MITSUBISHI ELECTRIC

Lossnay

TECHNICAL MANUAL



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CHAPTER 1
Ventilation for Healthy Living

Fresh outdoor air must be introduced constantly at a set ratio in an air conditioning system. This fresh air is introduced to be mixed with the return air from the room, to adjust the temperature and humidity, supply oxygen, reduce body and other odors, remove tobacco smoke and to increase the cleanness of the air.
The standard ventilation (outdoor air intake) volume is determined according to the type of application, estimated number of persons in the room, room area, and relevant regulations. Systems which accurately facilitate these requirements are increasingly being required to be installed in buildings.

1. Necessity of Ventilation

The purpose of ventilation is basically divided into "oxygen supply", "cleaning of air", "temperature control" and "humidity control". Cleaning of the air includes the elimination of "odors", "gases", "dust" and "bacteria". The needs of ventilation are divided into "personal comfort", "assurance of environment for animals and plants", and "assurance of environments for machinery and constructed materials".
In Japan legal regulations regarding ventilation are set in the Building Standards Act Enforcement Ordinance and the "Building Management Law" for securing a sanitary environment in buildings. These are in general agreeance with similar regulations in other countries.

1) Room air environment in buildings.

In Japan, the Building Management Law, a law concerning the sanitary environment of buildings, designates eleven applications including offices, shops, and schools with a total floor area of 3,000m^2 or more, as buildings. According to this law maintenance and management of the ventilation and water supply and discharge according to the Environmental Sanitation Management Standards is obligatory.

In the case of Japan, an Instruction Guideline based on these regulations has been issued, and unified guidance is carried out. Part of the Instruction Guideline regarding ventilation is shown below.

- The fresh outdoor air intake must be 10m or higher from ground level, and be distanced appropriately from the exhaust air outlet. (Neighbouring buildings must also be considered.)
- The fresh outdoor air intake volume must be 25 to 30m^3/h·person in design.
- An air volume measurement hole must be installed at an effective position to measure the treated air volume of the ventilating device.
- The position and shape of the supply diffuser and return grille must be selected so the air environment in the room is distributed evenly.

2) Effect of air contamination on human bodies

Effect of oxygen (O_2) concentration

Concentration (%)	Standards and effect of concentration changes
Approx. 21	Standard atmosphere
20.5	Ventilation air volume standard will be a guideline where concentration does not decrease more than 0.5% from normal value. (Building Standards Act)
20 ~ 19	An oxygen deficiency of this amount does not directly endanger life in a normal air pressure, but if there is a combustion device in the area, the generation of CO will increase rapidly due to incomplete combustion.
18	Labor Safety and Sanitation Law standards. (Hypoxia prevention regulations.)
16	Normal concentration in exhaled air
16 ~ 12	Increase in pulse and breathing resulting in dizziness and headaches.
15	Flame in combustion devices will extinguish.
12	Threat to life in short time
7	Fatal

Effect of carbon monoxide (CO) 10,000ppm = 1%

Concentration(ppm)	Effect of concentration changes	
0.01 ~ 0.2	Standard atmosphere	
5	Considered to be long-term tolerable value	Approx. 5ppm is an annual average value in city areas. This value may exceed 100ppm near roads, in tunnels and parking areas.
10	Building Standards Act, Building Management Law standards Environmental standard 24-hour average	
20	Considered to be short-term tolerable value Environmental standard 8-hour average	
50	Tolerable concentration for labor environment (Japan Industrial Sanitation Association)	
100	No effect for 3 hours. Effect noticed after 6 hours. Headache, illness after 9 hours; harmful for long-term but not fatal.	
200	Light headache in the forehead in 2 to 3 hours.	
400	Headache in the forehead, nausea in 1 to 2 hours; headache in the back of head in 2.5 to 3 hours.	
800	Headache, dizziness, nausea, convulsions in 45 minutes. Comatose in 2 hours.	
1600	Headache, dizziness in 20 minutes. Death in 2 hours.	
3200	Headache, dizziness in 5 to 10 minutes. Death in 30 minutes.	
6400	Death in 10 to 15 minutes.	
12800	Death in 1 to 3 minutes	
Several 10,000 ppm (Several %)	This level may be found in automobile exhaust.	

Effect of carbon dioxide (CO_2)

Concentration (%)	Effect of concentration changes	
0.03 (0.04)	Standard atmosphere	
0.04 ~ 0.06	City air	
0.07	Tolerable concentration when many people stay for long time.	There is no toxic level in CO_2 alone. However, these tolerable concentrations are a guideline of the contamination estimated when the physical and chemical properties of the air deteriorate in proportion to the increase of CO_2.
0.10	General tolerable concentration. Building Standards Act, Building Management Law standards	
0.15	Tolerable concentration used for ventilation calculations.	
0.2 ~ 0.5	Observed as relatively poor.	
0.5 or more	Observed as the poorest.	
0.5	Long-term safety limits (U.S. Labor Sanitation) ACGIH, regulation of laborer offices	
2	Depth of breathing and inhalation volume increases 30%	
3	Work and physical functions deteriorate, breathing doubles	
4	Normal exhalation concentration	
4 ~ 5	The respiratory centre is stimulated; depth and times of breathing increases. Dangerous if breathed in for a long period. If an O_2 deficiency also occurs, trouble will occur sooner and be more dangerous.	
8	When breathed in for 10 minutes, breathing difficulties, redness in the face and headaches will occur. The trouble will worsen when there is also a deficiency of O_2.	
18 or more	Fatal	

* According to Facility Check List published by Kagekuni-sha.

3) Effect of air contamination in buildings

- Dirtiness of interior
  New ceilings, walls and ornaments will turn yellow in one to two years. This is caused by dust and the tar in tobacco smoke.

2. Ventilation Standards

The legal standards for ventilation differ according to each country. Please follow the standards set by the country. In the US, Ashrae revised their standards in 1989 becoming more strict.
In Japan, regulations are set in the Building Standards Act Enforcement Ordinance, the so-called "Building Management Law" for securing a sanitary environment in buildings. According to the Building Standards Law, a minimum of $20m^3/h$ per person of ventilation air is required.

3. Ventilation Method

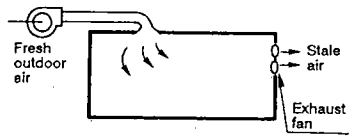
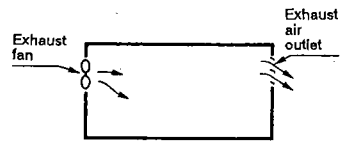
1) Ventilation class and selection points

An appropriate ventilation method must be selected according to the purpose.
Ventilation is composed of "air supply" and "air exhaust" functions. These functions are classified according to natural flow or mechanical ventilation using a fan (forced ventilation).

Classification of ventilation (according to Building Standards Law)

	Supply	Exhaust	Ventilation volume	Room pressure
Class 1	Mechanical	Mechanical	Random (constant)	Random
Class 2	Mechanical	Natural	Random (constant)	Positive pressure
Class 3	Natural	Mechanical	Random (constant)	Negative pressure
Class 4	Natural	Mechanical & natural	Limited (inconstant)	Negative pressure

Classification of mechanical ventilation

	Ex. of application	System effect	Design and construction properties	Selection points
1. Class 1 ventilation Fresh outdoor air is mechanically brought in and simultaneously the stale air in the room is mechanically discharged. 	• Ventilation of air conditioned rooms (buildings, hospitals, etc.) • Ventilation of room not facing an outer wall. (basement, etc.) • Ventilation of large room (office, large conference room, hall, etc.)	By changing the balance of the supply fan and exhaust fan's air volumes, the pressure in the room can be balanced freely, and the interrelation with neighbouring spaces can be set freely.	• An ideal design in which the supply diffuser and exhaust air outlet position relation and air volume, etc., can be set freely is possible. • A system which adjusts the temperature and humidity of the supply air flow to the room environment can be incorporated. • The supply and exhaust volume can be set freely according to the changes in conditions.	• Accurate air supply can be maintained. • The room pressure balance can be maintained. • The supply air temperature and humidity can be adjusted and dust treatment is possible.
2. Class 2 ventilation Fresh outdoor air is mechanically brought in and the exhaust air is discharged from the exhaust air outlet (natural). 	• Surgery theatre • Clean rooms. • Foodstuff processing factories	As the room is pressurised, the flow of odors and dust, etc., from neighbouring areas can be prevented.	• The position and shape of the supply diffuser can be set. • The temperature and humidity of the supply air flow can be set accordingly, and dust can be removed as required.	• The pressure is positive. • The supply air temperature and humidity can be adjusted, and dust treatment is possible. • The positional relation of the exhaust air outlet to the supply diffuser is important.
3. Class 3 ventilation The stale air in the room is mechanically discharged and simultaneously fresh outdoor air is mechanically introduced from the supply diffuser (natural). 	• Local ventilation in kitchens. • Ventilation of hot exhaust air from machine rooms, etc. • Ventilation of humid exhaust air from indoor pools, bathrooms, etc. • General simple ventilation.	The exhaust air is removed from a local position in the room, and dispersion of the stale air can be prevented by applying an entire negative pressure.	• Effective exhausting of dispersed stale air generation sites is possible from a local exhaust air outlet. • Ventilation in which the air flow is not felt is possible with the supply diffuser setting method.	• The room pressure is negative. • Local exhaust is possible. • Ventilation without dispersing stale air is possible. • Ventilation with reduced air flow is possible. • The positional relation of the exhaust air outlet to the supply diffuser is important.

2) Comparison of ventilation methods

There are two main types of ventilation methods.

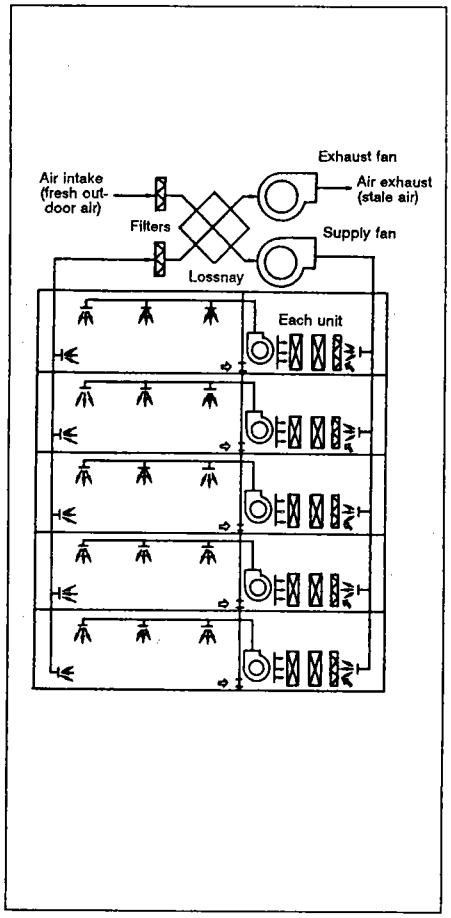
Centralised ventilation method

This is mainly used in large buildings, with the fresh outdoor air intake being installed in one machine room. For this method, primary treatment of the fresh outdoor air, such as heat exchange to the intake air and dust removal is performed, being distributed to the building by ducts.

Independent dispersed ventilation method

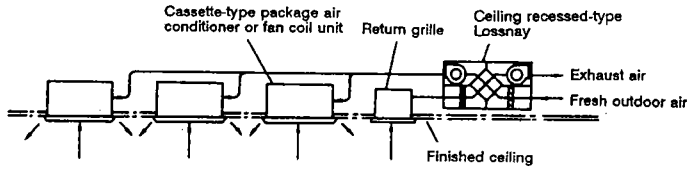
This is mainly used in small to medium sized buildings, with areas being ventilated using fresh outdoor air intakes formed of independent ventilation devices. The rate of use of this method has recently increased as independent control is becoming ever more feasible.

Centralised ventilation method

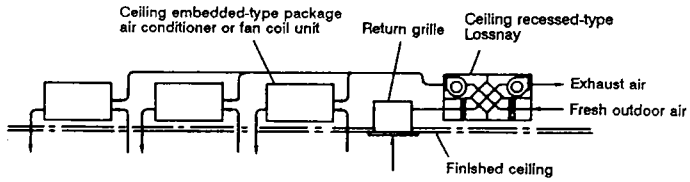


Independent zoned ventilation method

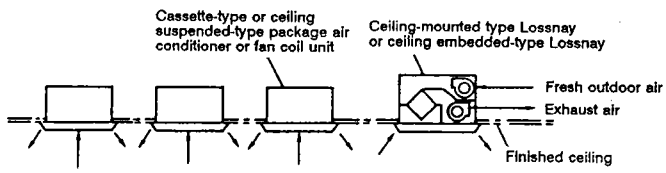
① System operation with cassette-type air conditioner



② System operation with ceiling embedded-type air conditioner



③ Independent operation with ceiling suspended-type air conditioner



Comparison of centralised ventilation method and independent zoned ventilation method

	Centralized ventilation method	Independent zoned ventilation method
Fan power	The air transfer distance is long thus requiring much fan power.	As the air transfer distance is short, the fan power is small.
Installation space	• Machine room is required. • Duct space is required. • Penetration of floors with vertical shaft is not desired in terms of fire prevention.	• Machine room is not required. • Piping space is required only above the ceiling.
Zoning	Generalized per system.	Can be utilised for any one area.
Designability	• Design of outer wall is not lost. • The indoor supply diffuser and return grille can be selected freely for an appropriate design.	• The number of intakes and exhaust air outlets on the outer wall will increase; design must be considered. • The design will be fixed due to the installation fittings, so the design of the intakes and exhaust air outlets must be considered.
Clarification of costs	As there are many common-use areas, if the building is a tenant building, the fair charging of tenants is difficult.	Charging of each user separately is possible even in a tenant building.
Controllability	• As the usage time setting and ventilation volume control, etc., is performed in a central monitoring room, the user's needs may not be met appropriately. • A large amount of ventilation is required even for a few persons.	• The user can operate the ventilator freely. • The ventilator can be operated even during off-peak hours.
Comfort	• An ideal supply diffuser and return grille position can be selected as the supply diffuser and return grilles can be laid out freely. • The only noise in the room is the aerodynamic sound. • Anti-vibration measures must be taken as the fan in the machine room is large.	• Consideration must be made of the noise from the main unit. • Anti-vibration measures are often not required as the unit is compact and can be dispersed.
Maintenance and management	• Centralised management is easy as it can be performed in the machine room. • The machines can be inspected at any time.	• Work efficiency is poor as the machines are dispersed. • The machines can be inspected only when the room is empty.
Trouble correspondence	• Damage is large as the entire system is affected. • Immediate checks can be performed in the machine room.	• The damage is small as the machines are dispersed. • Consultation with the tenant is required as the checks must be made in the room.

4. Ventilation Performance

The ventilation performance is largely affected by the installation conditions. Ample performance may not be achieved unless the model and usage methods are selected according to the conditions.
Generally, the ventilation performance is expressed by "air volume" and "wind pressure (static pressure)", and these are necessary when considering ventilation.

1) Air volume

Air volume expresses the volume of air exhausted (or supplied) by the machine in a unit period. Generally, this is expressed with m^3/hr (hour).

2) Wind pressure

When a piece of paper is placed in front of a fan and let go, the piece of paper will be blown away. The force that blows the paper away is called the wind pressure, and this is normally expressed in units of mmH_2O or mmAq {Pa (Pascal) in SI unit system: $1mmH_2O$ = approx. 9.8Pa}. The wind pressure is divided into the following three types:

(1) Static pressure

This is the force that presses the surroundings when the air is still such as in an automobile tyre or rubber balloon. For example, in a water gun, the hydraulic pressure increases when pressed by a piston, and if there is a small hole, the water sprays out with force. The pressure of this water is equivalent to the static pressure for air. The higher the pressure is, the further the water (air) can be sprayed.

(2) Dynamic pressure

This expresses the speed at which air flows, and can be thought of as the force at which a typhoon presses against a building.

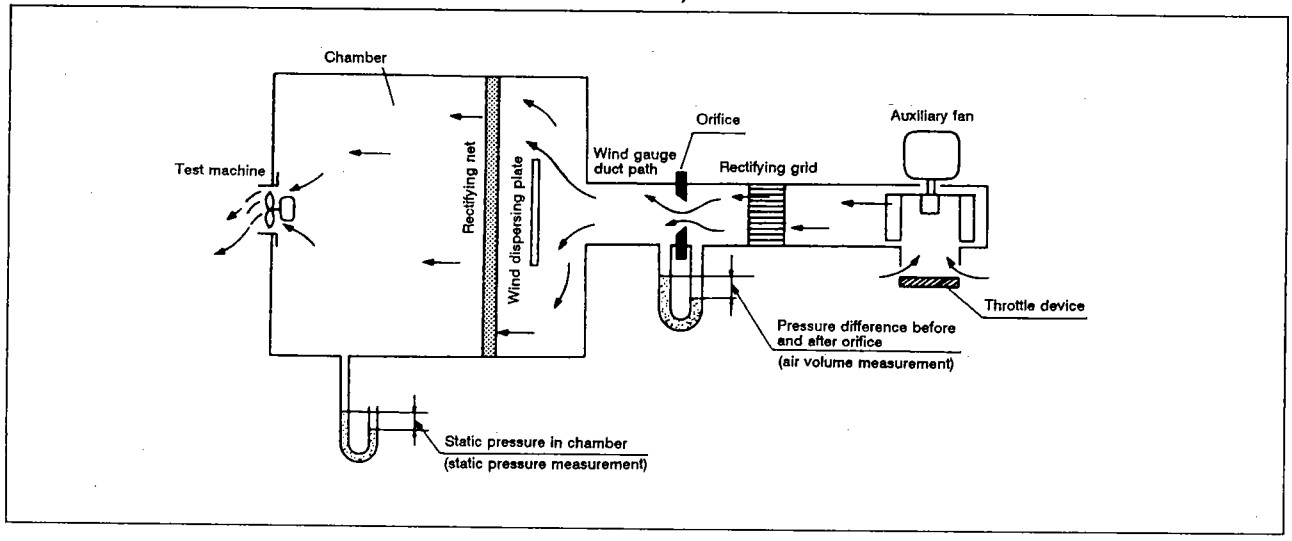
(3) Total pressure

This is the total force that wind has, and is the sum of the static pressure and dynamic pressure.

3) Measurement of the air volume and wind pressure

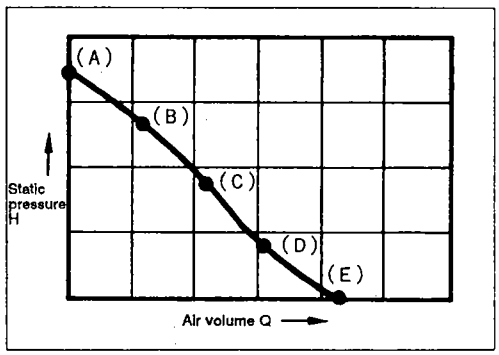
Mitsubishi measures the machine's air volume and wind pressure with a device as shown below according to the Japan Industrial Standards (JIS C 9603).

Measuring device using orifice (JIS C 9603 standards)



- Measurement method

  The machine is operated with the throttle device fully closed. There is no air flow at this time, and the air volume is 0. The maximum point of the static pressure (A point, the static pressure at this point is called the totally closed pressure) can be obtained. Next, the throttle device is gradually opened, the auxiliary fan is operated, and the middle points (points B, C and D) are obtained. Finally, the throttle device is completely opened, and the auxiliary fan is operated until the static pressure in the chamber reaches 0. The maximum point of the air volume (point E, the air volume at this point is called the fully opened air volume) is obtained. The points are connected as shown below, and are expressed as air volume, static pressure curves (Q-H curve).



5. Outdoor Air (ventilation) Load

1) How to calculate each approximate load

The outdoor air load can be calculated with the following formula if the required outside air intake volume Qm^3/h to be introduced is known:

(Outdoor air load) = γ • Q_F • (i_O ~ i_R)

= γ[kg/m^3] × S[m^2] × k × n[person/m^2] × Vf[m^3/h·person] × (i_O ~ i_R): Δi[kJ/kg (kcal/kg)]

γ : Specific gravity of air — 1.2kg/m^3

S : Building's airconditioned area

k : Thermal coefficient; generally 0.7 ~ 0.8.

n : The average population concentration is the inverse of the occupancy area per person. If the number of persons in the room is unclear, refer to the Floor space per person table below.

Vf : Outdoor air intake volume per person
Refer to the Required outdoor air intake volume per person table below.

i_O : Outdoor air enthalpy — kJ/kg (kcal/kg')

i_R : Indoor enthalpy — kJ/kg (kcal/kg')

Floor space per person table (m^2)
(According to the Japan Federation of Architects and Building Engineers Associations)

	Office building	Department store, shop			Restaurant	Theatre or cinema hall
		Average	Crowded	Empty		
General design value	4 ~ 7 5	0.5 ~ 2 3.0	0.5 ~ 2 1.0	5 ~ 8 6.0	1 ~ 2 1.5	0.4 ~ 0.6 0.5

Required outdoor air intake volume per person table (m^3/h·person)

Degree of smoking	Application example	Required ventilation volume	
		Recommended value	Minimum value
Extremely heavy	Broker's office Newspaper editing room Conference room	85	51
Quite heavy	Bar Cabaret	51	42.5
Heavy	Office Restaurant	25.5 25.5	17 20
Light	Shop Department store	25.5	17
None	Theatre Hospital room	25.5 34	17 25.5

■ **Caution**

The application of this table to each type of room should be carefully considered in relation to the degree of smoking in the room.

Example calculations of determining ventilation load during both cooling and heating are given as follows:

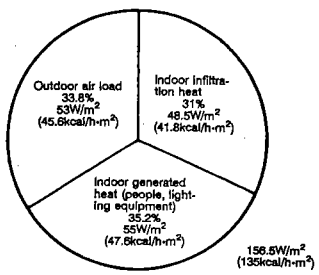
2) Ventilation load during cooling (in general office building)

Classification of cooling load

	Class	
(a)	Indoor infiltration heat	Heat from walls (q_{WS}) Heat from glass { from direct sunlight (q_{GS}) from conduction & convection (q_{GS}) Accumulated heat load in walls (q_{SS})
(b)	Indoor generated heat	Generated heat from people { Sensible heat (q_{HS}) Latent heat (q_{HL}) Generated heat from electrical equipment { Sensible heat (q_{ES}) Latent heat (q_{EL})
(c)	Reheating load	(q_{RL})
(d)	Outdoor air load	{ Sensible heat (q_{FS}) Latent heat (q_{FL})

(a) is the heat infiltrating the room, and often is 30 to 40% of the entire cooling load.
(b) is the heat generated in the room.
(c) is generated only when reheating is necessary.
(d) is the heat generated when outdoor air is mixed into part of the supply air volume and introduced into the room.
The outdoor air is introduced to provide ventilation for the people in the room, and is referred to as the ventilating load.

- **Typical load values (during cooling)**



Type of load		Load
Outdoor air load		53W/m² (45.6kcal/h·m²)
Indoor generated heat	People	26W/m² (22.6kcal/h·m²)
	Lighting equipment	29W/m² (25.0kcal/h·m²)
Indoor infiltration heat		48.5W/m² (41.8kcal/h·m²)
Total		156.5W/m² (135kcal/h·m²)

Conditions: Middle floor of a general office building facing south.

- **Cooling load per unit area**

When the volume of outdoor air per person is 25m³/h, and the number of persons per 1m² is 0.2, the cooling load will be approximately 156.5W/m² (135kcal/h·m²).
How these values are determined can be seen as follows:

Outdoor air load

Air conditions <Standard design air conditions in Tokyo>

		Dry bulb temp.	Relative humidity	Wet bulb temp.	Enthalpy	Enthalpy difference
Cooling	Outdoor air	33°C	63%	27°C	85kJ/kg (20.3kcal/kg')	31.8kJ/kg (7.6kcal/kg')
	Indoors	26°C	50%	18.7°C	53.2kJ/kg (12.7kcal/kg')	

When the load per floor area of 1m² with a ventilation volume of 25m³/h·person is calculated with the above air conditions, the following is obtained:

Outdoor air (ventilation) load = 1.2kg/m³ (Specific gravity of air) × 0.2 persons/m² (no. of persons per 1m²) × 25m³/h·person (outdoor air volume) × 31.8kJ/kg (7.6kcal/kg') (air enthalpy difference indoors/outdoors) × 0.2777 (1000 Watts/3600 secs) = 53W/m² (45.6kcal/h·m²)

The Lossnay recuperates approximately 70% of the exhaust air load and saves on approximately 20% of the total load.

Determining internal heat gain

When classifying loads, the internal heat gain (indoor generated heat + indoor infiltration heat) will be the value of the outdoor air load subtracted from the approximate cooling load when it is assumed that there is no reheating load.

(Internal heat gain)

= 156.5W/m^2 (135kcal/h·m^2) – 53W/m^2 (45.6kcal/h·m^2) = 103.5W/m^2 (89.4kcal/h·m^2)

- This value of internal heat gain is based on assumptions for typical loads. To determine individual levels of internal heat gain, the following is suggested:

Indoor generated heat

1. Heat generated from people

Heat generation design value per person in office

Sensible heat (SH) = 62.8W·person (54kcal/h·person)
Latent heat (LH) = 68.6W·person (59kcal/h·person)
Total heat (TH) = 131.5W·person (113kcal/h·person)
The heat generated per 1m^2 of floor space is

(heat generated from people)

= 131.5W·person (113kcal/h·person) × 0.2person/m^2 = 26.3W/m^2 (22.6kcal/h·m^2)

2. Heat generated from electrical equipment (lighting)

The approximate value of the room illuminance and power for lighting for a general office with illuminance of 300 ~ 350Lux, is 20 ~ 30W/m^2.

Indoor infiltration heat

This is the heat that infiltrates into the building from outside. This can be determined by subtracting the amount of heat generated by people and lighting from the internal heat gain.

(Indoor infiltration heat)

= 103.5 – (26.3 + 29) = 48.5W/m^2 (41.8kcal/h·m^2)

The Lossnay recuperates approximately 70% of the exhaust air load and saves on approximately 20% of the total load.

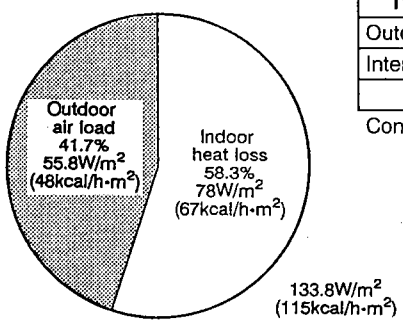
3) Ventilation load during heating

Classification of heating load

	Class	
(a)	Indoor heat loss	Heat lost from walls (q_{WS}) Heat lost from glass (q_{GS}) Heat loss from conduction & convection (q_{GS}) Accumulated heat load in walls (q_{SS})
(b)	Outdoor air load	Sensible heat (q_{FS}) Latent heat (q_{FL})

During heating, the heat generated by people and electrical equipment in the room can be subtracted from the heating load. However, as the warming up time at the start of heating is short, this generated heat may be ignored in some cases.

- Percentage of load



Type of load	Load
Outdoor air load	55.8W/m² (48kcal/h·m²)
Internal heat loss	78W/m² (67kcal/h·m²)
Total	133.8W/m² (115kcal/h·m²)

Conditions: Middle floor of a general office building facing south.

<Internal heat loss>

In terms of load classification, the internal heat loss is the value of the outdoor air load subtracted from the approximate heating load.

Internal heat loss = 133.8W/m² (115kcal/h·m²) – 55.8W/m² (48kcal/h·m²) = 78W/m² (67kcal/h·m²)

- **Heating load per unit area**

When the outdoor air volume per person is 25m³/h, and the number of persons per 1m² is 0.2 persons, the approximate heating load will be approximately 133.8W/m² (115kcal/h·m²).

Outdoor air load

Air conditions <Standard design air conditions in Tokyo>

		Dry bulb temperature	Relative humidity	Wet bulb temperature	Enthalpy	Enthalpy difference
Heating	Outdoor air	0°C	50%	–3°C	5kJ/kg (1.2kcal/kg')	33.5kJ/kg (8.0kcal/kg')
	Indoors	20°C	50%	13.7°C	38.5kJ/kg (9.2kcal/kg')	

When the load per 1m² of floor area with a ventilation volume of 25m³/h·person is calculated with the above air conditions, the following is obtained:

Outdoor air (ventilation) load = 1.2kg/m³ × 0.2 persons/m² × 25m³/h·person × 33.5kJ/kg (8.0kcal/kg') × 0.2777 (1000 Joules/3600 secs) = 55.8W/m² (48kcal/h·m²)

The Lossnay recuperates approximately 70% of the exhaust air load and saves on approximately 20% of the total load.

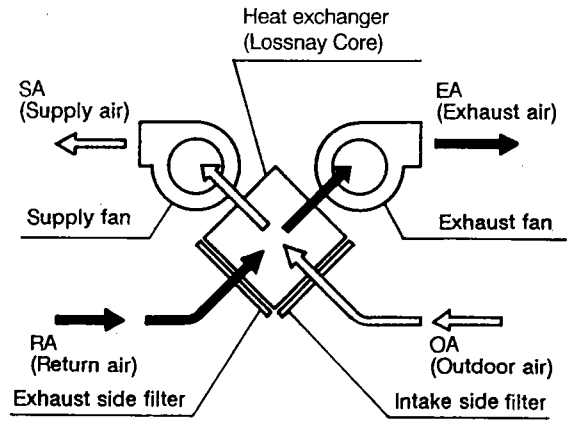
CHAPTER 2
Lossnay Construction and Principle

1. Construction and Features of Lossnay

- **Lossnay construction**

  The Lossnay is constructed so that the exhaust air passage from the indoor side to the outdoor side (RA → EA) and the fresh air passage from the outdoor side to the indoor side (OA → SA) cross. The Lossnay heat exchanger is installed at this cross point, and exchanges the heat by conduction through the separating medium between these airflows. This enables the heat loss during exhaust to be greatly reduced.

  * RA : Return Air
    EA : Exhaust Air
    OA : Outdoor Air
    SA : Supply Air



* The duct inlet and outlet are linear in the actual product.

Main Features of Lossnay

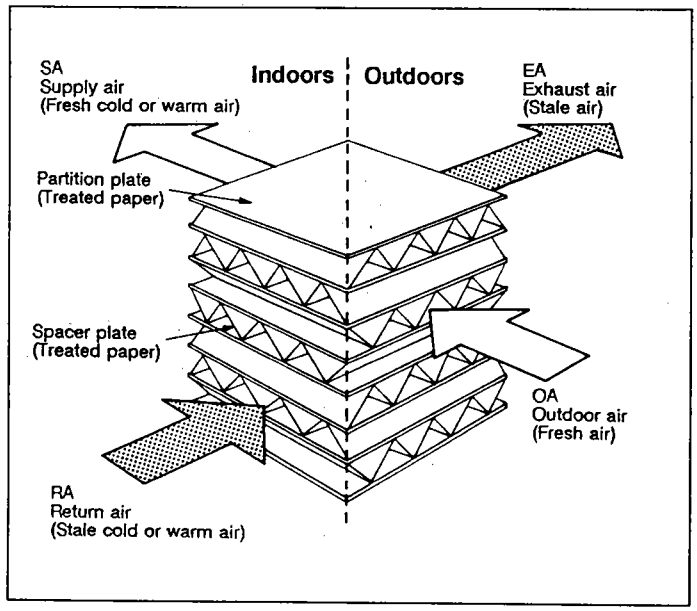
(1) Cooling and heating maintenance fees are saved while ventilating.
(2) The capacity and performance of the air conditioner can be reduced.
(3) Humidity control is possible.
(4) Comfortable ventilation is possible, (the outdoor air being adjusted to the room temperature.)
(5) Effective sound-proofing.

2. Construction and Principle of Heat Exchanger (Lossnay Core)

- **Simple construction**

  The Lossnay Core is a cross-flow total heat exchanger constructed of plates and fins made of treated paper.

  The fresh air and exhaust air passages are totally separated allowing the fresh air to be introduced without mixing with the exhaust air.



- **Principle**

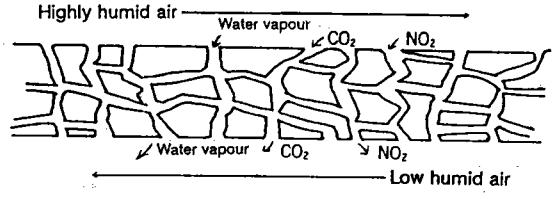
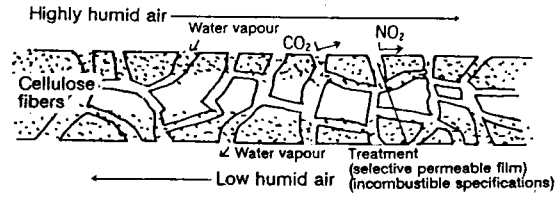
  The Lossnay Core uses the heat transfer properties and moisture permeability of the treated paper. Total heat (sensible heat plus latent heat) is transferred from the stale exhaust air to the fresh air being introduced into the system when they pass through the Lossnay. Try this simple experiment. Roll a piece of paper into a tube and blow through it. Your hand holding the paper will immediately feel warm. If cold air is blown through the tube, your hand will immediately feel cool. This means heat is transferred through paper. Lossnay is a total heat exchanger that utilizes these special properties of paper.

- **Treated paper**

  The paper partition plates are specially treated so that the Lossnay Core is an appropriate heat exchanger for the ventilator. This paper differs from ordinary paper, and has the following unique properties.

  1) The paper is incombustible and is strong.
  2) The paper has selective hydroscopicity and moisture permeability that permits the passage of water vapour only (including some water-soluble gases).
  3) The paper has gas barrier properties that does not pass gases such as CO_2.

  A comparison of the ordinary paper and the Lossnay plates is as shown in the table.

Ordinary paper	
Water vapour is transferred, but gas elements that are easily dissolved in water such as CO_2, NO_2 are also transferred. ▼ The contaminated air passes through the plates during ventilation and returns to the room.	
Treated paper	
Water vapour is transferred, but gas elements such as CO_2, NO_2 are not transferred. ▼ The contaminated air does not return to the room when ventilated.	

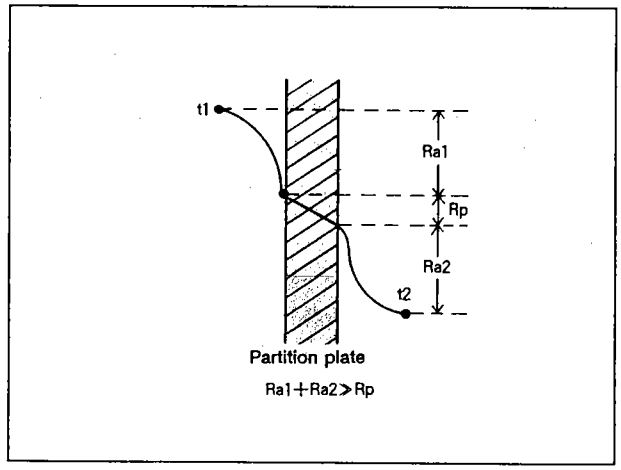
Total heat exchange mechanism

Sensible heat and latent heat

The heat that enters and leaves in accordance with changing temperature (rise or drop) is called sensible heat. The heat that enters and leaves due to the changes in a matter's physical properties (evaporation, condensation) is called latent heat.

(1) Heat (sensible heat) exchange

1) Heat conduction and heat passage is performed through a partition plate from the high temperature to low temperature side.
2) As shown on the right, the heat exchange efficiency is affected by the resistance of the boundary layer, and for the Lossnay there is little difference when compared to materials such as copper or aluminium which also have high thermal conductivity.

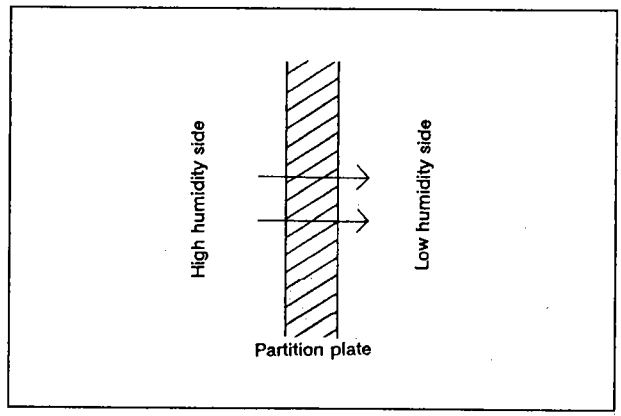


Heat resistivity coefficients

	Treated paper	Cu	Al
Ra_1	10	10	10
Rp	1	0.00036	0.0006
Ra_2	10	10	10
Total	21	20.00036	20.0006

(2) Humidity (latent heat) exchange

1) Water vapour is moved through the partition plate from the high humidity to low humidity side by means of the differential pressure in the vapour.

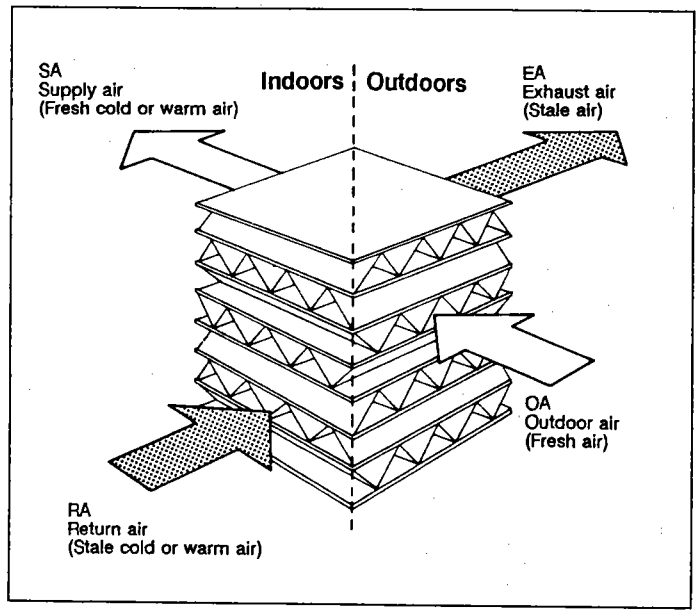


3. Calculation of the Total Heat Exchange Efficiency

The Lossnay Core's heat exchange efficiency can be considered using the following three transfer rates:

1) Temperature (sensible heat) exchange efficiency
2) Humidity (latent heat) exchange efficiency
3) Enthalpy (total heat) exchange efficiency

The heat recovery effect can be calculated if two of the above efficiencies is known. (The temperature and enthalpy efficiencies are indicated in the applicable catalogue.)



- Each exchange efficiency can be calculated with the formulas given below.
- When the supply air volume and exhaust air volume are equal, the heat exchange efficiencies on the supply and exhaust sides are the same.
- When the supply air volume and exhaust air volume are not equal, the total heat exchange efficiency is low if the exhaust volume is lower, and high if the exhaust volume is higher.
  Refer to the Exchange Efficiency Correction Curve in the applicable catalogue for more details.

Item	Formula
Temperature heat exchange efficiency (%)	$\eta t = \frac{t_{(OA)} \sim t_{(SA)}}{t_{(OA)} \sim t_{(RA)}} \times 100$
Enthalpy heat exchange efficiency (%)	$\eta i = \frac{i_{(OA)} \sim i_{(SA)}}{i_{(OA)} \sim i_{(RA)}} \times 100$

η : Efficiency (%)
t : Dry bulb temperature (°C)
i : Enthalpy (kJ/kg) (kcal/kg')

Calculation of air conditions after passing through Lossnay

If the Lossnay heat exchange efficiency and the conditions of the room and outdoor air are known, the conditions of the air entering the room and the air exhausted outdoors can be determined with the following formulas.

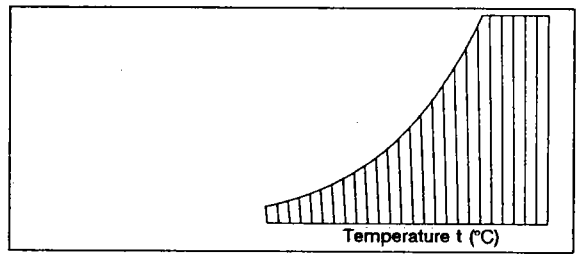
	Supply side	Exhaust side
Temperature	$t_{SA} = t_{OA} - (t_{OA} - t_{RA}) \cdot \eta t$	$t_{EA} = t_{RA} + (t_{OA} - t_{RA}) \cdot \eta t$
Enthalpy	$i_{SA} = i_{OA} - (i_{OA} - i_{RA}) \cdot \eta i$	$i_{EA} = i_{RA} + (i_{OA} - i_{RA}) \cdot \eta i$

4. What is a Psychrometric Chart? (Refer to page 3-11)

The chart which shows the properties of humid air is called a psychrometric chart. The psychrometric chart can be used to find the 1) dry bulb temperature, 2) wet bulb temperature, 3) absolute humidity, 4) relative humidity, 5) dew point and 6) enthalpy (total heat) of a certain air condition. If two of these values are known beforehand, the other values can be found with this chart. The way that the air will change when it is heated, cooled, humidified or dehumidified can also be seen easily on the chart.

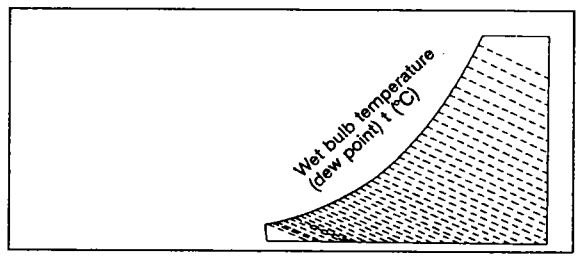
1) Dry bulb temperature t (°C)

Generally referred to as standard temperature this is measured with a dry bulb thermometer (conventional thermometer). The obtained value is the dry bulb temperature.



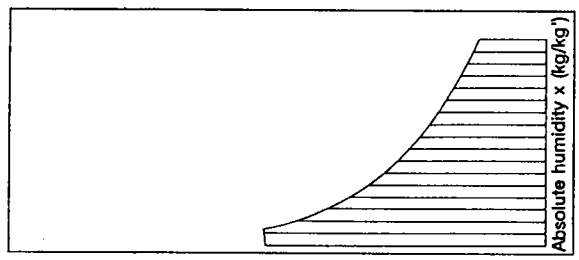
2) Wet bulb temperature t' (°C)

When a dry bulb thermometer's heat sensing section is wrapped in a piece of wet gauze and an ample air flow (3m/s or more) is applied, the heat applied to the wet bulb by the air and the heat of the water vapour that evaporates from the wet bulb will balance at an equal state. The temperature indicated at this time is called the wet bulb temperature.



3) Absolute humidity x (kg/kg')

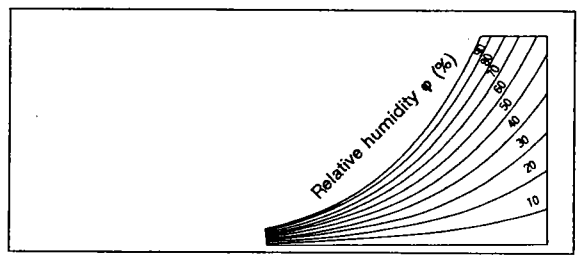
The weight (kg) of the water vapour that corresponds to the weight (kg') of the dry air in the humid air is called the absolute humidity.



