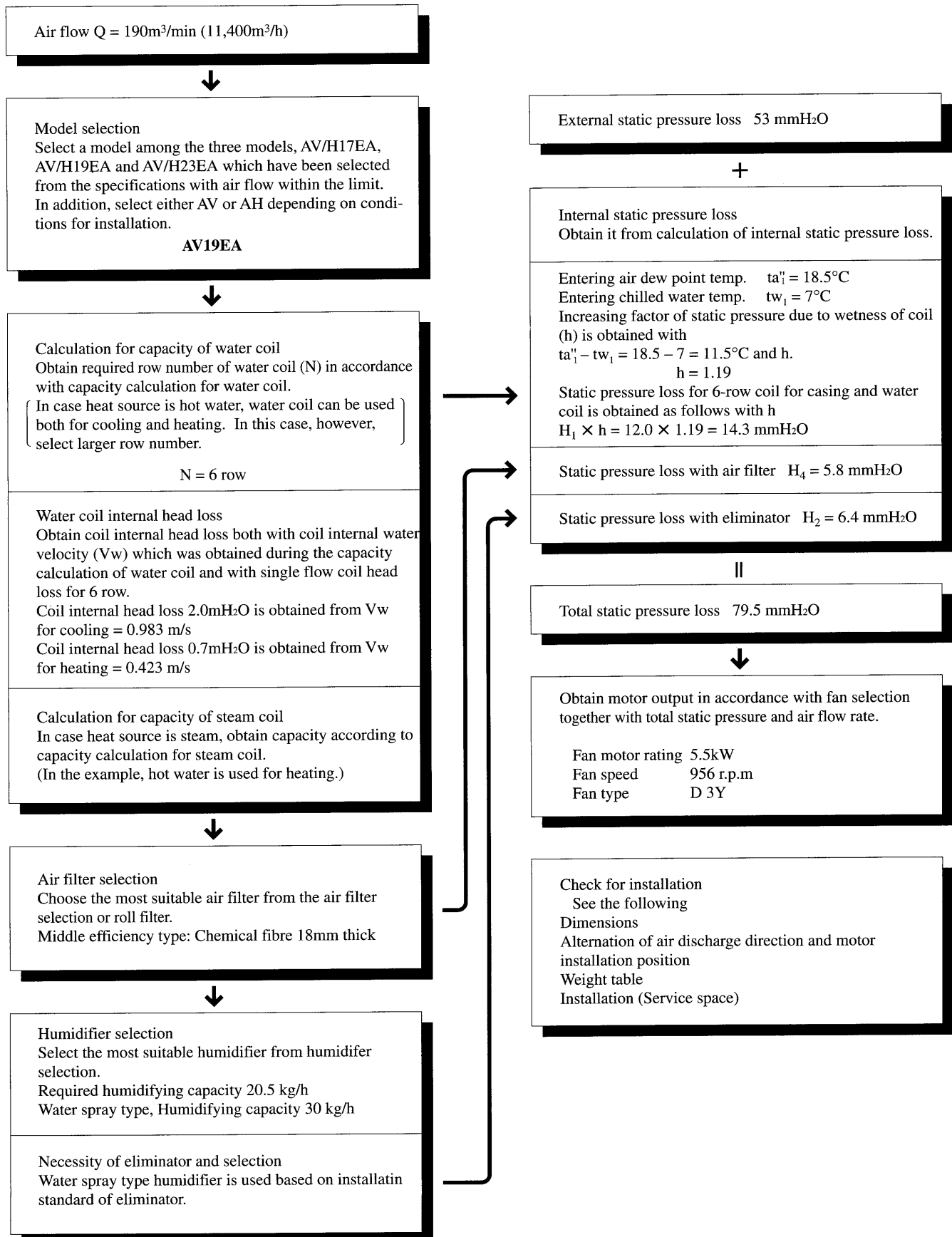
Conversion formulae			
Btu/h	= kcal/h	×	3.97
kW	= kcal/h	×	0.001163
Inches	= mm	×	0.0394
Pounds	= kg	×	2.205
Psi	= kg/cm ²	×	14.22
KPa	= kg/cm ²	×	98.07
Cfm	= m ³ /min	×	35.3
US Gallons	= Liter	×	0.264
UK Gallons	= Liter	×	0.220

e.g. 10,200 kcal/h = 10,200 × 3.97
= 40,500 Btu/h

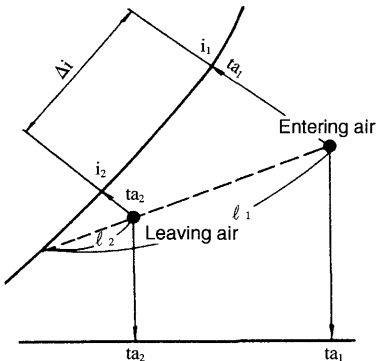
Conditions of flow chart



(C) Examples of model selection



7. Calculation for capacity of water coil

Calculation formula	Calculation example	
	Cooling	Heating
1. Given conditions a) Model AV 19EA b) Air flow 190 Q(m³/min) c) Cooling capacity 76,600 qt(kcal/h) d) Heating capacity qH(kcal/h) e) Entering air temp. 28.1 ta₁(°CD.B) 21.5 ta₁(°CW.B) f) Entering water temp. 7 tw₁(°C) g) Water flow 255.3 L(ℓ/min) h) Leaving water temp. 12 tw₂(°C) $ tw_2 - tw_1 = \frac{qt \text{ or } qH}{60 \times L}$	AV 19EA 190 76,600 28.1 21.5 7 255.3 12	AV 19EA 190 66,000 15.4 60 110 50
2. Obtain coil face velocity (Va) (m/s) $Va = \frac{Q}{60 \times Aa}$ Aa (m²) is coil face area, which is obtained from specifications.	Aa = 1,260 $Va = \frac{190}{60 \times 1.260} = 2.51$	Aa = 1,260 $Va = \frac{190}{60 \times 1.260} = 2.51$
3. Obtain coil internal water velocity (Vw) (m/s) $Vw = \frac{L}{6 \times Aw}$ Aw (cm²) is section area on water side which is obtained from specification.	Aw = 43.3 $Vw = \frac{255.3}{6 \times 43.3} = 0.983$	Aw = 43.3 $Vw = \frac{110}{6 \times 43.3} = 0.423$
4. Obtain leaving air conditions For cooling: 4-1 Obtain leaving air enthalpy i₂ (kcal/kg) a. Obtain entering air enthalpy i₁ (kcal/kg) from psychrometric chart $\Delta i = \frac{qt}{72 \times Q} \text{ (kcal/kg)}$ $i_2 = i_1 - \Delta i$ b. Assume necessary row number N as follows. For normal air conditioning, 6 row For large volume of fresh air intake, 8 row c. Obtain bypass factor BF from Table AV-1 with coil face velocity (Va) BF = 0.17 d. Obtain leaving air temp. ta₂ (°CD.B) from psychrometric chart as BF = $\frac{\ell_2}{\ell_1}$  For heating: 4-2 Obtain leaving air temp. ta₂ (°CD.B) $ta_2 = ta_1 + \frac{qH}{17.4 \times Q}$	i₁ = 14.96 $\Delta i = \frac{76600}{72 \times 190} = 5.60$ $i_2 = 14.96 - 5.60 = 9.36$ N = 6 (Assumption) BF = 0.17 ta₂ = 15.0	ta₂ = 15.4 + $\frac{66000}{17.4 \times 190} = 35.4$

5. Obtain sensible heat factor SHF For cooling: $SHF = \frac{0.24 \times (ta_1 - ta_2)}{\Delta i}$ Note: In case $SHF < 0.95$ calculate with SHF obtained from the above formula. In case $SHF \geq 0.95$, calculate with $SHF = 1$ For heating: $SHF = 1$	$SHF = \frac{0.24 \times (28.1 - 15.0)}{5.6} = 0.561$	$SHF = 1$
6. Obtain coefficient of overall heat transmission K (kcal/m²·h·°C, row) $K = \frac{20.1}{\left(\frac{1}{\alpha a} \times SHF\right) + \frac{R}{\alpha w}}$ Obtain $\frac{1}{\alpha a}$ from Table AV-2 with coil face velocity Va Obtain $\frac{R}{\alpha w}$ from Table AV-3 with coil internal water velocity αa: Sensible heat transfer coefficient – air side (kcal/m²·h·°C) αw: Heat transfer coefficient – water side (kcal/m²·h·°C) R: Ratio between external and internal surface area	$\frac{1}{\alpha a} = 0.02544$ $\frac{R}{\alpha w} = 0.00549$ $K = \frac{20.1}{(0.02544 \times 0.561) + 0.00549} = 1017$	$\frac{1}{\alpha a} = 0.02544$ $\frac{R}{\alpha w} = 0.01135$ $K = \frac{20.1}{(0.02544 \times 1) + 0.01135} = 546$
7. Obtain logarithmic mean temp. difference Δtm (°C) For cooling: $\Delta t_1 = ta_1 - tw_2$ $\Delta t_2 = ta_2 - tw_1$ For heating: $\Delta t_1 = tw_2 - ta_1$ $\Delta t_2 = tw_1 - ta_2$ When obtaining from calculation $\Delta tm = \frac{\Delta t_1 - \Delta t_2}{2.3 \times \log_{10} \left(\frac{\Delta t_1}{\Delta t_2} \right)}$ When obtaining from Chart, obtain from chart AV-1.	$\Delta t_1 = 28.1 - 12 = 16.1$ $\Delta t_2 = 15.0 - 7 = 8.0$ From Chart AV-1 $\Delta tm = 11.6$	$\Delta t_1 = 50 - 15.4 = 34.6$ $\Delta t_2 = 60 - 35.4 = 24.6$ From Chart AV-1 $\Delta tm = 29.0$
8. Calculation for necessary row number N $N = \frac{qt \text{ or } qH}{K \times Aa \times \Delta tm}$	$N = \frac{76600}{1017 \times 1.260 \times 11.6} = 5.15$	$N = \frac{66000}{546 \times 1.260 \times 29.0} = 3.31$
9. Decision of row number (Note 1) In case coil can be used for cooling/heating, use larger value. (In the example, 6-row coil is used) (Note 2) If necessary row number obtained from the calculation in 8 differs greatly with assumed row number, recalculate it, after changing assumption of row number. (Note 3) In case of $\Delta t_2 < 3$, consult Daikin.	$N = 6$ row $N = 4$ row Use 6-row coil	$N = 4$ row

Table AV-1. Bypass factor BF

Coil face velocity Va (m/s)	Water coil row number			
	4 rows	6 rows	8 rows	10 rows
2.0	0.27	0.14	0.07	0.04
2.1	0.27	0.15	0.08	0.04
2.2	0.28	0.15	0.08	0.04
2.3	0.29	0.16	0.08	0.05
2.4	0.29	0.16	0.09	0.05
2.5	0.30	0.17	0.09	0.05
2.6	0.31	0.17	0.09	0.05
2.7	0.31	0.18	0.10	0.06
2.8	0.32	0.18	0.10	0.06
2.9	0.33	0.19	0.10	0.06
3.0	0.33	0.19	0.11	0.06

The table is prepared for fin pitch 3.5mm.

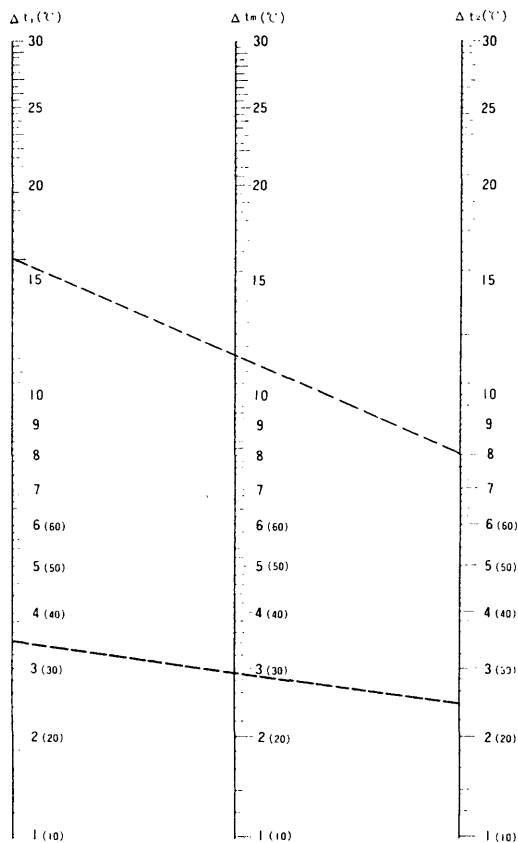
Table AV-2. $I/\alpha a$

Coil face velocity Va (m/s)	$I/\alpha a$ (m ² h°C/kcal)
2.00	0.02896
2.05	0.02854
2.10	0.02815
2.15	0.02778
2.20	0.02741
2.25	0.02705
2.30	0.02671
2.35	0.02637
2.40	0.02606
2.45	0.02575
2.50	0.02544
2.55	0.02515
2.60	0.02487
2.65	0.02459
2.70	0.02433
2.75	0.02407
2.80	0.02382
2.85	0.02357
2.90	0.02334
2.95	0.02311
3.00	0.02288

Table AV-3. $R/\alpha w$

Coil internal water velocity Vw (m/s)	$R/\alpha w$ (m ² h°C/kcal)
0.2	0.01956
0.3	0.01443
0.4	0.01135
0.5	0.00951
0.6	0.00827
0.7	0.00731
0.8	0.00657
0.9	0.00598
1.0	0.00549
1.1	0.00509
1.2	0.00475
1.3	0.00445
1.4	0.00420
1.5	0.00397
1.6	0.00377
1.7	0.00359
1.8	0.00343
1.9	0.00329
2.0	0.00316

Chart AV-1. Logarithmic mean temp. difference Δt_m (°C)



$$\Delta t_m = \frac{\Delta t_1 - \Delta t_2}{2.3 \log (\Delta t_1 / \Delta t_2)}$$

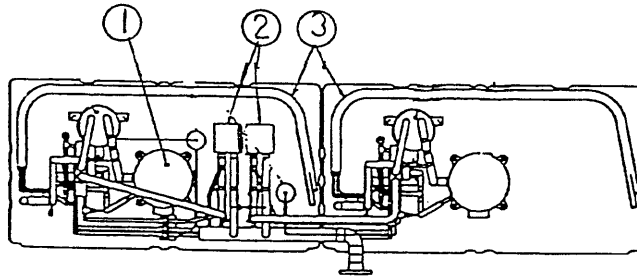
2-3 Heat source equipment : Air cooled heat pump chiller

2-3-1 What an air cooled heat pump chiller is.

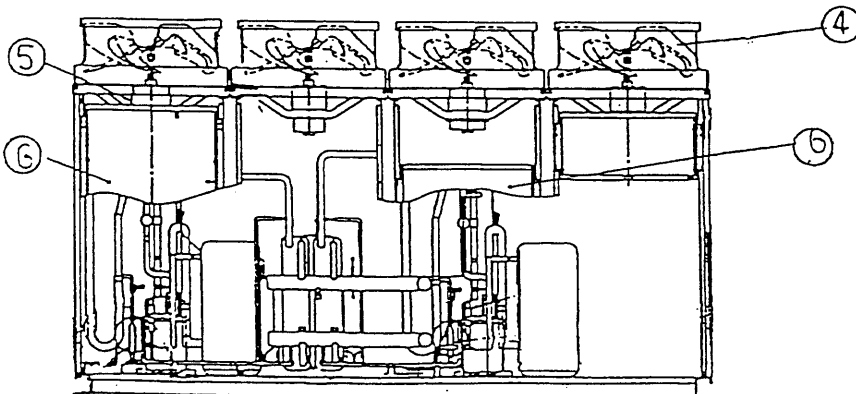
Central airconditioning system requires chilled water in cooling mode and hot water or steam in heating mode. Equipment to make chilled water, hot water, and steam is given a generic name a heat source equipment or a primary equipment which has many variety of the types.

An air cooled heat pump chiller produces chilled water(planing outlet water temperature in a range of 5 ~ 9°C) and hot water (planing outlet water temperature in a range of 45~55°C), and then supplies the water to airconditioners. Hence, the big difference to an airconditioner can be said that an airconditioner produces chilled air or hot air, while a chiller produces chilled water or hot water.

Fig. 16 Air cooled heat pump chiller structure (example)



- ① Compressor
- ② Water side heat exchanger
- ③ Air side heat exchanger
- ④ Propeller fan
- ⑤ Fan motor
- ⑥ Electric panel



Structured components

(1) Compressor

A compressor type, totally hermetic reciprocating, totally hermetic scroll, semi-hermetic single screw, is chosen so as to suit the planning applications which will operate in high efficiency.

(2) Water side heat exchanger

Water side heat exchanger, durable tube type, plate type made of stainless steel, dry type shell and tube, also is chosen so as to suit the requirement to produce chilled water and hot water in high efficiency. A freeze up protection thermostat is equipped.

(3) Air side heat exchanger

This is a cross fin coil type heat exchanger composed of copper tubes and aluminum fins. In heating mode (producing hot water), drain water exhausting problem will take place because defrost operation is needed periodically due to formation of frost on the heat exchanger depending on the ambient. Besides, in a location where strong side wind blows or snow accumulates on the machine, some counter measure is needed beforehand.

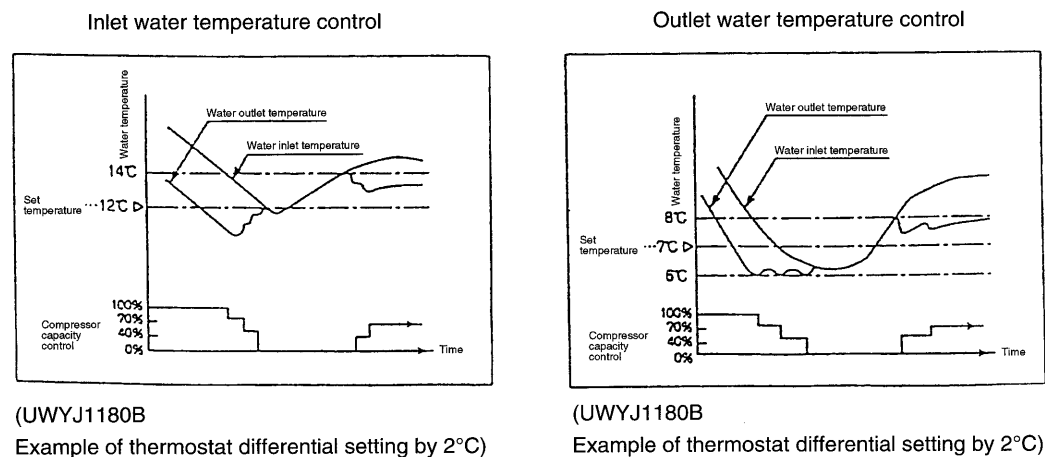
(4) Propeller fan and fan motor

As a propeller fan is directly connected to a fan motor, number of fan will be determined based on the chiller capacity, for example, one fan to smallest capacity and twelve fans to biggest capacity unit. Especially we take a consideration of fan blowing noise and try to reduce such a noise.

(5) Water temperature control

Chilled water and hot water control is standardized to carry out in accordance with the detection of water temperature at the inlet of water side heat exchanger. However, a chiller on which a hermetic single screw compressor is mounted can be changed to other control method like a detection of water temperature at the water outlet (outlet temperature control). (40 ~ 120HP)

Fig. 17 [Example of water temperature control of air cooled heat pump chiller 1180 type (40 HP)]



2-3-2 Model selection of heat pump chiller

(A) In case that equipment specification is decided

When equipment list based on the system plan is offered by a building design office, building construction company and so forth, the model selection should be proceeded depending on the equipment list.

(1) Example of equipment specification list

Shows equipment code		Display of capacity has kcal/h or kW	Shows compressor motor output	
RE-02	Water cooled screw refrigeration machine	Heat reclaiming type (Change-over cooling only type to heat-reclaim type) Cooling capacity in cooling only mode. 284,000 kcal/h (94USRT) Cooling capacity in heat reclaiming mode. 205,000 kcal/h (68USRT) Heating capacity in heat reclaiming mode. 312,000 kcal/h Chilled water outlet/inlet temperature 13 ~ 5°C Water flow rate 600L/min Pressure loss : 8mAq or less Hot water outlet/inlet temperature 47 ~ 55°C Water flow rate 600L/min Pressure loss : 8mAq or less Cooling water outlet/inlet temperature 32 ~ 37°C Water flow rate 1,220L/min Pressure loss : 8mAq or less (Special mention) 1. Thermal storage system 2. Chilled water condition in cooling only mode. 3. Vibration isolator (made of rubber)	Refrigerant R-134a C 110 Start method Star- Delta	1
HP-03	Air cooled heat pump unit	Cooling capacity 285,000 kcal/h (94USRT) Refrigerant R-134a Heating capacity 331,000 kcal/h Chilled water outlet/inlet temperature 13 ~ 5°C Water flow rate 600L/min Pressure loss 2mAq or less Hot water outlet temperature 55°C Water flow rate 600L/min Pressure loss 2mAq or less Ambient conditions in cooling 35 °CDB in heating 7 °CDB (Special mention) 1. for thermal storage 2. Vibration isolator (made of rubber)	C 45×2 F 0.55×12	1

Shows air cooled heat pump chiller.
Example of different expression

Pay attention describing what standard type cannot cope with or goods which are not attached.

(2) Required conditions for model selection

Read the following conditions through equipment list or other air conditioning system drawing. Figures in () stand for display conditions in catalogue.

- | | |
|---|------------------------|
| ① Model series | |
| ② Cooling capacity | kW (kcal/h) |
| ③ Chilled water outlet temperature | °C (7°C) |
| ④ Chilled water flow rate | L/min |
| ⑤ Heating capacity | kW (kcal/h) |
| ⑥ Hot water outlet temperature | °C (45°C) |
| ⑦ Hot water flow rate | L/min |
| ⑧ Ambient condition (in cooling) dry bulb temperature | °CDB (35°CDB) |
| ⑨ Ambient condition (in heating) wet bulb temperature | °CWB
(7°CDB, 6°CWB) |
| ⑩ Power source frequency | (50Hz or 60Hz) |

※ If special indications are listed like permissible noise level, remedy for vibration and earthquake-resistance rank, etc., it is required to cope with that indications.

(3) Model selection

① Model series

Model series are generally indicated on system design drawing and equipment list, but especially pay attention to a special series which has no certain indication.

Let's take up an example of special specifications like a salty water resist chiller, three samples are available as follows.

(a) Specially mentioned specification tells us to deliver a chiller with salty water resist specification.

(b) Listed up in the equipment list as special remark.

(c) Mentioned the manufacture's model name in the list given.

It is not cleared if light duty or heavy duty salt water resist specification should be used. In addition, sometimes special mention are not written on the list except the power source if they are requesting special voltage specifications.

② To check equipment's capacity

Since equipment capacity is not displayed by means of unified method in between manufacturers unlike Sky-air, if you will select a model and make quotation just according to the nominal horse powers, be careful for the fact there would be a case that cannot satisfy the specification on the system drawing.

◆ Let's show you the key points of reading capacity specifications in accordance with DAIKIN engineering handbook as follows.

Especially it should be noticed that capacity, in the characteristic table of heating capacity, is based on outdoor temperature (DB) with relative humidity 85%, while capacity reduction at frosting or defrost operation is not shown in the characteristic table.

Refer to [Caution in use of heating capacities] of DAIKIN technical document.

Classifications of Hz

• Cooling capacity characteristics

Power consumption includes fan motor output

Displays pressure loss in evaporator

Leaving chilled water temperature (°C)

FQ	OT	TI	5				7				9				11				13			
			CAP Kw	WFE L/M	PD KPa	PI Kw	CAP Kw	WFE L/M	PD KPa	PI Kw	CAP Kw	WFE L/M	PD KPa	PI Kw	CAP Kw	WFE L/M	PD KPa	PI Kw	CAP Kw	WFE L/M	PD KPa	PI Kw
25	3	3	11.5	55	50	3.2	11.9	57	54	3.3	12.4	59	57	3.3	12.9	62	61	3.4	13.4	64	63	3.5
	4	4		41	32			43	34			44	36			46	38			48	40	
	5	5		33	23			34	24			36	26			37	27			38	29	
	3	3		54	49			56	52			58	56			61	60			63	63	
	4	4	11.3	40	31	3.4	11.8	42	33	3.4	12.2	44	35	3.5	12.7	46	37	3.6	13.2	47	40	3.6
27	3	3		32	23			34	24			35	25			36	27			38	28	
	4	4		53	48			55	51			58	55			60	58			62	62	
	5	5		40	30	3.5	11.6	42	32	3.6	12.1	43	34	3.6	12.5	45	36	3.7	13.0	47	39	3.8
	3	3		52	47			55	50			57	53			59	57			61	60	
	4	4	11.1	39	30	3.6	11.4	41	32	3.7	11.9	43	34	3.8	12.3	44	36	3.9	12.8	46	38	3.9
29	3	3		31	22			33	23			34	24			35	26			37	27	
	4	4		52	46			54	49			56	52			58	56			61	59	
	5	5		39	29	3.8	11.3	41	31	3.9	11.8	42	33	3.9	12.2	44	35	4.0	12.7	45	37	4.1
	3	3		51	45			54	48			56	52			58	55			60	58	
	4	4	10.9	39	29	3.9	11.2	40	31	4.0	11.6	42	33	4.1	12.1	43	35	4.2	12.5	45	37	4.2
31	3	3		31	21			32	22			33	24			35	25			36	26	
	4	4		51	45			54	48			56	52			58	55			60	58	
	5	5		39	29	3.9	11.2	40	31	4.0	11.6	42	33	4.1	12.1	43	35	4.2	12.5	45	37	4.2
	3	3		51	45			54	48			56	52			58	55			60	58	
	4	4	10.8	39	29	3.9	11.2	40	31	4.0	11.6	42	33	4.1	12.1	43	35	4.2	12.5	45	37	4.2
33	3	3		31	21			32	22			33	24			35	25			36	26	
	4	4		51	45			54	48			56	52			58	55			60	58	
	5	5		39	29	3.9	11.2	40	31	4.0	11.6	42	33	4.1	12.1	43	35	4.2	12.5	45	37	4.2
	3	3		51	45			54	48			56	52			58	55			60	58	
	4	4	10.8	39	29	3.9	11.2	40	31	4.0	11.6	42	33	4.1	12.1	43	35	4.2	12.5	45	37	4.2
35	3	3		31	21			32	22			33	24			35	25			36	26	
	4	4		51	45			54	48			56	52			58	55			60	58	
	5	5		39	29	3.9	11.2	40	31	4.0	11.6	42	33	4.1	12.1	43	35	4.2	12.5	45	37	4.2
	3	3		51	45			54	48			56	52			58	55			60	58	
	4	4	10.8	39	29	3.9	11.2	40	31	4.0	11.6	42	33	4.1	12.1	43	35	4.2	12.5	45	37	4.2

Ambient temperature is shown in DB with relative humidity 85%.

• Heating capacity characteristics

			Leaving Hot water temperature (°C)																															
FQ	OT	TI	41				43				45				47				49				51				53				55			
			CAP Kw	WFE L/M	PD KPa	PI Kw	CAP Kw	WFE L/M	PD KPa	PI Kw	CAP Kw	WFE L/M	PD KPa	PI Kw	CAP Kw	WFE L/M	PD KPa	PI Kw	CAP Kw	WFE L/M	PD KPa	PI Kw	CAP Kw	WFE L/M	PD KPa	PI Kw	CAP Kw	WFE L/M	PD KPa	PI Kw	CAP Kw	WFE L/M	PD KPa	PI Kw
-5	4	9.7	35	25	3.5	9.7	46	38	3.5	9.7	45	35	3.6	9.6	35	25	3.7	9.6	35	25	3.8	9.6	46	38	3.8	9.6	34	25	4.0	9.6	34	24	4.4	
	5		28	19			28	19			28	19			28	19			28	19			28	19			27	18			27	18		
	3	10.3	37	27	3.5	10.3	37	27	3.6	10.2	37	27	3.7	10.2	37	27	3.8	10.2	37	27	3.9	10.2	36	27	4.0	10.2	36	27	4.1	10.1	36	27	4.5	
	4		29	20			29	20			29	20			29	20			29	20			29	20			29	20			29	20		
	5		25	16			25	16			25	16			25	16			25	16			25	16			25	16			25	16		
0	4	11.2	40	31	3.5	11.1	40	31	3.6	11.1	40	31	3.7	11.1	40	31	3.9	11.1	40	31	4.0	11.1	40	30	4.1	11.1	40	30	4.1	11.0	39	30	4.5	
	5		32	22			32	22			32	22			32	22			32	22			32	22			32	22			32	22		
	3	12.1	43	34	3.6	12.0	43	34	3.7	12.0	43	34	3.8	12.0	43	34	3.9	12.0	43	34	4.0	12.0	43	34	4.1	11.9	43	34	4.2	11.9	43	34	4.5	
	4		35	25			35	25			35	25			35	25			35	25			35	25			34	24			34	24		
	5		30	20			30	20			30	20			30	20			30	20			30	20			29	20			29	20		
5	4	12.7	45	37	3.6	12.6	45	37	3.7	12.6	45	37	3.8	12.6	45	37	3.9	12.6	45	37	4.0	12.5	45	37	4.1	12.5	45	36	4.2	12.5	45	36	4.5	
	5		36	27			36	27			36	27			36	27			36	26			36	26			35	26			35	26		
	3	13.3	47	40	3.6	13.2	47	40	3.7	13.2	47	40	3.8	13.2	47	40	3.9	13.1	47	39	4.0	13.1	47	39	4.1	13.1	47	39	4.2	13.1	47	39	4.6	
	4		38	28			38	28			38	28			38	28			38	28			38	28			37	28			37	28		
	5		32	22			32	22			32	22			32	22			32	22			32	22			31	22			31	22		
9	4	13.8	50	43	3.6	13.8	50	43	3.7	13.8	49	43	3.8	13.8	49	42	3.9	13.7	49	42	4.0	13.7	49	42	4.1	13.7	49	42	4.2	13.7	49	42	4.6	
	5		40	30			40	30			40	30			40	30			40	30			40	30			39	30			39	30		
	3	14.4	52	46	3.6	14.4	52	46	3.7	14.4	52	46	3.8	14.4	52	45	3.9	14.3	51	45	4.0	14.3	51	45	4.1	14.3	51	45	4.2	14.2	51	45	4.6	
	4		41	32			41	32			41	32			41	32			41	32			41	32			40	32			40	32		
	5		34	24			34	24			34	24			34	24			34	24			34	24			33	24			33	24		
13	4	15.0	54	49	3.6	15.0	54	49	3.7	15.0	54	49	3.8	15.0	54	48	4.0	14.9	53	48	4.1	14.9	53	48	4.2	14.9	53	48	4.2	14.8	53	48	4.6	
	5		43	34			43	34			43	34			43	34			43	34			43	34			42	34			42	34		
	3																																	
	4																																	
	5																																	
15	4	15.6	56	52	3.6	15.6	56	52	3.7	15.6	56	52	3.8	15.5	56	52	4.0	15.5	56	52	4.1	15.5	55	51	4.2	15.5	55	51	4.2	15.4	55	51	4.6	
	5		45	36			45	36			45	36			45	36			45	36			45	36			44	36			44	36		
	3																																	
	4																																	
	5																																	

③ Key points on systems

(a) Subjects related to chilled /hot water Items

Items	Contents
Chilled/Hot water quality	Depending on JRA water quality standard
Equipment's permissible water pressure	0.68 MPa (7kg/cm ²) or less
Permissible circulation water flow rate	Max. and Min. water flow rates are decided . Be sure to keep the rates while referring to the engineering data.
Minimum water holding volume in circuit	Min. holding water volume in chilled/hot water circuit is decided. Be sure to keep the volume while referring to the engineering data book.
Range of chilled/hot water temperature	It relates to ambient temperature. Refer to the engineering data book.
Chilled/Hot water strainer	Use a strainer attached as a standard accessory for UWYJ 125 ~ 750B.

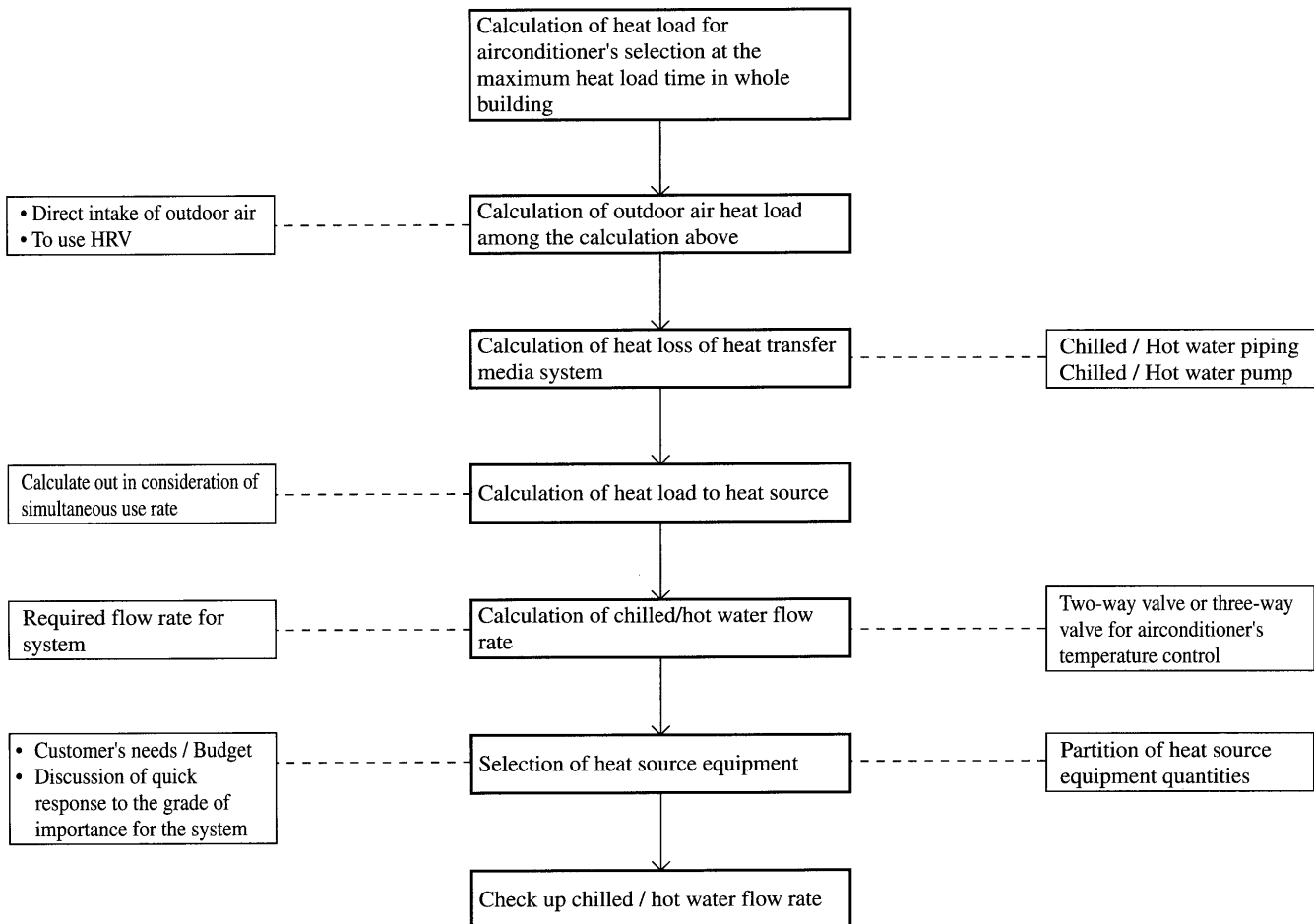
(b) Subjects related to electricity and operation

Items	Contents
Power supply	Voltage variation : Base volts ± 10 % Imbalance in between phases : ± 2 % Frequency : ± 2 %
Pull-dawn time	Within one hour without load
Start/Stop interval of compressor	On/Off frequency per hour within six times
Remote control switch (Remote operation)	UWYJ125B ~ UWYJ(D)3550B is an optional accessory. (Refer to the engineering data book if you will operate a remote control by out of the way mentioned above).
Chilled /Hot water pump operation	* Concerning UWYJ125B ~ 250B Wiring from electric panel on the unit's body to a pump motor makes it possible to operate by the remote control switch of optional accessories. Note) ① As pump motor output is limited, make sure the output through the engineering data book at the selection of the motor. ② The compressor must be prepared not so as to operate compulsorily, when just test run is required. * Concerning UWYJ375B ~ UWYJ(D) 3550B5/6 Since electric parts related to pumps are not built in at all, get ready them separately. However, as the connection places of electric control wiring such as magnetic contactor and over-current relay or so are decided by equipment side, carry out the wiring in a correct way in accordance with the wiring diagram of the equipment.

(B) Selection of heat source equipment based on the airconditioning system plan.

The capacity of heat source will be selected depending on the max. heat load at the certain time in the space where air conditioners are going to be installed in consideration of the whole building circumstance. Let's show an example of selection procedure of heat source equipment as follows.

Heat source equipment selection procedure.



2-4 Fundamentals of water piping

2-4-1 Fundamentals of water circuit

There are an open circuit and a closed circuit for circulation water circuit.

(1) Open circuit

Open circuit is the circuit in which an expansion tank doesn't use but the piping is connected to a thermal tank or so where water opens to the ambient. There are variety of the kinds as follows.

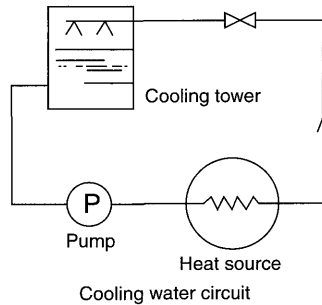
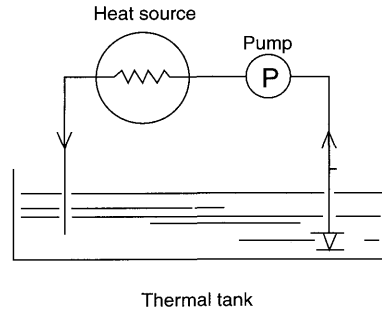


Fig. 18 Open circuit (A)



Thermal storage tank circuit in building and so force

Fig. 19 Open circuit (B)

(2) Closed circuit

A closed circuit is a circuit in which water doesn't open to the ambient. (including a circuit in which an expansion tank is connected to open water to the air in the out of the circulation line).

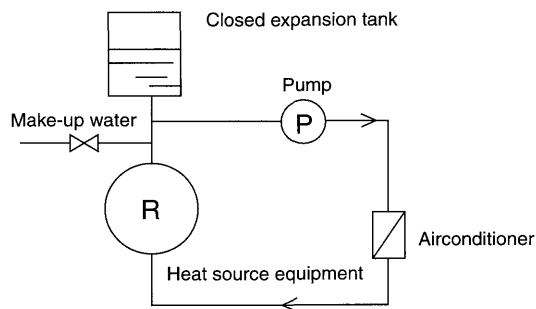


Fig. 20 (A) Closed circuit (Pressurized by air)

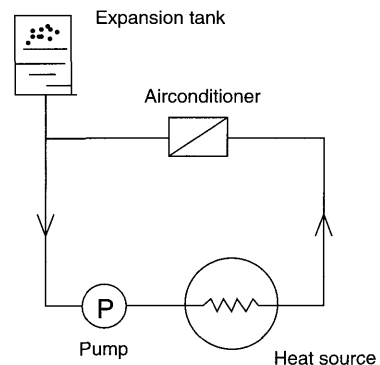


Fig. 21 (B) Closed circuit (Pressurized by water head)

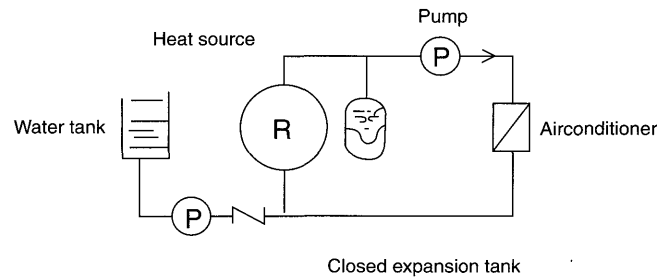


Fig. 22 (C) Closed circuit (Pressurized by pump)

(3) Comparison between open circuit and closed circuit

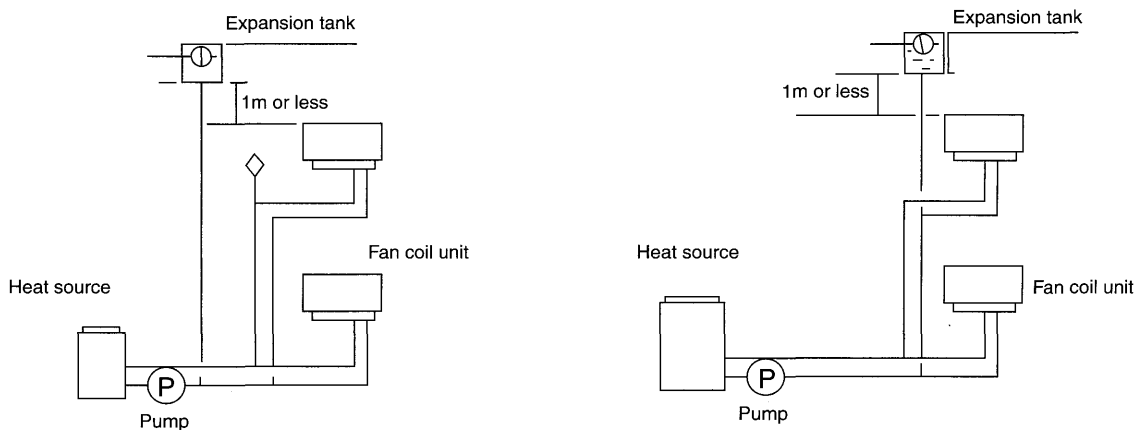
It can be clarified the difference between open circuit and closed circuit by watching the required output of pump motor to circulate system water and the piping endurance.

For open circuit, the pressure in tubes at the outlet of equipment on the highest position must be hold above atmospheric pressure from a view point of eliminating mixed air. Accordingly, the pump head requires the corresponding static head to this height. The pump required head, or required out put will become bigger by the equivalency.

Corrosion inside tube is influenced by air volume inside tube, or oxygen volume. Therefore, there will be many cases air may always mix into water circuit in open circuit, and unless otherwise proper water treatment will be conducted, corrosion will be promoted, causing short-life of pipes.

Instead, closed circuit requires sufficient air purging and proper installation of expansion tank are required in initial stage of operation. However, the pump's required head can be reduced corresponding to the static head, and air mixture will not take place because of no touch to air, resulting in rare corrosion rate and few water treatment.

Fig. 23 (4) Example of common system with air cooled heat pump chiller



In a system that air cooled heat pump chiller is used, piping system, shown in Fig. 23 on previous page or Fig. 24 shown right, is adopted. The important subject here is to install expansion tank 1 m or higher above fan coil unit at the top position.

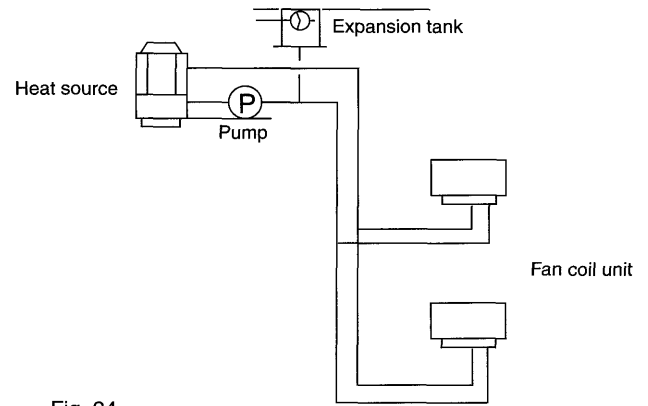


Fig. 24

(5) Example of mistakable water circuit

(a) Pump and tank are installed in the outlet side of heat source equipment.

- Problems ① Internal pressure around heat source equipment and pump is apt to be below atmospheric pressure.
 ② Internal pressure after fan coil unit is apt to be below atmospheric pressure if the piping distance from fan coil to heat source equipment is long.

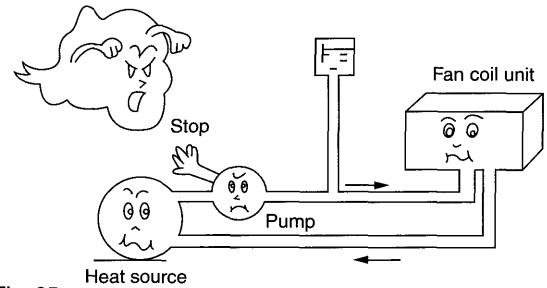


Fig. 25

(b) Expansion tank is connected between pump and heat source equipment.

- Problems ① Internal pressure around fan coil unit located at highest position is apt to be below atmospheric pressure.
 ② If location of expansion tank is low, internal pressure sometimes falls to below atmospheric pressure even though in the outlet side.

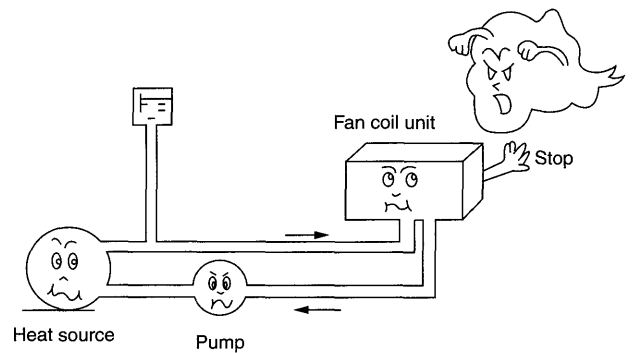


Fig. 26

(c) Expansion tank is connected in the outlet side of heart source equipment.

- Problem ① Internal pressure is apt to be below atmospheric pressure around fan coil unit at highest position.

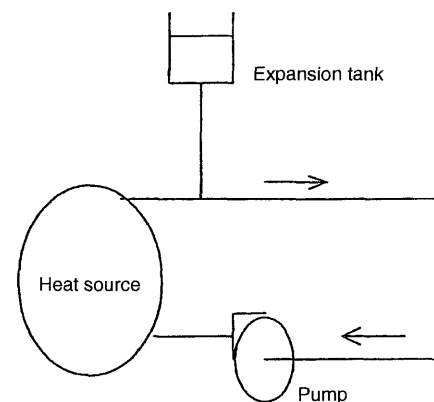


Fig. 27

2-4-2 Water piping systems

There are various water piping of chilled /hot water, cooling water, and high temperature water in airconditioning systems. For planning water piping, keep in your mind the following suggestions.

- ① Water must be supplied proper volume to proper places (corresponding to airconditioning load).
- ② The loss due to heat loss and friction loss should be as small as possible.
- ③ Never arise mechanical trouble such as water streaming noise, pipe vibration, or tube expansion due to temperature difference.
- ④ Never arise water trouble such as water expansion, air mixture, or water quality's influence, water velocity.
- ⑤ Make arrangement for easy service work and easy maintenance.

(1) Piping system

Many types of classification are available for water piping systems. Here, "Method by return water", "Method by water pipe number" and "Method by flow control" will be discussed.

① Method by return water

(a) Direct return system

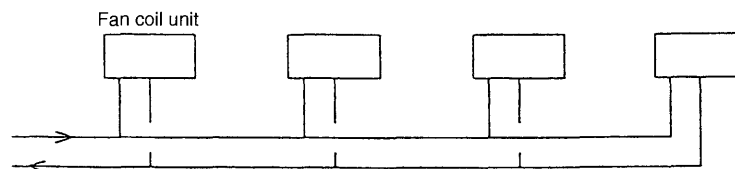
The piping length connected to the fan coil unit at the nearest location to heat source equipment is the shortest, while the piping connected to the fan coil unit at the farthest location is the longest. Thus, the head loss of each fan coil unit is different to each other. Accordingly, water channeling will easily happen and necessitate control mechanism at each fan coil unit.

(b) Reverse return method

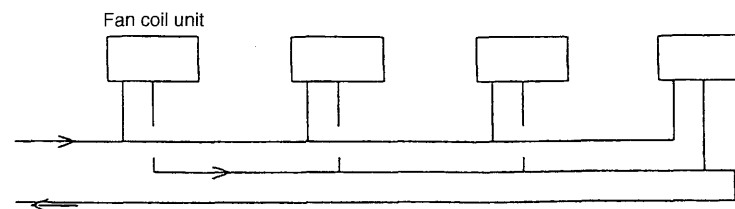
Since the piping lengths to go and back are almost equal to and make piping friction loss equal, this method gives good balance of water flow rate to each fan coil unit. Conversely, it has disadvantage like the total length of piping is longer and required space for piping is larger. However, another merit is to enable flow control easier at test run or maintenance work.

Fig. 28

<<Direct return method>>



<<Reverse return method>>



② Method by piping number

- (a) Single pipe method: Method to be used in small scale hot water heating. Low cost in installation work but difficult in flow control.
- (b) Two-pipe method: Commonly used method. Consists of one pipe to each to go and back piping. Chilled or hot water to fan coil unit in use.
- (c) Three-pipe method: Two pipes, and one pipe are provided for supply and return piping respectively. When cooling and heating are needed simultaneously in one building, hot water and chilled water flow in separate pipe to supply energy to fan coil unit, and then return through one return pipe in mixed condition with chilled/hot water. Finally, one return piping separate into two which flow into separate heat source equipment.
- (d) 4-pipe method: For avoiding demerit of 3-pipe method, supply and return pipes are separately provided. Consists of supply two pipes and return two pipes of chilled /hot water.

Fig. 29 <<Single pipe method>>

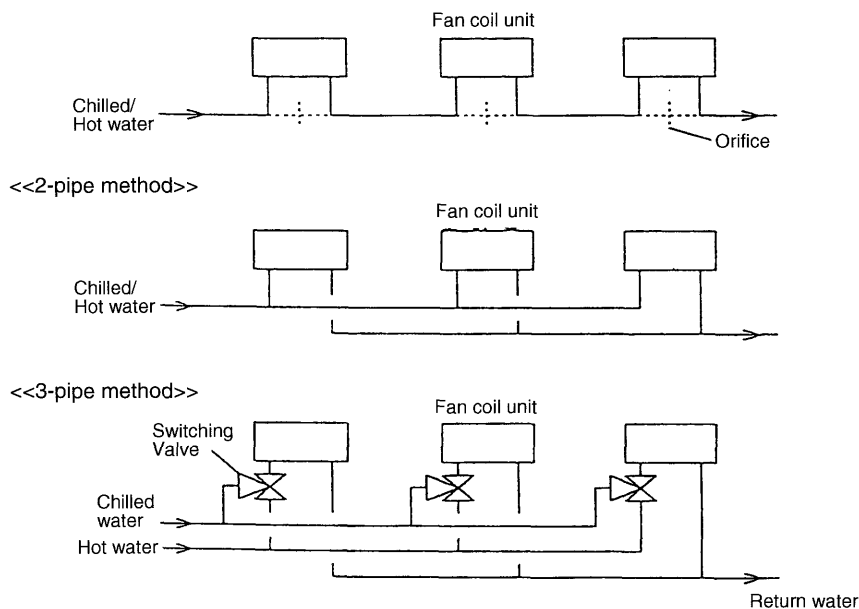
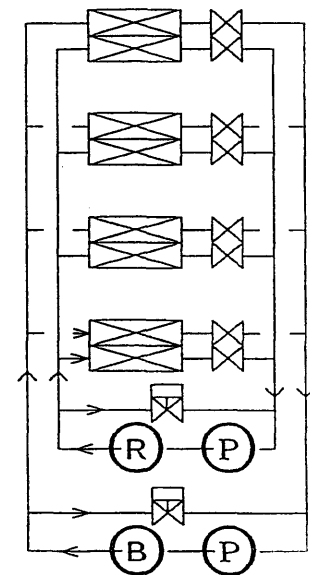


Fig. 30 <<4-pipe method>>



③ Method by flow control

(a) Constant flow method

The flow in this side of fan coil unit (at the outlet of a control valve) keeps constant flow rate. Namely, chilled/hot water pump's flow rate is constant always without relation of load variation in constant flow method.

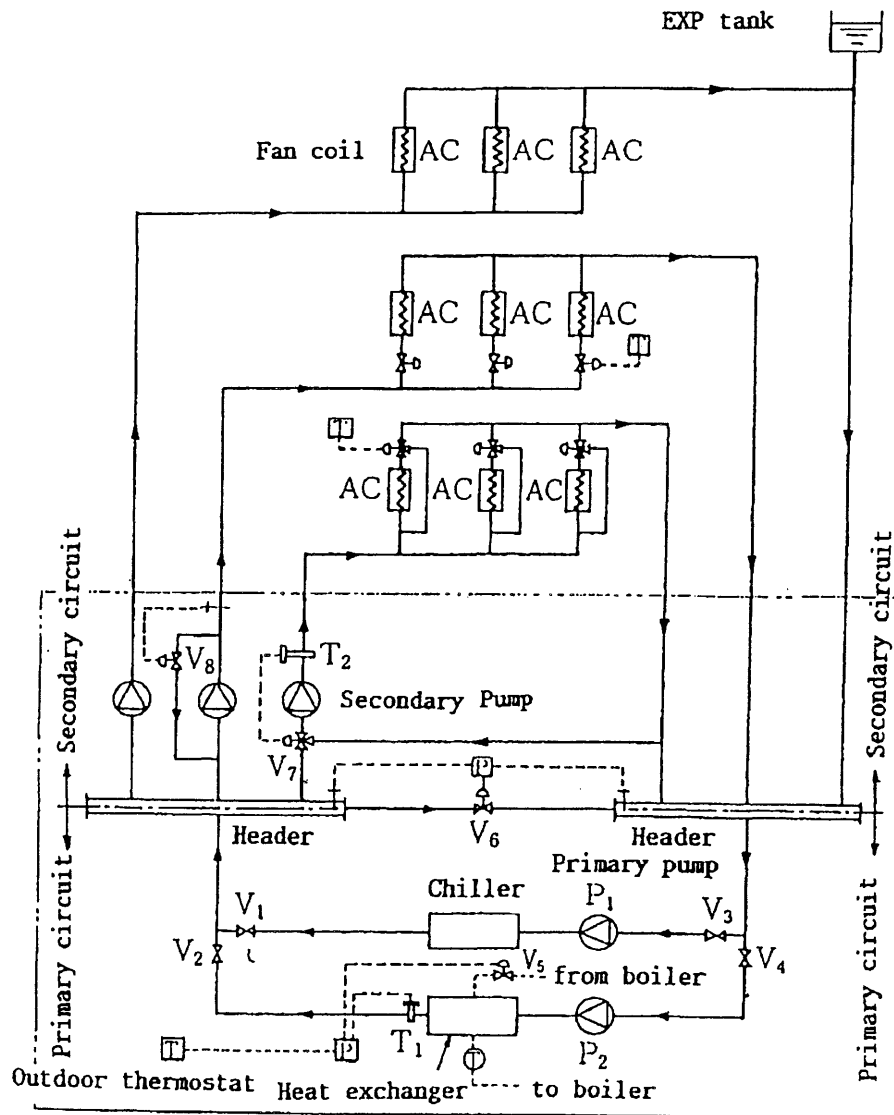
(b) Variable flow rate method

There would be no problem to vary water flow rate or chilled/hot water temperature in accordance with the variation of heat load in order to keep room temperature constant. This method will contribute to save energy.

The method to take this into consideration is a variable water flow rate method. For more specific, two-way valve is used for flow control so as to control air temperature.

Here, let's show one example which uses big sized water chiller with fan coil units and primary pump covers a primary circuit with heat source equipment, and secondary pump covers a secondary circuit with terminal units like fan coil units.

Fig. 31: Example of system with primary pumps and secondary pumps. (Features group management of pumps and variations of fan coil unit connection)



FCU at top position :

Non control system just stop valves at both inlet and outlet of water piping are provided.

In the middle position of fan coil line-up:

Two-way control system. Motorized valve controls water flow rate to fan coil units by detecting room temperature. Good control performance. Transport's power saving will be achieved by this system in a linkage of pump's group management and inverter pump.

In the bottom position of fan coil line-up:

Internal water flow rate of fan coil varies but water flow rate in the circuit keeps constant. However, pumping water flow rate keeps constant which will result in no saving of transport power.

V6: Differential pressure regulating valve:

When controlling water flow rate by means of two way valve, return water volume to chiller reduces and becomes afraid of freezing evaporator in chiller. This is the valve to avoid such trouble beforehand by making water in high pressure side to low pressure side bypass.

V1, V2, V3, V4: Switching valve of chilled water to hot water.

(2) Piping selection

① Determination of chilled /hot water flow rate

$$L (\ell /h) = \frac{q}{\Delta t}$$

q: airconditioning load (kcal/h)
 Δt : Water temperature differential between outlet and inlet of water coil (°C)

However, the decision of specification necessitates to take the required flow rate of heat source equipment into consideration.

② Decision of piping diameter

In airconditioning water piping design, the piping diameters are decided in most cases based on the equal friction method so as to make pump selection easy.

On the first stage of piping diameter's selection, the reasonable piping circuit should be decided first. On the next step, calculate flow rate in each piping circuit and then decide the piping diameter in accordance with the flow rate and basic friction loss in a standard unit.

Equal friction loss method (to make use of the friction loss head chart)

Decide the main pipe size based on whole water circulation flow rate, and generally basic friction loss in a standard unit in a range of 30 ~ 100mmH₂O/m, and check the water velocity (refer to tables below).

On the next step, each size of pipe after branching should be decided based on water flow rate and basic friction loss in a standard unit just read through chart and read the intersection and then decide the size.

In the process of sizing pipes after branching, keep in your mind that pipe size selection has to be done so that basic friction loss in a standard unit will not exceed the value which was adopted at the selection of main pipes because the more friction loss, the harder the water flows in a branch circuit. Nevertheless, if the flow rate still exceeds the value selected in a main piping, adjust valve not so as to exceed the main pipe's value.