4) Relative humidity φ (%)

The ratio of the water vapour pressure Pw in the humid air and the water vapour pressure Pws in the saturated air at the same temperature is called the relative humidity. This is obtained with the following formula:

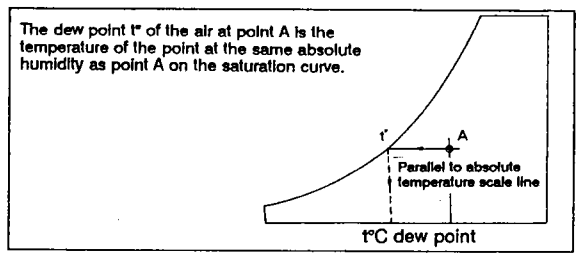
$\varphi R = Pw/Pws \times 100$



5) Dew point t" (°C)

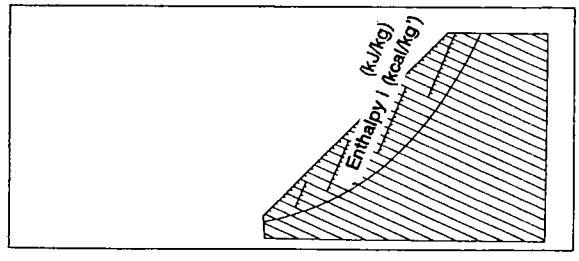
The water content in the air will start to condense when air is cooled.

The dry bulb temperature at this time is called the dew point.



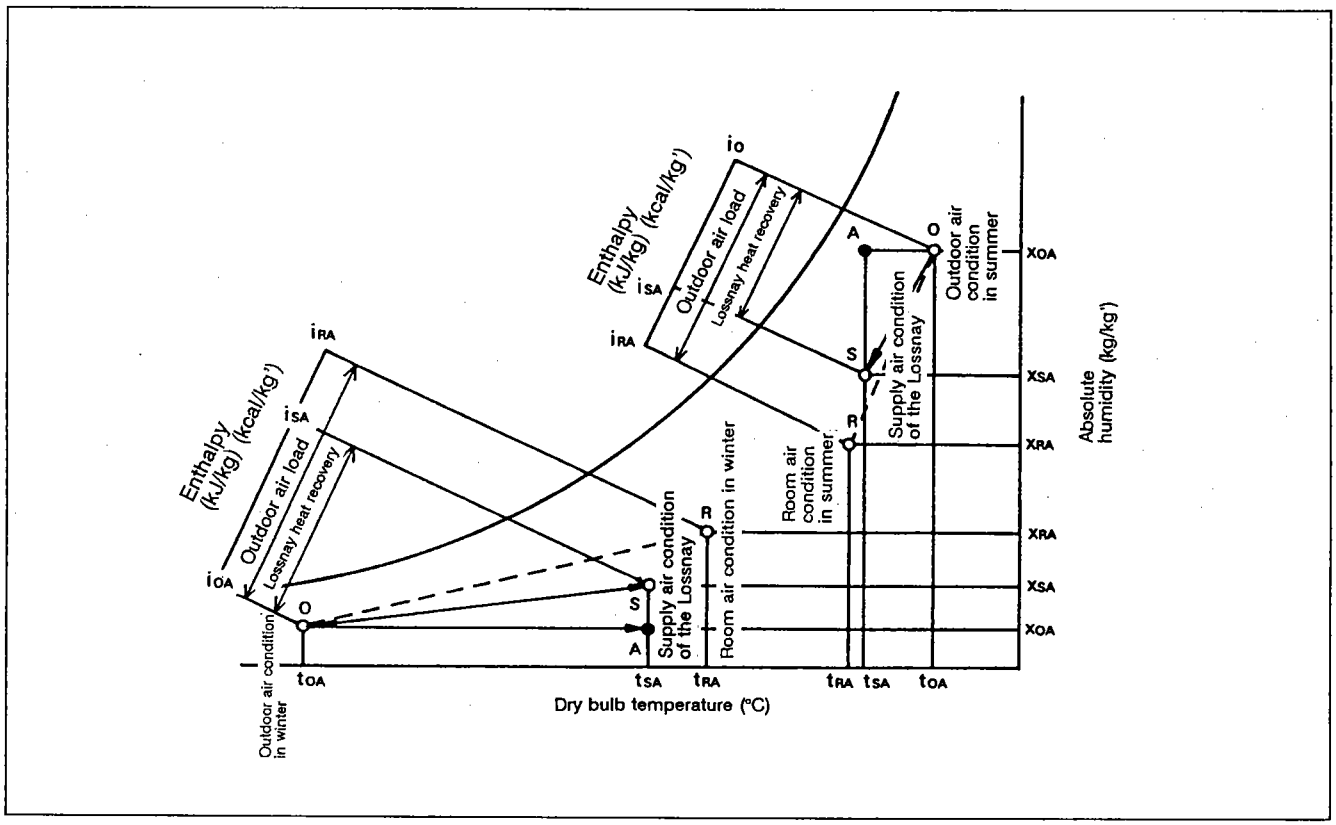
6) Enthalpy i (kJ/kg) (kcal/kg')

Physical matter has a set heat when it is at a certain temperature and state. This retained heat is called the enthalpy, with dry air at 0°C being set at 0



5. Calculation of Lossnay Heat Recovery

The following figure shows the conditions of various air states when fresh air is introduced through the Lossnay Core. If a conventional temperature (sensible heat) exchanger is used alone and is assumed to have the same heat exchange efficiency as Lossnay, the condition of the air supplied to the room is expressed by point A in the figure. This point shows that the air is very humid in summer and very dry in winter.
The air supplied to the room with Lossnay is indicated by point S in the figure. The air is precooled and dehumidified in the summer and preheated and humidified in the winter before it is introduced to the room.



The quantity of heat recovered by using the Lossnay Core can be calculated with the following formula.

Total heat recovered: $q_T = \gamma \cdot Q \cdot (i_{OA} \sim i_{SA})$ [W (kcal/h)]
$= \gamma \cdot Q \cdot (i_{OA} \sim i_{RA}) \times \eta i$

Where γ = Specific weight of air under standard conditions 1.2 (kg/m^3)
Q = Treated air volume (m^3/h)
t = Temperature (°C)
x = Absolute humidity (kg/kg')
i = Enthalpy (kJ/kg) (kcal/kg')
η = Exchange efficiency (%)

- Suffix meanings
  OA : Outdoor air
  RA : Return air
  SA : Supply air

CHAPTER 3
General Technical Considerations

1. Lossnay Heat Recovery Effect

1) Comparison of outdoor air load of various ventilators

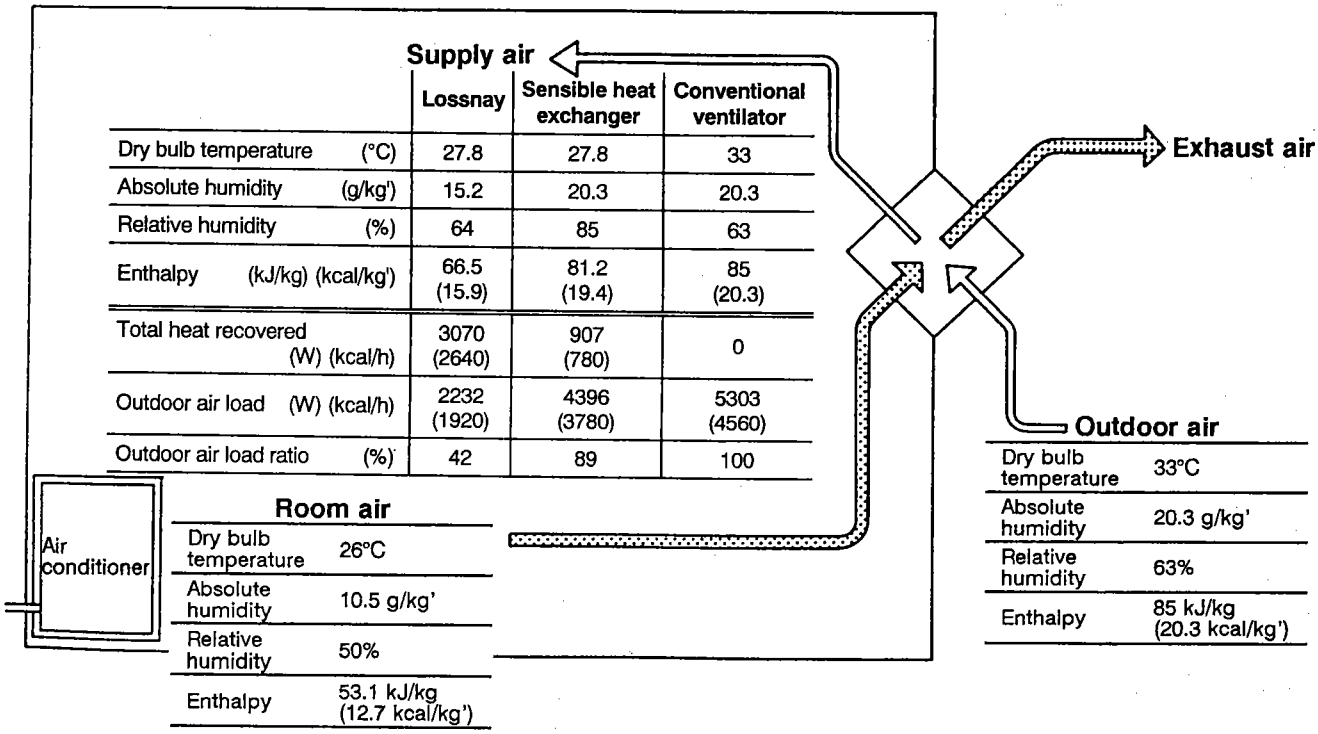
Examples of formulas to compare the heat recovered and outdoor air load when ventilating with the Lossnay (total heat exchanger), sensible heat exchanger and conventional ventilators are shown below.

(1) Cooling during summer

Conditions

- Model LGH-50R type (at 50Hz high notch)
- Heat exchange efficiency table (%) (For summer)
- Ventilation rate: 500m^3/h (specific gravity of air γ = 1.2kg/m^3)

	Lossnay	Sensible heat exchanger	Conventional ventilator
Temperature (sensible heat)	74	74	0
Enthalpy (total heat)	58	—	0



		Lossnay	Sensible heat exchanger	Conventional ventilator
Dry bulb temperature	(°C)	27.8	27.8	33
Absolute humidity	(g/kg')	15.2	20.3	20.3
Relative humidity	(%)	64	85	63
Enthalpy	(kJ/kg) (kcal/kg')	66.5 (15.9)	81.2 (19.4)	85 (20.3)
Total heat recovered	(W) (kcal/h)	3070 (2640)	907 (780)	0
Outdoor air load	(W) (kcal/h)	2232 (1920)	4396 (3780)	5303 (4560)
Outdoor air load ratio	(%)	42	89	100

Calculation example

- **Lossnay**

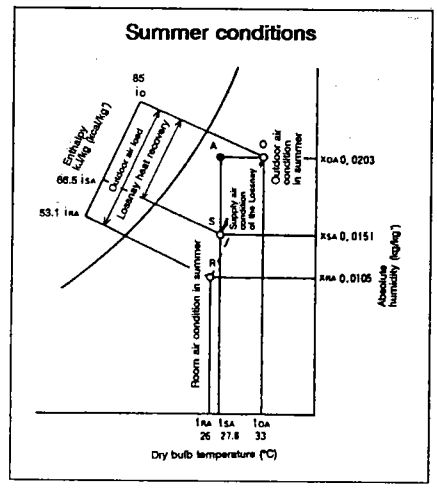
(Supply air temperature) t_{SA} = 33°C – (33°C – 26°C) × 0.74 = 27.8°C
(Supply air enthalpy) 85 – (85 – 53.1) × 0.58 = 66.5 (15.9)
Heat recovered (85 – 66.5) × 1.2 × 500 × 0.2777$^+$ = 3083W (2640kcal/h)
Outdoor air load (66.5 – 53.1) × 1.2 × 500 × 0.2777$^+$ = 2233W (1920kcal/h)

- **Sensible heat exchanger**

(Supply air temperature) t_{SA} = 33°C – (33°C – 26°C) × 0.74 = 27.8°C
(Supply air enthalpy) i_{SA} = 79.5kJ/kg (19.0 kcal/kg) (from psychrometric chart)
Heat recovered (85 – 79.5) × 1.2 × 500 × 0.2777$^+$ = 916W (780kcal/h)
Outdoor air load (79.5 – 53.1) × 1.2 × 500 × 0.2777$^+$ = 4400W (3780kcal/h)

- **Conventional ventilator**

If a conventional ventilator is used, the heat recovered will be 0 as the supply air is equal to the outdoor air.
The outdoor air load is: (85 – 53.1) × 1.2 × 500 × 0.2777$^+$ = 5316W (4560kcal/h)
+ Conversion Factor (1000 Watts/3600 secs)

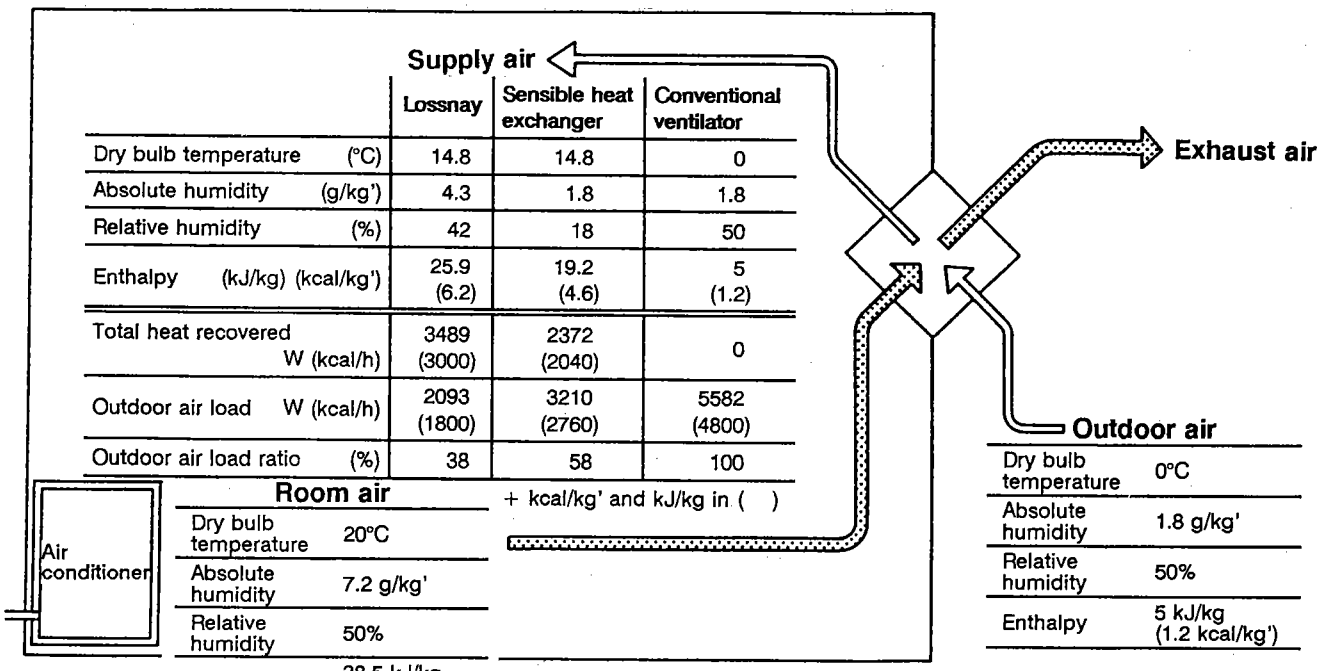


(2) Heating during winter

Conditions

- Model LGH-50R type (at 50Hz high notch)
- Heat exchange efficiency table (%) (For winter)
- Ventilation rate: 500m^3/h (specific gravity of air γ = 1.2kg/m^3)

	Lossnay	Sensible heat exchanger	Conventional ventilator
Temperature (sensible heat)	74	74	0
Enthalpy (total heat)	62	—	0



	Lossnay	Sensible heat exchanger	Conventional ventilator
Dry bulb temperature (°C)	14.8	14.8	0
Absolute humidity (g/kg')	4.3	1.8	1.8
Relative humidity (%)	42	18	50
Enthalpy (kJ/kg) (kcal/kg')	25.9 (6.2)	19.2 (4.6)	5 (1.2)
Total heat recovered W (kcal/h)	3489 (3000)	2372 (2040)	0
Outdoor air load W (kcal/h)	2093 (1800)	3210 (2760)	5582 (4800)
Outdoor air load ratio (%)	38	58	100

+ kcal/kg' and kJ/kg in ( )

Room air	
Dry bulb temperature	20°C
Absolute humidity	7.2 g/kg'
Relative humidity	50%
Enthalpy	38.5 kJ/kg (9.2 kcal/kg')

Outdoor air	
Dry bulb temperature	0°C
Absolute humidity	1.8 g/kg'
Relative humidity	50%
Enthalpy	5 kJ/kg (1.2 kcal/kg')

Calculation example

● Lossnay

(Supply air temperature)

t_{SA} = (20°C – 0°C) × 0.74 + 0°C = 14.8°C

(Supply air enthalpy)

i_{SA} = (38.5 – 5) × 0.62 + 5

= 25.7kJ/kg (6.2kcal/kg)

Heat recovered (25.9 – 5) × 1.2 × 500 × 0.2777$^+$

= 3483.3W (3000kcal/h)

Outdoor air load (38.5 – 25.9) × 1.2 × 500 × 0.2777$^+$

= 2100W (1800kcal/h)

● Sensible heat exchanger

(Supply air temperature)

t_{SA} = (20°C – 0°C) × 0.74 + 0°C = 14.8°C

(Supply air enthalpy) i_{SA} = 19.2 kJ/kg (4.6 kcal/kg)

(from psychrometric chart)

Heat recovered (19.2 – 5) × 1.2 × 500 × 0.2777$^+$

= 2366W (2040kcal/h)

Outdoor air load (38.5 – 19.2) × 1.2 × 500 × 0.2777$^+$

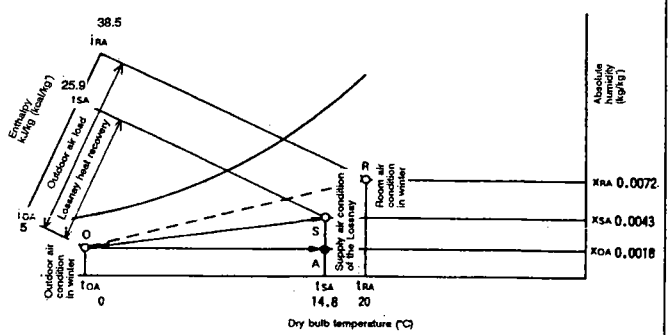
= 3216W (2760kcal/h)

● Conventional ventilator

If a conventional ventilator is used, the supply air is the same as the outdoor air and the exhaust is the same as the room air. Thus the heat recovered is 0 kcal and the outdoor air load is (38.5 – 5) × 1.2 × 500 × 0.2777$^+$ = 5583W (4800kcal/h)

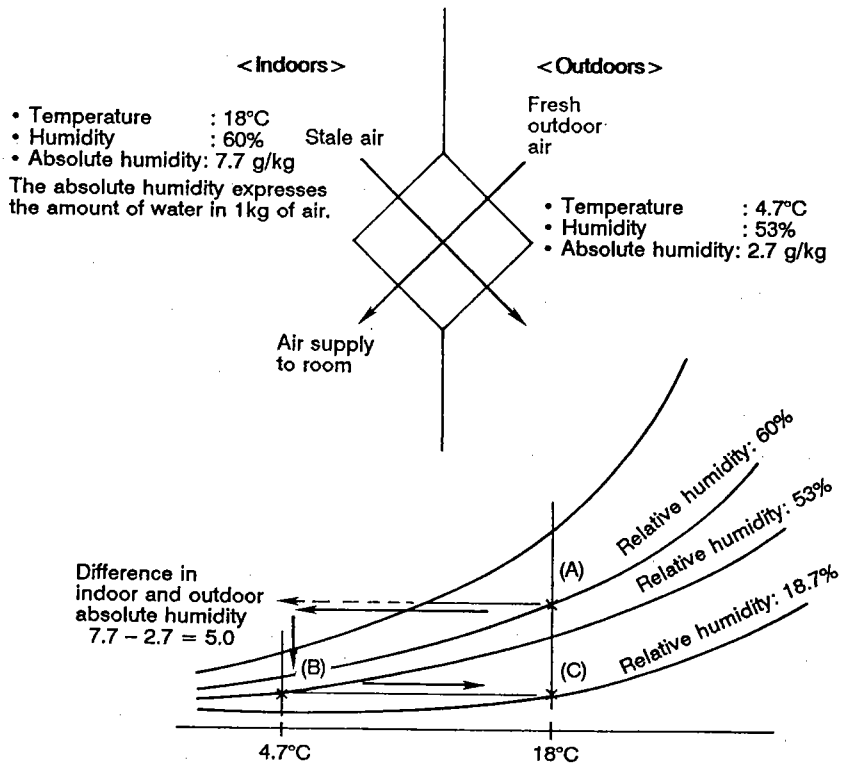
+ Conversion Factor (1000 Watts/3600 secs)

Winter conditions



2. Special Dehumidification Type Lossnay Heat Exchanger

Why is the plastic element type Lossnay effective in dehumidification during the winter?
This is due to a combination of the use of a special type of plastic which does not pass humidity through to the Core and the fact that the amount of vapour in the air changes with temperature.
With this Lossnay type dehumidification is performed while retaining the temperature of the air in the room by replacing this air with dry air supplied from outdoors.
This phenomenon is explained further below.



We can tell from the psychrometric chart that for room temperature of 18°C and relative humidity of 60% the absolute humidity will be 7.7g/kg (A). When the outdoor air is 4.7°C and relative humidity is 53%, the absolute humidity is 2.7g/kg (B). Thus, without changing the room temperature, the indoor and outdoor airs are interchanged, and the outdoor air enters the room with an absolute humidity of 2.7g/kg. Looking at the psychrometric chart, the relative humidity at this point is approximately 18.7% (C).
Using this low value of supply air humidity the room air humidity can be decreased 10 to 20% from the initial 60%. This is the dehumidifying effect of the Lossnay.

The dehumidifying effect cannot be benefited from during the summer also when the outdoor humidity is high, but the air conditioner load can still be reduced with the temperature exchange.

3. Selecting the Most Suitable Lossnay with an Example of Heat Recovery Calculation

● Selecting the model

The Lossnay model is selected by the outdoor air volume. This volume can be obtained from the building's air conditioning area, capacity and ventilation volume for one person. Using this outdoor air volume and the exhaust air volume that pass through the Lossnay as a reference, find the most appropriate model in terms of heat exchange efficiency, static pressure loss characteristics and installation space for the model's treated air volume. Then, select a Lossnay model that satisfies the heat recovery effect and cost requirements.

(1) Setting of conditions

(Note: Tokyo Power, industrial power 6kV supply, 1kW = 2,750kcal/h cooling and heating capacity)

- Return air volume (RA) = 7,200m^3/Hr
- Outdoor air volume (OA) = 8,000m^3/Hr
- Air volume ratio (RA/OA) = 0.9
- Values calculated for Japan (¥) and converted to US$: 1US$ = ¥130
- Air conditions

Season	Winter heating					Summer cooling				
Item	Dry bulb temp. DB [°C]	Wet bulb temp. WB [°C]	Relative humidity RH [%]	Absolute humidity x [kg/kg']	Enthalpy i [kJ/kg (kcal/kg')]	Dry bulb temp. DB [°C]	Wet bulb temp. WB [°C]	Relative humidity RH [%]	Absolute humidity x [kg/kg']	Enthalpy i [kJ/kg (kcal/kg')]
Outdoors	0	–2.7	50	0.0018	5 (1.2)	33	27.1	63	0.0202	85 (20.3)
Indoors	20	13.8	50	0.0072	38.5 (9.2)	26	18.7	50	0.0105	53 (12.7)

- Operation time: Heating = 10 hours/day x 26 days/month x 5 months/year = 1300 hours/year
  Cooling = 10 hours/day x 26 days/month x 4 months/year = 1040 hours/year
- Energy: Heating = Type: Electricity Cost: $0.0000108/J
  Cooling = Type: Electricity Cost: $0.0000119/J
  Power rates: Winter: $0.12/kWh Summer: $0.14/kWh

(2) Selection of Lossnay model (select from treatment air volume catalogue)

- Model name: LU-160 with combination of LU-1605 x 1 unit
- Processing air volume per unit RA=7,200m^3/Hr, OA=8,000m^3 Air volume ratio (RA/OA) = 0.9
- Exchange efficiency: Heat exchange efficiency = 73%,
  Enthalpy exchange efficiency (cooling) = 62%,
  Enthalpy exchange efficiency (heating) = 67%
- Static pressure loss (unit-type) RA= 157Pa (16mmH_2O), OA = 186.4Pa (19mmH_20) (Note: Each with filters)
- Power consumption (pack-type) = none because of unit type

(3) State of indoor supply air

	Heating	Cooling
Temperature [°C]	= {20 (Indoor temperature) – 0 (outdoor air temperature)} x 0.73 (heat exchange efficiency) + 0 (outdoor air temperature) = 14.6	= 33 (Outdoor air temperature) – {33 (outdoor air temperature) – 26 (indoor temperature)} x 0.73 (heat exchange efficiency) = 27.89
Enthalpy [kJ/kg (kcal/kg)]	= {38.5 (9.2) (Indoor enthalpy) – 5 (1.2) (outdoor air enthalpy)} x 0.67 (enthalpy exchange efficiency) + 5 (1.2) (outdoor air enthalpy) = 27.4 (6.56)	= 85 [20.3] (Outdoor air enthalpy) – {85 [20.3] (outdoor air enthalpy) – 53 [12.7] (indoor enthalpy)} x 0.62 (enthalpy exchange efficiency) = 65.3 [15.59]
Numerical value obtained from above equation and psychometric chart	● Dry-bulb temperature = 14.6°C ● Wet-bulb temperature = 9.2°C ● Relative humidity = 49% ● Absolute humidity = 0.005kg/kg' ● Enthalpy = 27.4 kJ/kg (6.56kcal/kg')	● Dry-bulb temperature = 27.89°C ● Wet-bulb temperature = 22.4°C ● Relative humidity = 62% ● Absolute humidity = 0.0146kg/kg' ● Enthalpy = 65.3 kJ/kg (15.59kcal/kg)

(4) Outdoor air load and heat recovered

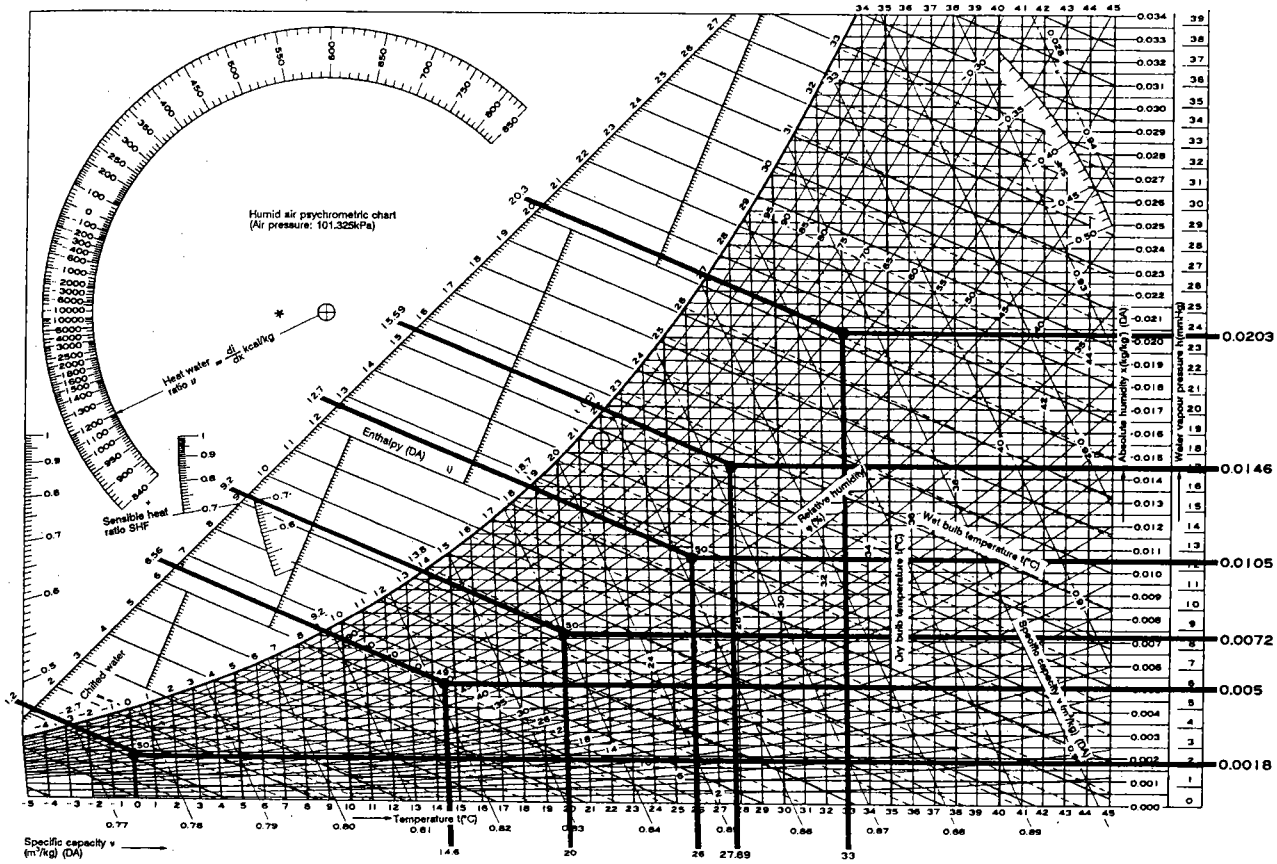
	Heating	Cooling
Fresh air load without Lossnay (q_1)	= 1.2 (Air specific gravity) × 8,000 × 0.2777+ (outdoor air volume) × { 38.5 (indoor enthalpy) – 5 (outdoor air enthalpy) } = 89,333W (76,800kcal/hr)	= 1.2 (Air specific gravity) × 8,000 × 0.2777+ (outdoor air volume) × { 85 (outdoor air enthalpy) – 53 (indoor enthalpy) } = 85,333W (72,960kcal/hr)
Outdoor air load with Lossnay (q_2)	= 89,333W (76,800kcal/hr) (Outdoor air load) (q_1) × { 1 – 0.67 (enthalpy exchange efficiency)} = 29,475W (25,344kcal/hr) or = Air specific gravity × outdoor air volume × (indoor enthalpy – indoor blow enthalpy)	= 85,333W (72,960kcal/hr) (Outdoor air load) (q_1) × { 1 – 0.62 (enthalpy exchange efficiency) } = 32,244W (27,725kcal/hr) or = Air specific gravity × fresh air volume × (indoor blow enthalpy – indoor enthalpy)
Heat recovered (q_3)	= $q_1 - q_2$ = 89,333 – 29,475 = 59,858 (51,456kcal/hr) or = Outdoor air load (q_1) × enthalpy exchange efficiency	= $q_1 - q_2$ = 85,333 – 32,244 = 53,089W (45,235kcal/hr) or = Outdoor air load (q_1) × enthalpy exchange efficiency
(%) outdoor air load	● Outdoor air load = 89,333W = 100% ● Outdoor air load with Lossnay = 29,475W = 33% ● Heat recovered = 59,858W (51,456kcal/hr) = 67%	● Outdoor air load = 85,333W = 100% ● Outdoor air load with Lossnay = 32,244W = 38% ● Heat recovered = 53,089W (45,235kcal/hr) = 62%

+ Conversion Factor (1000 Watts/3600 secs)

(5) Recovered money (power rates)

	Heating	Cooling
Yearly saved money	= Heat recovered: kW × Unit price $/W × operation time Hr/year = 59.858kW × $0.0000108/J × (1,300hr/year × 3,600sec) = $3,025	= Heat recovered: kW × Unit price $/W × operation time Hr/year = 53.089kW × $0.0000118 × (1,040hr/year × 3,600sec) = $2,345

● Psychrometric chart for calculating Lossnay economical effect



*1kcal/kg' = 4.186kJ/kg

The following can be determined from the above calculation results:

- Saving of 59,858W (51,456 kcal/h) of the heating load, and 53,089 W (45,235kcal/h) of the cooling load is possible.
  The heat source equipment and related ventilator capacity that is equivalent to this saved amount can be reduced, thus the operation and maintenance costs can also be saved.
- Approximately $3,000 can be saved in operation and maintenance costs during heating and $2,300 during cooling, totally to a total savings of approximately $5,300. Furthermore, as 17.1 kW can be saved from the basic power rates during cooling, approximately $2,642 (17.1 × $12/month × 12 months) can be saved annually.

4. Calculation for Economic Effects with Lossnay

The following is a sample questionnaire from which it is possible to assess the economical benefits of using the Lossnay in particular applications.

(1) Setting of conditions

- Return air volume (RA) = m^3/Hr
- Outdoor air volume (OA) = m^3/Hr
- Air volume ratio (RA/OA) =
- Air conditions

Season	Winter heating					Summer cooling				
Item	Dry bulb temp. DB [°C]	Wet bulb temp. WB [°C]	Relative humidity RH [%]	Absolute humidity x[kg/kg']	Enthalpy i kJ/kg (kcal/kg')	Dry bulb temp. DB [°C]	Wet bulb temp. WB [°C]	Relative humidity RH [%]	Absolute humidity x[kg/kg']	Enthalpy I kJ/kg (kcal/kg')
Outdoors										
Indoors										

- Operation time: Heating = hours/day × days/month × months/year = hours/year
  Cooling = hours/day × days/month × months/year = hours/year
- Energy: Heating = Type: Electricity Cost: $ /kcal
  Cooling = Type: Electricity Cost: $ /kcal
  Power rates: Winter: $ /kWh Summer: $ /kWh

(2) Selection of Lossnay model (select from treatment air volume catalog)

- Model name:
- Processing air volume per unit RA= m^3/Hr, OA= m^3 Air volume ratio (RA/OA) =
- Exchange efficiency: Heat exchange efficiency = %,
  Enthalpy exchange efficiency (cooling) = %,
  Enthalpy exchange efficiency (heating) = %
- Static pressure loss (unit-type) RA= mmH_2O OA = mmH_20 (Note: Each with filters)
- Power consumption (pack-type) = none because of unit type

(3) State of indoor blow air

	Heating	Cooling
Temperature [°C]	= (Indoor temperature – outdoor air temperature) × heat exchange efficiency + outdoor air temperature =	= Outdoor air temperature – (outdoor air temperature – indoor temperature) × heat exchange efficiency =
Enthalpy [kJ/kg(kcal/kg)]	= (Indoor enthalpy – outdoor air enthalpy) × enthalpy exchange efficiency + outdoor air enthalpy =	= Outdoor air enthalpy – (outdoor air enthalpy – indoor enthalpy) × enthalpy exchange efficiency =
Numerical value obtained from above equation and psychometric chart	• Dry-bulb temperature = °C • Wet-bulb temperature = °C • Relative humidity = % • Absolute humidity = kg/kg' • Enthalpy = kJ/kg (kcal/kg)	• Dry-bulb temperature = °C • Wet-bulb temperature = °C • Relative humidity = % • Absolute humidity = kg/kg' • Enthalpy = kJ/kg (kcal/kg)

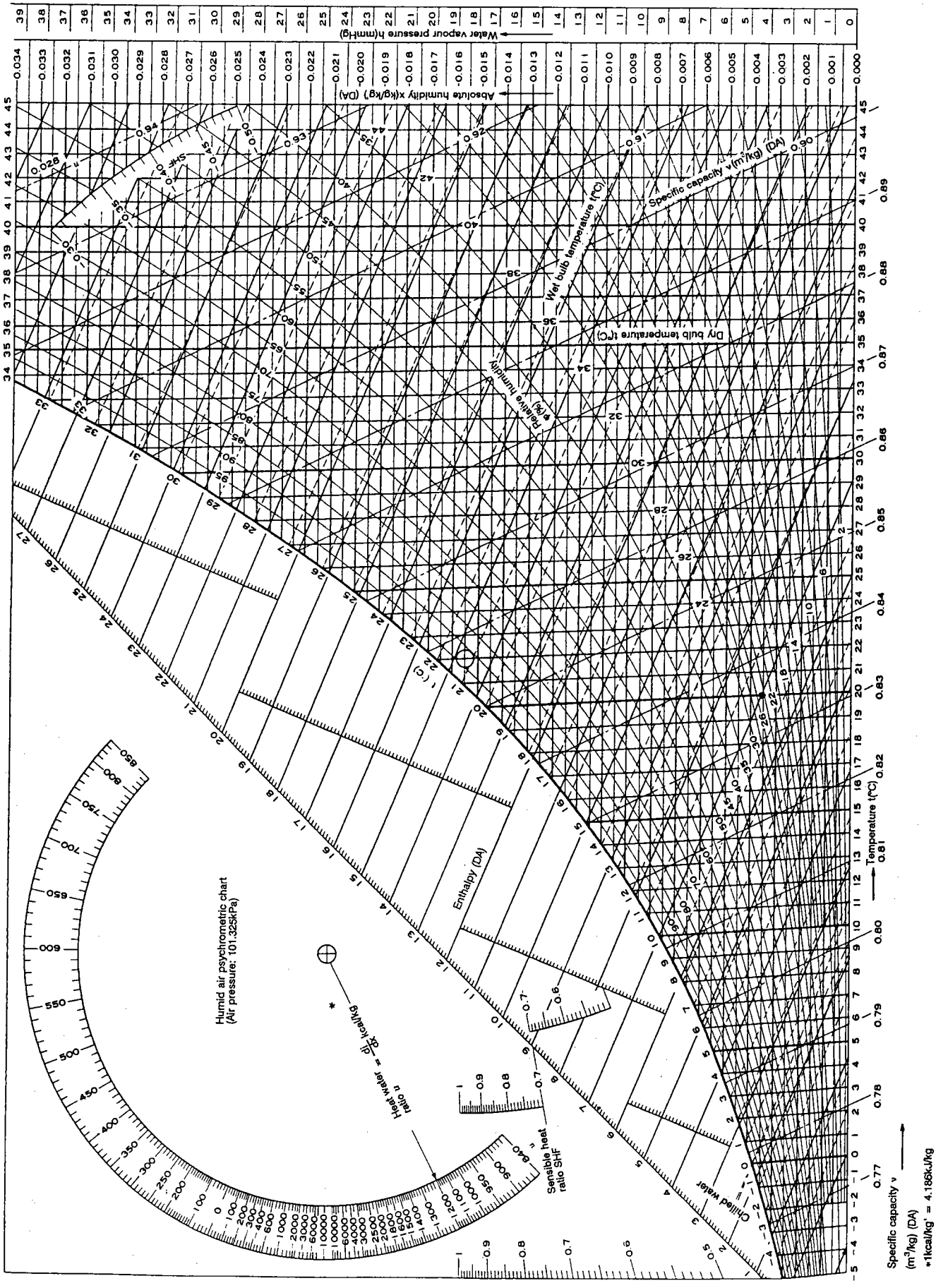
(4) Outdoor air load and heat recovery

	Heating	Cooling
Fresh air load without Lossnay (q_1)	= Air specific gravity × outdoor air volume × (indoor enthalpy – outdoor air enthalpy) =	= Air specific gravity × outdoor air volume × (outdoor air enthalpy – indoor enthalpy) =
Outdoor air load with Lossnay (q_2)	= Outdoor air load (q_1) × (1 – enthalpy exchange efficiency) = or = Air specific gravity × outdoor air volume × (indoor enthalpy – indoor blow enthalpy)	= Outdoor air load (q_1) × (1 – enthalpy exchange efficiency) = or = Air specific gravity × fresh air volume × (indoor blow enthalpy – indoor enthalpy)
Heat recovery (q_3)	= $q_1 - q_2$ = – = or = Outdoor air load (q_1) × enthalpy exchange efficiency	= $q_1 - q_2$ = – = or = Outdoor air load (q_1) × enthalpy exchange efficiency
(%) to outdoor air load	● Outdoor air load = W = % ● Outdoor air load with Lossnay = W = % ● Heat recovered = W = %	● Outdoor air load = W = % ● Outdoor air load with Lossnay = W = % ● Heat recovered = W = %

(5) Recovered money (power rates)

	Heating	Cooling
Yearly saved money $	= Heat recovered: W × Unit price $/J × operation time Hr/year = W × $/J × (Hr/year × 3600 sec) =	= Heat recovered: W × Unit price $/J × operation time Hr/year = W × $/J × Hr/year =
Remarks		

5. Psychrometric Chart



6. The Result of No Bacterial Cross Contamination for the Lossnay Core and Determining Resistance of the Lossnay Core to Molds

Test Report

This document reports the result that there is no bacterial cross contamination for the Lossnay Core.

1) Object

The object of this test is to verify that there is no bacterial cross contamination from the outlet air to the inlet air of the Lossnay Core in the heat exchange process.

2) Client

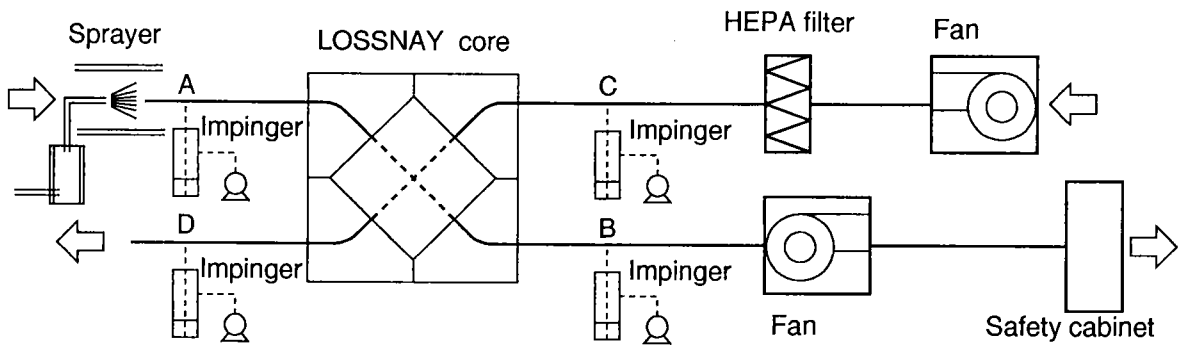
MITSUBISHI ELECTRIC CO. NAKATSUGAWA WORKS.

3) Test period

April 26, 1999 - May 28, 1999

4) Test method

The configuration of the test equipment is shown below. The test bacteria suspension is sprayed in the outlet duct at a pressure of 1.5 kg/cm^2 with a sprayer whose dominant particle size is 0.3-0.5 μm. The air sampling tubes are installed at the each center of the locations of A, B, C, D, in the Lossnay inlet/outlet ducts so that their openings are directly against the air flow, and then connected to the impinger outside the duct. The impinger is filled with 100 mL physiological salt solution. The airborne bacteria in the duct air are sampled at the rate of 10L air/minute for three minutes.



5) Test bacteria

The bacteria used in this test are as followed;

Bacillus subtilis IFO 3134

Pseudomonas diminuta IFO14213 (JIS K 3835 Method of testing bacteria trapping capability of precision filtration film elements and modules; applicable to precision filtration film, etc. applied to air or liquid)

6) Test result

The result of the test with *Bacillus subtilis* is shown in Table-1.

The result of the test with *Pseudomonas diminuita* is shown in Table-2.

Table-1 Test Result with *Bacillus Subtilis* (CFU/30L air)

No.	A	B	C	D
1	5.4×10^4	5.6×10^4	$<10^3$	$<10^3$
2	8.5×10^3	7.5×10^3	$<10^3$	$<10^3$
3	7.5×10^3	$<10^3$	$<10^3$	$<10^3$
4	1.2×10^4	1.2×10^4	$<10^3$	$<10^3$
5	1.8×10^4	1.5×10^3	$<10^3$	$<10^3$
Average	2.0×10^4	1.5×10^4	$<10^3$	$<10^3$

Table-2 Test Result with *Pseudomonas Diminuita* (CFU/30L air)

No.	A	B	C	D
1	3.6×10^5	2.9×10^5	$<10^3$	$<10^3$
2	2.5×10^5	1.2×10^5	$<10^3$	$<10^3$
3	2.4×10^5	7.2×10^5	$<10^3$	$<10^3$
4	3.4×10^5	8.4×10^5	$<10^3$	$<10^3$
5	1.7×10^5	3.8×10^5	$<10^3$	$<10^3$
Average	2.7×10^5	4.7×10^5	$<10^3$	$<10^3$

7) Considerations

Bacillus subtilis is commonly detected in the air and resistant to dry. *Pseudomonas diminuita* is susceptible to dry and only a few exists in the air. However, it is used in the performance verification of the bacteria trapping filter since the particle size is small (Cell diameter; 0.5 μm: Cell length 1.0 - 4.0 μm).

Both *Bacillus subtilis* and *Pseudomonas diminuta* are detected at the location A and B in the outlet side duct where they are sprayed, but neither them are detected at location C (in the air filtered by the HEPA filter) and the location D (in the air crossed in the Lossnay Core) on the inlet side.

Since the number of bacteria in the location A is substantially equal to one in the location B, it is estimated that only a few bacteria are attached to the Lossnay Core on the outlet side. Also, no test bacteria is detected at the location D where the air is crossed in the Lossnay Core. Therefore, it can be concluded that the bacteria attached to the outlet side will not pass through the inlet side even after the heat is exchanged.

Shunji Okuda
Manager, Biological Section
Kitasato Research Center of Enviromental Sciences

Test Report

This document reports the result of determining resistance of the Lossnay Core to molds.

1) Object

The object of this test is to determining resistance of the Lossnay Core to molds.

2) Client

MITSUBISHI ELECTRIC CO. NAKATSUGAWA WORKS.

3) Test sample

Lossnay Core (paper separator)

4) Test period

April 26, 1999 - May 28, 1999

5) Test method

The testing method is in accordance with "5. General Industrial Products," "Test Method of Resistance to Mold," JIS Z 2911.

The Lossnay Core is cut into 5 × 5 cm square. pole. The test mold spore solution is sprayed on one side of the core and, after covering one side of the crossing core with sponge sheet, the core is left in the chamber with 27°C, (relative humidity 95%) for four weeks.

6) Test mold

The molds used in this test are as follows;

Aspergillus niger ATCC 6275
Penicillium citrinum ATCC 9849
Rhizopus oryzae IFO 31005
Cladosporium cladosporioides IFO 6348
Chaetomium globosum ATCC 6205

7) Determination criterion

Observed growth on specimens	Degree
None growth	3
Light growth (less than 1/3 area)	2
Heavy growth (more than 1/3 area)	1

8) Test result

No hypha was growth in the place where the test mold spore solution was applied. So the degree of resistance to mold was judged to be 3.

Shunji Okuda
Manager, Biological Section
Kitasato Research Center of Enviromental Sciences

7. Flame-proofing Properties of Lossnay Core

The Lossnay Core satisfied all requirements of Paragraph 4-3 of the Fire Prevention Law Enforcement Rules. Details of the tests carried out are as seen below.

Notation format 2 – (3)

Notification of flame-proofing property test (For flame-proof materials and related items)

Flame-proofing committee test No,. B-80028
April 17, 1980

Messrs.: Mitsubishi Electrical Corporation

Japan Flame-proofing committee

The results of the test, requested on April 8, 1980, are as follows.

Whereas

Part name	Air filter Total heat exchanger	**Material, Mixture ratio, Organization, Fan number, Density, Weight (g/m²)**	Specially treated paper: (Partition (white): Thickness 0.2mm) (Filler block (blue): Thickness 0.2mm) Adhesive agent: Vinyl acetate (Specific gravity ratio 2.6%) 600g/m²
Product name (Brand)	Lossnay (ventilation fan) B		

Test No.	Test item	Residual flame (sec.)	Residual dust (sec.)	Carbonized area (cm²)
2-min. heating	1 (Vertical)	0.	4.1	35.4
	2 (Vertical)	0.	7.7	38.2
	3 (Horizontal)	0.	1.4	35.9
6-sec. heating after igniting	1 (Vertical)	0.	0.	26.3
	2 (Horizontal)	0.	0.	20.3

Test No.	Test item	Carbonization length (cm)	No. of flame contact times (times)
1			
2			
3			
4			
5			

Evaluation	Passing

Remarks

Test method
Application of Paragraph 4-3 Standards of Fire Prevention Laws Enforcement Rules (Ministry of Home Affairs Ordinance No. 6, 1961) (Thick cloth test)

Passing standards
Residual flame : 5 sec. or less
Residual dust : 20 sec. or less
Carburized area : 40 cm² or less

Washing test

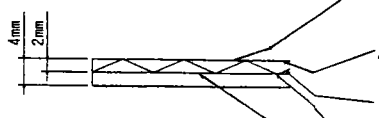
The Lossnay Core was also tested at the Japan Construction General Laboratories according to the fire retardancy test methods of thin materials for construction as set forth by JIS A 1322. The material was evaluated as Class 2 flame retardant. Details of the tests carried out are as seen below.

Flame-proofing property test report

Acceptance No.	VF-93-11-(2)
Date of acceptance	September 7, 1993
Date of report	October 12, 1993

Messrs. Mitsubishi Electric Corp., Nakatsugawa Works

Japan Construction General Laboratories
1-8-5 Fujishirodai, Suita City 565
Tel: 06-872-0391
Hiroshi Wakabayashi Dr.
of Engineering, Director

Applicant	**Company name**	Mitsubishi Electric Corp., Nakatsugawa Works		
	Address	1-3 Komaba-cho, Nakatsugawa, Gifu		
Specimen and test body	**Specimen type**	Single-face laminated corrugated board	**Product name**	Lossnay Core (total heat exchanger)
	Material structure and cross-sectional diagram, etc.	 Single-face laminated corrugated board ..... Thickness; 4mm (Single-face corrugated board with 2mm cell size laminated alternately at right angle) Partition (liner paper) Flame-proof treated paper ... Thickness:0.085mm, Weight:70g/m^2 Adhesive agent ... Vinyl acetate resin ... Weight: 30g/m^2 (solid) Filler (flute paper) ... Colored wood free paper ... Thickness:0.093mm, Weight:79g/m^2 Adhesive agent ... Vinyl acetate resin ... Weight: 30g/m^2 (solid) Partition (liner paper) Flame-proof treated paper ... Thickness:0.085mm, Weight:70g/m^2		
	Test body size and thickness (mm)	300 (long side) × 200 (short side) × 4 (thickness)		
	Test body direction	The longer side is the vertical side.		

Testing method	**Testing standards**	**Pre-treatment of test body**	**Heating time**	**Heating surface class and direction**
	JIS A 1322 (45° Meckelian burner method)	Method A (drying method)	3 min.	The direction of which the corrugated board fold was vertical was set as the front of the heating surface.

Test results	**Test date**			October 5, 1993				
	Test position			**Residual flame (sec.)**	**Residual dust (sec.)**	**Carbonized length (vertical × horizontal) (cm)**	**Discoloration length (vertical × horizontal) (cm)**	**Remarks**
	Class	**Direction**	**No.**					
	Front	Vertical	1	0	0	8.2 × 4.7	18.7 × 7.3	*1
			2	0	0	8.4 × 4.9	24.3 × 7.8	
			3	0	0	7.4 × 5.0	22.0 × 8.4	

Evaluation	The specimen conforms to Class 2 flame-proofing (heating time: 3 min.) according to the "Fire retardancy test methods of thin materials for construction" as set forth by JIS A 1322.
Persons in charge of testing	Material Testing Laboratory Laboratory chief: Hiroshi Tamura, Technicians: Shigeru Fujikawa, Nobuaki Oohiro, Tetsuya Ogawa

Note: *1: Immediately after starting heating, the flame was ignited simultaneously with the generation of smoke. Penetration was observed approx. 2 min. 30 sec., after heating was started. There were no further changes.

8. Lossnay Core's Soundproofing Properties Test

As the Lossnay Core is made of paper and the permeable holes are extremely small, the Core has outstanding soundproofing properties and is appropriate for ventilation in soundproof rooms.
For example, the exposed ceiling-type LGH-50E has soundproofing characteristics of 33.9 dB with a centre frequency of 400 Hz. This means that a sound source of 96.9 dB can be shielded to 63 dB.

No.122-1

Soundproofing effect test results

For Mitsubishi Electric Corporation
Nakatsugawa Works

Test number	IVA – 78 – 122
Acceptance data :	February 22, 1979
Report :	May 24, 1979

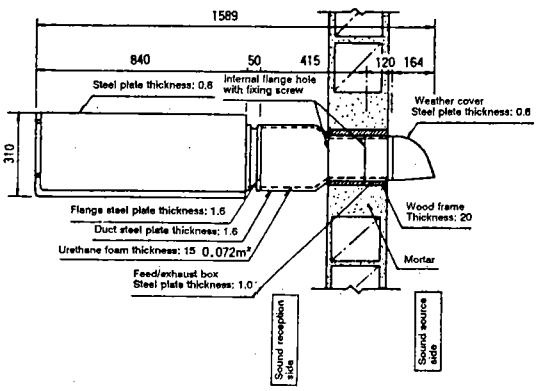
The results of the tests are as noted below.
General Building Research Corporation
General Manager, S. Okushima

General Building Research Corporation
Fujishirodai 5-125, Suita-shi, Osaka-Fu, Japan

Person in charge of testing: Takeshi Tokura

Certificate number		IVA – 78 – 122
Specimen	**Product name**	LGH-50E
	Item name	Heat exchange-type ventilator
	Application	Ventilation
	Date of manufacture	October 1978
	Place of assembly	General Building Research Corporation
	Dimensions	W1250 × H310 × D1589
	Area concentration	——
	Remarks Cultures, specimen installation method at test facility	An existing hole (4000mm×3000mm) was covered with a hollow concrete block with double-faced mortar (thickness 20mm each), with a wood frame with inner dimension of 580mm × 190mm × 230mm being installed. The supply/exhaust box and duct was mounted in this, and the main unit and weather cover was mounted.
	Peripheral sections	Oil clay was filled around the sound source

Specimen configuration (dimensions mm)
Refer to appendix 1, 2 for details. S: 1/20



Remarks
Urethane foam (15mm thick) was stuck onto the inside of the duct and feed/exhaust box.

Testing facility						General Building Research Corporation	
Client	**Address**					1-3 Komaba-cho, Nakatsugawa, Gifu	
	Company name					Mitsubishi Electric Corporation Nakatsugawa Works	
Sound transmission loss test	**Testing method**					According to "soundproofing effect test" in Ministry of Construction No. 108	
	Measurement date					March 9, 1979	
	Measurement conditions					Temperature: 12.5°C, humidity: 77%	
	Soundproof area dimensions					W580 × H190	
		Centre frequency				125Hz	500Hz	2000Hz
	Measurement results	**Each measured sound pressure level (dB)**	**Sound source side**	**Measurement point**	1	101.5	96.5	98.5
					2	99.0	——	——
					3	100.0	97.5	98.5
					4	102.0	——	——
					5	101.5	96.5	98.5
				Average level		100.9	96.9	98.5
			Reception side	**Measurement point**	1	81.5	63.5	53.0
					2	79.5	——	——
					3	79.5	63.0	43.0
					4	82.5	——	——
					5	81.5	62.5	43.5
				Average level		81.1	63.0	43.2
		Average sound pressure level difference (dB)				19.8	33.9	55.3
		Sound absorbed by reverberation chamber on reception side (m^2)				2.79	3.90	7.22
		Sound transmission loss (dB)				5.8	18.4	37.1
		Refer to next page for details of test results						

Remarks
The soundproofed area of the specimen is small in this test, and as the transmission of sound though the surrounding concrete block wall cannot be ignored, the concrete block wall was measured after the main test, and the main test measurement results were corrected.

Persons in charge of testing: Mitsuo Morimoto, Toshifumi Murakami

9. Change in Lossnay Core Over Time

The following details show an example of a building that has installed the Lossnay units, from which it is possible to assess the change in the units over time.

1) Outline of building where Lossnay is installed

(1) Building name : Meiji Seimei, Nagoya Office/shop building
1-1 Shinsakae-machi Naka-ku, Nagoya

(2) No. of floors : 16 above ground, 2-storey penthouse, 4 basement floors

(3) Total floor space : 38,893 m^2

(4) Reference floor space : 1,388 m^2

2) Outline of installed ventilation equipment

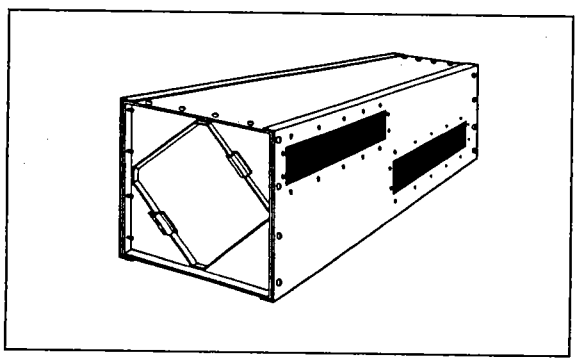
(1) Air handling method : 4 fan coil units (perimeter zone) per floor

Chilling unit : Absorption-type 250kT × 1 unit, turbo 250kT × 2 units

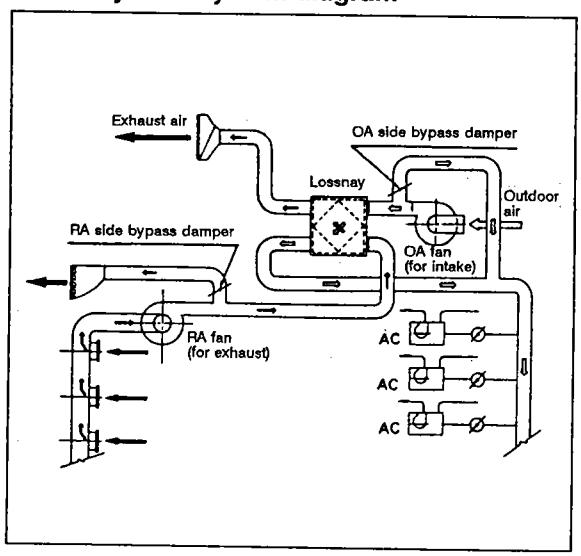
Gas direct heating/cooling boiler : 340kT, heating 1400 × 10^3kcal/h

(2) Ventilation method : Air - air total heat exchanger "Lossnay"
LS-200 × 18 units installed in penthouse.
Outdoor air treatment volume 46,231CMH,
Exhaust air treatment volume 54,335CMH.

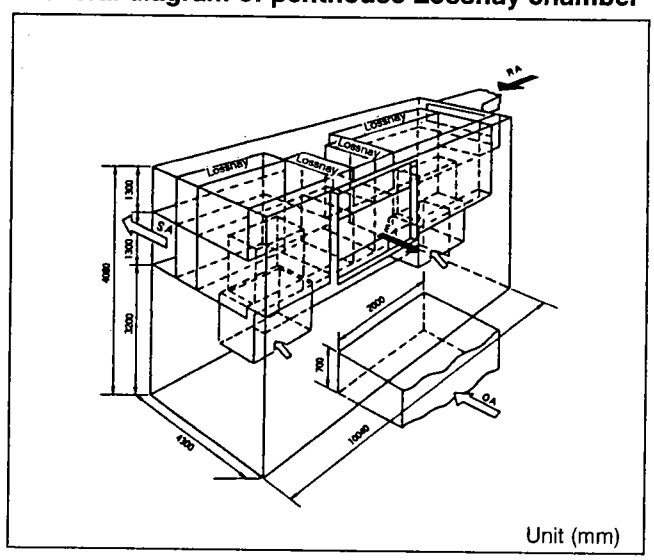
(3) Lossnay outline diagram : LS-200 (with four Lossnay Cores)



Lossnay duct system diagram



General diagram of penthouse Lossnay chamber



3) Outline of Lossnay operation

(1) Start of operation : September 1972
Start of daily operation : 7:00
End of daily operation : 18:00
] Average daily operation 11 hours

(2) Inspection after usage : November 1983

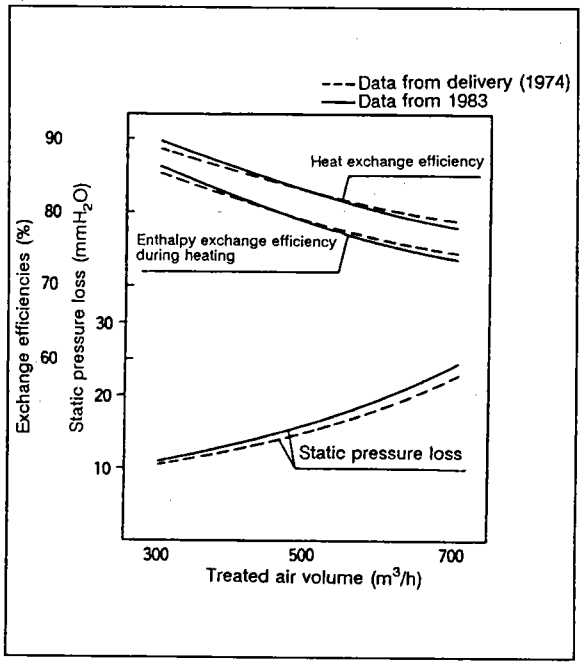
(3) Bypass operation month : Three months of April, May, June

(4) Total operation time : (134-33) months × 25 days/month × 11 hours/day = 27,775 hours

4) Characteristics in change of Lossnay Core over time

Two Lossnay Core were removed from the 18 Lossnay LS-200 installed in the Meiji Seimei Building, and the static pressure loss and exchange efficiencies were measured. The comparison with the initial value is shown on the right. The appropriate air volume for one Lossnay Core is 500m^3/hr, and the measurement point was ±200m^3/hr of this value.

Characteristics in change of Lossnay Core over time



5) Conclusion

(1) Changes in the characteristics of the Lossnay Core after approximately eleven years of use and an estimated 28,000 operation hours were not found.
In numerical values, the static pressure loss was 15 ~ 16 mmH$_2$O at 500 m^3/hr which was a 1 mmH$_2$O increase, and the exchange efficiencies had decreased slightly at above 500 m^3/hr. However, this is considered to be insignificant and remained in the measurement error range.

(2) Looking at the appearance, the Core surface was black with dust, but there were no gaps, deformation or mold that would pose problems during practical use.

10. Comparison of Heat Recovery Techniques

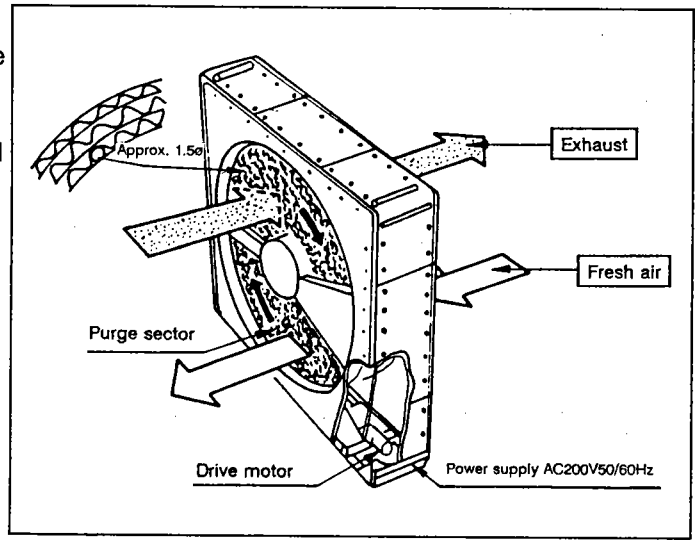
The methods by which heat recovery devices can be categorised may be considered as follows:

Basic methods of total heat exchangers

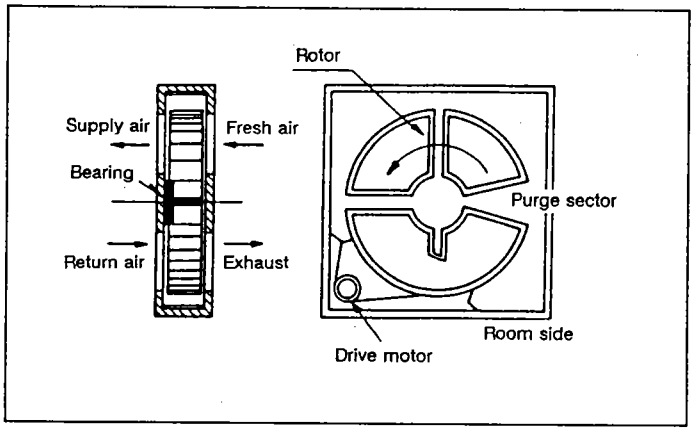
Heat recovery principle	Type	Method	Air flow	Country of development
	Static (Mitsubishi Lossnay)	Conductive transmission type	Cross-flow	Japan
	Rotary type	Heat accumulation/ humidity accumulation type	Counterflow	Sweden

1) Principle construction of rotary-type

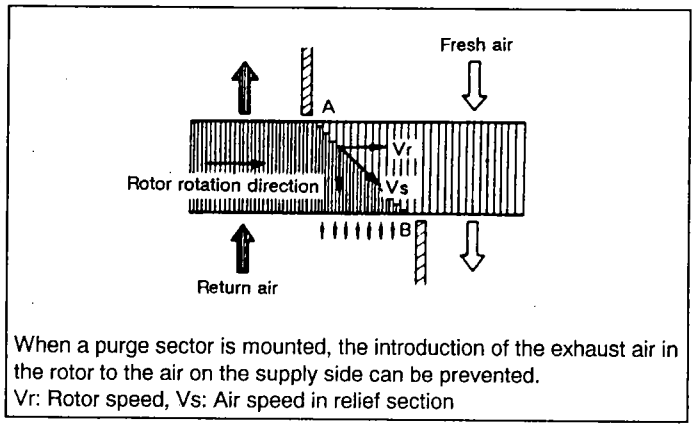
- The rotary-type heat exchanger is composed of a rotor that has a layered honeycomb structure made of kraft paper, drive motor and housing.
  A large quantity of moisture absorbent material (lithium chloride, etc.) is applied onto the rotor, and humidity is transferred. The rotor is rotated eight times a minute by the drive motor.



- The principle of this rotary-type is for example when cooling, the high temperature and high humidity fresh air passes through the rotor, with the heat and humidity being absorbed by the rotor. As the rotor is rotating, it moves into the exhaust air passage, and the heat and humidity is discharged to outdoors because the exhaust is cool and has a low humidity.
  The rotor rotates and returns to the fresh air passage to absorb the heat and humidity again.



- Function of purge sector
  There are two separation plates (purge sector) in the front and back of the rotor to separate the flow of the air. As one of the plates is slightly shifted, part of the fresh air always flows into the exhaust air passage to prevent the exhaust air and fresh air from mixing. (A balanced pressure difference is required.)



When a purge sector is mounted, the introduction of the exhaust air in the rotor to the air on the supply side can be prevented.
Vr: Rotor speed, Vs: Air speed in relief section

2) Comparison of static-type and rotary-type heat exchangers

Item	Static-type		Rotary-type	
Construction/principle	<Conductive transmission-type: cross-flow> Static-type transmission total heat exchanger with orthogonally layered honeycomb shaped treated paper formed into multiple layers. ● As the supply air and exhaust air pass through different passages (sequentially layered), the air passages are completely separated.		<Heat accumulation/humidity accumulation-type: counterflow> The rotor element is composed of honeycomb-shaped kraft paper, etc., to which a moisture absorbent is applied (lithium chloride, etc.). This rotor is rotated, and heat accumulation/humidity accumulation - heat discharge/humidity discharge of total heat exchange is performed by passing the exhaust and intake airs into a honeycomb passage. X Supply air and exhaust airs flow into the same air passage because of the rotary-type construction.	
Moving parts	● None Fixed heat exchanger		X Used (rotor driven with belt by gear motor) Rotor heat exchanger (8RPM)	
Material quality	Treated paper		Treated paper, aluminum plates, etc.	
Mounting of prefilter	Required (periodic cleaning required)		Required (periodic cleaning required)	
Heat exchanger clogging	● Occurs (state where dirt adheres onto element air passage surface. However, this is easily removed with a vacuum cleaner.)		X Occurs (Dust is smeared into element air passage filter.) (The dust adhered onto the element surface is smeared into the air passage by the purge sector packing. Thus, it cannot be removed easily and the air volume decreases.)	
Air leakage Gas transmission rate	Approximately 2.5% air leak at standard fan position. Leaks on the air supply side can be reduced to 0 by leaking the loss air volume (approx. 10%) on the exhaust side with the fan position to the element. ● Gas transmission (Ammonia : 28%, hydrogen sulfide : approx. 6.7%)		X Purged air volume occurs To prevent leakage of exhaust to the air intake side, a purge air volume (6 to 14%) leak is created to the exhaust side. Thus, there are problems in the purge sector operation conditions (pressure difference, speed), and the air volume balance must be balanced. X Gas transmission (Ammonia : 45~57%, hydrogen sulfide : approx. 3.2~4%)	
Bacteria transmission rate	● Low (As air intake/exhaust are separate, transmission is low.)		X High (As air intake/exhaust are the same, transmission is high.)	
Operation during off-seasons	Bypass circuit required (OK on one side of air intake and exhaust air outlet passage)		Bypass circuit required (Required on both air intake and exhaust air outlet sides) (In theory, operation is possible by stopping the rotation, but the element will over-absorb, causing drainage.)	
Maintenance	Element cleaning: More than once a year The element surface will clog with lint and dirt, but cleaning is easy with a vacuum cleaner. Only the two element air passage intakes need to be cleaned.		Element cleaning: Once every one to two years Cleaning is difficult as dust is smeared into element with the packing. X Gear motor for rotor drive: Periodic inspection X Rotor bearing, rotor drive belt : Periodic inspection	
Life	Element: Semi-permanent (10 years or more) (The static-type does not break.)		Element: Semi-permanent (10 years or more) (Periodic replacement is required according to the rotor bearings and element clogging.) X Rotor drive belt : Periodic replacement X Drive motor, rotor bearing: Periodic replacement	
Model system and comparison	O Available from small to large. O Characteristic design of small and medium models possible. Large models are easy to match to machine room layout.	Example LU-1605	Large type only X Small models are difficult to design because of the rotor magnitude.	Example EV-1500
Standard treatment air volume	40 ~ 25000m^3/h	8000m^3/h	O 100 ~ 63000m^3/h	8000m^3/h
Enthalpy exchange efficiency		Temperature:77% Enthalpy Heating : 71% Cooling : 66%		74%
Pressure loss		17mmAg		18mmAg
Installation space (W × D × H)	Effective for small to medium capacity (Layout is free according to combination.)	600 × 2100 × 2540	Large capacity models are effective	320 × 1700 × 1700

Measure of useability

● High O Average X Poor

CHAPTER 4
Characteristics

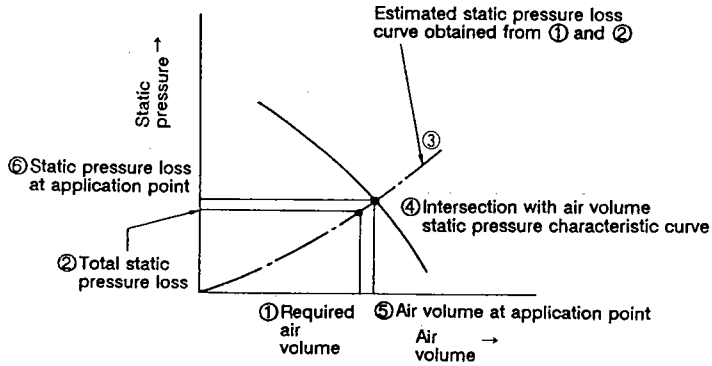
1. How to Read the LGH Series Lossnay Characteristic Curves

1) Obtaining characteristics from static pressure loss

(1) Static pressure loss from straight pipe duct length (at required air volume)
(2) Static pressure loss at curved section (at required air volume)
(3) Static pressure loss of related parts (at required air volume)

⇓

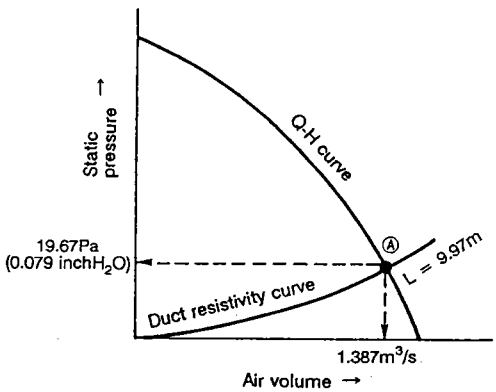
Total static pressure loss



2. Obtaining the Static Pressure Loss

1) How to read the air volume - static pressure curve

It is important to know the amount of static pressure loss applied onto the Lossnay when using parts such as ducts for the air distribution. If the static pressure increases, the air volume will decrease. The air volume - static pressure curve (Q-H curve) shows this percentage. A static pressure of 19.67Pa (0.079 inch H_2O) is applied on to point A, and the air volume is 294CFM. The duct resistivity curve shows how the static pressure is applied when a duct is connected to the Lossnay. Thus, the L=9.97m duct resistivity curve in the diagram is the curve that shows how the static pressure is applied when a 9.97m duct is connected. The intersecting point A with the Lossnay Q-H curve is the operation point.

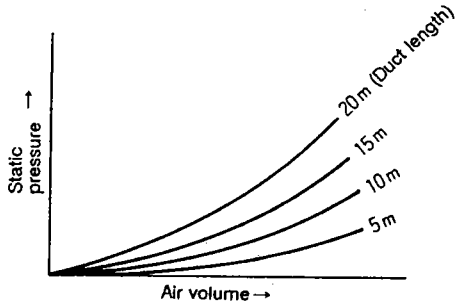


Duct resistivity curve

The duct resistivity curve shows how much static pressure a duct will apply on the Lossnay, as explained above.

In general, the interrelation between the duct and static pressure is as follows:

Duct	Static pressure
When duct is long	Increases
If length is the same but the air volume increases	Increases
If the duct diameter is narrow	Increases
If the duct inner surface is rough (such as a spiral)	Increases



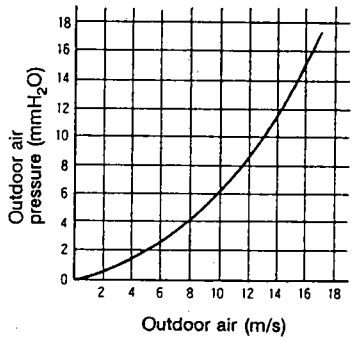
Reference

- The pressure loss caused by the outdoor air is as follows:

Pressure loss caused by outdoor air

$$= \frac{r}{2 \times g} \times V^2 = \frac{1.2}{2 \times 9.8} \times (\text{velocity})^2$$

r : Air weight 1.2kg/m^3 (0.075lb/ft^3)
g : Gravity acceleration 9.81m/s^2 (385.8inch/s^2)
v : Velocity (m/s) (inch/s)

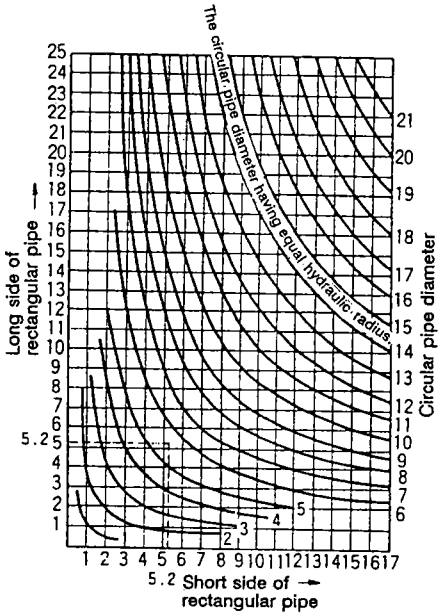


2) Calculation of duct pressure loss

When selecting a model that is to be used with a duct, calculate the volumes according to Tables 3, 4, 5 and 6, and then select the unit according to the air volume and static pressure curve.

(1) Calculation of a rectangular pipe

Table 3 Conversion table from rectangular pipe to circular pipe

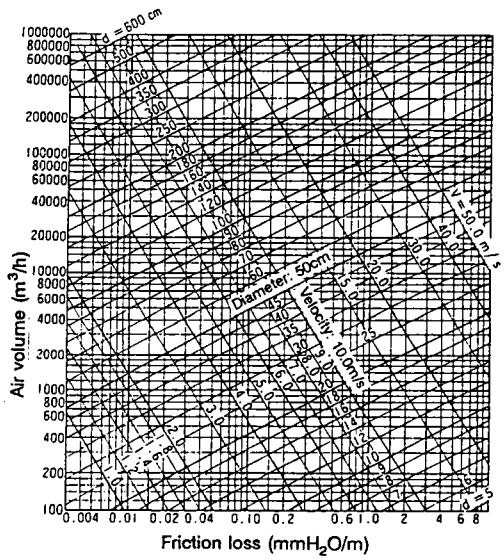


How to read Table 3

Select the unit as per each duct. In the above example, the □520 rectangular pipe only goes as far as 17. Thus, the long side, short side and converted circular pipe values are all multiplied by 100. The point 560 where the two lines cross is hence the value where the rectangular pipe equates to the circular pipe.

(2) How to obtain the duct resistivity

Table 4 Circular duct friction loss (steel plate duct, inner roughness ε = 0.18mm)

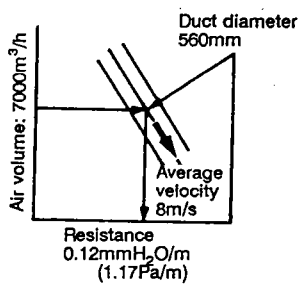


How to read Table 4

The point where the line of the circular duct diameter (leftward slanting line) and of the required air velocity (horizontal line) intersect is the pressure loss per 1m of duct.

The value of the slanted line to the lower right of the intersecting point is the average velocity.

(Outline of Table 4)



The figure obtained from Table 4 must then be corrected for duct type at various velocities. This can be done using Table 5 below.

Table 5 Friction coefficient compensation table

Duct inner surface	Example	Average velocity (m/sec)			
		5	10	15	20
Very rough surface	Concrete finish	1.7	1.8	1.85	1.9
Rough	Mortar finish	1.3	1.35	1.35	1.37
Very smooth	Drawn steel pipe Vinyl pipe	0.92	0.85	0.82	0.8

An alternative, more detailed method for determining the pressure loss in ductwork is as shown using the following formula:

Circular pipe section pressure loss

$$\Delta p = \lambda \cdot \frac{\ell}{d} \cdot \frac{\gamma}{2g} \cdot v^2 \ (mmH_2O)$$

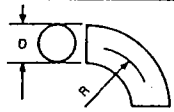
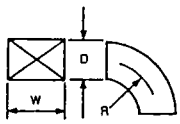
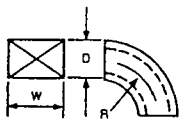
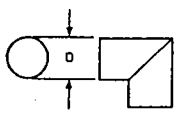
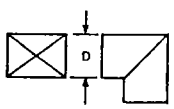
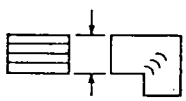
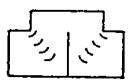
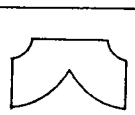
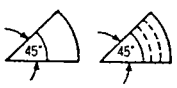
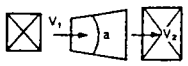
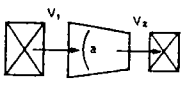
$$\Delta p = C \cdot \frac{\gamma}{2g} \cdot v^2 \ (mmH_2O)$$

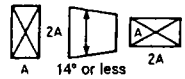
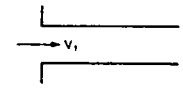
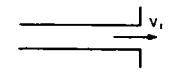
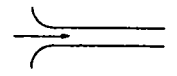
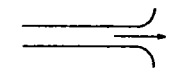
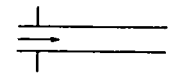
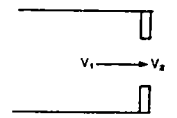
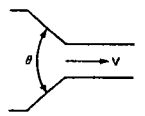
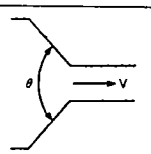
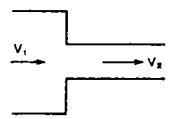
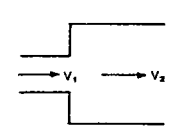
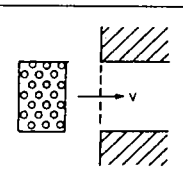
$$= 0.0612 \cdot C \cdot v^2$$

- λ : Friction resistance coefficient (smooth pipe 0.025)
- C : Local loss coefficient (refer to Table 6)
- d : Duct diameter (m)
- ℓ : Duct length (m)
- γ : Air weight ($1.2kg/m^2$)
- g : Gravity acceleration ($9.8m/s^2$)
- v : Wind velocity (m/s)
- • $1mmH_2O = 9.81Pa$

(3) How to calculate curved sections

Table 6 List of pressure losses in each duct section

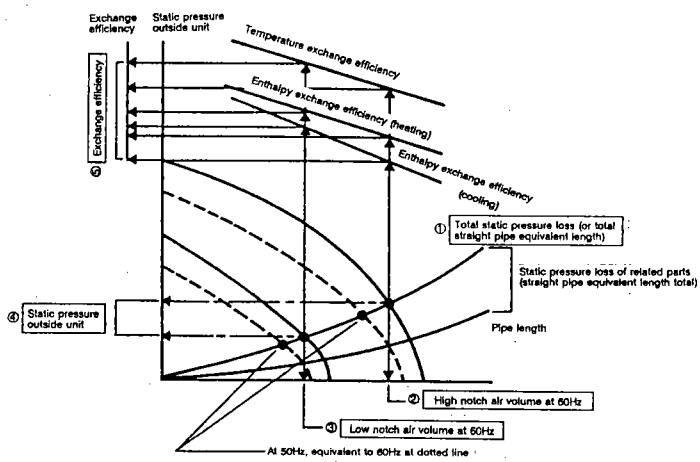
No.	Duct section	Outline diagram	Conditions		C value	Length of equivalent circular pipe
1	90° Smooth Elbow		R/D = 0.5 = 0.75 = 1.0 = 1.5 = 2.0		0.73 0.38 0.26 0.17 0.15	43D 23D 15D 10D 9D
2	Rectangular Radius Elbow		W/D	R/D		
			0.5	0.5 0.75 1.0 1.5	1.30 0.47 0.28 0.18	79D 29D 17D 11D
			1-3	0.5 0.75 1.0 1.5	0.95 0.33 0.20 0.13	57D 20D 12D 8D
3	Rectangular Vaned Radius Elbow		No. of vanes	R/D		
			1	0.5 0.75 1.0 1.5	0.70 0.16 0.13 0.12	42D 10D 8D 7D
			2	0.5 0.75 1.0 1.5	0.45 0.12 0.10 0.15	27D 7D 6D 9D
4	90° Miter Elbow				0.87	53D
5	Rectangular Square Elbow				1.25	76D
6	Rectangular Vaned Square Elbow				0.35	21D
7	Rectangular Vaned Square Junction		Same loss as circular duct Velocity is based on inlet			
8	Rectangular Vaned Radius Junction					
9	45° Smooth Elbow		With or without vanes, rectangular or circular		1/2 times value for similar 90°	
10	Expansion		a = 5° 10° 20° 30° 40° Loss is for $hV_1 - hV_2$		0.17 0.28 0.45 0.59 0.73	10D 17D 27D 36D 43D
11	Contraction		a = 30° 45° 60° Loss is for V_2		0.02 0.04 0.07	1D 2D 4D

No.	Duct section	Outline diagram	Conditions		C value	Length of equivalent circular pipe
12	Transformer				0.15	9D
13	Abrupt Entrance				0.50	30D
14	Abrupt Exit				1.0	60D
15	Bellmouth Entrance				0.03	2D
16	Bellmouth Exit				1.0	60D
17	Re-entrant inlet				0.85	51D
18	Sharp Edge Round Orifice		V_1/V_2 = 0 0.25 0.50 0.75 1 Loss is for V_2		2.8 2.4 1.9 1.5 1.0	170D 140D 110D 90D 60D
19	Pipe inlet (with circular hood)		β	20° 40° 60° 90° 120°	0.02 0.03 0.05 0.11 0.20	
20	Pipe inlet (with rectangular hood)		β	20° 40° 50° 90° 120°	0.03 0.08 0.12 0.19 0.27	
21	Abrupt contraction		V_1/V_2 = 0 0.25 0.50 0.75 Loss is for V_2		0.5 0.45 0.32 0.18	30D 27D 19D 11D
22	Abrupt expansion		V_2/V_1 = 0 0.20 0.40 0.60 0.80 Loss is for V_2		1.0 0.64 0.36 0.16 0.04	60D 39D 22D 9D 2D
23	Suction inlet (punched narrow plate)		Free area ratio	0.2 0.4 0.6 0.8	35 7.6 3.0 1.2	

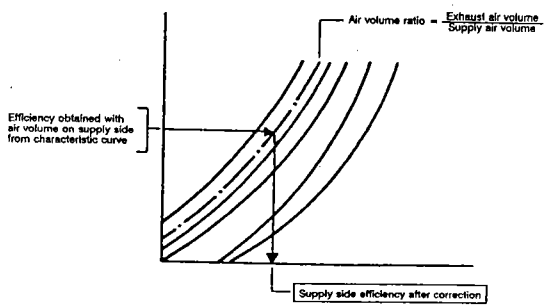
3. How to Obtain Efficiency from Characteristic Curves

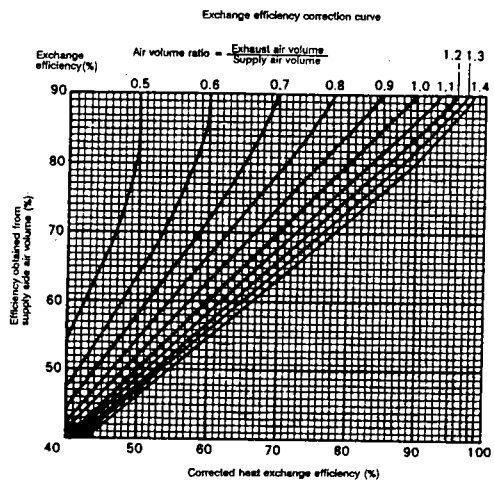
1) Commercial-use Lossnay

How to read commercial-use Lossnay characteristic curve



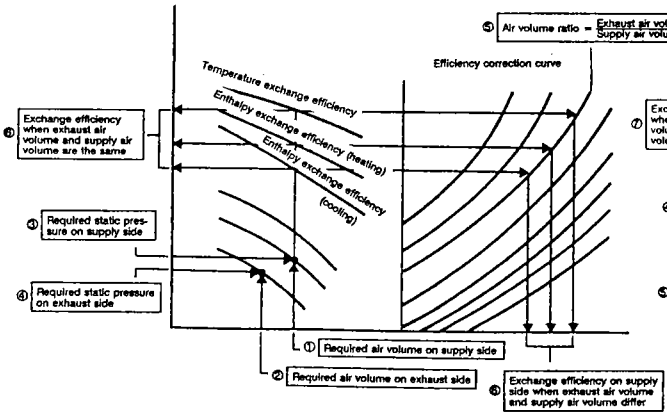
- Obtaining the efficiency when supply air and exhaust air volumes differ
  The efficiency obtained from the intake side air value in each characteristic curve can be corrected with the air volume ratio in the chart on the right.
  If the intake side and exhaust side duct lengths differ greatly or if a differential air volume is required, obtain the intake side efficiency from the chart on the right.