<<Recommended internal velocity>>

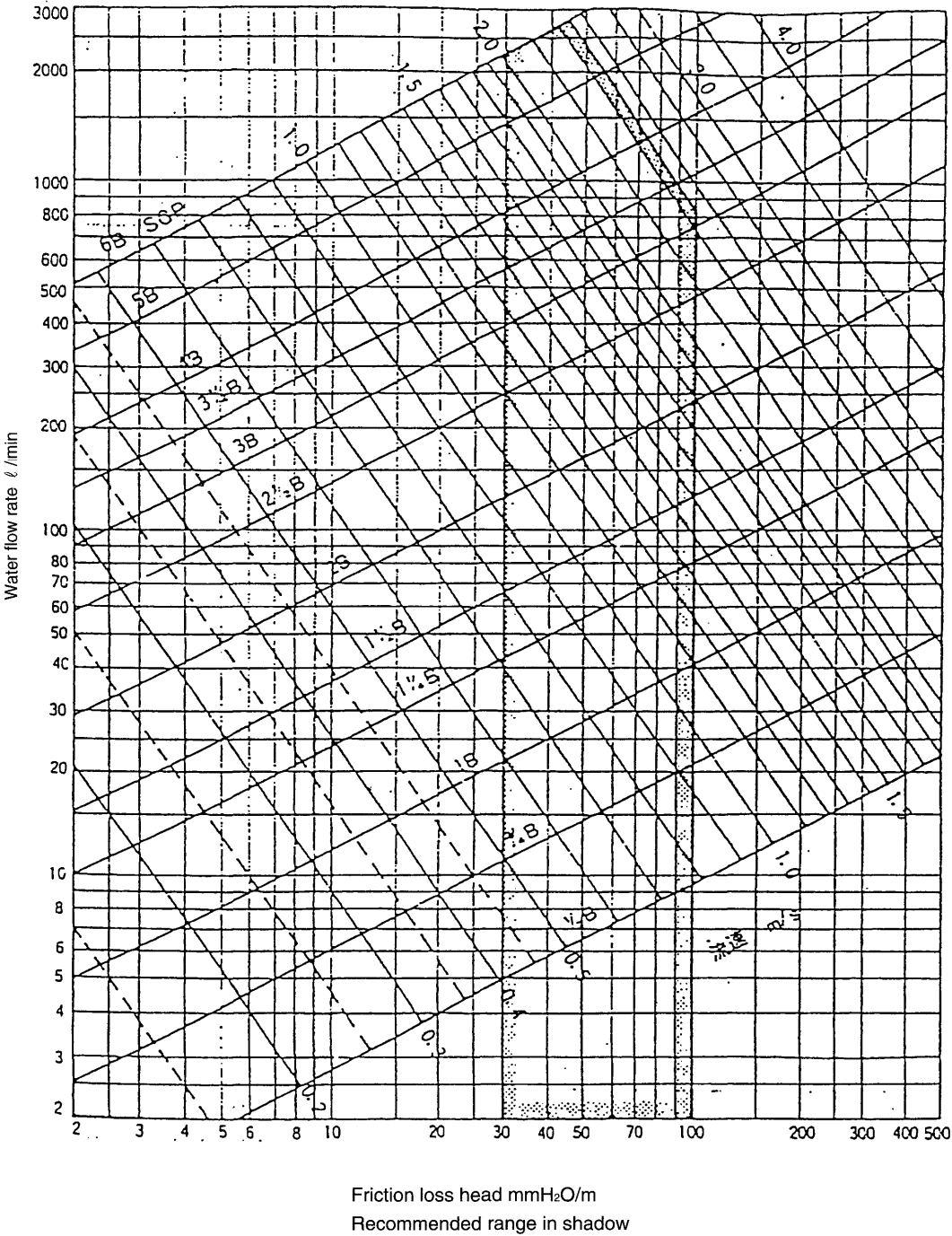
Tube diameter (A)	Velocity (m/s)
125 or bigger	2.1 ~ 2.7
50 ~ 100	1.2 ~ 2.1
Around 25	0.6 ~ 1.2

<<Permissible max. velocity>>

Annual operation hours	Velocity (m/s)
1,500 (hr)	3.6
2,000	3.5
3,000	3.3
4,000	3.0
6,000	2.7
8,000	2.4

Note) If velocity is too high, erosion or water flow noise comes up to high level. Instead, if velocity is too slow, accumulation of foreign objects or residue of air arises, resulting in piping corrosion. The least permissible velocity is less than 0.6m/s.

Fig. 32 Friction loss head chart for steel pipe



Correction factors for friction loss

Steel pipe	0.87
Gas pipe	1.0
Gas pipe in common use	1.2 ~1.5
Aged gas pipe	1.3 ~2.7

③ Securing water holding volume

There are various kinds of heat source equipment for central airconditioning system. Minimum water holding volume in heat source equipment and in water circuit has been decided in every heat source equipment to protect equipment. It is securely required to keep the min. water holding volume anyway.

Make sure the required min. holding volume for the equipment in plan by the technical engineering data book.

Reason to ensure the min. water holding volume

- ◆ Air cooled heat pump chiller
 - To secure the limit of ON/OFF frequency.
 - To prevent cold draft during defrosting.
- ◆ Absorption water chiller
 - To prevent freeze-up of chilled water

(3) Selection of expansion tank

Unless there is something to absorb an expanded volume due to water temperature's differential, the piping system will be broken. So, expansion tank will be ready for absorbing the water volume alteration.

Two kinds of expansion tanks are available; a closed tank type and an open tank type. The purpose to provide an expansion tank is the same with both a close type and an open type. An open type provides a make-up water supply inlet (with ball tap) so as to make up water at a time of water shortage in a water circuit or in an expansion tank itself.

① Sizing of an open type expansion tank

$$E = (1.2 \sim 1.5) \times \Delta v$$

E: Expansion tank volume (ℓ)

$$\Delta v = \left(\frac{1}{\rho_2} - \frac{1}{\rho_1} \right) \times V$$

Δv : Expansion volume (ℓ)

ρ_1 : Specific weight of water at lowest temperature (kg/ ℓ)

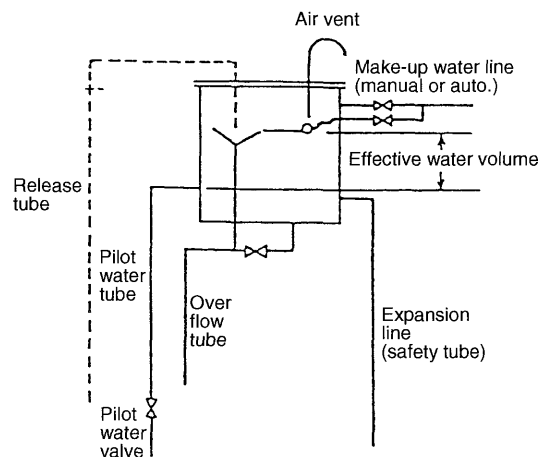
ρ_2 : Specific weight of water at highest temperature (kg/ ℓ)

V: Holding water volume in whole circuit (ℓ)

<<Water temperature and specific volume>>

Temperature (°C)	Specific weight (kg/ ℓ)	Temperature (°C)	Specific weight (kg/ ℓ)
4	1	50	0.9881
10	0.9997	60	0.9832
20	0.9982	70	0.9778
30	0.9956	80	0.9718
40	0.9922	90	0.9653

Fig. 33: Piping around open type expansion tank



(4) Water valve selection

(a) Kinds of stop valve and check valve

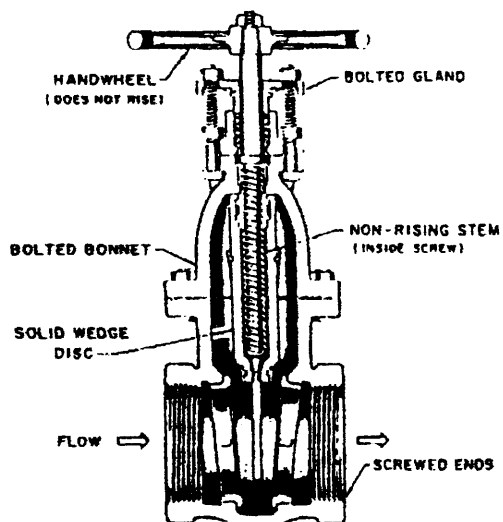


Fig. 35 : Gate valve (Non-rising stem)

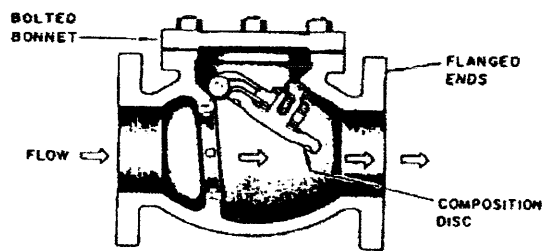


Fig. 34 : Swing check valve

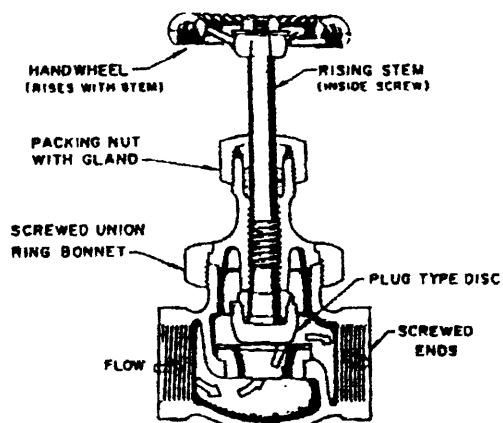


Fig. 36: Glove valve

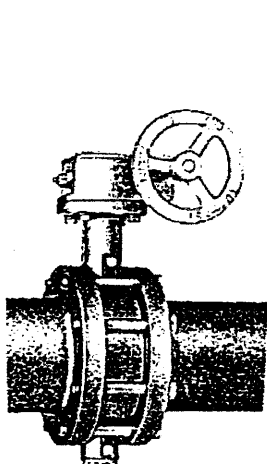


Fig. 37: Butterfly valve

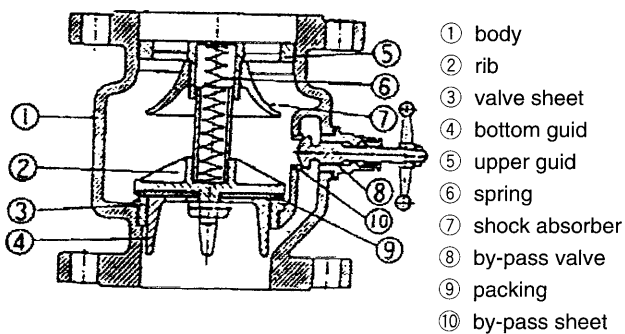
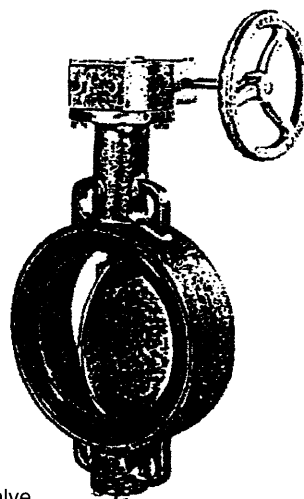


Fig. 38: Smorensky check valve

(b) Applications of valves

Globe valve(Glove type and ball type) :	Slow motion but secure controllability. Frequent use as volumetric control device. Few occasion to use for general water circuit due to its large friction loss except at the position requiring volumetric control.
Gate valve (or Sluice valve) :	Quick action for ON/OFF, small friction loss, frequent use for general water circuit. No use for volumetric control due to the vague characteristic. In recent years, butterfly valve has taken the place of gate valve.
Butterfly valve:	Simple structure and used for both purpose ; ON/OFF, volumetric control. Frequent use in recent years.
Smorensky check valve:	Frequent use almost 100 % for stop valve at discharge side of a volute pump. Good performance for preventing water hammer at stop of a pump. Used from comparatively old age.

(c) Be careful for pressure endurance

100 m rising pipe gives 10kg/cm² static pressure when a pump stops. Take a valve position into consideration.
Choose valves properly in accordance with Table 2: valve selection table in consideration of pressure resistance.

Table 2: Valve selection table in every application (Courtesy, DAIKIN Plant company)

	Steam	Steam drain	Chilled & hot water	Cooling water	Make-up water	Size (A)	Conn.	Material
Gate valve		○	○ (5K)	○ (5K)	○ (5K)	65 ~300	Flange	FC
			○ (10K)	○ (10K)	○ (10K)	65 ~300	Flange	FC
		○	○ (5K)	○ (5K)	○ (5K)	15 ~ 50	Screw	BC
			○ (10K)	○ (10K)	○ (10K)	15 ~ 50	Screw	BC
Glove valve	○ (7K)					65 ~200	Flange	FC
	○ (10K)					15 ~ 50	Screw	BC
Butterfly valve			○ (10K)	○ (10K)	○ (10K)	25 ~ 300	Flange	FC · AL

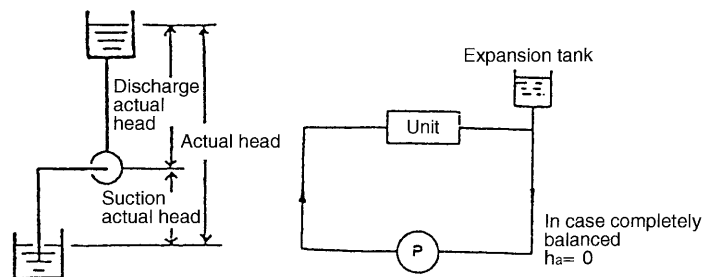
Note: 5K, 10K --- Max pressure permissible based on Japanese Industrial Standard, 5 kg/cm², 10kg/cm², respectively.
FC, BC --- Ferrous casting, Bronze casting, respectively.

(Example)	Circulation pump	-----	Line pump
	Self suction type	-----	Volute self suction pump
			Multi-self suction pump
			Self suction volute pump
	Industrial pump	-----	Volute pump



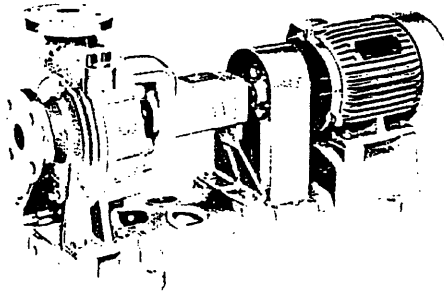
Volute pump

<<Concept of actual head>>



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.....



Technical drawing showing a grid with curved lines and labels for various sizes and dimensions. The grid is defined by horizontal and vertical lines, with curved lines intersecting them. Labels include:

- 125 × 100
- 80 × 65FS4K511
- 80 × 65FS4K57.5
- 80 × 65FS4K55.5
- FS4L530
- FS4L522
- FS4K518
- FS4K515
- FS4K511
- FS4J515
- FS4H53.7
- FS4H52.2
- FS4H51.5
- FS4G5.4
- FS4G5.75
- FS4G51.5
- 100 × 80 125 × 100 150 × 125
- 40 × 32
- 50 × 40
- 65 × 50
- 80 × 65
- FS4L525
- FS4L515
- FS4L507
- FS4L500
- FS4K518
- FS4K515
- FS4K511
- FS4J515
- FS4H53.7
- FS4H52.2
- FS4H51.5
- FS4G5.4
- FS4G5.75
- FS4G51.5
- 100 × 150FS4K518
- 100 × 150FS4K515
- 100 × 150FS4K511
- 100 × 150FS4J515
- 100 × 150FS4H53.7
- 100 × 150FS4H52.2
- 100 × 150FS4H51.5
- 100 × 150FS4G5.4
- 100 × 150FS4G5.75
- 100 × 150FS4G51.5
- 100 × 150FS4L530
- 100 × 150FS4L522
- 100 × 150FS4L525
- 100 × 150FS4L515
- 100 × 150FS4L507
- 100 × 150FS4L500
- 100 × 150FS4K518
- 100 × 150FS4K515
- 100 × 150FS4K511
- 100 × 150FS4J515
- 100 × 150FS4H53.7
- 100 × 150FS4H52.2
- 100 × 150FS4H51.5
- 100 × 150FS4G5.4
- 100 × 150FS4G5.75
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- 100 × 150FS4L525
- 100 × 150FS4L515
- 100 × 150FS4L507
- 100 × 150FS4L500
- 100 × 150FS4K518
- 100 × 150FS4K515
- 100 × 150FS4K511
- 100 × 150FS4J515
- 100 × 150FS4H53.7
- 100 × 150FS4H52.2
- 100 × 150FS4H51.5
- 100 × 150FS4G5.4
- 100 × 150FS4G5.75
- 100 × 150FS4G51.5
- 100 × 150FS4L530
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- 100 × 150FS4J515
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- 100 × 150FS4H52.2
- 100 × 150FS4H51.5
- 100 × 150FS4G5.4
- 100 × 150FS4G5.75
- 100 × 150FS4G51.5
- 100 × 150FS4L530
- 100 × 150FS4L522
- 100 × 150FS4L525
- 100 × 150FS4L515
- 100 × 150FS4L507
- 1

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(b) Friction loss in straight line (h_f)

Friction loss in straight line in has the following relations:

- Increases in proportion to piping length.
- Increases in inverse proportion to internal diameter.
- Increases in proportion to a square of velocity.

Calculate the friction loss in the straight line where maximum friction loss will be expected.

$$h_f = \text{Straight line in round distance (m)} \times \text{Basic friction loss in a standard unit (mH}_2\text{O/m)}$$

(c) Partial friction loss (h_t)

Friction loss at elbows or valves in piping lines is called "Partial friction loss". Partial friction loss is converted to equivalent length in referring to the conversion chart, and then get the loss in the same way above.

$$h_t = \text{Equivalent length of each fittings (m)} \times \text{Basic friction loss in a standard unit (mH}_2\text{O/m)}$$

Refer to Table 3 in page 48 "Loss at fittings in equivalent meter" for picking up the value of individual fitting's friction loss. Here, Let's show the simple way to get partial friction loss at fittings as follows;

$$h_t = h_f \times k \quad k : \text{Rate of Partial friction loss}$$

<<k value depending on a building's application and piping conditions>>

Building's application and piping conditions	Rate of Partial friction loss
Piping with few fittings (valve, joint, branch)	0.2 ~ 0.5
General office building	0.5 ~ 1.0
House and other small building	1.0 ~ 1.5

(d) Internal friction loss (h_k)

Refer to the data in engineering handbook for internal friction loss of the related equipment. However, calculation procedure is not related to all of the equipment in the circuit, but choose just terminal units and heat source equipment which are located in a route where maximum friction loss will be expected.

Table 3: Friction loss at fittings in equivalent meter for water circuit.

(UNIT: m)

Nominal dia.		elbow 90°	elbow 45°	Tee thru branch	Tee straight thru	Gate valve	Globe valve	Angle valve	Swing check valve	SM * check valve	Y type strainer
A [mm]	B [inch]										
15	1/2	0.6	0.36	0.9	0.18	0.12	4.5	2.4	1.2	---	1.38
20	3/4	0.75	0.45	1.2	0.24	0.15	6.0	3.6	1.6	---	2.18
25	1	0.9	0.54	1.5	0.27	0.18	7.5	4.5	2.0	---	3.0
32	1 1/4	1.2	0.72	1.8	0.36	0.24	10.5	5.4	2.5	---	4.62
40	1 1/2	1.5	0.9	2.1	0.45	0.3	13.5	6.6	3.1	4.2	5.47
50	2	2.1	1.2	3.0	0.6	0.39	16.5	8.4	4.0	3.8	8.0
65	2 1/2	2.4	1.5	3.6	0.75	0.48	19.5	10.2	4.6	3.8	11.45
80	3	3.0	1.8	4.5	0.90	0.63	24.0	12.0	5.7	4.0	14.11
90	3 1/2	3.6	2.1	5.4	1.08	0.72	30.0	15.0	7.1	4.0	17.64
100	4	4.2	2.4	6.3	1.20	0.81	37.5	16.5	7.6	2.0	21.62
125	5	5.1	3.0	7.5	1.5	0.99	42.0	21.0	10.0	2.0	31.57
150	6	6.0	3.6	9.0	1.8	1.2	49.5	24.0	12.0	2.0	41.17
200	8	6.5	3.7	14.0	4.0	1.4	70.0	33.0	15.0	2.8	54.83
250	10	8.0	4.2	20.0	5.0	1.7	90.0	43.0	19.0	1.7	70.37

* Smorensky type check valve (shock absorbing type)

NOTE: Loss at foot valve equates with loss at angle valve.

(6) Drain piping

When an airconditioner is installed, drain piping securely becomes necessary, because many drainage exist such as drain by dehumidifying, exhausting water from a coil at maintenance work and drain by inside cleaning. Consequently, drain piping should be carried out so that the function as drain can be kept completely.

① Key points for making drain piping.

- (a) Drain pipe for airconditioners has to be provided in separate to other drain pipes in the building and must stretch up to a ditch or a drain pot.
- (b) Either pressure condition is available; negative pressure or positive pressure at outlet of airconditioner depending on the structure of the airconditioner. So, in case negative pressure is supposed, provide a drain trap, etc. not so as to enter air to the airconditioner in care of the structure.
- (c) Make drains so that bad smell doesn't flow into an airconditioner.
- (d) Provide minimum gradient for horizontal drain line with 1/50 for pipe size 65 mm dia. or less and 1/100 for 75 mm dia. or more.
- (e) Provide air vent, which supplies air to inside drain, at a top of drain riser, because air which contacts water in a riser falls down as being induced, and results in creating positive pressure.
- (f) Make piping with elbows as few as possible so that clogging in pipes will take place. Use elbow with degree by 45° and conjunct branches with Y shape joint.

② Sizing of drain pipe

As drain pipe will have internal corrosion, related to the phenomena which internal tube wall contact air, and a scale formed by accumulation of dust inside airconditioner, sizing of pipe must be conducted with sufficient allowance. Outlet pipe size of equipment is recommended to use 25 A dia. or more to suit the outlet of equipment.

③ Permissible water flow rate in drain pipe (with air vent at top)

Table 4: Permissible water flow rate in drain pipe.

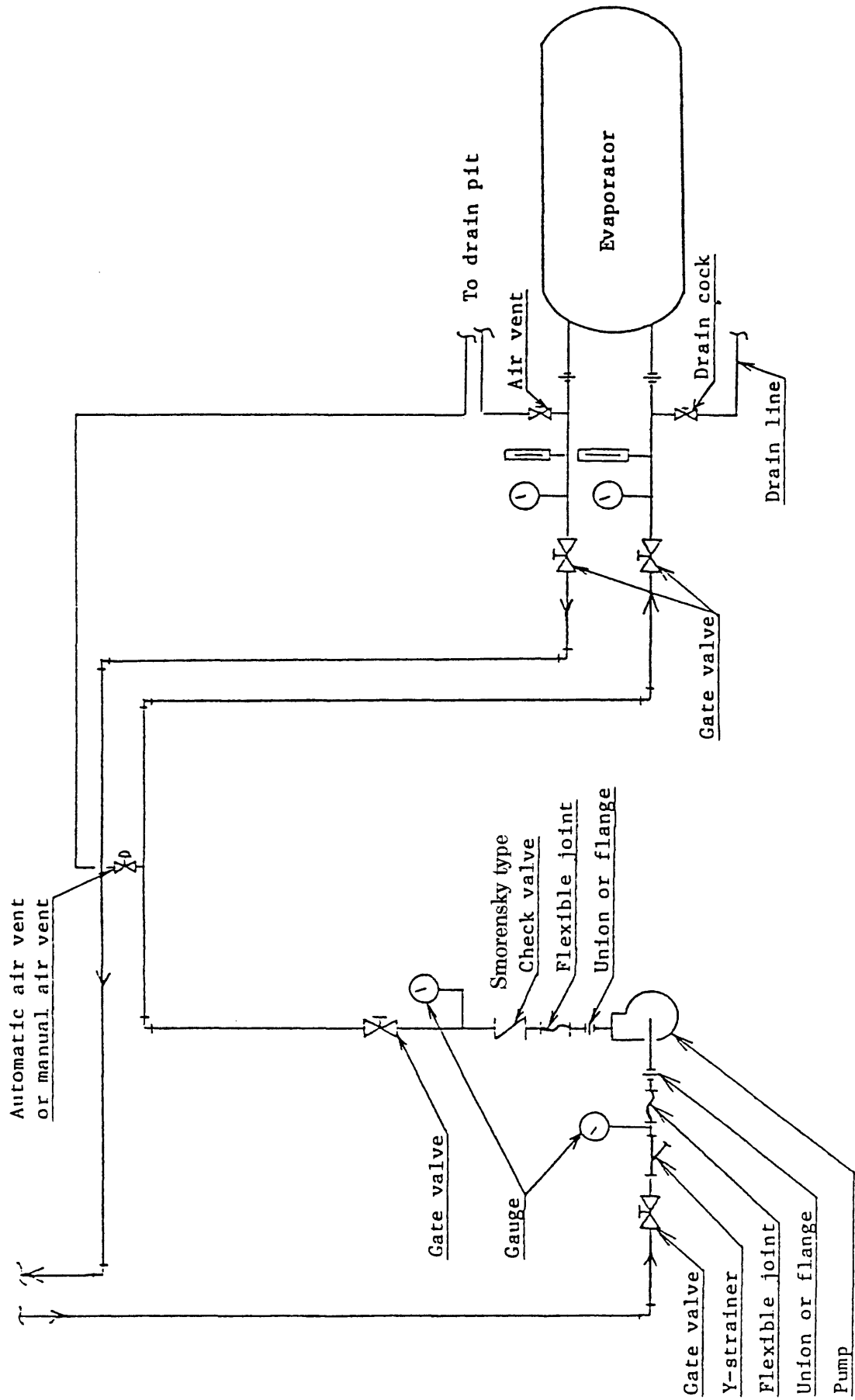
Pipe size	Gradient	flow rate (ℓ /min.)			
		1/25	1/50	1/100	Riser
30A		13.8	—	—	9.6
40A		29.4	21.0	—	21.6
50A		52.8	37.8	—	36.6
65A		108	75	—	72
75A		156	111	78	108
100A		366	237	168	234

- Note) 1. Average internal water velocity ranges in 0.6 m/s ~ 1.5 m/s.
2. This table is quoted from HASS 206-1991.

④ Other

Guide line of drain volume can be expected 0.4 ~ 0.6 L/h per cooling capacity 1 kW (860 kcal/h) in general airconditioning in office building or so.

Fig. 40 Example of water piping around pump and chiller



(7) Chilled/hot water piping guide around airconditioner

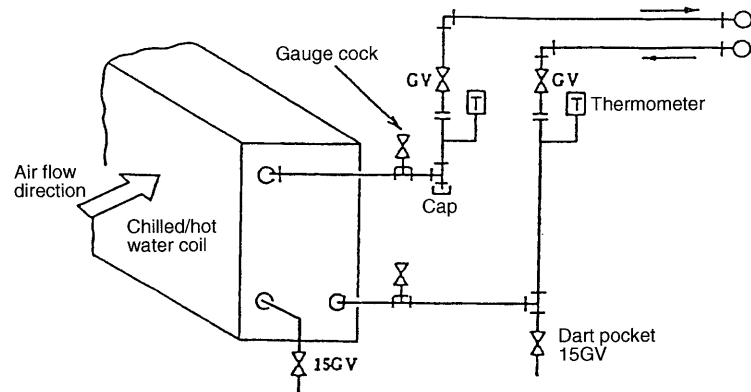
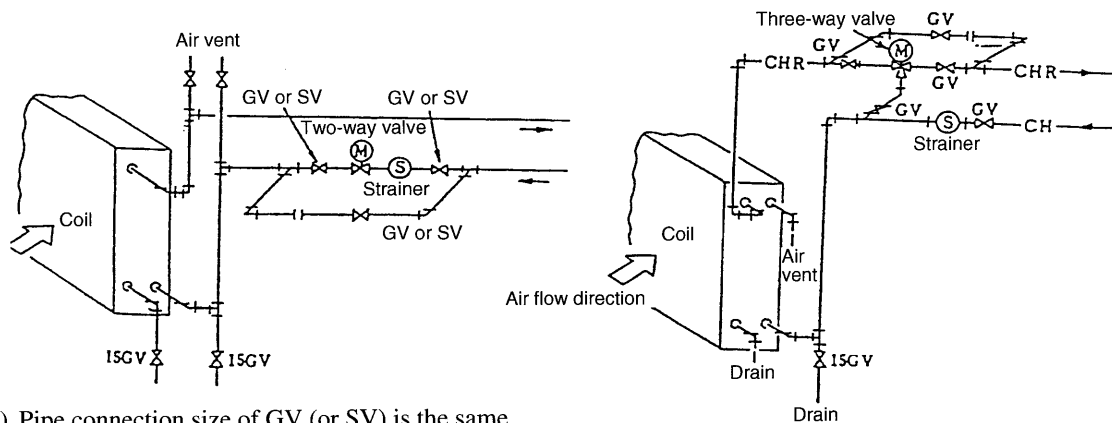


Fig. 41 : Piping diagram on manual control



Note) Pipe connection size of GV (or SV) is the same with main pipe, while bypass tube and GV (or SV) on the bypass line is the same size with two-way valve.

Note) Pipe connection size of GV (or SV) is the same with main pipe, while bypass tube and GV (or SV) on the bypass line is the same size with three-way valve.

Fig. 42 : Piping diagram with motor drive two-way valve

Fig. 43 : Piping diagram with motor drive three-way valve

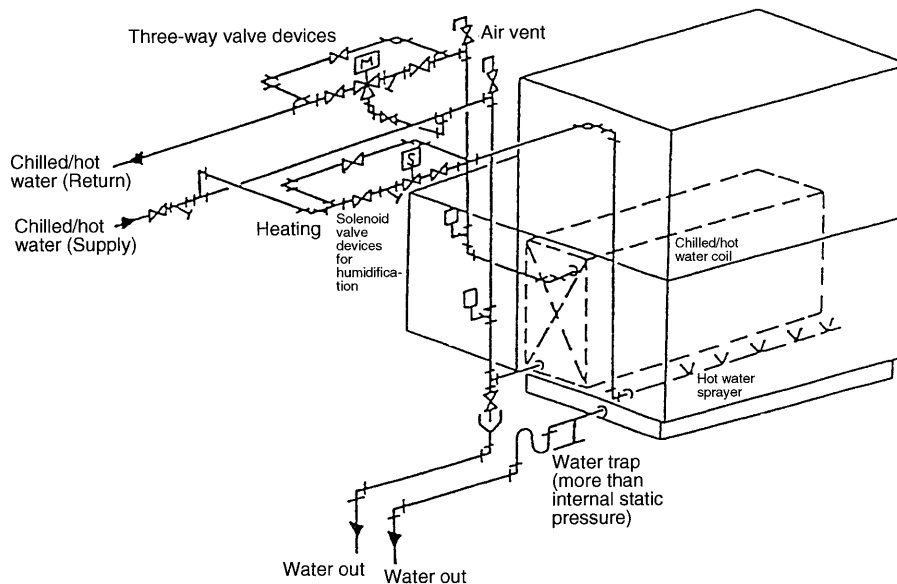


Fig. 44 : Piping diagram around airconditioner

Selection of VRV & HRV



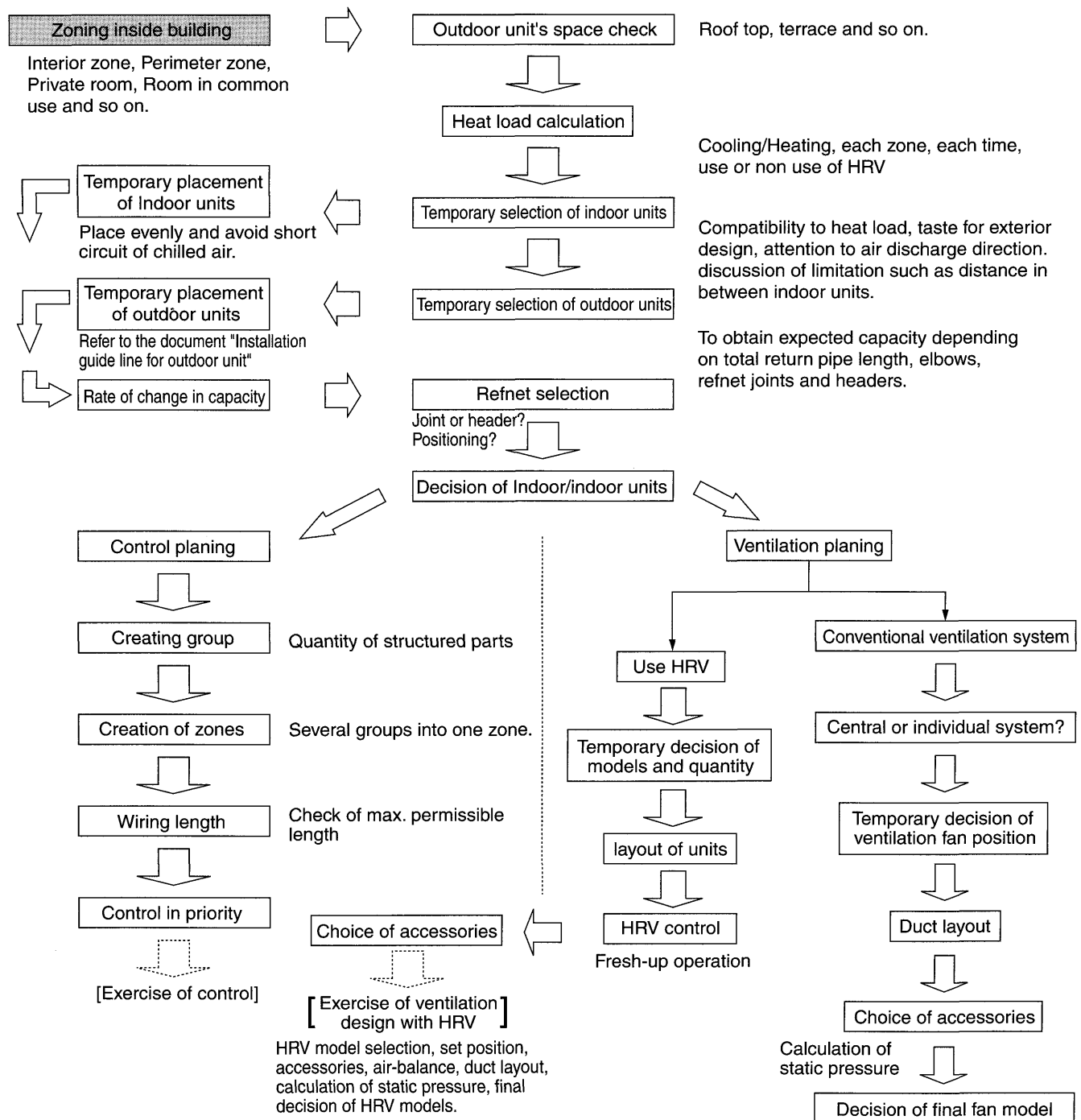
Preface : What's VRV system ?

Here, once again, let's review what features VRV system has.

- Systems which vary transportation speed of heat transfer media depending on heat load are VAV, VWV, and VRV. The heat transfer media are air, water and refrigerant for VAV (Variable Air Volume), VWV (Variable Water Volume), and VRV (Variable Refrigerant Volume) respectively.
- VRV provides variable speed compressor driven by inverter which will choose the most suitable revolution speed depending on heat load. Accordingly, refrigerant is supplied to indoor units with variable volume, while indoor unit has an electronic expansion valve regulating the valve's opening in a range of 0 ~ 100 % automatically. So VRV makes it possible to connect just one outdoor unit to thirty indoor units among which even one indoor unit can be operated independently. Heat exchanger capacity in an outdoor unit depending on the refrigerant volume change can compensate by providing various bypass routes.
- VRV is actually so facile system that no matter how several tens indoor unit are connected to an outdoor unit, one pipe starts from an outdoor unit and go around indoor units, and then return again to the outdoor unit. Actual length by 100 m can run all the through of the one way pipe line between an outdoor unit to indoor units.
- Every functional parts or devices must not be chosen, but all are contained in VRV unit itself inherently (self-contained type). Thus, it needs no long years experience for the system designing.

3-1 Design procedure of system to use VRV/HRV

Design procedure is indicated in this below chart. The topics shaded signify topics which will be explained in the succeeding pages till the other similar chart with other topics shaded appears.



3-1-1 Zoning inside building

A typical office building's plan view is shown in next page. Our actual work will start from the like what a building owner or a design consultant will give us drawings first. Then, How to read the drawings?

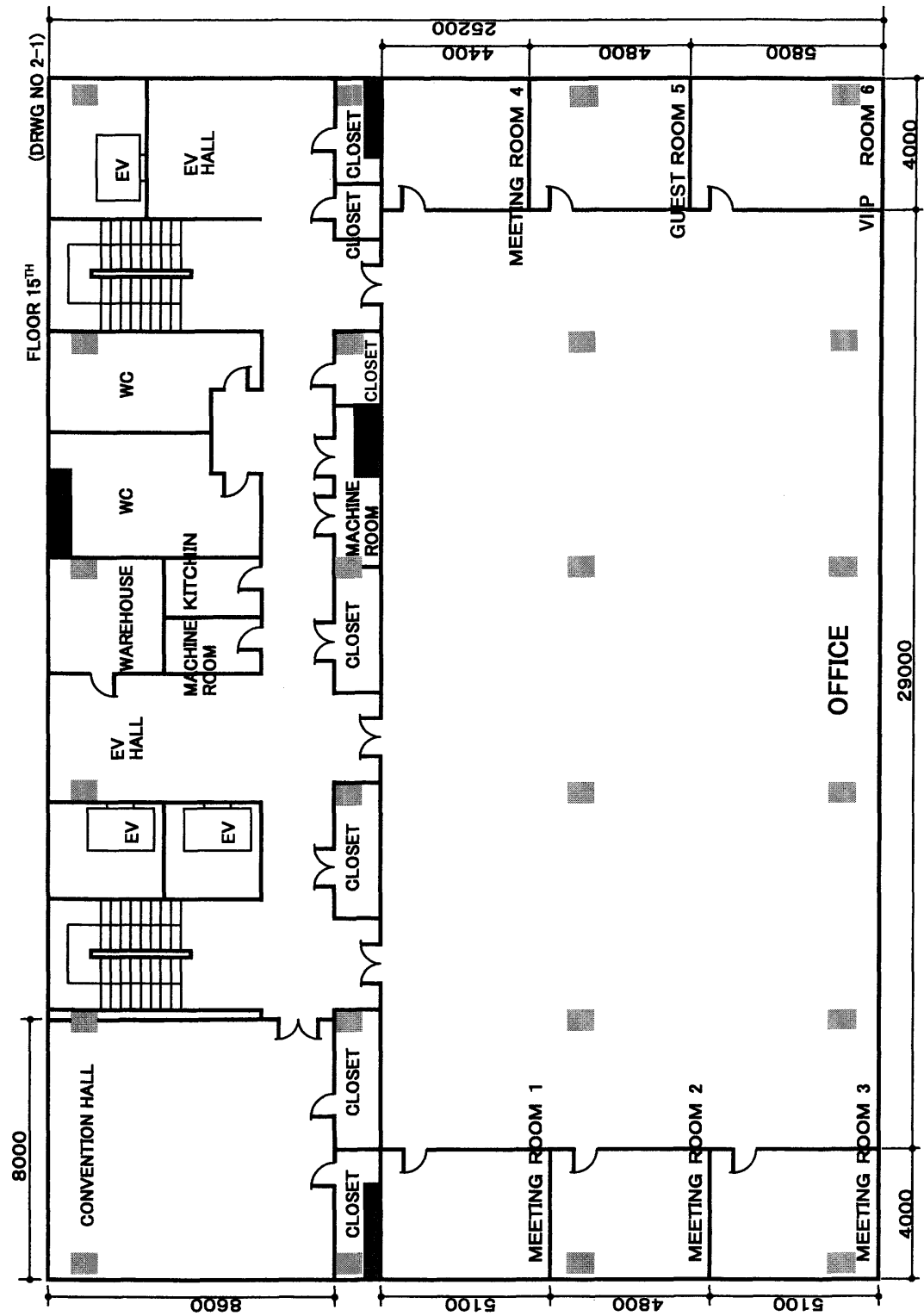
Let's explain the points of proceeding the plan by taking up this drawing.

Outline of this sample building on the drawing :

Floor area of one floor is 730m². Fifteen floors above ground and two floors under ground. Total building floor is approx. 12,400m². It would be classified in large building. Upper part of the drawing indicates north. Glass windows are installed all around outer wall with opening rate 30% of wall area except north of the utility core.

- Utility core : The place where elevator core, toilet, steps, kitchen, warehouse, and machine room, etc. for common use get together. Utility core generally occupies approx. 1/4 of all floors in any building.
- Convention hall: High density of inhabitant. The room capacity is thirty persons in so narrow space as 69m² at the rate of one person in 2.3m² on the contrast that average office capacity is one person in 5m². If smoking is not prohibited, a lot of ventilation will be required.
- Office area : Typical office. Inhabitant rate is one person in 5m².
- Meeting room: In both sides of office, several meeting rooms are provided. Three rooms in west side and one room in east side.
- Guest room and VIP room: In the almost same size room to meeting rooms, comparatively few persons will be expected to live in, 5 persons in each room. So, these two rooms are spacious.
- Building facility shaft : Portions with mark  in the drawing. The shafts are available in the north part of toilet, closets lined up in south side of the corridor, machine room. Refrigerant pipes, drain pipes and electric wires pass these shaft.
- Structural pillar of building:  All facilities being installed in the room should avoid to locate around the pillars, because these pillars are the structural members.

Fig. 45 : Example of building's plan view



3-1-2 Practical zoning

(a) Perimeter zone and Interior zone

Heat gain (or loss) arisen by the temperature difference between indoor and outdoor temperature through outer wall, solar radiation heat gain through windows, heat load from wind invaded through clearance of building ; all these loads are called "Skin load". Indoor units located in this area are responsible to cover all of the skin load. This zone is called "**Perimeter zone**". Perimeter zone is the area ranging 3m ~ 5m apart from outer wall in common. This sample building takes 4m for the perimeter zone. Then, the meeting room 1 ~ 4 , the guest room, the VIP room, the south end of the office are included in this perimeter zone. Let's name this area **ZONE 15**.

Area without strong influence of skin load and located in inside is called "**Interior zone**". There are generally few differentials of heat load by every hour in interior zone where heat load can be kept almost constant . In large building, cooling sometimes is required even in winter. For this sample building, the area of office except perimeter zone is defined as **ZONE 14**.

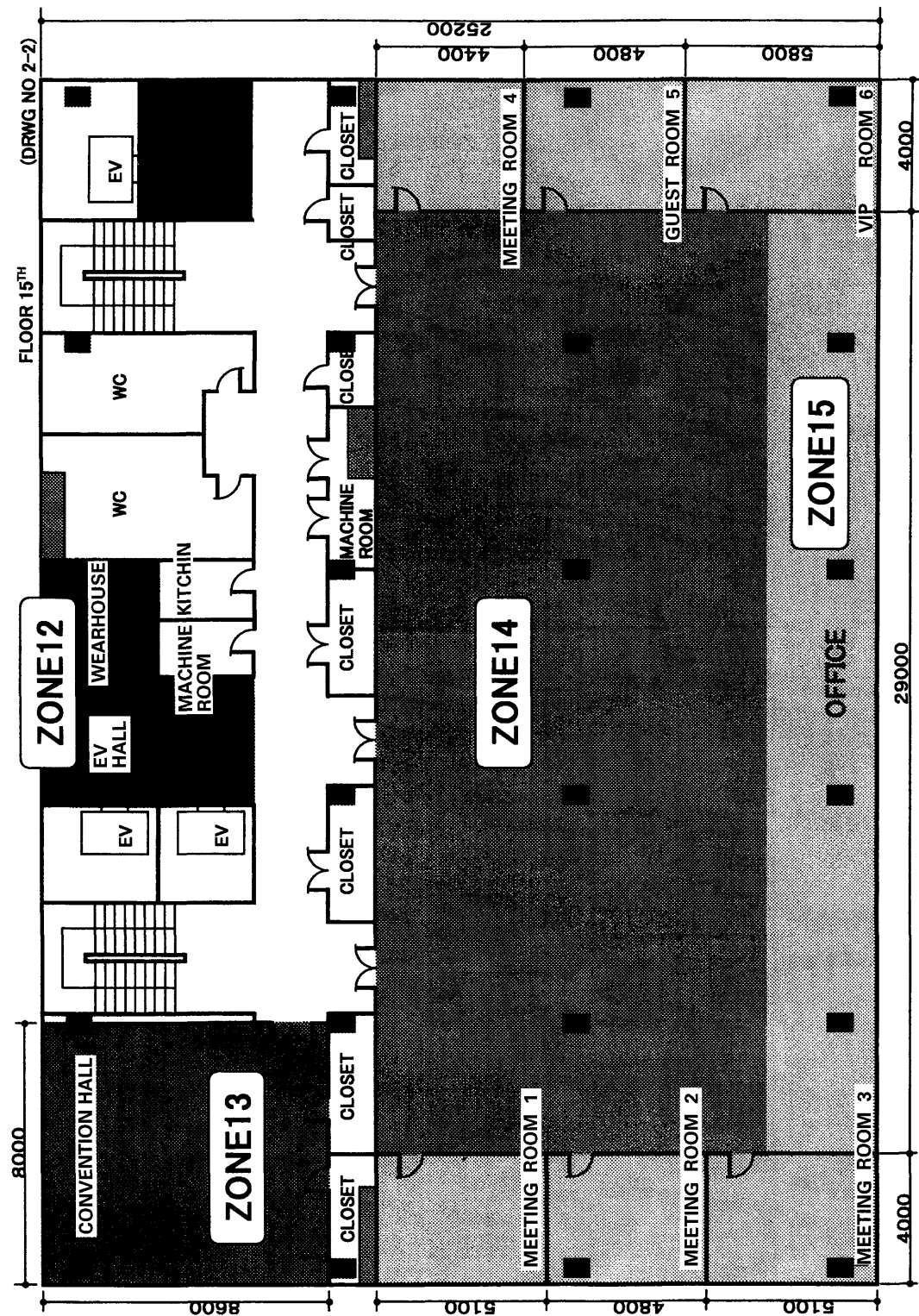
(b) Independent rooms in small to middle sized.

Convention hall corresponds to this category. It has outer wall facing outdoor air but the size is so small as separation by perimeter and interior is not needed, while the room is independent from other zone's influence. This sort of room is carried out the load calculation independently. Now this area is defined as **ZONE 13**.

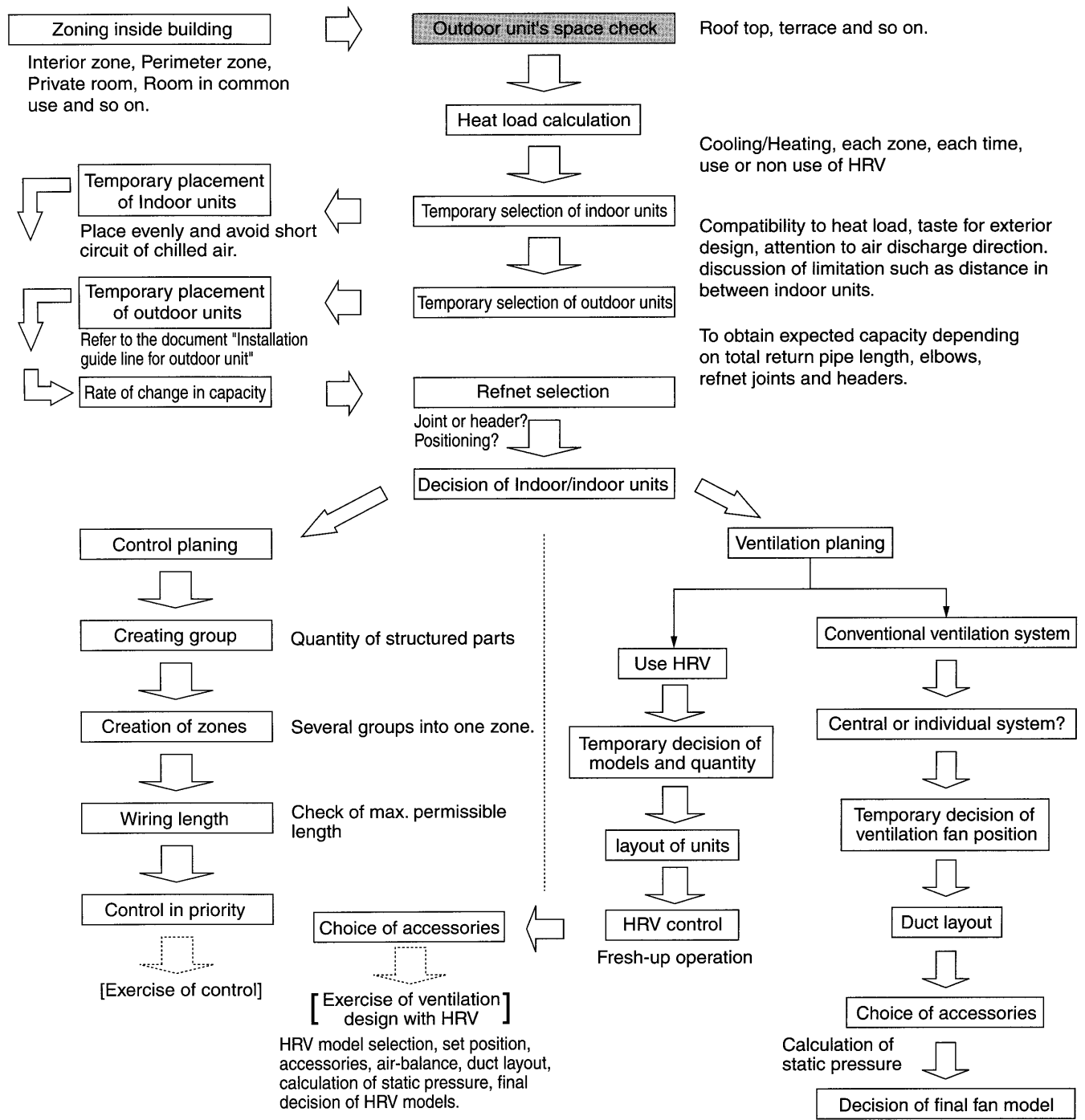
(c) Utility core

The area in common use and open space. This area is generally air conditioned by return air from inhabitant zone in free temperature and so humidity. In this sample building, the warehouse in the utility core is included in airconditioning plan in consideration of stock goods and so heat load calculation was carried out. In the elevator halls, as the purpose is to give cooling effect to passengers who just come out from elevator cabin like pinpoint-cooling, the heat load calculation was eliminated. Guide line of this kind airconditioners selection is to choose one horse power unit per one cabin of elevator. This rate is applied for this sample building too. The utility core of sample building is defined as **ZONE 12**.

Fig. 46 Example of zoning



Design procedure is indicated in this below chart. The topics with shaded enclosure signify topics which will be explained in the succeeded several pages till the other similar chart with other topics in shaded enclosures will appear.



3-1-3 Outdoor unit's space check

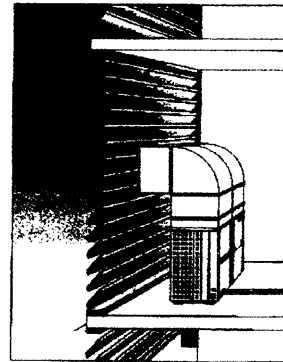
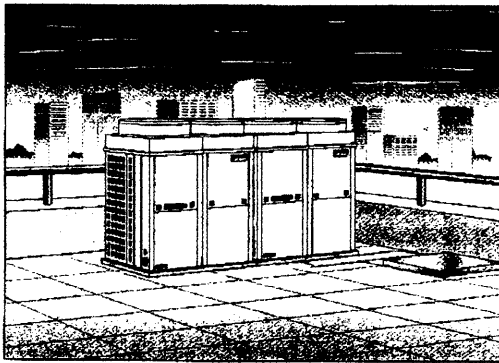
Building in down town area has not enough space on the ground around the building. Accordingly, the place to install outdoor units is concluded on the roof top or terrace. However, these are some exceptions to install units on the ground when auxiliary units are required to add on for covering insufficient capacity.

- Installation on roof top

Judgement of the quantities to be able to install on the roof should be referred to the late chapter, but here we are going to have prospect whether the effective space on the top is available or not, any trouble exists, and so forth. On roof top, various facilities are concentrated such as penthouse where winding up motor of elevator is stored, reserve tank of city water, emergency generator room or so. The place where hot air from winding up motor blows doesn't suit the place for installation of outdoor unit even though sufficient space is available around there. Pay attention to the place available where service person hardly approaches. Access way is anyway required. Building shaft's outlet must be open near to the place where VRV is going to be installed.

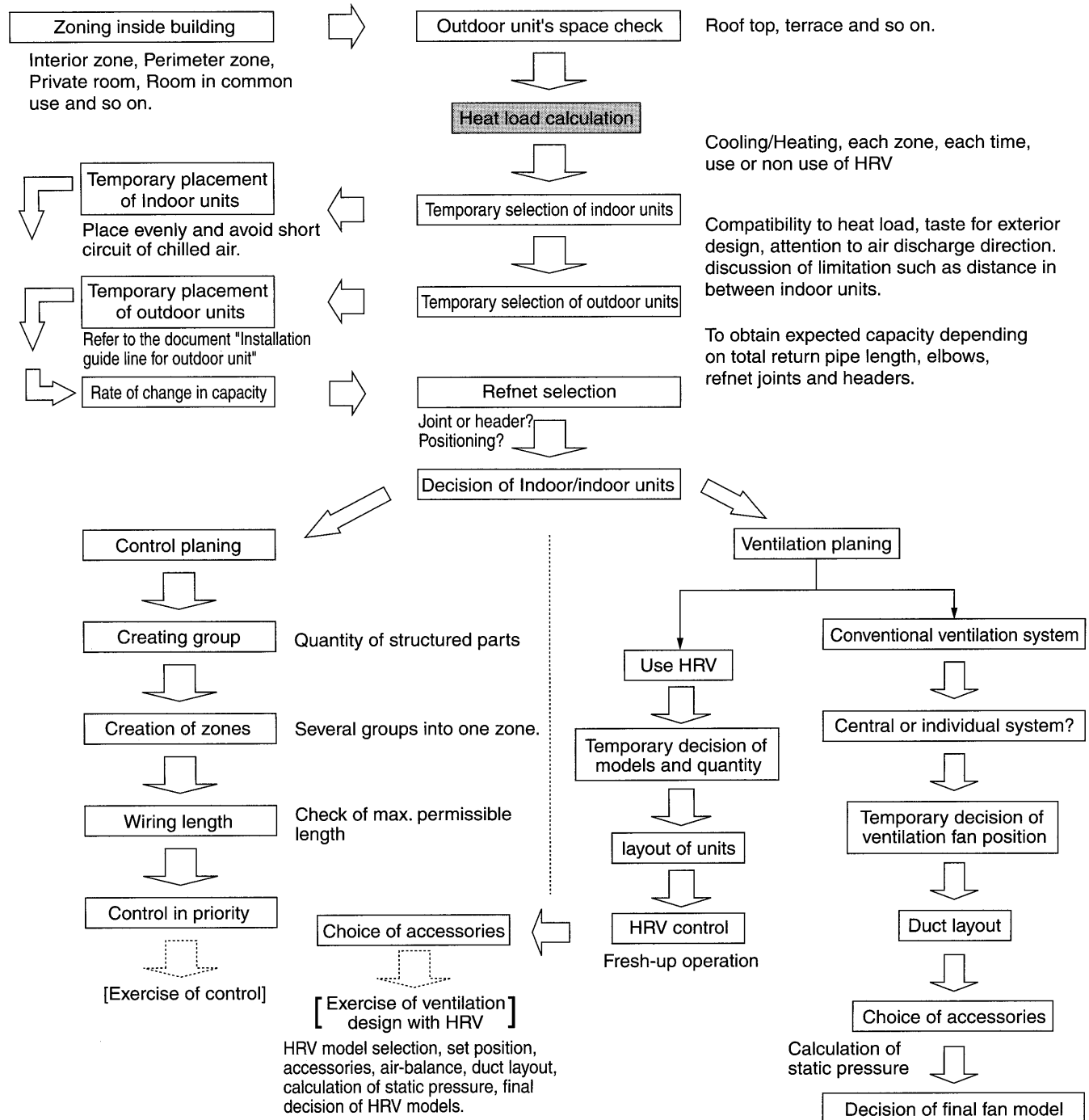
- Installation on terrace

It is a general way to install VRV on terrace with a simple duct attached on the air outlet of outdoor unit so that air can be discharged horizontally, though air discharges upward normally. Therefore, make sure whether the place doesn't bother neighbors by air blowing to or the place air smoothly blows. Hold enough space for servicing which should be secured on the technical document in advance.



After checking the installation place, let's go into heat load calculation.

Design procedure is indicated in this below chart. The topics with shaded enclosure signify topics which will be explained in the succeeded several pages till the other similar chart with other topics in shaded enclosures will appear.



3-2 Heat load calculation

- There are two ways, by manual or by personal computer.
- The way to take up the estimated maximum load time and to calculate every heat load in all time air conditioners work are available. Since max. heat load time differs by every exposure, if possible to use large sized unit like the Plus series, the smaller outdoor unit can be chosen through the way grasping the calculation area as wide as possible so that heat load in every exposure can be broken up.

- DAIKIN Heat load calculation software

Input conditions: Building application

Outline of outer wall of building

Dimension : Outer wall, internal wall, floor, ceiling height, windows

Window area

Town specified on the globe

Indoor temperature and humidity conditions

Time

Structural members (wall, floor, etc.)

Inhabitant density

Indoor heat emitting devices (OA devices, increase of heat emitting device).

Notice: Estimation of heat load at the border: Heat load from floor, ceiling, internal wall is affected by the conditions with or without heat transfer depending on the outside of the border with or without air conditioning. Especially, in rental building, the occupied condition will vary often. So, for heat load calculation, it is better to calculate in estimation that next door is not airconditioned.

- Sample building's heat load calculation.

Calculation conditions

- Place: Thailand Bangkok (Outdoor temp: 37°CDB, Indoor temperature 19°CWB)
- Top floor on 15 stories building
- Two conditions are provided for ventilation, with or without HRV.
- One company occupies whole floor on 15th.
- Standard ventilation rate : 20m³/person·h
- On 14th floor, it is estimated that many rental rooms are located.
- Heat load from partition wall in meeting room, VIP room, guest room can be neglected because office space are totally air conditioned.
- Elevator hall in utility core is not calculated the heat load. One horse power airconditioner gives pinpoint cooling effect to one cabin of elevator.

Calculation result

- The result shows in Table 5 and Table 6.
- The time heat load reaches peak is different. Namely, **the maximum load time** in zone and **each room's maximum load time** are different to each other. Each room's maximum load is affected by the exposure. The maximum heat load in each room is used for determination of indoor unit model and load in zone is used for outdoor unit's selection.
- When HRV is used, heat load from fresh air intake can be reduced by up to 60%. The percentage of heat load reduction that HRV contributes varies depending on the fresh air intake load rate in all the heat load.

Table 5: Hourly cooling load in the sample building on 15th floor without HRV
(DAIKIN simple calculation soft HKG is used)

Room	ZONE	FA; m ²	OA; CMH	unit: heat load, kW air flow rate, CMH											
				8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	constant
OFFICE(perimeter)	15	116	280	15.8	16.8	17.9	19.1	20.2	21.1	21.7	21.9	21.8	21.2	20.0	
MEETING ROOM1	15	20.4	200	6.0	6.2	6.4	6.6	6.7	7.0	7.6	8.1	8.2	8.2	7.8	
MEETING ROOM2	15	19.2	200	5.9	6.1	6.3	6.5	6.7	6.9	7.6	8.0	8.2	8.2	7.8	
MEETING ROOM3	15	20.4	200	6.4	6.7	7.0	7.3	7.5	7.9	8.5	9.0	9.1	9.0	8.5	
MEETING ROOM4	15	17.6	200	7.0	7.3	7.3	7.1	6.8	6.9	6.9	6.9	6.9	6.8	6.6	
GUEST ROOM	15	19.2	100	5.4	5.6	5.7	5.4	5.1	5.2	5.2	5.2	5.2	5.1	4.9	
VIP ROOM	15	23.2	100	6.0	6.4	6.6	6.4	6.1	6.2	6.2	6.2	6.1	5.9	5.5	
SUB TOTAL for ZONE 15			1280	52.6	55.2	57.3	58.4	59.2	61.1	63.8	65.5	65.6	64.3	61.2	
OFFICE(interior)	14	319	1280	43.7	44.5	45.6	46.9	48.4	50.0	51.9	53.4	54.5	54.8	54.2	
CONVENTION HALL	13	68.8	600	18.4	19.2	20.0	20.7	21.3	22.1	23.5	24.6	24.9	24.6	23.6	
WAREHOUSE	12	13	40	1.7	1.9	2.0	2.1	2.3	2.4	2.4	2.5	2.4	2.4	2.3	

UTILITY CORE

	ZONE	FA; m ²	EA; CMH	SPOT COOLING EFFECT	
EV HALL(person)					5.8
EV HALL(luggage)	12				2.9
KITCHEN	12	4.8m ²	290		
TOILET(WC)	12	42m ²	1260		
MACHINE ROOMS	12	9.5m ²	90		

Note) 1.Pinpoint cooling effect is chosen so that one horse power of indoor unit will cover one cabin of elevator without any heat load estimation.