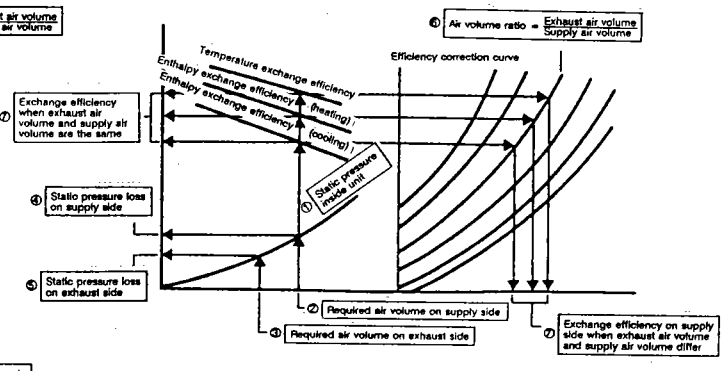


2) Building-use Lossnay

How to read LP Lossnay characteristic curve



How to read LU, LUT, and LUP Lossnay characteristic curves



4. Sound

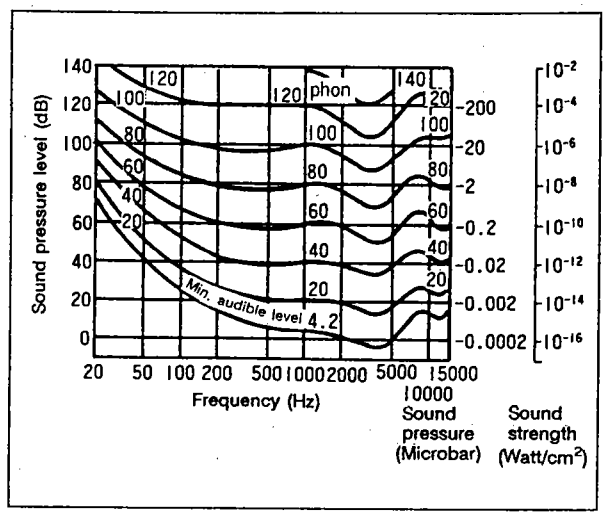
Sound is emitted when any object is excited causing it to vibrate. The object that vibrates is called the sound source, and the energy that is generated at the source is transmitted through the air to the human ear. Humans can hear the sound only when the ear drum vibrates.

1) Sound level and auditory perception

Sound level is the sound wave energy that passes through a unit area in a unit time, and is expressed in dB (decibel) units.

The sound heard by the human ear differs according to the strength of the sound and the frequency, and the relation to the pure tone sound is as shown on the right. The vertical line shows the strength of the sound and the horizontal line shows the frequency. For frequencies between 20Hz to 15,000Hz which can be felt by the human ear, the strength of sound that can be felt that is equivalent to a 1,000Hz sound is obtained for each frequency. The point where these points cross is the sound level curve, and a sound pressure level numerical value of 1,000Hz is expressed. These are called units of phons. For example, the point on the 60 curve is perceived as 60 phons.

ISO Audio perception curve

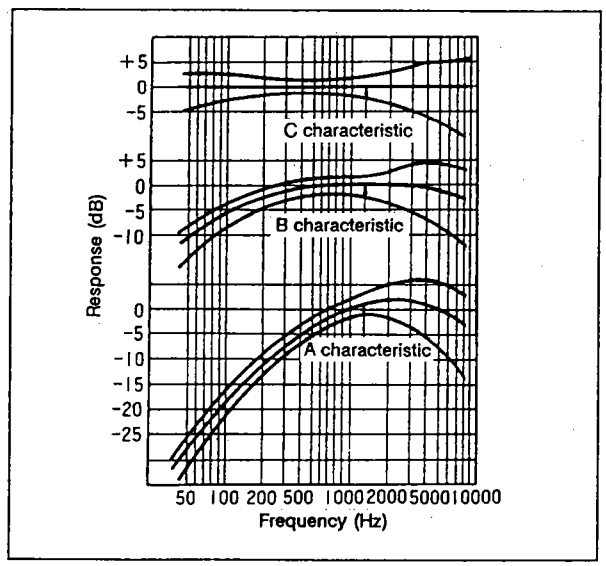


- On average, the human senses a sound that is less than 1,000Hz as rather weak, and a sound between 2,000 to 5,000Hz as strong.

2) How to measure sound levels

A sound level meter (JIS C 1502) is used to measure sound levels. This sound level meter has three characteristics (A, B and C characteristics) as shown on the right. These represent various sound wave characteristics.

Generally, the A characteristic, which is the most similar to the human ear, is used.

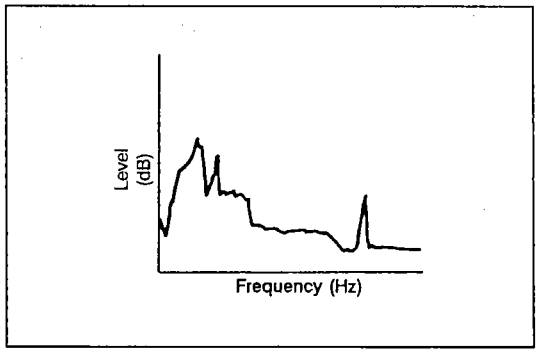


3) Frequency analysis of sound

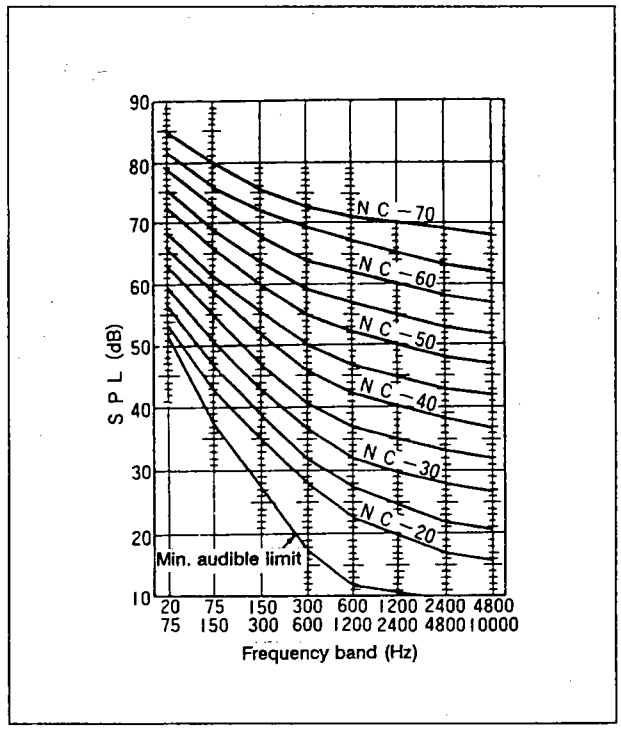
It is said that the human ear senses differently according to the frequency. However, the sound generated from a vibration is not limited to one frequency, but instead, various frequencies are generated at differing levels. This is expressed by the N-C curve, which is determined according to the difficulty of hearing a conversation.

- Even if the sound is a very low level, it is annoying if a specific frequency is emitted very loudly. These sounds are suppressed to a minimum during product design stages, but, the sound may become very disturbing with resonance of the ceiling, wall, etc.

(Ex.) Continuous frequency analysis



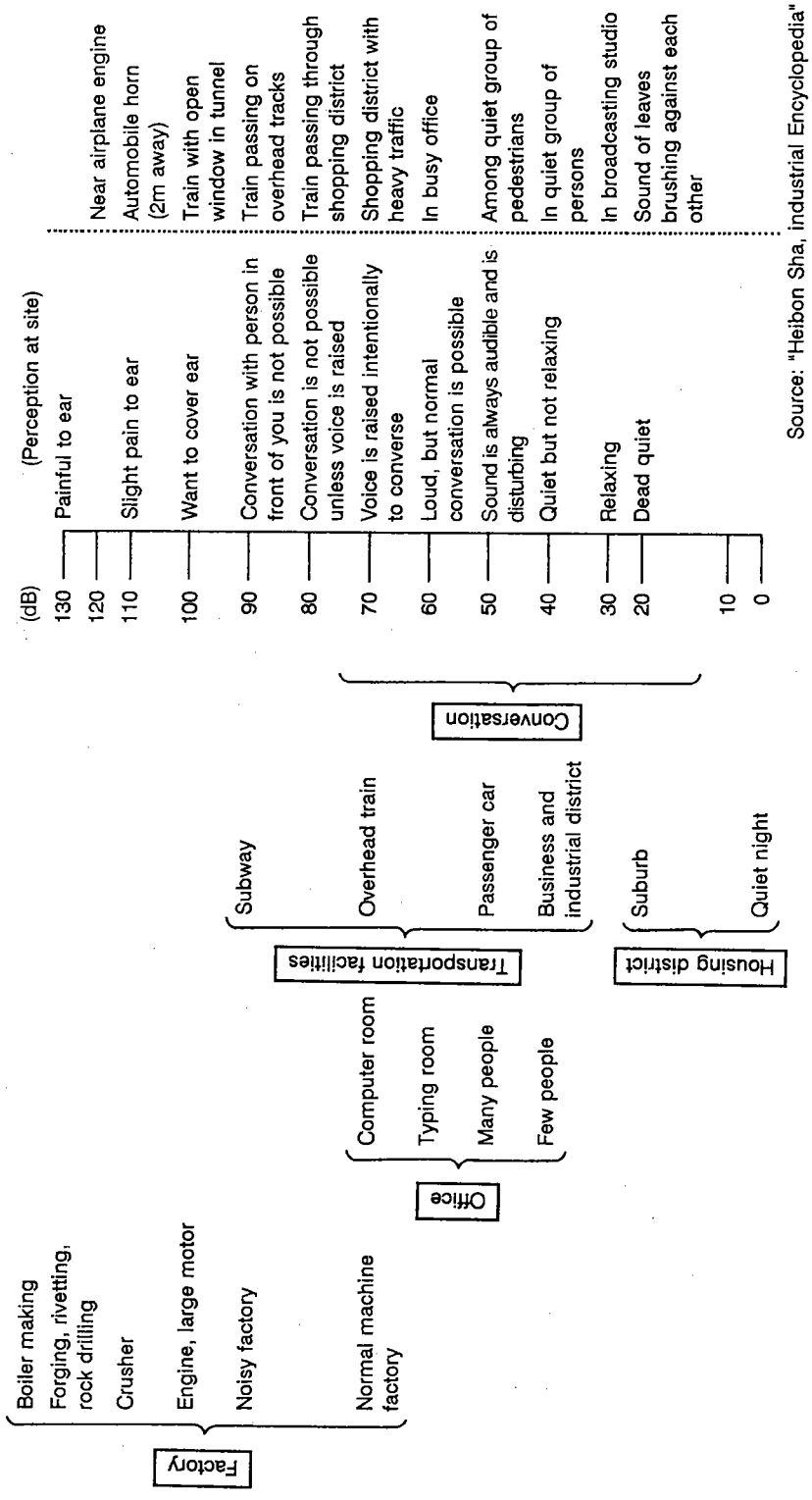
N-C curve



- **Tolerable noise levels and NC values according to room application**

Room application	dB	NC value	Room application	dB	NC value
Broadcasting studio	25	15 ~ 20	Cinema	40	30
Music hall	30	20	Hospital	35	30
Theatre(approx. 500 seats)	35	20 ~ 25	Library	40	30
Classroom	40	25	Small office	45	30 ~ 35
Conference room	40	25	Restaurant	50	45
Apartment	40	25 ~ 30	Gymnasium	55	50
Hotel	40	25 ~ 30	Large conference room	50	45
Housing (room)	40	25 ~ 30	Factory	70	50 ~

* Approximate values of noise levels using practical examples
  The following diagram shows noises found near us.
  Approximate degree of noise levels can be seen with these examples.
* Noise levels and perception



4) Indoor noise

(1) Principle of indoor noise

① Power levels

The power level (PWL) of the sound source must be understood when considering noise effects.

The following formula is used to obtain PWL from the measured sound pressure data (values noted in catalog) in an anechoic chamber.

$$PWL = SPLo + 20\log ro + 11[dB] \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (I)$$

PWL : Sound source power level (dB)
SPLo : Measured sound pressure in anechoic chamber (dB)
ro : Measurement distance (m)

② Principle model

Consider the room shown in Figs. 1 and 2.

- Fig. 1 shows an example of the integrated main unit and supply diffuser (and return grille). This is equivalent to the cassette-type Lossnay.
  Fig. 2 shows an example of a separated main unit and supply diffuser (and return grille). This is equivalent to the ceiling embedded-type Lossnay.
- (a) is the direct sound from the supply diffuser (return grille) and (b) is the echo sound. (c) ((c1) to (c3)) is the direct sound that is emitted from the main unit and duct and passes through the finished ceiling and leaks. (d) is the echo sound of (c).

③ Setting of noise

- The following formula is used to obtain the noise value at a position in the room.

$$SPL[dB] = PWL + 10\log\left\{\frac{Q}{4\pi r^2} + \frac{4}{R}\right\} \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (II)$$

(i) (ii)

SPL : Sound pressure level at reception point [dB]
PWL: Sound source power level [dB]
Q : Directivity factor (Refer to Fig. 3)
r : Distance from sound source [m]
R : Room constant [$R = \bar{\alpha}S/(1 - \bar{\alpha})$]
$\bar{\alpha}$: Average sound absorption ratio in room (Normally, 0.1 to 0.2)
S : Total surface area in room [m^2]

Fig. 1

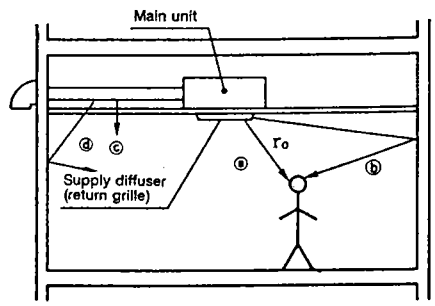


Fig. 2

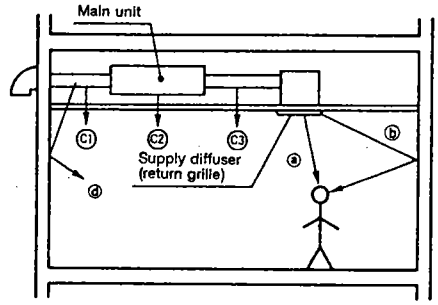
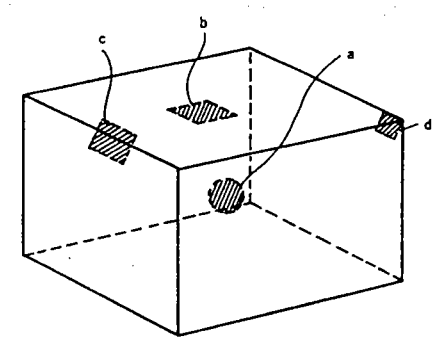


Fig. 3 (Sound source position and directivity factor Q)



	Sound source position	Q
a	Centre of room	1
b	Centre of ceiling	2
c	Edge	4
d	Corner	8

- For the supply diffuser (and return grille) in Fig. 2, PWL must be corrected for the noise alternation provided by the duct work (TL) such that:

  PWL' = PWL – TL

- Item i in formula (II) is the direct sound (ⓐ, ⓒ), and ii is the echo sound (ⓑ, ⓓ).
- The number of sound sources in the room (main unit, supply diffuser, return grille etc.) is obtained by calculating formula (II), and combining the number with formula (III).

  $SPL = 10\log(10^{SPL_1/10} + 10^{SPL_2/10})$ ..... (III)

- The average sound absorption rate in the room and the ceiling transmission loss differ according to the frequency, so formula (II) is calculated for each frequency band, and is combined with formula (III) for an accurate value.

Transmission loss in ceiling material (dB) (Example)

Material ( ) indicates thickness (mm)		Plaster board (7)	Plaster board (9)	Lauan plywood (12)
Average		20	22	23
Frequency band (Hz)	125	10	12	20
	250	11	15	21
	500	19	21	23
	1000	26	28	26
	2000	34	35	24
	4000	42	39	—

(2) Avoiding noise disturbance from Lossnay unit

① When unit air passage behind ceiling is sound source
(Fig. 1 ⓒ, ⓓ, Fig. 2 $ⓒ_1$ to $ⓒ_3$, ⓓ)

A) Avoid the following types of construction when disturbing noise may be emitted from large units. (Refer to Fig. 4)
  (a) Sudden contraction of duct diameter
  (Ex. ø250 → ø 150, ø200 → ø100)
  (b) Sudden curves in aluminum flexible ducts, etc.
  (Especially right after unit outlet)
  (c) Opening in ceiling plates
  (d) Suspension on weak material

B) The following countermeasures should be taken.
  (Refer to Fig. 5)
  (a) Use ceiling material with high soundproofing properties (high transmission loss). (Care is required for low frequency components as the difference in material is great.)
  (b) Addition of soundproofing material to areas below sound source
  (The entire surface must be covered when using soundproofing sheets. Note, that in some cases, covering of the area around the unit may not be possible due to the heat generated from the unit.)

Fig.4

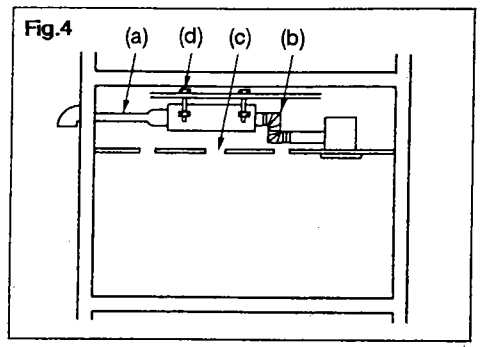
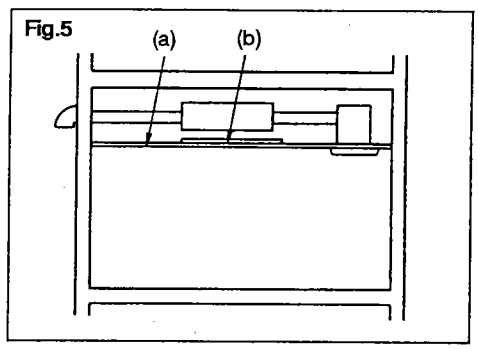


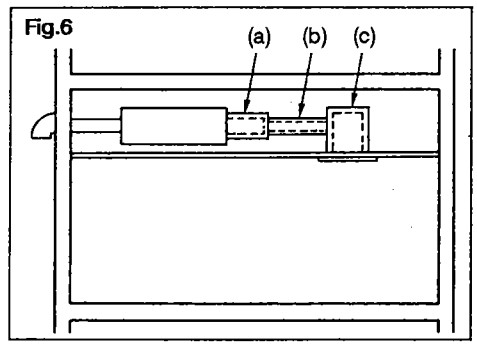
Fig.5



② When supply diffuser (and return grille) is sound source
..... part 1

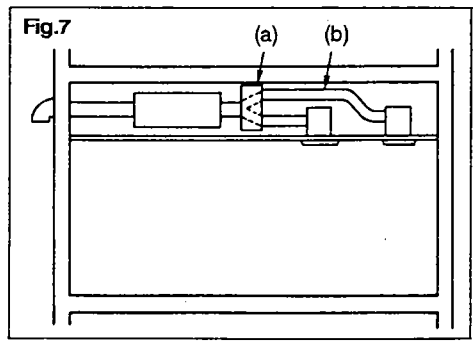
A) If the main unit is separated from the supply diffuser (and return grille) as shown in Fig. 6, the use of a silence box (a), silence duct (b) or silence grille (c) is recommended.

Fig.6



B) If a draft sound is being emitted from the supply diffuser (and return grille), branch the flow as shown in Fig. 7 (a), lower the flow velocity with a grille, and add a silence duct to section (b).
(If the length is the same, a silence duct with the small diameter is more effective.)

Fig.7

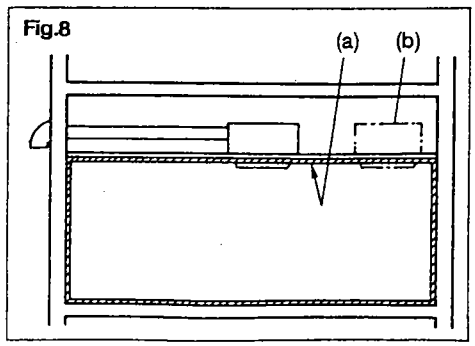


③ When supply diffuser (and return grille) is sound source
..... part 2

A) If the main unit and supply diffuser (and return grille) are integrated as shown in Fig. 8, or if the measures taken in ② (a) and (b) are inadequate, the interior material in the room can be changed to that having a high sound absorbency as shown in Fig. 8 (a).
This is not, however, very effective towards direct sounds.

B) Installing the sound source in the corner of the room as shown in Fig. 8 (b) is effective towards the centre of the room, but will be inadequate towards people in the corner of the room.

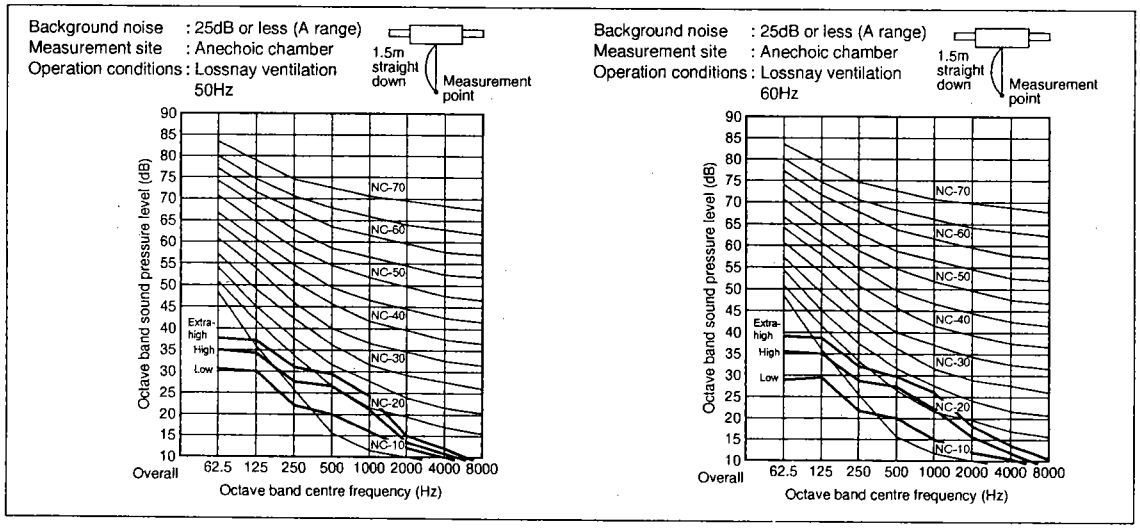
Fig.8



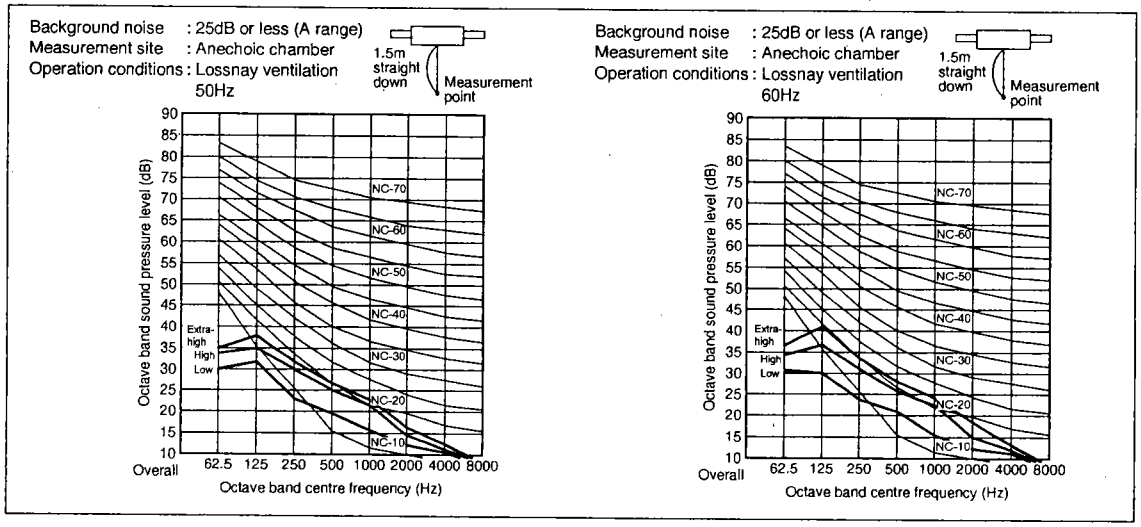
5. Results of Noise Analysis

- Ceiling embedded-type

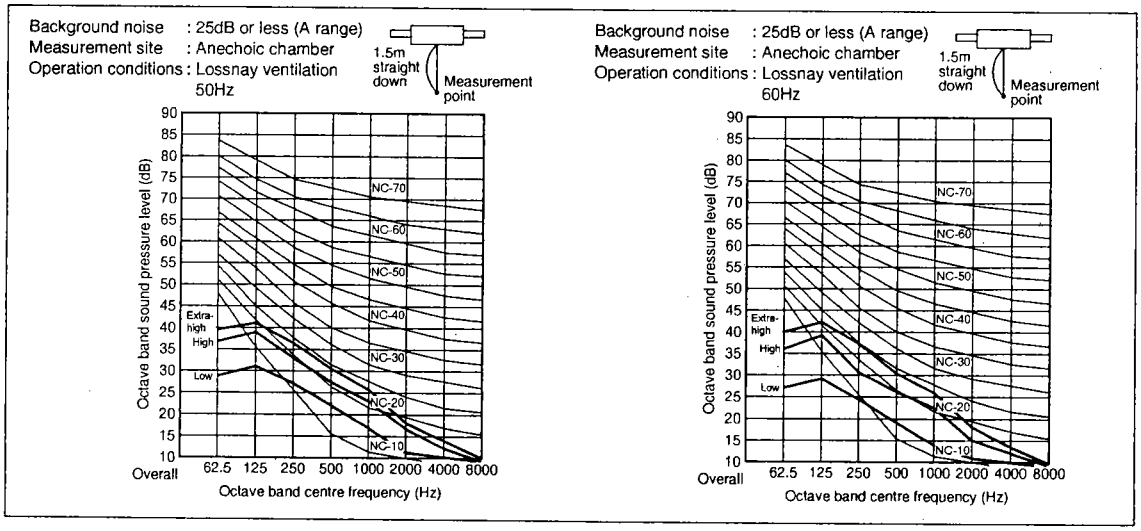
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LGH-25RS2

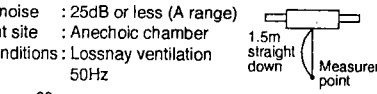


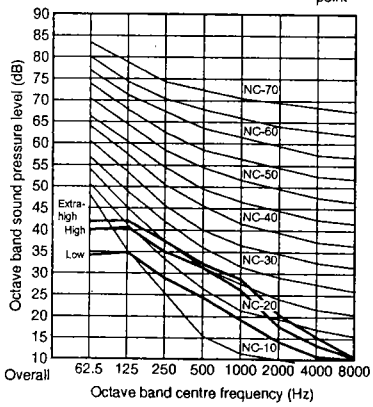
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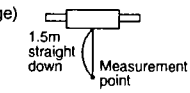
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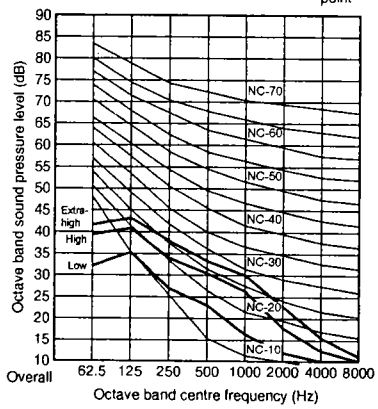
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Measurement site : Anechoic chamber
Operation conditions : Lossnay ventilation
50Hz





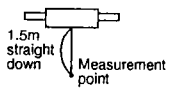
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Operation conditions : Lossnay ventilation
60Hz

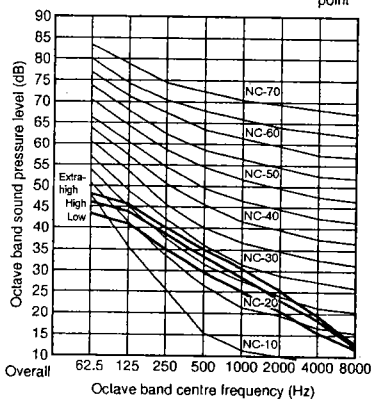




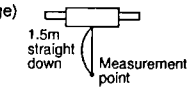
LGH-80RS2

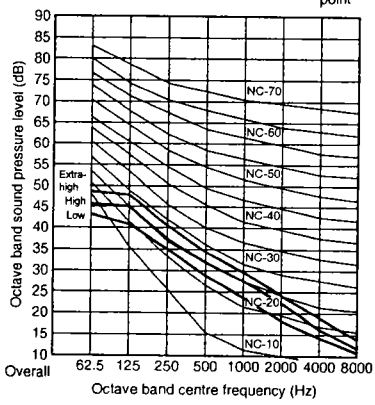
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50Hz





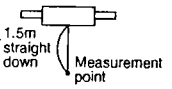
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Measurement site : Anechoic chamber
Operation conditions : Lossnay ventilation
60Hz

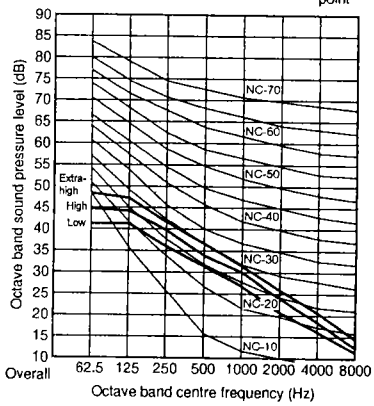




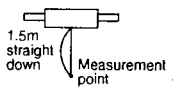
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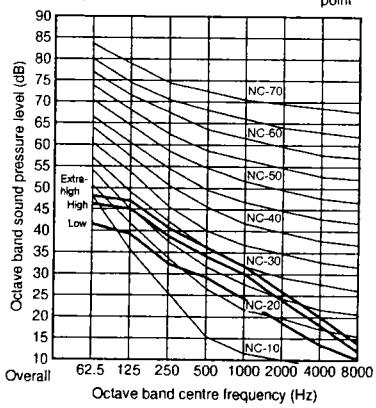
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Operation conditions : Lossnay ventilation
50Hz





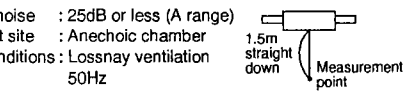
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60Hz

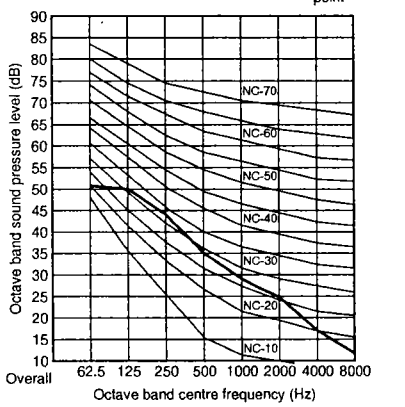




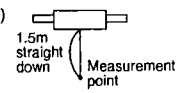
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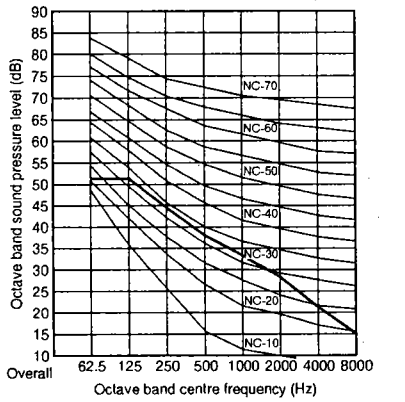
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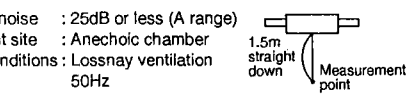
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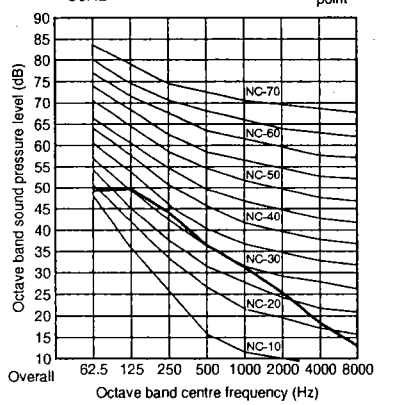




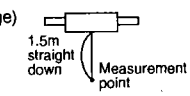
LGH-200RS2

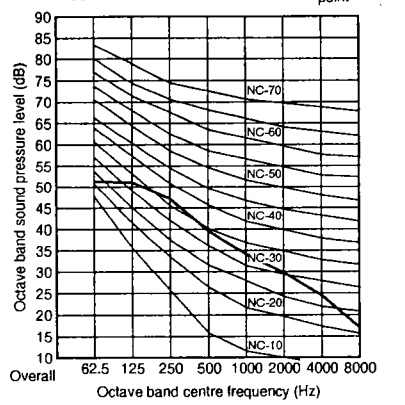
Background noise : 25dB or less (A range)
Measurement site : Anechoic chamber
Operation conditions : Lossnay ventilation
50Hz





Background noise : 25dB or less (A range)
Measurement site : Anechoic chamber
Operation conditions : Lossnay ventilation
60Hz





6. List of Models

1) Model specifications

Type			Model	Air volume (m^3/h)			Power supply	Connection duct diameter or embedded dimensions	Application			Applicable No. of people
				Extra-high	High	Low			Instal-lation site	Building example	Application site example	
Commercial-use <Lossnay>	Ceiling embedded-type		LGH-15RS$_2$	150/150	150/150	130/130	Single-phase 50/60Hz	ø100	Independent dispersed installation	Government agency, office building, tenant building, hospital, school, welfare facility, shop, hotel	Office, conference room, salon, board room, hall, clinic room, etc.	5 ~ 8
			LGH-25RS$_2$	250/250	250/250	195/195	Same as above	ø150				8 ~ 13
			LGH-35RS$_2$	350/350	350/320	250/210	Same as above	ø150				11 ~ 18
			LGH-50RS$_2$	500/500	500/480	360/280	Same as above	ø200				16 ~ 25
			LGH-80RS$_2$	800/800	800/800	700/700	Same as above	ø250				26 ~ 40
			LGH-100RS$_2$	1000/1000	1000/1000	845/750	Same as above	ø250				33 ~ 50
			LGH-150RS$_2$	—	1500/1500	—	Three-phase 50/60Hz	ø350				50 ~ 75
			LGH-200RS$_2$	—	2000/2000	—	Same as above	ø350				66 ~ 100
	Ceiling exposed-type		LGH-50E$_5$	—	490/480	300/260	Single-phase 50/60Hz	ø200 or 210×590		School, shop, welfare facility, hall	Office, conference room, etc.	16 ~ 25
Building-use <Lossnay>	Lossnay Pack		LP-200B	1000 ~ 2900			Three-phase 50 or 60Hz	250 × 350	Machine room installation	Government agency, office building, hospital, welfare facility, hall, shop, school, hotel	Office, conference room, hall	40 ~ 145
			LP-350B	2000 ~ 5000			Same as above	325 × 400			Office, conference room, hall, library	80 ~ 250
			LP-500B	4000 ~ 7000			Same as above	405 × 500			Office, hall, library, pachinko parlour	160 ~ 350
			LP-750B	4000 ~ 10000			Same as above	405 × 540 1200 × 540			Office, theatre, library, pachinko parlour	160 ~ 500
			LP-1000B	6000 ~ 13000			Same as above	405 × 540 1200 × 540			Office, theatre	240 ~ 650
	Lossnay unit	Vertical-type	LUT-2302~2308	2000 ~ 28000			—	—		Government agency, office building, hospital, welfare facility, hall, shop, school, hotel	Office, conference room, hall, library, pachinko parlour, theatre	185 ~ 920
			LUT-3002~3008	3000 ~ 36000			—	—				240 ~ 1200
		Horizontal-type	LU-80,160,500	300 ~ 7000			—	—				30 ~ 250
			LU-1602-1606	1200 ~ 13200			—	—				130 ~ 480
			LU-502-505	4000 ~ 35000			—	—				400 ~ 1250
Industrial-use <Lossnay>	Moisture resistant		LUP-80,160,500	500 ~ 6000			—	—		Hotel, pension, welfare facility, sports facility, factory	Large bath, heated pool, drying equipment	—
			LUP-1602~1606	1600 ~ 14400			—	—				—
			LUP-502~505	4000 ~ 35000			—	—				—

2) List of material colours for Industrial Lossnay

Model	Colour		Outside		Heat exchanger				Humidifier		
	Colour Munsell symbol	Mitsubishi colour No.	Material	Paint specifications	Material	Dimensions without frame	Weight with frame/unit	Q'ty	Humidifying method	Dimensions	Q'ty
LGH-15RS$_2$	—	—	Molten galvanized steel plate	—	Incombustible treated paper	□145 × 546	1.7 kg	1	—	—	—
LGH-25RS$_2$	—	—	Molten galvanized steel plate	—	Incombustible treated paper	□171 × 322	1.2 kg	2	—	—	—
LGH-35RS$_2$	—	—	Molten galvanized steel plate	—	Incombustible treated paper	□198 × 387	2.0 kg	2	—	—	—
LGH-50RS$_2$	—	—	Molten galvanized steel plate	—	Incombustible treated paper	□198 × 458	2.3 kg	2	—	—	—
LGH-80RS$_2$	—	—	Molten galvanized steel plate	—	Incombustible treated paper	□267 × 440	3.8 kg	2	—	—	—
LGH-100RS$_2$	—	—	Molten galvanized steel plate	—	Incombustible treated paper	□267 × 533	4.8 kg	2	—	—	—
LGH-150RS$_2$	—	—	Molten galvanized steel plate	—	Incombustible treated paper	□267 × 440	3.8 kg	4	—	—	—
LGH-200RS$_2$	—	—	Molten galvanized steel plate	—	Incombustible treated paper	□267 × 533	4.8 kg	4	—	—	—
LGH-50E$_5$	5Y 8.5/1	Y-62	Steel plate	Melamine baked finish	Incombustible treated paper	178 × 198 × 1129	8.0 kg	1	—	—	—

Model	Blades		Filter				Insulation material	Drain tray	Product usage conditions		
	Material	Shape, diameter	Material	Dimensions	Q'ty	Filtering efficiency	Material		Ambient temperature	Exhaust air conditions (RA)	Supply air conditions (OA)
LGH-15RS$_2$	ABS resin	Centrifugal ø180	Non-woven fabrics NP/400	552 × 125 × 15	2	Gravitational method 82%	Self-extinguishing urethane foam	—	–10°C to 40°C RH80% or less	–10°C to 40°C RH80% or less	–10°C to 40°C RH80% or less
LGH-25RS$_2$	ABS resin	Centrifugal ø180	Non-woven fabrics NP/400	658 × 151 × 15 (Bendable into 1/2)	2	Gravitational method 82%	Self-extinguishing urethane foam	—	–10°C to 40°C RH80% or less	–10°C to 40°C RH80% or less	–10°C to 40°C RH80% or less
LGH-35RS$_2$	ABS resin	Centrifugal ø200	Non-woven fabrics NP/400	789 × 178 × 15 (Bendable into 1/2)	2	Gravitational method 82%	Self-extinguishing urethane foam	—	–10°C to 40°C RH80% or less	–10°C to 40°C RH80% or less	–10°C to 40°C RH80% or less
LGH-50RS$_2$	ABS resin	Centrifugal ø200	Non-woven fabrics NP/400	931 × 178 × 15 (Bendable into 1/2)	2	Gravitational method 82%	Self-extinguishing urethane foam	—	–10°C to 40°C RH80% or less	–10°C to 40°C RH80% or less	–10°C to 40°C RH80% or less
LGH-80RS$_2$	Steel plate	Centrifugal ø230	Non-woven fabrics NP/400	894 × 238 × 15 (Bendable into 1/2)	2	Gravitational method 82%	Self-extinguishing urethane foam	—	–10°C to 40°C RH80% or less	–10°C to 40°C RH80% or less	–10°C to 40°C RH80% or less
LGH-100RS$_2$	Steel plate	Centrifugal ø230	Non-woven fabrics NP/400	1122 × 238 × 15 (Bendable into 1/2)	2	Gravitational method 82%	Self-extinguishing urethane foam	—	–10°C to 40°C RH80% or less	–10°C to 40°C RH80% or less	–10°C to 40°C RH80% or less
LGH-150RS$_2$	Steel plate	Centrifugal ø230	Non-woven fabrics NP/400	894 × 238 × 15 (Bendable into 1/2)	4	Gravitational method 82%	Self-extinguishing urethane foam	—	–10°C to 40°C RH80% or less	–10°C to 40°C RH80% or less	–10°C to 40°C RH80% or less
LGH-200RS$_2$	Steel plate	Centrifugal ø230	Non-woven fabrics NP/400	1122 × 238 × 15 (Bendable into 1/2)	4	Gravitational method 82%	Self-extinguishing urethane foam	—	–10°C to 40°C RH80% or less	–10°C to 40°C RH80% or less	–10°C to 40°C RH80% or less
LGH-50E$_5$	ABS resin	Centrifugal ø200	Non-woven fabrics NP/400	(Intake side) 1129 × 200 × 15 (Exhaust side) 376 × 143 × 14	1 3	Gravitational method 82%	Self-extinguishing urethane foam	—	–10°C to 40°C RH80% or less	–10°C to 40°C RH80% or less	–10°C to 40°C RH80% or less

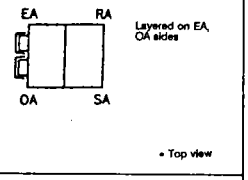
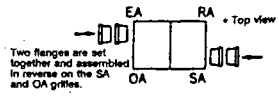
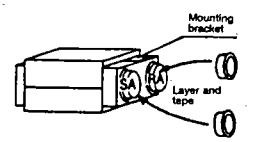
3) List of material colours for Building Lossnay

Model	Colour		Outside		Heat exchanger			
	Colour Munsell symbol	Mitsubishi colour No.	Material	Paint specifications	Material	Dimensions without frame	Weight with frame/unit	Q'ty
LP-200B	5Y 6.5/1	N-E6	Steel plate Thickness: 1.6t	Polyester powder	Incombustible treated paper	□550 × 487	22kg	2
LP-350B	5Y 6.5/1	N-E6	Steel plate Thickness: 1.6t	Polyester powder	Incombustible treated paper	□550 × 487	22kg	3
LP-500B	5Y 6.5/1	N-E6	Steel plate Thickness: 1.6t	Polyester powder	Incombustible treated paper	□550 × 487	22kg	4
LP-750B	5Y 6.5/1	N-E6	Steel plate Thickness: 1.6t	Polyester powder	Incombustible treated paper	□550 × 487	22kg	6
LP-1000B	5Y 6.5/1	N-E6	Steel plate Thickness: 1.6t	Polyester powder	Incombustible treated paper	□550 × 487	22kg	8

Model	Air-supply fan				Filter				Insulation material	Product usage conditions (Ambient temperature, exhaust air, supply air conditions)
	Blade diameter	Suction method	Drive method	Blade shape	Material	Dimensions	Q'ty	Filtering efficiency	Material	
LP-200B	#1 1/2	Single-side suction	Belt	Centrifugal	Non-woven fabrics NP/600	505 × 531 × 20	4	Gravitational method 85%	Self-extinguishing urethane foam	–10°C to +40°C RH80% or less
LP-350B	#2	Single-side suction	Belt	Centrifugal	Non-woven fabrics NP/600	505 × 531 × 20	6	Gravitational method 85%	Self-extinguishing urethane foam	–10°C to +40°C RH80% or less
LP-500B	#2 1/2	Single-side suction	Belt	Centrifugal	Non-woven fabrics NP/600	505 × 531 × 20	8	Gravitational method 85%	Self-extinguishing urethane foam	–10°C to +40°C RH80% or less
LP-750B	#2	Double-side suction	Belt	Centrifugal	Non-woven fabrics NP/600	505 × 531 × 20	12	Gravitational method 85%	Self-extinguishing urethane foam	–10°C to +40°C RH80% or less
LP-1000B	#2	Double-side suction	Belt	Centrifugal	Non-woven fabrics NP/600	505 × 531 × 20	16	Gravitational method 85%	Self-extinguishing urethane foam	–10°C to +40°C RH80% or less

Model	Colour		Outside		Heat exchanger				Insulation material	Product usage conditions (Ambient temperature, exhaust air, supply air conditions)
	Colour Munsell symbol	Mitsubishi colour No.	Material	Paint specifications	Material	Dimensions without frame	Weight with frame/unit	Q'ty	Material	
LUT-2302	5Y 6.5/1	N-E6	Steel plate thickness: 1.6t	Polyester powder	Incombustible treated paper	□299.5 ×742	19.2 kg	6	Self-extinguishing urethane foam	–10°C to +50°C RH80% or less
LUT-2303	5Y 6.5/1	N-E6	Steel plate Thickness: 1.6t	Polyester powder	Incombustible treated paper	□299.5 ×742	19.2 kg	9	Self-extinguishing urethane foam	–10°C to +50°C RH80% or less
LUT-3002	5Y 6.5/1	N-E6	Steel plate Thickness: 1.6t	Polyester powder	Incombustible treated paper	□299.5 × 742	19.2 kg	8	Self-extinguishing urethane foam	–10°C to +50°C RH80% or less
LUT-3003	5Y 6.5/1	N-E6	Steel plate Thickness: 1.6t	Polyester powder	Incombustible treated paper	□299.5 × 742	19.2 kg	12	Self-extinguishing urethane foam	–10°C to +50°C RH80% or less
LU-80	5Y 6.5/1	N-E6	Steel plate Thickness: 1.2t	Polyester powder	Incombustible treated paper	□300 × 488	8 kg	2	Self-extinguishing urethane foam	–10°C to +50°C RH80% or less
LU-160	5Y 6.5/1	N-E6	Steel plate Thickness: 1.2t	Polyester powder	Incombustible treated paper	□300 × 488	8 kg	4	Self-extinguishing urethane foam	–10°C to +50°C RH80% or less
LU-500	5Y 6.5/1	N-E6	Steel plate Thickness: 1.6t	Polyester powder	Incombustible treated paper	□550 × 487	22 kg	4	Self-extinguishing urethane foam	–10°C to +50°C RH80% or less
LUP-80	5Y 6.5/1	N-E6	Steel plate Thickness: 1.2t	Polyester powder	Polypropylene resin	□300 × 489	21 kg	2	—	–10°C to +80°C RH100%
LUP-160	5Y 6.5/1	N-E6	Steel plate Thickness: 1.2t	Polyester powder	Polypropylene resin	□300 × 489	21 kg	4	—	–10°C to +80°C RH100%
LUP-500	5Y 6.5/1	N-E6	Steel plate Thickness: 1.6t	Polyester powder	Polypropylene resin	□550 × 495	32 kg	4	—	–10°C to +80°C RH100%

4) List of Lossnay accessories

Model	Accessories	Duct packaging site
LGH-15RS$_2$	Duct connection flange: 2 (other two are assembled onto main unit), M4 tapping screw: 8	
LGH-25RS$_2$	Duct connection flange: 2 (other two are assembled onto main unit), M4 tapping screw: 8	
LGH-35RS$_2$	Duct connection flange: 4, M4 tapping screw: 16	
LGH-50RS$_2$	Duct connection flange: 4, M4 tapping screw: 16	
LGH-80RS$_2$	Duct connection flange: 4, M4 tapping screw: 16	
LGH-100RS$_2$	Duct connection flange: 4, M4 tapping screw: 16	
LGH-150RS$_2$	Duct connection flange: 2 (other two are assembled onto main unit), flange mounting bracket: 4, M4 tapping screw: 16	
LGH-200RS$_2$	Duct connection flange: 2 (other two are assembled onto main unit), flange mounting bracket: 4, M4 tapping screw: 16	
LGH-50E$_5$	Round duct connection flange: 2, slave unit fixing plate: 1	
LP-200B	Touch-up paint	
LP-350B	Touch-up paint	
LP-500B	Touch-up paint	
LP-750B	Touch-up paint, M6 nut: 6, M6 washer: 6	
LP-1000B	Touch-up paint, M6 nut: 6, M6 washer: 6	
LUT-2302, 2303	Upper connection fitting: 2, lower connection fitting: 2, M8 screw: 8, M10 screw: 4, M10 washer: 4, packing: 3	
LUT-3002, 3003	Upper connection fitting: 2, lower connection fitting: 2, M8 screw: 8, M10 screw: 4, M10 washer: 4, packing: 3	

CHAPTER 5
System Design Recommendations

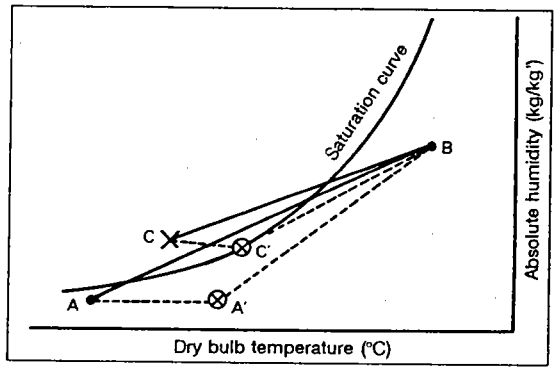
1. Lossnay Usage Conditions

		Main unit installation conditions	Outdoor air and exhaust air conditions
Commercial-use Lossnay		–10°C to +40°C, RH80% or less	–10°C to +40°C, RH80% or less.
Building-use Lossnay	LP model Lossnays	–10°C to +40°C, RH80% or less	Same as left The room air temperature/humidity is controlled by separate devices.
	LU, LUT model Lossnays	–10°C to +50°C, RH80% or less	Same as left
	LUP model Lossnay	–10°C to +80°C, RH100%	Same as left

In some cases special attention needs to be paid to extreme operating conditions.
These are described as below:

1) Use in cold climates (Outdoor temperature: –5°C or less)

Plot the Lossnay intake air conditions A and B on a psychrometric chart as shown on the right. If the high temperature side air B intersects the saturation curve such as at C, moisture condensation or frosting will occur on the Lossnay. In this case, the low temperature side air A should be preheated to the temperature indicated by point A' so that point C shifts to the point C'.



2) Use in high humidity conditions (Relative humidity: 80% or more)

When using the system in high humidity conditions such as heated pools, bathrooms, mushroom cultivation houses, etc., moisture will condense inside the Core, and drainage will occur. In these cases, the general purpose Lossnay that uses treated paper cannot be used. Instead the moisture resistant Lossnay must be used.

The following moisture resistant Lossnay models are available. The usage conditions differ so select the model according to the application.

- Total moisture resistant-type (Relative humidity for both installation site and supply/exhaust conditions can be 100%)

  LUP series (sensible heat exchange-type with independent Lossnay Core)

3) Use in other special conditions

- The Lossnay cannot be used where toxic gases and corrosive elements such as acids, alkalis, organic solvents, oil mist or paints exist.
- Use where heat is recovered from odor-laiden air and supplied to another place (area) is not possible.
- Avoid use where salt or hot water damage may occur.

2. Noise Value of Lossnay with Built-in Fans

The noise level specified for Lossnay units is as that measured in an anechoic chamber. The sound level may increase by 8 to 10 dB according to the installation construction material, and room contents.
When using the Lossnay in a quiet room, it is recommended that measures such as installing a muffling duct, optional silencer intake/exhaust grill (PZ-FG type)* or silencer box (PZ-SB type)* be carried out.

* Please consult with nearest Lossnay supplier about availability of these parts.

3. Attachment of Air Filter

An air filter must be mounted to the air inlets (both intake and exhaust) of the Lossnay to clean the air and to prevent the Core from clogging. Always mount this filter, and periodically service it.

4. Duct Construction

- Always treat the two ducts on the outdoor side (outdoor air intake and exhaust outlet) with insulation to prevent frosting or condensition.
- The outdoor duct gradient must be 1/30 or more (to wall side) to prevent rain water from infiltrating the system.
- Do not use the standard vent caps or round hoods where they may come into direct contact with rain water. (Instead, use of a deep hood is recommended.)

5. By-pass Ventilation

Do not operate with "by-pass ventilation" when heating during winter. Frost or condensation may generate on the main unit and cause discolouring of the ceiling, etc.

6. Transmission Rate of Various Gases and Related Maximum Workplace Concentration

Measurement conditions	Gas	Air volume ratio Q_{SA}/Q_{RA}	Exhaust air concentration C_{RA} (ppm)	Supply air concentration C_{SA} (ppm)	Transmission rate (%)	Max. workplace concentrations (ppm)
Exhaust air t = 24°C Supply air t = 30°C Measurement method Gas detection pipe for HF, HCl, HNO_3 Chemical analysis with colorimetric method for H_2SO_4 Gas chromatography for organic solvents, etc. The fans are positioned at the air supply/exhaust suction positions of the element	Hydrogen fluoride	1.0	36	<0.5	~ 0	0.6
	Hydrogen chloride	1.0	42	<0.5	~ 0	5
	Nitric acid	1.0	20	<0.5	~ 0	10
	Sulphuric acid	1.0	2.6 mg/m^3	~0mg/m^3	~ 0	0.25
	Trichlene	1.0	85.1	3.7	4.3	200
	Acetone	1.0	3.3	0.15	4.5	1000
		1.5	20.4	0.54	2.6	
	Xylene	0.5	5.9	0.14	2.4	150
		1.0	5.9	0.5	8.5	
		1.5	4.9	0.48	9.8	
	Isopropyl alcohol	0.5	38.4	0.17	0.4	400
		1.0	44.7	2.0	4.5	
		1.5	31.0	2.6	8.4	
	Methanol	1.0	34.4	1.5	4.4	200
	Ethanol	1.0	32.7	1.6	4.9	1000
	Ethyl acetate alcohol	0.5	3.3	0	0	400
		1.0	21.7	0.83	3.8	
		1.5	26.3	1.39	5.3	
	Ammonia	1.0	75.0	21	28	50
	Hydrogen sulphide	1.0	1.5	0.1	6.7	10
	Carbon monoxide	1.0	50	0.5	1	
	Carbon dioxide	1.0	5000	100	2	
	Smoke	1.0			1 ~ 2	
	Formaldehyde	1.0	0.5	0.01	2	0.08

• The above does not apply to the moisture resistant total heat exchanger.

7. Solubility of Odors and Toxic Gases, etc., in Water and Effect on Lossnay Core

Main generation site	Gas name	Molecular formula	Gas Vapour Mist	Non-toxic/ Toxic/ Odor	Solubility in water		Max. workplace concentration	+Useability of Lossnay
					mℓ/mℓ	g/100g		
Chemical plant or chemical laboratory	Sulphuric acid	H_2SO_4	Mist	Found		2380	0.25	×
	Nitric acid	HNO_3	Mist	Found		180	10	×
	Phosphoric acid	H_3PO_4	Mist	Found		41	0.1	×
	Acetic acid	CH_3COOH	Mist	Bad odor		2115	25	×
	Hydrogen chloride	$HC\ell$	Gas	Found	427	58	5	×
	Hydrogen fluoride	HF	Gas	Found		90	0.6	×
	Sulphur dioxide	SO_2	Gas	Found	32.8		0.25	△
	Hydrogen sulphide	H_2S	Gas	Found	2.3		10	△
	Ammonia	NH_3	Gas	Bad odor	635	40	50	×
	Phosphine	PH_3	Gas	Found	0.26		0.1	○
	Methanol	CH_3OH	Vapour	Found	Soluble		200	△
	Ethanol	CH_3CH_2OH	Vapour	Found	Soluble		1000	△
	Ketone		Vapour	Found	Soluble		1000	△
Toilet	Skatole	C_9H_9N	Gas	Bad odor	Minute			○
	Ammonia	NH_3	Gas	Bad odor	635	40	50	×
	Indole	C_9H_7N	Gas	Bad odor	Minute			○
Others	Nitric monoxide	NO			0.0043		50	○
	Ozone	O_3				0.00139	0.1	○
	Methane	CH_4			0.0301			○
	Chlorine	$C\ell_2$			Minute		0.5	○
Air (reference)	Air	Mixed gases	Gas	None	0.0167			○
	Oxygen	O_2	Gas	None	0.0283			○
	Nitrogen	N_2	Gas	None	0.0143			○
	Carbon monoxide	CO	Gas	Found	0.0214			○
	Carbon dioxide	CO_2	Gas	None	0.759			○

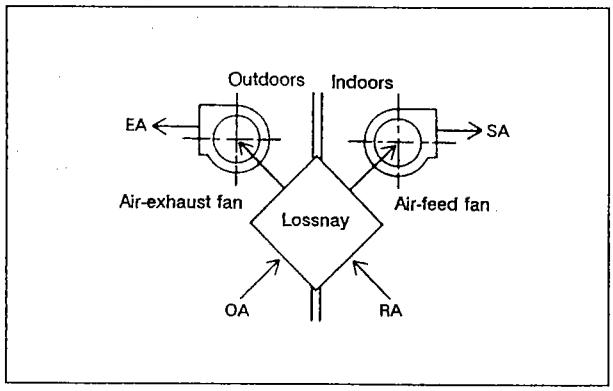
1. Water soluble gases and mists cannot be used as the amount that transmits with the water is too great.
2. Acidic gases and mists cannot be used as these will accumulate in the Core, causing damage.

+○ OK
△ Caution should be used
× Should not be used

8. Positioning of the Supply/Exhaust Fans and the Air Transmission Rate (excluding moisture resistant total heat exchangers)

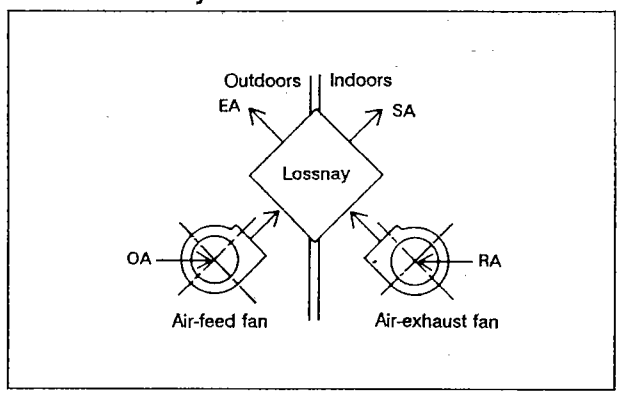
The following four methods can be used for when setting the Lossnay supply and exhaust fans around the Lossnay Core. When using the LU and LUT models, methods a or b should be used in respect of both the Lossnay Core air leakage and effective air ventilation. Use method c if air leakage to the RA or SA sides is not allowed such as in hospital air conditioning, or transmission of the fan noise into the room must be suppressed by putting the Lossnay Core between the supply/exhaust fans and room, and if a certain degree of air leakage is allowed between OA to EA.

a Installing the supply fan (OA-SA) and exhaust fan (RA-EA) for suction feed to the Lossnay Core.



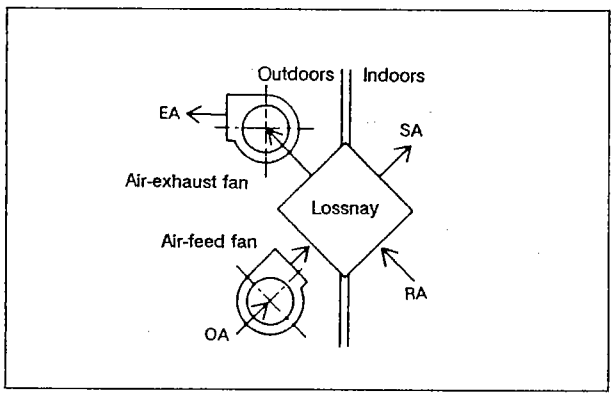
If the static pressure difference between SA and RA and between EA and OA is 50mmAq, the air leakage rate will be 2.5%, and 3.4%. This value is of no problem for most standard uses.

b Installing the supply fan (OA-SA) and exhaust fan (RA-EA) for forced supply to the Lossnay Core



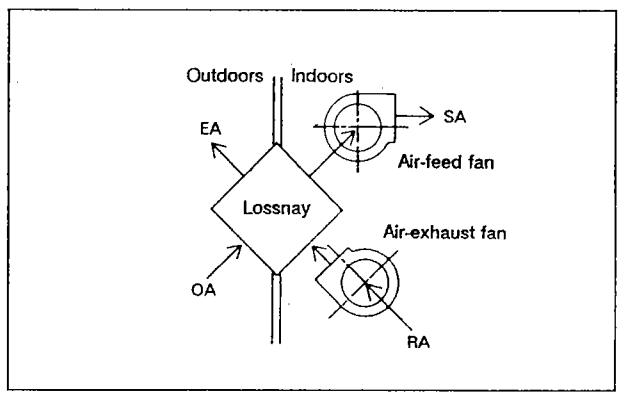
The air leakage rate is the same as in system a.

c Installing the supply fan (OA-SA) for force feed and the exhaust fan (RA-EA) for suction feed



In this case, the positive/negative relation of the static pressure will be the reverse of that in system d, and the air leakage outside the room (leakage from OA to EA) will be the same as system d. Thus, the effective volume of ventilating air will be reduced by that rate.

d Installing the supply fan (OA-SA) for suction feed and the exhaust fan (RA-EA) for force feed



In this case, the intake side pressure (OA-SA) will be negative, and the exhaust side pressure (RA-EA) will be positive, so the amount of air leakage to the intake side will be the greatest. If the static pressure difference between OA and RA is 50mmAq, the air leakage rate will be 10.5%, and 13.0%.
This system can be used when an air leakage of 10% to the intake side (OA-SA) is permitted, but should be avoided in all other cases.

9. Combined Operation with Other Air Conditioners

The Lossnay standard product may be connected to all standard air-conditioning systems as shown below.

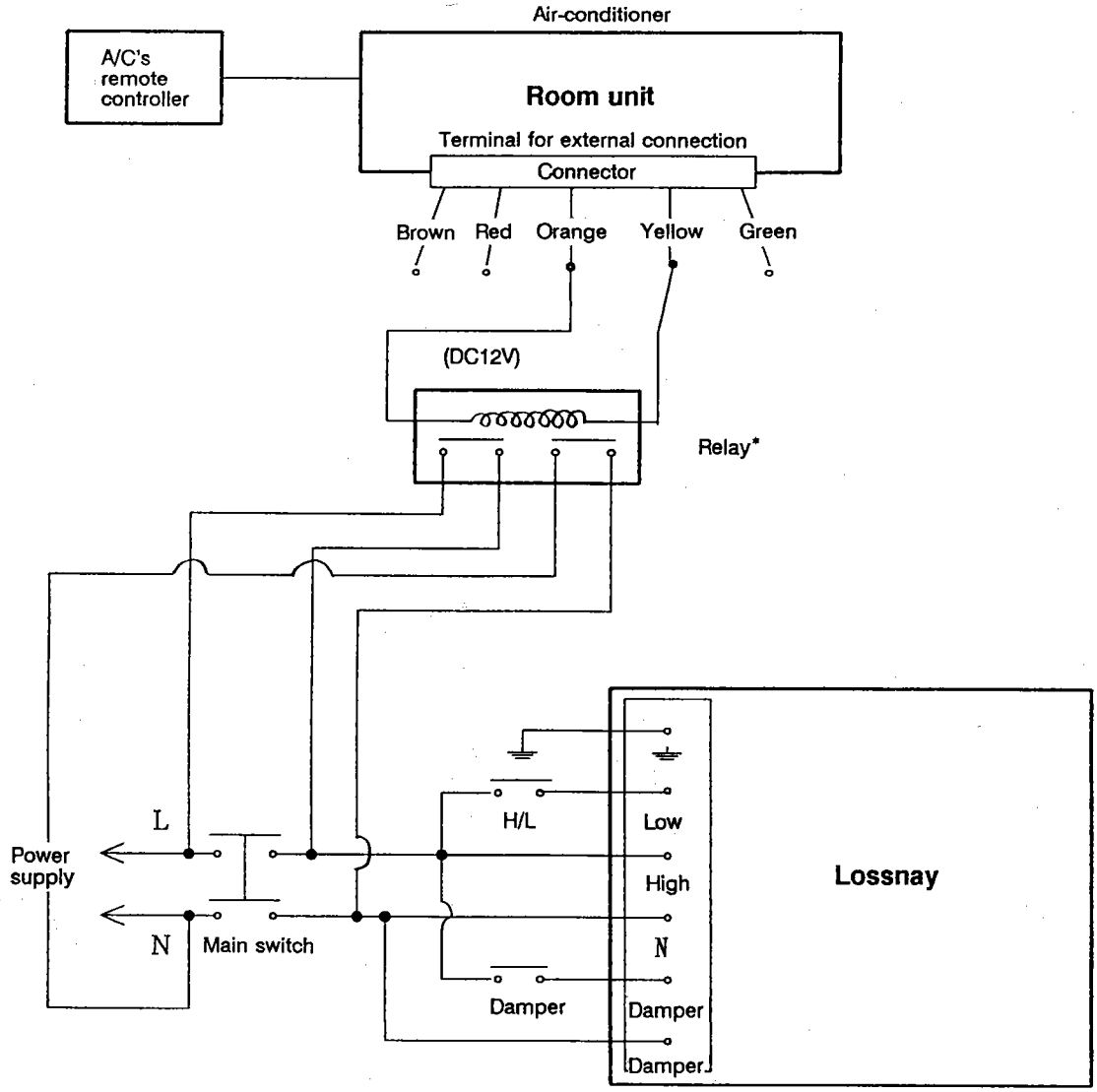


Fig. Wiring diagram, Lossnay LGH-series connection to Air-conditioning systems.

* Optional part (PZ-12RB) is also available.

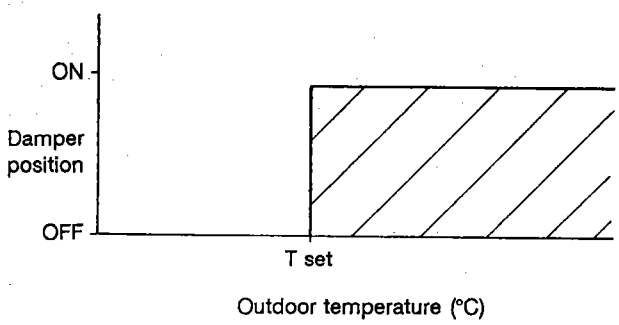
10. Automatic Damper Control

The damper is included in the Lossnay unit so as to provide an optional by-pass mode for the supply air-flow. Although this is normally connected with a manually-operated ON/OFF switch, connection to a secondary control mechanism, capable of assessing optimum damper operating conditions from temperature sensors is also possible.

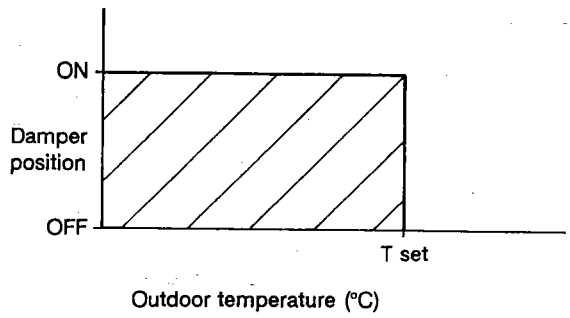
This mechanism may take the form of:

- Building Energy Management System
- Optimum setting thermostat

Signal control may be provided either directly or through a relay.
As shown below, the temperature setting for energising of the damper will differ for both heating and cooling of the controlled space.



By-pass damper for heating



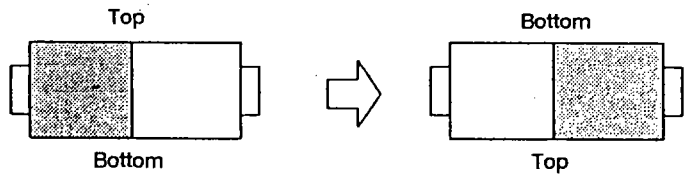
By-pass damper for cooling

11. Vertical Installation of LGH Series

Installation of ceiling embedded-type industrial Lossnay

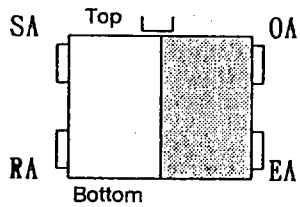
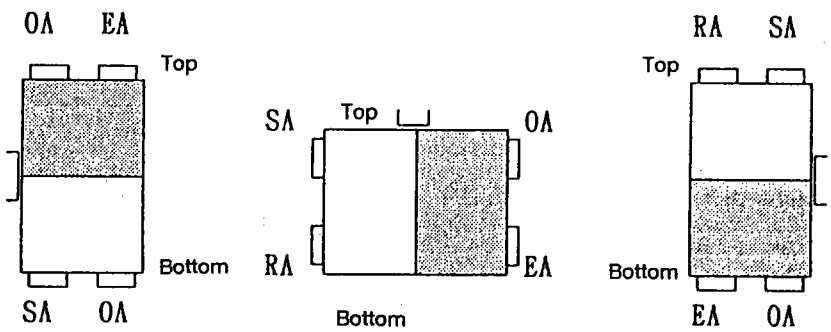
1) Top/bottom reverse installation

All LGH-RS$_2$ models can be installed in reverse.



2) Vertical installation

Vertical installation is possible, but the installation pattern is limited for some models. Refer to the following table for the installation patterns.

Model name	Installation patterns
LGH-15RS$_2$ LGH-25RS$_2$	
LGH-35RS$_2$ LGH-50RS$_2$ LGH-80RS$_2$ LGH-100RS$_2$	

(Precautions)

- When constructing for vertical installation, make sure that rain water will not enter the Lossnay unit from outdoors.
- Always transport the unit in the specified state. Vertical installation applies only to after installation, and does not apply to transportation.
  (The motor may be damaged if the unit is transported vertically.)

3) Slanted installation

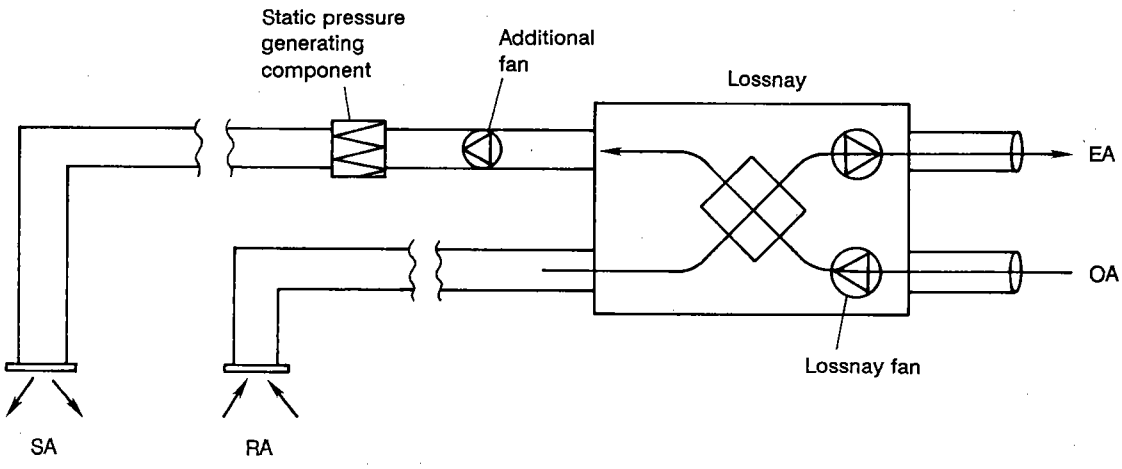
Slanted installation is not possible.

Special note

The LGH-RS$_2$ model was conventionally designed for being embedded in the ceiling. If possible, vertical installation should be avoided in regard to construction and maintenance.

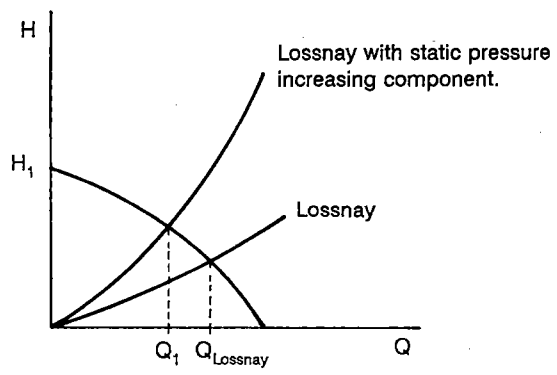
12. Installation of Supplementary Fan Devices After Lossnay Unit

On occasions it may be necessary to install additional fans in the ductwork following the LGH type Lossnay. This is because of the inclusion of extra components such as control dampers, high-efficiency filters, sound attenuators, etc. which create a significant extra static pressure to the airflow. An example of such an installation is as shown below.

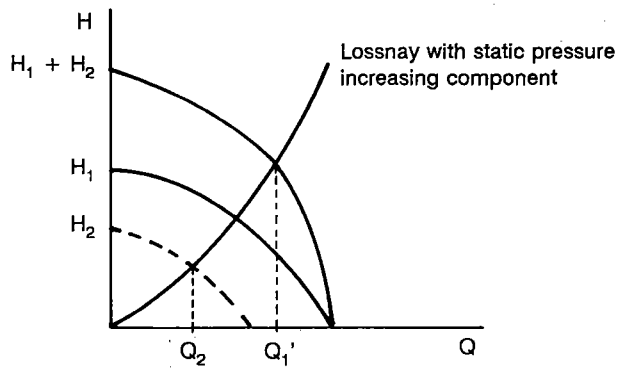


For such an installation care should be taken to avoid undue stress on the fan motors. Referring to the diagrams below, so long as $Q_1' \geq Q_2$, there is no adverse effect on the motors. This is generally such in the majority of cases.

Q-H for Lossnay without extra fan



Q-H for Lossnay with extra fan



CHAPTER 6
Examples of Lossnay Applications

Lossnay ventilation systems are proposed for eight types of applications in this chapter. These systems are planned for Japanese use, and actual systems will differ according to each country. These should be used only as reference.

1. Large Office Building

1) System plan points

Conventional central systems in large buildings, run in floor and building ducts, have generally been preferred to individual room units. Thus, air conditioning and ventilation after working hours was not possible.
In this plan, an independent dispersed ventilation method has been applied to resolve this problem. Such a system's main advantage is that it allows 24-hour operation.
A package-type air conditioning unit is installed in the ceiling, and ventilation is performed with the ceiling-embedded-type Lossnay. Ventilation in the toilet, kitchenette and lift halls, etc., is performed with a straight sirocco fan.

Setting outline

Building form	:	Basement floor SRC (Slab Reinforced Concrete), 8 floors above ground S construction Total floor space 30,350m^2
Basement	:	Employee cafeteria
Ground floor	:	Lobby, conference room
2 to 7th floor	:	Offices, salons, board room
Air conditioning	:	Package air conditioning
Ventilation	:	Ceiling embedded-type Lossnay, straight sirocco fan

2) Current topics

(1) Operation system that answers individual needs is required.
- Free independent operation system
- Simple control

(2) Effective use of floor space
(elimination of machine room)

(3) Application to Building Management Laws
- Effective humidification
- Elimination of indoor dust

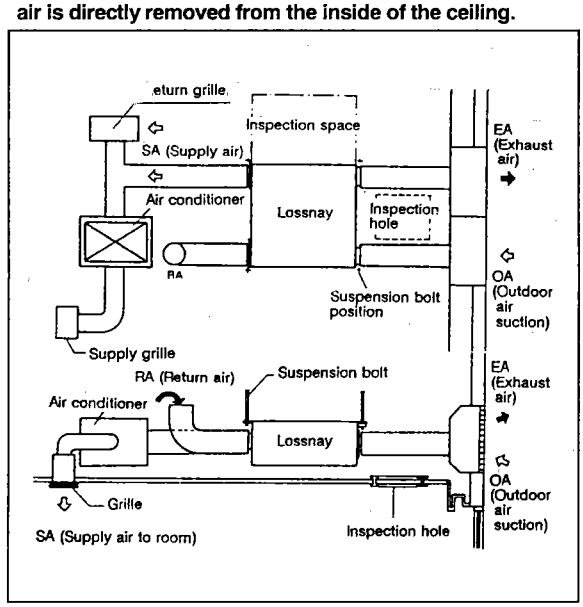
(4) Energy conservation

3) Proposed details

(1) Air conditioning

- In general offices, the duct method will be applied with several ceiling-embedded multiple cooling heat pump packages in each zone to allow total zone operation.
- Board rooms, conference rooms and salons will be air conditioned with a ceiling embedded-type or cassette-type multiple cooling heat pump package in each room.

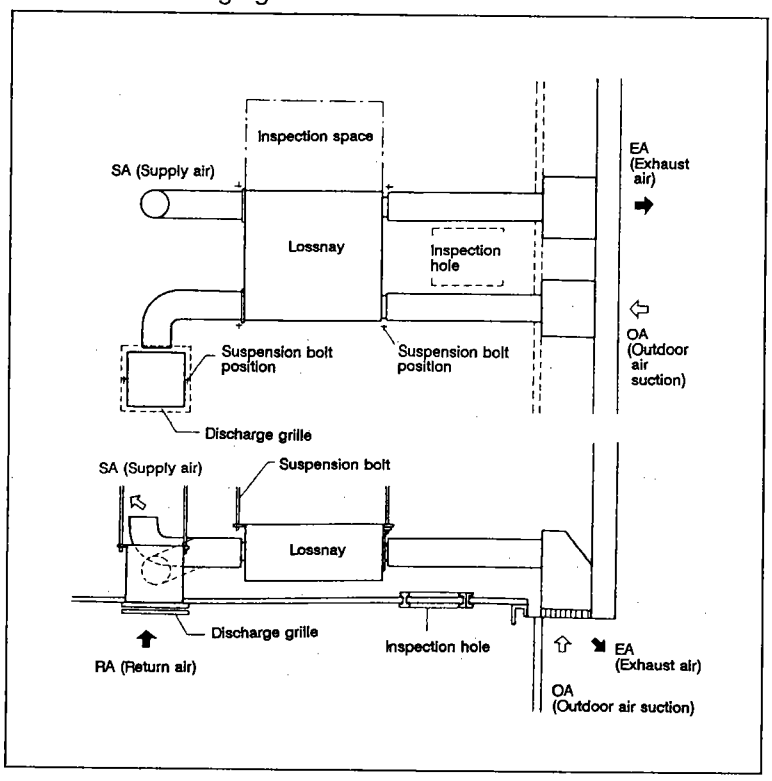
Installation state of office system air conditioning system — The air supplied from the Lossnay is introduced into the intake side of the air conditioner, and the room stale air is directly removed from the inside of the ceiling.



(2) Ventilation

- For general offices, a ceiling embedded-type Lossnay will be installed in the ceiling. The inside of the ceiling will be used as a return chamber for exhaust, and the air from the Lossnay will be supplied to the air-conditioning return duct and mixed with the air in the air conditioning passage. (Exhaust air is taken in from the entire area, and supply air is introduced into the air conditioner to increase the ventilation effectiveness for large rooms.)
- For board rooms, conference rooms and salons, a ceiling embedded-type Lossnay will be installed in the ceiling. The stale air will be duct exhausted from the discharge grille installed in the centre of the ceiling. The supply air will be discharged into the ceiling, where after mixing with the return air from the air conditioner it is supplied to the air conditioner.
- The air in the toilet, kitchenette, and lift hall, etc., will be exhausted with a straight sirocco fan in each room. The OA supply for this section will use the air supplied from the Lossnay. (The OA volume will be obtained by setting the Lossnay supply fan in the general office to the extra-high notch.)

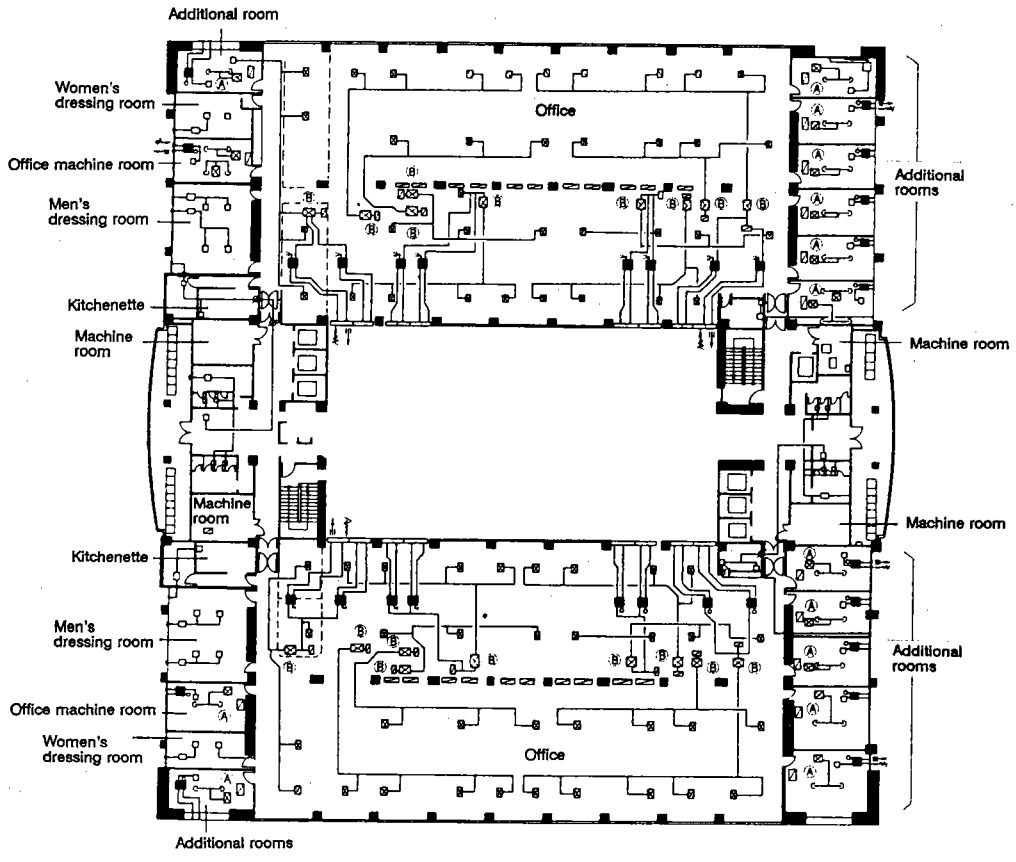
Installation state of air conditioning system for board rooms, conference rooms, salons — the air supplied from the Lossnay is blown into the ceiling, and the stale air is removed from the discharge grille.



- A gallery will be constructed on the outer wall for the outer wall exhaust air outlets to allow for blending in with the exterior.

Reference floor air conditioner system layout

= Lossnay A Air-cooling heat pump air conditioner
B Air-cooling heat pump air conditioner



(3) Humidification

If the load fluctuation of the required humidification amount is proportional to the ventilation volume, it is ideal to combine the humidifier installation with the ventilation system. For this application, the humidifier is installed on with the air supply side of the Lossnay.

(4) Conformation to Building Laws

The most important consideration here is humidification and dust removal; in these terms, it is recommended that a humidifier is added to the air conditioning system for the office system to allow adequate humidification.

Installation of a filter on each air circulation system in the room is effective for dust removal, but if the outdoor air inlet is near the dust source, such as a road, a filter should also be installed on the ventilation system.

4) Effect

(1) Air conditioning and ventilation needs can be met on an individual basis.
(2) Operation is possible with a 24-hour system.
(3) Operation is simple with the switches being in the room. (A controller is not required.)
(4) Floor space is saved and thus the floor can be used to the maximum.
(5) Energy is conserved with the independent heat recovery.
(6) Fresh air air-conditioning is possible with the independent system.

2. Medium Size Office Building

1) System plan point

In recent building air conditioning systems, demands for a consistent rationalization from design through operation and control aspects are being made to meet diversified building needs.

In the entire air conditioning facility, either the cooling/heating source equipment or specific air conditioning equipment is considered as being only one element. Thus, it is important to design this element so that it covers the user's needs while providing total amenity.

This air conditioning system plan is for a so-called company building that is largely divided into the general office section (hereinafter referred to as general floors) and special room sections including board rooms and conference rooms (hereinafter referred to as special floors). Furthermore, Building Management Laws are applied to the building due to the scale.

Setting outline

- Building area : 862.2m^2
- Total floor area : 7,093m^2
- No. of floors : Basement, above ground 8, penthouse 1
- Application per floor : Basement ..... Parking area
  Ground floor ..... Large hall
  1 ~ 5 ..... Offices
  6 ~ 7 ..... Special rooms

2) Current topics

For general office buildings of the past, centralised air conditioning methods allowing the total centralised control and systematization of the entire building (or divided into floor systems) were favoured due mainly to facility control, uniformity of operation hours, maintenance efficiency and building usage. However, when additional work was required to be done on these systems problems occurred.