2.Regarding "air balance" in relation between supply air, exhausting

air and return air. Total outdoor air intake volume supplying every inhabitant room, exhausting direct to outdoor , and once returned to the corridor then exhausting to outdoor through ventilation fan in the utility core amount 3200 CMH ,1560 CMH and 1640 CMH, respectively. In this connection, the following formula can be formulated. This air flow rate 1640 CMH is the sun of (290+1260+90 CMH) above mentioned.

Fresh air intake = Exhausting air + Return air (Ventilated to outdoor by exhausting fan, from Kitchen, Toilet and machine room).

Detailed discussion will be shown in page 149~150.

Table 6: Hourly cooling load in the sample building on 15th floor with HRV.

(DAIKIN simple calculation soft HKG is used)

Room	ZONE	FA; m ²	OA; CMH	unit: heat load, kW air flow rate, CMH															
				8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	constant				
OFFICE(perimeter)	15	116	280	13.6	14.6	15.7	16.8	17.9	18.9	19.5	19.7	19.5	18.9	17.8					
MEETING ROOM1	15	20.4	200	4.2	4.3	4.5	4.7	4.8	5.2	5.8	6.2	6.4	6.3	5.9					
MEETING ROOM2	15	19.2	200	4.1	4.3	4.4	3.4	4.8	5.1	5.7	6.2	6.0	6.3	5.9					
MEETING ROOM3	15	20.4	200	4.5	4.8	5.1	5.4	5.7	6.0	6.7	7.0	7.1	7.1	6.6					
MEETING ROOM4	15	17.6	200	5.2	5.4	5.4	5.2	5.0	5.0	5.1	5.1	5.0	4.9	4.7					
GUEST ROOM	15	19.2	100	4.0	4.3	4.3	4.0	3.7	3.8	3.8	3.9	3.8	3.7	3.5					
VIP ROOM	15	23.2	100	5.1	5.5	5.6	5.4	5.2	5.3	5.3	5.3	5.1	4.9	4.6					
SUB TOTAL for ZONE 15			1280	40.7	43.1	45.1	45.1	47.0	49.2	51.9	53.5	53.5	52.1	49.0					
OFFICE(interior)	14	319	1280	31.8	32.4	33.5	34.8	36.4	38.1	40.0	41.5	42.5	42.7	42.0					
CONVENTION HALL	13	68.8	600	12.9	13.5	14.3	15.0	15.8	16.5	18.0	19.0	19.3	18.9	17.9					
WAREHOUSE	12	13	40	1.4	1.5	1.6	1.8	1.9	2.0	2.1	2.1	2.1	2.0	1.9					

UTILITY CORE

	ZONE	FA; m ²	EA; CMH	SPOT COOLING EFFECT	
EV HALL(person)				SPOT COOLING EFFECT	5.8
EV HALL(luggage)	12			SPOT COOLING EFFECT	2.9
KITCHEN	12	4.8m ²	290		
TOILET(WC)	12	42m ²	1260		
MACHINE ROOMS	12	9.5m ²	90		

Note) 1.Pinpoint cooling effect is chosen so that one horse power of indoor unit will cover one cabin of elevator without any heat load estimation.

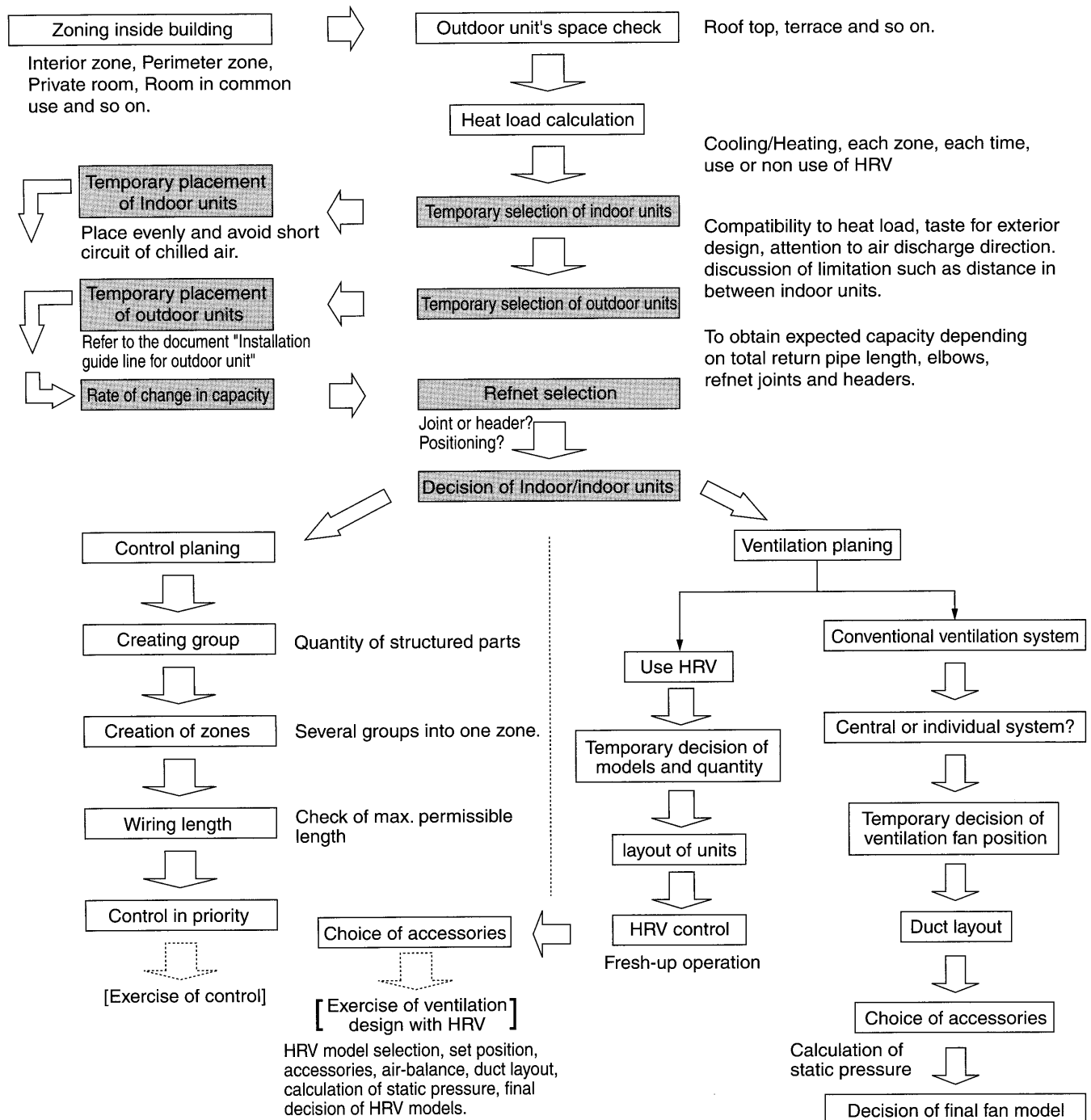
2.Regarding "air balance" in relation between supply air, exhausting

air and return air. Total outdoor air intake volume supplying every inhabitant room, exhausting direct to outdoor , and once returned to the corridor then exhausting to outdoor through ventilation fan in the utility core amount 3200 CMH ,1560 CMH and 1640 CMH, respectively. In this connection, the following formula can be formulated. This air flow rate 1640 CMH is the sun of (290+1260+90CMH) above mentioned.

Fresh air intake = Exhausting air + Return air (Ventilated to outdoor by exhausting fan; from Kitchen, Toilet and machine room).

Detailed discussion will be shown in page 149~150.

Design procedure is indicated in this below chart. The topics with shaded enclosure signify topics which will be explained in the succeeded several pages till the other similar chart with other topics in shaded enclosures will appear.



3-3 Temporary selection of indoor unit's.

a) Indoor unit's model series

As there are various features in every type, select the types while referring to catalogue. 66 models in 10 types are available in total. For your reference, all indoor units in all series in Fig.47. and all models in every capacity in Table 7 are shown. In this table, the same sized units are enclosed.

b) Attention on layout

- Arrange units on a per capita basis in rooms to be air-conditioned.
- Survey the locations of structural pillars, lights, sprinklers, or smoke detectors for fire prevention, and avoid such locations.
- Provide at least 4 m distance to each other so as to avoid short circuit of discharging air.(Note:Discharge flow patterns can be found in Engineering Data.)
- Choose units with the appearance as equal as possible. DAIKIN provides quite a few models with same appearance in different capacity. (Refer to Table 7).
- Provide standard space for servicing or maintenance and so as to secure sufficient passage of air.

c) Coping with heat load

Select indoor units in 100 % capacity required in the result of heat load estimation. Heat load varies as time goes on, but if the capacity doesn't cope with the maximum heat gain, the design temperature cannot be kept constant. Choose a model slightly larger than the required capacity as actual available capacity from the indoor unit may drop slightly depending on combination ratio and refrigerant piping length (there will be covered later).The indoor unit's capacity of specified design conditions can be checked on indoor unit capacity tables found in engineering data books.

(Ex.)Meeting room 1. in the sample building. Heat load (with HRV) : 6.4kW
Thus, let's choose a larger model just near by. Model 63 has been chosen.

Never choose a model with lower capacity, but is the less grade is within one percent or so, there will be a case that the model in little lower capacity sometimes will be selected due to the economical point of view.

Next, check the capacity depending on the temperature conditions.

Capacity of model FXYC 63 in the conditions: outdoor temperature 37°CDB, indoor temperature 27°CDB and 19°CWB (50Hz) can be read (7.1 kW). It is concluded to be accepted.

d) Selection example on the sample building

The following procedure is based on the gist above mentioned. It is estimated that HRV is used for the ventilation.

If numbers of indoor units are set in high rate, it will cost high and have good distribution of air, while if adopting low rate of the quantity, it will cost low but sometimes arise a problem of air distribution. Here, for the example, let's take up the quantity of indoor units rather many number. Then, when the units are distributed evenly, layout has been concluded as shown in Fig. 49.

As temporary selection is being gone on, the following result comes out.

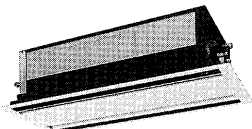
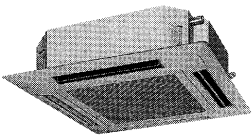
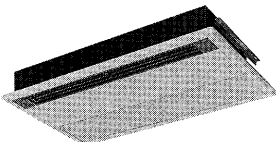
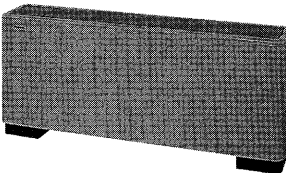
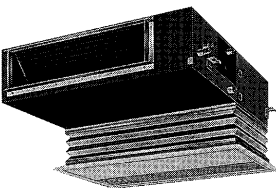
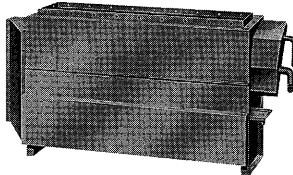
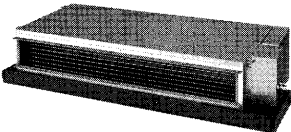
	ZONE	Q'ty	Max. load	Load per 1 unit	Temporary selection	Temporary models	Capacity check	Judgement
			kW	kW			kW	
Office in perimeter	15	7	19.7	2.8	32type	FXYC32K	3.6	OK
Meeting room 1.	15	1	6.4	6.4	63type	FXYC63K	7.1	OK
Meeting room 2.	15	1	6.0	6.4	63type	FXYC63K	7.1	OK
Meeting room 3.	15	1	7.1	7.3	63type	FXYC63K	7.1	NO!
					80type	FXYC80K	9.8	OK
Meeting room 4.	15	1	5.4	5.1	63type	FXYC63K	7.1	OK
Guest room	15	1	4.3	5.1	50type	FXYC50K	5.6	OK
VIP room	15	2	5.6	2.8	32type	FXYC32K	3.6	OK
Office in interior zone	14	21	42.7	2.0	20type	FXYC20K	2.2	OK

Check on appearance

The large office is desirable to unify the indoor unit's appearance. 20,25 and 32 types have the same appearance without any problem. As small rooms located in both sides are separated, the units are not needed to unify the appearance.

Fig. 47: All indoor unit models

● Indoor Unit

Ceiling mounted cassette type (Double flow) FXYC20K FXYC25K FXYC32K FXYC40K FXYC50K FXYC63K FXYC80K FXYC125K		Ceiling suspended type FXYP32K FXYP63K FXYP100K	
Ceiling mounted cassette type (Multi flow) -Super Cassette- FXYP25KB FXYP32KB FXYP40KB FXYP50KB FXYP63KB FXYP80KB FXYP100KB FXYP125KB		Wall mounted type FXWA25K FXWA32K FXWA40K FXWA50K FXWA63K	
Ceiling mounted cassette corner type FXYP25K FXYP32K FXYP40K FXYP63K		Floor standing type FXYL20KJ FXYL25KJ FXYL32KJ FXYL40KJ FXYL50KJ FXYL63KJ	
Ceiling mounted built-in type FXYS20K FXYS25K FXYS32K FXYS40K FXYS50K FXYS63K FXYS80K FXYS100K FXYS125K		Concealed floor standing type FXYLM20KJ FXYLM25KJ FXYLM32KJ FXYLM40KJ FXYLM50KJ FXYLM63KJ	
Ceiling mounted duct type FXYM40K FXYM50K FXYM63K FXYM80K FXYM100K FXYM125K FXYM200KJ FXYM250KJ	 FXYM40-125K  FXYM200-250KJ	Ceiling mounted low silhouette duct type FXYP20K FXYP25K FXYP32K FXYP40K FXYP50K FXYP63K	

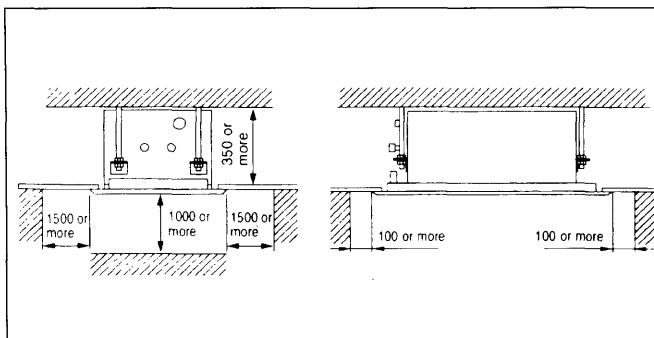
(5) Service space for indoor units/BS units

Indoor units

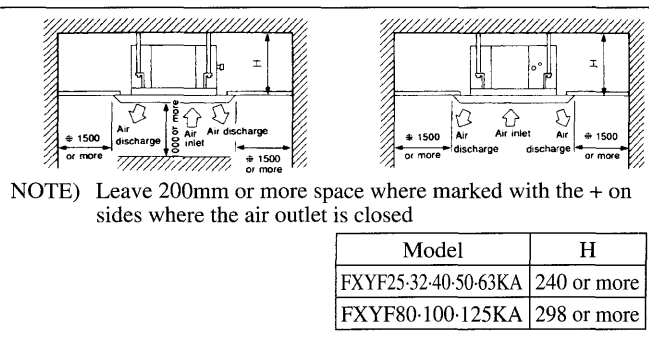
Fig. 48: Service space required for indoor units

Unit (mm)

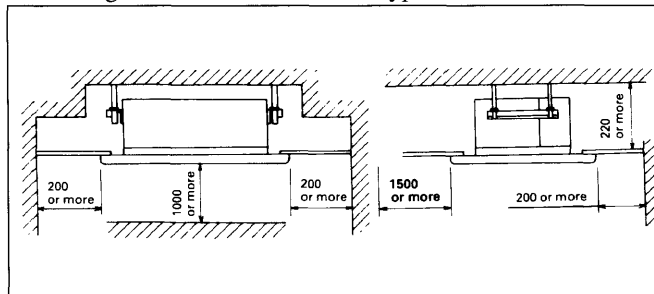
• Ceiling mounted cassette type <Double flow>



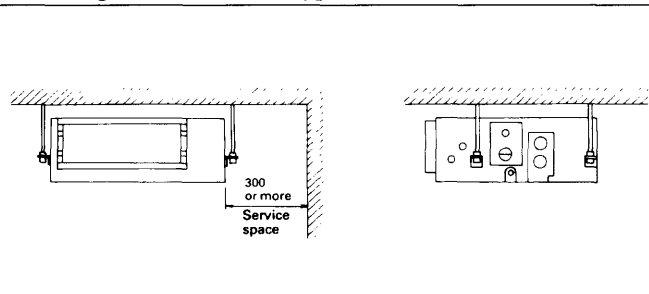
• Ceiling mounted super cassette type <Multi-flow>



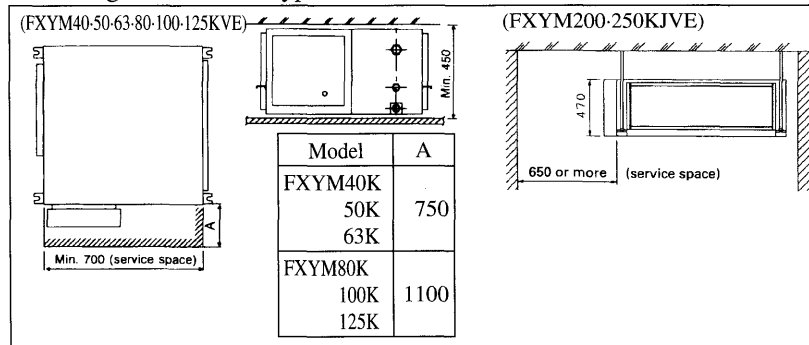
• Ceiling mounted cassette corner type



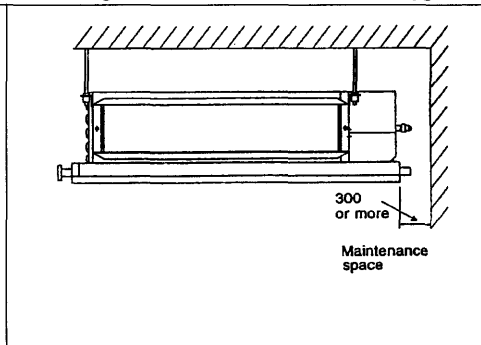
• Ceiling mounted built-in type



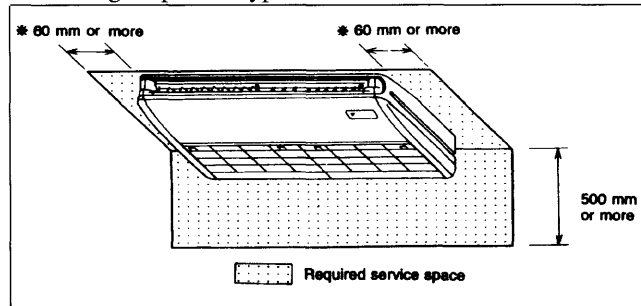
• Ceiling mounted duct type



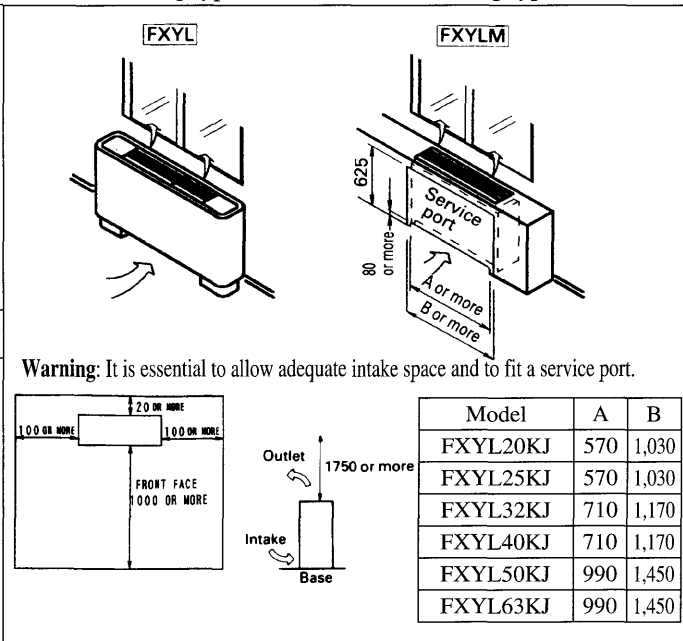
• Ceiling mounted low silhouette duct type



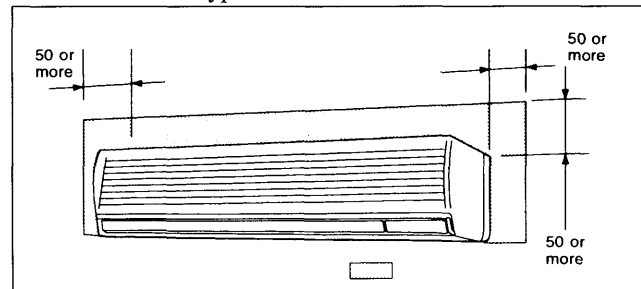
• Ceiling suspended type



• Floor standing type/Concealed floor standing type



• Wall mounted type



Note: Above figure means minimum value. Please keep these value at least.

Indoor Units Line Up

Table 7 : Model series the appearance equals

VRV plus

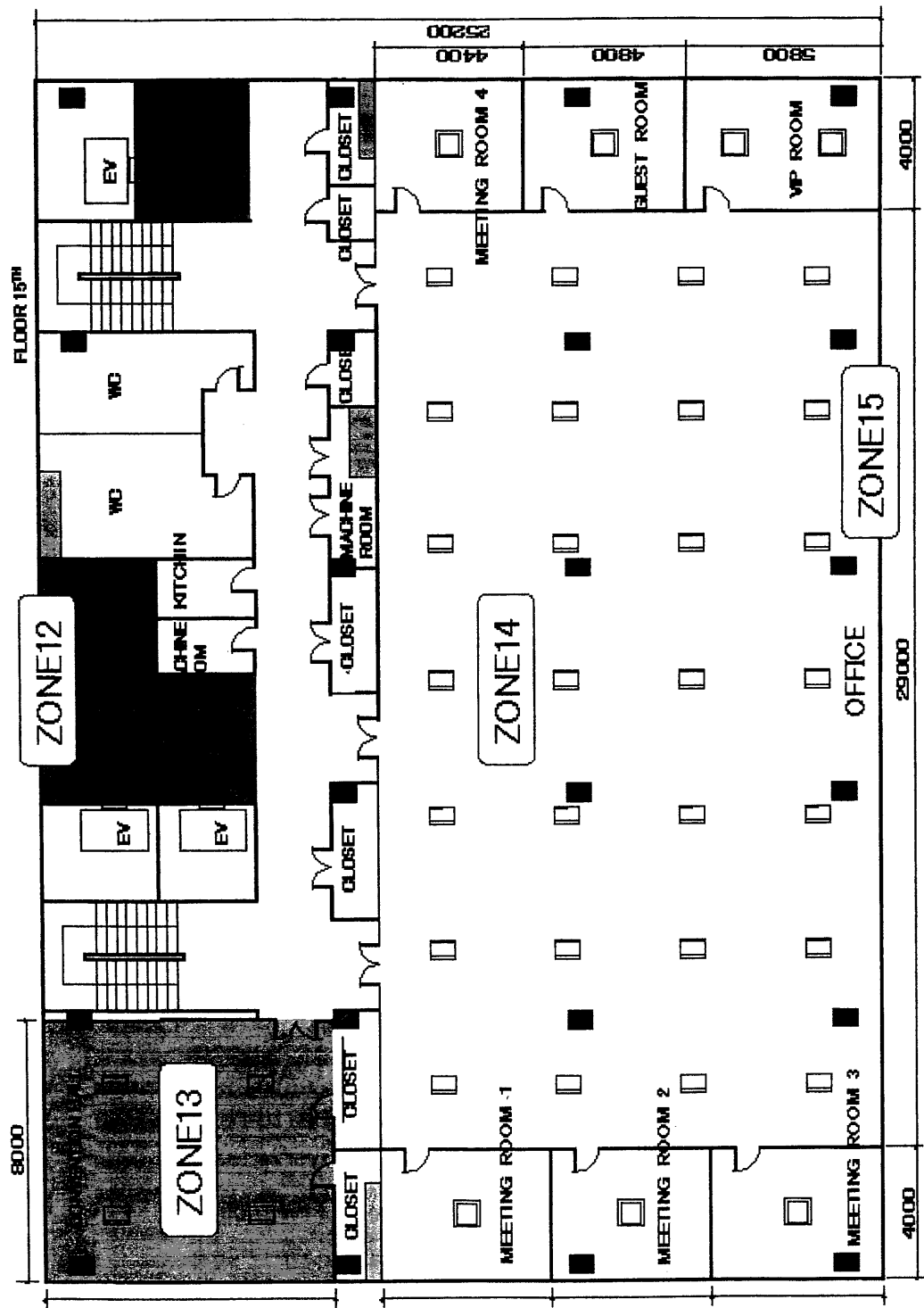
Type	Model name	Capacity Range										
		20 (0.6HP)	25 (1HP)	32 (1.25HP)	40 (1.8HP)	50 (2HP)	63 (2.5HP)	80 (3.2HP)	100 (4HP)	125 (5HP)	200 (8HP)	250 (10HP)
Ceiling Mounted Cassette <Double-flow> type	FXYC-K	○	○	○	○	○	○	○		○		
Ceiling Mounted Cassette <Multi-flow> super cassette type	FXYF-KB		○	○	○	○	○	○	○	○		
Ceiling Mounted Cassette Corner type	FXYK-K		○	○	○		○					
*Ceiling Mounted Duct type <Low Silhouette type>	FXD-K	○	○	○	○	○	○	○	○	○		
Ceiling Mounted Built-in type	FXYS-K	○	○	○	○	○	○	○	○	○		
Ceiling Mounted Duct type	FXYM-K				○	○	○	○	○	○	○	○
Ceiling Suspended type	FXYH-K			○			○		○			
Wall Mounted type	FXYA-K		○	○	○	○	○					
Floor Standing type	FXYL-KJ	○	○	○	○	○	○					
Concealed Floor Standing type	FXYLM-KJ	○	○	○	○	○	○					

* Consult us for a Ceiling Mounted Duct type <Low Silhouette Type> with heat pump.

○ Cooling only & Heat pump

○ Cooling only

Fig. 49: Example of indoor units layout



3-4 Temporary selection of outdoor units

a) Composition of Daikin VRV series

(1) Kinds of VRV series

Composed of the following four series. Indoor units can be used in common to outdoor unit. Each series has several outdoor unit with different capacity. All models can be chosen depending on the room heat load and applications in combination of different type of indoor units as you like. Design can be applied most suit the needs of various types of building's air conditioning.

1. VRV System "K" Series

Consists of outdoor unit and indoor unit. There are four kinds: 5, 6, 8, 10 HP models for outdoor units.(note:there is only a 6HP unit in the KU and KA series)

2. VRV System Heat Recovery "KL" Series

Consists of outdoor unit, indoor unit, and BS unit. There are two kinds for the outdoor unit with 8 and 10 horse power. BS unit is connected between a outdoor unit and indoor units , and has a function which enables a group with several indoor units connected to the BS unit to carry out the airconditioning or heating operation.

3. VRV System "Plus" Series (Heat pump system, Cooling only System)

Consists of outdoor unit and indoor unit. The outdoor unit provides seven types with 16, 18, 20, 24, 26, 28, 30 HP . Each outdoor unit has the following units.

- a. Function unit × one unit
- b. 8 HP or 10 HP inverter unit × one unit
- c. (8 HP and/or 10 HP constant speed model) × (1~2) units

4. VRV System "Plus" Series (Heat Recovery System)

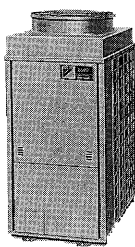
Seven types of outdoor unit, 16,18, 20, 24,26, 28,30 HP are available. Each outdoor unit is composed of the following units.

- a. Function unit × one unit
- b. 8 HP or 10 HP inverter unit × one unit
- c. (8 HP and/or 10 HP constant speed unit) × one unit or 2
- d. BS unit----- BS unit is connected between a outdoor unit and indoor units, and has a function which enables a group with several indoor units connected to the BS unit to carry out the airconditioning or heating operation.

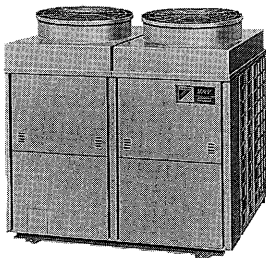
Fig. 50 ~ 51 show the Plus series composition and appearance.

Fig. 50 : Outdoor units combination

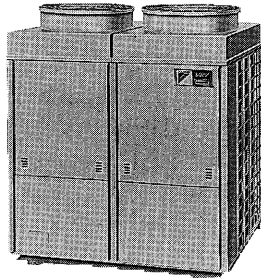
K series



(5HP)
RSX(Y)5K



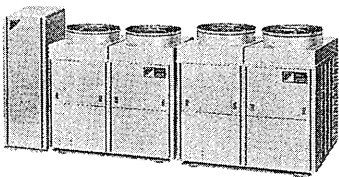
(8HP)
RSX(Y)8K



(10HP)
RSX(Y)10K

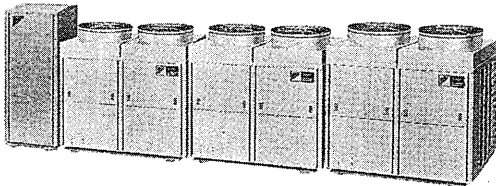
Plus series

44.8kW
(16HP)
System



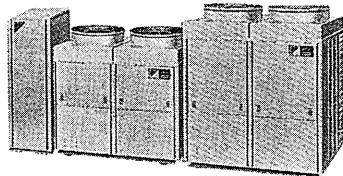
RXY16K
RX16K
REY16K

67.2kW
(24HP)
System



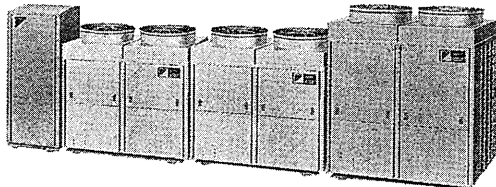
RXY24K
RX24K
REY24K

50.4kW
(18HP)
System



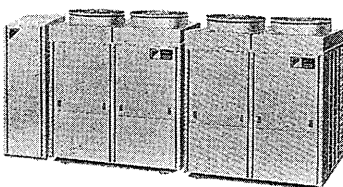
RXY18K
RX18K
REY18K

72.8kW
(26HP)
System



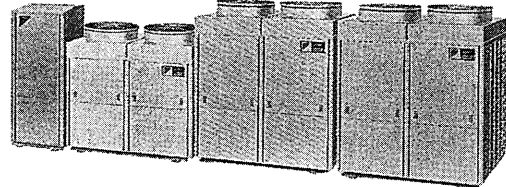
RXY26K
RX26K
REY26K

56.0kW
(20HP)
System



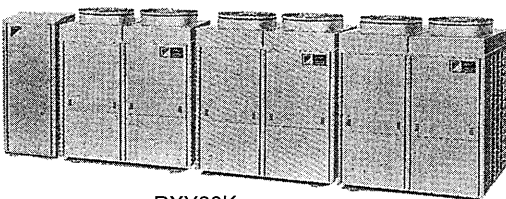
RXY20K
RX20K
REY20K

78.4kW
(28HP)
System



RXY28K
RX28K
REY28K

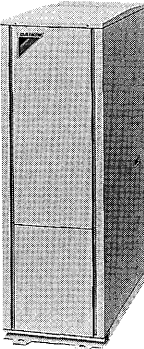
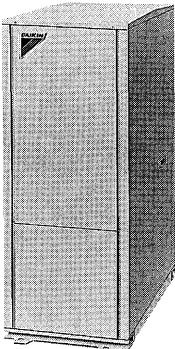
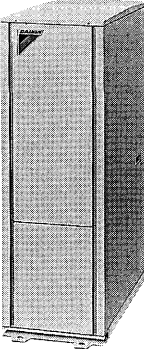
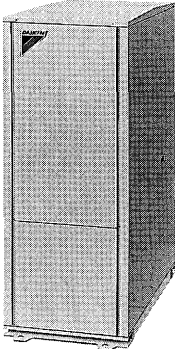
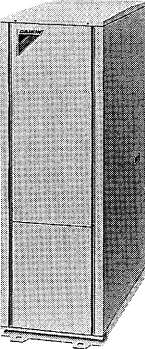
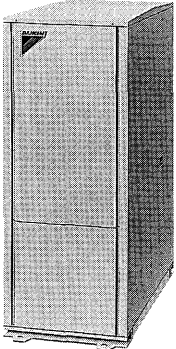
84.0kW
(30HP)
System



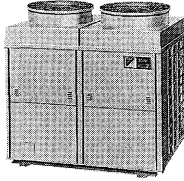
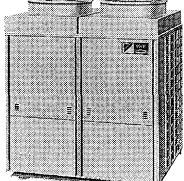
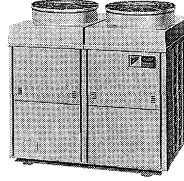
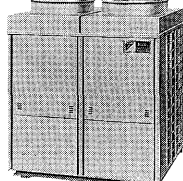
RXY30K
RX30K
REY30K

Fig. 51: Outdoor unit in combination of function unit

● Function Unit

[Heat pump (L-unit) system]		[Cooling only (C-unit) system]		[Heat Recovery (R-unit) system]	
					
BL2K (for 2 outdoor units type)	BL3K (for 3 outdoor units type)	BC2K (for 2 outdoor units type)	BC3K (for 3 outdoor units type)	BR2K (for 2 outdoor units type)	BR3K (for 3 outdoor units type)

● Outdoor Unit (the same for both Heat pump, Cooling only system and Heat-Recovery system)

<Inverter type>		<Constant speed type>	
			
RXY8K (8HP) RX8K (8HP)	RXY10K (10HP) RX10K (10HP)	RNY8K (8HP) RN8K (8HP)	RNY10K (10HP) RN10K (10HP)

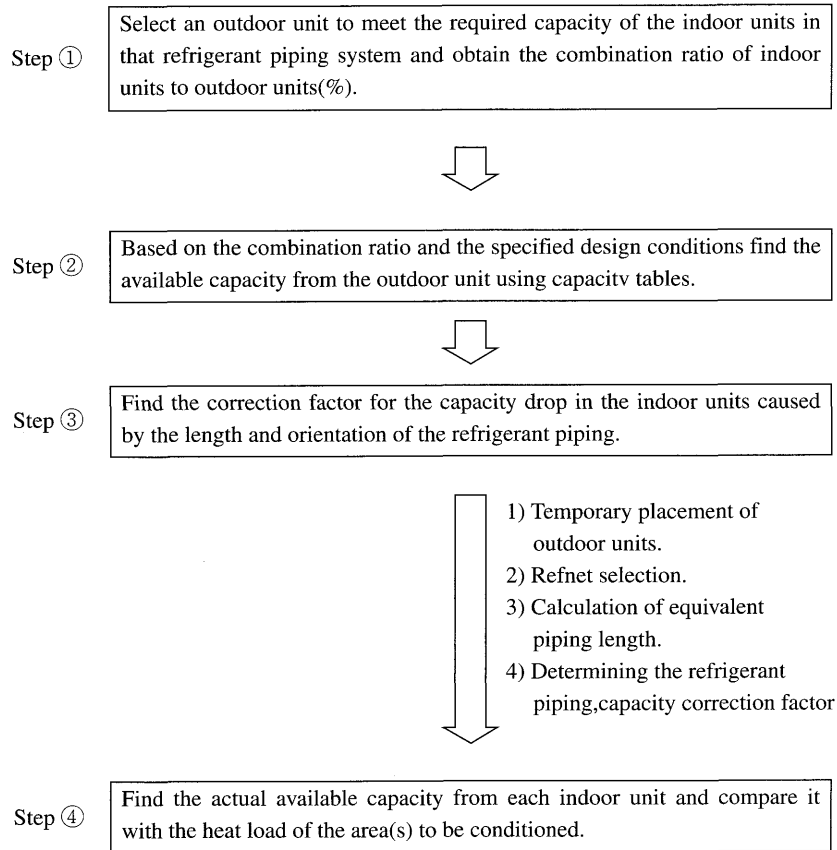
Combination	Function Unit				Combination of Outdoor Unit			
	Capacity	L-unit	C-unit	R-unit	Inverter Type		Constant Speed Type	
					8HP	10HP	8HP	10HP
Heat pump System	16HP	● (BL2K)	—	—	●		●	
	18HP					●	●	
	20HP					●		●
	24HP	● (BL3K)	—	—	●		●×2	
	26HP					●	●×2	
	28HP					●	●	●
	30HP					●		●×2
Cooling Only System	16HP	—	● (BC2K)	—	●		●	
	18HP					●	●	
	20HP					●		●
	24HP	—	● (BC3K)	—	●		●×2	
	26HP					●	●×2	
	28HP					●	●	●
	30HP					●		●×2
Heat-Recovery System	16HP	—	—	● (BR2K)	●		●	
	18HP					●	●	
	20HP					●		●
	24HP	—	—	● (BR3K)	●		●×2	
	26HP					●	●×2	
	28HP					●	●	●
	30HP					●		●×2

b) Combination of indoor unit and outdoor unit (Table 8)

Quantity of indoor units to be able to connect outdoor unit has the limitation. Besides, the capacity of outdoor unit and indoor unit are shown in CAPACITY INDEX whose ratio is limited in the certain steady range.

Outdoor unit		Indoor unit to be connected	
Models	Index	Max. connecting quantity.	Total index
Inverter K series(Heat pump and cooling only)			
RSX(Y)5K	125	8	50 % ~ 130 % of outdoor unit index
RSX(Y)8K	200	13	
RSX(Y)10K	250	16	
Heat recovery KL series			
RSEY8KL	200	13	50 % ~ 130 % of outdoor unit index
RSEY10KL	250	16	
Plus series (Heat pump and cooling only)			
RX(Y)16K	400	20	50 % ~ 130 % of outdoor unit index
RX(Y)18K	450		
RX(Y)20K	500		
RX(Y)24K	600	30	
RX(Y)26K	650		
RX(Y)28K	700		
RX(Y)30K	750		
Plus series (Heat recovery)			
RE(Y)16K	400	20	50 % ~ 130 % of outdoor unit index
RE(Y)18K	450		
RE(Y)20K	500		
RE(Y)24K	600	30	
RE(Y)26K	650		
RE(Y)28K	700		
RE(Y)30K	750		

Selection of the outdoor unit



- Note) 1. If the capacity found is less than the required amount then the size of the indoor unit (and/or outdoor unit) should be increased and Step ④ carried out again at the new combination ratio.
2. If the required heating load is higher then the system should be selected using capacity tables and data for the heating operation.

Step 1

Selection of the outdoor unit is done using a capacity index system (see Table 9. and Table 10.) based on the capacity of the unit. It is possible to combine indoor units and outdoor units in a ratio of 50 to 130%, for example 6 model FXYC50K units (index 50 each) is 300, connected to an RSXY10K (index 250) = $300/250 \times 100 = 120\%$.

Table 9 : Indoor unit combination total capacity index table

K series

● Indoor unit combination total capacity index table

Outdoor unit	Indoor unit combination ratio								
	130%	120%	110%	100%	90%	80%	70%	60%	50%
RSXY5K	162.5	150	137.5	125	112.5	100	87.5	75	62.5
RSXY8K	260	240	220	200	180	160	140	120	100
RSXY10K	325	300	275	250	225	200	175	150	125

Plus series

● Indoor unit combination total capacity index table

Outdoor unit	Indoor unit combination ratio								
	130%	120%	110%	100%	90%	80%	70%	60%	50%
RXY16K-RX16K-REY16K	520	480	440	400	360	320	280	240	200
RXY18K-RX18K-REY18K	585	540	495	450	405	360	315	270	225
RXY20K-RX20K-REY20K	650	600	550	500	450	400	350	300	250
RXY24K-RX24K-REY24K	780	720	660	600	540	480	420	360	300
RXY26K-RX26K-REY26K	845	780	715	650	585	520	455	390	325
RXY28K-RX28K-REY28K	910	840	770	700	630	560	490	420	350
RXY30K-RX30K-REY30K	975	900	825	750	675	600	525	450	375

Table 10 : Indoor unit capacity index

Code name	Index
20 type	20
25 type	25
32 type	31.25
40 type	40
50 type	50
63 type	62.5
80 type	80
100 type	100
125 type	125
200 type	200
250 type	250

Step 2

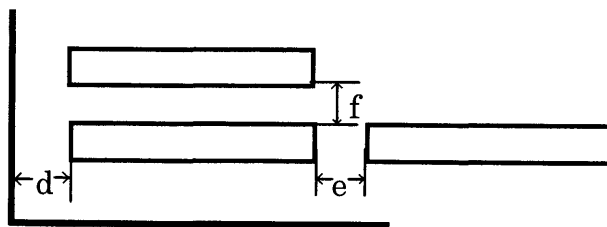
The available capacity from the outdoor unit will vary depending on the combination ratio of indoor to outdoor units and also on the design conditions (temperatures). The available capacity from the selected outdoor unit can be found from capacity tables listed in the Engineering Data book, this is the maximum available capacity from the outdoor unit at the chosen conditions. If this capacity is then divided proportionally between the indoor units in the same refrigerant circuit then the maximum available capacity from each indoor unit can be obtained. It is important to note that if the heating capacity requirements are larger than the those for cooling then the outdoor unit should be selected from heating capacity tables. Also note that if the combination of indoor units to outdoor units is less than 100% then for design purposes the maximum available capacity from outdoor unit capacity tables can be taken at 100% combination ratio. However when divided proportionally between the indoor units the capable capacity of the indoor unit cannot exceed the capacity stated in indoor unit capacity tables (even if more capacity is available from the outdoor unit).

Step 3

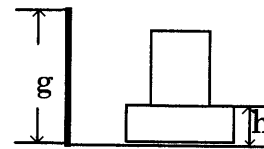
The available capacity of the system is effected by the length and orientation of the refrigerant piping as this has a direct effect on the resistance generated inside the refrigerant piping. Large resistance in the circuit reduces suction pressure at the compressor which reduces the available capacity. In very long runs of refrigerant piping available capacity from the indoor unit can be reduced by as much as 30%, so it is very important to consider this factor when selecting equipment. With experience it is possible to quite accurately estimate the length of refrigerant piping from engineering drawings, however for the most accurate result the following method should be used.

1) Temporary Placement of Outdoor Units

Firstly it is necessary to decide on a position for the outdoor units (e.g. on the roof, on the ground or on consecutive floors). Guidelines for the positioning and spacing between outdoor units are given in the engineering data book.



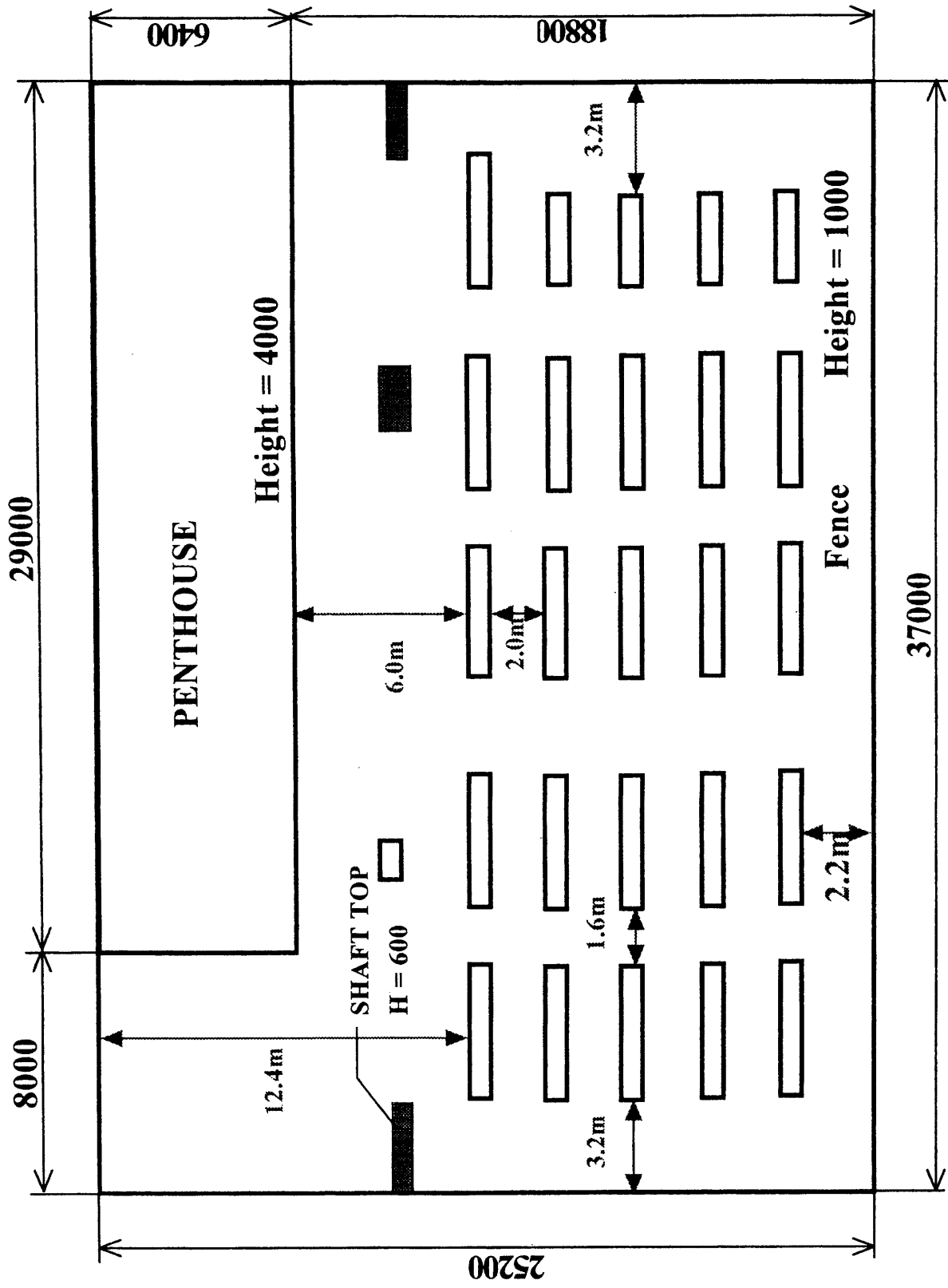
Distance between fence and unit: d
Distance in between units : e
Distance in between row of unit : f



Fence height : g
Height of foundation : h

Try to make drawing of the position of the outdoor units on the top plan view of the building, while avoiding the locations of various obstacles such as penthouse, top booth of building shaft and so force. Concern of units to fence around the roof top, intervals in between units, base height, permissible unit number to be able to install in the limited place, etc. are related to the positioning. So, design the location of units so that exhausting hot air from condensers won't short circuit. Example of the positioning based on this guide book is shown in Fig. 52 using the sample building.

Fig. 52: ROOFTOP PLAN



2) Refnet Selection

- One order with one parts number gets two types of refnets: gas and liquid, with the insulation.
- One refnet has many sizes of connection port. One pipe has several sizes. Cut connection pipe in the size suitable for the connection and blaze it to connect. Refer to the engineering data for the details.

Fig. 53: Refnet joint

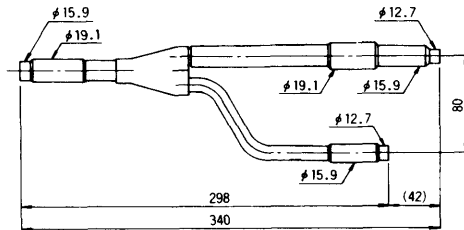


Fig. 54: Refnet header

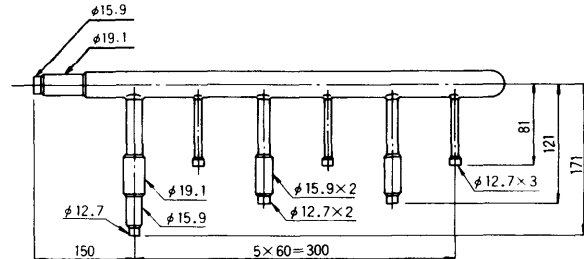
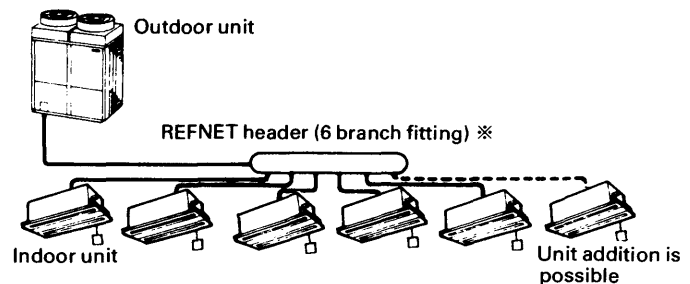
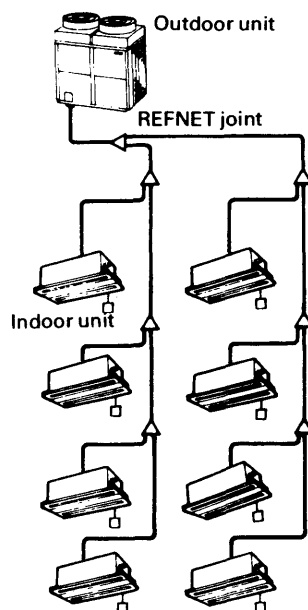


Fig. 55: Refnet connection example (Left: joint, Right : header)



Features of Refnet joint

- Heat strain affected to another branch is out of the consideration.
- One indoor unit needs one refnet joint (except the last unit). Easy handling for blazing and easy work.
- Since main piping line becomes smaller and smaller in sizes as coming to down stream, the supply of many size pipes are not avoidable.

Features of Refnet header

- If the number of indoor units are within the number of legs (branches) on refnet header and all the indoor units are equal model, same sizes pipes can be used. Thus, easy ordering the materials and easy bringing in can be realized.
- If wide access opening can be hold, complex blazing points can be concentrated around header.
- Only few main line blazing with many branch blazing. (Never provide a joint on a down stream line after the header).

Refnet joints and headers are selected by considering the total Capacity Index of the indoor units downstream in the refrigerant piping system (note that refrigerant pipe sizes are also selected using the same method). Selection charts for Refnets and pipe sizes can be found in engineering data books, Table 12. shows this selection chart for the VRV PLUS series.

REFRIGERANT PIPE FITTING WORK

Heat pump, Cooling Only System (RX(Y))

Table 12: Piping selection guide

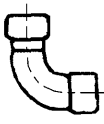
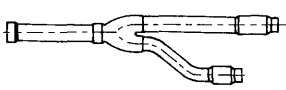
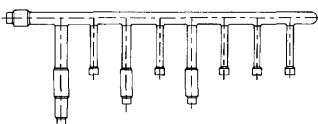
Heat pump, Cooling only system			Branch using REFINET joint 1		Branch using REFINET joint and REFINET header 2		Branch using REFINET header 3																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Maximum allowable length	Between function and outdoor units	Actual pipe length	10m or less		10m or less		10m or less																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
		Equivalent length	12.5m or less		12.5m or less		12.5m or less																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
	Between outdoor and indoor units	Actual pipe length	100m or less		100m or less		100m or less																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
		Equivalent length	125m or less (Assume equivalent pipe length of function unit to be 5m, that of REFINET joint to be 0.5m, that of REFINET header to be 1m, computation purposes)		125m or less (Assume equivalent pipe length of function unit to be 5m, that of REFINET joint to be 0.5m, that of REFINET header to be 1m, computation purposes)		125m or less (Assume equivalent pipe length of function unit to be 5m, that of REFINET joint to be 0.5m, that of REFINET header to be 1m, computation purposes)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Allowable height length	Between adjacent outdoor units	Difference in height	4m or less		4m or less		4m or less																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
	Between function and outdoor units	Difference in height	4m or less		4m or less		4m or less																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
	Between outdoor and indoor units	Difference in height	50m or less (H1)		50m or less (H1)		50m or less (H1)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
	Between adjacent indoor units	Difference in height	15m or less		15m or less		15m or less																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Allowable length after the branch		Actual pipe length	40m or less		40m or less		40m or less																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Refrigerant branch kit selection			How to select REFINET joint - When using REFINET joints on the first branch counted from the function unit side. If system capacity is less than 500, use KHRJ26K40T+KHRJ26K40TP. - If system capacity is 500 or greater, use KHRJ26K75T+KHRJ26K75TP. - In the case of REFINET joints other than the first branch, select the proper branch kit model based on the total capacity sum (for computation) of the indoor units installed after the first branch using the following table. (For the total capacity, see the item 1 in the section under "COMBINATION" at the beginning.)		How to select REFINET header - Select the proper branch kit model based on the total capacity sum (for computation) of the indoor units installed after the first branch using the following table. (For the total capacity, see the item 1 in the section under "COMBINATION" at the beginning.) - Branching is impossible between REFINET header and indoor unit.		For systems with a total capacity of 640 and over, connect a REFINET header after the REFINET joint branch.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Example of downstream indoor units			(Example) In the case of REFINET joint C Indoor units ③ + ④ + ⑤ + ⑥ + ⑦ + ⑧.		(Example) In the case of REFINET joint B Indoor units ① + ② + ③ + ④ + ⑤ + ⑥.		(Example) In the case of REFINET header Indoor units ① + ② + ③ + ④ + ⑤ + ⑥ + ⑦ + ⑧.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Outline of selecting pipe size			Between function unit and outdoor unit Match the pipe size to that connected to outdoor unit.		Between function unit and uppermost stream refrigerant branch kit Select pipe size according to outdoor system name.		Between two immediately adjacent refrigerant branch - Select the proper pipe size based on the total capacity sum (for computation) of the indoor units connected downstream using the following table. (For the total capacity see the item in the selection under "COMBINATION" at the beginning.) - Select connection pipe size according to outdoor unit (table on left). Do not select a larger size than the outdoor unit.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
			<table> <tr> <th>Outdoor system name</th><th>Pipe size (Outer diameter x minimum wall thickness) (Unit: mm)</th></tr> <tr> <td>RXY17BK</td><td>12.7 x 0.8</td></tr> <tr> <td>RXY17BK(E)</td><td>12.7 x 0.8</td></tr> <tr> <td>RXY17BK(E)</td><td>15.9 x 1.0</td></tr> <tr> <td>RXY17BK(E)</td><td>19.1 x 1.1</td></tr> <tr> <td>RXY17BK(E)</td><td>22.2 x 1.2</td></tr> <tr> <td>RXY17BK(E)</td><td>25.4 x 1.3</td></tr> <tr> <td>RXY17BK(E)</td><td>28.6 x 1.4</td></tr> <tr> <td>RXY17BK(E)</td><td>31.8 x 1.5</td></tr> <tr> <td>RXY17BK(E)</td><td>35.0 x 1.6</td></tr> <tr> <td>RXY17BK(E)</td><td>38.2 x 1.7</td></tr> <tr> <td>RXY17BK(E)</td><td>41.4 x 1.8</td></tr> <tr> <td>RXY17BK(E)</td><td>44.6 x 1.9</td></tr> <tr> <td>RXY17BK(E)</td><td>47.8 x 2.0</td></tr> <tr> <td>RXY17BK(E)</td><td>51.0 x 2.1</td></tr> <tr> <td>RXY17BK(E)</td><td>54.2 x 2.2</td></tr> <tr> <td>RXY17BK(E)</td><td>57.4 x 2.3</td></tr> <tr> <td>RXY17BK(E)</td><td>60.6 x 2.4</td></tr> <tr> <td>RXY17BK(E)</td><td>63.8 x 2.5</td></tr> <tr> <td>RXY17BK(E)</td><td>67.0 x 2.6</td></tr> <tr> <td>RXY17BK(E)</td><td>70.2 x 2.7</td></tr> <tr> <td>RXY17BK(E)</td><td>73.4 x 2.8</td></tr> <tr> <td>RXY17BK(E)</td><td>76.6 x 2.9</td></tr> <tr> <td>RXY17BK(E)</td><td>79.8 x 3.0</td></tr> <tr> <td>RXY17BK(E)</td><td>83.0 x 3.1</td></tr> <tr> <td>RXY17BK(E)</td><td>86.2 x 3.2</td></tr> <tr> <td>RXY17BK(E)</td><td>89.4 x 3.3</td></tr> <tr> <td>RXY17BK(E)</td><td>92.6 x 3.4</td></tr> <tr> <td>RXY17BK(E)</td><td>95.8 x 3.5</td></tr> <tr> <td>RXY17BK(E)</td><td>99.0 x 3.6</td></tr> <tr> <td>RXY17BK(E)</td><td>102.2 x 3.7</td></tr> <tr> <td>RXY17BK(E)</td><td>105.4 x 3.8</td></tr> <tr> <td>RXY17BK(E)</td><td>108.6 x 3.9</td></tr> <tr> <td>RXY17BK(E)</td><td>111.8 x 4.0</td></tr> <tr> <td>RXY17BK(E)</td><td>115.0 x 4.1</td></tr> <tr> <td>RXY17BK(E)</td><td>118.2 x 4.2</td></tr> <tr> <td>RXY17BK(E)</td><td>121.4 x 4.3</td></tr> <tr> <td>RXY17BK(E)</td><td>124.6 x 4.4</td></tr> <tr> <td>RXY17BK(E)</td><td>127.8 x 4.5</td></tr> <tr> <td>RXY17BK(E)</td><td>131.0 x 4.6</td></tr> <tr> <td>RXY17BK(E)</td><td>134.2 x 4.7</td></tr> <tr> <td>RXY17BK(E)</td><td>137.4 x 4.8</td></tr> <tr> <td>RXY17BK(E)</td><td>140.6 x 4.9</td></tr> <tr> <td>RXY17BK(E)</td><td>143.8 x 5.0</td></tr> <tr> <td>RXY17BK(E)</td><td>147.0 x 5.1</td></tr> <tr> <td>RXY17BK(E)</td><td>150.2 x 5.2</td></tr> <tr> <td>RXY17BK(E)</td><td>153.4 x 5.3</td></tr> <tr> <td>RXY17BK(E)</td><td>156.6 x 5.4</td></tr> <tr> <td>RXY17BK(E)</td><td>159.8 x 5.5</td></tr> <tr> <td>RXY17BK(E)</td><td>163.0 x 5.6</td></tr> <tr> <td>RXY17BK(E)</td><td>166.2 x 5.7</td></tr> <tr> <td>RXY17BK(E)</td><td>169.4 x 5.8</td></tr> <tr> <td>RXY17BK(E)</td><td>172.6 x 5.9</td></tr> <tr> <td>RXY17BK(E)</td><td>175.8 x 6.0</td></tr> <tr> <td>RXY17BK(E)</td><td>179.0 x 6.1</td></tr> <tr> <td>RXY17BK(E)</td><td>182.2 x 6.2</td></tr> <tr> <td>RXY17BK(E)</td><td>185.4 x 6.3</td></tr> <tr> <td>RXY17BK(E)</td><td>188.6 x 6.4</td></tr> <tr> <td>RXY17BK(E)</td><td>191.8 x 6.5</td></tr> <tr> <td>RXY17BK(E)</td><td>195.0 x 6.6</td></tr> <tr> <td>RXY17BK(E)</td><td>198.2 x 6.7</td></tr> <tr> <td>RXY17BK(E)</td><td>201.4 x 6.8</td></tr> <tr> <td>RXY17BK(E)</td><td>204.6 x 6.9</td></tr> <tr> <td>RXY17BK(E)</td><td>207.8 x 7.0</td></tr> <tr> <td>RXY17BK(E)</td><td>211.0 x 7.1</td></tr> <tr> <td>RXY17BK(E)</td><td>214.2 x 7.2</td></tr> <tr> <td>RXY17BK(E)</td><td>217.4 x 7.3</td></tr> <tr> <td>RXY17BK(E)</td><td>220.6 x 7.4</td></tr> <tr> <td>RXY17BK(E)</td><td>223.8 x 7.5</td></tr> <tr> <td>RXY17BK(E)</td><td>227.0 x 7.6</td></tr> <tr> <td>RXY17BK(E)</td><td>230.2 x 7.7</td></tr> <tr> <td>RXY17BK(E)</td><td>233.4 x 7.8</td></tr> <tr> <td>RXY17BK(E)</td><td>236.6 x 7.9</td></tr> <tr> <td>RXY17BK(E)</td><td>239.8 x 8.0</td></tr> <tr> <td>RXY17BK(E)</td><td>243.0 x 8.1</td></tr> <tr> <td>RXY17BK(E)</td><td>246.2 x 8.2</td></tr> <tr> <td>RXY17BK(E)</td><td>249.4 x 8.3</td></tr> <tr> <td>RXY17BK(E)</td><td>252.6 x 8.4</td></tr> <tr> <td>RXY17BK(E)</td><td>255.8 x 8.5</td></tr> <tr> <td>RXY17BK(E)</td><td>259.0 x 8.6</td></tr> <tr> <td>RXY17BK(E)</td><td>262.2 x 8.7</td></tr> <tr> <td>RXY17BK(E)</td><td>265.4 x 8.8</td></tr> <tr> <td>RXY17BK(E)</td><td>268.6 x 8.9</td></tr> <tr> <td>RXY17BK(E)</td><td>271.8 x 9.0</td></tr> <tr> <td>RXY17BK(E)</td><td>275.0 x 9.1</td></tr> <tr> <td>RXY17BK(E)</td><td>278.2 x 9.2</td></tr> <tr> <td>RXY17BK(E)</td><td>281.4 x 9.3</td></tr> <tr> <td>RXY17BK(E)</td><td>284.6 x 9.4</td></tr> <tr> <td>RXY17BK(E)</td><td>287.8 x 9.5</td></tr> <tr> <td>RXY17BK(E)</td><td>291.0 x 9.6</td></tr> <tr> <td>RXY17BK(E)</td><td>294.2 x 9.7</td></tr> <tr> <td>RXY17BK(E)</td><td>297.4 x 9.8</td></tr> <tr> <td>RXY17BK(E)</td><td>300.6 x 9.9</td></tr> <tr> <td>RXY17BK(E)</td><td>303.8 x 10.0</td></tr> <tr> <td>RXY17BK(E)</td><td>307.0 x 10.1</td></tr> <tr> <td>RXY17BK(E)</td><td>310.2 x 10.2</td></tr> <tr> <td>RXY17BK(E)</td><td>313.4 x 10.3</td></tr> <tr> <td>RXY17BK(E)</td><td>316.6 x 10.4</td></tr> <tr> <td>RXY17BK(E)</td><td>319.8 x 10.5</td></tr> <tr> <td>RXY17BK(E)</td><td>323.0 x 10.6</td></tr> <tr> <td>RXY17BK(E)</td><td>326.2 x 10.7</td></tr> <tr> <td>RXY17BK(E)</td><td>329.4 x 10.8</td></tr> <tr> <td>RXY17BK(E)</td><td>332.6 x 10.9</td></tr> <tr> <td>RXY17BK(E)</td><td>335.8 x 11.0</td></tr> <tr> <td>RXY17BK(E)</td><td>339.0 x 11.1</td></tr> <tr> <td>RXY17BK(E)</td><td>342.2 x 11.2</td></tr> <tr> <td>RXY17BK(E)</td><td>345.4 x 11.3</td></tr> <tr> <td>RXY17BK(E)</td><td>348.6 x 11.4</td></tr> <tr> <td>RXY17BK(E)</td><td>351.8 x 11.5</td></tr> <tr> <td>RXY17BK(E)</td><td>355.0 x 11.6</td></tr> <tr> <td>RXY17BK(E)</td><td>358.2 x 11.7</td></tr> <tr> <td>RXY17BK(E)</td><td>361.4 x 11.8</td></tr> <tr> <td>RXY17BK(E)</td><td>364.6 x 11.9</td></tr> <tr> <td>RXY17BK(E)</td><td>367.8 x 12.0</td></tr> <tr> <td>RXY17BK(E)</td><td>371.0 x 12.1</td></tr> <tr> <td>RXY17BK(E)</td><td>374.2 x 12.2</td></tr> <tr> <td>RXY17BK(E)</td><td>377.4 x 12.3</td></tr> <tr> <td>RXY17BK(E)</td><td>380.6 x 12.4</td></tr> <tr> <td>RXY17BK(E)</td><td>383.8 x 12.5</td></tr> <tr> <td>RXY17BK(E)</td><td>387.0 x 12.6</td></tr> <tr> <td>RXY17BK(E)</td><td>390.2 x 12.7</td></tr> <tr> <td>RXY17BK(E)</td><td>393.4 x 12.8</td></tr> <tr> <td>RXY17BK(E)</td><td>396.6 x 12.9</td></tr> <tr> <td>RXY17BK(E)</td><td>399.8 x 13.0</td></tr> <tr> <td>RXY17BK(E)</td><td>403.0 x 13.1</td></tr> <tr> <td>RXY17BK(E)</td><td>406.2 x 13.2</td></tr> <tr> <td>RXY17BK(E)</td><td>409.4 x 13.3</td></tr> <tr> <td>RXY17BK(E)</td><td>412.6 x 13.4</td></tr> <tr> <td>RXY17BK(E)</td><td>415.8 x 13.5</td></tr> <tr> <td>RXY17BK(E)</td><td>419.0 x 13.6</td></tr> <tr> <td>RXY17BK(E)</td><td>422.2 x 13.7</td></tr> <tr> <td>RXY17BK(E)</td><td>425.4 x 13.8</td></tr> <tr> <td>RXY17BK(E)</td><td>428.6 x 13.9</td></tr> <tr> <td>RXY17BK(E)</td><td>431.8 x 14.0</td></tr> <tr> <td>RXY17BK(E)</td><td>435.0 x 14.1</td></tr> <tr> <td>RXY17BK(E)</td><td>438.2 x 14.2</td></tr> <tr> <td>RXY17BK(E)</td><td>441.4 x 14.3</td></tr> <tr> <td>RXY17BK(E)</td><td>444.6 x 14.4</td></tr> <tr> <td>RXY17BK(E)</td><td>447.8 x 14.5</td></tr> <tr> <td>RXY17BK(E)</td><td>451.0 x 14.6</td></tr> <tr> <td>RXY17BK(E)</td><td>454.2 x 14.7</td></tr> <tr> <td>RXY17BK(E)</td><td>457.4 x 14.8</td></tr> <tr> <td>RXY17BK(E)</td><td>460.6 x 14.9</td></tr> <tr> <td>RXY17BK(E)</td><td>463.8 x 15.0</td></tr> <tr> <td>RXY17BK(E)</td><td>467.0 x 15.1</td></tr> <tr> <td>RXY17BK(E)</td><td>470.2 x 15.2</td></tr> <tr> <td>RXY17BK(E)</td><td>473.4 x 15.3</td></tr> <tr> <td>RXY17BK(E)</td><td>476.6 x 15.4</td></tr> <tr> <td>RXY17BK(E)</td><td>479.8 x 15.5</td></tr> <tr> <td>RXY17BK(E)</td><td>483.0 x 15.6</td></tr> <tr> <td>RXY17BK(E)</td><td>486.2 x 15.7</td></tr> <tr> <td>RXY17BK(E)</td><td>489.4 x 15.8</td></tr> <tr> <td>RXY17BK(E)</td><td>492.6 x 15.9</td></tr> <tr> <td>RXY17BK(E)</td><td>495.8 x 16.0</td></tr> <tr> <td>RXY17BK(E)</td><td>499.0 x 16.1</td></tr> <tr> <td>RXY17BK(E)</td><td>502.2 x 16.2</td></tr> <tr> <td>RXY17BK(E)</td><td>505.4 x 16.3</td></tr> <tr> <td>RXY17BK(E)</td><td>508.6 x 16.4</td></tr> <tr> <td>RXY17BK(E)</td><td>511.8 x 16.5</td></tr> <tr> <td>RXY17BK(E)</td><td>515.0 x 16.6</td></tr> <tr> <td>RXY17BK(E)</td><td>518.2 x 16.7</td></tr> <tr> <td>RXY17BK(E)</td><td>521.4 x 16.8</td></tr> <tr> <td>RXY17BK(E)</td><td>524.6 x 16.9</td></tr> <tr> <td>RXY17BK(E)</td><td>527.8 x 17.0</td></tr> <tr> <td>RXY17BK(E)</td><td>531.0 x 17.1</td></tr> <tr> <td>RXY17BK(E)</td><td>534.2 x 17.2</td></tr> <tr> <td>RXY17BK(E)</td><td>537.4 x 17.3</td></tr> <tr> <td>RXY17BK(E)</td><td>540.6 x 17.4</td></tr> <tr> <td>RXY17BK(E)</td><td>543.8 x 17.5</td></tr> <tr> <td>RXY17BK(E)</td><td>547.0 x 17.6</td></tr> <tr> <td>RXY17BK(E)</td><td>550.2 x 17.7</td></tr> <tr> <td>RXY17BK(E)</td><td>553.4 x 17.8</td></tr> <tr> <td>RXY17BK(E)</td><td>556.6 x 17.9</td></tr> <tr> <td>RXY17BK(E)</td><td>559.8 x 18.0</td></tr> <tr> <td>RXY17BK(E)</td><td>563.0 x 18.1</td></tr> <tr> <td>RXY17BK(E)</td><td>566.2 x 18.2</td></tr> <tr> <td>RXY17BK(E)</td><td>569.4 x 18.3</td></tr> <tr> <td>RXY17BK(E)</td><td>572.6 x 18.4</td></tr> <tr> <td>RXY17BK(E)</td><td>575.8 x 18.5</td></tr> <tr> <td>RXY17BK(E)</td><td>579.0 x 18.6</td></tr> <tr> <td>RXY17BK(E)</td><td>582.2 x 18.7</td></tr> <tr> <td>RXY17BK(E)</td><td>585.4 x 18.8</td></tr> <tr> <td>RXY17BK(E)</td><td>588.6 x 18.9</td></tr> <tr> <td>RXY17BK(E)</td><td>591.8 x 19.0</td></tr> <tr> <td>RXY17BK(E)</td><td>595.0 x 19.1</td></tr> <tr> <td>RXY17BK(E)</td><td>598.2 x 19.2</td></tr> <tr> <td>RXY17BK(E)</td><td>601.4 x 19.3</td></tr> <tr> <td>RXY17BK(E)</td><td>604.6 x 19.4</td></tr> <tr> <td>RXY17BK(E)</td><td>607.8 x 19.5</td></tr> <tr> <td>RXY17BK(E)</td><td>611.0 x 19.6</td></tr> <tr> <td>RXY17BK(E)</td><td>614.2 x 19.7</td></tr> <tr> <td>RXY17BK(E)</td><td>617.4 x 19.8</td></tr> <tr> <td>RXY17BK(E)</td><td>620.6 x 19.9</td></tr> <tr> <td>RXY17BK(E)</td><td>623.8 x 20.0</td></tr> <tr> <td>RXY17BK(E)</td><td>627.0 x 20.1</td></tr> <tr> <td>RXY17BK(E)</td><td>630.2 x 20.2</td></tr> <tr> <td>RXY17BK(E)</td><td>633.4 x 20.3</td></tr> <tr> <td>RXY17BK(E)</td><td>636.6 x 20.4</td></tr> <tr> <td>RXY17BK(E)</td><td>639.8 x 20.5</td></tr> <tr> <td>RXY17BK(E)</td><td>643.0 x 20.6</td></tr> <tr> <td>RXY17BK(E)</td><td>646.2 x 20.7</td></tr> <tr> <td>RXY17BK(E)</td><td>649.4 x 20.8</td></tr> <tr> <td>RXY17BK(E)</td><td>652.6 x 20.9</td></tr> <tr> <td>RXY17BK(E)</td><td>655.8 x 21.0</td></tr> <tr> <td>RXY17BK(E)</td><td>659.0 x 21.1</td></tr> <tr> <td>RXY17BK(E)</td><td>662.2 x 21.2</td></tr> <tr> <td>RXY17BK(E)</td><td>665.4 x 21.3</td></tr> <tr> <td>RXY17BK(E)</td><td>668.6 x 21.4</td></tr> <tr> <td>RXY17BK(E)</td><td>671.8 x 21.5</td></tr> <tr> <td>RXY17BK(E)</td><td>675.0 x 21.6</td></tr> <tr> <td>RXY17BK(E)</td><td>678.2 x 21.7</td></tr> <tr> <td>RXY17BK(E)</td><td>681.4 x 21.8</td></tr> <tr> <td>RXY17BK(E)</td><td>684.6 x 21.9</td></tr> <tr> <td>RXY17BK(E)</td><td>687.8 x 22.0</td></tr> <tr> <td>RXY17BK(E)</td><td>691.0 x 22.1</td></tr> <tr> <td>RXY17BK(E)</td><td>694.2 x 22.2</td></tr> <tr> <td>RXY17BK(E)</td><td>697.4 x 22.3</td></tr> <tr> <td>RXY17BK(E)</td><td>700.6 x 22.4</td></tr> <tr> <td>RXY17BK(E)</td><td>703.8 x 22.5</td></tr> <tr> <td>RXY17BK(E)</td><td>707.0 x 22.6</td></tr> <tr> <td>RXY17BK(E)</td><td>710.2 x 22.7</td></tr> <tr> <td>RXY17BK(E)</td><td>713.4 x 22.8</td></tr> <tr> <td>RXY17BK(E)</td><td>716.6 x 22.9</td></tr> <tr> <td>RXY17BK(E)</td><td>719.8 x 23.0</td></tr> <tr> <td>RXY17BK(E)</td><td>723.0 x 23.1</td></tr> <tr> <td>RXY17BK(E)</td><td>726.2 x 23.2</td></tr> <tr> <td>RXY17BK(E)</td><td>729.4 x 23.3</td></tr> <tr> <td>RXY17BK(E)</td><td>732.6 x 23.4</td></tr> <tr> <td>RXY17BK(E)</td><td>735.8 x 23.5</td></tr> <tr> <td>RXY17BK(E)</td><td>739.0 x 23.6</td></tr> <tr> <td>RXY17BK(E)</td><td>742.2 x 23.7</td></tr> <tr> <td>RXY17BK(E)</td><td>745.4 x 23.8</td></tr> <tr> <td>RXY17BK(E)</td><td>748.6 x 23.9</td></tr> <tr> <td>RXY17BK(E)</td><td>751.8 x 24.0</td></tr> <tr> <td>RXY17BK(E)</td><td>755.0 x 24.1</td></tr> <tr> <td>RXY17BK(E)</td><td>758.2 x 24.2</td></tr> <tr> <td>RXY17BK(E)</td><td>761.4 x 24.3</td></tr> <tr> <td>RXY17BK(E)</td><td>764.6 x 24.4</td></tr> <tr> <td>RXY17BK(E)</td><td>767.8 x 24.5</td></tr> <tr> <td>RXY17BK(E)</td><td>771.0 x 24.6</td></tr> <tr> <td>RXY17BK(E)</td><td>774.2 x 24.7</td></tr> <tr> <td>RXY17BK(E)</td><td>777.4 x 24.8</td></tr> <tr> <td>RXY17BK(E)</td><td>780.6 x 24.9</td></tr> <tr> <td>RXY17BK(E)</td><td>783.8 x 25.0</td></tr> <tr> <td>RXY17BK(E)</td><td>787.0 x 25.1</td></tr> <tr> <td>RXY17BK(E)</td><td>790.2 x 25.2</td></tr> <tr> <td>RXY17BK(E)</td><td>793.4 x 25.3</td></tr> <tr> <td>RXY17BK(E)</td><td>796.6 x 25.4</td></tr> <tr> <td>RXY17BK(E)</td><td>799.8 x 25.5</td></tr> <tr> <td>RXY17BK(E)</td><td>803.0 x 25.6</td></tr> <tr> <td>RXY17BK(E)</td><td>806.2 x 25.7</td></tr> <tr> <td>RXY17BK(E)</td><td>809.4 x 25.8</td></tr> <tr> <td>RXY17BK(E)</td><td>812.6 x 25.9</td></tr> <tr> <td>RXY17BK(E)</td><td>815.8 x 26.0</td></tr> <tr> <td>RXY17BK(E)</td><td>819.0 x 26.1</td></tr> <tr> <td>RXY17BK(E)</td><td>822.2 x 26.2</td></tr> <tr> <td>RXY17BK(E)</td><td>825.4 x 26.3</td></tr> <tr> <td>RXY17BK(E)</td><td>828.6 x 26.4</td></tr> <tr> <td>RXY17BK(E)</td><td>831.8 x 26.5</td></tr> <tr> <td>RXY17BK(E)</td><td>835.0 x 26.6</td></tr> <tr> <td>RXY17BK(E)</td><td>838.2 x 26.7</td></tr> <tr> <td>RXY17BK(E)</td><td>841.4 x 26.8</td></tr> <tr> <td>RXY17BK(E)</td><td>844.6 x 26.9</td></tr> <tr> <td>RXY17BK(E)</td><td>847.8 x 27.0</td></tr> <tr> <td>RXY17BK(E)</td><td>851.0 x 27.1</td></tr> <tr> <td>RXY17BK(E)</td><td>854.2 x 27.2</td></tr> <tr> <td>RXY17BK(E)</td><td>857.4 x 27.3</td></tr> <tr> <td>RXY17BK(E)</td><td>860.6 x 27.4</td></tr> <tr> <td>RXY17BK(E)</td><td>863.8 x 27.5</td></tr> <tr> <td>RXY17BK(E)</td><td>867.0 x 27.6</td></tr> <tr> <td>RXY17BK(E)</td><td>870.2 x 27.7</td></tr> <tr> <td>RXY17BK(E)</td><td>873.4 x 27.8</td></tr> <tr> <td>RXY17BK(E)</td><td>876.6 x 27.9</td></tr> <tr> <td>RXY17BK(E)</td><td>879.8 x 28.0</td></tr> <tr> <td>RXY17BK(E)</td><td>883.0 x 28.1</td></tr> <tr> <td>RXY17BK(E)</td><td>886.2 x 28.2</td></tr> <tr> <td>RXY17BK(E)</td><td>889.4 x 28.3</td></tr> <tr> <td>RXY17BK(E)</td><td>892.6 x 28.4</td></tr> <tr> <td>RXY17BK(E)</td><td>895.8 x 28.5</td></tr> <tr> <td>RXY17BK(E)</td><td>899.0 x 28.6</td></tr> <tr> <td>RXY17BK(E</td></tr></table>	Outdoor system name	Pipe size (Outer diameter x minimum wall thickness) (Unit: mm)	RXY17BK	12.7 x 0.8	RXY17BK(E)	12.7 x 0.8	RXY17BK(E)	15.9 x 1.0	RXY17BK(E)	19.1 x 1.1	RXY17BK(E)	22.2 x 1.2	RXY17BK(E)	25.4 x 1.3	RXY17BK(E)	28.6 x 1.4	RXY17BK(E)	31.8 x 1.5	RXY17BK(E)	35.0 x 1.6	RXY17BK(E)	38.2 x 1.7	RXY17BK(E)	41.4 x 1.8	RXY17BK(E)	44.6 x 1.9	RXY17BK(E)	47.8 x 2.0	RXY17BK(E)	51.0 x 2.1	RXY17BK(E)	54.2 x 2.2	RXY17BK(E)	57.4 x 2.3	RXY17BK(E)	60.6 x 2.4	RXY17BK(E)	63.8 x 2.5	RXY17BK(E)	67.0 x 2.6	RXY17BK(E)	70.2 x 2.7	RXY17BK(E)	73.4 x 2.8	RXY17BK(E)	76.6 x 2.9	RXY17BK(E)	79.8 x 3.0	RXY17BK(E)	83.0 x 3.1	RXY17BK(E)	86.2 x 3.2	RXY17BK(E)	89.4 x 3.3	RXY17BK(E)	92.6 x 3.4	RXY17BK(E)	95.8 x 3.5	RXY17BK(E)	99.0 x 3.6	RXY17BK(E)	102.2 x 3.7	RXY17BK(E)	105.4 x 3.8	RXY17BK(E)	108.6 x 3.9	RXY17BK(E)	111.8 x 4.0	RXY17BK(E)	115.0 x 4.1	RXY17BK(E)	118.2 x 4.2	RXY17BK(E)	121.4 x 4.3	RXY17BK(E)	124.6 x 4.4	RXY17BK(E)	127.8 x 4.5	RXY17BK(E)	131.0 x 4.6	RXY17BK(E)	134.2 x 4.7	RXY17BK(E)	137.4 x 4.8	RXY17BK(E)	140.6 x 4.9	RXY17BK(E)	143.8 x 5.0	RXY17BK(E)	147.0 x 5.1	RXY17BK(E)	150.2 x 5.2	RXY17BK(E)	153.4 x 5.3	RXY17BK(E)	156.6 x 5.4	RXY17BK(E)	159.8 x 5.5	RXY17BK(E)	163.0 x 5.6	RXY17BK(E)	166.2 x 5.7	RXY17BK(E)	169.4 x 5.8	RXY17BK(E)	172.6 x 5.9	RXY17BK(E)	175.8 x 6.0	RXY17BK(E)	179.0 x 6.1	RXY17BK(E)	182.2 x 6.2	RXY17BK(E)	185.4 x 6.3	RXY17BK(E)	188.6 x 6.4	RXY17BK(E)	191.8 x 6.5	RXY17BK(E)	195.0 x 6.6	RXY17BK(E)	198.2 x 6.7	RXY17BK(E)	201.4 x 6.8	RXY17BK(E)	204.6 x 6.9	RXY17BK(E)	207.8 x 7.0	RXY17BK(E)	211.0 x 7.1	RXY17BK(E)	214.2 x 7.2	RXY17BK(E)	217.4 x 7.3	RXY17BK(E)	220.6 x 7.4	RXY17BK(E)	223.8 x 7.5	RXY17BK(E)	227.0 x 7.6	RXY17BK(E)	230.2 x 7.7	RXY17BK(E)	233.4 x 7.8	RXY17BK(E)	236.6 x 7.9	RXY17BK(E)	239.8 x 8.0	RXY17BK(E)	243.0 x 8.1	RXY17BK(E)	246.2 x 8.2	RXY17BK(E)	249.4 x 8.3	RXY17BK(E)	252.6 x 8.4	RXY17BK(E)	255.8 x 8.5	RXY17BK(E)	259.0 x 8.6	RXY17BK(E)	262.2 x 8.7	RXY17BK(E)	265.4 x 8.8	RXY17BK(E)	268.6 x 8.9	RXY17BK(E)	271.8 x 9.0	RXY17BK(E)	275.0 x 9.1	RXY17BK(E)	278.2 x 9.2	RXY17BK(E)	281.4 x 9.3	RXY17BK(E)	284.6 x 9.4	RXY17BK(E)	287.8 x 9.5	RXY17BK(E)	291.0 x 9.6	RXY17BK(E)	294.2 x 9.7	RXY17BK(E)	297.4 x 9.8	RXY17BK(E)	300.6 x 9.9	RXY17BK(E)	303.8 x 10.0	RXY17BK(E)	307.0 x 10.1	RXY17BK(E)	310.2 x 10.2	RXY17BK(E)	313.4 x 10.3	RXY17BK(E)	316.6 x 10.4	RXY17BK(E)	319.8 x 10.5	RXY17BK(E)	323.0 x 10.6	RXY17BK(E)	326.2 x 10.7	RXY17BK(E)	329.4 x 10.8	RXY17BK(E)	332.6 x 10.9	RXY17BK(E)	335.8 x 11.0	RXY17BK(E)	339.0 x 11.1	RXY17BK(E)	342.2 x 11.2	RXY17BK(E)	345.4 x 11.3	RXY17BK(E)	348.6 x 11.4	RXY17BK(E)	351.8 x 11.5	RXY17BK(E)	355.0 x 11.6	RXY17BK(E)	358.2 x 11.7	RXY17BK(E)	361.4 x 11.8	RXY17BK(E)	364.6 x 11.9	RXY17BK(E)	367.8 x 12.0	RXY17BK(E)	371.0 x 12.1	RXY17BK(E)	374.2 x 12.2	RXY17BK(E)	377.4 x 12.3	RXY17BK(E)	380.6 x 12.4	RXY17BK(E)	383.8 x 12.5	RXY17BK(E)	387.0 x 12.6	RXY17BK(E)	390.2 x 12.7	RXY17BK(E)	393.4 x 12.8	RXY17BK(E)	396.6 x 12.9	RXY17BK(E)	399.8 x 13.0	RXY17BK(E)	403.0 x 13.1	RXY17BK(E)	406.2 x 13.2	RXY17BK(E)	409.4 x 13.3	RXY17BK(E)	412.6 x 13.4	RXY17BK(E)	415.8 x 13.5	RXY17BK(E)	419.0 x 13.6	RXY17BK(E)	422.2 x 13.7	RXY17BK(E)	425.4 x 13.8	RXY17BK(E)	428.6 x 13.9	RXY17BK(E)	431.8 x 14.0	RXY17BK(E)	435.0 x 14.1	RXY17BK(E)	438.2 x 14.2	RXY17BK(E)	441.4 x 14.3	RXY17BK(E)	444.6 x 14.4	RXY17BK(E)	447.8 x 14.5	RXY17BK(E)	451.0 x 14.6	RXY17BK(E)	454.2 x 14.7	RXY17BK(E)	457.4 x 14.8	RXY17BK(E)	460.6 x 14.9	RXY17BK(E)	463.8 x 15.0	RXY17BK(E)	467.0 x 15.1	RXY17BK(E)	470.2 x 15.2	RXY17BK(E)	473.4 x 15.3	RXY17BK(E)	476.6 x 15.4	RXY17BK(E)	479.8 x 15.5	RXY17BK(E)	483.0 x 15.6	RXY17BK(E)	486.2 x 15.7	RXY17BK(E)	489.4 x 15.8	RXY17BK(E)	492.6 x 15.9	RXY17BK(E)	495.8 x 16.0	RXY17BK(E)	499.0 x 16.1	RXY17BK(E)	502.2 x 16.2	RXY17BK(E)	505.4 x 16.3	RXY17BK(E)	508.6 x 16.4	RXY17BK(E)	511.8 x 16.5	RXY17BK(E)	515.0 x 16.6	RXY17BK(E)	518.2 x 16.7	RXY17BK(E)	521.4 x 16.8	RXY17BK(E)	524.6 x 16.9	RXY17BK(E)	527.8 x 17.0	RXY17BK(E)	531.0 x 17.1	RXY17BK(E)	534.2 x 17.2	RXY17BK(E)	537.4 x 17.3	RXY17BK(E)	540.6 x 17.4	RXY17BK(E)	543.8 x 17.5	RXY17BK(E)	547.0 x 17.6	RXY17BK(E)	550.2 x 17.7	RXY17BK(E)	553.4 x 17.8	RXY17BK(E)	556.6 x 17.9	RXY17BK(E)	559.8 x 18.0	RXY17BK(E)	563.0 x 18.1	RXY17BK(E)	566.2 x 18.2	RXY17BK(E)	569.4 x 18.3	RXY17BK(E)	572.6 x 18.4	RXY17BK(E)	575.8 x 18.5	RXY17BK(E)	579.0 x 18.6	RXY17BK(E)	582.2 x 18.7	RXY17BK(E)	585.4 x 18.8	RXY17BK(E)	588.6 x 18.9	RXY17BK(E)	591.8 x 19.0	RXY17BK(E)	595.0 x 19.1	RXY17BK(E)	598.2 x 19.2	RXY17BK(E)	601.4 x 19.3	RXY17BK(E)	604.6 x 19.4	RXY17BK(E)	607.8 x 19.5	RXY17BK(E)	611.0 x 19.6	RXY17BK(E)	614.2 x 19.7	RXY17BK(E)	617.4 x 19.8	RXY17BK(E)	620.6 x 19.9	RXY17BK(E)	623.8 x 20.0	RXY17BK(E)	627.0 x 20.1	RXY17BK(E)	630.2 x 20.2	RXY17BK(E)	633.4 x 20.3	RXY17BK(E)	636.6 x 20.4	RXY17BK(E)	639.8 x 20.5	RXY17BK(E)	643.0 x 20.6	RXY17BK(E)	646.2 x 20.7	RXY17BK(E)	649.4 x 20.8	RXY17BK(E)	652.6 x 20.9	RXY17BK(E)	655.8 x 21.0	RXY17BK(E)	659.0 x 21.1	RXY17BK(E)	662.2 x 21.2	RXY17BK(E)	665.4 x 21.3	RXY17BK(E)	668.6 x 21.4	RXY17BK(E)	671.8 x 21.5	RXY17BK(E)	675.0 x 21.6	RXY17BK(E)	678.2 x 21.7	RXY17BK(E)	681.4 x 21.8	RXY17BK(E)	684.6 x 21.9	RXY17BK(E)	687.8 x 22.0	RXY17BK(E)	691.0 x 22.1	RXY17BK(E)	694.2 x 22.2	RXY17BK(E)	697.4 x 22.3	RXY17BK(E)	700.6 x 22.4	RXY17BK(E)	703.8 x 22.5	RXY17BK(E)	707.0 x 22.6	RXY17BK(E)	710.2 x 22.7	RXY17BK(E)	713.4 x 22.8	RXY17BK(E)	716.6 x 22.9	RXY17BK(E)	719.8 x 23.0	RXY17BK(E)	723.0 x 23.1	RXY17BK(E)	726.2 x 23.2	RXY17BK(E)	729.4 x 23.3	RXY17BK(E)	732.6 x 23.4	RXY17BK(E)	735.8 x 23.5	RXY17BK(E)	739.0 x 23.6	RXY17BK(E)	742.2 x 23.7	RXY17BK(E)	745.4 x 23.8	RXY17BK(E)	748.6 x 23.9	RXY17BK(E)	751.8 x 24.0	RXY17BK(E)	755.0 x 24.1	RXY17BK(E)	758.2 x 24.2	RXY17BK(E)	761.4 x 24.3	RXY17BK(E)	764.6 x 24.4	RXY17BK(E)	767.8 x 24.5	RXY17BK(E)	771.0 x 24.6	RXY17BK(E)	774.2 x 24.7	RXY17BK(E)	777.4 x 24.8	RXY17BK(E)	780.6 x 24.9	RXY17BK(E)	783.8 x 25.0	RXY17BK(E)	787.0 x 25.1	RXY17BK(E)	790.2 x 25.2	RXY17BK(E)	793.4 x 25.3	RXY17BK(E)	796.6 x 25.4	RXY17BK(E)	799.8 x 25.5	RXY17BK(E)	803.0 x 25.6	RXY17BK(E)	806.2 x 25.7	RXY17BK(E)	809.4 x 25.8	RXY17BK(E)	812.6 x 25.9	RXY17BK(E)	815.8 x 26.0	RXY17BK(E)	819.0 x 26.1	RXY17BK(E)	822.2 x 26.2	RXY17BK(E)	825.4 x 26.3	RXY17BK(E)	828.6 x 26.4	RXY17BK(E)	831.8 x 26.5	RXY17BK(E)	835.0 x 26.6	RXY17BK(E)	838.2 x 26.7	RXY17BK(E)	841.4 x 26.8	RXY17BK(E)	844.6 x 26.9	RXY17BK(E)	847.8 x 27.0	RXY17BK(E)	851.0 x 27.1	RXY17BK(E)	854.2 x 27.2	RXY17BK(E)	857.4 x 27.3	RXY17BK(E)	860.6 x 27.4	RXY17BK(E)	863.8 x 27.5	RXY17BK(E)	867.0 x 27.6	RXY17BK(E)	870.2 x 27.7	RXY17BK(E)	873.4 x 27.8	RXY17BK(E)	876.6 x 27.9	RXY17BK(E)	879.8 x 28.0	RXY17BK(E)	883.0 x 28.1	RXY17BK(E)	886.2 x 28.2	RXY17BK(E)	889.4 x 28.3	RXY17BK(E)	892.6 x 28.4	RXY17BK(E)	895.8 x 28.5	RXY17BK(E)	899.0 x 28.6	RXY17BK(E
Outdoor system name	Pipe size (Outer diameter x minimum wall thickness) (Unit: mm)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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3) Calculation of Equivalent Piping Length

Equivalent piping length means the length of actual piping plus nominal lengths for bends, joints and headers to take into account the flow resistance in these components, see Table 13. for relevant values.

Table 13 : Pressure loss in fittings of piping
REFRIGERANT PIPE EQUIVALENT LENGTH

(UNIT : m)

MODELS PIPE NOMINAL DIA. (UNIT: mm)	L JOINT 	REFNET JOINT 	REFNET HEADER 
6.4	0.16	0.5	1.0
9.5	0.18		
12.7	0.20		
15.9	0.25		
19.1	0.35		
22.2	0.40		
25.4	0.45		
28.6	0.50		
31.8	0.55		
38.1	0.65		
44.5	0.80		
50.8	0.90		

For the most accurate results the equivalent piping length from the outdoor unit to each individual indoor unit should be calculated and used to find the correction factor for their respective indoor units capacity. However this can be very time consuming in a large system and so we offer the alternative solution of taking the longest piping run (outdoor unit to indoor unit) to find the correction factor and applying this to all indoor units. This also adds a degree of safety to the selection by effectively taking the worse case scenario. It is also important at this point to note refrigerant piping limitations.

Limitations of installation position and relevant position of units in the same refrigerant circuit to each other.

- Total piping length within 100m
- Overall equivalent length within 125m
- Level difference in between indoor units within 15m
- Level difference between indoor unit and outdoor unit where indoor unit in inferior position within 50m
- The distance from the first refnet to the far end indoor unit within 40m

Limitation special for Plus series.

- Actual piping length from function unit to the far end outdoor unit within 10m
- Equivalent piping length from function unit to the far end outdoor unit within 12.5m
- Level difference in between outdoor units, or between function unit and outdoor unit within 4m

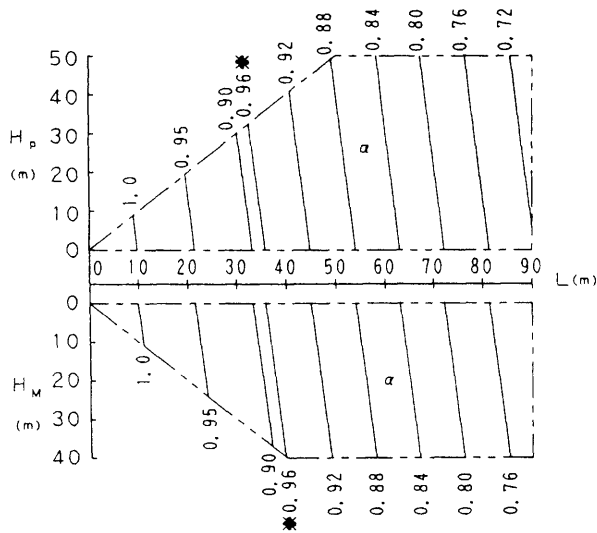
4) Determining the Refrigerant Piping Capacity Correction Factor

Using the calculated Equivalent piping length and knowing the vertical distance between the outdoor unit and the indoor unit the capacity correction factor can be found from the charts found in Fig 57.

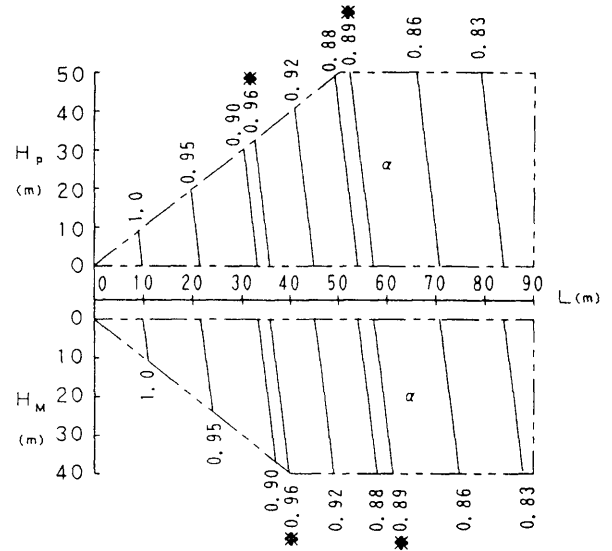
Fig 57

Rate of change in cooling capacity

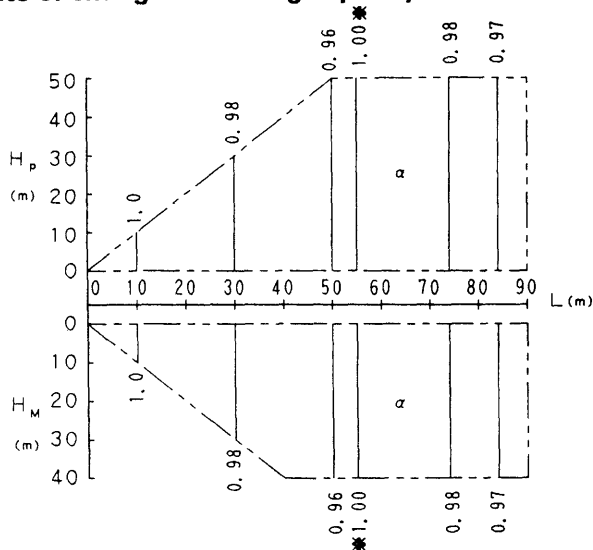
50Hz



60Hz



Rate of change in heating capacity



Explanation of symbols:

- H_p : Level difference between indoor and outdoor unit where indoor is lower(m).
- H_m : Level difference between indoor and outdoor unit where indoor is higher(m).
- L : Equivalent pipe length (m)
- α : Capacity correction factor

Step 4

Actual Available Capacity from Individual Indoor Units

Take the available outdoor unit capacity (found in step 2.), based on combination ratio at design conditions and multiply this by the refrigerant piping capacity correction factor, this capacity is the actual outdoor units capacity (OCA). This capacity must then be divided proportionally between the indoor units in the refrigerant piping circuit, i.e. proportional to the size of the indoor unit, capacity indexes are used for simplicity.

$$ICA = OCA \times INX / TNX$$

Where,

ICA = Individual Indoor Unit Capacity (or PI)

OCA = Outdoor Unit Capacity (or PI)

INX = Individual Indoor Unit Capacity Index

TNX = Total (sum of) Indoor Unit Capacity indexes

If the available capacity does not satisfy the maximum heat load increase the size of the indoor unit(s) and/or outdoor unit as required and find the new capacity from step 2) and then repeat step 4).

Note: If individual piping length capacity correction factors are to be applied to each indoor unit then the above mentioned formula should first be applied to the outdoor unit capacity found in step 2) and then the individual indoor unit capacity multiplied by the respective refrigerant piping capacity correction factor.

Applying this procedure to the sample building,

Zone 14

Interior zone of large office

Step 1

Heat Load = 42.7 kW

Indoor Units = 21 x FXYC20K (index 20)

Total indoor unit index = 21 x 20 = 420

To cover this required capacity an RXY18K type outdoor unit is selected (index 450) (see table 9).

Note: In this situation we don't want to exceed a combination ratio of 100% as the indoor units are all conditioning the same area and will not be subject to individual control.

In this case the combination ratio = $420/450 = 93\%$

Step 2

From before we have the design conditions,

Outdoor temperature = 37°CDB

Indoor temperature = 19°CWB

The capacity of the outdoor unit at these conditions can now be found from capacity tables in the Engineering Data book.

Note that as the combination ratio is less than 100% we can take the capacity reading at 100% as the outdoor unit is capable of providing this.

From capacity tables the RXY18K at 37°CDB outdoor, 19°CWB indoor and 100% combination is 50.2 kW.

Step 3

To find the refrigerant piping capacity correction factor,

- 1) The position of the outdoor units on the roof are shown in Fig. 52.
- 2) Refnet selection

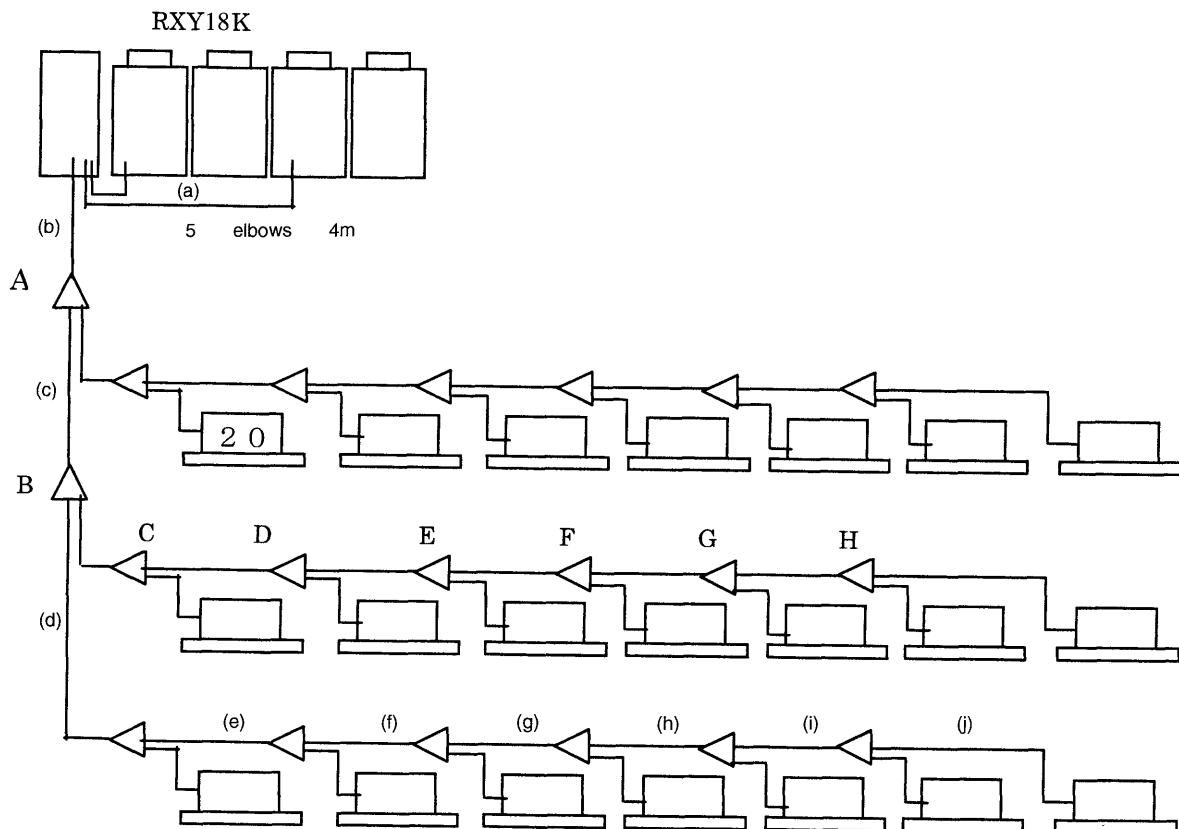


Table 11 Refnet in interior zone of office in the sample building (Zone 14)

Position	Index in down stream	Refnet model	Quantity
A	420	KHRJ26K40T + KHRJ26K40TP	1
B	280	KHRJ26K37T	1
C	140	KHRJ26K18T	3
D	120	KHRJ26K18T	3
E	100	KHRJ26K18T	3
F	80	KHRJ26K11T	3
G	60	KHRJ26K11T	3
H	40	KHRJ26K11T	3

Table 14 : Sizing of pipes in Zone 14 of the sample building

Route	IDX (unit)	Liquid pipe	Gas pipe	Equalizing pipe	Quantity
a	RXY18K	Ø 12.7	Ø 25.4	Ø 19.1	Each 1
b		Ø 19.1	Ø 34.9		1
c	280	Ø 12.7	Ø 25.4		1
d	140	Ø 9.5	Ø 19.1		1
e	120	Ø 9.5	Ø 19.1		3
f	100	Ø 9.5	Ø 19.1		3
g	80	Ø 9.5	Ø 15.9		3
h	60	Ø 9.5	Ø 15.9		3
i	40	Ø 9.5	Ø 15.9		3
j		Ø 6.4	Ø 12.7		3

Selected from data found in Table 12. (also available in Engineering Data books).

Note that in the case of the VRV plus series piping between outdoor units (and the function unit) is taken into account.

3) Calculation of equivalent piping length, taking the longest pipe run,

Mark	Route	Estimated actual length
a)	From the far end outdoor unit to function unit	4m
b)	From the function unit to the first refnet	9m
c)	From the first refnet to the far end refnet	39m
Total		52m

Bends and joints and the equivalent length(refer to Table 13)

- When resistance in piping is going to be calculated, take just gas piping instead of liquid piping.
- Resistance in elbow can be taken from Table 13 "Pressure loss in fittings of piping" for most accurate valves. However for simplicity we will use an average equivalent length of 0.4m for all bends.

Mark	Route	Part name	Number	Equivalent length/pc.	Total equivalent length
a)	From the far end outdoor unit to function unit	elbow	5	0.4	2.0
a)-b)		Function unit	1	5.0	5.0
-b)	From the function unit to the first refnet	elbow	6	0.4	2.4
c)	From the first refnet to the second refnet	elbow	2	0.4	0.8
d)	From the second refnet to the third refnet	elbow	2	0.4	0.8
e)-l	From the second refnet to the third refnet	elbow	5	0.4	2.0
j)	From the final refnet to the far end outdoor unit	elbow	3	0.4	1.2
b-j		Refnet	8	0.5	4.0
Total					18.2

Overall equivalent length = 52m (actual length) + 18.2m (equivalent length) = 70.2m

4) Determining the refrigerant piping capacity correction factor.

The level difference between the outdoor unit and the indoor units on the 15th floor is 1.5m. So from charts listed in Engineering Data (also shown in Fig. 57) the capacity correction factor (α) for equivalent length (L) 70.2m and level difference (Hp) 1.5m is found to be 0.81.

Step 4

Actual available capacity from individual indoor units.

In the case of the interior office (zone 14) all the indoor units are conditioning the same area so there is no need to divide the available capacity from the outdoor unit proportionally between the indoor units.

So Outdoor unit capacity = $50.2 \times 0.81 = 40.7 \text{ kW}$

Heat load for zone 14 = 42.7 kW

The required capacity is not satisfied. There are 2 solutions to this,

1) Increase the size of the outdoor unit from RXY18K to RXY20K (combination ratio changes to 84%)

So available capacity taken at 100% combination ratio, 37°CDB outdoor, 19°CWB = 55.8 kW

Outdoor unit capacity = $55.8 \times 0.81 = 45.2 \text{ kW}$

This satisfies the cooling requirements.

2) Increase the size of the indoor units from FXYC20K x 21 to (FXYC25 x 14) + (FXYC32 x 7) at combination ratio 128%.

So available capacity taken at 128% combination ratio, 37°CDB outdoor, 19°CWB = 53.8 kW

Outdoor unit capacity = $53.8 \times 0.81 = 43.6 \text{ kW}$

This satisfies the cooling requirements.

Either of these are suitable solutions but in this case the second one was chosen, reasons for this are; The larger 32 size units can be positioned along the perimeter zone by the window where the heat load is expected to be slightly higher. The appearance of the room will not be effected as the size of the decoration panels are the same for the 25 and 32 sizes. Note that cost is also a factor to be considered in these cases.

Zone 15

Perimeter zone.

Step 1

Heat Load = sum of maximum heat load in each room = 54.5 kW

Indoor Units = (9 x FXYC32K) + (1 x FXYC50K) + (3 x FXYC63K) + (1 x FXYC80K)

Total indoor unit index = 598.75

To cover this required capacity an RXY26K type outdoor unit is selected (index 650) (see table 9).

The combination ratio = $598.75/650 = 92\%$

Step 2

From before we have the design conditions,

Outdoor temperature = 37°CDB

Indoor temperature = 19°CWB

The capacity of the outdoor unit at these conditions can now be found from capacity tables in the Engineering Data book.

Note that as the combination ratio is less than 100% we can take the capacity reading at 100% as the outdoor unit is capable of providing this.

From capacity tables the RXY26K at 37°CDB outdoor, 19°CWB indoor and 100% combination is 72.5 kW.

Step 3

Refrigerant piping capacity correction factor (α) is taken to be 0.81 (the same as for zone 14).

Step 4

Actual available capacity from individual indoor units.

In the case of the interior office (zone 14) all the indoor units are conditioning the same area so there is no need to divide the available capacity from the outdoor unit proportionally between the indoor units.

So Outdoor unit capacity = $72.5 \times 0.81 = 58.73$ kW

Heat load for zone 15:	Proposed units
Office perimeter = 19.7 kW	7 x FXYC32K
Meeting room 1 = 6.4 kW	1 x FXYC63K
Meeting room 2 = 6.0 kW	1 x FXYC63K
Meeting room 3 = 7.1 kW	1 x FXYC80K
Meeting room 4 = 5.4 kW	1 x FXYC63K
Guest room = 4.3 kW	1 x FXYC50K
VIP room = 5.6 kW	2 x FXYC32K

To find individual indoor unit capacities using $ICA = OCA \times INX/TNX$

Where,

ICA = Individual Indoor Unit Capacity

OCA = Outdoor Unit Capacity = 58.73 kW

INX = Individual Indoor Unit Capacity Index

TNX = Total (sum of) Indoor Unit Capacity indexes = 598.75

For FXYC32K: $ICA = 58.73 \times (31.25/598.75) = 3.07$ kW OK

For FXYC50K: $ICA = 58.73 \times (50/598.75) = 4.9$ kW OK

For FXYC63K: $ICA = 58.73 \times (62.5/598.75) = 6.13$ kW NO (meeting room 1)

For FXYC80K: $ICA = 58.73 \times (80/598.75) = 7.85$ kW OK

The required capacity is **not** satisfied for Meeting room 3 so the indoor is replaced with one size up (FXYC63K to FXYC80K) and the check carried out again (note that the total index will change)

So total indoor unit index (TNX) = 616.25

This is still less than 100% combination so outdoor unit capacity (OCA) = 58.73 kW

Heat load for zone 15:	Proposed units
Office perimeter = 19.7 kW	7 x FXYC32K
Meeting room 1 = 6.4 kW	1 x FXYC80K
Meeting room 2 = 6.0 kW	1 x FXYC63K
Meeting room 3 = 7.1 kW	1 x FXYC80K
Meeting room 4 = 5.4 kW	1 x FXYC63K
Guest room = 4.3 kW	1 x FXYC50K
VIP room = 5.6 kW	2 x FXYC32K

For FXYC32K: $ICA = 58.73 \times (31.25/616.25) = 3.0$ kW OK

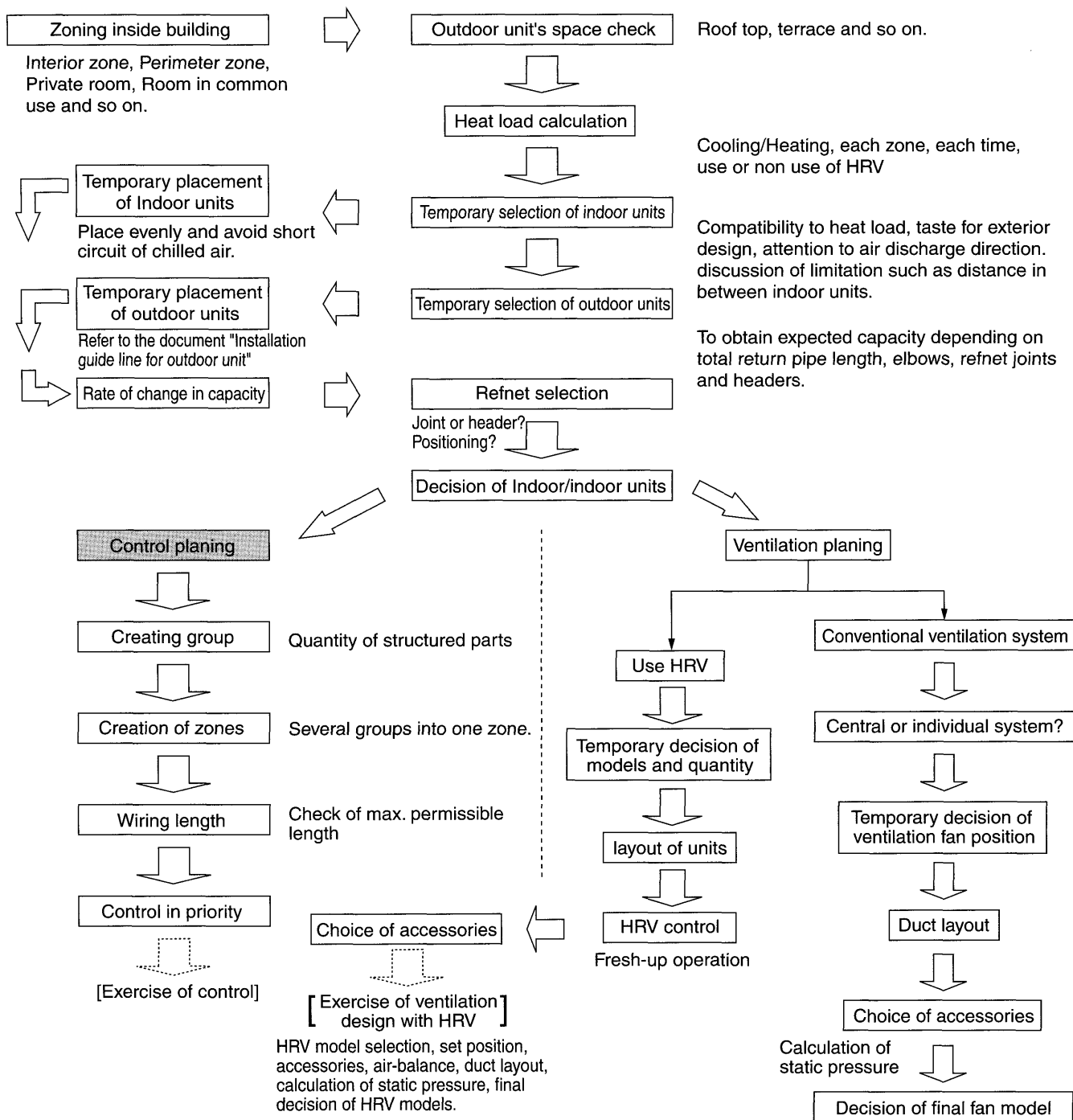
For FXYC50K: $ICA = 58.73 \times (50/616.25) = 4.8$ kW OK

For FXYC63K: $ICA = 58.73 \times (62.5/616.25) = 6.0$ kW OK

For FXYC80K: $ICA = 58.73 \times (80/616.25) = 7.6$ kW OK

All cooling requirements are satisfied.

Design procedure is indicated in this below chart. The topics with shaded enclosure signify topics which will be explained in the succeeded several pages till the other similar chart with other topics in shaded enclosures will appear.



3-5 Control planning

3-5-1 What's Super Wiring

As refrigerant piping was so, if compound transfer wiring with two cores in on one wire is connected from an outdoor unit to indoor units arranged in one connection, all the control in the same system can be carried out. Besides, this is so convenient system that if a central controller is combined to several combination wiring circuits, further many independent control lines can be uniformed by single control line. This system is called super wiring system.

Each indoor unit has its individual address like a house number. A central controller can control indoor units individually. The rough image is shown below.

Fig. 58 VRV System "K" Series

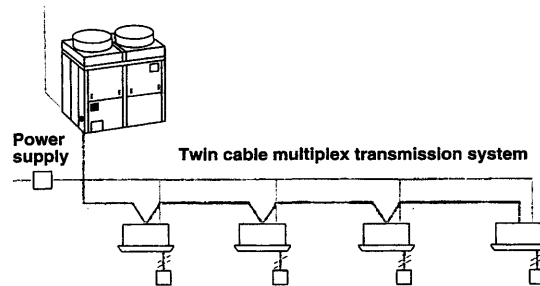


Fig. 59 VRV System Heat Recovery "KL" Series

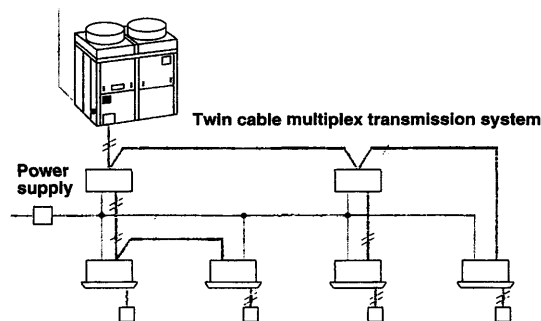
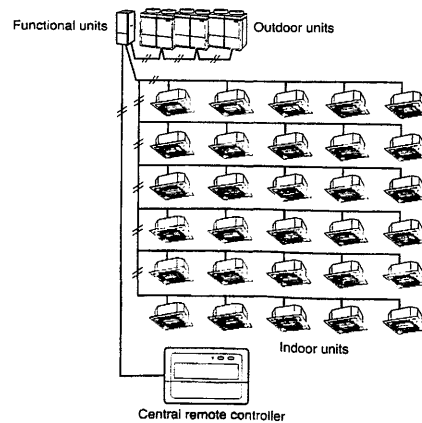


Fig. 60 VRV System "Plus" Series (Heat pump system, Cooling only System)



3-5-2 Preliminary knowledge on the control system planning

Keep in your mind the following matters before going into detailed planing.

- 1) What control devices are available?
- 2) What's a meaning of "group"? What should we do for creating groups? The method to make zones by putting together several groups.
- 3) It will be impossible to build in numberless devices described before. There are several limitations on the number connected and method to connect with, and moreover the wiring length too.
- 4) Possible to link up with a building management system. You might note what kinds of devices are necessary and what we can do by those.

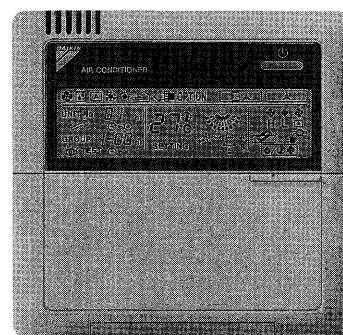
3-5-3 Control devices composed

Four main devices are remote controller, central remote controller, unified ON/OFF controller, and schedule timer. Each device can be sorted out. Multi-function are provided though small devices they are. You should note all these devices are optional accessories.

● Remote controller

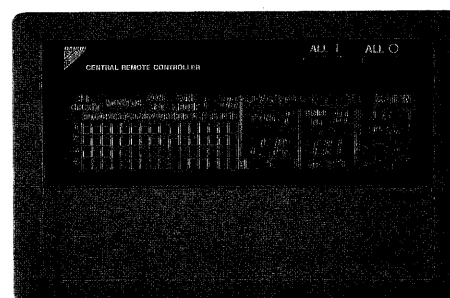
This is most familiar controller and a device a air conditioner's operator directly handle. There are two kinds; a wired and a wireless controllers.

The four main functions are provided: daily operation, group setting, field setting, and service mode. Refer to the figures in next page "Remote controller's function" about each details.



● Central controller

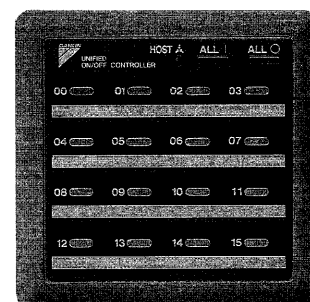
This is provided mainly in a machine room or in a room of management staffs and not a device the inhabitants or air conditioner's user directly handle. One central controller can control 64 groups with 128 indoor units. Two central controllers in combination can control 128 groups but it should be noted that the indoor units controllable are still 128 units without any increase of unit's number. Another function is to set zones by combining several groups. This controller can make settings; operation mode in a unit of zone (cooling, heating, ventilation, etc.), indoor temperature, air flow rate, weekly scheduled operation in link with a schedule timer. This can display the situation of the same refrigerant circuit line-up, kind of trouble showing the group which has the trouble, priority status to remote controllers.