A comparison of the following items in each system is shown in Table 1.

- Energy conservation (air conditioning power)
- Space saving (area required for air conditioning facilities)
- Flexibility (zoning and refurbishing)

Table 1 Comparison of air conditioning systems

	Air conditioning system	Air conditioning power (kW)			Required area (m^2)				Sleeve size of beam × Q'ty (Per floor)	Zoning	Refurbishing	Cleanliness (Building Management Law)	Noise
		Heat source	Load	Total	Shaft	Machine room	Roof	Total					
A	Air-cooling heat pump chiller + Air handling unit on each floor + Floor-type fan coil unit (perimeter)	317	105	422	80	513	140	733	ø100 × 162	Possible for each system (each air conditioner)	Same as left	Possible by assembling required specification filter on air conditioner	Noise control possible
B	Air-cooling heat pump chiller + Ceiling embedded-type fan coil unit + Ceiling embedded-type outdoor air treatment unit	317	45	362	80	—	140	220	ø100 × 162 ø250 × 108	Possible for each outdoor air treatment unit (Per unit size)	Same as left	Possible by assembling required specification filter on outdoor air treatment unit and fan coil unit	Little noise emitted
C	Air-cooling heat pump chiller Single suction method	393	67	460	50	567	—	617	ø100 × 45	Possible for each air conditioner	Same as left	Possible by assembling required specification filter on air conditioner	Relatively loud
D	Ceiling embedded-type air-cooling heat pump Package air conditioner (City Multi) + Ceiling embedded-type outdoor air treatment unit	239	47	286	80	—	150	230	ø250 × 189	Possible for each outdoor air treatment unit (Per unit size)	Same as left	Possible by assembling required specification filter on air conditioner and outdoor air treatment unit	Little noise emitted, but louder than B system
E	B system + D system (combined use) (B system for general floors) (D system for special floors)	285	53	338	80	—	200	280	ø100 × 144 ø250 × 21	Possible for each outdoor air treatment unit (Per unit size)	Same as left	Possible by assembling required specification filter on outdoor air treatment unit, air conditioner and fan coil unit	Little noise emitted

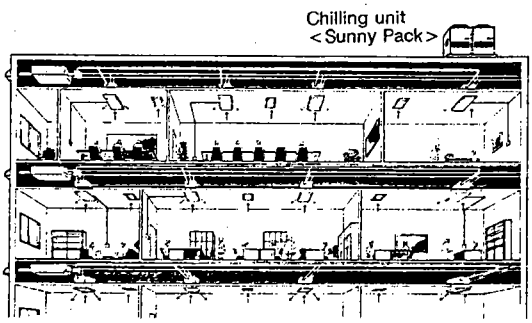
3) Proposed details

A) General floors

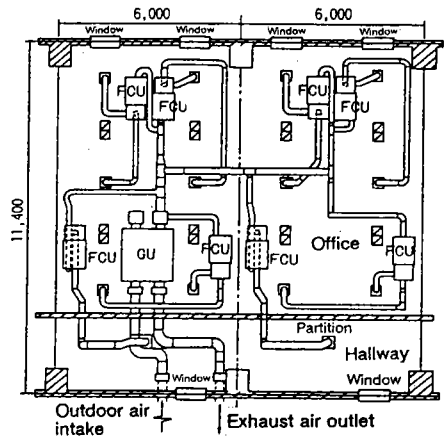
An independent dispersed-type control system incorporating an air cooling heat pump chiller and cassette-type fan coil unit for cooling and heating is used. This can cater for load fluctuations resulting from increases in office automation systems or changes in partitions hence requiting independent control of each module zone (approx. 70m^2). Fresh Master is used for ventilation and humidification, and construction and space is reduced by using a system ceiling and ceiling chamber method. (Table 1 B system)

B) Special floors

City Multi and Fresh Master are applied as package-type independent units, located so as to conform with lighting fixtures, air outlets and suction inlets in rooms where the interior is important while ensuring the required air-conditioning quality. (Table 1 D system)



System using fan coil unit (general floors)



General floor air conditioning facilities

4) Effect

(1) Individual control is possible

Individually dispersed air conditioning that creates a comfortable environment according to general floor and special floor needs is realised.

(2) Energy conservation

Wasted air conditioning energy is eliminated allowing great reduction in operation costs.

(3) Space saving

The Fresh Master, fan coil unit and building air conditioner are all ceiling embedded-types, so the back of the ceiling is used effectively, saving machine room space and floor space.

(4) Construction saving

The ventilation functions have been unitised with the Fresh Master, and all air conditioner units can be unitised allowing construction to be reduced.

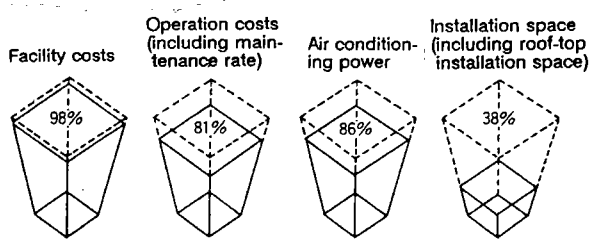
(5) Simple architecture layout

Machine room space and main duct space for air conditioning are not required, so limits in the layout are reduced.

: Air intake
: Supply diffuser
FCU : Fan coil unit
GU : Fresh Master

	New air conditioning system	Conventional air conditioning system
Heat source equipment	Air-cooling heat pump chiller	Air-cooling heat pump chiller
Air conditioner	Outdoor air treatment unit Fresh Master (8 units on each floor) ⇐ Ceiling embedded-type fan coil unit	Air handling unit (1 unit on each floor) Floor-type fan coil unit

Ratio with conventional air conditioning system as 100



Comparison with conventional air conditioning system

5) System trends

- Creation of an environment including independence, management and control of each zone can be realised as work trends become more diversified.
- Simultaneous cooling/heating system due to necessity from increased fixed sash windows and increase in office automation systems.
- Attention is being paid to building management methods which manage not only air conditioning systems for several buildings at one location but also manage other information.

3. Multipurpose Tenant Building

1) System plan points

In many business district buildings, use of the lower floors for shops, halls and theatres, etc., and the middle and upper floors for offices and tenants is often seen. An air conditioning and ventilation system using a per floor method with each floor as a tenant unit is proposed in this example.

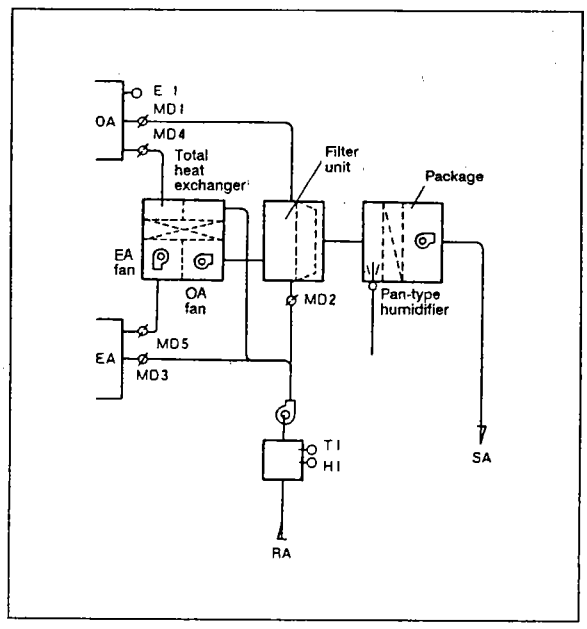
Setting outline

- Application : Business (lower floors), office tenants (mid- to upper floors)
- Building form : SRC (Slab Reinforced Concrete)
- Total floor space : 6334m^2 (B1 to 8F)
- Application per floor : B1: Storage, machine room
  GF, 1F : Bank
  2F, 3F : Theatre, concert hall
  4F ~ 8F : Tenant offices
- Air conditioning : Machine room installation-type package air conditioner, ceiling suspended cassette-type air conditioner
- Ventilation : Building Lossnay, ceiling suspended cassette-type Lossnay, straight sirocco fan

2) Current topics

(1) The operation times of the lower floors and that in the mid- to upper floors differ. (Efficiency and adaptability is required in control and operation aspects.)
(2) Maintainability is poor when the system is too dispersed.
(3) Handling of needs in tenant units is poor when the system is too concentrated.
(4) When a centralised heat source system is applied, a maximum load adaptability and maintenance control system is required.
(5) When ventilation is too dispersed, designing of the outer wall becomes a problem.

Installation state



3) Plan details

(1) Lower floors for business

A machine room installation-type package and building Lossnay is applied as a centralized method for each unit.

(One system for ground and 1st floor banking institution, one system for 2nd and 3rd floor hall.)

(2) Mid- to upper floors for office tenants

As an air conditioning system for each floor unit, a package air conditioner and Lossnay LP is combined in the machine room to handle the interior load and ventilation, and a ceiling suspended cassette-type package to handle the perimeter.

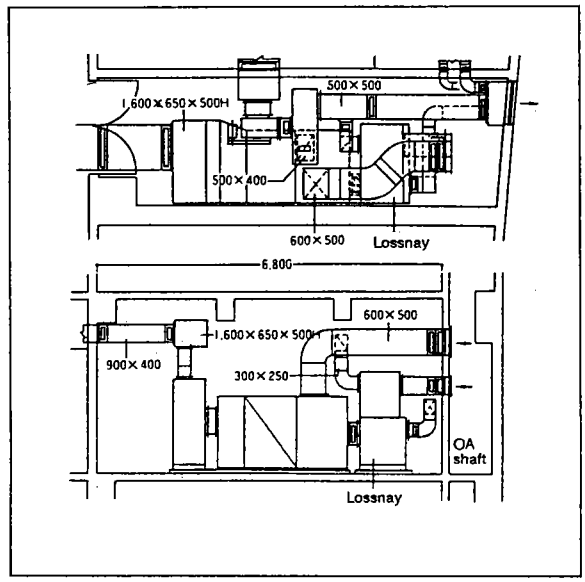
The toilet and kitchenette are ventilated with a straight sirocco fan on each floor, and supply for the outdoor air is provided to the LP Lossnay air supply. This allows independent operation and control for each floor.

(3) Control room, lounge, etc.

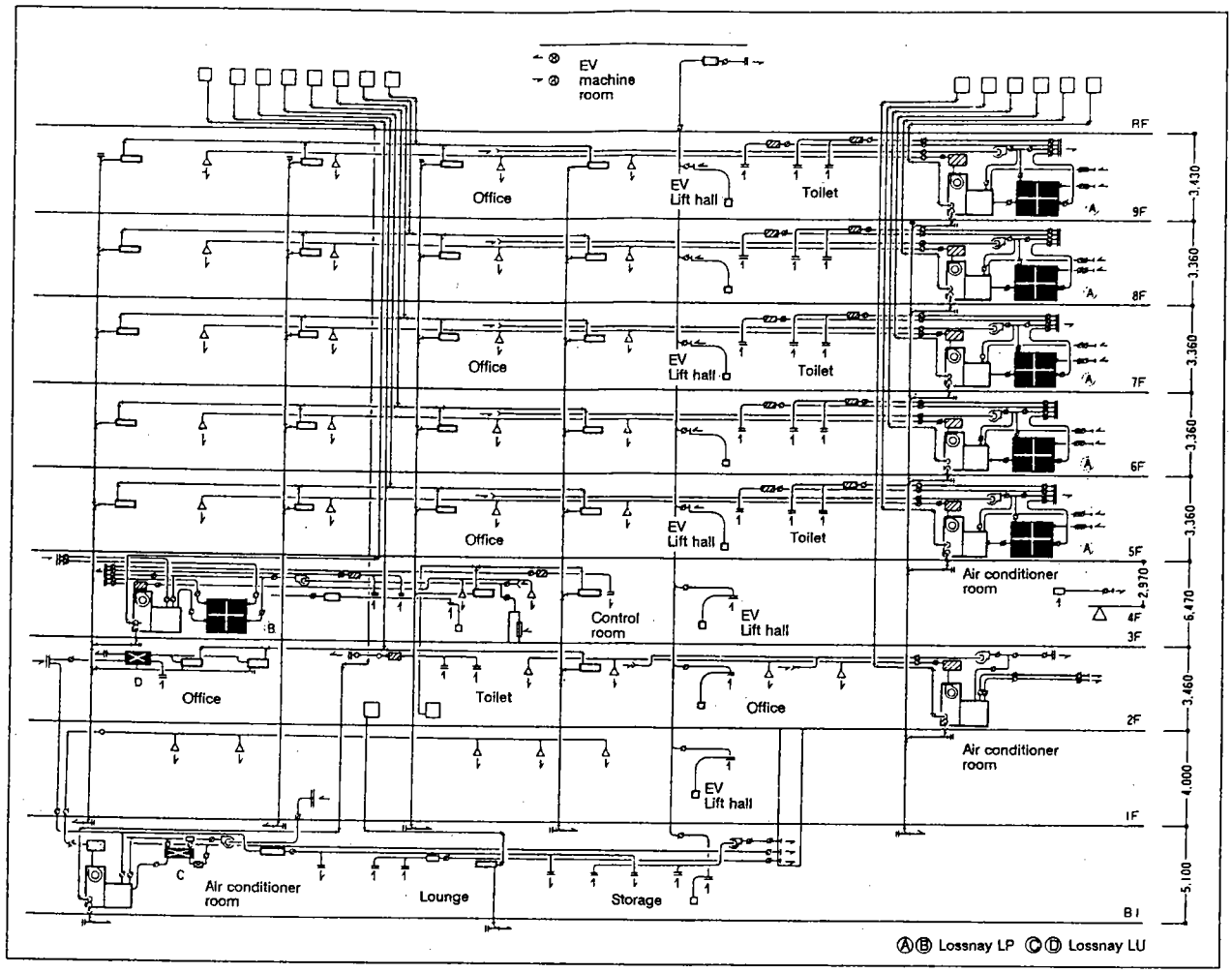
Independent use is possible with the ceiling suspended-type air-conditioner and ceiling suspended cassette-type Lossnay.

- **4F to 8F:**
  Tenant offices — Lossnay installation sites: machine room on each floor

To reduce installation space, a package-type LP Lossnay with built-in air-supply fan and filter is incorporated and combined with the air conditioner in the machine room on each floor.



Air conditioning system diagram



4) Effect

(1) Management in tenant units is clear and simple
(2) Maintenance is simple as the maximum centralization can be planned while having independent tenants.
(3) As ventilation units are considered per floor, there are few openings on the outer wall, making designing of the outer wall more simple.
(4) Outdoor air cooling is possible while ventilating.

4. Urban Small-Scale Building

1) System plan points

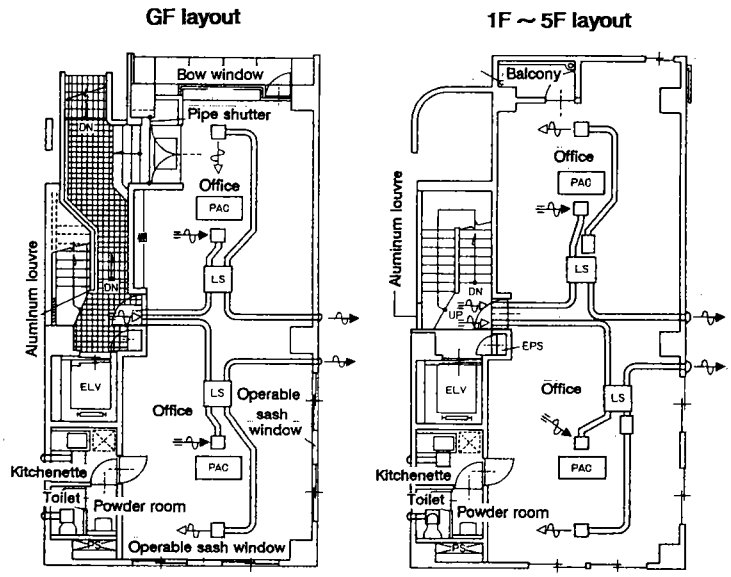
This system is based on effectively using available space within a limited area by installing the air conditioner and ventilator in available excess space.
For this application, the air flow must be considered for the entire floor with the ventilator installed in the ceiling space.

Setting outline

- Application : Office
- Building form : RC (Reinforced Concrete)
- Total floor space : 552m^2 (B1 to 5F)
- Application per floor : B1: Parking area
  GF ~ 5F: Office
- Air conditioning : Package air conditioner
- Ventilation : Ceiling embedded-type and cassette-type Lossnay, straight centrifugal fan, duct ventilation fan.

2) Current topics

(1) Three sides of the building are surrounded by other buildings, and windows cannot be installed. (Dependency on mechanical ventilation is high.)
(2) Ample fresh outdoor air cannot be supplied. (Generally, only Class 3 ventilation (forced exhaust) is possible.)
(3) If the exhaust in the room is large, odors from the toilet, etc., flow into the room.
(4) Humidification during winter is not possible.



PAC: Package air conditioner
LS : Lossnay

3) Plan details

(1) Air conditioning
- Space efficiency and comfort during cooling/heating is improved with ceiling embedded cassette-type package air conditioner.

(2) Ventilation
- Room, Salon corner: Entire area is ventilated by installing several ceiling embedded-type Lossnay units. Humidification is possible by adding a humidifier. (Outdoor air is supplied to the toilet and kitchenette by setting the selection switch on the Lossnay unit for supply to the extra-high notch.)
- Conference room, Board room: Area is independently ventilated by installing a ceiling embedded-type or cassette-type Lossnay in each room.
- Toilet, powder room, Kitchenette: Area is exhausted with straight centrifugal fan or duct ventilation fan. (An adequate exhaust volume can be obtained by taking in outdoor air, with the toilet being ventilated constantly.)

- Position of air intake/exhaust air outlets on outer wall
  The freshness of the outdoor air taken in by the Lossnay is important, thus considering that the building is surrounded by other buildings, the intake and exhaust ports must be separated as far as possible.

4) Effect

(1) Accurate ventilation is possible with Class 1 ventilation (forced simultaneous air intake/exhaust) using the Lossnay.
(2) Outdoor air supply to the toilet and kitchenette is possible with the Lossnay, and accurate ventilation is possible even in highly sealed buildings.
(3) Flow of odors can be prevented with constant ventilation using an adequate ventilation volume.
(4) Humidification is possible by adding a simple humidifying unit to the Lossnay.

5. Hospitals

1) System plan points

The principle of ventilation in hospitals requires adequate exhausting from the generation site and ensuring a supply of ample fresh air. An appropriate system would be an independent ventilation system with Class 1 ventilation (forced simultaneous air intake/exhaust).
The fan coil and package air conditioning are used according to material and place, and the air conditioned room is ventilated with the ceiling embedded-type Lossnay. The toilet and kitchenette, etc., are ventilated with a straight centrifugal fan.

Setting outline

- Building form : RC (Reinforced Concrete)
- Total floor space : 931 m^2 (GF to 2F)
- Application per floor : GF: Waiting room, diagnosis rooms, surgery theatre, director room, kitchen
  1F: Patient rooms, nurse station, rehabilitation room, cafeteria
  2F: Patient rooms, nurse station, head nurse room, office
- Air conditioning : Fan coil unit, package air conditioner
- Ventilation : Ceiling embedded-type Lossnay, straight centrifugal fan

2) Current topics

(1) Prevention of in-hospital transmission of diseases
  (Measures meeting needs for operating rooms, diagnosis rooms, waiting rooms and patient rooms are required.)
(2) Adequate ventilation for places where odors are generated
  (Measures to prevent odors from toilets from flowing to other rooms are required.)
(3) Shielding of external noise
  (Shielding of noise from outside of building and noise from adjacent rooms and hallway is required.)
(4) Assurance of adequate humidity
(5) Energy conservation

3) Plan proposals

(1) Air conditioning

- Centralised heat source control using a fan coil for the general system allows efficient operating time control and energy conservation.
- 24-hour system using a package air conditioner for special rooms (surgery theatre, nurse station, special patient rooms, waiting room) is the most practical.

(2) Ventilation

- Hall system

  Independent system using centralised control with LP Lossnay or independent system with installation of ceiling suspended-type Lossnay

- Surgery theatre

  Combination use of LP Lossnay and package air-conditioner with HEPA filter on room supply air outlet.

- Diagnosis rooms and examination room

  Patient rooms

  Nurse stations

  Independent ventilation for each room using ceiling suspended/ embedded-type Lossnay.

  - Integral system with optional humidifier possible for required rooms.
  - Positive/negative pressure adjustment, etc., is possible by setting main unit selection switch to extra-high notch (25R, 50R models) according to the room.

- Toilet/kitchenette

  Straight centrifugal fan or duct ventilation fan

- Storage/linen closet

  Positive pressure ventilation fan or duct ventilation fan

  The outdoor air is supplied from the hallway ceiling with the straight centrifugal fan, and is distributed near the air conditioner after the air flow is reduced.

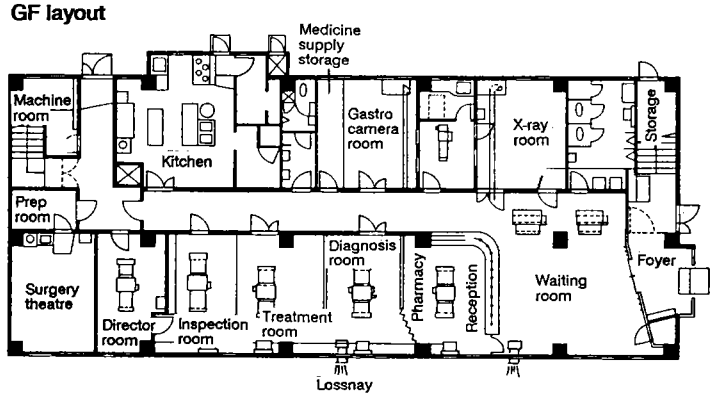
- Kitchen

  Exhaust with negative pressure ventilation fan or straight centrifugal fan. Outdoor air is supplied with the straight centrifugal fan.

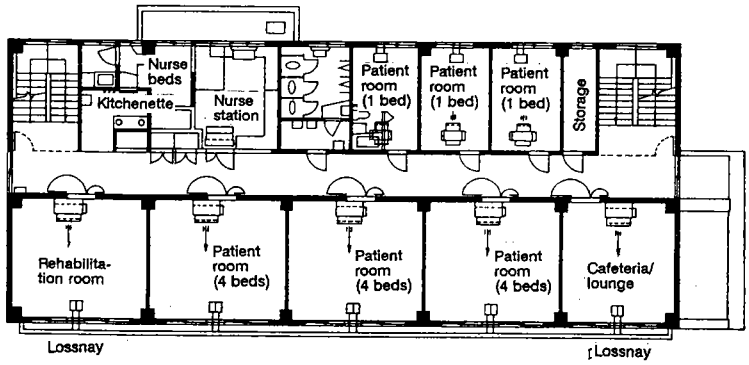
- Machine room

  Exhaust with positive pressure ventilation fan.

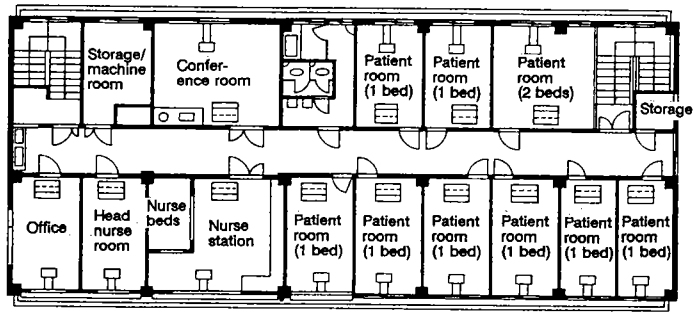
GF layout



1F layout



2F layout



4) Effect

(1) The following is possible by independently ventilating the air-conditioned rooms with the Lossnay:
- Transmission of diseases can be prevented by shielding the air between rooms.
- Infiltration of outside noise can be prevented with the Lossnay Core's soundproof properties.
- As outdoor air does not need to be taken in from the hallway, the door can be sealed, shutting out hallway noise.
- Humidification is possible by adding a humidifier.

(2) By exhausting the toilet, etc., and supplying outdoor air to the hallway:
- Flowing of odors to other rooms can be prevented.

6. Schools

1) System plan points

A comfortable environment in classrooms is necessary to improve the children and students' desire to study. Schools near airports, railroads and highways have sealed structures to soundproof the building, and thus air conditioning and ventilation facilities are required. This is also true for schools in polluted areas such as industrial districts.

At university facilities which have a centralised design to efficiently use land and to improve the building functions, the room environment must also be maintained with air conditioning.

2) Current system details and problem points

(1) Mainly single duct methods, fan coil unit methods, or package methods are used for cooling/heating, but the diffusion rate is still low, and water-based heaters are still the main source of heating.

(2) The single duct method is difficult to control according to the usage state, and there are problems in running costs.

(3) Rooms are often ventilated by opening the windows or using a ventilation gallery, where although this provides ample ventilation volume it may create a problem of infiltration of outside noise.

3) Building outline

Total floor space : 23,000m^3
Building outline : Prep school (high school wing)
Memorial hall wing
Library wing
Main management wing

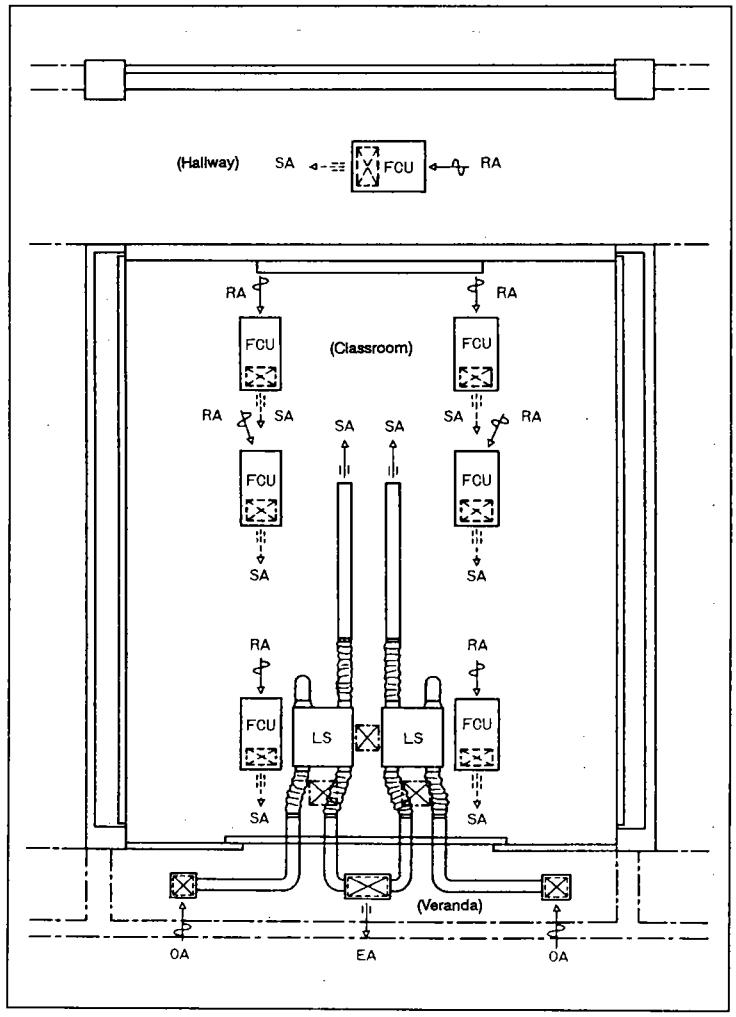
4) Plan details

(1) To pursue comfort, save energy and space, an air conditioning and ventilation system using a ceiling embedded-type fan coil unit and ceiling embedded-type Lossnay was applied.

(2) Automatic operation using a weekly program timer was applied, energising when the general classrooms and special classrooms are to be used.

(3) By using a ventilation system with a total heat exchanger, energy is saved and soundproofing is realised.

Classroom layout



5) Conditions for air-conditioning in schools

(1) Zoning according to application must be possible.

(2) Response to load fluctuations must be swift.

(3) Ventilation properties must be good.

(4) The system must be safe and rigid.

(5) Expansion of the facility must be easy.

(6) Installation on existing buildings must be possible.

(7) Installation and maintenance cost must be low.

6) System trends

(1) It is believed that environmental needs at schools will continue to progress towards high quality, and various factors such as temperature/humidity, noise, natural lighting, and colour must be considered at the design stages. Important topics are air conditioning, ventilation and soundproofing.

(2) Independent heating using a centralised control method is mainly applied when the air conditioner is for heating only. For cooling/heating, a combination of a fan coil method and package-type is the main method used.

(3) Highly accurate Class 1 ventilation is applied for the ventilation method, and the total heat exchanger is mainly used in consideration of the energy saved during air conditioning and the high soundproofing properties.

7. Hotels (convention halls, wedding halls)

1) System plan points

Hotels in Japan often have functions such as a resort hotel at tourist spots, convention hotel with conference and banquet halls, and business hotels for short-term stays. These are all labeled as hotels, and often, more importance is laid on the wedding, convention and banquet halls, etc.

This is because air conditioning systems in these places must have a ventilation treatment system that can handle extremely large fluctuations in loads, tobacco smoke and removal of odors.

2) Current systems and problem points

CO and CO_2 permissible values, removal of odors, and tobacco smoke are often considered as standards for ventilation and often the ventilation is set at $30m^3/h \cdot$person to $35m^3/h \cdot$person. Several outdoor air introduction-type package air conditioners or air handling unit facilities are often used, but, these are greatly affected by differences in capacity, ratio of smokers and length of stay.

3) Plan details

This proposed plan has two examples with the use of a Lossnay as a ventilator for total heat recovery in the air conditioned conference room, and the use of several outdoor air type package air-conditioners for convention and banquet halls.

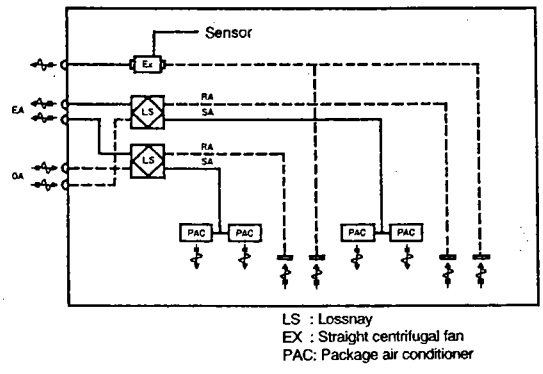
A) Conference room

Heat recovery ventilation is executed with constant use of the Lossnay unit, but when the number of persons increases suddenly and the CO_2 concentration reaches a set level (for example, 1,000 ppm in the Building Management Law), a separate centrifugal fan operates automatically. This system can also be operated manually to rapidly remove smoke and odors.

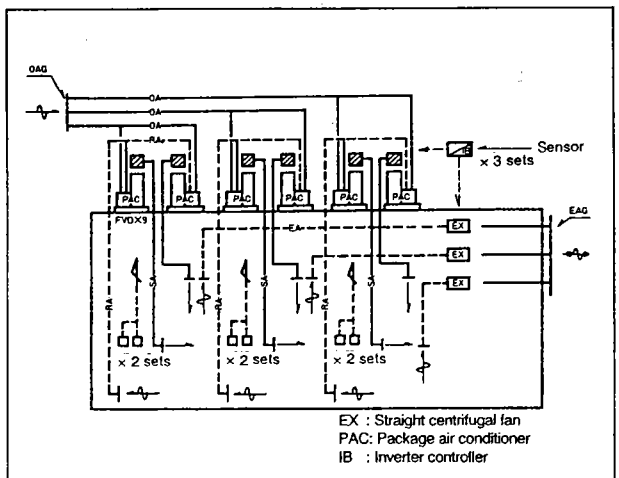
B) Convention and banquet halls

Basically, this system is composed of several outdoor air introduction-type package air conditioners and straight centrifugal fans for ventilation. However, an inverter controller is connected to the centrifugal fan so that it is constantly at 50 percent of the operation state, allowing fluctuations in ventilation loads to be handled. By interlocking with several package air-conditioners, detailed handling of following up the air condition loads in addition to the ventilation volume is possible.

Systems using Lossnay are also possible.



Conference room ventilation system diagram



Convention and banquet hall ventilation system diagram

4) System trends

The load characteristics at hotels is complex compared to general buildings, and are greatly affected by the bearing, time, and operation state as mentioned above. Further to this, the high ceilings in meeting rooms and banquet halls, requires preheating and precooling to be considered. Further research on management and control systems and product development will be required in the future to pursue even further comfortable control within these spaces.

8. Public Halls (combination facilities such as day-care centres)

1) System plan points

Air conditioning and ventilation facilities for buildings located near airports and military bases, etc., that require soundproofing, have conventionally been of the centralised method. However, independent dispersed air conditioning and ventilation has been demanded due to the need for operation in zones, as well as for energy conservation purposes. This system is a plan for these types of buildings.

Setting outline

Building form	:	Above ground 2, Total floor space: 385m^2
Application	:	GF ..... Study rooms (2 rooms), office, day-care room, lounge
		1F ..... Meeting room
Air conditioning	:	GF ..... Air-cooling heat pump chiller and fan coil unit
		1F ..... Air-cooling heat pump package air conditioner
Ventilation	:	Ceiling embedded Lossnay

2) Conventional system and topics

(1) Conventional systems have used centralised methods with air handling units, and air conditioning and ventilation were generally performed together.

(2) Topics

① Special knowledge is required for operation, and there are problems in response to the users' needs.

② When the centralised method is used, the air even in rooms that are not being used is conditioned, increasing running costs unnecessarily.

③ Machine room space is necessary.

④ Duct space is necessary.

3) Plan details

(1) Air conditioning facilities

① Small rooms : Air-cooling heat pump chiller and fan coil unit combination

② Meeting rooms : Single duct method with air-cooling heat pump package air conditioner

(2) Ventilation facilities

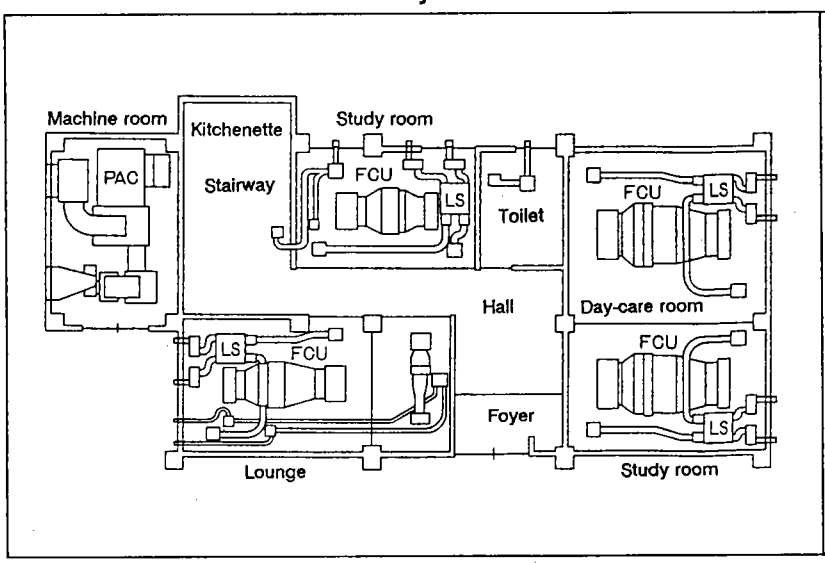
① A ceiling embedded-type Lossnay is used in each room, and a silence chamber, silence-type supply/return grille, silence duct, etc. is incorporated on the outer wall to increase the total soundproofing effect.

4) Effect

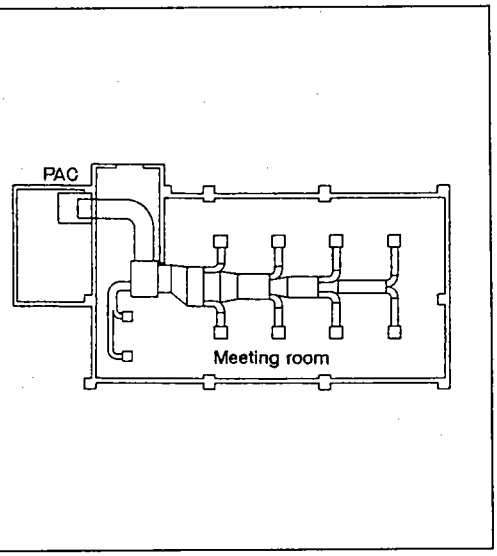
(1) Operation is possible without special knowledge, so management is easy.
(2) Operation is possible according to each room's needs, and is thus energy-saving.
(3) Soundproof ventilation is possible with the separately installed ventilators.
(4) Energy saving ventilation is possible with the heat recovery ventilation.
(5) Space saving with the ceiling embedded-type.

Soundproofing standards ➡	Soundproofing effect
High pressure level difference 30dB or more	Study room : 34.0dB Rest room : 47.2dB

GF layout



1F layout

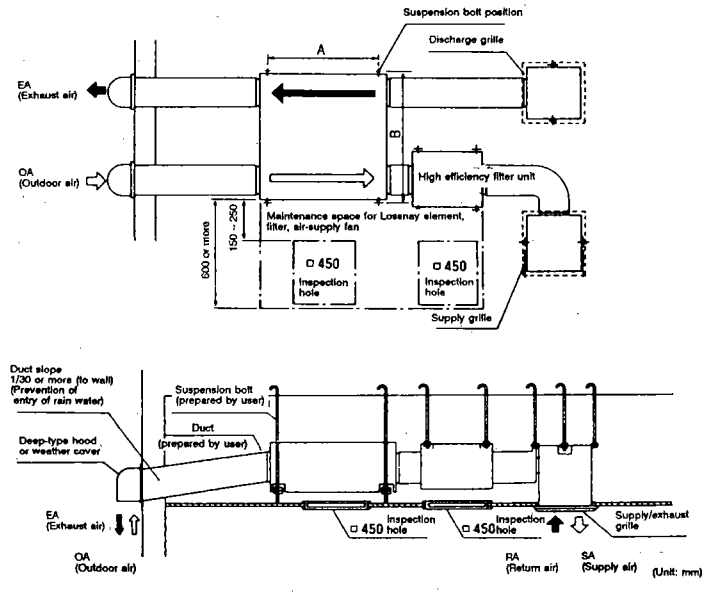


CHAPTER 7
Installation Considerations

1. LGH-Series Lossnay Ceiling Embedded-Type (LGH, RS Series)

LGH-15·25·35·50·65·80·100, RS_2 models

■ Installation diagram

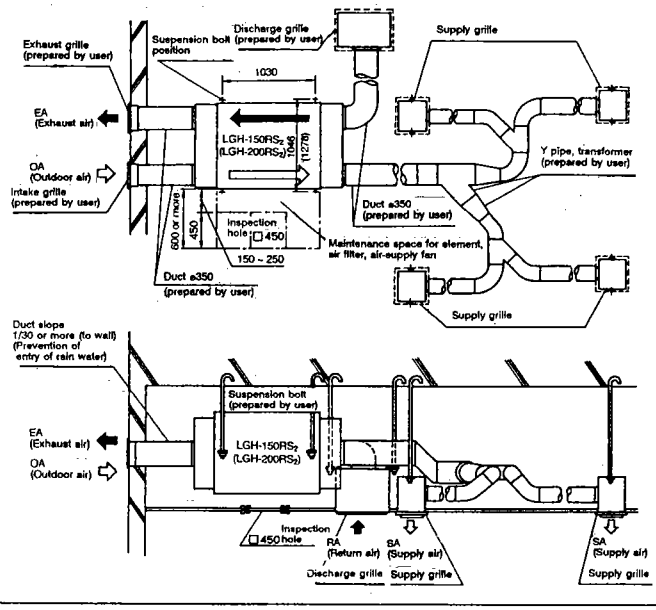


■ Table of transformed dimensions

Air volume (m^3/h)	Model	A	B
150	LGH-15RS_2	700	641
250	LGH-25RS_2	700	765
350	LGH-35RS_2	760	906
500	LGH-50RS_2	790	1048
800	LGH-80RS_2	1030	1036
1000	LGH-100RS_2	1030	1263

150RS_2 · 200RS_2

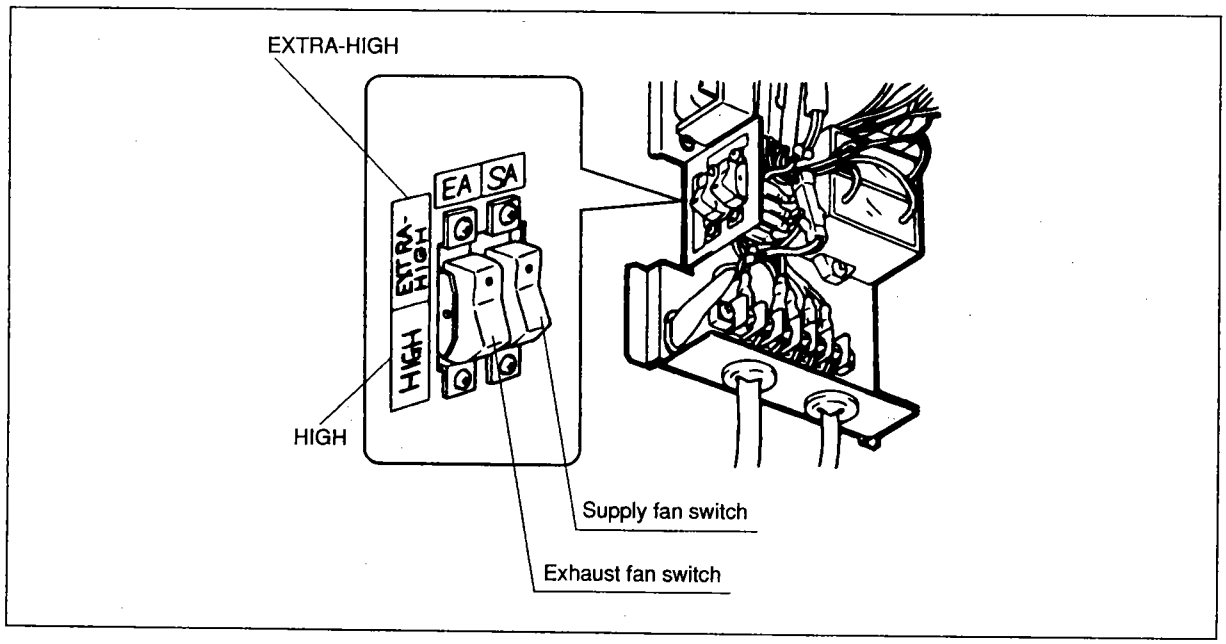
■ Installation diagram for LGH-150RS_2 (for LGH-200RS_2)



(Unit: mm)

① The ceiling embedded-type: 150, 250, 350, 500, 650, 800, 1000, 1500 and 2000m^3/h types are available. Select an adequate model according to the room size, air volume for the application and noise levels.

② The LGH-15, 25, 35, 50, 65, 80, 100 types have an extra-high notch. This setting is for when a long duct is used or when a large air volume is required. The positive and negative pressures of the room can also be adjusted with this.



The diagram shows the RS series.