DCS302B61

● Unified ON/OFF controller

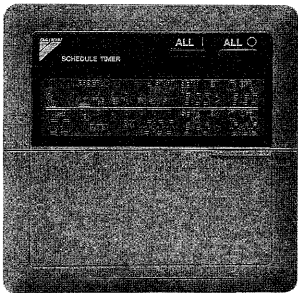
This controller normally is installed in a machine room in each floor or a place where air conditioner's user can not touch and carries out ON/OFF altogether or in every group. One Unified controller can control 16 groups with 128 indoor units. It will just fit to avoid the case that stop is forgotten after the work time. A person who is going back home at the last will push the simultaneous OFF button and then all equipment will stop. Another function is to display the group under trouble on lamp though the kind of trouble is not cleared.



DCS301B61

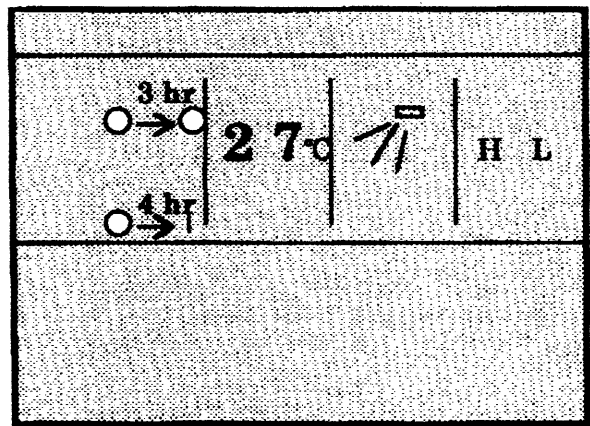
- Schedule timer

Most of the case it is used together with a central remote controller. ON/OFF of twice a day can be set for the week in an increment of one minutes. Holiday mode except week end can be set for special day like a national holiday or so. Since eight kind combinations of weekly schedule plus national holiday plan can be set in total, the basis of timer modes which will be selected by a central remote controller are programmed in the central remote controller as the patterns of (1) to (8). It can link up to 64 groups with 128 indoor units.



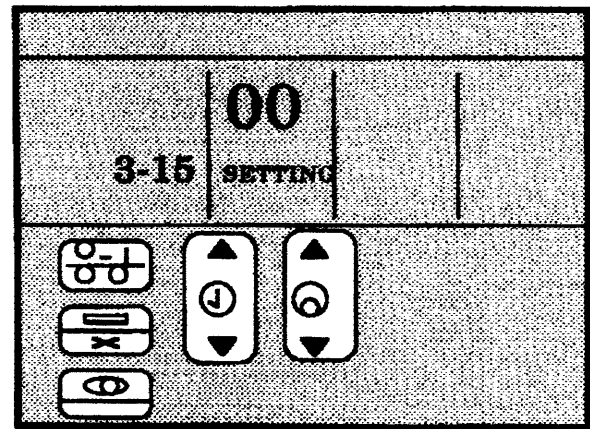
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Fig. 61 Functions of remote controller



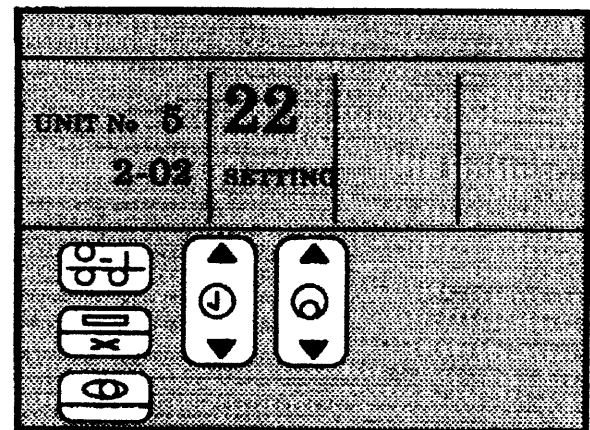
Daily Operation

Not only ON/OFF but also switching over the operation mode(Heating/Cooling/Dehumidifying), room temperature, air flow direction, air flow rate (H or L), OFF timer, ON timer can be set on this controller. It can display a trouble in every unit with code number and filter cleaning time.



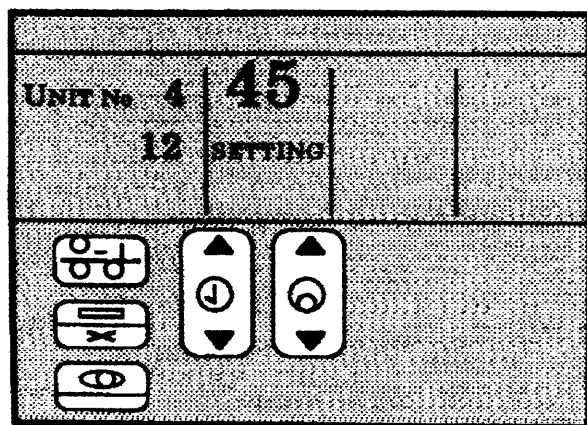
Group Setting with mode number "00"

It can set the address for 16 groups with a code number 0 ~ 15. The setting mode is provided. Do the group setting by means of a button with a clock mark after 00 is displayed.



Field Setting with mode number "22"

Several settings, such as differential of thermostat, air filter change time, thermostat choice (body thermostat or remote controller's thermostat), etc., can be carried out by field work. "2-02" in the figure left means the kinds of field setting with the first figure "2", and the selection range with the last two figures "02".



Service Mode with mode number "45"

Possible to know the unit No. of certain specified indoor unit by operating the fan only, and to alter the unit number, and so forth. In this connection, a unit No. of a indoor unit has been decided automatically with a young number in its turn in the production at the time of the delivery from the factory.

Printed circuit board as an adaptor

The adapter basically is not necessary for VRV system itself, but when Sky-Air series or special low noise control is required to be built into the system, this special adapter gives us an effective connection to the main system. Hence, the adapters are summarized as follows. Check them in accordance with the latest technical document, because some models may have changed the model number.

Table 14 List of adapters (PC board)

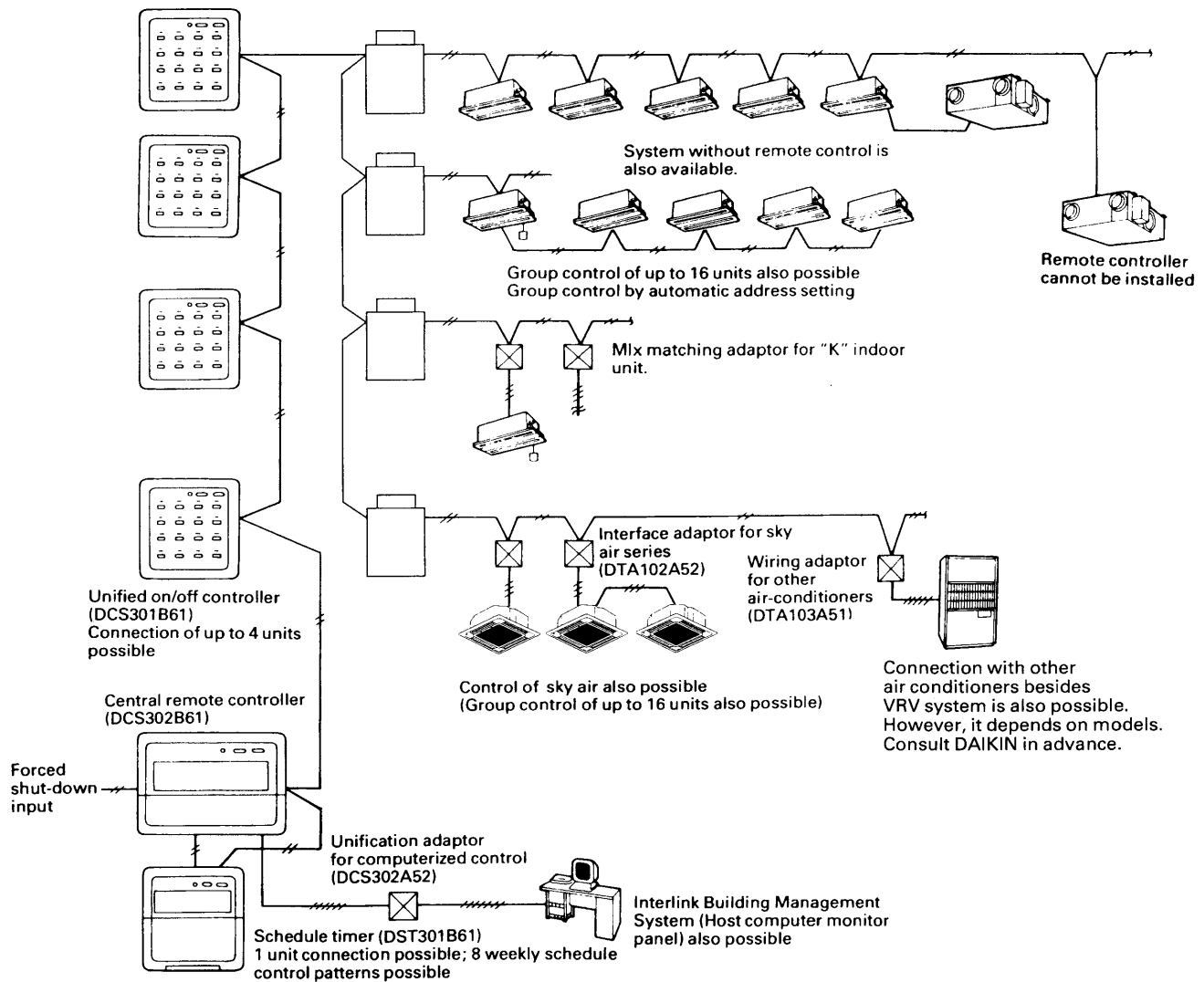
Function	Adapter
For Demand control (K and Plus only)	External control adapter DTA104A61-62
For Noise control (K and Plus only)	
For cool/heat changeover of several outdoor units	
For K type indoor unit added to G or H series system	Mix-matching adapter for K 6162 DTA 106A
For electric heater, humidifier, or fresh air intake kit mounted	Adapter for wiring KRP1B61-2-3
For sequential start of heat recovery series	Adapter for sequential start KRP80-53
Sky air series is connected.	Interface adapter DTA102A52
Sky air series (C, D type) is connected.	Interface adapter DTA102A51
Room air conditioner is connected.	Wiring adapter DTA103A51
Other equipment, such as fan etc. is connected.	
Air conditioner of other manufacturer is connected.	
To connect indoor units with central control equipment	Unification adapter for computerized control DCS302A52
To connect indoor units with central control equipment All air conditioners are controlled simultaneously.	Wiring adapter for electrical appendices (1) KRP2A61-62
To connect indoor units with central control equipment, air conditioners are controlled group by group.	Wiring adapter for electrical appendices (2) KRP4A51-52-53

- Summary of devices composed

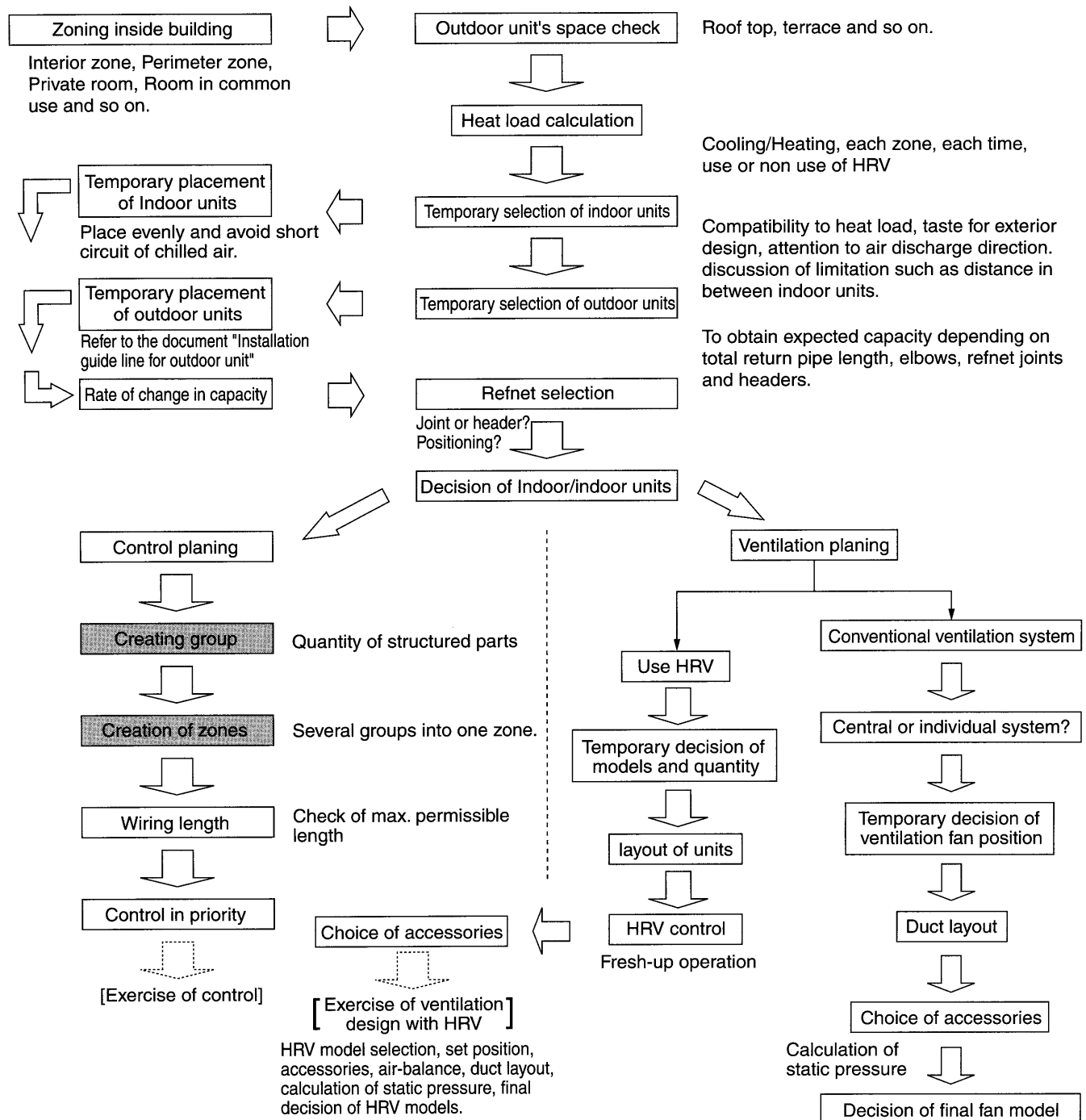
Let's make sure where the devices, we have been studying so far, are used in the control wiring system through the following drawing. Major four devices; remote controller, unified ON/OFF controller, central remote controller, schedule timer, and further, adapter to connect different series of air conditioner instead of VRV, or another adapter to connect to building management system. Did you find all of them? At the top of this picture, HRV units not explained yet are connected. HRV can connect to the control wiring circuit with the same feeling of VRV indoor unit.

- Central remote controller should link to an outdoor unit instead to an indoor unit because of avoiding signal wiring trouble.

Fig. 62



Design procedure is indicated in this below chart. The topics with shaded enclosure signify topics which will be explained in the succeeded several pages till the other similar chart with other topics in shaded enclosures will appear.



3-5-4 Control group and zone

Grouping becomes mostly important among several problem of control for the design engineer. The problem how to set a remote controller, a central controller can be solved after the installation. These will be jobs of rather installers. You should note that this booklet is edited just for the field of system designing instead of servicing. Comfort and installation work's quotation will be achieved by this work of system design.

a) Group

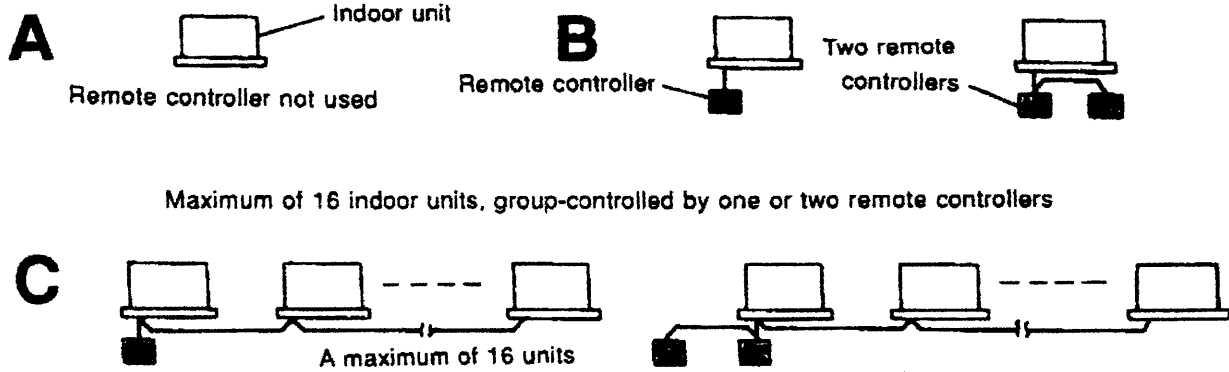
Take a look at Fig 63 in next page. The three stories building as D has many varieties of groups. Let's look at various examples.

- A: A single indoor unit without a remote controller. Just a single unit is one group in this case which a central controller directly manages this indoor unit. Address should be put on this unit.
- B: A remote controller is attached to an indoor unit. On the left figure, two remote controller are attached, but they are just derived from one terminal and the function is the same to one remote controller method. It has a merit to be able to control from two places. If one remote controller is placed in a room and another is placed in a corridor, it will prevent not to turn off the operation because from either side; corridor or room where any body can turn off the operation.
- C: It displays major merit of a remote controller to connect 16 units of indoor units to one remote controller. Right figure is like the case B which connects two remote controllers to the same terminal and can control from two places. Each case is one group in this combination.
- D: On the 3rd story, four indoor units are controlled by one remote controller, while five indoor units are controlled by one remote controller. That means two groups are provided in total.
On the 2nd floor, four indoor units are arranged without remote controller which shows the case A. There are four groups in total.
On the 1st floor, Each indoor unit has one or two remote controllers which stands for the case B. That means three groups are provided. Each floor is classified in one zone and total three zones are controlled by one central remote controller.

Fig.63 What's a group? What's a zone?

A single indoor unit without remote controller

A single indoor unit controlled by one or two remote controllers



Maximum of 16 indoor units, group-controlled by one or two remote controllers

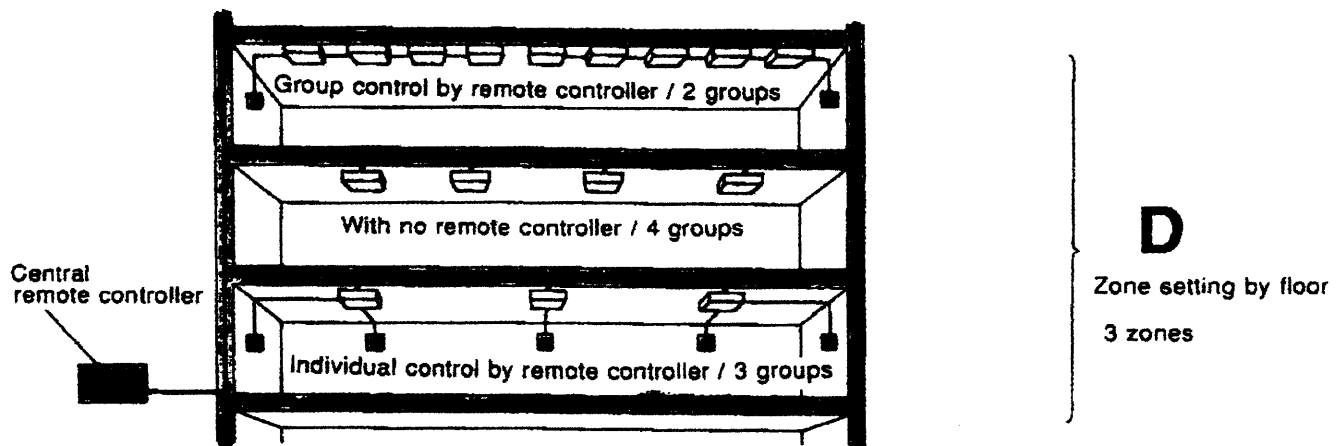
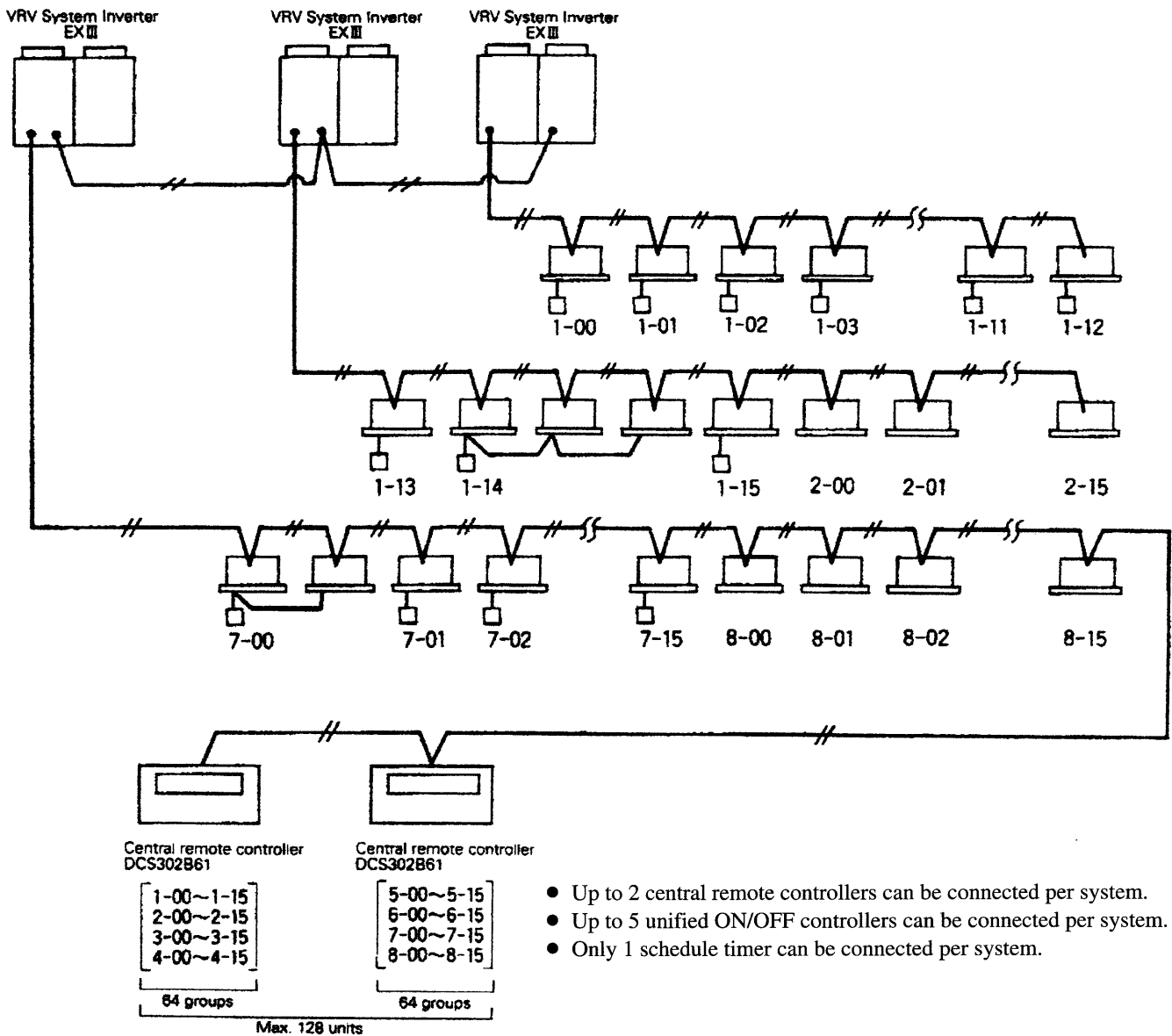


Fig. 64 : Example of address setting

■ When using model B centralized control device

- Up to 128 indoor units can be connected within a system. (Group control is not required to increase the number of units that can be connected within the system.)
- When double remote controllers are connected, the same indoor unit cannot be registered for more than one central remote controller.



- Up to 2 central remote controllers can be connected per system.
- Up to 5 unified ON/OFF controllers can be connected per system.
- Only 1 schedule timer can be connected per system.

c) Zone

- Zone of control is different from zone of heat load plan

On the process of heat load calculation to determine outdoor units and indoor units on the sample building, the area on the 15th floor were divided into 4 sections as zone 12 ~ 15. That is completely different from heat load zone if the 15th floor is divided into several zones from the view point of control. Creation of control zones depends on a central remote controller.

In case of heat load zoning, it necessitated the zoning from the view point that the skin loads affected by solar radiation varies from in every period of time. Control zoning is affected by the handling convenience for the room space, and especially greatly by the air conditioners operation time belt. Major purpose of control zone setting is to make plan of airconditioning system with uselessness by means of setting time belt of each zone managed by a building supervisory staff.

- Practical planing of zoning

While investigating drawings on which the selected outdoor units and refrigerant piping are arranged, zoning must be advanced.

Let's describe the relation between group and zone. Minimum unit of a zone is one group. On a group with 128 indoor units or HRV units, any numbers of groups are possible to be one zone so far as kept in the permissible range. One central remote controller can control 64 group, 128 indoor units, and 64 zones. In the two remote controllers in one terminal, it becomes 128 groups, 128 zones, and indoor units.



In this case, components which are counted as indoor units are HRVs, BS unit of heat recovery units, and adapters connected with indoor units except VRV.

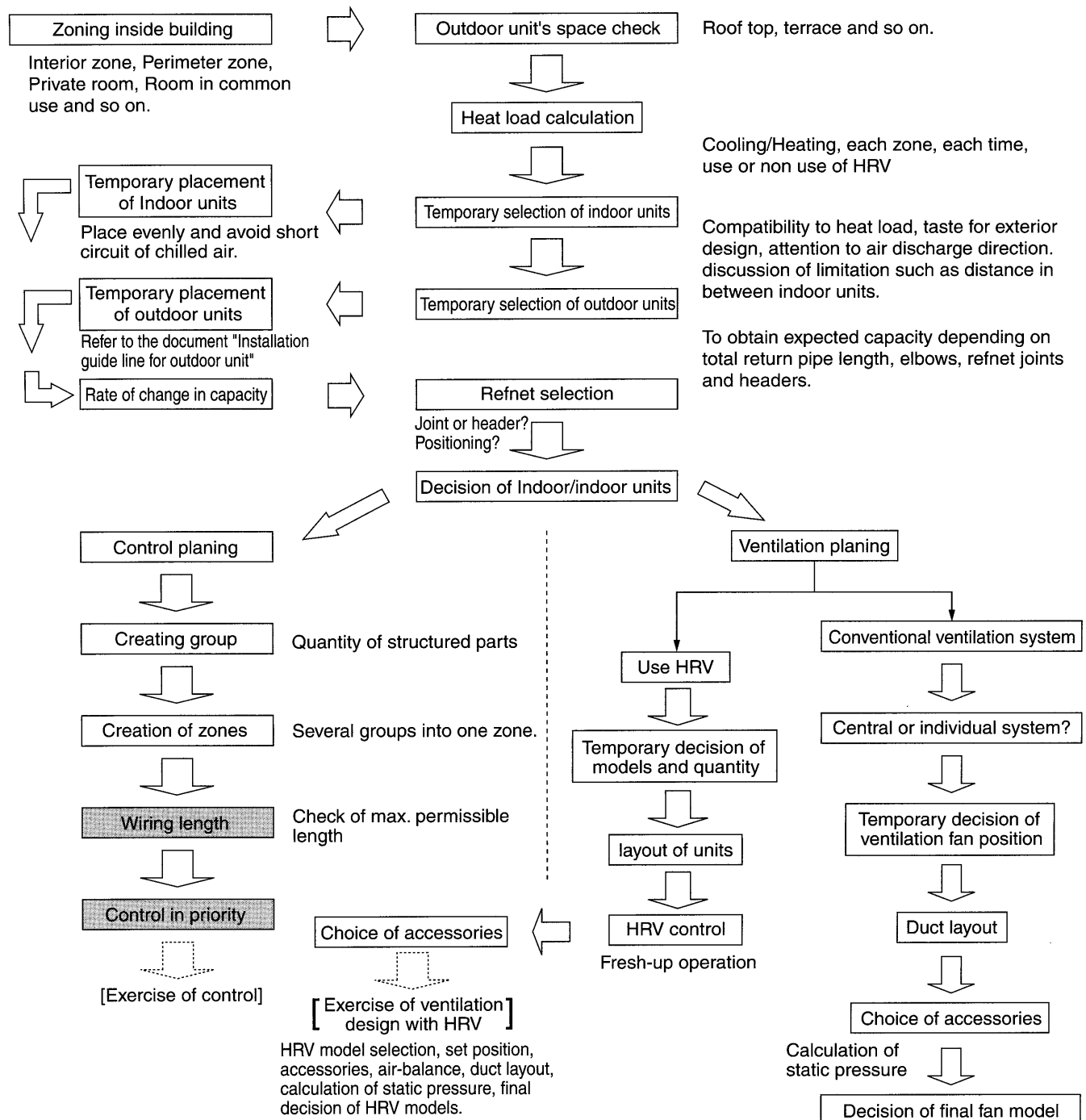
If the address is securely put on the group, which groups are uniformed into one zone will be decided by the operative convenience and operation time belts. Once combination of groups and zones are produced, the things remained is the manual setting on the central remote controller. Only thing to do is to input data of timer code among (1) to (8) onto every zone. Refer to the Engineering Data for the more detailed zone setting on a central remote controller.

Prohibit overlapping zone to zone.



Unless exercise will be conducted based on the concrete examples, it would be difficult to understand the grouping and the control zoning. Accordingly, try to solve the comprehensive exercise provided in pages behind.

Design procedure is indicated in this below chart. The topics with shaded enclosure signify topics which will be explained in the succeeded several pages till the other similar chart with other topics in shaded enclosures will appear.



3-5-5 Control devices and wiring condition of limitation

a) Limited quantities of control devices

VRV is an all-in-one system. Sophisticated control devices are built in the unit body. Every control device described in this chapter are the type of attachment installing out of the unit. Therefore, when the quantity limitation is talked about in the range of whole system, not only attachments but also VRV units themselves must be counted. Keep in your mind this limitation quantity all time in your control planning.

- Control devices themselves

Main control devices possible to use in one control system are summarized in Table 15. Each device has three columns. The first column shows how many this device can be used in one system. The second column stands for group quantity this device can cover. The third column indicates the maximum quantity of connectable terminal units (indoor unit, HRV, any kinds of adapter, BS unit) .

- Limitation of outdoor unit quantity

Limited within 10 units in total 100 HP. Outdoor unit structured in Plus series is not counted one by one. Instead, every model is counted as one unit for the limited quantity. For example, model RXY30K has three of 10 HP unit and is unified by a function unit. It is not counted as three units but counted totally in one unit. However, for counting total permissible horse powers, each outdoor unit structured in Plus series is counted one by one. Thus, RXY 30K is counted to be 30 HP.

Function unit quantity is limited in five units.

- Overall quantity limitation

Units and devices are shown in Fig.65 in relation to the limited quantity. This figure is useful for the final check-up in control wiring system design. If the final quantity is over the limitation, try again the designing.

b) Central control wiring limitation for the length

- Main line :1000 m
- Total length including branches : 2000 m
- Branch number : 16 portions

The main line length signifies the farthest distance from a central remote controller through all the outdoor units in one control system to the terminal unit located in farthest position. The branch line is the wire derived in the middle of main line. There are two kinds; a chain of branch wiring stretched from outdoor unit and connects the terminal unit, and for another one, branch which comes out from the mainline connecting indoor units to each other, instead of connecting outdoor units.

Fig. 66 well shows the situation of wiring length limitation. The wire starting from ㉠ through ㉡ to ㉢ is a main line with 900 m long, while the wire starting from ㉡ to ㉣ is a branch with 200 m long.

$$\textcircled{A} \text{---} \textcircled{D} \text{---} \textcircled{C} \quad 900 \text{ m} < 1000 \text{ m}$$

$$\textcircled{A} \text{---} \textcircled{D} \text{---} \textcircled{C} \quad + \quad \textcircled{B} \text{---} \textcircled{D} = 900 \text{ m} + 200 \text{ m} = 1100 \text{ m} < 2000 \text{ m}$$

All these length have satisfied the limitation and accepted.

Table 15: Limitation of control device quantity in use

HANDLING EQUIPMENT NUMBER

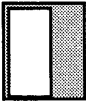
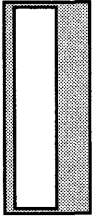
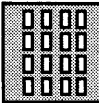
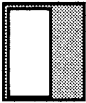
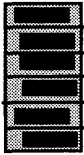
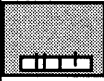
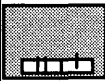
Device		Numbers connectable	Numbers (Groups)	controllable (Units)
Remote controller		64	-----	16
Central remote controller		2	64×2 (128)	128
Unified ON/ OFF controller		8	16×8 (128)	128
Schedule timer		1	64	128
Parallel interface		4	16×4 (64)	128
Data station		1	64	128
Master station		1	64×4 (256)	128×4 (512)

Fig. 65: Flow chart to determine the number of units or devices connected

CHECK SHEET FOR NUMBER OF UNIT IN ONE SYSTEM

Centralized controller	Qty	Y/N
Central remote controller (Note 1)		
Unified ON/OFF controller		
Schedule timer		
Data station (Note 4)		
Parallel interface		
Total		

≤ 2
 ≤ 8
 ≤ 1
 ≤ 1
 ≤ 4
 ≤ 7
 ≤ 8

	$\times 10$	$=$	
	$\times 1 (B) \text{ or } 10 (A)$	$=$	
	$\times 10$	$=$	
	$\times 10$	$=$	
	$\times 10$	$=$	

$$\boxed{} + \boxed{} + \boxed{} + \boxed{} = \boxed{} \leq 200$$

Indoor unit	Qty	Y/N
VRV		
Sky Air with adaptor		
VAM		
Wiring adaptor for other air conditioner		
BS unit (Note 2)		
Total		

≤ 128

Outdoor unit	Qty	Y/N
VRV PLUS (Note 3)		
RSX(Y) - K		
RSEY - K		
Total		

≤ 10

RSX(Y), RNY5K		$\times 5\text{HP}$	$=$	
RSX(Y), RSEY, RXY, RNY8K		$\times 8\text{HP}$	$=$	
RSX(Y), RSEY, RXY, RNY10K		$\times 10\text{HP}$	$=$	

Total $\leq 100\text{HP}$

	Qty	Y/N
BL2K		
BL3K		
BC2K		
BC3K		
BR2K		
BR3K		

Total ≤ 5

Other adaptors	Qty	Y/N
External control adaptor for outdoor unit		
Wiring adapter for electrical appendices		
Total		

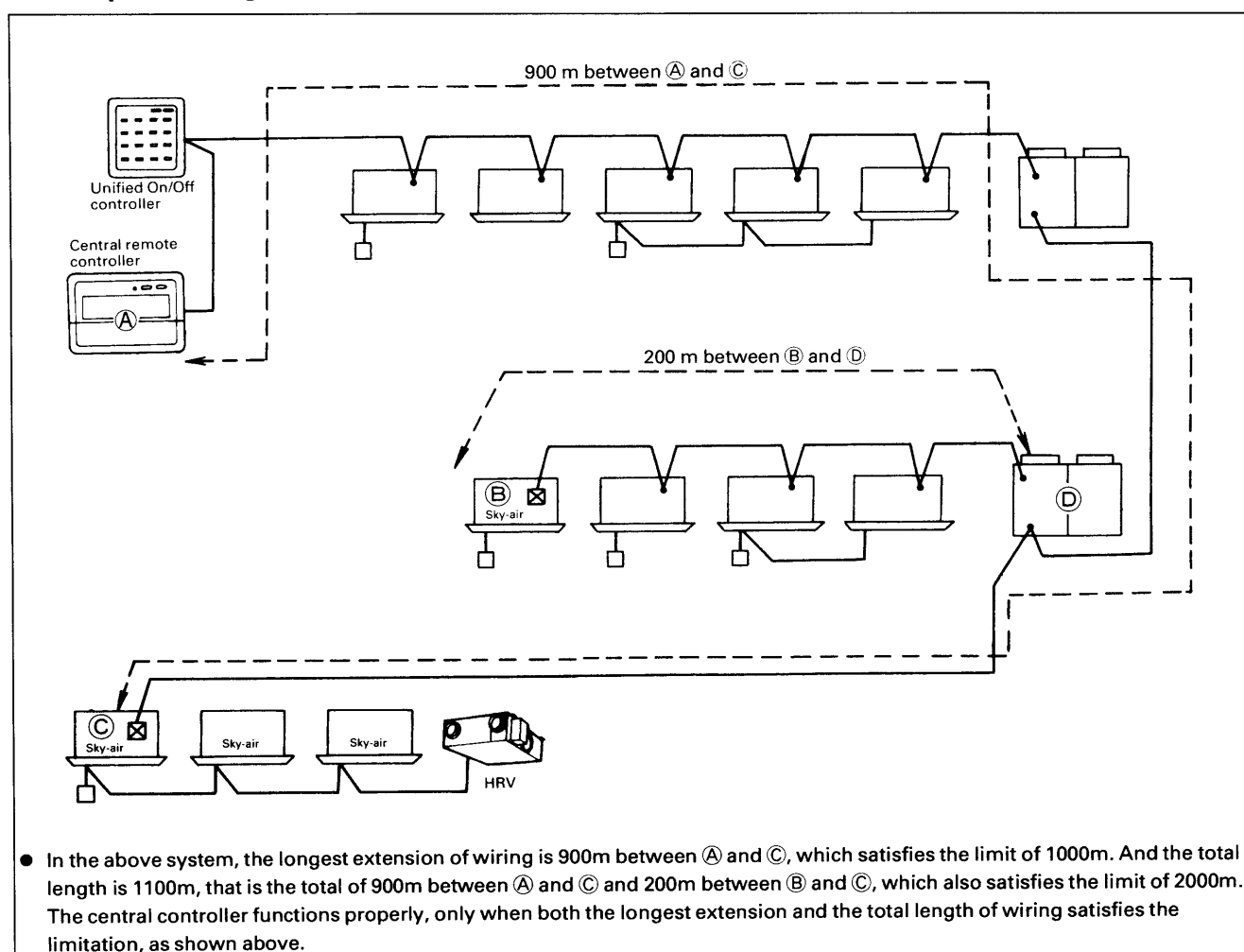
Total ≤ 10

Note: Condition A means;

- Central control equipment + Indoor units + Outdoor units + other adaptors ≤ 160 units
- Conversion number of central control equipment + Indoor units + Outdoor units + other adaptors ≤ 200 units

Fig. 66 : Check-up of control wiring length

■ Example of wiring



Caution When designing the system, be sure to check both the longest extension and the total length of wiring. If it exceeds the limitation, there is no other way but to split into several systems.

3-5-6 Concept of "Priority" control

In this chapter, it doesn't relate to quotation or arrangement any more though, let's explain the concept "Priority" by which superiority of remote controllers is decided depending on the main control device's setting way after the installation, because the system engineers have to know this concept.

- 1) Master and slave relationship in between indoor units
- 2) Master and slave relationship between a central remote controller and remote controllers

- Master and slave relationship in between indoor units

Take a look at Fig. 67. Several indoor units are connected with one outdoor unit. Imagine that several remote controllers are equipped in each group among which only one remote controller can be master controller and others are set to be slave controller. When the master controller has chosen any of operation mode; cooling, heating, or dehumidifying, the slaves cannot chose any other operation mode than the mode the master has chosen. At that time on the slave controller, the following mark is displayed meaning under control of master controller. On the master controller, nothing is shown.



Master's setting

Among a lot of remote controller, if the master controller has been chosen and power is on, the unit to start operation first will get automatically the position of master. You should note that the position of the master remote controller must be the representative position.

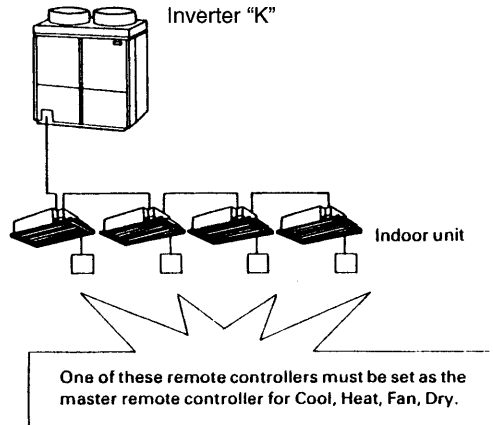
This setting for the master controller can be done just one time at initial operation after power-on for the first time. Even if power will be off after this, the master setting is fixed and can not change any more.

Fig. 67: Setting of Master Remote Controller

■ Setting of master remote controller by indoor unit remote controller

- Operation mode (Fan, Dry, Cool, Heat) can be freely selected by indoor unit remote controller for the Inverter "K" series outdoor units, however, as shown in the example below, the remote controller of one of the indoor units connected to 1 outdoor unit must be set as the master remote controller for Fan, Dry, Cool, Heat.

(Operation mode can be switched by only the remote controller set as the master remote controller.)



● Setting method

Preparations

- When turning the power supply on for the first time, the display of **CHANGEOVER UNDER CONTROL** lights when the power supply is turned on.

When you want to set:

1	Set the outdoor unit's cool/heat selector (Field setting mode1) to inside.
---	--

Setting of master remote controller

2	Continue pushing OPERATION MODE SELECTOR for about 4 seconds. The display of CHANGEOVER UNDER CONTROL on all remote controllers connected to the same outdoor unit blinks.
---	--

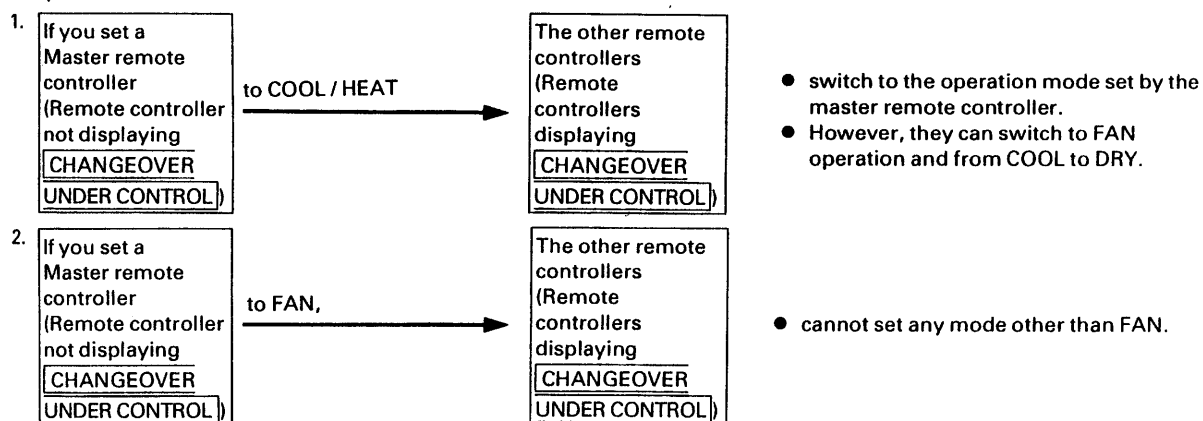
Setting of master remote controller

3	Push the OPERATION MODE SELECTOR of the remote controller you want to set as the master remote controller. This completes the setting. The remote controller is now set as the master remote controller and the display of CHANGEOVER UNDER CONTROL goes off. CHANGEOVER UNDER CONTROL is displayed on the other remote controllers.
---	--

Operation mode selection

4	Push the OPERATION MODE SELECTOR of the master remote controller (remote controller not displaying CHANGEOVER UNDER CONTROL) the amount of times required to select the desired operation mode. Each push switches the display from FAN to DRY, COOL, and HEAT. The operation mode changes automatically for all remote controllers that are not set as a master remote controller.
---	---

● Operation contents and function



● Master and slave relationship between a central remote controller and remote controllers

How do you solve the competition between a central remote controller, which is going to be installed in a buiding management staff room,and a remote controller, which is going to be installed in an air conditioning room, to get a master position.

Refer to Table 16

- ON function
- OFF function
- Temperature setting
- Determination of operation mode
- Timer setting on the remote controller

For these five functions, possibility to carry out these or not makes twenty kinds combinations.

- From either side, the above functions can be commanded-----control mode No.7 (factory set)
- Impossible to set temperature from remote control side. Save energy type control so that inhabitants cannot set indoor temperature as the inhabitant likes -----control mode No.6
- All the settings will be conducted in a central remote controller.-----control mode No.11

as they are. You may choose any mode, but be careful if you will have chosen the mode carelessly, freedom in remote controller side will be loosen. A choice of No.7 mode, factory set, will be safer.

The following mark will appear under the control of central remote controller. At this time, remote controller cannot command at all.

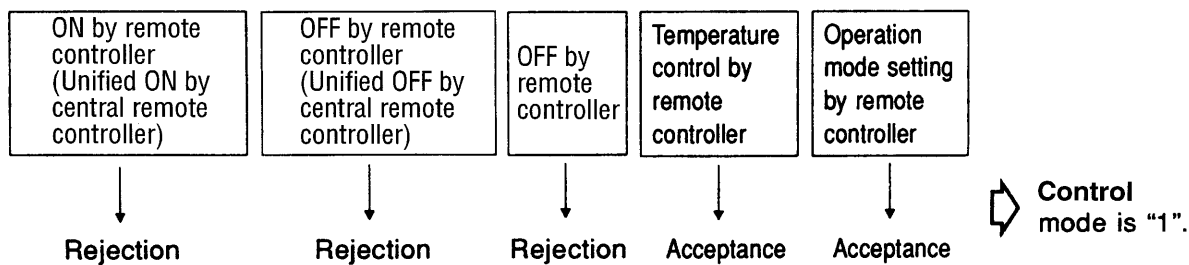


Table 16: Priority setting between a central remote controller and a remote controller

How to select operation mode

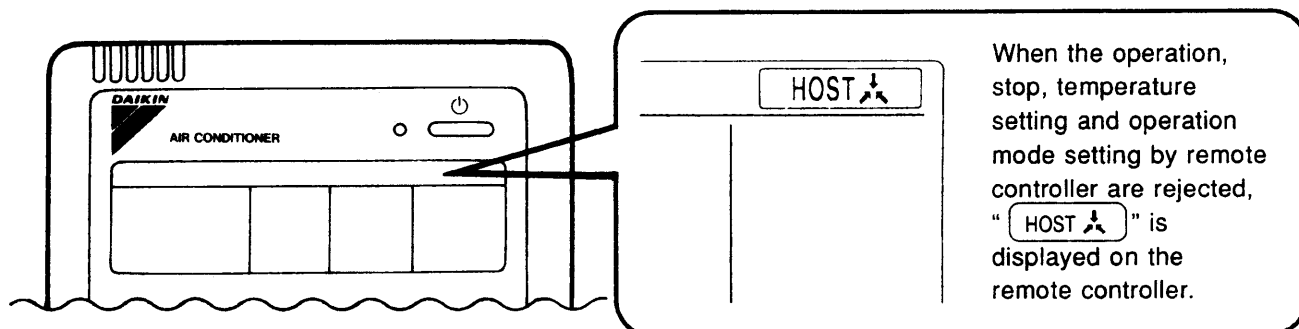
- Whether operation by remote controller will be possible or not for turning on/off, controlling temperature or setting operation mode is selected and decided by the operation mode given on the right edge of the table below.

[Example]



Control mode	Control by remote controller					Control mode
	Operation		OFF	Temperature control	Operation mode setting	
	Unified operation, individual operation by central remote controller, or operation controlled by timer	Unified OFF, individual stop by central remote controller, or timer stop				
ON/OFF control impossible by remote controller	Rejection (Example)	Rejection (Example)	Rejection (Example)	Rejection	Acceptance	0
					Rejection	10
			Acceptance (Example)	Acceptance (Example)	1 (Example)	
				Rejection	11	
OFF control only possible by remote controller	Acceptance	Rejection (Example)		Rejection	Acceptance	2
					Rejection	12
			Acceptance	Acceptance	3	
				Rejection	13	
Centralized	Acceptance		Rejection	Acceptance	4	
					Rejection	14
			Acceptance	Acceptance	5	
				Rejection	15	
Individual	Acceptance	Acceptance	Rejection	Acceptance	6	
					Rejection	16
			Acceptance	Acceptance	7	
				Rejection	17	
Timer operation possible by remote controller	Acceptance (During timer at ON position only)	Acceptance (During timer at ON position)	Rejection	Acceptance	8	
					Rejection	18
	Acceptance		Acceptance	Acceptance	9	
					Rejection	19

Do not select "timer operation possible by remote controller" if not using a remote controller. Operation by timer is impossible in this case.



3-5-7 Wiring error is avoidable.

- Impossible to take a branch from a branch

Refer to "Warning for wiring error". Main line is shown with thick line and branch line is shown with thin line. Branches of wiring code ⑩⑪⑫ are derived from main line, but wiring with code ⑧ is derived from a branch and is not accepted. A branch is derived from a branch ⑪ and is not accepted. Be careful for these matters at the period of wiring design.(refer to fig.68)

3-5-8 Sequential starting

VRV system in which many outdoor units are combined may affect voltage drop caused by the simultaneous compressors starting. Consequently, the sequential starting is programmed in an outdoor unit to avoid simultaneous starting. Power supply wiring connection method has the limitation as follows.

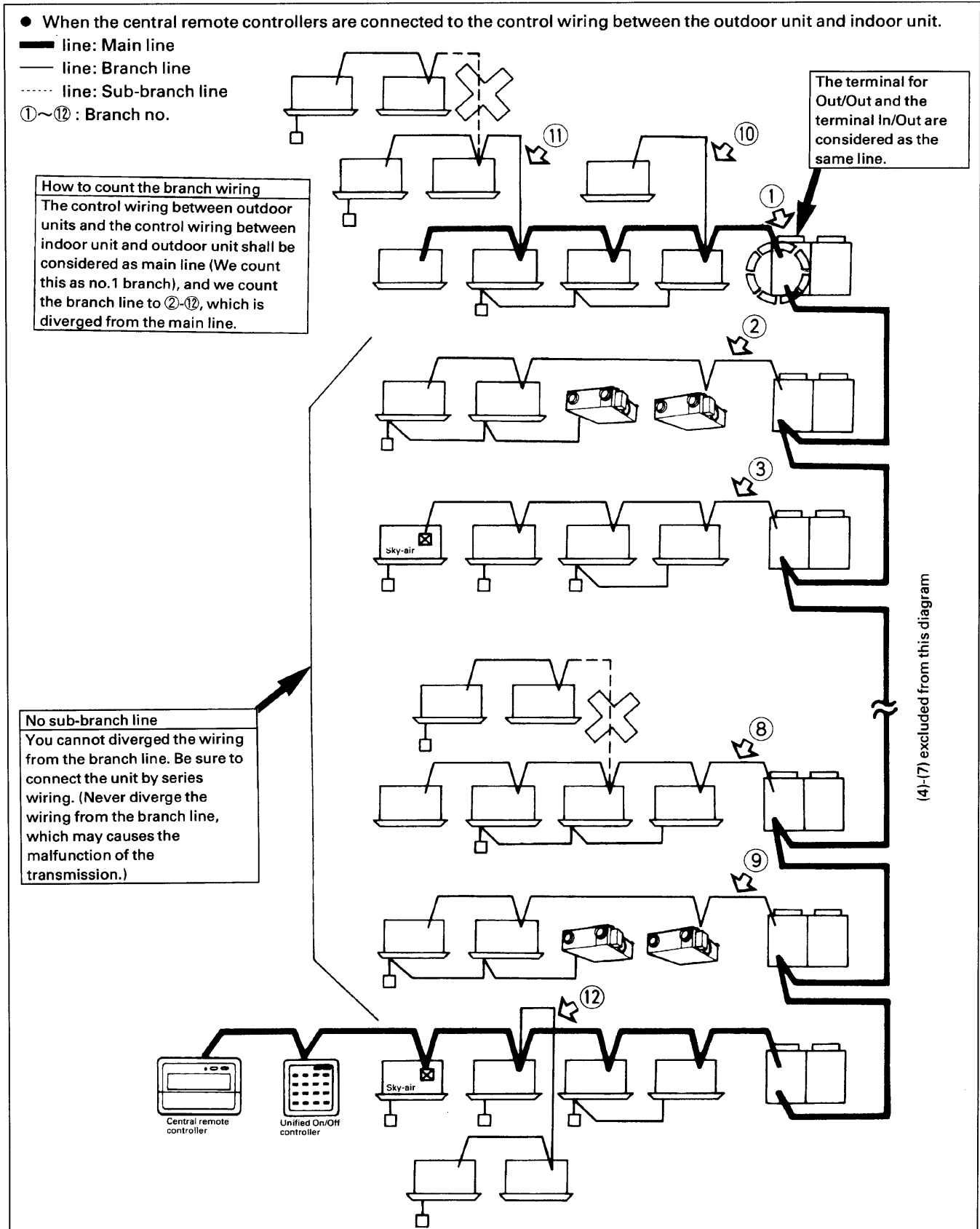
- Function units : within five units
- Outdoor units : within ten units
- Compressor 100 HP in total (Priority conditions)

As the limitation for the total horse power is up to 100, in case that various outdoor units are in one system, quantity of outdoor unit may exceed 10 units sometimes. But, this case can be applied too, if total horse powers don't exceed 100HP. On the above conditions, outdoor unit is counted every model by model. For example, RXY30K is counted as one unit, though three 10 HP outdoor units are provided.

Refer to Fig. 69 [Sequential start] for the wiring method and terminal connections. This example system shows eight units of outdoor unit. The outdoor units with terminal for sequential start will start every three seconds. In this connection, indoor unit has a program of sequential start which let indoor units start every two seconds.

Fig. 68: Warning for wiring error

※Here we define as branch line, which is diverged from the main line and also call it sub-branch line, which is diverged from the branch line.



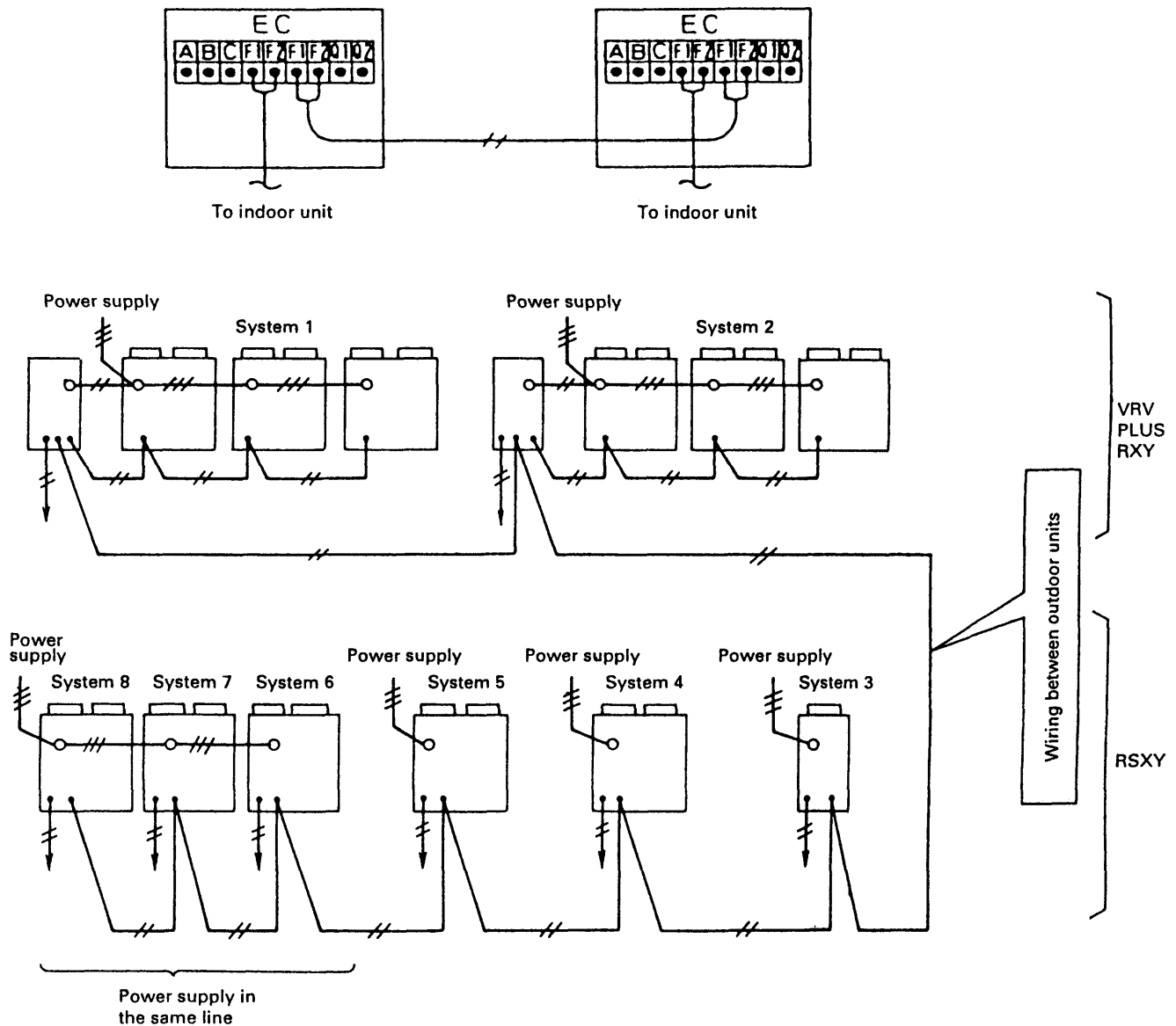
Caution As shown above, if the central remote controllers are connected to the control wiring between indoor unit and outdoor unit, it may not be able to control the units even on the normal circuit, if the circuit connected to the central controller is out of order. Be sure to connect the central controllers to the control wiring between the outdoor units.