③ The units have a low-noise design, however, for further noise reduction a silencer-type supply/return grille (PZ-FG-type) for supply/return air in the room, a silencer box (PZ-SB-type) for reducing the air sound into the room, and a flexible silencer (PZ-SD-type) are available.

Silencing effect of each part

	Model	Silencing effect	Application models	Duct diameter
Supply/return grille	PZ-10FG_3	3 dB	LGH-15RS_2	ø100
	PZ-15FG_3	4 dB	LGH-25, 35RS_2	ø150
	PZ-20FG_3	4 dB	LGH-50RS_2	ø200
	PZ-25FG_3	4 dB	LGH-80, 100RS_2	ø250
Silencer box	PZ-20SB_2	6 dB	LGH-35, 50RS_2	ø200
	PZ-25SB_2	6 dB	LGH-80, 100RS_2	ø250
Flexible silencer	PZ-10SD	22 dB	LGH-15RS_2	ø100
	PZ-15SD	21 dB	LGH-25RS_2	ø150
	PZ-20SD	20 dB	LGH-35, 50RS_2	ø200
	PZ-25SD	18 dB	LGH-80, 100RS_2	ø250

1) Installation and maintenance

(1) Always leave an inspection hole (□450) on the filter and Lossnay Core removal side.

(2) Always insulate the two ducts outside the room (intake air and exhaust air ducts) to prevent frosting.

(3) Enforce measures to prevent rain water from entering.

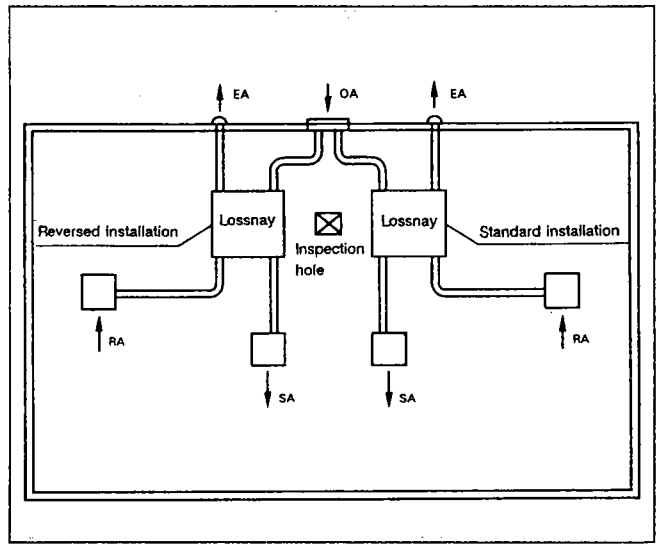
- Apply a slope of 1/30 or more towards the wall to the two ducts outside the room (intake air and exhaust air ducts).
- Do not install the vent cap or round hood where it will come into direct contact with rain water.

(4) Use the optional system part "control switch" (Ex. PZ-05SLB$_2$, etc.) for the RS$_2$-type.
A centralised controller can also be used.

2) Installation applications

(1) Combined installation of two units

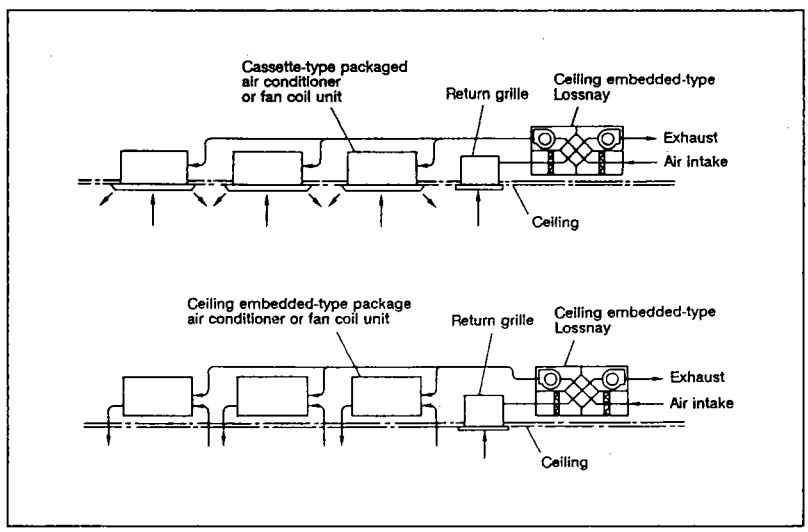
The main unit's supply outlet and suction inlet and the room side and outdoor side positions cannot be changed. However, the unit can be turned over, and installed as shown below. (This is applicable when installing two units in one classroom, etc.)



(2) System operation with air conditioner

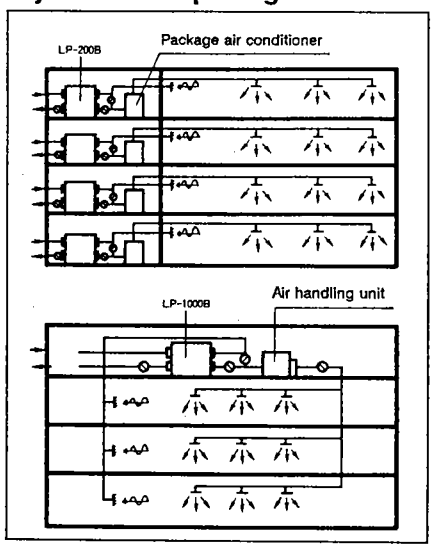
Air conditioning systems with independent dispersed multiple unit air-conditioners are increasing due to merits such as improved controllability, energy conservation and space saving.

For these types of air conditioning systems, combined operation of the dispersed air conditioners with the Lossnay, is possible.

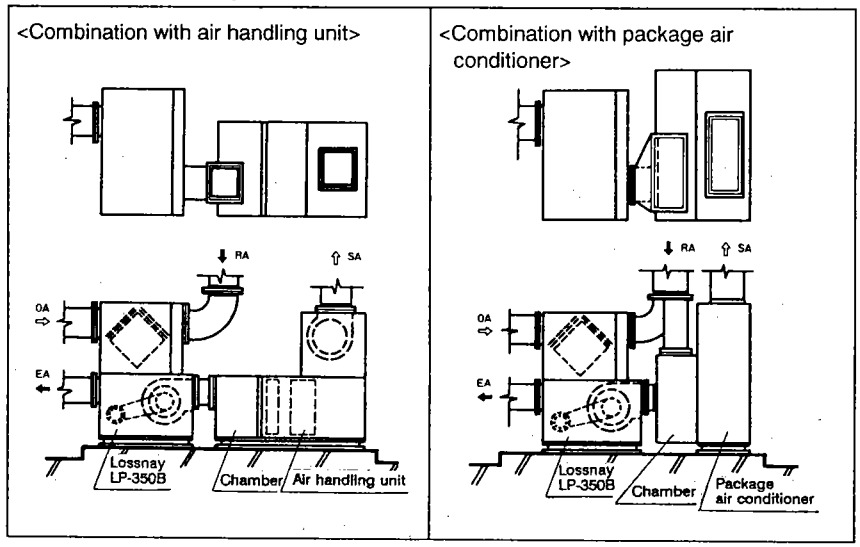


2. Building Lossnay Pack-type (LP-200B, 350B, 500B, 750B, 1000B)

System concept diagram



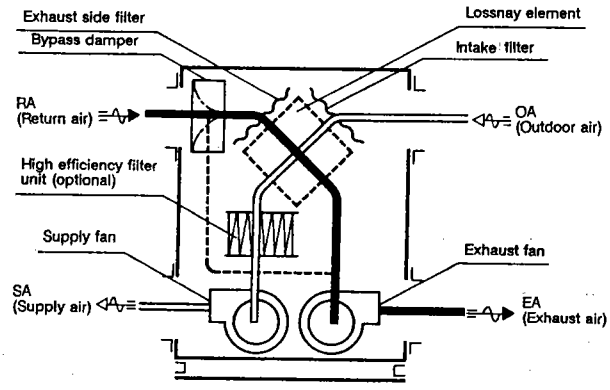
Installation examples



(1) The LP-200B, 350B, 500B, 750B and 1000B building Lossnay Packs models are available with an air volume of 1000 to 13000m^3/h.

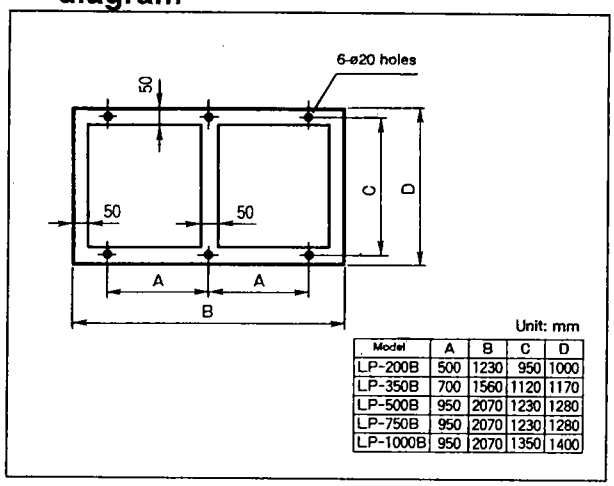
(2) Select an adequate model according to the building size, air volume for application and static pressure of outside unit.

Air passage



1. The fresh outdoor air is filtered with the intake filter, and the heat is recovered with the Lossnay Core (during winter; heated and humidified, during summer; cooled and dehumidified). Then it is supplied by the supply fan.
2. The optional high efficiency filter is placed between the Lossnay Core and supply fan, to refilter the air that has been filtered by the intake filter.
3. The stale air passes through the damper, and is filtered by the exhaust filter. The heat is recovered with the Lossnay Core, and then discharged by the exhaust fan.
4. The bypass passage for normal ventilation bypasses the air on the exhaust side. If the bypass damper is closed, the stale air will be directly drawn in by the exhaust fan and discharged.

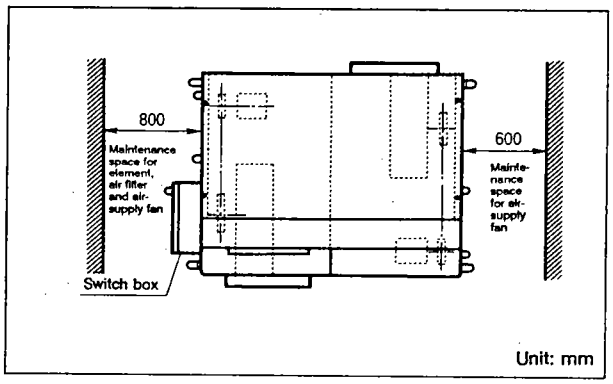
1) Main unit base installation surface diagram



Unit: mm

Model	A	B	C	D
LP-200B	500	1230	950	1000
LP-350B	700	1560	1120	1170
LP-500B	950	2070	1230	1280
LP-750B	950	2070	1230	1280
LP-1000B	950	2070	1350	1400

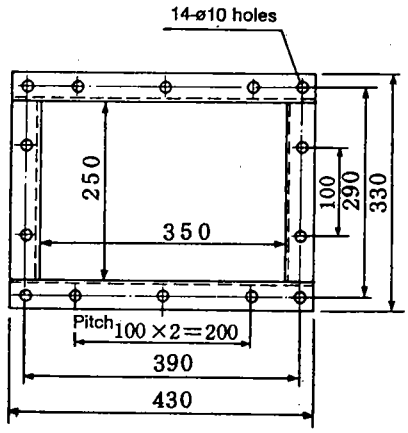
2) Maintenance space



Unit: mm

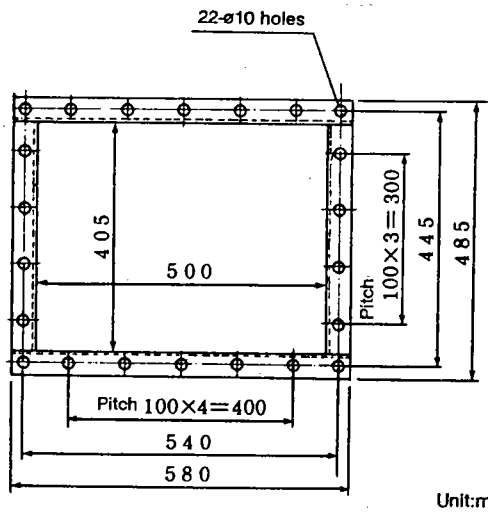
3) Flange dimensions

LP-200B



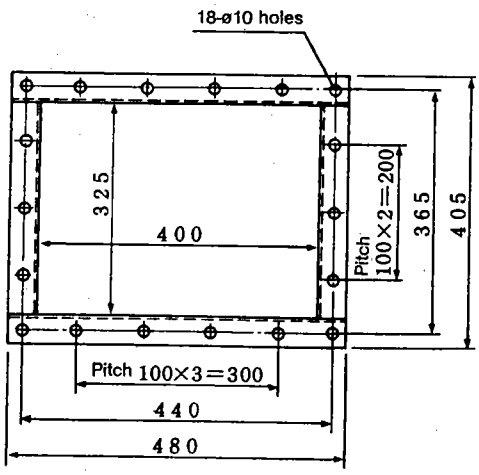
Unit:mm

LP-500B



Unit:mm

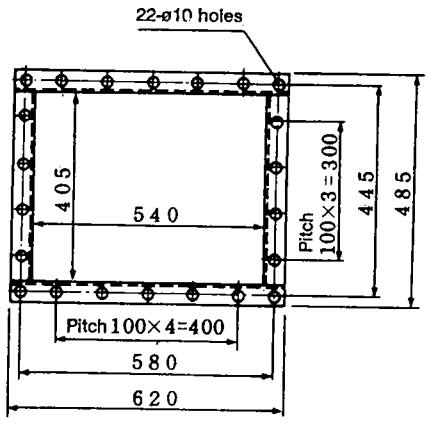
LP-350B



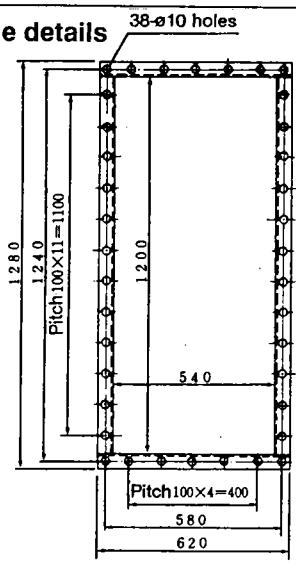
Unit:mm

LP-750B, 1000B

■ Supply flange details



■ Return flange details

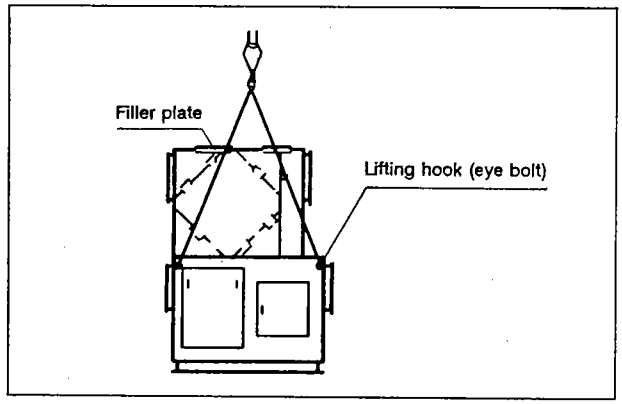


Unit:mm

4) Transportation and installation

(1) LP-200B, 350B, 500B

- The product is shipped in the fully assembled state. Transport the unit gently and do not apply shock or tilt the unit.
- Use eyebolts (or eyenuts) when lifting the unit. Always use the four eyebolts, and fix with rope. Adjust the rope length so that the angle between the rope and the unit is 45° or more. The panel will be damaged if the rope directly contacts the unit. Always use filler plates or wood.
- The foundation for the unit must be sturdy and level.
- Install the unit perpendicularly to the foundation and securely fix the unit with anchor bolts.
- Install the unit where it will not come into contact with rain water, and where rain water will not enter the unit from the ducts.
- The unit may be disassembled into two parts, and transported with the following procedure if installation as a complete product is not possible.

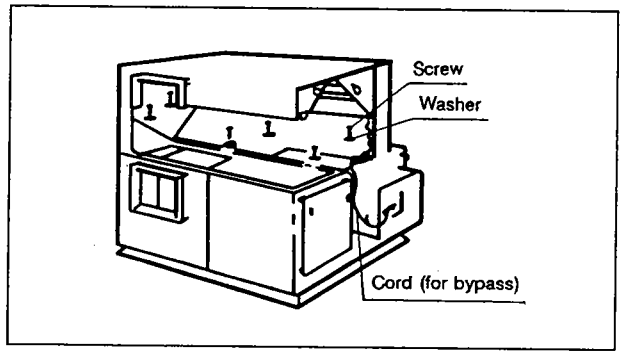


Weight when disassembled Unit: kg

	Top (element chamber)	Bottom (fan chamber)	Total
LP-200B	140	240	380
LP-350B	230	290	520
LP-500B	300	380	680

Disassembly

① Remove the cover for the air filter and Lossnay Core. Remove the air filter and then the Lossnay Core.
② Disconnect the cord (for bypass) connected to the fan chamber motor in the lower part of the unit.
③ Remove the six screws fixing the top and bottom of the unit.



Weight when disassembled Unit: kg

	Top (element chamber)	Bottom (fan chamber)	Total
LP-750B	140	240	380
LP-1000B	230	290	520

(2) LP-750B, 1000B

- This product is shipped in two parts and assembled at the installation site.
- Always lift the element chamber and the fan chamber separately even when lifting the entire product in the assembled state using the eyebolts (or eyenuts) mounted on the unit.
- Always be sure to use the eyebolts (or eyenuts) when lifting the unit. Always use the four eyebolts, and securely fix the rope. Adjust the rope length so that the angle between the rope and the unit is 45° or more.
- The foundation for the unit must be sturdy and level.
- Install the unit perpendicularly to the foundation and securely fix the unit with anchor bolts.
- Install the unit so rain water will not enter the unit from the ducts.
- To assemble the separate parts, align the slots on the element chamber to the bolts on top of the fan chamber, and fix with the enclosed washers and nuts (six each).
- Remove the inspection hole cover and connect the geared motor plug for the bypass to the plug in the element chamber from inside.

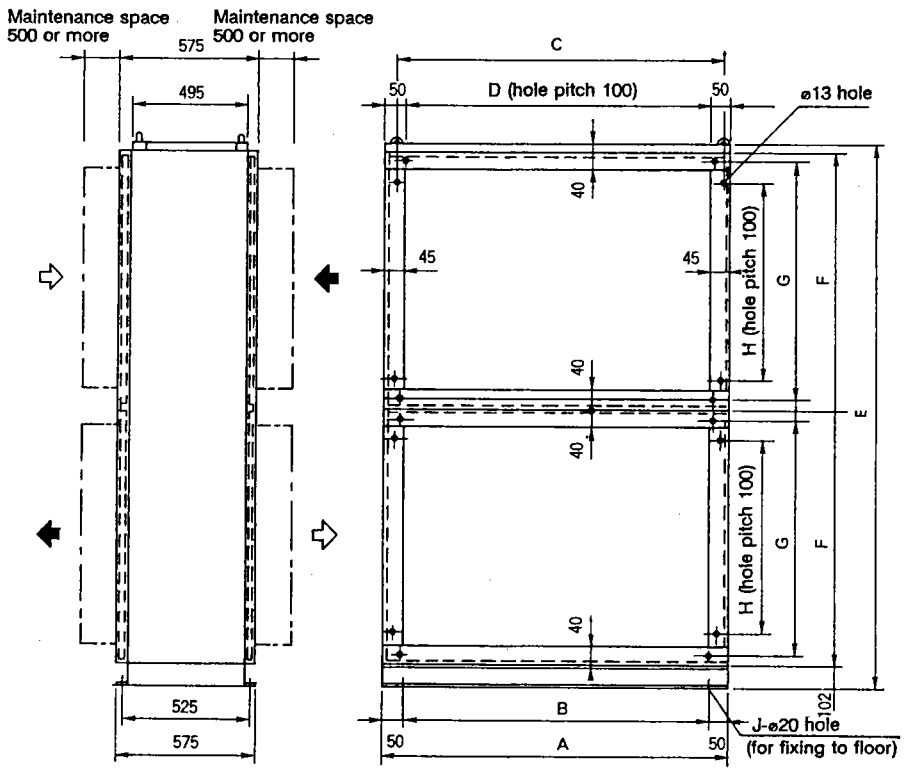
3. Building Lossnay Unit Vertical-type (LUT-2302, 2303, 3002, 3003)

1) Main unit dimensions and flange dimensions

- This unit is for indoor installation.
- The flange is an inner-flange.
- The special filter is not sold separately and must be prepared by the user. (Two on element's intake side.)

Unit: mm

		A	B	C	D	E	F	G	H	J
Single-type	LUT-2302	1000	900	950	900	2382	1125	1085	1000	4
	LUT-2303	1500	1400	1450	1400	2382	1125	1085	1000	6
	LUT-3002	1000	900	950	900	3132	1500	1460	1400	4
	LUT-3003	1500	1400	1450	1400	3132	1500	1460	1400	6

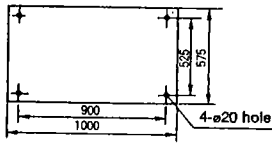


Unit: mm

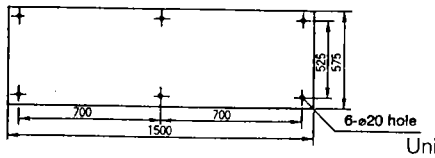
2) Main unit installation surface diagram

● Single-type floor installation surface diagram

LUT-2302, 3002 models



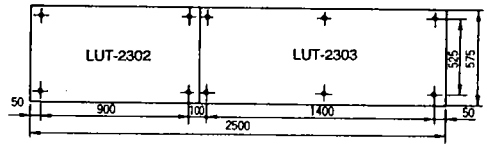
LUT-2303, 3003 models



Unit: mm

● Combination-type floor installation surface diagrams (Example)

For LUT-2305



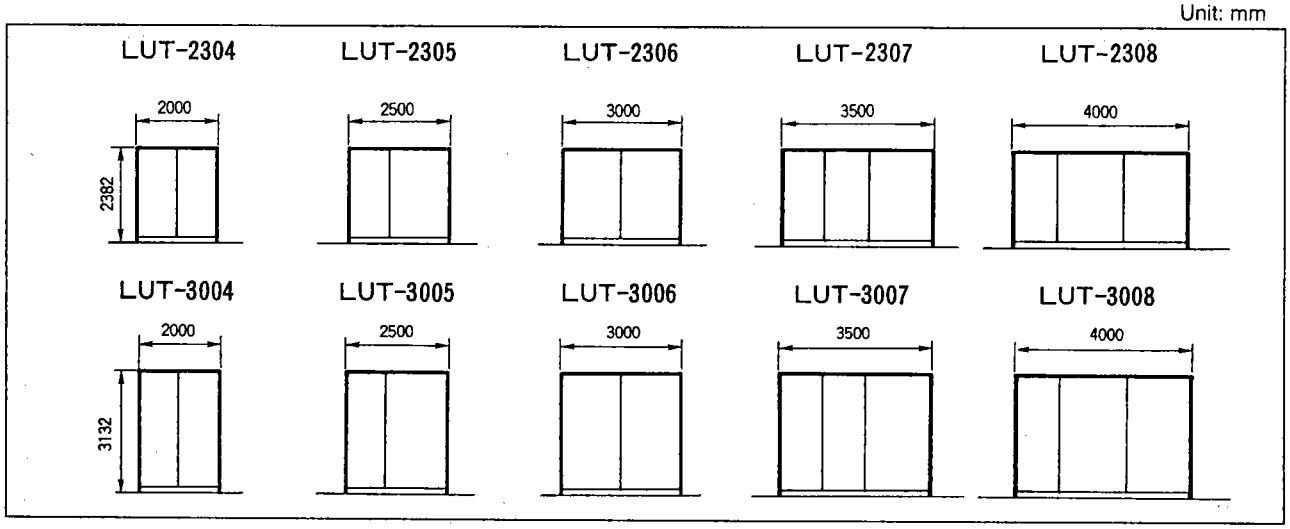
Unit: mm

(The single-type model installation surface is combined in this case.)

3) Combination dimensions

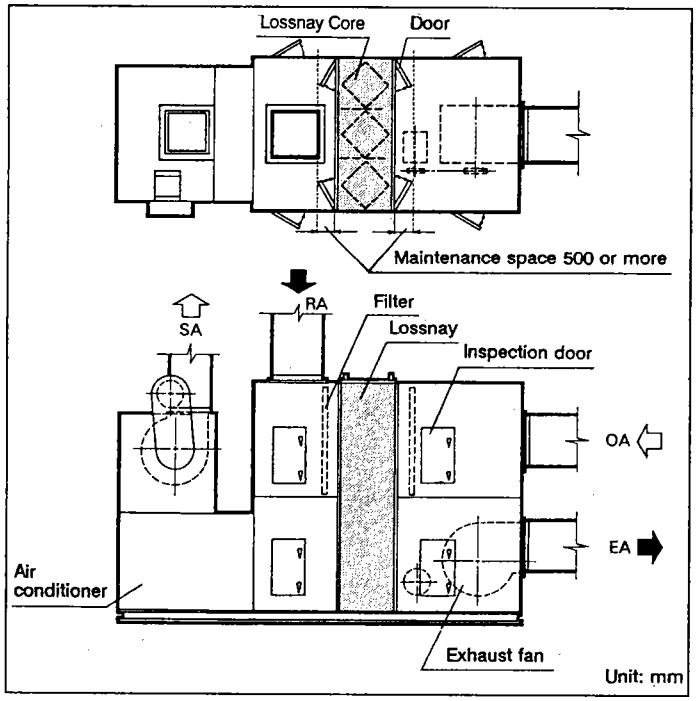
- The combined-type uses a combination of single-type units.
- The combined-type is shipped in the disassembled state. (A combination of single-type units.)

Unit: mm



4) Maintenance space

- The Lossnay Core is cleaned from the intake/exhaust chamber sides.
  Allow an inspection space of 50cm or more in the chamber.
- Ensure that the Core inspection door can open and close, and always install an inspection door for cleaning the ducts.



5) Transportation and installation

- Always use shackles to lift the Lossnay Core section as shown in the figure. Fix the main unit with the eyenuts for lifting the unit, and suspend the unit in four places. (Fig. 1)
- Adjust the rope length so that the angle between the rope and the unit is 45° or more. (Fig. 1)
- The panel will be damaged if the rope directly contacts the unit.
- When combining the units, use the enclosed top connection fittings (two) and bottom connection fittings (two). Securely fix the top with the four M10 screws and four washers and the bottom with eight M8 screws so that the fitting with the flange is tight.
- Always leave the maintenance space shown in the diagram.
- The foundation for the unit must be sturdy and level.
- Install the unit perpendicularly to the foundation and securely fix the unit with anchor bolts.
- Install the unit so rain water will not enter the unit from the ducts.

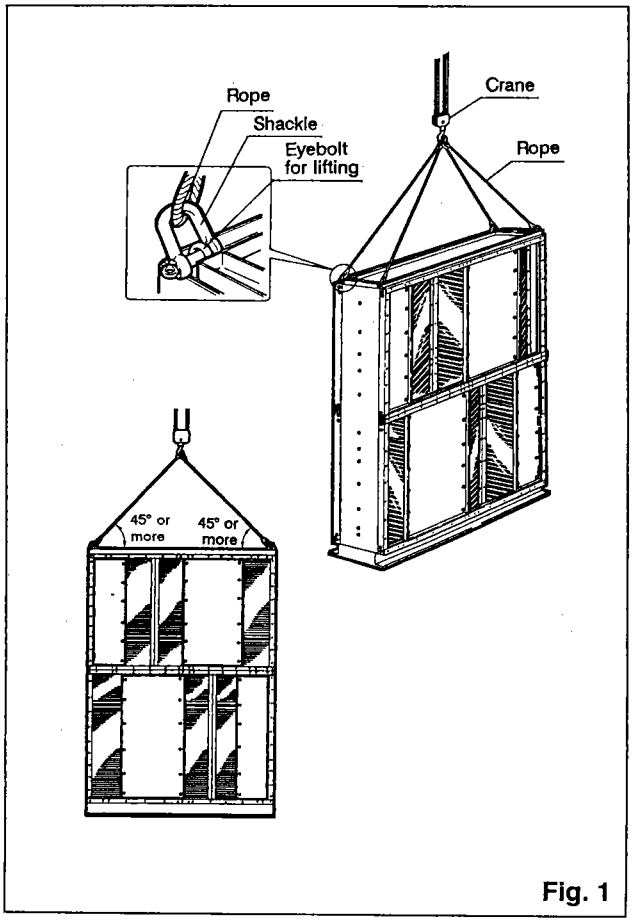


Fig. 1

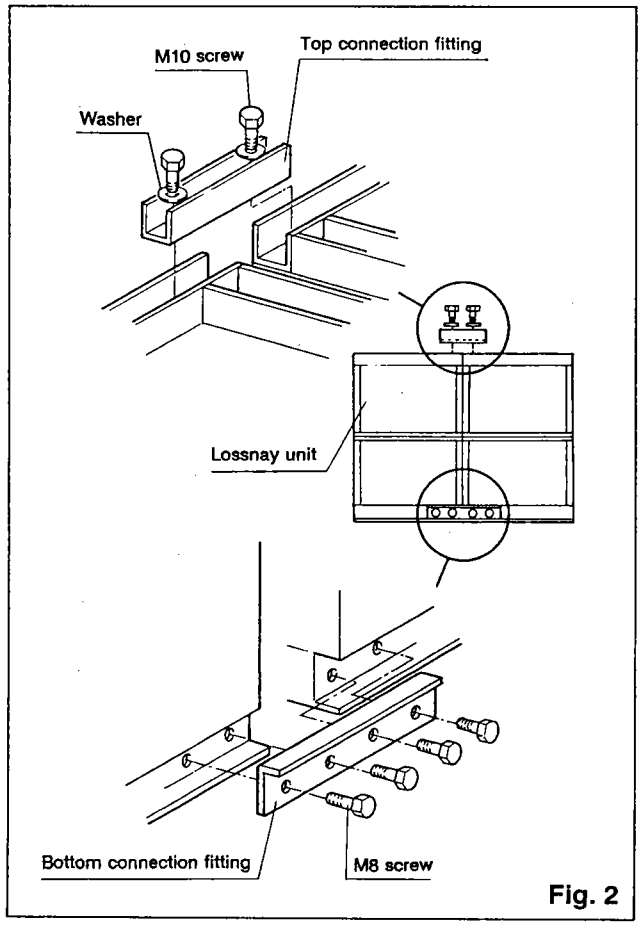
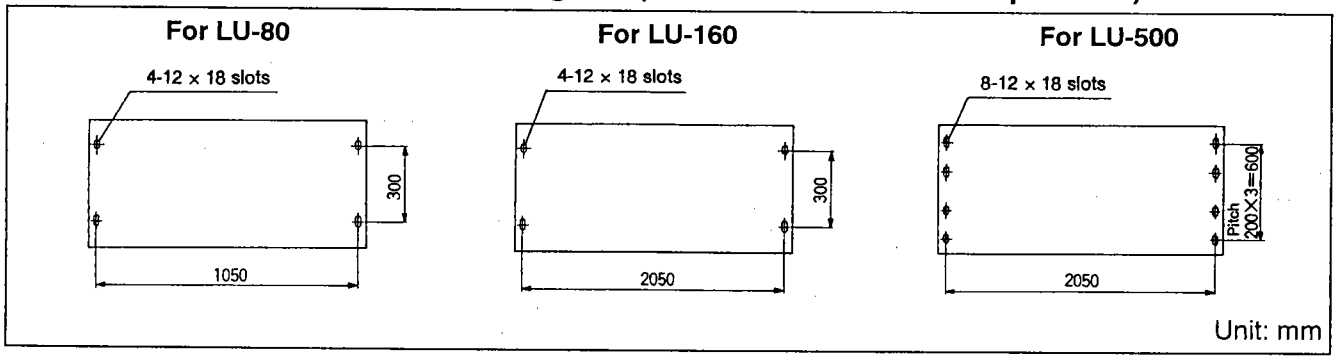


Fig. 2

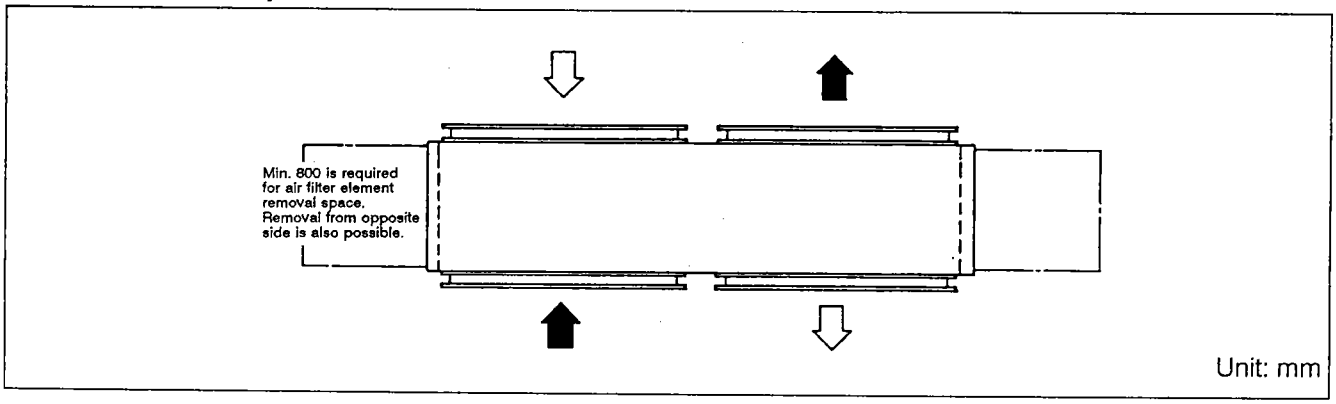
4. Building Lossnay Unit Horizontal-type (LU-80, 160, 500)

1) Main unit installation surface diagram (anchor bolt installation position)



Unit: mm

2) Maintenance space



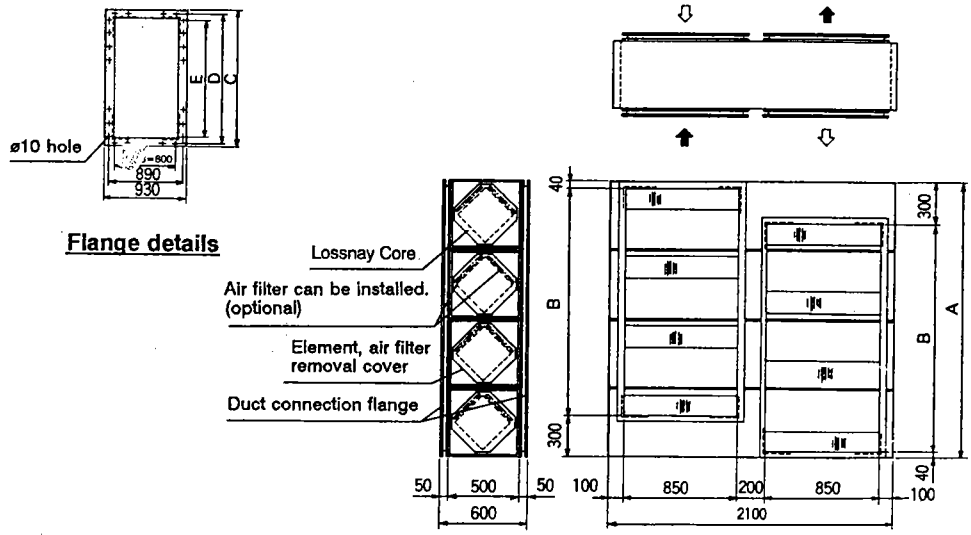
Unit: mm

3) Combination dimensions and flange dimensions

LU-1602 · 1603 · 1604 · 1605 · 1606

Unit: mm

	A	B	C	D	E
LU-1602	1010	670	750	710	Pitch 100 × 6 = 600
LU-1603	1520	1180	1260	1220	Pitch 100 × 10 = 1000
LU-1604	2030	1690	1770	1730	Pitch 100 × 16 = 1600
LU-1605	2540	2200	2280	2240	Pitch 100 × 20 = 2000
LU-1606	3050	2710	2790	2750	Pitch 100 × 25 = 2500

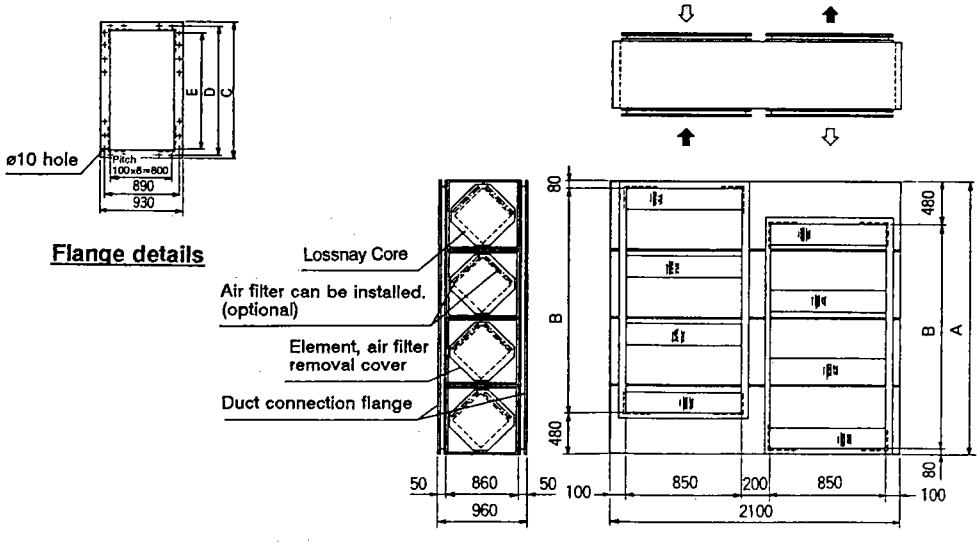


Unit: mm

LU-502 · 503 · 504 · 505

Unit: mm

	A	B	C	D	E
LU-502	1730	1170	1250	1210	Pitch 100 × 10 = 1000
LU-503	2600	2040	2120	2080	Pitch 100 × 20 = 2000
LU-504	3470	2910	2990	2950	Pitch 100 × 27 = 2700
LU-505	4340	3780	3860	3820	Pitch 100 × 36 = 3600

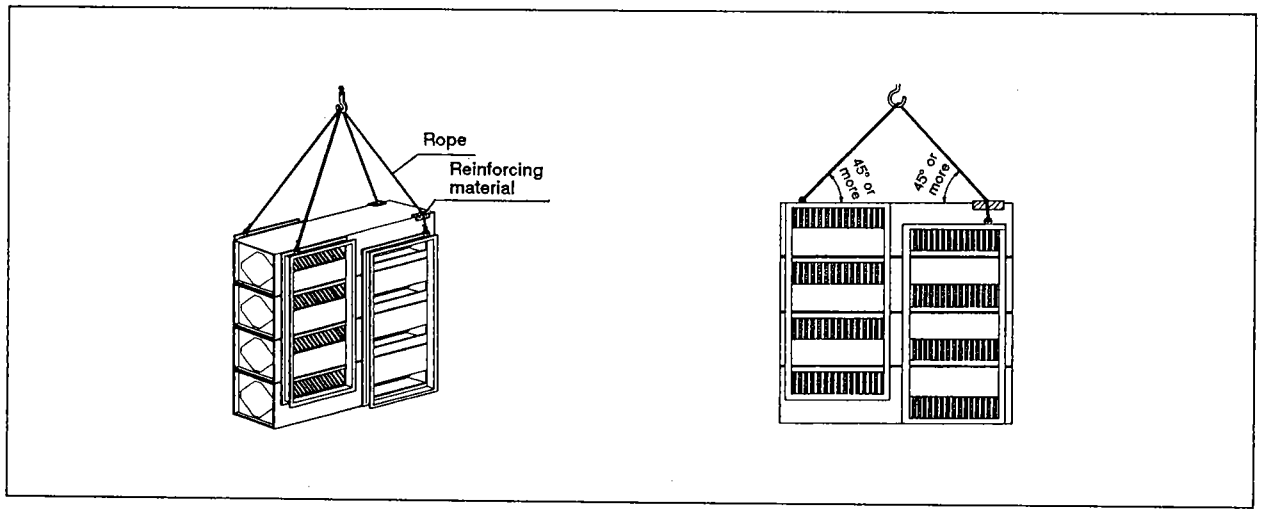


Unit: mm

4) Transportation and installation

The product is shipped in the fully assembled state. Transport the unit gently and do not apply shock or tilt the unit.

① Use eyebolts (or eyenuts) and rope when lifting the unit. Make sure that the rope can withstand the weight of the unit.
Always use all four eyebolts, and fix the rope.
Adjust the rope length so that the angle between the rope and the unit is 45° or more.



② Use filler plates to protect the panel so that the panel is not damaged by the rope during lifting.
③ The unit will be damaged if the rope directly contacts the unit.
④ The foundation must be made of concrete. The concrete foundation must be level and have ample strength.
⑤ Install the unit perpendicularly to the foundation and securely fix the unit with anchor bolts.
⑥ Install the unit where rain water will not come into contact, and where rain water will not infiltrate the unit from the ducts.

■ Caution

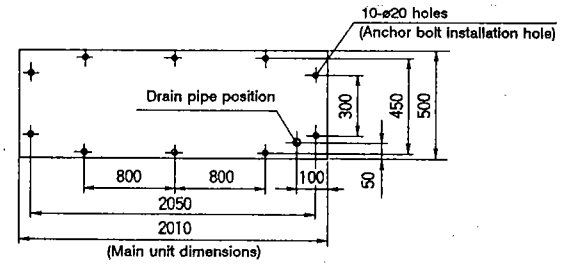
This unit has indoor specifications and cannot be installed in sites where it will come into contact with rain water or in high temperature, high humidity locations.

5. Industrial Moisture Resistant Lossnay (LUP-80, 160, 500)

The moisture resistant Lossnay requires drains. Install the unit by lifting it from the floor with a base, etc., so that draining from under the unit is also possible. (A base is provided for the combined types.)