Fig. 69 : Sequential start

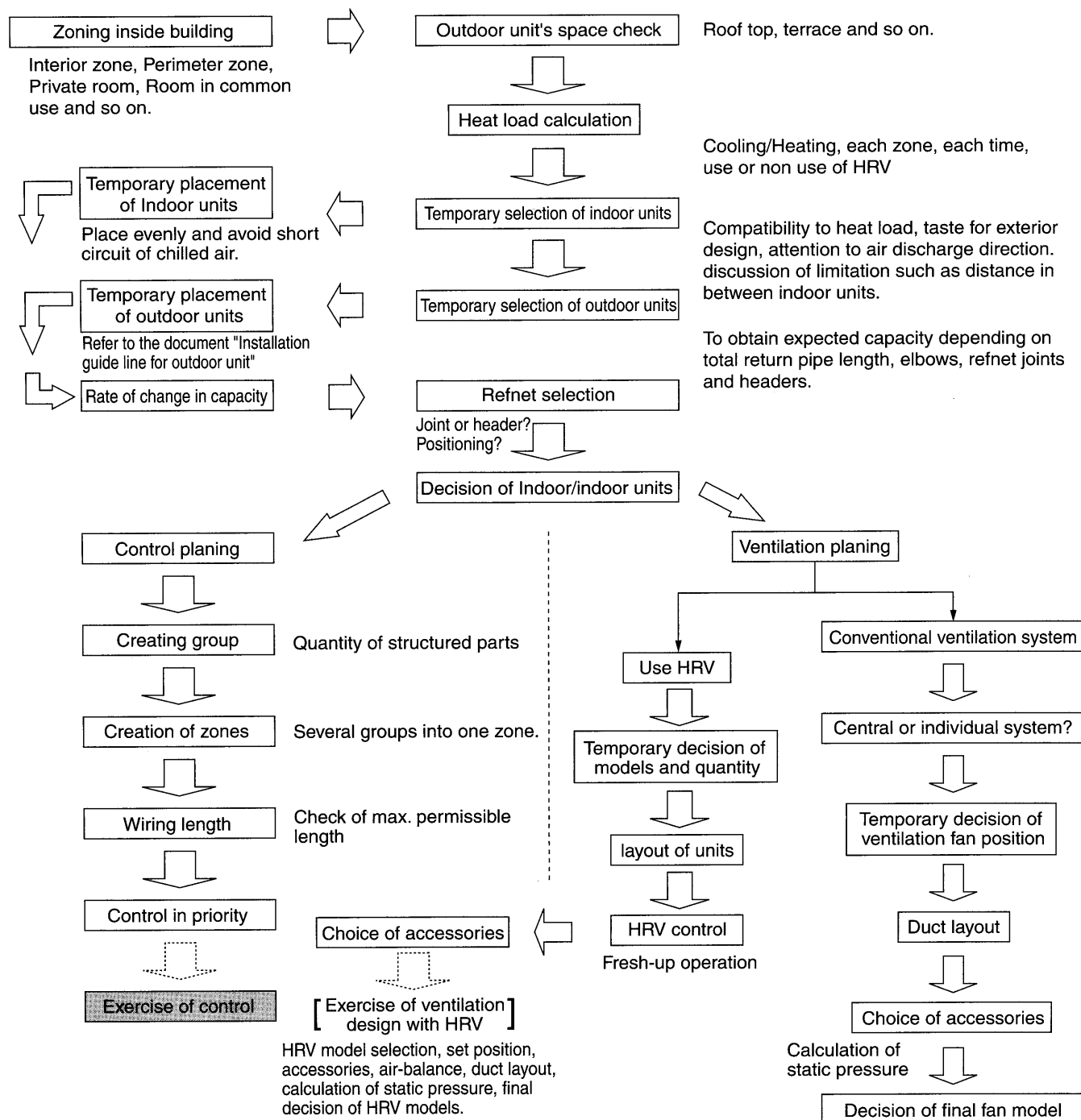
Sequential Start

- Separates path timing of commercial power supply compressors by 3 seconds each in order to prevent overcurrent when several compressor are to be started at the same time.
- Improved wiring system enables sequential start of up to 5 function units and 10 outdoor units.

If you want to carry out sequential start, connect outdoor unit - outdoor unit transmission wiring as shown below. The function unit PC board (EC) is factory set to "sequential start".



Design procedure is indicated in this below chart. The topics with shaded enclosure signify topics which will be explained in the succeeded several pages till the other similar chart with other topics in shaded enclosures will appear.



3-5-9 Control wiring example

Let's solve the following exercise in accordance with the plan view of sample building in Fig. 70

- 1) Draw grouping wires in consideration of grouping indoor units and HRV units.
- 2) Draw central remote control wiring so that a central remote controller is positioned at the center.
- 3) Put address on each group.
- 4) Check up if total length of control wiring, quantity of control devices, and overall components or devices are within the standard limitations or not.
- 5) Make control zones.

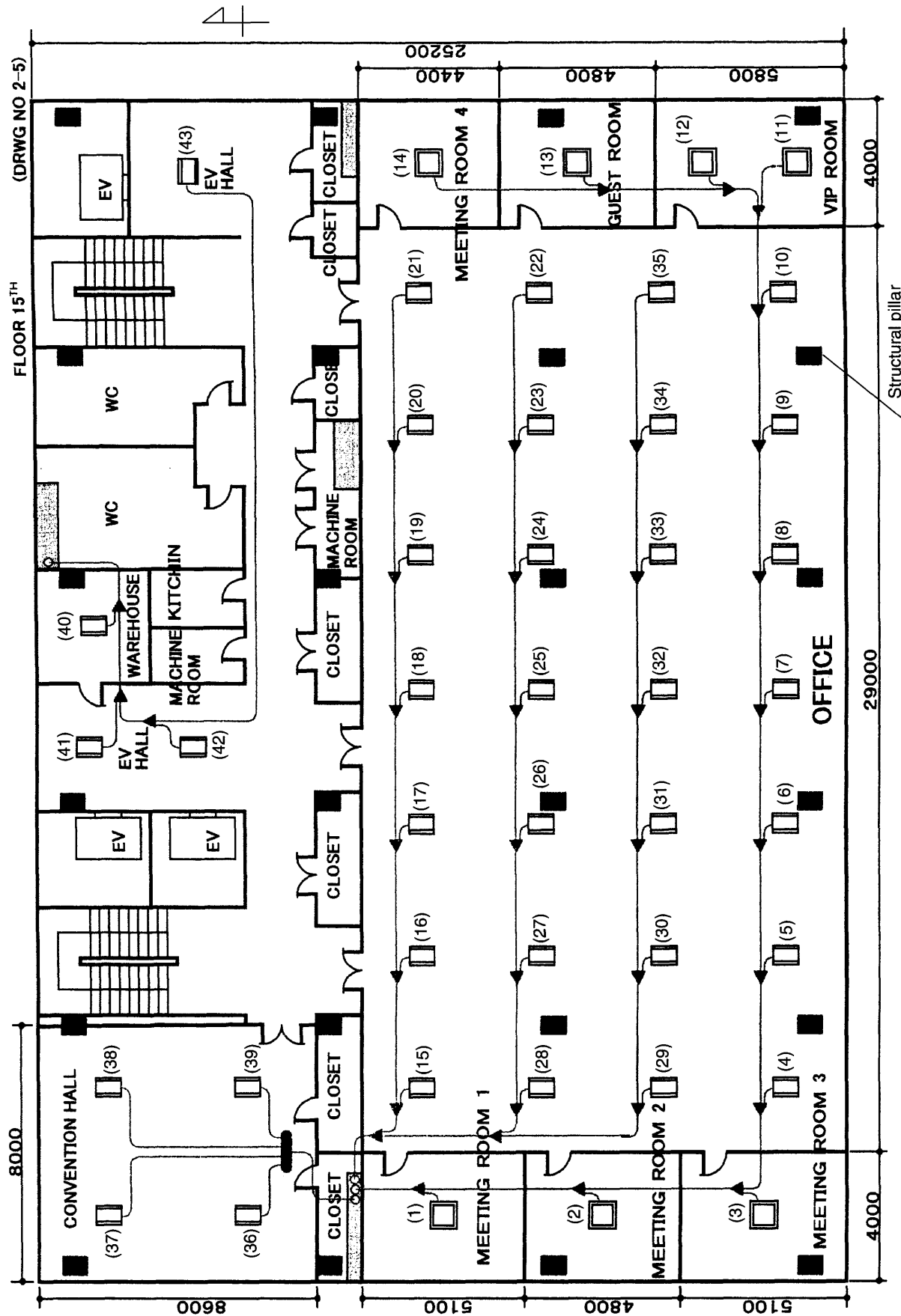
a) Investigation of building plan view

- Units in small rooms located on both sides in west and east (unit No. 1~3 and 11~14 in Fig. 70), and one row of units lined up in south end of large office (unit No. 4 ~ 10 in Fig. 70) are unified with one line of refrigerant circuit and included in Zone 15.
- Interior zone in the large office was classified in Zone 14. Three rows of each seven indoor units in one row (unit No. 15~21 in the 1st row, No. 22~28 in the 2nd row and No. 29~35 in the 3rd row) are lined up in parallel and finally unified in one refrigerant circuit.
- Convention hall will be normally used independently. The refrigerant pipes will be drawn independently too.
- Utility core originally is used under control of building management system in its character. The small warehouse is provided in which a airconditioner is operated only when person comes in to work. On the elevator core, the airconditioner works just for pinpoint cooling to people just get off cabin of elevator . These airconditioners are always under management of the building concierge .
- Four units of HRV will be used on the same floor , though those are not shown in this figure.
- Several indoor units other than these indoor units mentioned above are combined in the system of utility cores corresponding to the floors of 4-story (12th ~ 15th floor) with one big sized outdoor unit. Consequently, the VRV units corresponding these 4-story are controlled together with other VRV units for the 15th floor by one central remote controller.

b) Plan of grouping

- Four unified ON/OFF controllers including standby one are provided.
- It is better way to provide one remote controller in each room of the both sides six small rooms (unit No.1, 2, 3, 11~12, 13, 14).
- It might be better for the large office to be able to provide individual setting in consideration of temperature distribution such as temperature ,air flow rate, and air flow direction. Therefore, at any unit among units lined up horizontally (unit No. for the 1st row; 15~21, for the 2nd row; 22~28, for the 3rd row; 29 ~35.), a remote controller must be provided.
- Since convention hall is used independently, it might be best to provide a remote controller to make a group for all indoor units here (unit No. 36~39).
- Regarding utility core, the small warehouse provides one independent remote controller (for the unit No. 40), but for other places like elevator cores, each indoor unit (for unit No. 41~43) has independent group address and is managed by the building concierge.
- HRV will have a style of operation commanded by the building concierge and be independent from airconditioning system, because if HRV can be operated by inhabitants, air balance, be told in next chapter, will be broken. In addition, these four units of HRV shall be connected to a central control system with one central remote controller separated from other outdoor unit circuit and by means of bath method in parallel.

Fig. 70 : Plan view of the sample building for the exercise. (Layout of indoor units, HRV units, refrigerant piping have finished)



- It is easy way to arrange the wiring so as to adopt same line with the refrigerant circuit as much as possible and connect it to outdoor unit to outdoor unit, and then take out one end of the wire to connect to a central remote controller.
- The group quantity produced so far;
 For the 15th floor, 16 groups (including HRV)
 For the utility cores on the 12th ~ 14th ; 4 groups $\times$ 3 stories = 12 groups
 One central remote controller should bear :
 $16 + 12 = 28$ groups in total.

c) Check the quantity of control devices and components.

[Thick letters in gothic means the limitation]

- Indoor units located on the 15th floor 43 units
- Utility cores other than 15th floor four units $\times$ 3 stories = 12 units
- HRV ----- 4 units
- Outdoor units 4 units < 10 units
- Function units 3 units < 5 units
- Outdoor units 8 HP $\times$ units + 10 HP $\times$ units = 76 HP < **100HP**
- Control devices Central remote controller one piece + Unified ON/OFF 4 pieces + schedule timer 1 piece = 6 pieces < 7 pieces (So, overall quantity is within 160 units)
- Group quantity On the 15th floor 19 groups
 Utility cores on the 12 ~ 14 floor 24 groups
- Overall limitation quantity :
 Indoor units and the equivalent units; 59 units + 4 outdoor unit + 3 function units = 66 units < **160 units**
- As mentioned above, all the units are within the limitation and accepted.

d) Address setting

As supposed to be progressing the exercise to Fig. 73 "Exercise : Drawing to fill in control wiring" , let's put address onto all the groups. 64 groups from 1-00 to 4-15 can be controlled by an unified controller or a central remote controller. The group quantity in this exercise; 15th floor + Utility cores on the 12 ~ 14th floor sufficiently can be covered by this control system.

Address planing for units other than utility core---- from 1-00
 for utility cores of 4-story -----from 4-00

See figure 73.

e) Control zoning

It is important to note that a central remote controller is in a building management room and put yourself in a concierge place to do the zoning. A concierge generally ought to mind "No useless power to a building" and "No complaint will come out from the inhabitants". "No useless power to a building" means eliminating the uselessness which will keep operation of airconditioning in a room where no body works after a normal working time. "No complaint will come out from the inhabitants" signifies some inhabitants will complain about "The room is not cooled (heated) enough" or "Discharging air is too strong" and so forth through telephone in case the central remote controller is in a priority mode.

- Looking at the sample building's plan view

All area of the office looks like to be able to unify into one zone, because each seven indoor units in one row are unified in one group with one remote controller, which enables to operate by every group. It is good for energy saving even if overtime work partially is going on.

Whether the small rooms in both sides should be included in the office zone or not is a matter of consideration. It can be imagined that some amount of jobs still remain and someone shifts the place of work to the both side small rooms and do the work until midnight. Thus, the zone of the small rooms should be separated from the large office. The convention hall is easy to provide a zone by itself due to the independence. Besides, the utility core structures an independent zone because a concierge directly manages this core. The ventilation facility is required for a concierge to start operation a little earlier than a normal work time belt. Therefore, the ventilation facility should provide an independent zone.

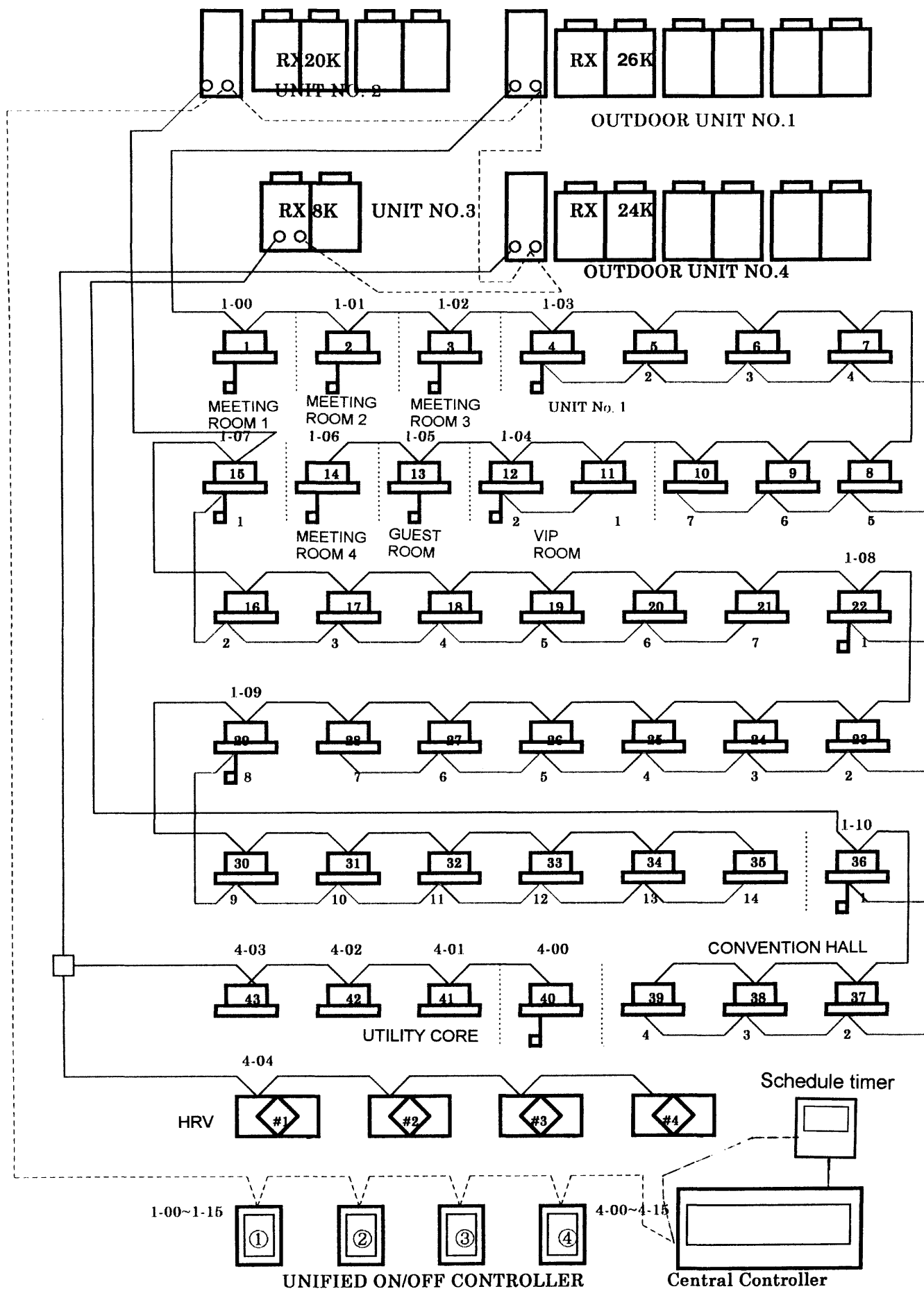
- Conclusion of zoning

Although the control zones which obtained through the exercise have gotten almost same zones to the heat load zone, five zones could be classified. After this, each zone should be input into a central remote controller by handling the central remote controller. Your work of inputting zones will be secured if a table like the followings will have been made.

Control zone number	Group under the control
1	1-00, 1-01, 1-02, 1-04, 1-05, 1-06
2	1-03, 1-07, 1-08, 1-09
3	1-10
4	4-00, 4-01, 4-02, 4-03
5	4-04, 4-05, 4-06, 4-07

Central controller's priority should be set for the control zone number (4) and (5).

Fig. 73: Exercise : Drawing to fill in group address



f) Investigation of wiring length

What part of wiring line corresponds to the main line in Fig. 73 "Exercise: Drawing to fill in group address"? A central remote controller is generally equipped in a concierge room or a control management room in a building. In most cases, these kind of rooms are located in a basement or the first floor.

Central remote controller (in a basement) → ON/OFF controller No.4 ~ No. 1 (15 floor) → Outdoor unit No.2 Function unit
79m 26m

(at top) → Outdoor unit No. 1 Function unit (at top) → Outdoor unit No.4 function unit(at top) → Outdoor unit No.3 →
6m 6m 6m 20m

Convention hall No.39 (15th floor)

- The building plan view and vertical sectional view is required for grasping the wiring distance and the location of facility shafts. Estimate a wiring length through the measurement of the distance, paying attention to the scale, in consideration of the pass of the wiring.
- For the vertical distance, the building story's module should take 4m. From the management room in the basement to the shaft in which piping risers run through; $4\text{m} \times 16 = 64\text{m}$. From the facility shaft in the basement to the central control board, estimate temporarily 15m. ON/OFF controller is put in the machine room by a corridor. Then, the wiring can be risen to the shaft connecting to the four controllers, and again come into the shaft and go out forwarding to the outdoor units on the roof top.
- Subsequent estimation should go ahead in the same way. The distance written above in the lower position than the main lines indicate the main line distance in between each terminal. Consequently, the total main line is 143m on this exercise.
- Branch
 - a) Line from outdoor unit No.1 to indoor unit (14) through indoor unit (1).
 - b) Line from outdoor unit No. 3 to indoor unit (35) through indoor unit (15) in case that the wiring groups will be combined in the order shown in the figure.
 - c) Line stretching out to HRV independent from outdoor unit No. 3.
 - d) Line stretching out to indoor unit in utility core from outdoor unit No.4.
 - e) Line stretching out to HRV No.4 from the terminal.
 - f) Line stretching out to indoor unit in utility core from outdoor unit No.4.(This line is not shown in the figure)

That's all. For the check of total length, only thing to do is to check if the total length is in the limitation standard **2000m** or not, though there is more accurate way to read the distance upon the drawings. Accordingly, estimate the longest one and the number of the branches should be added.

The longest branch is (a) above, the distance between (15) to (35) is approximately 42m. Total length 63.5m can be read with riser in the shaft 1.5m and distance on the flat at the top 20m.

Other length from (a) to (f) is obviously shorter than (b):

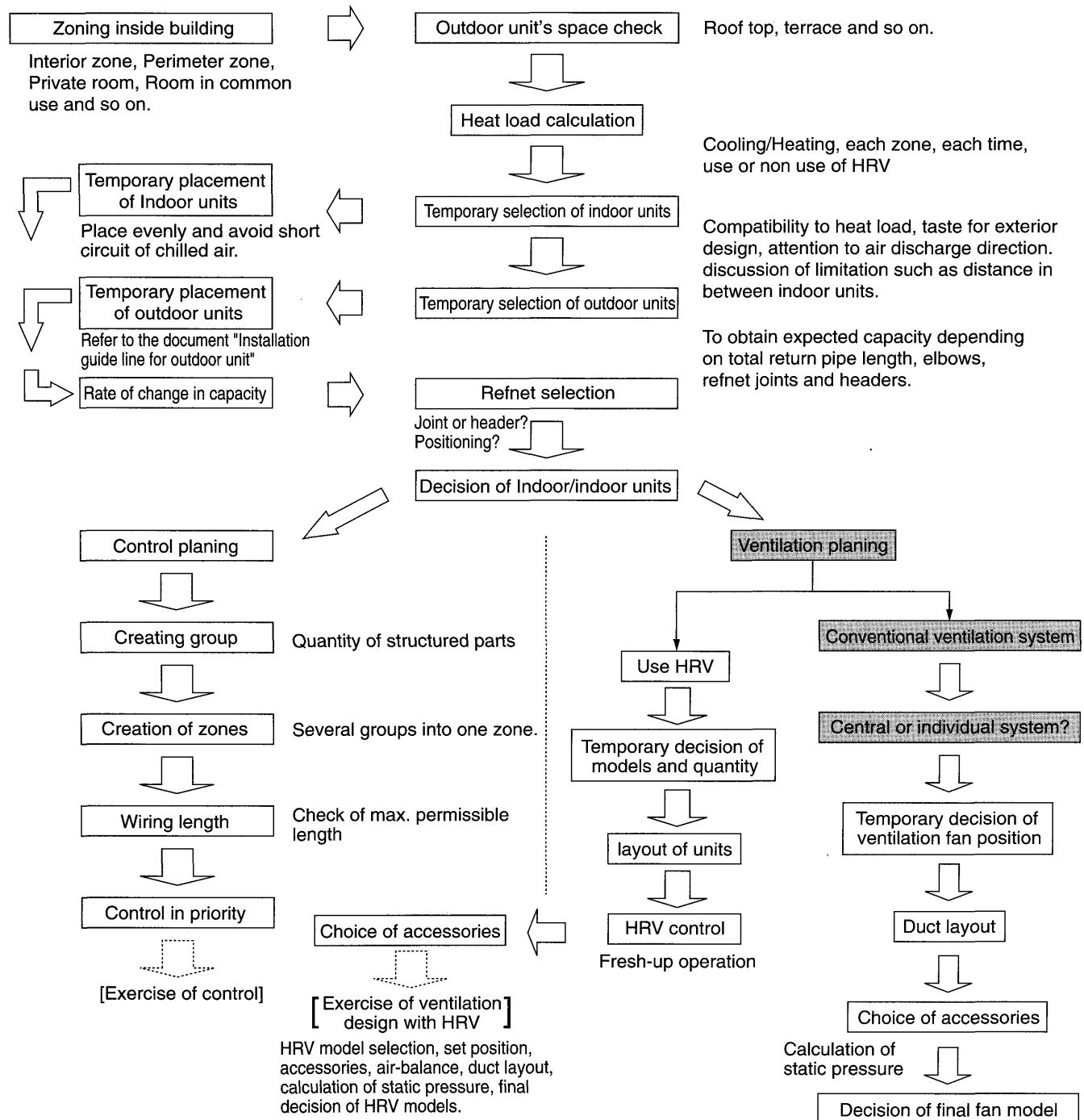
$$(b) \times 6 = 63.5\text{m} \times 6 = 381\text{m}$$

adding a main line to this;

$$143\text{m (main)} + 381\text{m (branch)} = 524\text{m} < \mathbf{2000\text{m}}$$

- It can conclude that the total length is within the limitation and accepted.

Design procedure is indicated in this below chart. The topics with shaded enclosure signify topics which will be explained in the succeeded several pages till the other similar chart with other topics in shaded enclosures will appear.



3-6 Ventilation planning

Ventilation system will be decided through the following process. Let's describe the key point on the system designing of ventilation, instead of machine handling , structure, etc. which should be referred to the HRV's engineering data.

- Decision of ventilation flow rate
- Selection of ventilation system
- Ventilation air flow
- Selection of models and place to install
- HRV control
- Choice of accessories including duct
- Pressure loss estimation
- Final selection of HRV models

3-6-1 Decision of ventilation flow rate

In the estimation process in the initial stage, ventilation basis must have been decided. Here, the standard ventilation rate will be just reviewed for the first stage. There are various standards of ventilation in the world. You should comply with one of the standards. Two standards based on Japan Building Standards Acts and ASHRAE standards in USA are shown here. The choice of standard depends on the judgement of designers.

- Ventilation flow rate based on Building Standard Act in Japan

The standard shown in Table 17 is the way to get the required flow rate with standard flow rate by 20m³/h /person. In this connection, Daikin heat load calculation software is based on this standard to gain ventilation heat load. Besides, another method is displayed in Table 18 depending on ventilation cycle number by hour. After comparing the calculation results of the both ways, larger one should be taken. Generally the former way from flow rate by person tends to get larger value.

- ASHRAE standards in USA

Shown in Table 19. It is broadly used in the world. Smoking volume is difficult to estimate, but it will be decided by the designer's experience.

Table 17 : Inhabitants occupied area by types of building

Type of building	Area occupied per person (N)	Remarks
Eating houses, restaurants, coffee-shops	3 m ²	Floor space of a part used for business purposes.
Cabarets, beer halls	2 m ²	Floor space of a part used for business purposes.
Japanese-style restaurants, hall for hire	3 m ²	Floor space of a part used for business purposes.
Store market	3 m ²	Floor space of a part used for business purposes.
Pool rooms, Ping-pong rooms, dance halls, bowling alleys	2 m ²	Floor space of a part used for business purposes.
Pin-ball parlors, Go club houses, mahjong parlors	2 m ²	Floor space of a part used for business purposes.
Inns, hotels, and motels	10 m ²	Floor space of a part used for business purposes.
Massage parlors	5 m ²	Floor space of a part used for business purposes.
Meeting places, public halls	0.5~1 m ²	Persons accommodated simultaneously with the number of persons calculated per unit.
Offices	5 m ²	Floor space of an office.

* Values set by the Metropolitan Maintenance Bureau in Japan.

Notes:

1. Table indicates the necessary ventilating air flow rate calculated as 20 m³/h.
2. The area occupied per person by type of business is calculated in reference to [Application standards for building administration in compliance with Building Standards Act in Japan.

Table 18 : Ventilation cycle per hour based on the room's volume

Groups	Type of room	Ventilation required	Groups	Type of room	Ventilation required	
Common household	Living room, bathroom, drawing room, toilet	6	Playhouses and movie theaters	Audience room, corridor, smoking room, toilet, projector room	6	
	kitchen	6				6
		10				12
		15				20
Eating places	Restaurant, sushi restaurant, banquet hall, tempura restaurant, cooking room	6	Plants	Office room, general work room, telephone room, spinning plant, printing plant, battery room, machinery plant, generator room, substation room, painting shop, welding plant, chemical plant, food plant, wood working plant, casting plant	6	
		6				6
		10				10
		20				10
Inns and hotels	Guest room, corridor, dance hall, large dining hall, washroom, toilet, cooking room, laundry room, engine room, boiler room	5				10
		5				10
		8				15
		10				15
		15				15
		15				20
		20				20
		20				50
Hospitals	Consultation office, sick room, office room, corridor, waiting room, bathroom, dining room, toilet, respiratory disease room, laundry room, cooking room, surgery room, sterilizing room, engine room, boiler room	6	General buildings	Office room, waiting room, show room, toilet, conference room	6	
		6				10
		10				10
		10				12
		10	Comfort stations		20	
		10	Dark rooms	Dark rooms for photo	16	
		15				
		15	Guest rooms of ship	Guest rooms	6	
		15				
		20	Room of potential noxious gas or combustible gas		20 or more	
	20					
Schools	Class room, library, auditorium, experimental chemistry room, gymnasium, toilet, cooking room	6				
		6				
		8				
		12				

Table 19 : ASHRAE ventilation standard

APPLICATION	SMOKING	m ³ /h PER PERSON		m ³ /h PER SQ m OF FLOOR Minimum*1
		Recommended	Minimum*1	
Apartment {Average De Luxe	Some	34	25.5	—
Banking Space	Some	51	42.5	6
Barber Shops	Occasional	17	12.8	—
Beauty Parlors	Considerable	25.5	17	—
	Occasional	17	12.8	—
Broker's Board Rooms	Very Heavy	85	51	—
Cocktail Bars	Heavy	51	42.5	—
Corridors(Supply or Exhaust)	—	—	—	5
Department Stores	None	12.8	8.5	1
Directors Rooms	Extreme	85	51	—
Drug Stores *3	Considerable	17	12.8	—
Factories *2, *4	None	17	12.8	2
Five and Ten Cent Stores	None	12.8	8.5	—
Funeral Parlors	None	17	12.8	—
Garage *2	—	—	—	18
Hospitals {Operating Rooms *2, *5 Private Rooms Wards	None	—	—	37
	None	51	42.5	6
	None	34	25.5	—
Hotel Rooms	Heavy	51	42.5	6
Kitchen {Restaurant *3 Residence	—	—	—	73
	—	—	—	37
Laboratories *3	Some	34	25.5	—
Meeting Rooms	Very Heavy	85	51	23
Office {General	Some	25.5	17	—
	None	42.5	25.5	5
	Considerable	51	42.5	5
Restaurant {Cafeteria *3 Dining Room *3	Considerable	20	17	—
	Considerable	25.5	20	—
School Rooms *2	None	—	—	—
Shop Retail	None	17	12.8	—
Theater *2	None	12.8	8.5	—
Theater	Some	25.5	17	—
Toilets *2 (Exhaust)	—	—	—	37

*1 : When minimum is used, use the larger.

*2 : See local codes which may govern.

*3 : May be governed by exhaust.

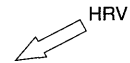
*4 : Use these values unless governed by other sources of contamination or by local codes.

*5 : All outdoor air is recommended to overcome explosion hazard of anesthetics.

3-6-2 Choice of ventilation system

In case of VRV system, there are many cases that individual airconditioning system will be used combined with total heat exchanger system. However, let's take a occasion to tell about general knowledge of airconditioning system with VRV here.

	Common vent. fan system.	Total heat exchanger system
Central system		
Individual systems		



- Central system

When big size air handling unit is used to do air conditioning in all air method, supply duct and exhausting duct are attached to the air-handling unit with volume dampers to regulate overall supply-exhausting flow rate, and ventilation air is supplied to living spaces mixed up with chilled air (or hot air). The exhaust air is returned to air-handling unit through return duct together with chilled air return (or hot air return).

In case of air conditioning system by VRV, sometimes central ventilation system is applied. Installing big sized supply-exhausting fans are provided in a machine room to take in outdoor air from the building top or the ground level to supply to the living space through a fan. The exhausting air blows out through exhausting duct or by means of the secondary ventilation method written in the text book of fundamental course, it's exhausted directly through ventilation ports in the building structure. There are cases to install a total heat exchanger in a machine room and connect duct. An exhaust duct is not insulated, but fresh air intake duct is always insulated to prevent dew formation in winter.

- Individual system

There are several ways such as to install small sized total heat exchangers on each floor or to provide normal fans in an utility core. It is good for saving energy, but noise sources ought to be scattered in an inhabitant space. So, it is required to pay attention for noise problem. Since control characteristic especially for HRV is linked to VRV system, HRV can enter the control range of VRV's remote controller. Details of HRV will be described in the following chapter.

3-6-3 Ventilation air flow in whole building

Basic concept

The place where contaminants are available should be kept in negative pressure, instead, the place without contaminants should be kept in positive. Namely, intake outdoor air more than the exhausting air in an inhabitant space, and exhaust air more than inlet air in a contaminated area like a utility core. Consequently, let the pressure on the whole floor even by keeping equal volume of inlet and outlet sides. On a first floor where entrance is available and people frequently go out and come in, outdoor air intake can be reduced by keeping a little bit positive pressure.

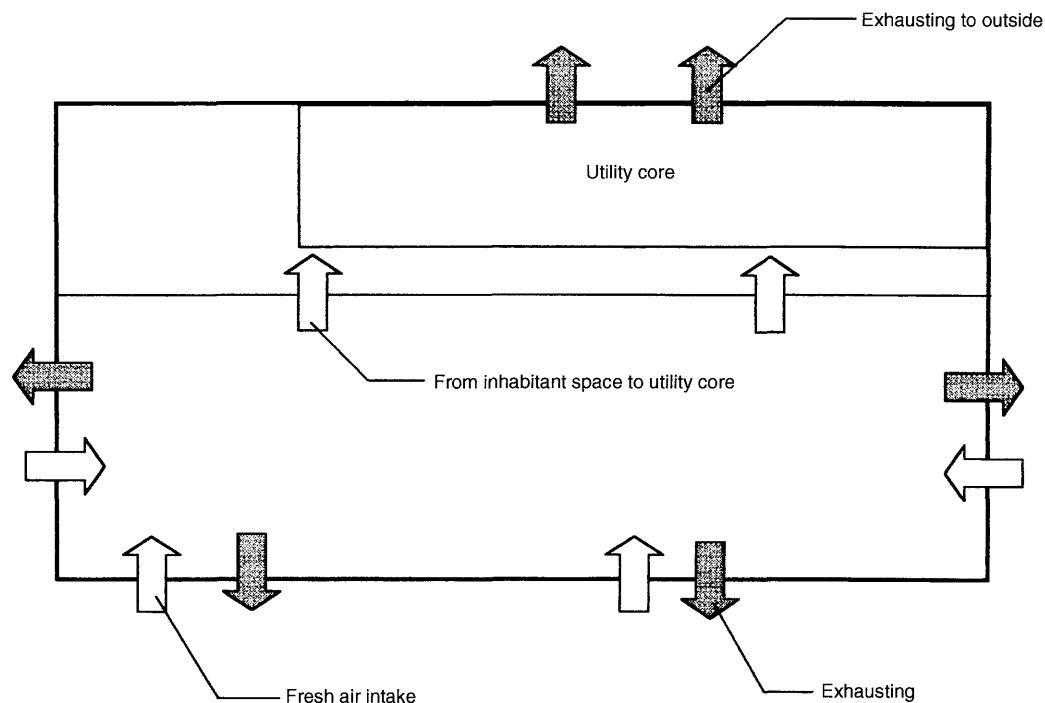
- What happens in utility core

Contaminated air normally exists here. That is from toilet or kitchen. In those area where contaminated air exist, provide exhausting fan based on the third method to exhaust the contaminated air. Places easy to bear contaminated air such as kitchen or toilet have a ventilation standard in much higher rate than in any other living space. The equivalent air exhausting from those contaminated places comes into there. Most of those air flown into the contaminated area comes from the inhabitant area. Several percent of air in an air conditioned room flows out from utility core to outside. In this process, utility core itself will be air conditioned though in free temperature and humidity.

- What is the air flow condition in inhabitant area

The equivalent to 75% of intake fresh air is directly blows out to outdoor in order to keep positive pressure. The remainder 25% is supplied to utility core. Let's tell the way to flow this air corresponding 25 % to utility core.

Fig. 74 Air flow pattern in building



- From inhabitant area to utility

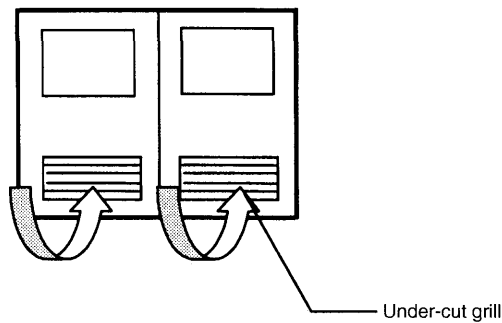


Fig. 75

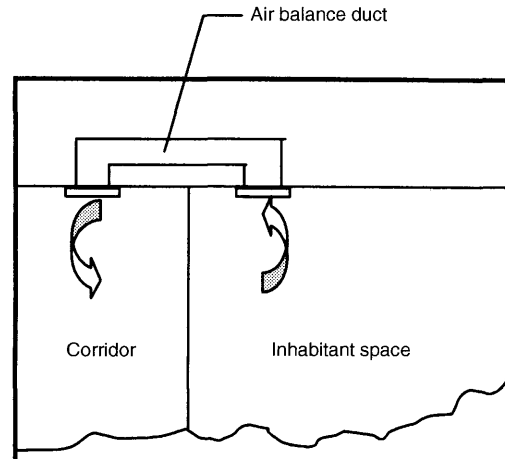


Fig. 76

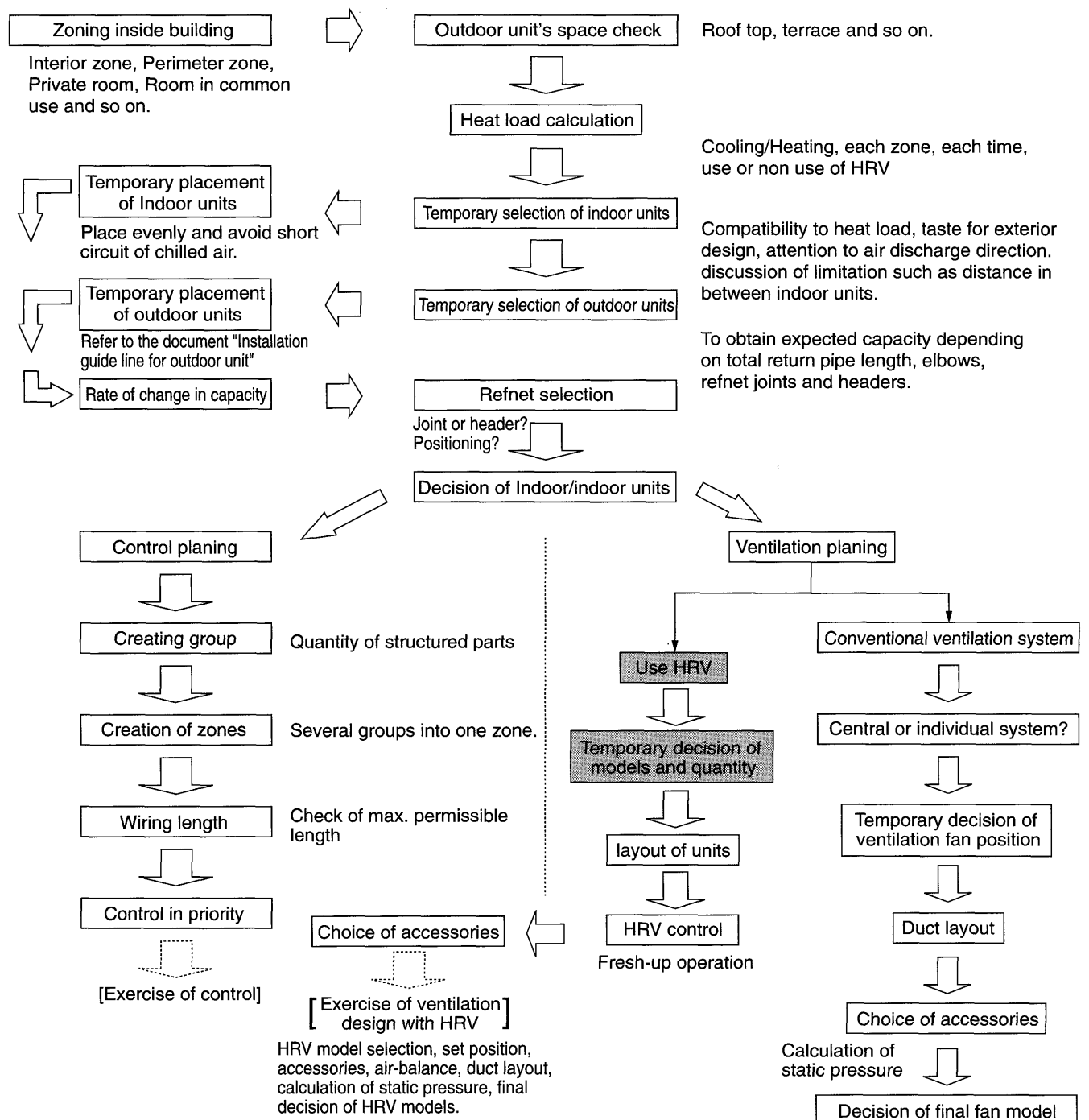
Provide a grille or a slit on a door of inhabitation space so that air can flow automatically by the air pressure difference in between spaces. Negative pressure is generated in utility core because an exhaust fan operates to draw the air to outdoor. On the other hand, positive pressure is generated in an inhabitant room due to the less exhausting volume than the fresh air intake volume. Thus, positive pressure generated pushes the room air toward the corridor.

Figure in the right shows a duct which bridges between an inhabitant space and a corridor and air passes through the duct to get effective pressure balance.

In all cases, good harmony of exhausting fan in an utility core to the exhausting fan in an inhabitant area (exhausting volume to outside and return air to corridor) enables to obtain a good pressure balance.

What happens if imbalance will be generated and pressure in a corridor will come down to extreme negative pressure. Stairway will become big sized air ducts and much air will flow into the corridor. This phenomena will not only affect people walking on the stairway to feel cold draft, but also cause to break air balance on the other floors.

Design procedure is indicated in this below chart. The topics with shaded enclosure signify topics which will be explained in the succeeded several pages till the other similar chart with other topics in shaded enclosures will appear.

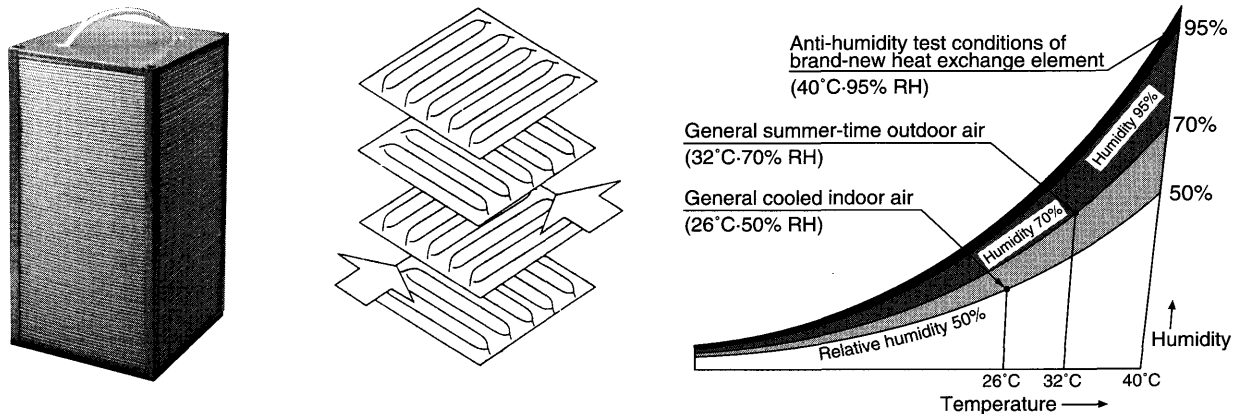


3-6-4 HRV (Heat Reclaim Ventilation)

a) What is HRV?

A heat exchanger made of paper in which special desiccant is soaked is built in an HRV unit. Supply air and exhaust air pass across in the integrally formed liners which crosses independently in different direction and in this crossing process, heat contained in each passing air exchanges to each other. HRV can save energy by 60% of heat gain from the outdoor and by 65% heat loss to the outdoor. It connects to indoor units with control wiring and enables to operate in harmony with VRV operation.

Fig.77



The appearance and the flow route inside unit are shown in Fig.78 and Fig. 79, respectively. Since two independent fans, for supply and for exhaust, are equipped, the change of air flow ratio (supply/exhaust) is possible (Defined as fresh up operation: describing later) . As outdoor temperature thermostat is built in , automatically it compares indoor set temperature and outdoor temperature and starts free cooling operation if indoor units of VRV are linked to HRV through control wiring. (by-pass mode operation).

b) Model selection of HRV

All models are shown in Table 20 in next page. There are 9 models from VAM 150 to 2000 for the time being. VAM 800 means this model has a capacity of 800 m³/h air flow rate at the position of switch [High] . Next, refer to the performance curve in Fig.81. You may understand 800 m³/h can be obtained only at 120Pa [Approx.12mmH₂O] [60Hz] or 100~110Pa[Approx.10~11mmH₂O] [50Hz], external static pressure for the model VAM800.

The enthalpy efficiency related to saving energy has been counted in the heat load calculation procedure, and here no attention to the enthalpy efficiency is needed.

Thus, Focus on the models to suit the required air flow rare,while referring to model names. → Make sure how much static pressure is related to obtain the required air flow rare → Complete the layout and calculate the pressure loss through the duct system → Check up the suitability of the model pre-determined and select again if necessary according to the performance curve .

Fig. 78

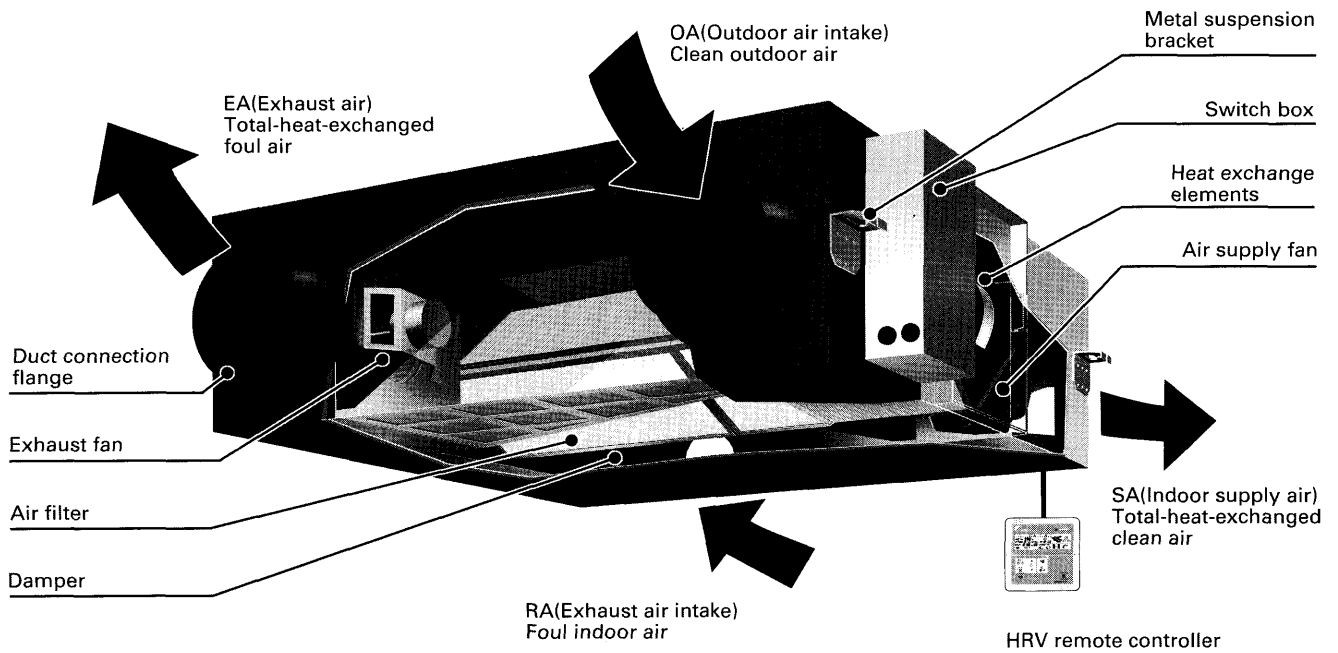
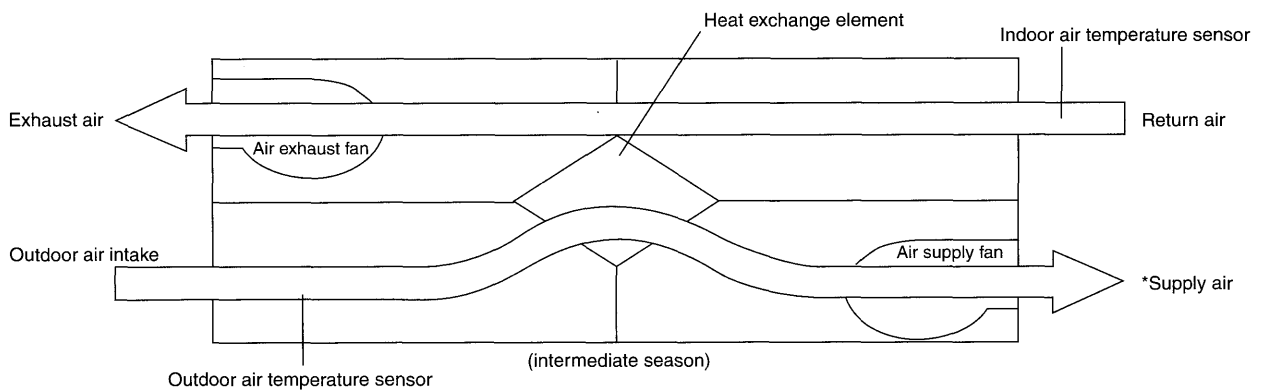
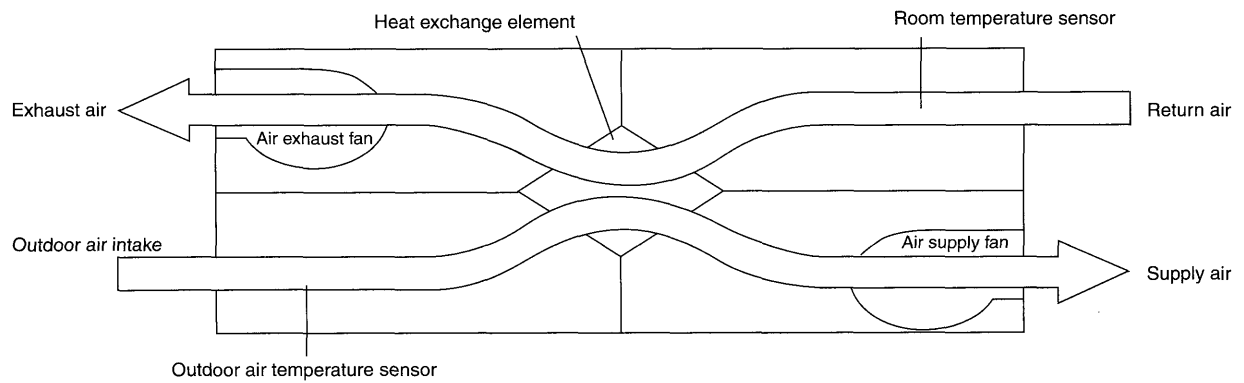


Fig. 79 Auto-ventilation mode change over switching



*The air cannot be supplied at the same temperature as the outdoor air because it is partly heat-exchanged.

Table 20: HRV specifications

Power Supply

VE: 1 phase, 220~240V/220V, 50Hz/60Hz

Models			VAM150FJVE	VAM250FJVE	VAM350FJVE	VAM500FJVE	VAM650FJVE	VAM800FJVE	VAM1000FJVE	VAM1500FJVE	VAM2000FJVE
Temp.Exchange Efficiency(%) [50Hz/60Hz]		Ultra-High	74/74	72/72	75/75	74/74	74/74	74/74	75/75	75/75	75/75
		High	74/74	72/72	75/75	74/74	74/74	74/74	75/75	75/75	75/75
		Low	79/80	77/77	80/81	77/78.5	77/78	76/76	76.5/78	78/78	78/78
Enthalpy Exchange Efficiency(%) [50Hz/60Hz]	For Heating	Ultra-High	64/64	64/64	65/65	62/62	63/63	65/65	66/66	66/66	66/66
		High	64/64	64/64	65/65	62/62	63/63	65/65	66/66	66/66	66/66
		Low	69/71	68/69	70/71	67/68.5	66/68	67/68	68/71	68/68	70/70
	For Cooling	Ultra-High	58/58	58/58	61/61	58/58	58/58	60/60	61/61	61/61	61/61
		High	58/58	58/58	61/61	58/58	58/58	60/60	61/61	61/61	61/61
		Low	64/66	62/63	67/68	63/65.5	63/65	62/63	63/66	64/64	66/66
Power Supply			1 phase,220~240V/220V,50Hz/60Hz								
Sound Level dB(A) [50Hz/60Hz]	Heat Exchange Mode	Ultra-High	27-28.5/28.5	28-29/29.5	32-34/34.5	33-34.5/34	34.5-35.5/36	36-37/37	36-37/37	39.5-41.5/40.5	40-42.5/41
		High	26-27.5/26.5	26-27/26	31.5-33/32	31.5-33/31	33-34/33	34.5-36/35	35-36/35	38-39/38	38-41/38
		Low	20.5-21.5/19	21-22/19.5	23.5-26/22	24.5-26.5/24	27-28/27	31-32/30	31-32/30	34-36/33	35-37/35
	Bypass Mode	Ultra-High	27-28.5/28	28-29/29	32-34/34.5	33.5-34.5/35	34.5-35.5/35.5	36-37/37	36-37/37	40.5-41.5/40.5	40-42.5/41
		High	26.5-27.5/27	27-28/27	31-32.5/33	32.5-33.5/33	34-35/34	34.5-36/35	35.5-36/35	38-39/38	38-41/38
		Low	20.5-21.5/20	21-22/20.5	24.5-26.5/22	25.5-27.5/24	27-28.5/27	31-33/31	31-32/31	33.5-36/33	35-37/35
Casing			Galvanized steel plate								
Insulation Material			Self-extinguishable urethane foam								
Dimensions(H×W×D)	mm	269×760×509			285×812×800		348×988×852		348×988×1,140	710×1,498×852	710×1,498×1,140
Weight	kg	24			33		48		61	132	158
Heat Exchange System			Air to air cross flow total heat(Sensible heat+latent heat) exchange								
Heat Exchange Element Material			Specially processed nonflammable paper								
Air Filter			Multidirectional fibrous fleeces								
Fan	Type		Sirroco fan								
	Air Flow Rate(m³/h) [50Hz/60Hz]	Ultra-High	150/150	250/250	350/350	500/500	650/650	800/800	1,000/1,000	1,500/1,500	2,000/2,000
		High	150/150	250/250	350/350	500/500	650/650	800/800	1,000/1,000	1,500/1,500	2,000/2,000
		Low	110/110	155/145	230/210	350/300	500/440	670/660	870/800	1,200/1,200	1,400/1,400
	External Static Pressure (pa) [50Hz/60Hz]	Ultra-High	69/98	64/98	98/142	98/147	93/162	137/225	157/196	137/206	137/196
		High	39/54	39/54	70/85	54/54	39/69	98/118	98/108	98/118	78/88
		Low	20/24	20/20	25/15	25/20	25/34	49/69	78/69	49/69	59/69
Moter Output		kW	0.030×2		0.090×2		0.140×2		0.230×2		0.230×4
Connection Duct Diameter	mm	φ 100	φ 150			φ 200		φ 250		φ 350	
Unit ambient condition			-10℃~+50℃DB,80%RH or less								

Note: 1. Sound level is measured at 1.5m below the center of the body.

2. Air flow rate can be changed over to Low mode or High mode.

3. Sound level is measured in an anechoic chamber.

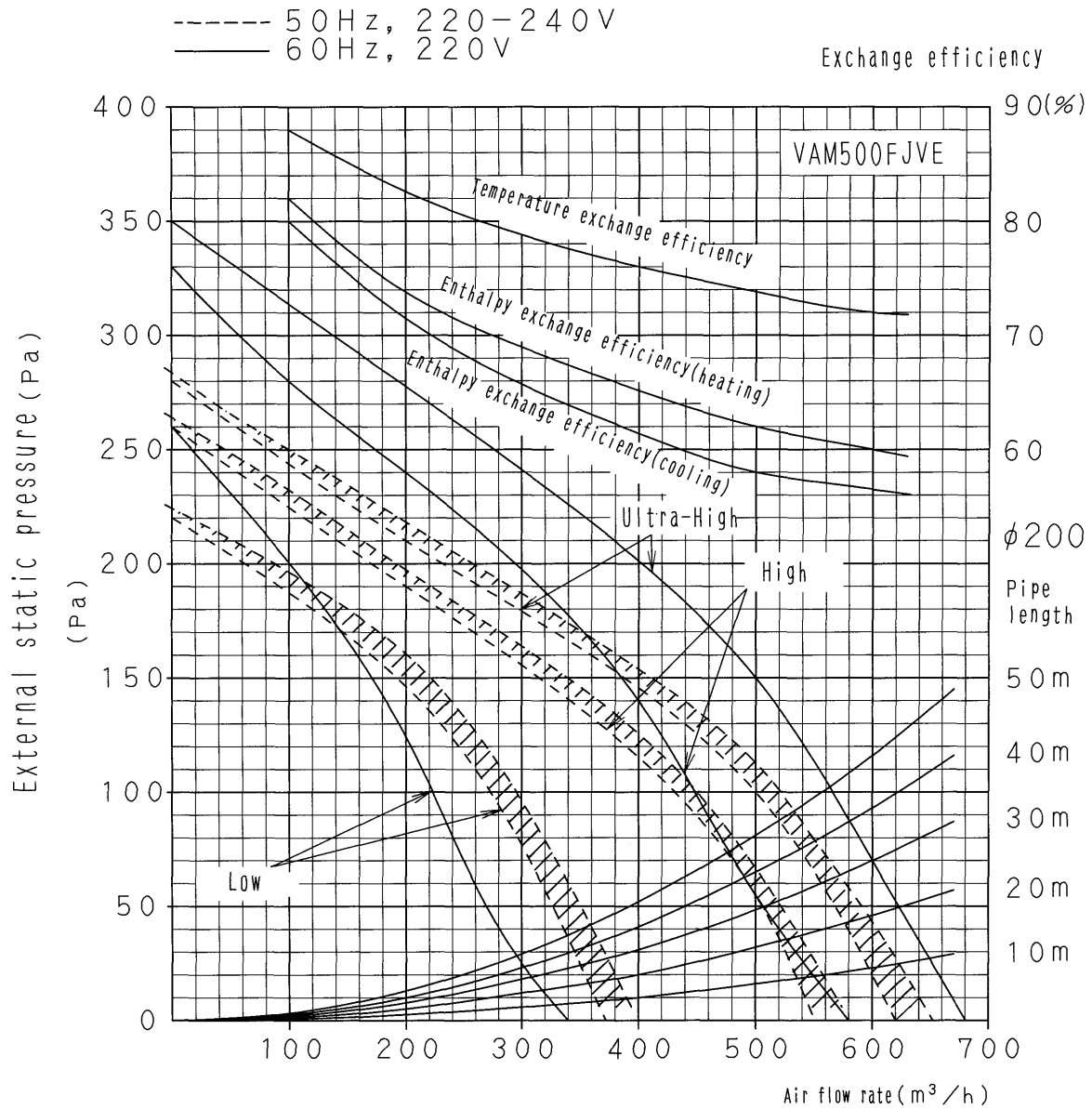
Sound level is generally become greater than this value depending on the operating conditions, reflected sound, and peripheral noise.

4. The sound level at the air discharge port is about 8dB higher than the unit's sound level.

5. Even when the outdoor temperature is below -10°C, the system is operable down to -20°C with the preheater installed at the outdoor air intake side.

Fig. 80: Fan performance curve

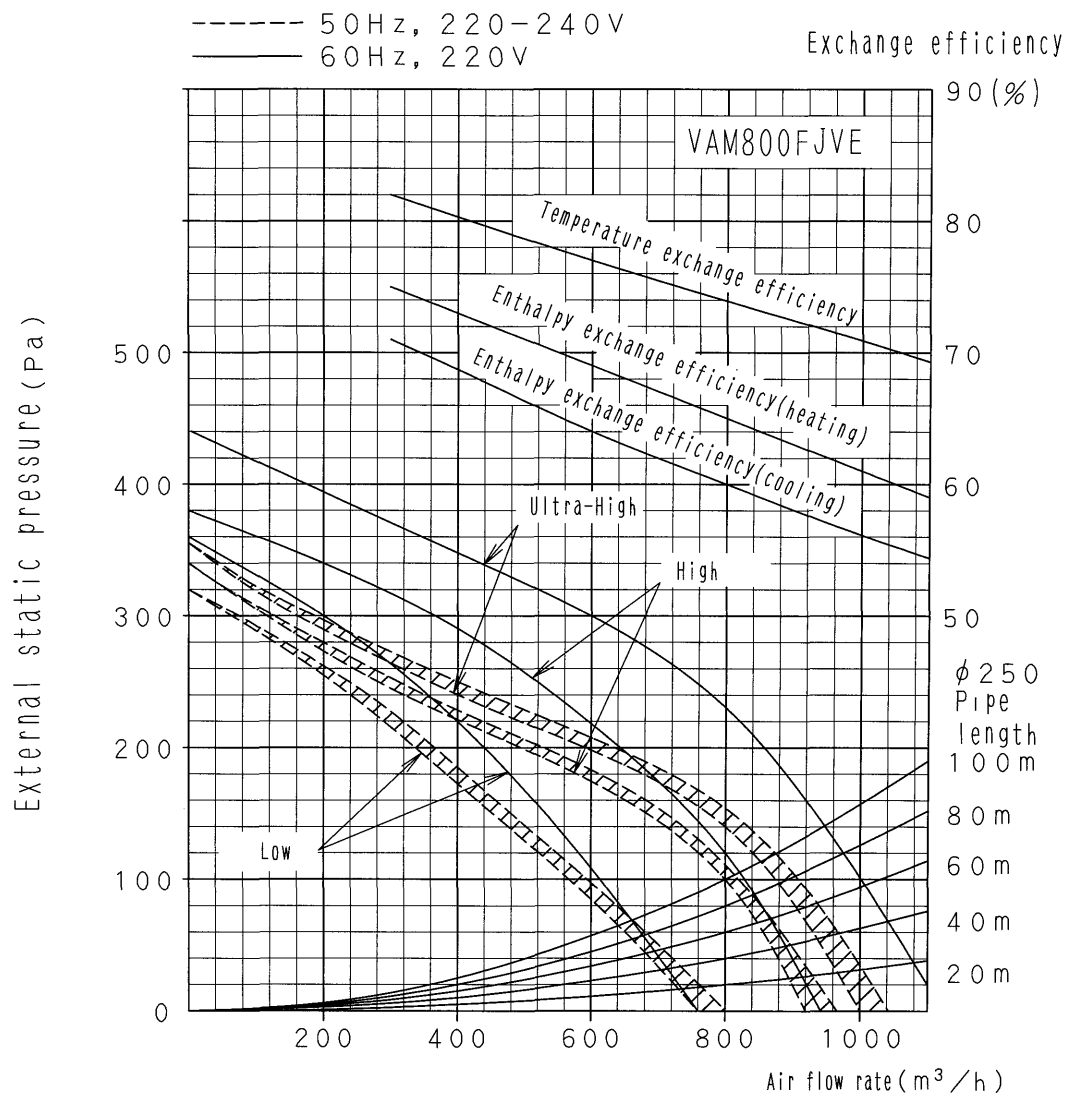
• VAM500FJVE



4D020868

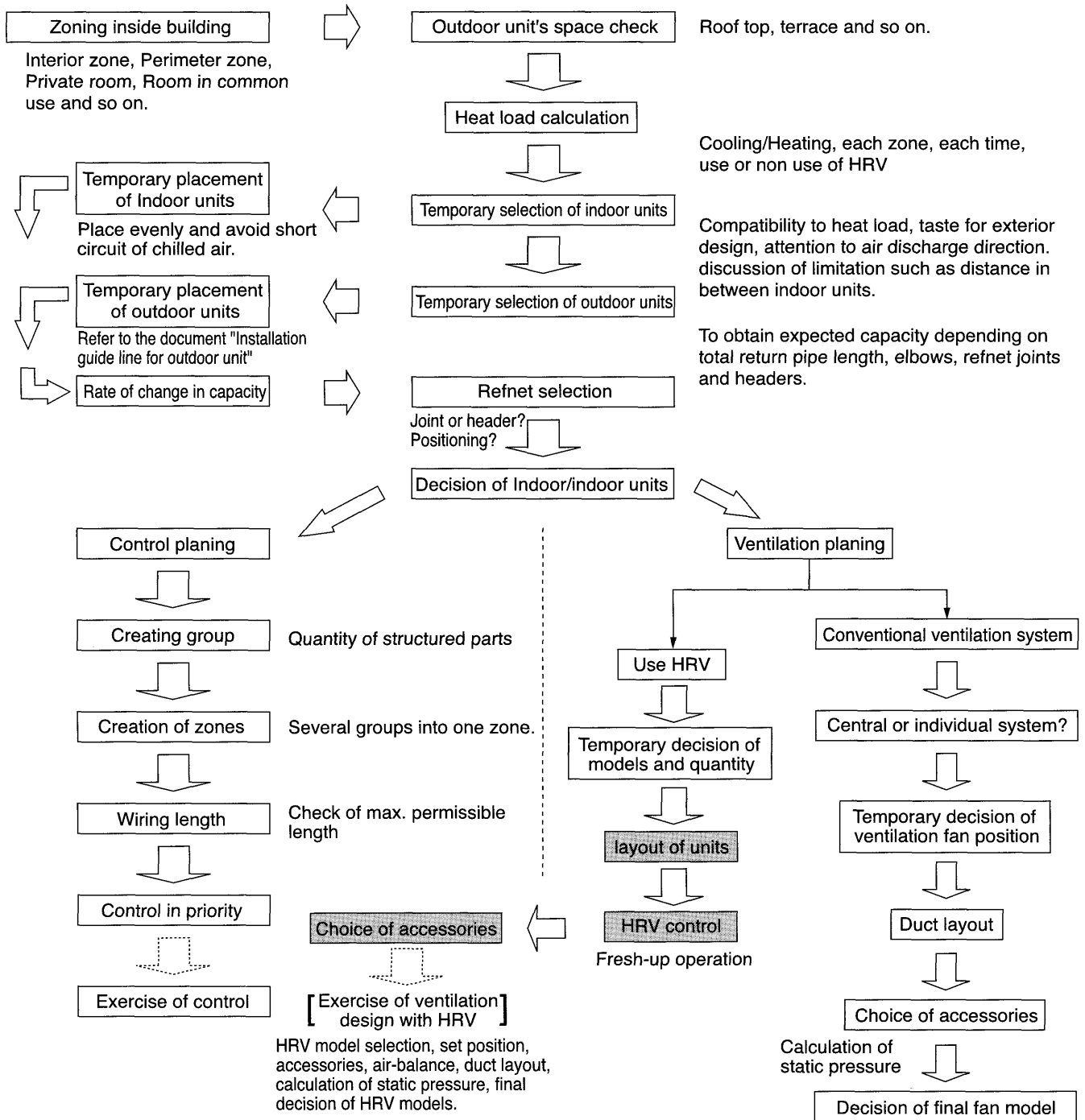
Fig. 81: Fan performance curve

• VAM800FJVE



4D020870

Design procedure is indicated in this below chart. The topics with shaded enclosure signify topics which will be explained in the succeeded several pages till the other similar chart with other topics in shaded enclosures will appear.



c) The place to install HRV

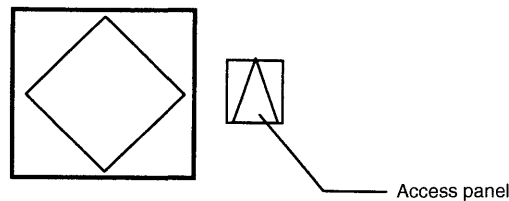
Points to choose the place

- Easy maintenance
- No nervous to noise
- Short duct can be used

Placement in space above ceiling over the inhabitant room makes it possible to shorten ducts, but anxious to the noise and trouble for maintenance.

If placed in the space above ceiling over the utility core or corridor, no curious for the noise and maintenance always is permissible, the duct length is a little longer though. In addition, cleaning up of filter should be conducted often. So, it will get new merit for the necessity of the frequent cleanings.

Be sure to provide a access panel near by the unit



The size in which head and one arm can enter suits an access panel. if an access panel has a size of 45 cm square, it is enough to take out the filter for cleaning.

Aiming at operating quietly

Operation sound level in every model and the effect with a silencer for noise reduction are shown in Table 21 and Fig. 82, respectively. When units must be installed in a space above ceiling over living space by all means, these remedy will become necessary.

Table 21: Overall sound level

Ventilation Mode		220V / 50Hz						230V / 50Hz					
		Total Heat Exchange mode			Bypass mode			Total Heat Exchange mode			Bypass mode		
Fan Speed		U-H	H	L	U-H	H	L	U-H	H	L	U-H	H	L
Model	VAM150FJVE	27	26	20.5	27	26.5	20.5	28	27	21	28	27	21
	VAM250FJVE	28	26	21	27.5	27	21	28.5	26.5	21.5	28	27.5	21.5
	VAM350FJVE	32	31.5	23.5	31.5	31	24.5	33	32	25	32	31.5	25.5
	VAM500FJVE	33	31.5	24.5	33.5	32.5	24	34	32.5	25.5	34	33	26.5
	VAM650FJVE	34.5	33	27	34.5	33	27	35	33.5	27.5	35	34.5	27
	VAM800FJVE	35.5	34.5	31	35.5	34.5	31	36.5	35.5	31.5	36.5	35.5	31.5
	VAM1000FJVE	36	35	31.5	36	35.5	32	36.5	35.5	31.5	36.5	35.5	32
	VAM1500FJVE	39.5	38	34	40.5	38	33	41	38.5	35	41	38.5	35
	VAM2000FJVE	40	38	35	41	38	33	41.5	40	36	41.5	40	35

Ventilation Mode		240V / 50Hz						220V / 60Hz					
		Total Heat Exchange mode			Bypass mode			Total Heat Exchange mode			Bypass mode		
Fan Speed		U-H	H	L	U-H	H	L	U-H	H	L	U-H	H	L
Model	VAM150FJVE	28.5	27.5	21.5	28.5	27.5	21.5	28.5	26.5	19	28	27	20
	VAM250FJVE	29	27	22	28.5	28	22	29.5	26	19.5	29	27	20.5
	VAM350FJVE	34	33	26	33.5	32.5	26.5	34.5	32	22	34.5	33	22
	VAM500FJVE	34.5	33	27.5	34.5	33.5	27.5	35.5	33.5	24	35	33	24
	VAM650FJVE	35.5	34	28	35.5	35	28.5	36	33	27	35.5	34	27
	VAM800FJVE	37	36	32	37	36	32	36	34.5	31	37	35	31
	VAM1000FJVE	37	36	32	37	36	33	37	35	31	37	35	31
	VAM1500FJVE	41.5	39	36	41.5	39	36	40.5	38	33	40.5	38	33
	VAM2000FJVE	41.5	40	38	42.5	41	37	41	38	34	41	38	35

Fig. 82 : Effect of a remedy for noise

Effect of remedy for sound

Caution

1. Be sure to connect a flexible duct (2 m) to an outlet of the main body in the indoor air supply side.
 2. Do not connect a spiral duct and an aluminium bellows directly to the outlet of the main body.
- * A silencer is effective especially when using the flexible duct at the same time.

General comparison of the effect (① → ⑥ in more effective order)

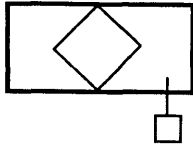
① Mounting a silencer + flexible duct 2 m long Mounting a silencer + flexible duct 6 m long	② Mounting a flexible duct 6 m long	③ Mounting a flexible duct 2 m long to the main body																																										
Main body Silencer Flexible duct 2 m Spiral duct 4 m Main body Silencer Flexible duct 6 m (Effect of a remedy for noise does not change) even for over 2 m long duct	Main body Flexible duct 6 m	Main body Flexible duct 2 m Spiral duct 4 m																																										
④ Mounting a flexible duct 2 m long to an air suction discharge grill	⑤ Mounting a silencer	⑥ Spiral duct 6 m No measures taken																																										
Main body Spiral duct 4 m Flexible duct 2 m	Main body Silencer Spiral duct 6 m	Main body Spiral duct 6 m Suction / discharge grill																																										
<table><tr><td></td><td>①</td><td>②</td><td>③</td><td>④</td><td>⑤</td><td>⑥</td></tr><tr><td>(dB)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>+ 10</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>+ 5</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Catalog value</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>- 5</td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>				①	②	③	④	⑤	⑥	(dB)							+ 10							+ 5							Catalog value							- 5						
	①	②	③	④	⑤	⑥																																						
(dB)																																												
+ 10																																												
+ 5																																												
Catalog value																																												
- 5																																												

Note:

Measure the noise at 1.5 m below the air supply grille. Operating noise conforms to JIS standard and the value is converted in terms of the anechoic chamber.

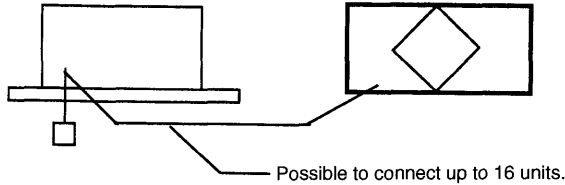
d) Control of HRV

- Independent operation



Possible to operate independently and also to centrally control linked with a central remote controller.

- Operation linked with indoor unit of VRV system



Possible to group with VRV indoor unit. Operation can be done by the command of indoor unit's remote controller or by the command of a central remote controller, if the HRV is linked to the central remote controller.

Basically, the two kinds and their combination to each other mentioned above are all.

- Grouping and zoning

You may think it same with VRV's indoor units. It is special difference that grouping by HRV's remote controller is prohibited unlike the grouping system by VRV's remote controller.

- What a remote controller can do.

Refer to Fig. 84 ~ 85.

By HRV remote controller

- ON/OFF, Switching the modes; Auto/Heat exchange/By-pass, Two steps changeover of airflow rate.

In the link to indoor units

- ON/OFF, operation mode (cooling/heating/dehumidifying, choice of ventilation mode, setting of group number, choice of fan speed, field setting mode (Table 22).

Fig. 83

Multi function central controller + Unified On/Off Controller

Proper controller should be selected according to the functions required.

System description

* It is possible to combine the schedule timer.

RC1 Central remote controller

RC2 Unified On/Off controller

RSA-D Remote controller for the Indoor unit

R1 - 11 Remote controller for the HRV unit

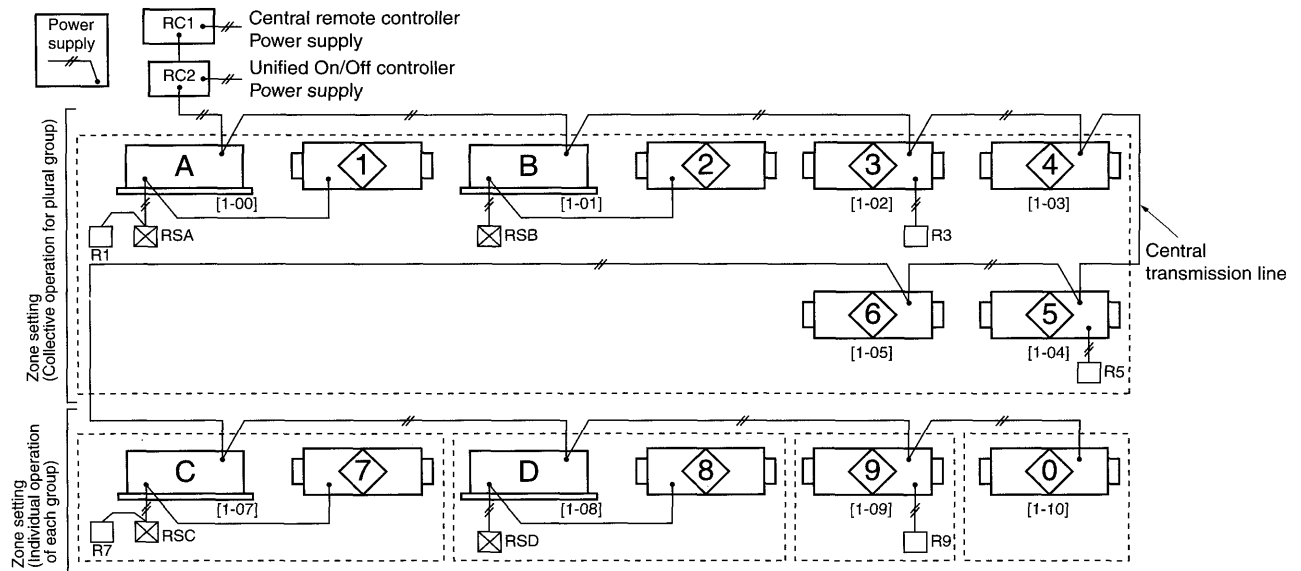


Fig. 84 : Function of remote controller

Operation

Method of operation

Operation with the remote control exclusively for air conditioning operation with HRV units. (BRC301B61)

For non-independent systems, starting / stopping operation and timer operation may not be possible.

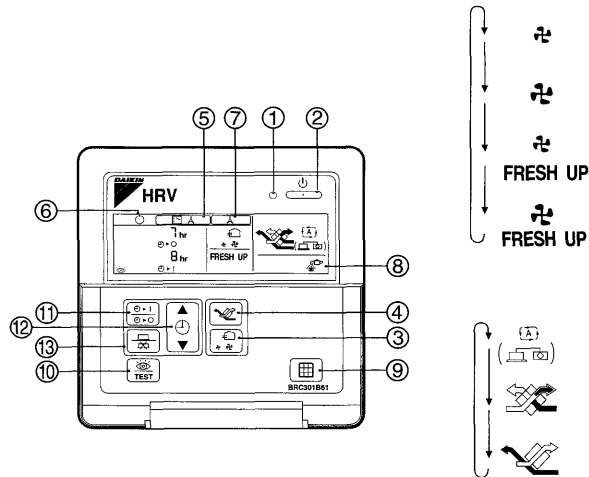
Use the air conditioner remote control or the Centralized controller in such cases.

① Operation lamp

This pilot lamp (red) light up while the unit is in Operation.

② Operation / Stop button

When pushed once, the unit starts operating.
When pushed twice, the unit stops.



③ Air flow rate changeover button

Air flow rate can be changed over to “” [Low] mode or “” [High] mode,
“ FRESH UP” [Low FRESH UP] mode,
“ FRESH UP” [High FRESH UP] mode.

For “FRESH UP” operation

When this indication does not show: The volume of outdoor air supplied into the room and that of the room air exhausted outdoors is equivalent.

For “FRESH UP” operation,

- If it is set to “Fresh up air supply”: The volume of outdoor air supplied into the room is larger than that of room air exhausted outdoors. (This operation prevents the odor and moisture from kitchens and toilets from flowing into the rooms.)
- If it is set to “Fresh up air exhaust”: The volume of room air exhausted outdoors is larger than that of outdoor air supplied into the room. (This operation prevents the hospital odor and floating bacteria from flowing out to the corridors.)

④ Ventilation mode changeover button

“” (Automatic) mode The temperature sensor of the unit automatically changes the ventilation of the unit in [Bypass] mode and [Heat Exchange] mode.

“” (Heat Exchange) mode In this mode, the air passes through the heat exchange element to effect [Total Heat Exchanging] ventilation.

“” (Bypass) mode In this mode, the air does not pass through the heat exchange element but by passes it to effect [Bypass] ventilation.

⑤ Indication of operation control method:

When the operation of HRVs are interlocked with the air conditioners, this indication may be shown. While the indication is shown, the ON / OFF of HRVs cannot be operated by the HRV remote controller.

⑥ Indication of operation standby:

It indicates the precooling / preheating operation. This unit is at stop and will start operation after the precooling / preheating operation is over. Precooling / preheating operation means the operation of HRVs is delayed during the startup operation of interlocked air conditioners such a before the office hours. During this period the cooling or heating load is reduced to bring the room temperature to the set temperature in a short time.

⑦ Indication of centralized control:

When a remote controller for air conditioners or devices for centralized control are connected to the HRVs, this indication may show.

During this indication appears on the display, the ON / OFF and timer operation may not be possible with the HRV remote controllers.

⑧ Indication of air filter cleaning

When the indication “ ” appears on the display, clean the filter.

⑨ Filter signal reset button

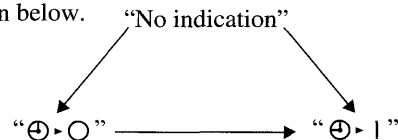
⑩ Inspection button

This button is to be used only for service. It is not to be used normally.

How To Operate With Timer

⑪ Push the button “” and select either one of “ > ” or “ > | ”.

Each time the button is pushed, the indication changes as shown below.



⑫ Push the button “” and set the time.

Each time when “” is pushed, the time advances one hour.

Each time when “” is pushed, the time goes back one hour.

⑬ Push the button “”.

Then, the reservation is finished.

Either “ > ” or “ > | ” changes from flashing to lighting. After the reservation is finished, the remaining time is indicated in the display.

For cancelling the timer operation, push the button “” once again.

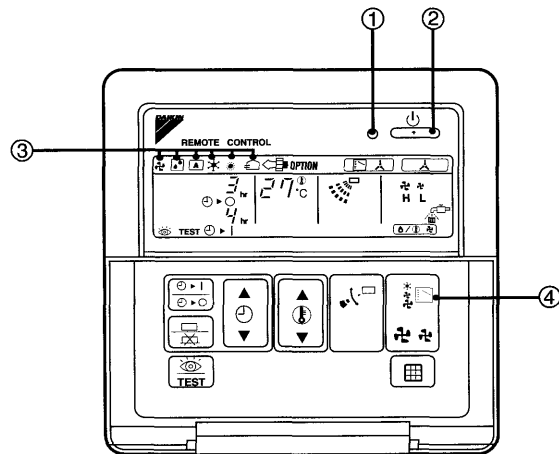
The indication disappears.

Fig.85 : Operating HRV unit by VRV's remote controller

Operating the HRV unit using the remote controller of the VRV- system air conditioner

When the VRV-system air conditioner is connected with the HRV unit with a direct duct, the remote controller of the air conditioner cannot be used to select the VENTILATION mode. To use the HRV unit without operating the air conditioner, set the air conditioner in the FAN VENTILATION mode and select the low fan speed.

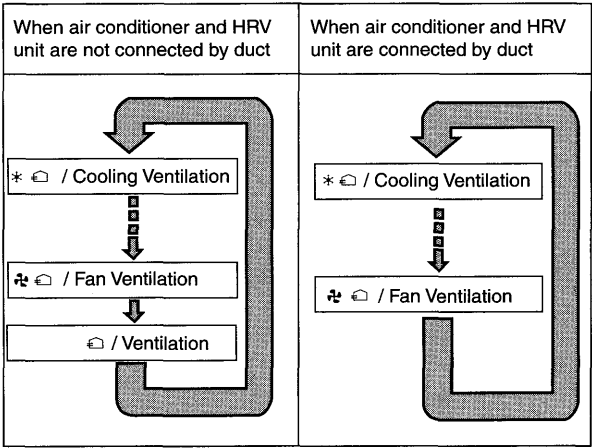
- ① Operation lamp
- ② Operation / stop button
- ③ Operation mode display
- ④ Operation mode selector



Remote controller for VRV
BRC1A51-52/61-62

- Every time the operation mode selector is pressed, the operation mode display changes as shown below.

example



When the “FILTER” indication appears on the display, clean the filter of the HRV unit. (Refer to the section 3.)

Table 22 : Field setting list on remote controller of VRV system related to HRV.

List of Settings

Mode no.		Setting switch no.	Description of Setting	Setting position no. (Caution *1.)					
Group settings	Individual settings			01	02	03	04	05	06
17	27	0	Filter cleaning time setting	Approx. 2500 hours	Approx. 1250 hours	No counting	—	—	—
		2	Precool / preheat on / off setting	Off	On	—	—	—	—
		3	Precool / preheat time setting	30 min	45 min	60 min	—	—	—
		4	Fan speed initial setting	Normal	Ultra high	—	—	—	—
		5	Yes / No setting for direct duct Connection with VRV system	No duct (Air flow setting)	With duct (fan off)	—	—	—	—
			Setting for cold areas (Fan operation selection for heater thermo OFF)	—	—	No duct		With duct	
						Fan off	Fan L	Fan off	Fan L
		7	Centralized / individual setting	Centralized	Individual	—	—	—	—
		8	Centralized zone interlock setting	No	Yes	Priority on Operation	—	—	—
		9	Preheat time extension setting	0 min	30 min	60 min	90 min	—	—
18	28	0	External signal JC / J2	Last command	Priority on external input	—	—	—	—
		1	Setting for direct Power ON	Off	On	—	—	—	—
		2	Auto restart setting	Off	On	—	—	—	—
		4	Indication of ventilation mode / Not indication	Indication	No Indication	—	—	—	—
		7	Fresh up air supply / exhaust setting	No Indication	No Indication	Indication	Indication	—	—
				Supply	Exhaust	Supply	Exhaust	—	—
		8	External input terminal function selection (between J1 and JC)	Fresh-up	Overall alarm	Overall malfunction	Forced off	Fan forced off	Air flow Increase
19	29	0	Ventilation air flow setting	Low	Low	Low	Low	High	High
		2	Ventilation mode setting	Automatic	Exchange	By pass	—	—	—
		3	“Fresh Up” on / off setting	Off	On	—	—	—	—
		8	Electric heater setting	No delay	No delay	On, off delay	On, off delay	—	—

Caution

- The setting positions are set at “01” at the factory.

The ventilation air flow, however, is set at “05” (medium) in the HRV unit. When lower or higher setting is desired, change the setting after installation.

Group number setting for centralized controller

- Mode no. 00: Group controller
- Mode no. 30: Individual controller

* Regarding the setting procedure, refer to the section “Group number setting for centralized control” in the operating manual of either the on / off controller or the central controller.

e) Fresh up operation

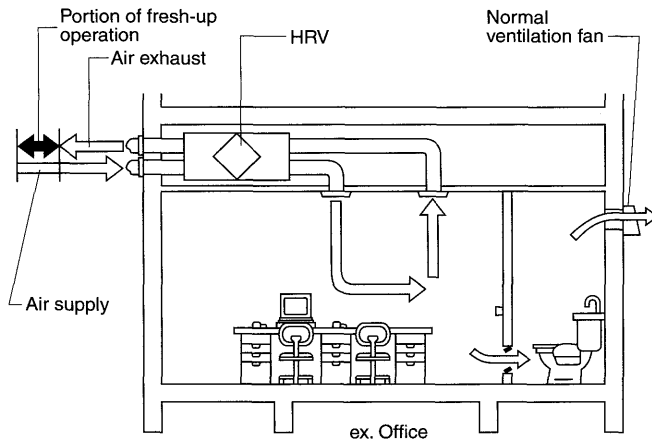
Although fresh up operation is one of controls, let's explain it in an independent section due to its importance for system designers.

The image is illustrated below

Fig. 86 Supply mode and exhausted mode.

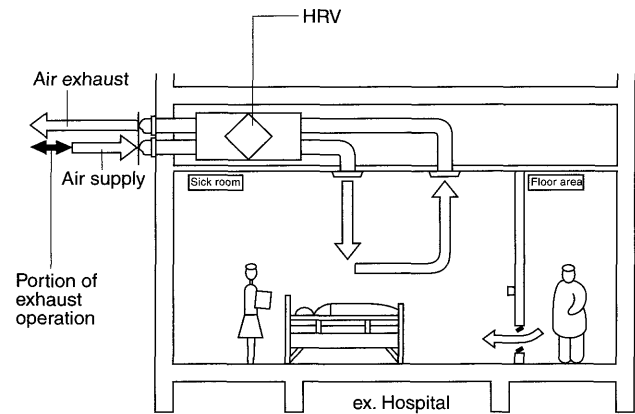
Supply rich mode:

Raising the air supply maintains proper room pressure to prevent back-flow of toilet/kitchen odors or moisture inflow.



Exhaust rich mode:

Raising exhaust air decreases room pressure to prevent the leaking of odors or floating bacteria into other rooms.



It is basic function for fresh up operation that supply fan and exhaust fan can be operated separately. There are two purposes;

- 1) The supply airflow rate is set over the exhaust airflow rate, and surplus air flows to utility core, keeping the living space in positive pressure.
 - 2) If static pressure differential is arisen in the duct system in the process of static pressure loss estimation and it seems difficult to have good balance between supply and exhaust air, either side of airflow can be decreased or increased by means of this fresh up operation mode in order to get good balance.
- Among these two above, item (2) can be altered by providing a damper in the duct system. As a result, item (1) would be a fundamental function required for the fresh up operation.

• Setting of fresh up operation mode

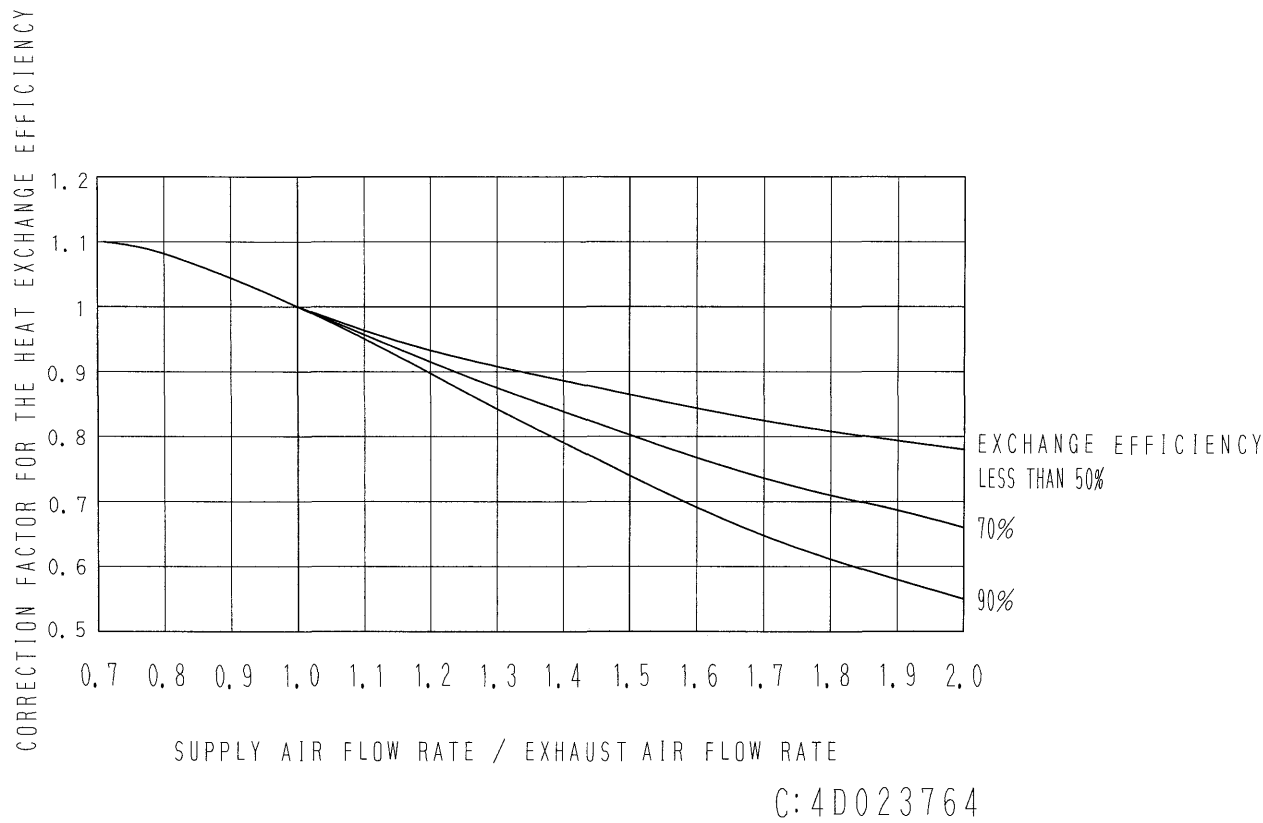
In the mode of field setting, select [Fresh-up] and choose set-switch number 3. and set position 02. This setting is done by a remote controller of VRV indoor unit's remote controller.

• Fan speed selection

Refer to Table 23 "Fan operation setting". If [Fresh up] is selected, fan speed automatically takes the speed defined in this selection list in the supply side and exhaust side. For example, If ventilation airflow setting is [Normal] and airflow rate is [High], the supply airflow rate and the exhaust airflow rate are automatically set to [Ultra high] and [High] respectively.

Concentrate on the column of fan airflow rate in Table 20 and take up the model VAM500. Supply airflow rate can be read 500 m³/h and exhaust airflow rate 350 m³/h. Consequently, supply/exhaust rate is gotten as 1.43.

Fig.87 : The correction ratio of exchange efficiency



<Example of correction>

VAM500 (50 Hz): Air flow rate at strong notch 500 m³/H
(Cooling) Enthalpy exchanging efficiency 58%

Supply air and exhaust air flow rate for fresh-up mode:
Supply air flow rate/Exhaust air flow rate = 550/500 = 1.1
(Cooling) Enthalpy exchange efficiency from above Table
 $58 \times 0.96 = 55.6\%$

↑ Correction ratio

Table 23: Fan operation setting

Interlocked operation system	With remote controller for indoor unit	Initial setting by the remote controller for indoor unit			Fan operation					
		Ventilation air flow setting	Fan speed	Fresh-up operation	Fresh-up Supply air setting		Fresh-up Exhaust air setting			
					Supply side	Exhaust side	Supply side	Exhaust side		
Independent system	With remote controller for HRV unit	Ventilation air flow setting	Fan speed	Terminal between J1 and JC (Fresh-up by external command)	Fan operation					
					Supply side	Exhaust side	Supply side	Exhaust side		
		Normal	Low	Open	Low	Low	Low	Low		
				Short-circuit	High	Low	Low	High		
			High	Open	High	High	High	High		
				Short-circuit	Ultra-high	High	High	Ultra-high		
		Ultra-high	Low	Open	Low	Low	Low	Low		
				Short-circuit	High	Low	Low	High		
			High	Open	Ultra-high	Ultra-high	Ultra-high	Ultra-high		
				Short-circuit	Ultra-high	High	High	Ultra-high		
		Centralized control system	With remote controller for HRV unit	Ventilation air flow setting	Fan speed	Terminal between J1 and JC (Fresh-up by external command)	Fan operation			
							Supply side	Exhaust side	Supply side	Exhaust side
Independent system	With remote controller	Switch on the PCB (H/M/L)		Terminal between J1 and JC (Fresh-up by external command)	Fan operation					
					Supply side	Exhaust side	Supply side	Exhaust side		
		"L"		Open	Low	Low	Low	Low		
				Short-circuit	High	Low	Low	High		
		"M"		Open	High	High	High	High		
				Short-circuit	Ultra-high	High	High	Ultra-high		
		"H"		Open	Ultra-high	Ultra-high	Ultra-high	Ultra-high		
				Short-circuit	Ultra-high	High	High	Ultra-high		

- Change of enthalpy efficiency

As the ratio of supply/exhaust changes, enthalpy efficiency changes too. It can be comprehended through Fig. 87. Taking up the example from the previous page about model VAM500, the enthalpy efficiency correction ratio is 0.87 at supply/exhaust airflow rate 1.43.

f) Choice of accessories

HRV system equipped with typical accessories is shown in Fig. 88. Ducts are connected to the body and round hoods (whether caps) are attached to the end of ducts projected to outdoor. A silencer is equipped at discharge side of supply air duct, connecting to flexible duct and in the middle, high efficiency filter unit is attached. Air flow is separated into two duct through a branch duct and finally discharged from discharge grilles to living space. Exhaust or return air is sucked from suction grille.

These accessories are provided as optional accessories. Of course, local made accessories will be accepted. In this handbook, the option parts number are not listed intentionally. If the number or product itself will have been changed, it will arise confusion. Every time you will request the optional accessories, refer to the parts list or the engineering data book.

HRV's airflow rate is affected by external static pressure loss in a duct. As static pressure loss must add the pressure loss caused by accessories, read the static pressure loss through the data given by the manufacturers at each accessory in accordance with the airflow rate. Partial examples given by manufactures about the static pressure and airflow rate relation ship are shown in next page Fig. 89.

Fig. 88 : System equipped with accessories

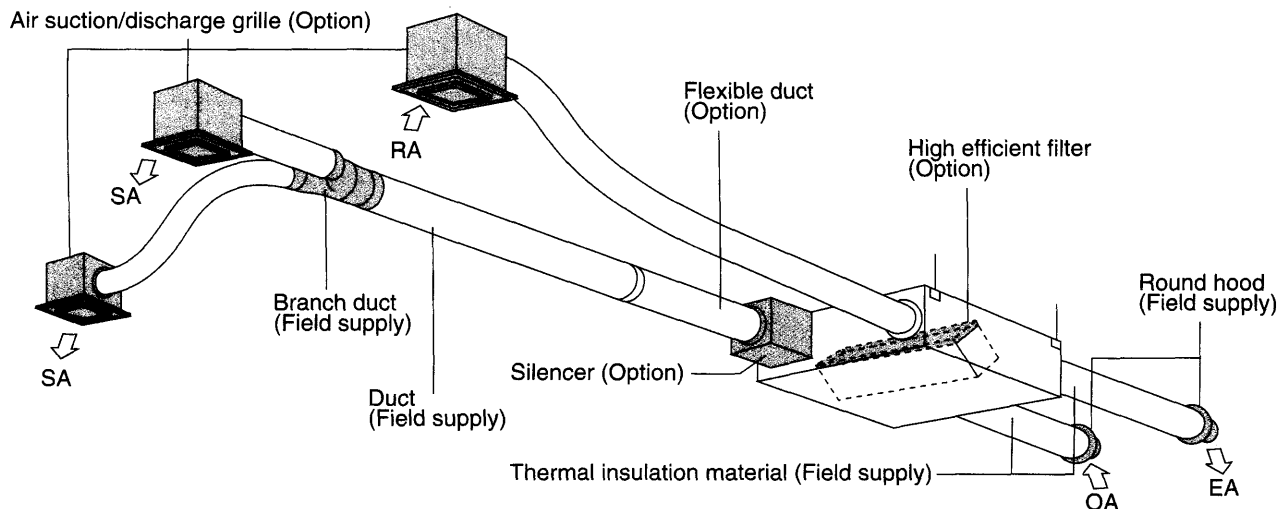
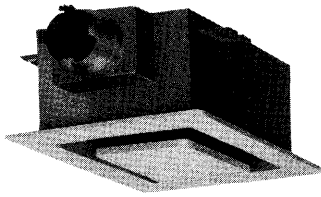


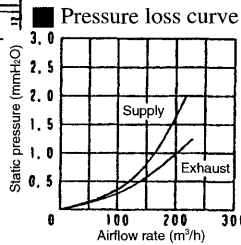
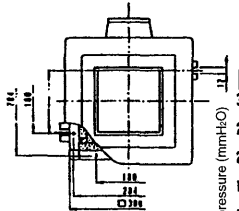
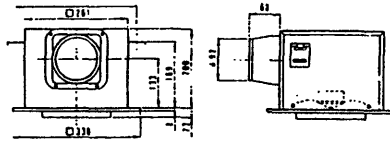
Fig. 89 : Optional accessories and static pressure loss

Slim type air suction/discharge grille



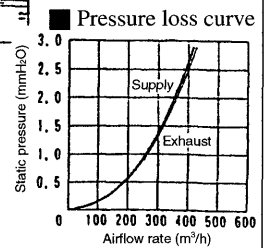
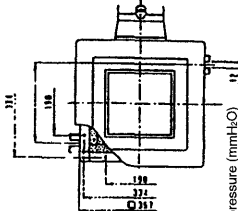
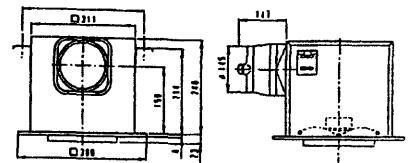
● YDGL100A

■ Dimensions (mm)



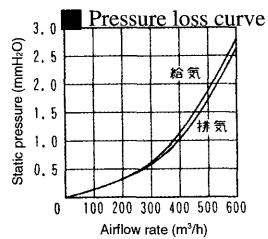
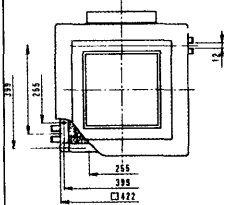
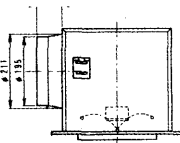
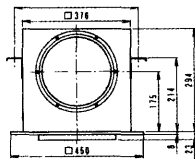
● YDGL150A

■ Dimensions (mm)



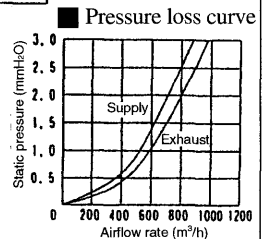
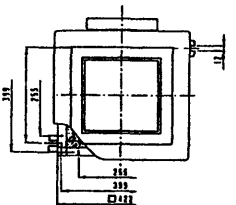
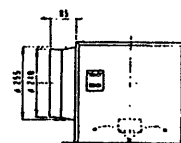
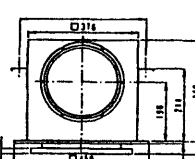
● YDGL200A

■ Dimensions (mm)

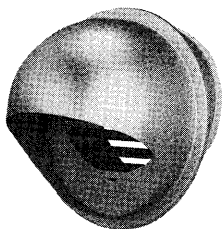


● YDGL250A

■ Dimensions (mm)

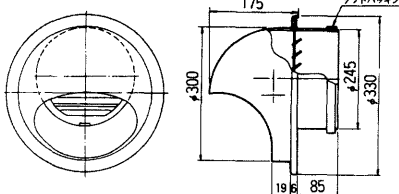


Round hood (weather cap) made of aluminum with gallery

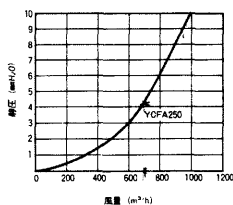


YCFA250

■ Dimensions (mm)

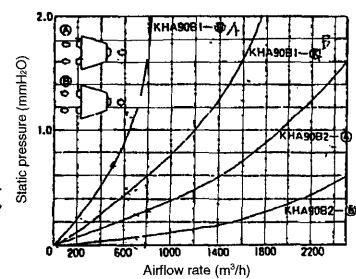
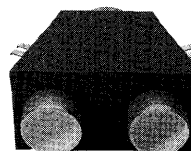


■ Pressure loss curve

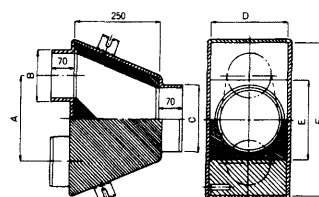


Branch duct

KHA90B1
KHA90B2



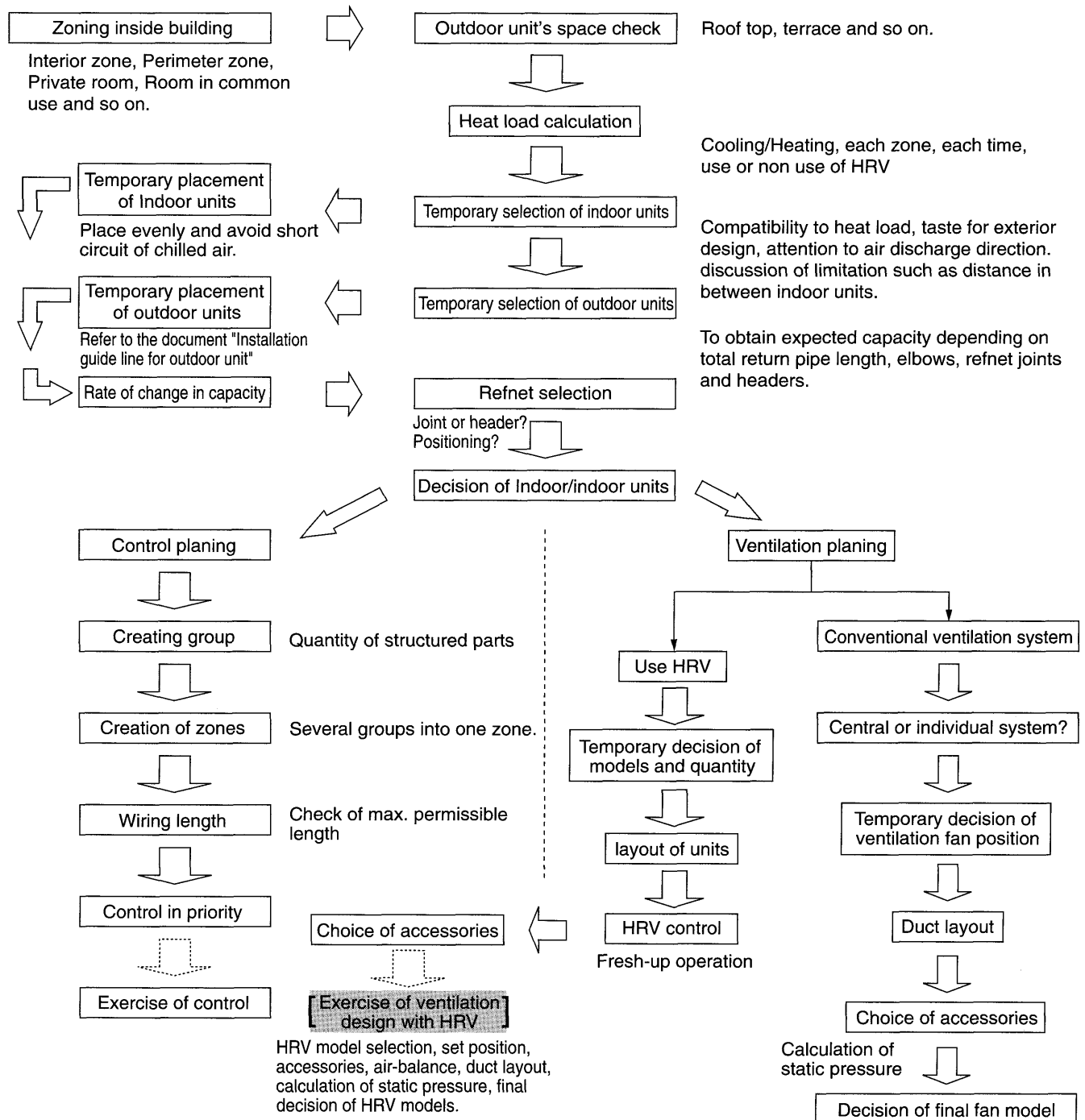
■ Dimensions (mm)



■ Dimensions

	A	B	C	D	E	F
KHA90B-1	255	φ150	φ200	242	240	448
KHA90B-2	300	φ198	φ248	290	290	544

Design procedure is indicated in this below chart. The topics with shaded enclosure signify topics which will be explained in the succeeded several pages till the other similar chart with other topics in shaded enclosures will appear.



3-6-5 Exercise of ventilation design with HRV

Let's exercise using the sample building

- a) Decision of ventilation rate
 - Positioning of supply inlet and exhausting outlet
- b) Temporary selection of HRV
- c) Layout of duct system
- d) Estimation of pressure loss
 - HRV airflow recheck and final selection

a) Decision of ventilation rate

Since this value was decided at the heat load calculation, pick them up from Table 6. Exhausting airflow rate should be decided based on another standard including exhausting rate in toilet, or so. However, the process to decide the exhausting rate for contaminated area is omitted here.

Table 27 Summary of air flow rate of ventilation

Room name	Supply (CMH)	Exhaust (CMH) ※
Office	1560	
Meeting room 1	200	
Meeting room 2	200	
Meeting room 3	200	
Meeting room 4	200	
Guest room	100	
VIP room	100	
Convention hall	600	
Small warehouse	40	
Small kitchen		290
Toilet		1260
Machine room		90
Total	3200	1640

Note) The meaning marked with ※ is the returned air to the corridor, then exhausting to outdoor.

Ratio of exhausting is very high approx. 50% in comparison to supply rate. Here, we recognize this high rate and let's go ahead to next subject.

- Positioning of supply inlet and exhausting outlet

As the office is very broad space, both supply inlets and exhaust outlets are shared to six portions;
 $1,560 \text{ CMH} \div 6 = 260 \text{ CMH}$

Convention hall will have two portions each for inlet and outlet: $600 \text{ CMH} \div 2 = 300 \text{ CMH}$, and small rooms in both sides will have one portion each for inlet and outlet.

Four portions of return grilles will be located over the corridor to return air from the living space to the utility core;
 $1,640 \text{ CMH} \div 4 \text{ portions} = 410 \text{ CMH}$

These would be rather large sized outlets. The temperature and humidity conditions blowing from these grilles will be able to estimate on the psychrometric chart if outdoor conditions are cleared. (Here, the evaluation of the discharging air is omitted)
This returned air is responsible to airconditioning for the utility core and compensates the amount to be exhausted from the utility core.

b) Temporary selection of HRV

If four units of HRV are used, $3,200 \text{ CMH} \div 4 = 800 \text{ CMH}$, and by three units $3,200 \text{ CMH} \div 3 = 1000 \text{ CMH}$

It can be estimated that four units of VAM 800 or three VAM 1000 are possible to cover the ventilation requirement. Normally, what either model selection is more suitable for the request depends on the whole cost estimated including duct construction, and the final decision must be judged in consideration of cost performance. But here, take the system with four units of VAM 800 owing to its simplicity of the duct system.

Air balance by four units of HRV

Unit: CMH

Room name	HRV #1		HRV #2		HRV #3		HRV #4		Total
	Supply	Exhaust	Supply	Exhaust	Supply	Return air	Supply	Return air	
Office			360	360	600		600		1560(Supply)
Meeting room 1	200	200							200(Supply)
Meeting room 2			200	200					200(Supply)
Meeting room 3			200	200					200(Supply)
Meeting room 4					200				200(Supply)
Guest room							100		100(Supply)
VIP room							100		100(Supply)
Convention hall	600	600							600(Supply)
Small warehouse			40						40(Supply)
Corridor				40※		800		800	1640(Exhaust)
Total	800	800	800	760+(40)	800	800	800	800	

Note) ※ : The exhausting at the small warehouse (air flow rate with 40CMH) is "Return air" and the air flows through the under-cut slit provided on the door out to the corridor.

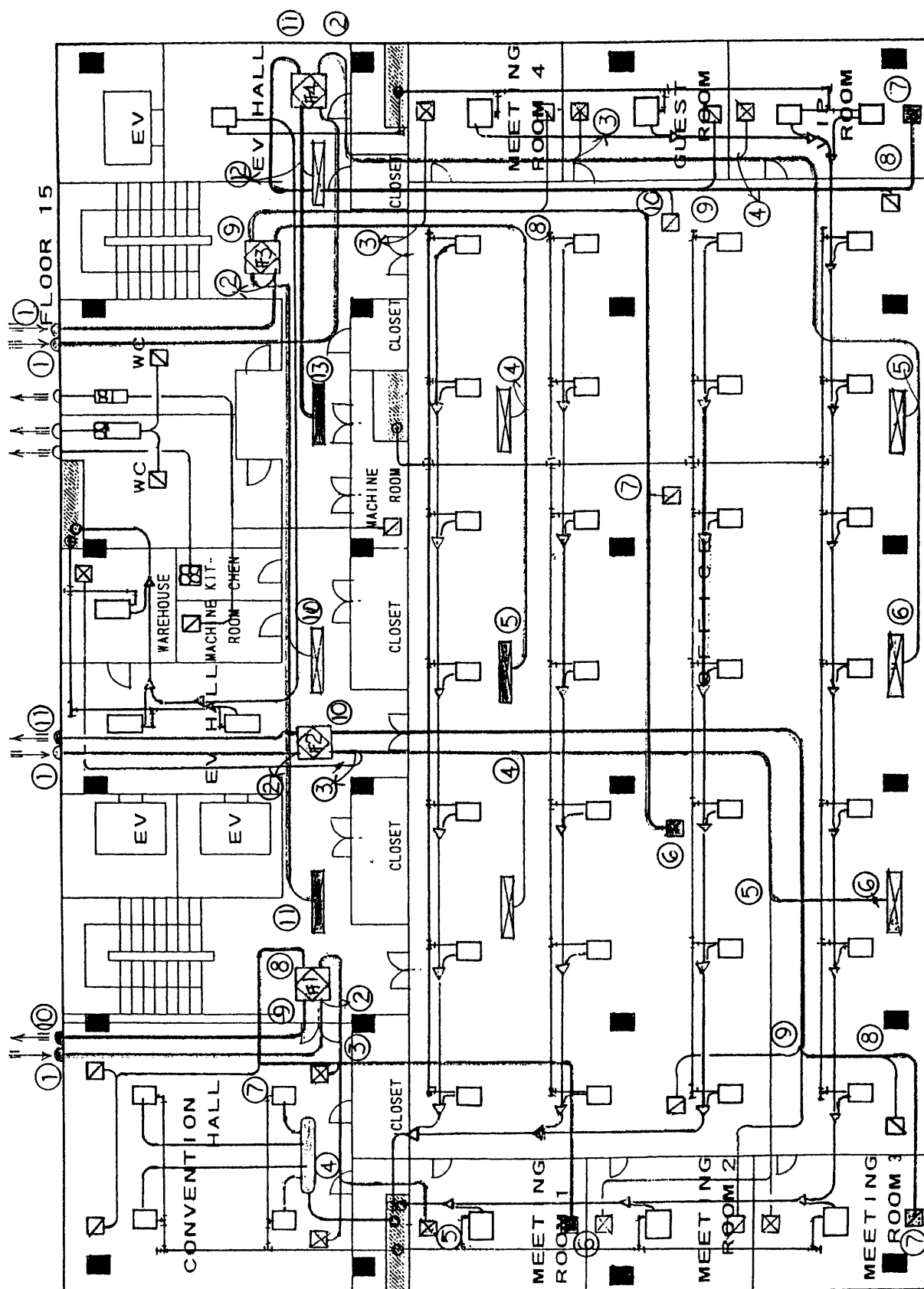
c) Layout of duct system

Four HRV units in accordance with the air distribution which has been decided before previous section are going to be installed on the ceiling over the corridor and duct system is to be provided like the layout shown in Fig. 90 "HRV layout example".

The use of flexible ducts in about 1m length are recommended at the four connections of outlets and inlets around HRV body to be able to adjust a little positional difference of HRV body to the duct core and to avoid vibration. The pressure loss in a flexible duct are shown in Fig.92 ~ Fig.95.

Let's look at the pass connecting to HRV #1 in detail. Air is sucked in through weather cap (1) and flows into HRV through flexible duct. Outdoor air which has been exchanged the heat contained passes through the flexible duct and branches into the convention hall and the meeting room 1, supplying to the rooms. The exhausting air are sucked from the suction grilles in the convention hall and meeting room No.1 and join together, going into HRV through flexible duct, and exchanges heat contained, flowing out to weather cap through flexible duct. Thus, finally the air exhausts out to outdoor.

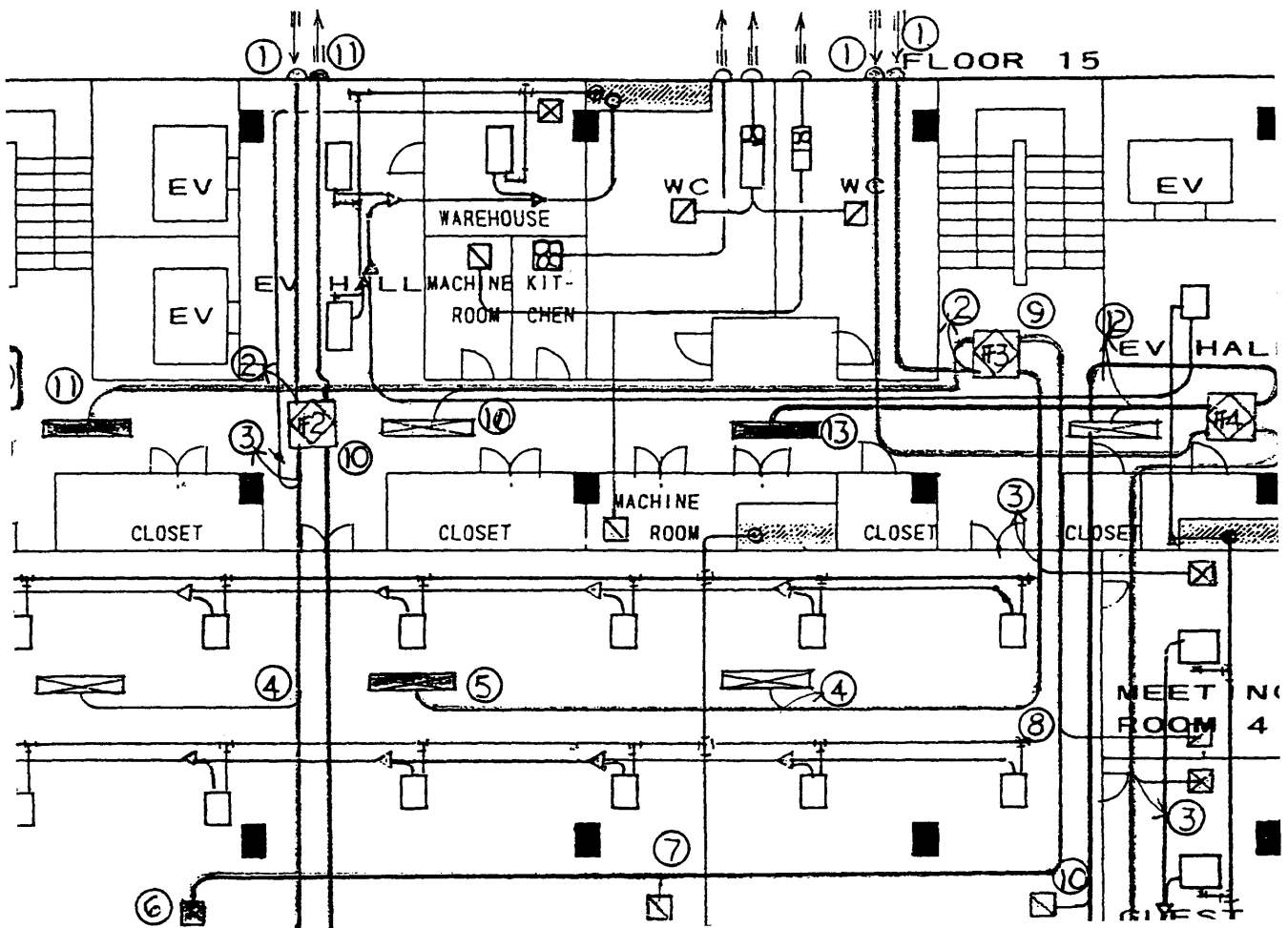
Fig. 90 Hrv layout of the sample building



Meaning of HRV #3 placement

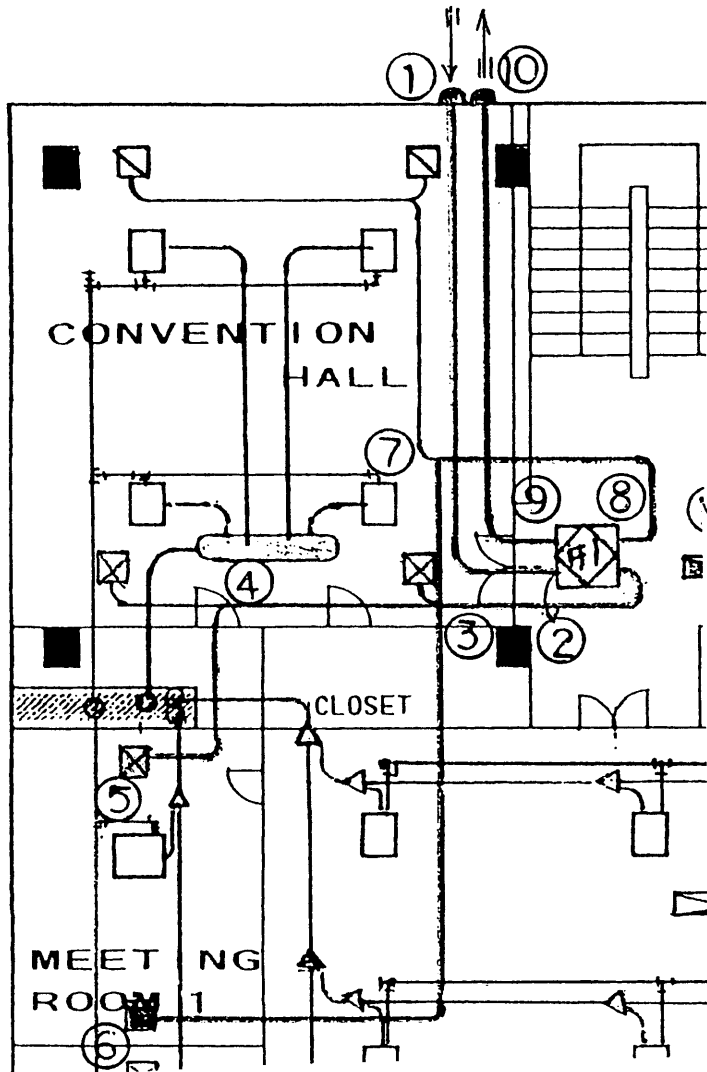
Especially #3 HRV unit takes a close-up below. Let's explain the air balance occurred here. The outdoor air supplied through a weather cap ① runs through HRV and flows into the interior zone through the discharge grille ⑤ and ④ in the air flow rate $800 \text{ m}^3/\text{h}$. On the other hand, the exhausting air is sucked from the suction grilles ⑥ and ⑦ in the interior zone and a grille in meeting room No.4, and supplies to the corridor with the airflow rate $800 \text{ m}^3/\text{h}$ through HRV and then the discharge grilles ⑩ and ⑪, compensating the air volume equivalent to the exhausting from the contaminated area (Toilet, Kitchen) of the utility core. The airconditioning in the utility core will be carried out by this return air though temperature and humidity are not controlled.

Fig. 91 : HRV accompanied with return air



d) Estimation of pressure loss

Paper volume of this handbook can not afford to calculate all of the cases (#1, #2, #3, #4). Therefore, only #1 unit is taken up and described the pressure loss on the duct system. Try to solve the other cases for #2, #3, #4 by yourselves after studying the procedure.



Pick up all fittings including elbows and read out the straight part of the duct, pressure loss at all the fittings, and then calculate the overall required static pressure. The results of the calculation are shown in Table 24 (supply duct) and Table 25 (exhausting duct). Keep in your mind to multiply 1.1 for final procedure to add allowance.

Fig. 96: Plan view of HRV unit #1 with duct system

Re-selection of HRV models

If the airflow rate which was read on the fan performance chart in accordance with the static pressure calculation result was too small or too large to the required airflow rate, the reviewing becomes necessary.

- 1) Adjust of fan speed: "Ultra-High" should be used by means of the field setting mode number 17 with the setting switch number 4 and the setting position number 01 and 02. Besides, use the switching of "Low" and "High" in the mode number 4 with the setting switch 0.
- 2) Reviewing the models: Since an adjustable range by fan speed is very limited, change the model if the range exceeds the limitation.
- 3) Provide a damper and throttle the airflow rate. This remedy just acts the airflow rate to reduce, but can adjust the imbalance by about 5%.

By the way, let's go back to the exercise and watch # 1 HRV unit. As the pressure loss 12 mm Aq. in the supply side and 12.5 mm Aq. in the exhausting side were calculated out, in case of the fan speed in "High", only 700 CMH comes out, but, when switching over to "Ultra-High", 800 CMH can be achieved. Thus, as possible to adjust by means of the method 1) above and it is concluded with no need to change the model.

Table 24 Duct calculation table

SUBJECT[Supply air duct calculation on HRV # 1]

Position	Air flow rate		Duct Length m	DUCT SIZE		Velocity m/sec	Basic Friction Loss mmAq/m	FITTINGS					Friction loss mmAq
								NAME	SPEC.	PCS	Unit loss		
	m ³ /min	m ³ /h		mm	cm						mmAq	mmAq	
1		800		250				whther cover	YCFA250	1	6	6	
1-2	13.33	800	7.2	250	4.6	0.12						0.86	
			1	250		0.15		Flexible duct		1		0.15	
								Flexible duct's 45° bend		2	0.17	0.34	
								Elbow		1	0.2	0.2	
2-3			1	250		0.15		Flexible duct		1		0.15	
								Flexible duct's elbow		2	0.28	0.56	
			3	250		0.12						0.36	
3								Distributor	KHA90B-2	1	0.3	0.3	
3-4	8.33	500	3.3	200	4.4	0.14						0.46	
4								Distributor	KHA90B-1	1	0.7	0.7	
4-5	3.33	200	3.1	150	3.2	0.11						0.34	
								Elbow		1	0.2	0.2	
5								Discharge grille	YDGL150A	1	0.5	0.5	
											TOTAL	11.12	
								Supply air duct's loss	11.12 X 1.1 = 12.232 ÷ 12mmAq [÷ 120Pa]				

MACHIN SELECTION RESULT: MODEL VAM800CJV CAN SUPPLY FRESH AIR 840m³/h AT ULTRA-HIGH POSITION AT 50 Hz ELECTRICITY.
SO, ADJUST DAMPER SO AS TO GAIN 800m³/h FRESH AIR PROPERLY.

Table 25 Duct calculation table

SUBJECT[Exhausting air duct calculation on HRV # 1]

Position	Air flow rate		Duct Length m	DUCT SIZE		Velocity m/sec	Basic Friction Loss mmAq/m	FITTINGS				Friction loss mmAq
	m ³ /min	m ³ /h		mm φ	cm φ			NAME	SPEC.	PCS	Unit loss mmAq	
6		200						Suction Grille	YDGL150A	1	0.5	0.5
6-7			13.5	150	15	3.2	0.11					1.49
								Elbow		1	0.2	0.2
7		800						Distributor	KHA90B-2	1	0.3	0.3
7-8	13.33	800	4.5	250		4.6	0.12	Elbow				0.54
								Elbow		1	0.2	0.2
			1.0				0.15	Flexible duct				0.15
								Flexible duct 45°		2	0.17	0.34
9-10		800	7.8	250		4.6	0.12					0.94
								Elbow		1	0.2	0.2
			1				0.15	Flexible duct				0.15
								Flexible duct 45°		2	0.17	0.34
10								Whether cap	YCFA250	1	6	6.0
											TOTAL	11.35
								Exhausting duct's loss	11.35 X 1.1	= 12.485	≒ 12.5 mmAq	
											(≒ 125Pa)	

MACHIN SELECTION RESULT: MODEL VAM800CJV CAN SUPPLY FRESH AIR 840m³/h AT ULTRA-HIGH POSITION AT 50 Hz ELECTRICITY.SO, ADJUST DAMPER SO AS TO GAIN 800m³/h FRESH AIR PROPERLY.

FLEXIBLE DUCT

Flexible duct makes it easy to install and design ducting systems. Recent flexible ducts are prefabricated and mainly made of aluminum around which glass-wool with thickness of 25mm and density of 24 kg/m^3 in the external surface or the internal surface is wrapped up for insulation and sound attenuation.

Fig. 92: Sectional view

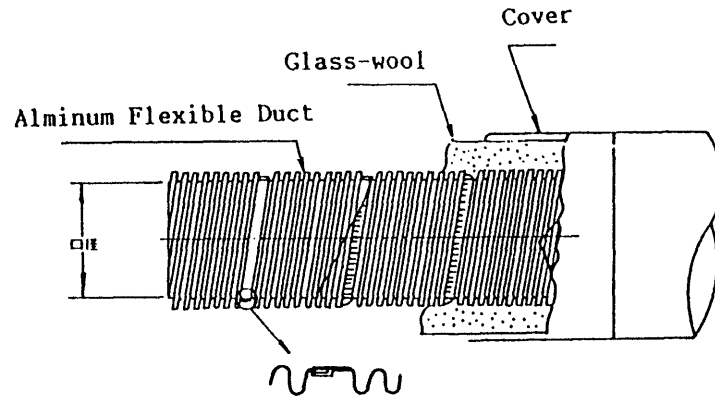


Fig. 93: Chart to get pressure loss

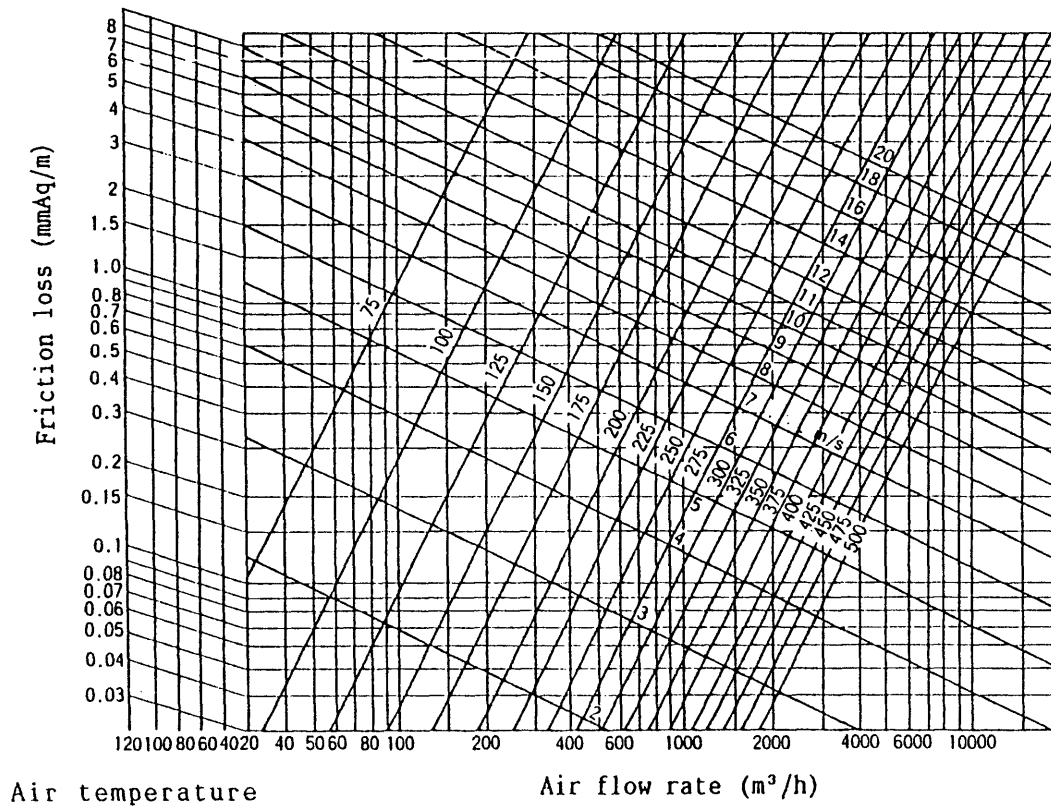
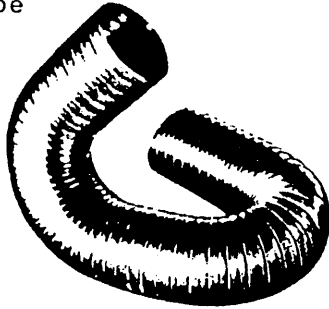


Fig. 94: Sectional view

Single Type



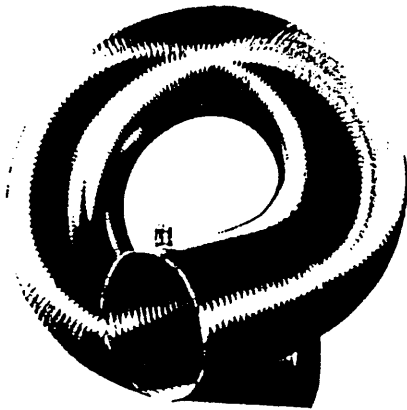
Available size



Internal Diameter

75	100	125	150	175	200	225
250	275	300	325	350	φ	

Double Type

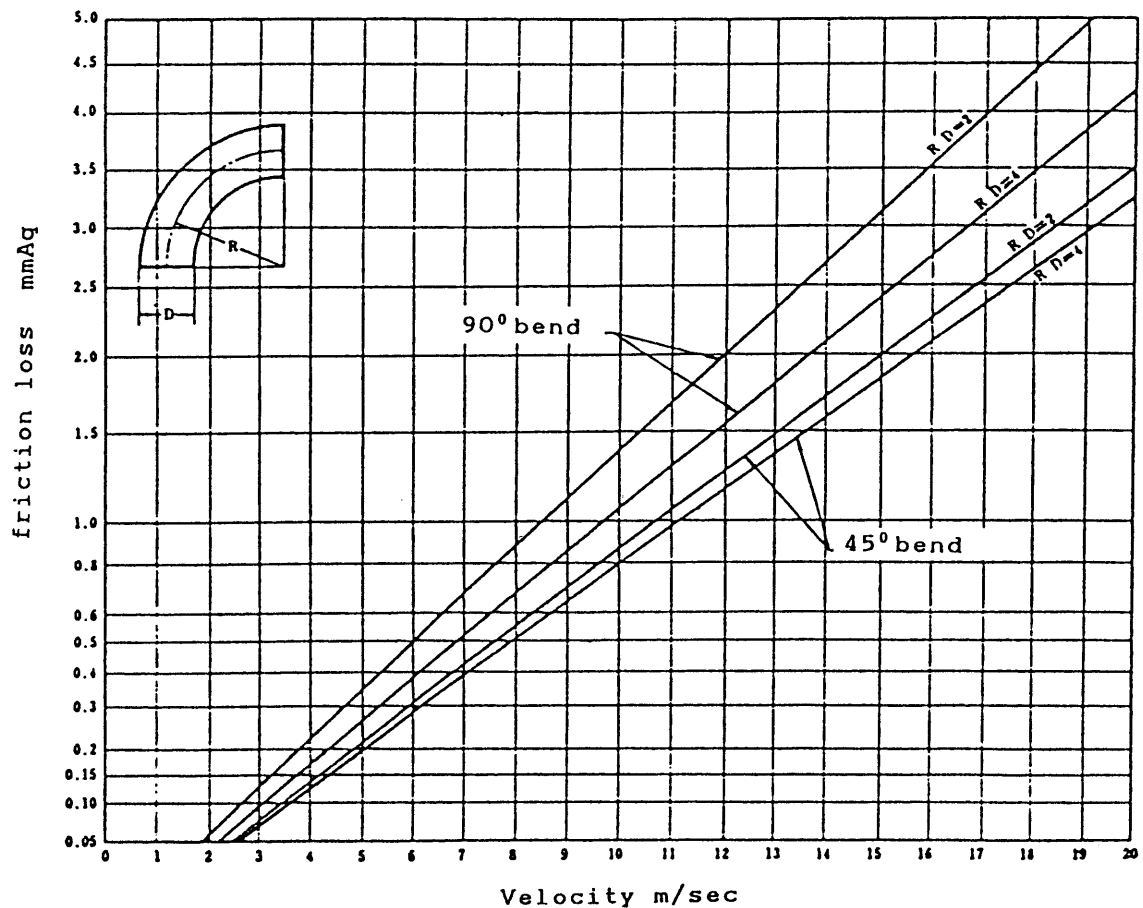


Internal Diameter

150	175	200	225	250	275	300	325
350	375	400	425	450	475	500	φ

BEND PART FRICTION LOSS OF FLEXIBLE DUCT

Fig. 95 : Pressure loss at bend



3-7 Drain piping planning

Although this subject was studied in the fundamental course of this "Sales Engineers Seminar", again here let's summarize the gist of drain piping design for targeting large sized building.

- 1) Design drain piping without any attention to the refrigerant circuit and electric wiring.
- 2) Take the shortest way to a building shaft and use the pipe in long span with the same diameter as much as possible so far as matching to the principle of sizing pipes in relation to the water internally held.
- 3) Indoor units are often installed in a space above ceiling. So, design the drain line with $1/50 \sim 1/100$ gradient in consideration of the lift realized by a drain pump.

Various drain-up are listed in Fig. 97. In addition, one example of drain piping applied to the sample building is shown in Fig. 98 for your reference.



Fig. 97: Drain-up piping using drain pump

Drain pump's lift-up level

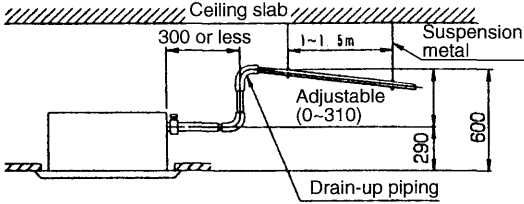
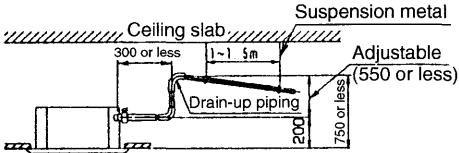
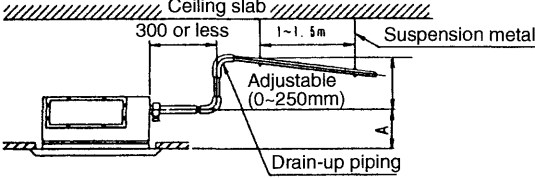
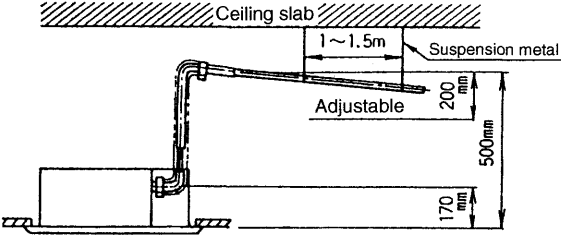
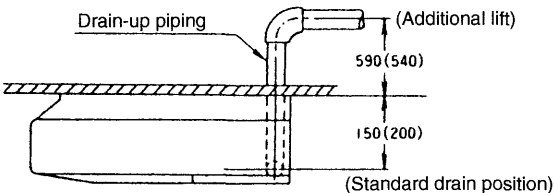
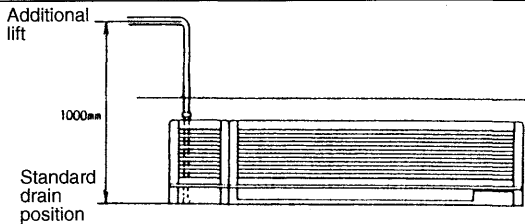
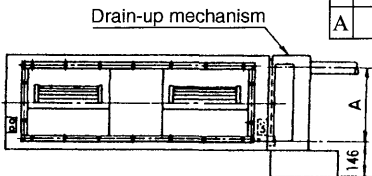
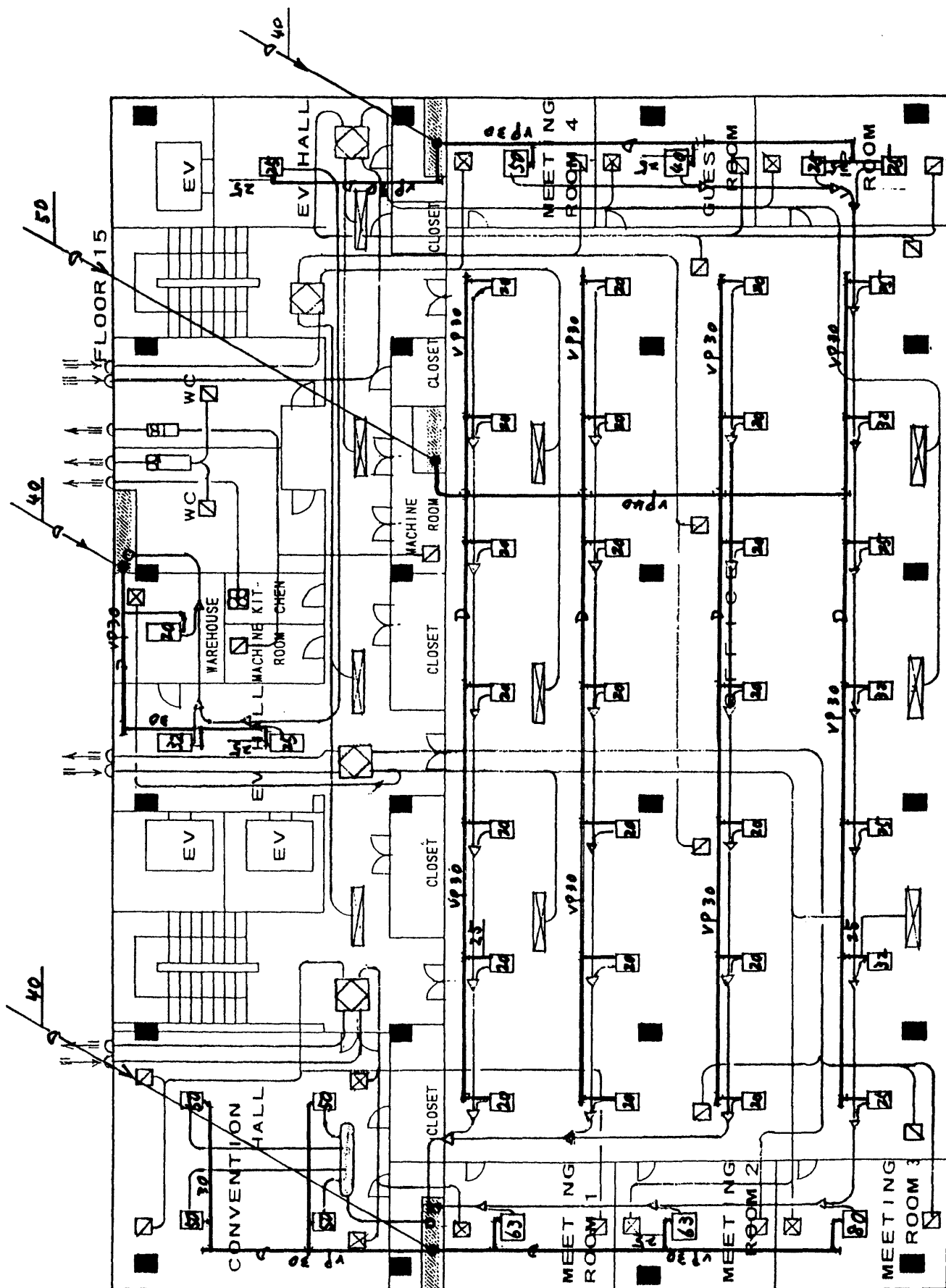
Indoor unit	Drain-up kit name	Lift from normal drain position	Additional lift	Appearance											
Ceiling mounted cassette <Double flow type> FXYC ~ KA	Standard	——	MAX 310mm												
Ceiling mounted cassette <Multi-flow type> FXYF ~ KA	Standard	——	MAX 550mm												
Built-in type FXYS ~ K	Standard	——	MAX 250mm	 <table border="1"><tr><td colspan="2"></td><td>A</td></tr><tr><td rowspan="2">Canvass duct at together use</td><td>Half panel</td><td>350~530</td></tr><tr><td>Full panel</td><td>390~530</td></tr><tr><td colspan="2">Suction panel (Full & Half) at direct mounting</td><td>275</td></tr></table>			A	Canvass duct at together use	Half panel	350~530	Full panel	390~530	Suction panel (Full & Half) at direct mounting		275
		A													
Canvass duct at together use	Half panel	350~530													
	Full panel	390~530													
Suction panel (Full & Half) at direct mounting		275													
Ceiling mounted cassette <Corner type> FXYK ~ K	Standard	——	MAX 330mm												
Ceiling suspended FXYH ~ K	Option KDUJ5F50 KDUJ5F80 KDUJ5F90 KDUJ5F160	*Lift from drain outlet in the unit 740mm (J36 ~ J160 Type)	(From ceiling board) 590mm (J36 ~ J80 Type) 540mm (J90 ~ J160 Type)												
Wall mounted	Option KDUJ421B112	——	1000mm												
Duct connection FXYM ~ K FXYMN ~ K	Option KDUJ30K140 (J45 ~ J140 Type) KDUJ30K280 (J224 ~ J280 Type)	*Lift from drain outlet in the unit 294mm (J45 ~ J160 Type) 375mm (J200 ~ J280 Type)	——	 <table border="1"><tr><td></td><td>KDUJ30K140</td><td>KDUJ30K280</td></tr><tr><td>A</td><td>294</td><td>375</td></tr></table>		KDUJ30K140	KDUJ30K280	A	294	375					
	KDUJ30K140	KDUJ30K280													
A	294	375													

Fig. 98 : Example of drain piping in the sample building



Making Presentation For System Proposal



Introduction

Presentation is a useful sales technique for differentiating your products from competitors. In project sales in particular, the most effective business strategy is to give a presentation to the key person as he/she is the one in charge of making a decision on which air-conditioning system to use.

There has been no systematic manual available to develop a presentation because presentations are used in such a wide range of applications and can take diverse forms depending on products, clients, media, and contents. However, through analysis of the contents and techniques of some cases, we could identify several basic ingredients of a good presentation.

This manual is intended for beginners. Below are procedures and tips on making a presentation for project sales.

4-1. Purpose of Presentation

The key person who selects the air-conditioning system of a project, such as the owner of the building, Architect or M & E consultant, is often an independent person with a creative personality. To convince these people, a brochure or technical material is not effective. He or she is too busy to read through the brochure. Also, general sales materials do not give a precise idea on how our air-conditioning system can be incorporated into their planned building. If another air-conditioning system has already been incorporated in the design of the building, there is little hope of your success unless you present an alternative system of substantial merit.

It is more effective if, within a short meeting with the key person, we can propose our system as well as make a comparison with the competitor's system, focusing on the project.

4-2. Preparation Stage

4-2-1 Target Setting

Before making a presentation, you should define what you want to achieve (target) through that presentation. The target is related to assessment. Whether a target has been achieved or not is a factor of assessment.

4-2-2 Identify the right timing

Check the progress of the project. Different stages of projects require different presentation strategies. It is important to know the "RIGHT" time to make the most impact with your presentation. Basically, there are five stages of projects.

Stage	1.The client has no specific plan to construct a building. 2.The client has an outline of the construction of a building, but no air-conditioning system has been selected. 3.The client has an outline of the construction of a building with a candidate air-conditioning system, or the design assumes an air-conditioning system. 4.Design drawings have been established including an air-conditioning system. The overall construction budget is not fixed yet. 5.Design drawings have been established including an air-conditioning system. The overall construction budget is already fixed.
-------	---

At stage 1, it is best to give an explanation using a brochure or a leaflet with descriptions of existing installations because little information is available from the client.

Stage 2 to 4 present the best opportunity for a presentation. The client has no definite idea at stage 2, in which case, you can make a complete presentation. At stages 3 or 4, you should concentrate on a comparison with the client's planned air-conditioning system. Emphasis is to differentiate our products and highlight the merits.

In the case of stage 5, it is too late to find an opportunity to make a presentation.

4-2-3 Key person Analysis

Key person analysis means finding out what information the client key personnel is interested in and what he/she feel is most important.

A general checklist used to collect information on the key person is shown on the following page.

Case studies indicate that the key person is principally interested in costs followed by performance.
Below is an analysis of common requests of the key person.

1. Attach importance to initial costs.
2. Attaches importance to initial costs, and is also concerned with running costs.
3. Attaches importance to initial costs, and is also interested in performance.
4. Desires a comparison with other air-conditioning systems.

Key person checklist	
Knowledge about the subject of proposal	Much / Average / Little / Not known
Key person's acquaintance with presenter; presenter's achievements	Close / Average / Near Stranger / Not known
Period (years)	Past achievements
Beneficial or detrimental factors (to key person) of the subject of presentation	Beneficial factors Detrimental factors
Range of key person's vocabulary	Includes technical terms / Generally wide / Generally narrow / Not known
Acceptance of new ideas	Eager / Open / Average / Hesitant / Opposed
Other factors influencing key person's understanding	Age Taboo words Interests
Information possibly of interest to key person	Logic / Case examples / Technical information / Statistical comparison / Costs Case examples in advanced countries / Convenience / Flexibility / Amenities
Feedback from the key person	Expected / Not expected

4-2-4 What is an Effective Proposal?

In general, presentations are classified into three types according to the contents. Presentations intended for projects fall under the persuasive type –3.

1. Informational
2. Educational
3. Persuasive

The persuasive type presentation is not a one-way conversation, i.e., you speak and the client listens. A presentation should be given as a dialogue between the presenter and the client. For a presentation to become more interactive, its contents should meet the following conditions.

1. The client's expected needs should be fulfilled.
2. Evaluation should be made in comparison with other air-conditioning systems including competitors' products.
3. The contents should be easy to understand.
4. Calculated figures should be used for explanation.
5. Merits and demerits should be identified impartially.

4-3. Layout

4-3-1 Layout of Pages for a Written Presentation

Below is a typical example of a layout of pages for a presentation.

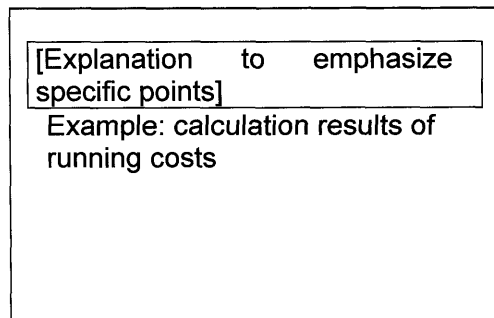
- Page 1: Carries a project title and the name of your proposed system to show first and quickly what you want to show the client.
- Page 2: Outlines your proposed system and highlights the merits and comparison with other air-conditioning systems. Use graphs and charts.
- Page 3: Focus on specific topics and, where possible, makes the most of figures.
- Page 4: Shows supplementary or background information worth presenting to the client or adds to the contents on Page 3.

Cover Project title Your proposed air-conditioning system Introduction

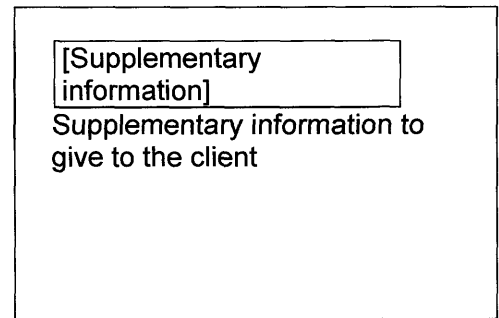
Page-1

[Outline of your proposed air-conditioning system] Main Equipments System Construction 1. Comparison of air-conditioning systems 2. Numerical and qualitative Comparisons
--

Page-2



Page-3

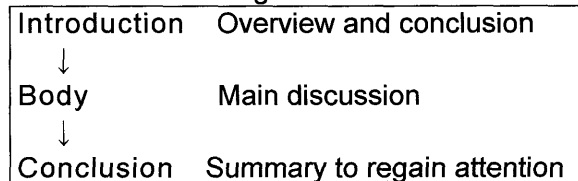


Page-4

4-3-2 Layout of a Slide Presentation

A similar layout to that of the written presentation (explained previously) can be used for a slide presentation. However, it is not recommended to write too much information on a slide as there is a distance between the audience and the projected image on the screen. The presentation contents on a written page should be divided for slides. Division will increase the number of slides compared with written pages. Therefore, it is advisable to present a conclusion on the last slide to regain the client's attention.

Slides become easier to understand if each slide carries about 3-selected topics. If you want to show a breakdown of your proposals, it is recommended to list them within about 8-lines to ensure they are easily viewable.



4-3-3 Effectiveness of Visual Elements

The effectiveness of a slide increases by using lists, if it is text-based material, or a table or graph if you want to make a comparison or summarize your point of view. A photograph or illustration on a slide makes it more impressive. A presentation incorporating these visual aids has the following effects.

Visual aids should be used sparingly. If you paste illustrations or the like on every slide, your point will be ambiguous.

To make points easier to understand
 Better memory
 Influence on explanations given later

You can use a digital camera, which has rapidly become popular, to take photographs to enhance reality compared with clip art or other illustrations. Given originality, your photographs can produce a friendlier atmosphere.

4-4. Comparison of Systems

4-4-1 Factors for Comparison

Fair assessment is vital to convince the client of your system. To make fair assessment, you need to identify the merits and demerits of your system in a comprehensive comparison with other air-conditioning systems. A system comparison chart is very useful.

In general, when building owners choose an air conditioning system, they are concern about two major factors: costs and performance. There will be an optimum choice somewhere between cost and performance.

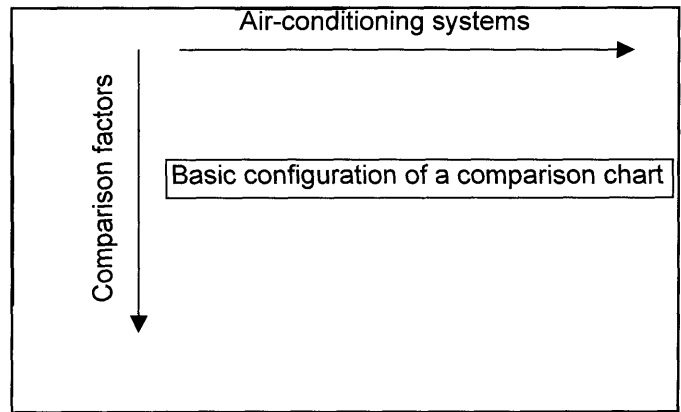
Costs include the initial cost and running costs. Performance is measured by the accuracy of temperature - humidity control, ease of use, safety, flexibility, the space it occupies, amenity, and the like. These parameters are used to make a comprehensive comparison of air- conditioning systems.

The chart shown at right illustrates an example of factors used to make a comparison.

Factors, affecting the choice of system	
The follows are some of the important design parameters with an indication of how well the various system are able to satisfy desiners.	
Spatial impact	Flexibility
Machine Space	To suit partitioning arrangement
Ducts and Piping shafts	To increase cooling load
Floor space encroachment	To increase ventilation
ceiling depth	Operation during non scheduled hours
Quality of IAQ Performance	Operation at some area
Temperature Control	safety
Humidity Control	Potential for water leakage from ceiling
Air Distribution	Dispersion of heat source equipments
Noise	Easy to backup
Number of sensors	easy to use
Costs	Remote controllers in each room
Capital(Initial)	
Operating Energy	
Maintenance	

4-4-2 Layout of a Comprehensive Comparison Chart

When designing a comparison chart, a common way is to list the comparison factors vertically, and air-conditioning systems on a horizontal row.



4-4-3 Terms Indicating Relative Merits

Cells in a comparison chart should carry terms that clearly indicate relative merits to the reader. Since it is likely to cause misunderstandings in some countries, use of symbols such as ○ and × and numerical values such as rating on a scale of 1 to 10 should be avoided.

Recommendable

Terms indicating relative merits

Excellent / good / poor
Excellent / moderate / poor
number of stars ~ ☆☆☆☆☆ / ☆☆☆ / ☆☆ / ☆
Simple / Complicated
High / Low, save / waste

4-4-4 Example of a Comparison Chart of Air-Conditioning Systems

Below is a comparison chart on different air-conditioning system designs. The chart makes a fair comparison. When developing a presentation for a specific project, select a parameter that highlights the specific advantage of the proposed system. You can also impress the client with information on major demerits, if any, of the competitor's air-conditioning system.

Factors, other than thermal, affecting the choice of system

	System type				
	Fan-coil system, 4-pipe with independent air supply	Single duct VAV with perimeter heating	Dual duct VAV	Induction system, 4-pipe	Reverse cycle heat pump, with independent air supply
Spatial impact					
plant space	Average	Poor	Poor	Average	Good
riser shafts	Average	Poor	Poor	Average	Average
floor space encroachment	Poor	Average	Good	Poor	Poor
ceiling depth	Average	Poor	Poor	Average	Average
Quality of performance					
temperature control	Good	Good	Excellent	Average	Satisfactory
humidity control	Adequate	Satisfactory	Good	Adequate	Poor
air distribution	Adequate	Satisfactory	Satisfactory	Poor	Poor
noise	Adequate	Good	Good	Adequate	Poor
Costs					
capital	Average	Average/high	High	Average	Low
operating energy	Average/high	Low	Average	Average	Average
maintenance	High	Average	Average	High	High
Flexibility					
to suit partitioning arrangements	Good	Good	Excellent	Poor	Poor
increase cooling load	Good	Average	Good	Poor	Poor
increase ventilation	Average	Good	Excellent	Poor	Average

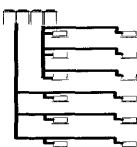
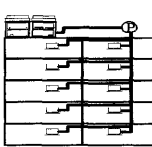
Reference : Faber & Kell's Heating & Air-conditioning of Building

The chart shown at right is suitable if the owner of a building does not have much knowledge of air-conditioning systems.

The comparison is done by means of the number of stars. Incorporation of visual aids makes your presentation more impressive.

Brief comments added to terms indicating relative merits in each column will facilitate your explanation.

Comparison between VRV and Chiller system

	VRV	Chiller
Layout		
Individually Control	☆☆☆☆☆ Possible~125 Individual	☆ Impossible
Running cost	☆☆☆☆☆ Low	☆☆ High
Operation	☆☆☆☆☆ Easy ~ remote controller	☆☆ Complicated
Installation	☆☆☆☆☆ Short	☆☆ Long
Safety	☆☆☆☆☆ No Problem	☆☆☆ Water Leakage

4-5. Running Costs

In most presentations, an explicit indication of cost calculations furthers the understanding of the audience. Comparison charts shown above are rather qualitative, which are intended for image building. Those visual elements should be supplemented with an explanation using calculated figures to make your proposal complete and to satisfy the client's needs.

The factor of running costs is as significant as the initial cost. Daikin's product line-up includes many energy-saving systems. For the presentation of an energy-saving system, a trial calculation of running costs to make a comparison with other air-conditioning systems provides the most convincing material.

4-5-1 The Operating Cost

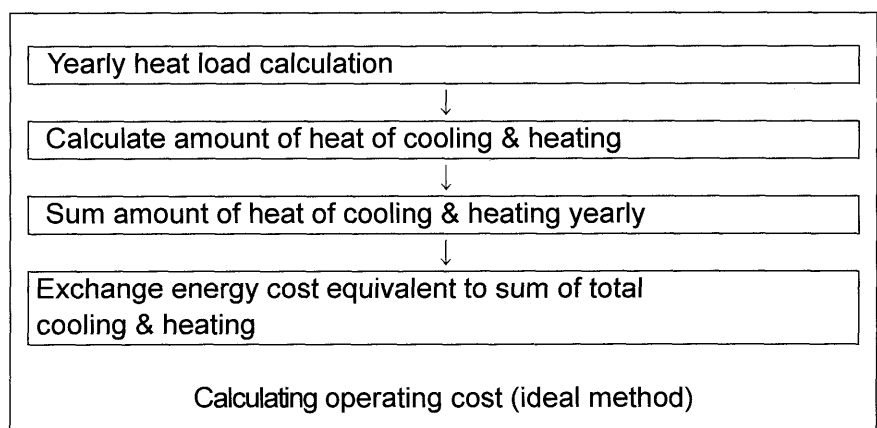
Running costs are divided into the operating cost (necessary for the operation of an air-conditioning system), periodic maintenance cost, and interest cost. The operating cost accounts for a large part of running costs. The concept of and a calculation method for the operating cost are described in the following sections.

Running costs
1. Operating cost (electricity, water, gas, etc.)
2. Maintenance cost (labor and spare parts)
3. Interest cost

4-5-2 Ideal Calculation of the Operating Cost

Ideally, trial calculation of the operating cost should be based on a yearly heat load calculation sheet, which take into account the hourly load for 24 hours a day for 365 days. The heat load is converted into the amount of heat in cooling and heating and the annual sum is calculated. The amount of heat is then converted into energy cost.

The calculation procedures are summarized on the right.



The yearly heat load calculation described above involves hourly, monthly, and seasonal climatic conditions and usage conditions of the system in each room. Such calculations are complicated and tedious. In addition, such data are usually not available in the planning stage.

The clients normally do not demand a detailed calculation of the operating cost before tendering stage. Rather, they are interested in the differences in the operating cost among several air-conditioning systems running under the same conditions. In that case, calculation conditions can be simplified, and results will be more easily understood.

4-5-3 Simplified Calculation of the Operating Cost

The basic formula used for a simplified calculation of the operating cost is:

$$\text{Operating cost} = \text{Unit price of energy} \times \text{Operating time} \times \text{Average energy consumption}$$

In this formula, the term "average energy consumption" is the average amount of energy consumed in an operating period. This term is required when the loads are variable. An air-conditioning system consists of several major components consuming energy. The control devices, pump, and fan undergo almost no load changes while the system is "ON".

For control devices, pump, and fan, we generally substitute their rated motor outputs, (or even at 90%) for the average energy consumption in the formula above.

The compressor and boiler, however, have load changes according to changes in heat load. Hence, for boiler and compressor, the average energy consumption taking into consideration the detailed conditions specified in section 4-5-2

Components of Air-conditioning Equipment	
Control devices	Remote controller Control Panel
Pump	Chilled & Hot water pump Condenser pump
Fan	FCU, AHU, Ventilation Cooling tower
Compressor	Package A/C Chiller
Boiler	Boiler

Ideal Calculation of the Operating Cost, based on practical data, the average energy consumption of the compressor and boiler is about 70% of ratings. A ratio exceeding 70% implies that there is little allowance for additional air-conditioning. If the ratio is smaller than 70%, the air-conditioning system has too much allowance. In either case, selection of an air-conditioning system is made depending on the balance between budget and performance. An economical choice is such that the average energy consumption is about 70% of the full load.

Energy consumption of control devices is negligible, accounting for less than 3% of the total energy consumed by air-conditioning system components.

Components	Characteristic of Energy consumption	Average Energy Consumption
Pump & Fan	Fixed energy consumption during operation	90% of rated motor output
Compressor Boiler	Variable depending on heat load	70% of rated energy output

4-5-4 Electricity Expenses

Below is an equation derived from the basic formula in 5-3 to use in the case of electricity.

$$\text{Electricity expenses} = \text{Unit price of electricity (price/KWH)} \times \text{Operating time (h)} \\ \times \text{Average power consumption (KW)}$$

4-5-5 Water Expenses

In water-cooled air-conditioning system, water evaporates from the cooling tower. Approximately 2% of the circulating water flow is required as supplementary feed.

$$\text{Water expenses} = \text{Unit price of water (price/m}^3\text{)} \times \text{Operating time (h)} \\ \times \text{Circulating water flow volume (m}^3\text{/h)} \times 0.02$$

4-5-6 Unit Price of Energy

The unit price of energy varies by countries, regions, and contracts with suppliers. Consult the utility company operating in the region for details. It should be noted, however, that some consultants have data on unit prices of energy. They may indicate a unit price of energy to you in some cases.

The unit price of energy should be borne in mind at all times to prepare for the development of a presentation.

Rate systems of some utility companies comprise demand rate or contracted capacity charge combined with per unit rates. In that case, the unit price of energy may be calculated by adding some percentage to the per unit rate so as to take both demand rate or contracted capacity charge and metering rate into consideration.

4-6. Simple Payback Period Calculation

The running cost calculation explained in the previous section is an effective method for your presentation to make a quantitative comparison with other systems. It should be remembered, however, that costs also include the initial cost. However low the running costs may be, it would be a futile presentation if the initial cost is considerably high.

The simple payback period calculation is a technique used to make a cost comparison taking into account both initial and running costs.

4-6-1 Definition of Simple Payback Period

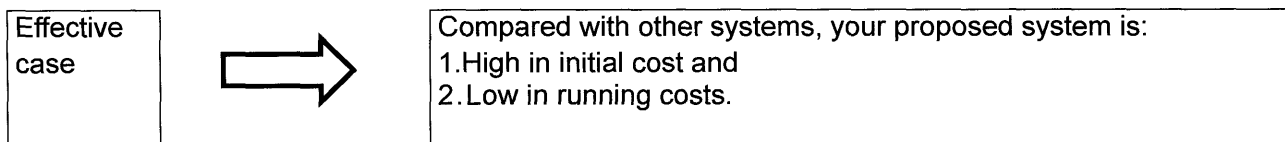
The most common term used when assessing the viability of a proposal to replace an existing scheme with one to be justified on grounds of running cost savings is **simple payback period**. This formula can be used to show the period of time it will take for our air-conditioning system to recover the difference of initial cost against competitor's system.

For example, if an energy conservation measure, costing US\$8000, could reduce annual running cost by US\$2,000, the simple payback period will be US\$8,000/2,000, i.e. 4 years.

4-6-2 Cases in Which the Simple Payback Period Calculation is Effective

In general, the VRV system is higher in initial cost and lower in running costs compared to other types of air-conditioning systems. The client would appreciate the benefits of the VRV system if your presentation shows a payback period by means of the simple payback period calculation.

If the client assumes the life of an air-conditioning system to be 12 years, the ideal payback period is about one quarter or less of that period, that is, 3 years or less.



4-6-3 Formula

The formula used for the simple payback period calculation is as follows.

$$\frac{(\text{Initial Cost of DAIKIN}) - (\text{Initial Cost of Competitor})}{(\text{The savings on Operation Cost per year})}$$

4-6-4 Example of the Simple Payback Period Calculation

Case Study

The quotation for our VRV system is 10% higher than the competitor's system.

However, our VRV system has lower running costs.

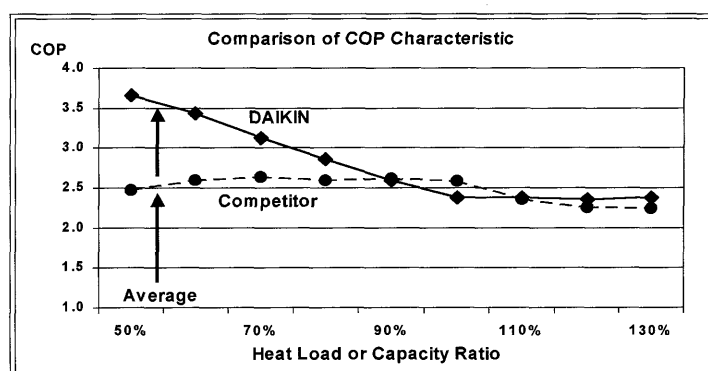
Conditions: 10 HP system, tropical area, and office building

Conditions are summarized at right.

The initial cost should include product cost and installation cost. The installation cost is omitted in this case study assuming that the systems' installation costs are the same because they are equivalent in design. Product costs are used as initial costs in this calculation.

Expected heat load characteristics based on measured values are used to calculate running

	DAIKIN	COMPETITOR	REMARKS
Product Cost	US\$ 11,400 (100%)	US\$ 10,260 (90%)	10HP system
Average COP	3.6	2.6	COP data during operation
Average Power Consumption	9 kW	12.3kW	data during operation
Heat Load Characteristic	graph6-1,6-2		Adopt typical office usage in tropical area
Operation Period	2,640 hours/year		10 hours/day, 22 days/month
Electricity Charge	US\$ 0.09		/KWH



costs instead of the calculation described in 5.5 using average power consumption. The average load is 55% of the full load. A smaller ratio than 70% of the full load, noted in 5-3, is adopted as individual operations were carried out for 20% of the operating time.

Load or capacity is plotted on the horizontal axis since the inverter-controlled VRV system exerts performance consistently in accordance with the load.

The COP of Daikin's system is 3.6 and that of the competitor's is 2.6 when the average load is 55%. Power consumption of Daikin's system is 9 KW and that of the competitor's is 12.3 KW.

a) Calculation of running costs

Daikin's system

$$9\text{KW} \times 2640\text{h} \times 0.09 = \text{US\$}2,138$$

Competitor's system

$$12.3\text{KW} \times 2640\text{h} \times 0.09 = \text{US\$}2,922$$

Saving on operation cost

$$2,922 - 2,138 = \text{US\$}784$$

b) Initial cost

Since the initial cost in this case is the product cost:

Daikin's system

US\$11,400

Competitor's system

US\$10,260

c) Simple Payback Period calculation

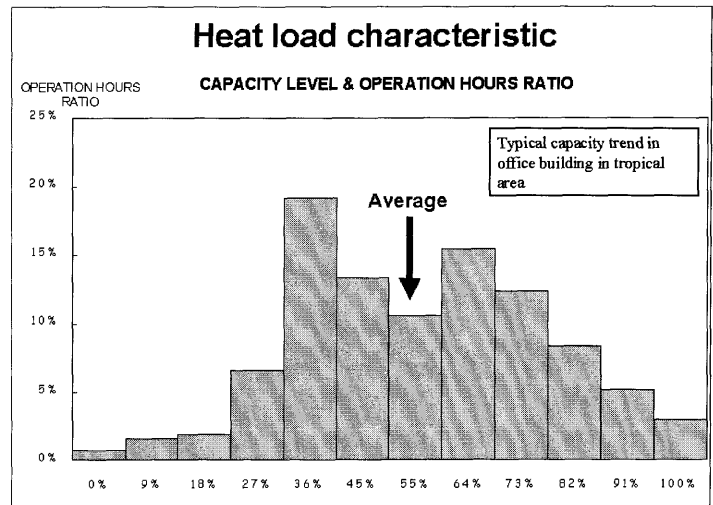
$$\frac{\text{US\$}11,400 - \text{US\$}10,260}{\text{US\$}784}$$

$$= 1.45 \text{ Years}$$

Hence, the payback period is about 1.5 years.

The results can be summarized as the conclusion of a presentation as follows.

- DAIKIN' s VRV is 10% higher cost than competitor' s.
- But thanks to DAIKIN' s higher COP at partial load (More efficient operation)
- Daikin' s VRV cost are lower after 1.5 years of operation



4-7. Example of presentation sheet

Finally, the bellow mentioned are shown as an example of presentation sheet

Background

Target : Change original plan from chiller system to VRV system

Decision maker : M & E Consultant

The times : Feasibility study of the developing has finished. But the budget of air-conditioning is not decided.

Character of decision maker : He is interested in operation cost of air-conditioning

He does not know about DAIKIN well

Slide sheet: 11 pages

Layout: Introduction - Proposed system - Comparison of proposed system & original system

Comparison operation cost - List of proposed system - Introduction of DAIKIN

Page-1 introduction

DAIKIN

VRV as advanced Air-Conditioning System

PROJECT A

We would like to introduce DAIKIN VRV system with confidence.
VRV system is the most developing air-cooled air-conditioning equipment, unique system and was invented by DAIKIN.
DAIKIN also developed the world's first multi-system air-conditioning, with markets around the world accepting the products using this cutting edge technology.
We hope this system will be recognized as the most suitable air-conditioning system in this project as well as your country.

Signature

Page-2 Outline of our proposal

OUTLINE OF AIR-CONDITIONING SYSTEM

- What is "VRV"?
- Variable Refrigerant Volume
- VRV Product Concept

"Providing comfort where you need it, only while you need it"
"Saving energy for market demand"

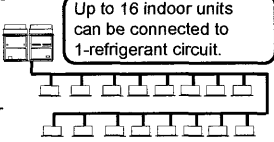
- Special Features of VRV

Outdoor Unit : Inverter Controlled
High Efficiency Compressor

Indoor Unit : Individually Controlled

Refrigerant Piping Length : Max. 100m

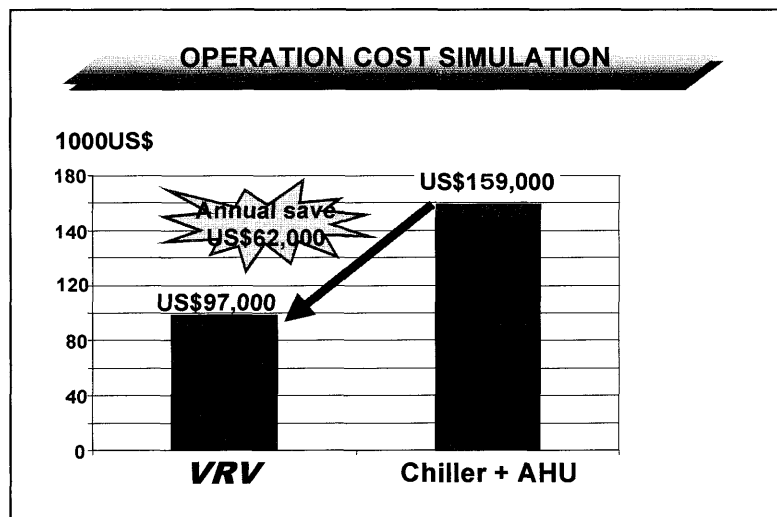
Up to 16 indoor units can be connected to 1-refrigerant circuit.



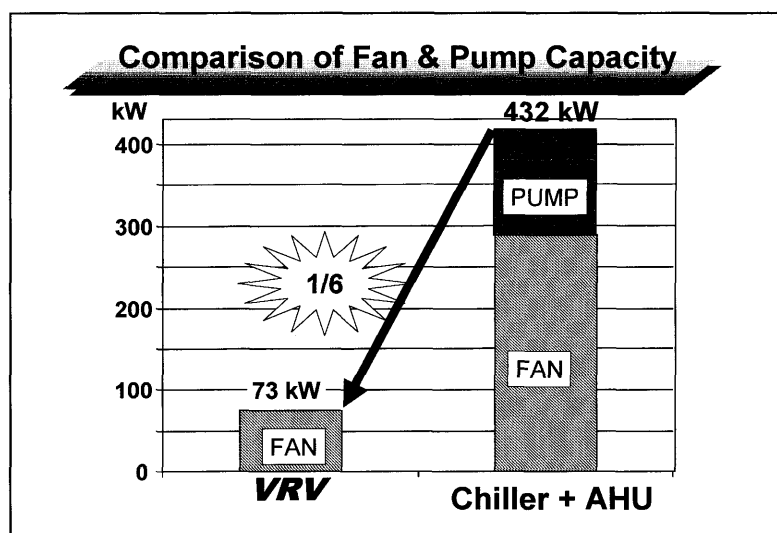
OUTLINE OF Proposal SYSTEM		
• Proposal		
	VRV System	Chiller + AHU
Main Equipment	Outdoor Unit Indoor Unit Local Controller	Chiller AHU Pump (Chilled Water, Condenser Water) Cooling Tower Control Board
	Outdoor Units Indoor Units Remote Controller REFNET joint	Chiller AHU Cooling Tower Pump Header Control Board

• Comparison Between VRV and Chiller System		
	VRV	Chiller + AHU
Layout	No structural reinforcement No standby unit No machine room Easier piping system	Need structural reinforcement Need standby unit Need machine room Complicate piping system
Running Cost	Low Excellent partial load characteristic Simple heat transfer Small heat transfer media	High Poor partial load characteristic Complicated heat transfer Big heat transfer media
Individual Control	Excellent 349 Zoning	Poor Zoning
Switch heat transfer	Simple - less heat loss Refrigerant → Cool air	Complicated much heat loss Refrigerant → Chiller water → Cool air
Operation	Easy, Useful Remote Controller in every room	Complicated Control board in every floor
Safety	No Problem	Possibility of water leakage
Maintenance	Simple, low lost	Complicated, high cost

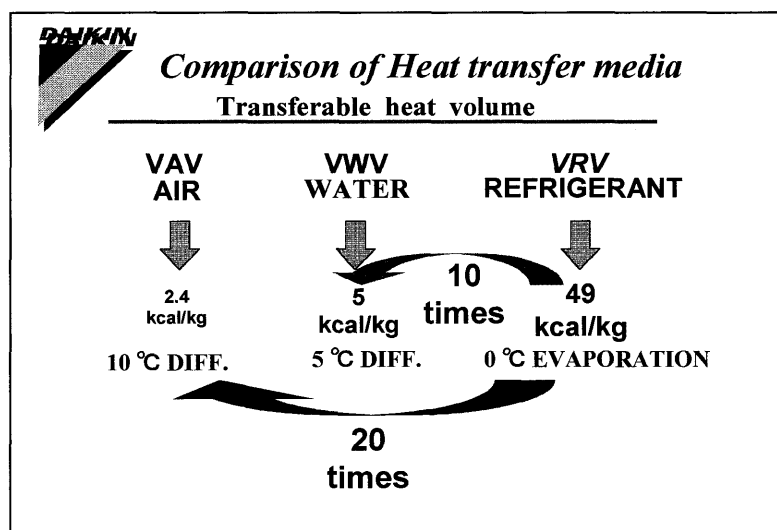
Background RUNNING COST SIMULATION				
	VRV	CHILLER	AVG. LOAD	REMARKS
Normal operation				
COMPRESSOR (kw)	607	519	70%	
FAN (kw)	ACCU 40.1 FCU 32.6	AHU : 259.8 TOWER 29.8	90%	
PUMP (kw)	-	Condenser 59.6 Chilled Wat 92.7	90%	
Operation Hours	2,740 hours/year	-	-	10 hours/day, 7 days/week, 9 months/year
Electricity Charge	US\$0.07/kWH	-	-	
Holiday				
COMPRESSOR (kw)	64.9	49.0	70%	
FAN (kw)	ACCU 4.3 FCU 5.2	AHU : 24.8 TOWER 6.8	90%	
PUMP (kw)	-	Condenser 9.0 Chilled Wat 13.5	90%	
Operation Hours	910 hours/year	-	-	10 hours/day, 7 days/week, 3 months/year
Electricity Charge	US\$0.07/kWH	-	-	



Explanation-1
the reason of
Running cost differences



Explanation-2
the reason of
Running cost differences



VRV Equipment List

MODEL	QTY	CAPACITY (kW.)	DESCRIPTION
FXYF125KAVE	26	14.5	Ceiling Mounted Type (Multi-flow)
FXYF100KAVE	250	11.6	Ceiling Mounted Type (Multi-flow)
FXYF80KAVE	28	9.3	Ceiling Mounted Type (Multi-flow)
FXYF63KAVE	12	7.3	Ceiling Mounted Type (Multi-flow)
FXYF50KAVE	4	5.8	Ceiling Mounted Type (Multi-flow)
FXYF40KAVE	3	4.7	Ceiling Mounted Type (Multi-flow)
FXYS100KV1	1	11.6	Ceiling Mounted Cassette Corner Type
FXYM250KJVE	5	28.8	Ceiling Mounted Duct Type
FXYM200KJVE	4	23	Ceiling Mounted Duct Type
FXYD63KVE	13	7.3	Ceiling Mounted Low Silhouette Duct Type
FXYD50KVE	1	5.8	Ceiling Mounted Low Silhouette Duct Type
FXYD25KVE	2	2.9	Ceiling Mounted Low Silhouette Duct Type
RSX10KUY1	116	28.8	Outdoor Unit
RSX8KUY1	4	23	Outdoor Unit
RSX5KUY1	1	14.5	Outdoor Unit
	228		Refnet Joints
	100		Remote Controller (Wired Type)
DCS302B61	3		Central Remote controller
DCS301B61	8		Unified On/Off Controller
DST301B61	3		Schedule Timer



OUTLINE OF DAIKIN

★SPECIALIST

★CONCENTRATE AIR CONDITIONING BUSINESS

- INNOVATION
- COMFORT
- RELIABILITY

IMPROVE
CUSTOMER
SATISFACTION

★UNIQUE

MANUFACTURE < AIR-CONDITIONING EQUIPMENT
REFRIGERANT GAS

★SERVICE & MAINTENANCE

i-Manager, Service checker



World Wide Manufacturing

Daikin Americas Inc.
U.S.A.(Chemical)

Daikin Europe N.V.
Belgium

Daikin Industries
Japan

Shanghai Daikin
Yah Chong A/C
China

DIT
(Daikin Industries Thailand,
Thailand

DAIKIN AIR-CON for Project A

Manufacturing - DAIKIN INDUSTRIES LTD (Japan)
DAIKIN INDUSTRIES Thailand (Thailand)
Maintain & After service - Distributor in your country
Spare Part Supply - Please specify