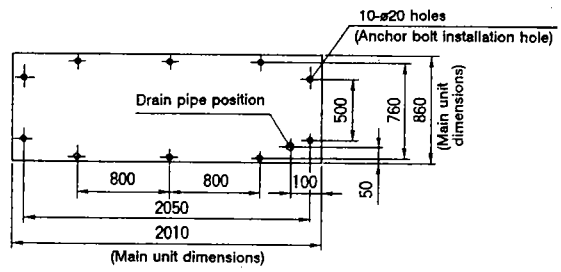
1) Combination-type installation surface diagram (anchor bolt installation position, drain pipe position)

For LUP-160 combination



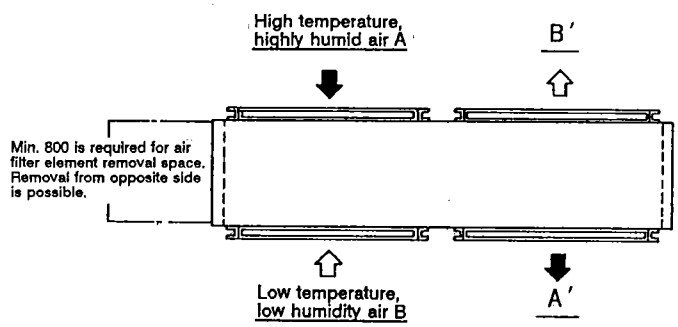
Unit: mm

For LUP-500 combination



Unit: mm

2) Maintenance space



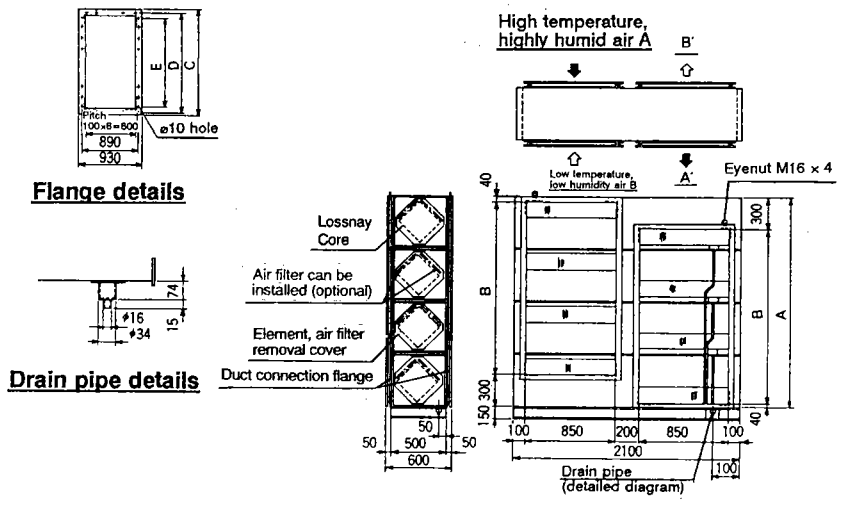
Unit: mm

3) Combination dimensions and flange dimensions

LUP-1602 · 1603 · 1604 · 1605 · 1606

Unit: mm

		A	B	C	D	E
LUP-160-type set parts	LUP-1602	1010	670	750	710	Pitch 100 × 6 = 600
	LUP-1603	1520	1180	1260	1220	Pitch 100 × 10 = 1000
	LUP-1604	2030	1690	1770	1730	Pitch 100 × 16 = 1600
	LUP-1605	2540	2200	2280	2240	Pitch 100 × 20 = 2000
	LUP-1606	3050	2710	2790	2750	Pitch 100 × 25 = 2500

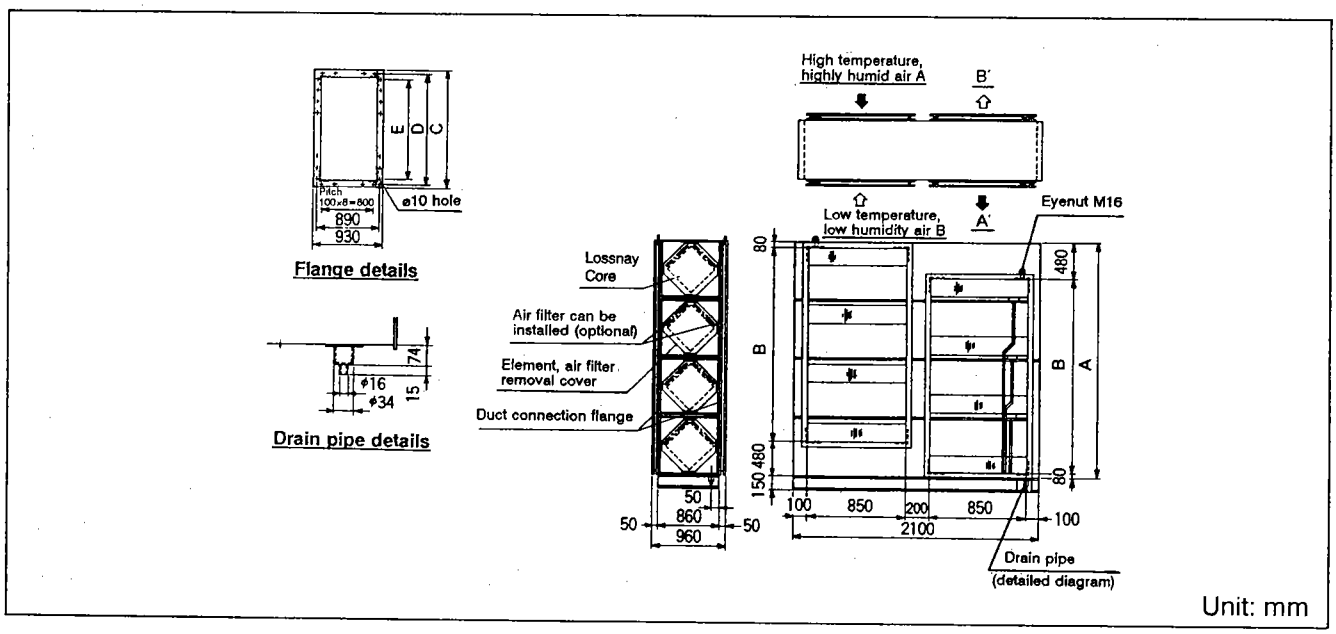


Unit: mm

LUP-502 · 503 · 504 · 505 · 506

Unit: mm

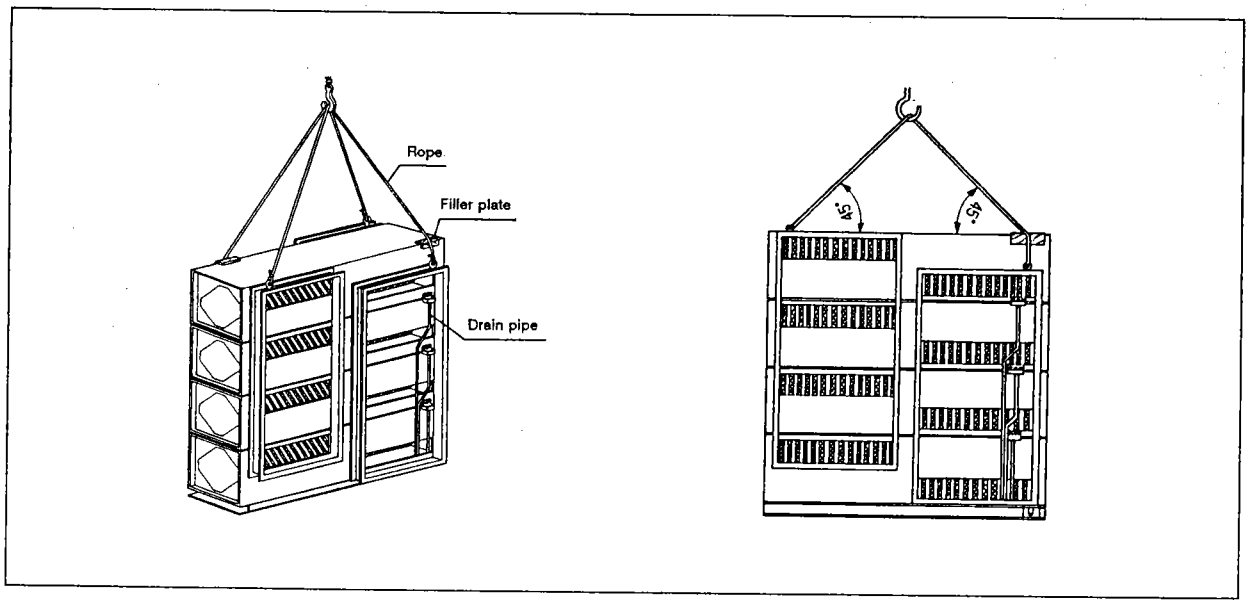
		A	B	C	D	E
LUP-500-type set parts	LUP-502	1730	1170	1250	1210	Pitch 100 × 10 = 1000
	LUP-503	2600	2040	2120	2080	Pitch 100 × 20 = 2000
	LUP-504	3470	2910	2990	2950	Pitch 100 × 27 = 2700
	LUP-505	4340	3780	3860	3820	Pitch 100 × 36 = 3600



4) Transportation and installation

The product is shipped in the fully assembled state. Transport the unit gently and do not apply shock.
When installing, allow a slight slant so that the drain pipe is lower than the unit.

① Use eyebolts (or eyenuts) and rope when lifting the unit. Make sure that the rope can withstand the weight of the unit.
Always use all four eyebolts (or eyenuts), and fix the rope.
Adjust the rope length so that the angle between the rope and the unit is 45° or more.



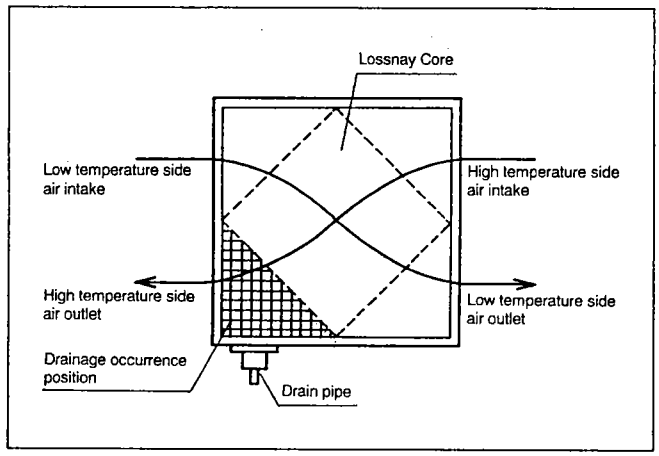
■ Caution

- Use filler plates to protect the panel so that the panel is not damaged by the rope during lifting.
- The unit will be damaged if the rope directly contacts the unit.
- Confirm that the drain pipe is at the set position when installing.
- The foundation must withstand the weight of the unit.
- Securely fix the unit with anchor bolts, etc.
- Make sure that rain water will not enter the unit from the ducts.
- Make sure that the indoor-type does not come into contact with rain water.
- Make sure that air will not leak and water will not enter from the duct connections.

5) Precautions for installation

(1) Installation and usage conditions

- The unit can be used in a temperature range of –10°C to +80°C.
- The Lossnay cannot be used where toxic gases and corrosive elements such as acids, alkalis, organic solvents, oil mist or paints exist.
- Always mount an air filter on the air suction sides (intake and return sides).
- A minimum of 800mm is required for the Lossnay Core and air filter maintenance space.



- Drainage may occur when the air from the high temperature side passes through the Lossnay Core. Construct the air passage so that the high temperature air flows from top to bottom, and connect a drain pipe.

(2) External dewing on product

Moisture may condense on the outside of the product or the dew may drip depending on the product installation site or the conditions of the air passing through the Lossnay Core. Install the unit in a place that will not be affected by the dew that drops.

Perform the following measures if the place will be affected:

① Insulate the outside of the product.

② Manufacture a drain pan that covers the entire unit, and catch the dew that drips from the entire unit.

(3) Mounting of air filter

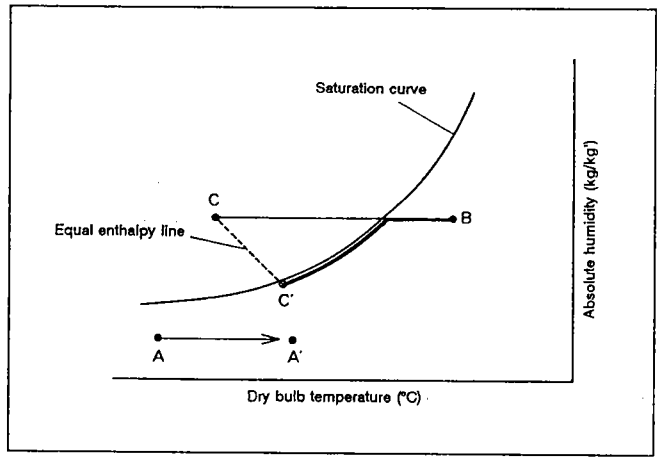
Always mount the optional air filter (PZ-80F, PZ-500F) to the air suction sides (intake and return sides) of the Lossnay Core to prevent the Core from clogging.

- When exhausting air containing oil mist or paint, etc., filter the mist with a grease filter or high efficiency filter before passing the air through the Lossnay.

(4) Dew and Frost on Lossnay Core

If a line is drawn horizontally from the high temperature conditions of B to C, as shown on the psychrometric chart, moisture will condense on the Lossnay Core, and the air at the outlet will be the conditions shown at C'.

If the C' temperature is lower than 0°C, frosting or ice may occur in the Lossnay Core. Thus, heat the air from the low temperature side from A to A', so that C' is higher than 0°C.



■ Caution

- When using the plastic Lossnay Core in the moisture condensed state, the pressure loss on the condensed side will increase by approximately 50%, so use fans that meets these conditions.

CHAPTER 8
Filtering for Freshness

1. Necessity of Filters

Clean air is necessary for humans to live a comfortable and healthy life. Besides atmospheric pollution that has been generated with the development of modern industries and the growth in the use of automobiles, air pollution in air-tight rooms has progressed to the point where it adversely affects the human body, and is now a major problem.

Hay fever is now a symptom often seen in the Spring, and demands for preventing pollen from entering rooms are increasing.

2. Data Regarding Dust

The particle diameter of dust and applicable range of filters are shown in Table 1, and representative data regarding outdoor air dust concentrations and indoor dust concentrations is shown in Table 2.

Table 1 Aerosol particle diameters and applicable ranges of various filters

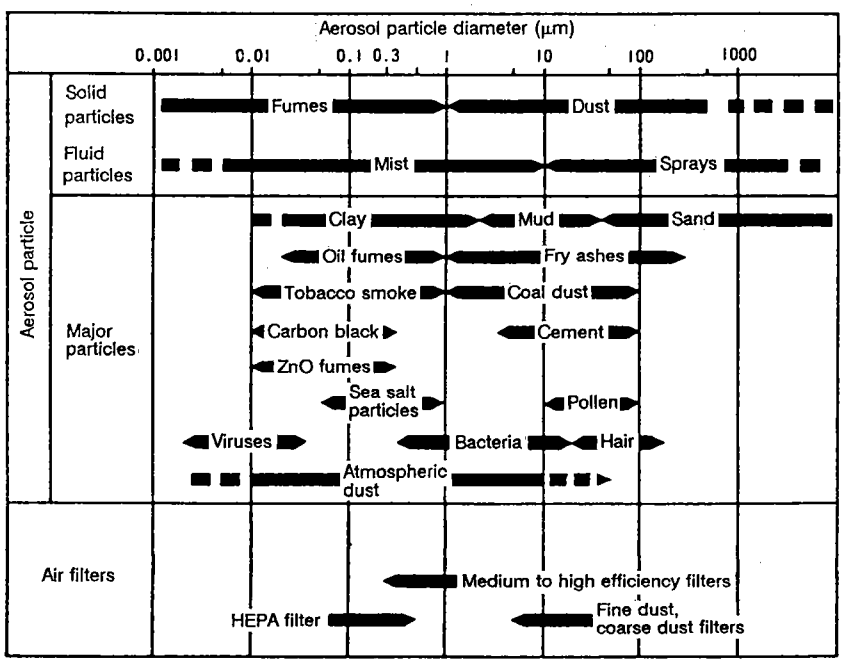


Table 2 Major dust concentrations

Type	Reference data	
Outdoor air floating dust concentration	Large city	0.1 ~ 0.15mg/m^3
	Small city	0.1mg/m^3 or less
	Industrial districts	0.2mg/m^3 or more
Indoor dust concentration	General office	10mg/h per person
	Stores (product vending stores)	5mg/h per person
	Applications with no tobacco smoke	5mg/h per person

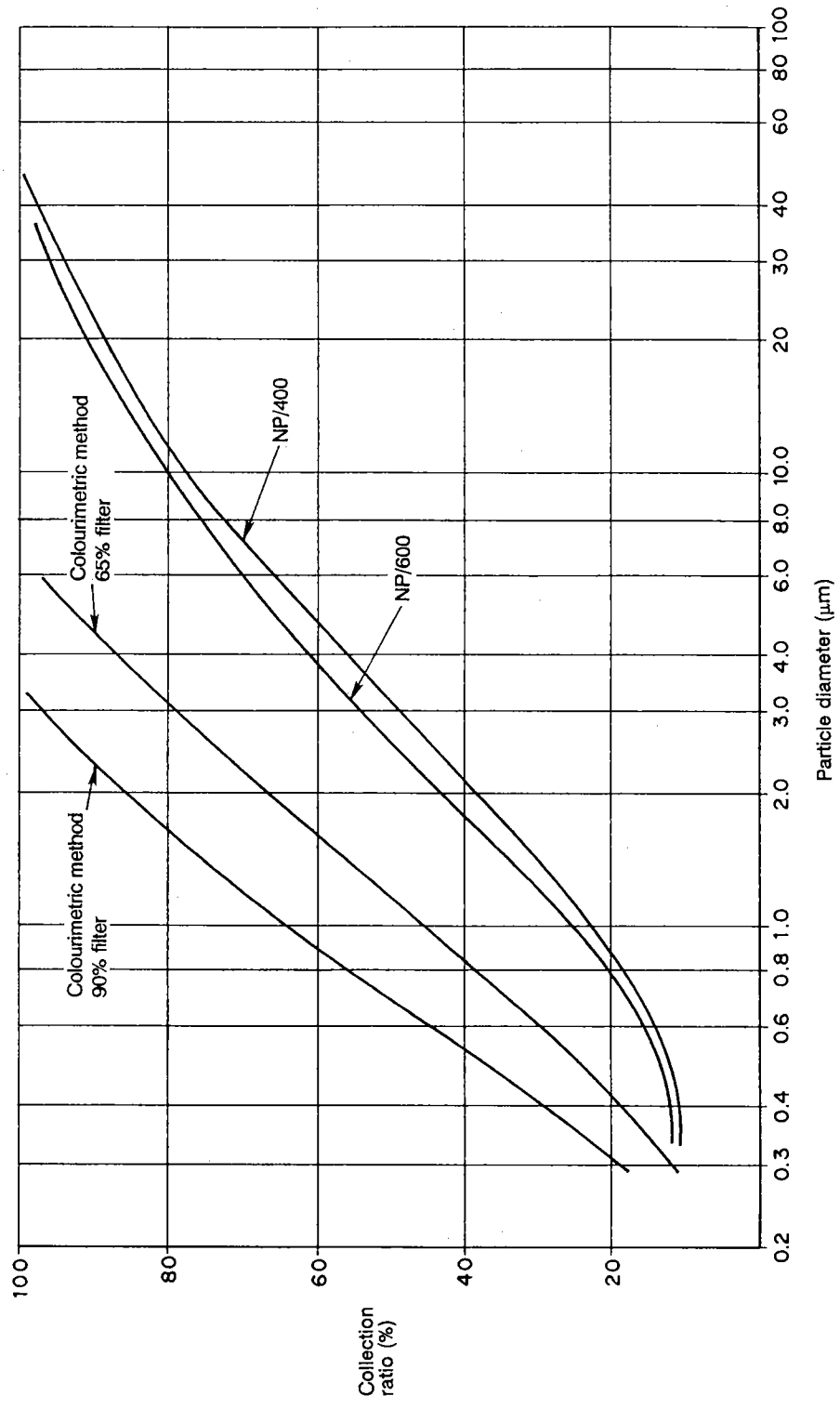
(Remarks)

1. The core diameter of outdoor air dust is said to be 2.1μ, and the 11 types of dust (average diameter 2.0μ) as set by JIS Z8901 as performance test particles are employed.
2. Dust in office rooms is largely caused by smoking, and the core diameter is 0.72μ. The 14 types of dust (average 0.8μ) as set by JIS Z8901 as performance test particles are employed.
3. The core diameter of dust generated in rooms where there is no smoking is approximately the same as outdoor air.
4. Smoking in general offices (as per Japan):
   Percentage of smokers : Approx. 70% (adult men)
   Average number of cigarettes : Approx. 1/person·hour (including non-smokers)
   Smoking length of cigarette : Approx. 4cm
   Amount of dust generated by one cigarette : Approx. 10mg/cigarette

3. Calculation Table for Dust Collection Efficiency of Each Lossnay Filter

Filter type	Applicable products	AFI Gravitational method	ASHRAE Colorimetric method	Counting method (DOP method)		Application
		Compound dust	Atmospheric dust	JIS 14 types DOP 0.8μm	DOP 0.3μm	
Pre-filter NP/400	Commercial Lossnay (LGH)	82%	8 ~ 12%	5 ~ 9%	2 ~ 5%	Protection of heat exchange element
Pre-filter NP/600	Lossnay for building use	85%	15 ~ 20%	10 ~ 15%	5 ~ 8%	
High efficiency filter Model PZ-15RFM~100RFM	Commercial-use Lossnay (LGH) (can be installed inside the unit)	99%	65%	60%	25%	Assurance of sanitary environment (According to Building Management Law)
High efficiency filter Model PZ-25FMY Model PZ-15FM~100FM	High efficiency filter unit	99%	65%	60%	25%	
High efficiency filter Model PZ-200FM~1000FM	Optional part for models LP-200B to 1000B	100%	65%	65%	40%	
High efficiency filter Model PZ-200FH~1000FH	High efficiency filter unit	100%	90%	90%	75%	

The ability of the filters used within the Lossnay units are shown below, expressed in terms of collection ratio (%).



4. Comparison of Dust Collection Efficiency Measurement Methods

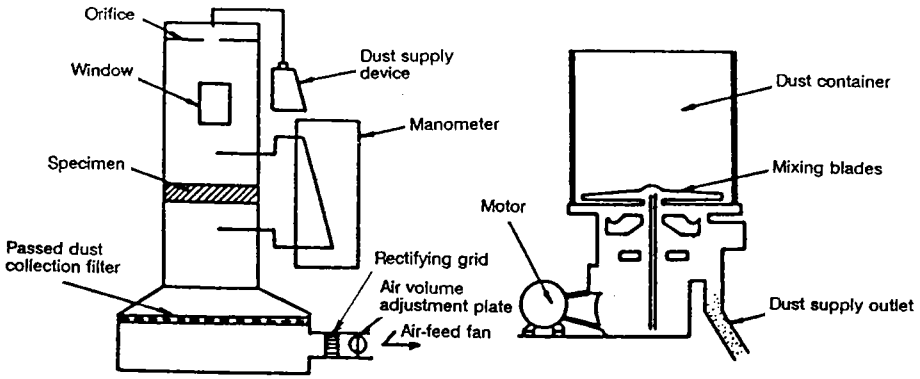
The gravitational, colorimetric and counting methods used for measuring dust collection efficiency each have differing features and must be used according to the application of the filter.

Test method	Test dust	Inward flow dust measurement method	Outward flow dust measurement method	Efficiency indication method	Type of applicable filters
AFI Gravitational method	Synthetic: • Dust on standard road in Arizona:72% • K-1 carbon black:25% • No.7 cotton lint:3%	Dust weight measured beforehand.	• Filter passage air volume measured • Weigh the dust remaining on the filter and compare.	Gravitational ratio	Synthetic dust filters
NBS Colorimetric method	Atmospheric dust	Degree of contamination of white filter paper	Degree of contamination of white filter paper	Comparison of percentage of reduction in degree of contamination	Electrostatic dust collector filter (for air conditioning)
DOP Counting method	Diameter of dicoctyl-phthate small drop particles: 0.3μ	Electrical counting measurement using light aimed at DOP	Same as left	Counting ratio	Absolute filter and same type of high efficiency filter
ASHRAE Gravitational method	Synthetic: • Regulated air cleaner fine particles: 72% • Morocco Black: 23% • Cotton linter: 5%	Dust weight measured beforehand.	• Filter passage air volume measured • Weigh the dust remaining on the filter and compare.	Gravitational ratio	Prefilter Filter for air conditioning (for coarse dust)
ASHRAE Colorimetric method	Atmospheric dust	Degree of contamination of white filter paper	Degree of contamination of white filter paper	Comparison of percentage of reduction in degree of contamination	Filter for air conditioning (for fine dust) Electrostatic dust collector
Air filter test for air conditioning set by Japan Air Cleaning Assoc. (Colorimetric test)	JIS 11 types of dust	Degree of contamination of white filter paper	Degree of contamination of white filter paper	Comparison of percentage of reduction in degree of contamination	Filter for air conditioning
Prefilter test set by Japan Air Cleaning Assoc. (Gravitational test)	JIS 8 types of dust	Dust weight measured beforehand.	• Filter passage air volume measured • Weigh the dust remaining on the filter and compare.	Gravitational ratio	Prefilter
Electrostatic air cleaning device test set by Japan Air Cleaning Assoc. (Colorimetric test)	JIS 11 types of dust	Degree of contamination of white filter paper	Degree of contamination of white filter paper	Comparison of percentage of reduction in degree of contamination	Electrostatic dust collector

Gravitational method

This method is used for air filters which remove coarse dust (10μ or more). The measurement method is determined by the gravitational ratio of the dust amount on the in-flow side and out-flow sides.

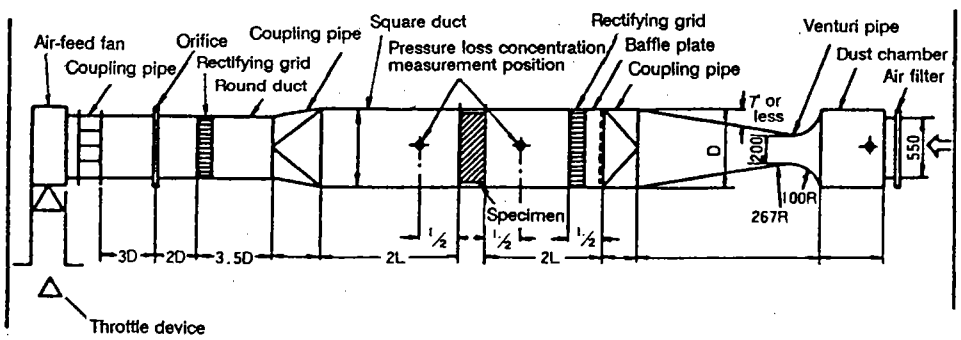
$$\text{Dust collection ratio} = \frac{\text{In - flow side dust amount} - \text{Out - flow side dust amount}}{\text{In - flow side dust amount}} \times 100\ (\%)$$



Colorimetric method

The in-flow side air and out-flow side air are sampled with a suction pump and passed though filtering paper. The sampled air is adjusted so that the degree of contamination on both filter papers is the same, and the results are determined by the sampled air volume ratios on both sides.

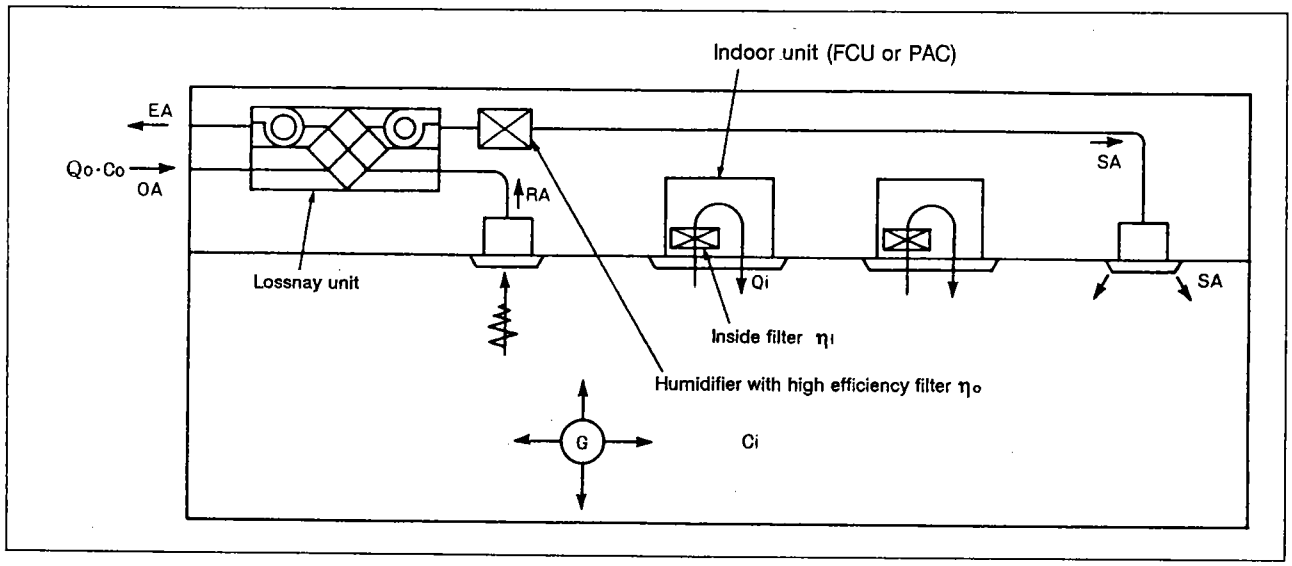
$$\text{Dust collection ratio} = \frac{\text{Out - flow side sampling amount} - \text{In - flow side sampling amount}}{\text{Out - flow side sampling amount}} \times 100\ (\%)$$



5. Calculation of Dust Concentration

An air conditioning system using the Lossnay is shown below. Using this diagram the level of dust concentration can be easily determined.

Dust concentration study diagram



Q_o : Outdoor air intake volume m^3/h
Q_i : Indoor unit air volume (Total air volume of indoor unit) m^3/h
η_o : Filtering efficiency of humidifier with high efficiency filter % (colorimetric method)
η_i : Filtering efficiency of filter for indoor unit % (colorimetric method)
C_o : Outdoor air dust concentration mg/m^3
C_i : Indoor dust concentration mg/m^3
G : Amount of dust generated indoors mg/h

In this type of system, when the performance of each machine is known, the indoor dust concentration Ci may be obtained with the filtering performance of the filters, η_o and η_i, having been set to specific values as per manufacturer's data. The following formula is used:

$$C_i = \frac{G + C_o Q_o (1-\eta_o)}{Q_o + Q_i \eta_i}$$

Also, with the value of Ci and η_o known, the efficiency of the indoor unit can be found using:

$$\eta_i = \frac{G + C_o Q_o (1-\eta_o) - C_i Q_o}{C_i Q_i} \times 100$$

[Calculation example]

The indoor dust concentration for the following types of design conditions with the above system shall be used in the following example.

- **Outline of air conditioning**

Air conditioning area	No. of persons in room	Outdoor air intake volume	Cooling capacity	Heating capacity
$100m^2$ (office)	20 persons	$25m^3/h$ per person × 20 persons = $500m^3/h$	15,700W (13,500kcal/h)	13,374W (11,500kcal/h)

- **Equipment used**

Lossnay + humidifier with high efficiency filter	Model	Heat recovery during cooling	Heat recovery during heating		Intake volume	Filtering efficiency
	LGH-50RS + PZ-50K (with high efficiency filter) 1 unit	3,710W (3,190kcal/h)	3,907W (3,360kcal/h)		$500m^3/h$	65% (colorimetric method)
Fan coil unit	Model	Cooling capacity	Heating capacity	Air volume	Filtering efficiency	
	LH-600CR-B_3F (with high efficiency filter) 2 units	5,338W (4,590kcal/h)	8,664W (7,450kcal/h)	$17m^3/min$	65% (colorimetric method)	

Calculation

Intake volume $Qo = 500m^3/h$

Indoor unit air volume $Qi = 17 \times 2 \times 60 = 2{,}040m^3/h$

Filtering efficiency of humidifier with high efficiency filter

$\eta o = 65\%$ ($\eta o' = 91\%$ Particle diameter 2.1 μ*)

Filtering efficiency of filter for inside unit

$\eta i = 65\%$ ($\eta i' = 57\%$ Particle diameter 0.72 μ*)

Outdoor air floating dust concentration

$Co = 0.1mg/m^3$

Amount of dust generated in room

G = amount of dust generated per person × no. of persons in room

= 10mg/h·person × 20 persons = 200mg/h

If the inside dust concentration Ci is found with the above, the following data is obtained:

$$Ci = \frac{200 + 0.1 \times 500(1 - 0.65)}{500 + 2{,}040 \times 0.65} \approx 0.12mg/m^3 \quad (\approx 0.123mg/m^3\ *)$$

The result is less than the dust concentration limit of $0.15mg/m^3$ set by the Building Standard Laws. If the filtering efficiency of a filter for the indoor unit is obtained to set the inside dust concentration Ci to $0.15mg/m^3$, the following is obtained:

$$\eta i = \left\{\frac{200 + 0.1 \times 500(1 - 0.65) - 0.15 \times 500}{0.15 \times 2{,}040}\right\} \times 100 \approx 47\% \quad (\approx 42\%\ *)$$

This shows that the filtering efficiency of the indoor unit filter must be a minimum of 47% (colorimetric method).

CHAPTER 9
Service Life and Maintenance

1. Service Life

The Lossnay Core has no moving parts. This stationary design eliminates vibration troubles and also permits greater installation flexibility. In addition, chemicals are not used in the heat exchange system. Performance characteristics remain constant throughout the period of service.

A lifetime test, currently in progress and so far reaching 17,300 hours, has revealed no evidence of either reduction in heat exchange efficiency or deterioration of materials. If 2,500 hours is taken as the number of hours a conditioner is used during a year, 17,300 hours corresponds to about seven (7) years.

Completing a two-year bathroom test where the relative humidity was close to 100%, the Lossnay Core was found to be free of defects in all respects.

2. Cleaning the Lossnay Core and Prefilter

The Lossnay Core should be cleaned with a vacuum cleaner at least once every 2 years. This will remove the dust that has accumulated at the surface and restore the functioning of the element to 98 to 100% of the original figure. A brush should not be used for cleaning because it may trap the dust in the element resulting in clogging.

The air filter on the intake side of the Lossnay Core should be cleaned at least once every year. After cleaning, reinstall the filter immediately.

CHAPTER 10
Lossnay Q and A

CHAPTER 10 Lossnay Q and A

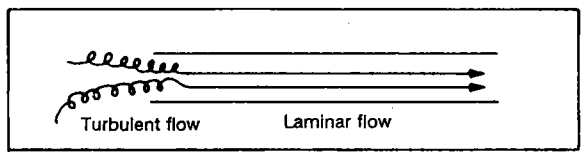
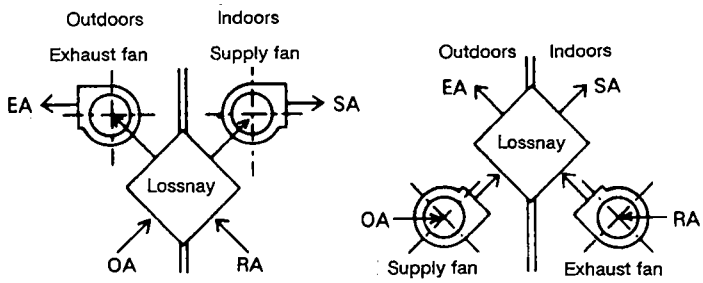
	Question	Answer	Remarks
1	Paper is used for the material, but is the life adequate?	There is no problem with the life of the paper unless it is intentionally damaged, directly placed in water or in direct sunlight (ultra-violet rays). The life is longer than metal as it does not rust. It can be used for a minimum of ten years.	Depending on how it is stored, paper can be stored for up to 2,000 years without deteriorating, such as documents in temples and churches.
2	Is paper not an insulation material? (Poor conductor of heat)	Paper is very thin, and thus the conductivity of the material is low, with heat being transferred approximately the same as with metal. Test this by placing a piece of paper between your hands and you will feel the warmth of your palms. The exchange of humidity can also be felt by blowing on the paper and feeling the moisture in your breath transfer to your palm.	
3	If paper can exchange humidity, will it not become wet?	Maybe you have seen the phenomenon during heating in winter where the window pane is wet but the paper blinds are dry. This is because the humidity is transferred through the paper membrane. The Lossnay is kept dry by employing this same principle.	
4	When is the forced simultaneous air intake/ exhaust-type more efficient?	When a building is sealed and normal ventilation is used, accurate exhaust is not possible unless a suction inlet is created. The Lossnay has both an air-supply fan and air-exhaust fan so Class 1 ventilation is possible.	
5	What are the energy conservation properties of the Lossnay?	For an example, in an approx. 13m^2 room with five people, a ventilation volume of 100m^3/h is required. The amount of power consumed in this case is approximately 45W, and the amount of heat recovered during cooling is approximately 600kcal/H or more. The coefficient of performance (C.O.P.) obtained when converted with the unit power generation amount is 16. In consideration that the popular heat pump-type has a C.O.P. of 2 to 3, the Lossnay is a high energy conserving machine. If a general-purpose ventilator is installed, the cooled air will be lost, thus increasing electrical costs throughout the year.	

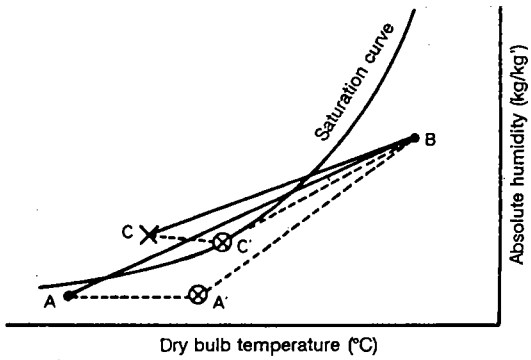
<table>
<tr><th></th><th>Question</th><th>Answer</th><th>Remarks</th></tr>
<tr><td>6</td><td>What are the economical factors?
(This is for Japan)</td><td>
55 to 60% of the heat energy that escapes with ventilation is recovered by the Lossnay, so the cooling/heating cost can be reduced by approximately $384.62 per year. The initial costs can be suppressed down to a $476.92 increase when comparing the air conditioner, Lossnay, and ventilator (fixed- price base).

Calculation conditions
Cooling:
Room temperature/humidity 26°C, 50%
Outdoor air temperature/humidity 32°C, 70%
Heating:
Room temperature/humidity 20°C, 50%
Outdoor air temperature/humidity 0°C, 50%
Building:
General office facing south on middle floor 100m^2
Cooling load (room) 104W/m^2
Heating load (room) 77.9W/m^2
Ventilation volume: 500m^3/h
Without Lossnay : Ventilator VD-18ZS$_2$$^+$ ..... two units
With Lossnay : Lossnay LGH-50RS ..... one unit
Cooling/heating load [W(kcal/h)]:
<table>
<tr><th></th><th colspan="3">Without Lossnay</th><th colspan="3">With Lossnay</th></tr>
<tr><th></th><th>Room</th><th>Outdoors</th><th>Total</th><th>Room</th><th>Outdoors</th><th>Total</th></tr>
<tr><td>Cooling</td><td>10,397
(8940)</td><td>5,582
(4800)</td><td>15,979
(13740)</td><td>10,397
(8940)</td><td>2,372
(2040)</td><td>12,769
(10980)</td></tr>
<tr><td>Heating</td><td>7,792
(6700)</td><td>5,652
(4860)</td><td>13,444
(11560)</td><td>7,792
(6700)</td><td>2,163
(1860)</td><td>9,955
(8560)</td></tr>
</table>
Air conditioner:
Without Lossnay : Ceiling-suspended cassette-type air conditioner PLHZ-140FK$^+$ ..... one unit
With Lossnay : PLHZ-112FK$^+$ ..... one unit
Operation time:
Cooling 10 hours/day, 26 days/month, 4 months/year, operation ratio 0.7
Heating 10 hours/day, 26 days/month, 5 months/year, operation ratio 0.7
Power costs (Tokyo Power special industrial power 6kV supply)
Summer $0.14/kWH, Other $0.12/kWH
Rates calculated in Japanese Yen and converted to US$:¥130=$1
</td><td>There are also "savings in maintenance cost", "ventilation functions", "soundproofing effects" as well as "comfort" and "safety" which are not visible.

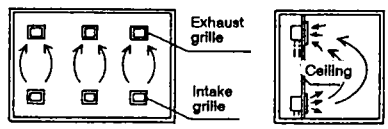
+ Japanese domestic market only.</td></tr>
<tr><td>7</td><td>If the air ventilated from the toilet is heat recovered, will the odors be transferred to other rooms?</td><td>
For an example if the total ventilation volume is 100, and the amount of odors generated from the toilet, etc., is 30, the total volume of conditioned air is still three times the ventilation amount. Thus, if the leakage rate of odors is 7% (hydrogen sulphide), this will be: 100 × 30% × 1/3 × 7% = 0.7%. Thus, no problem is seen in terms of total air conditioned air volume. However, exhaust is usually performed with a separate system. In the case of ammonia, the rate is 2.8% using the same formula.

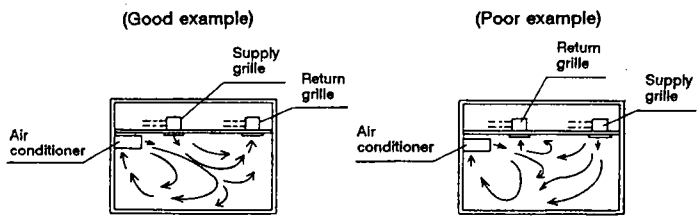
Note: (The rotary-type has approximately the same transmission rate, but for ammonia, the transmission rate is 50% or more than the Lossnay heat exchange method.)
</td><td><Gas/smoke transmission rate>
CO : 6~8%
CO_2 : 5~7%
H_2S : 6~8%
NH_3 : 25~30%
Smoke: 1~2%
<Conditions>
(Supply and exhaust fans installed for suction feed. Standard treatment air volume.)</td></tr>
</table>

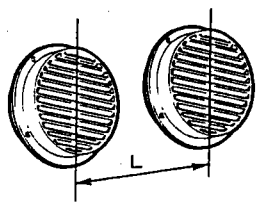
	Question	Answer	Remarks
8	Can the Lossnay be used for hospital air conditioning?	According to the results obtained from the test performed by the Tokyo University Hospital (Inspection Centre, Prof. Kihachiro Shimizu), as the supply air and exhaust air pass through different passages, transmission of bacteria from exhaust side to supply side is low. They found: ① Bacteria does not propagate in the Lossnay element. ② Even if bacteria accumulated in the Lossnay, it died off in approximately two weeks.	
9	Since the entry to the Lossnay element is fine and the incident air turbulent, won't it clog easily?	Normally, the original state of the filter can be regained by cleaning it more than once every one year, and the two intake side surfaces of the Lossnay Core more than once two years with a vacuum cleaner. Dust will not adhere in the passage due to the laminar flow if the air is normal.  	Normal air refers to air that does not contain oil mist, etc. When exhausting air containing oil mist, etc., install a filter at return grille to remove the oil mist.
10	What is the air leakage rate?	This will differ on the position of the fans, but for both suction or both forced, the rate is 2 to 3%.  If the static pressure difference between SA and RA and between EA and OA is 50mmAq, the air leakage rate will be 2.5%, and 3.4%. This value is considered to be of no problem for actual use. However, the single suction or single forced methods will have a leakage rate of 10% or higher and should be avoided.	

<table>
<tr><th></th><th>Question</th><th>Answer</th><th>Remarks</th></tr>
<tr><td>11</td><td>Can the Lossnay be used in extreme cold climates (–10°C or lower)?</td><td>If the winter room air temperature is above 20°C along with the humidity above 50%, and the outdoor temperature is –10°C or lower, moisture condensation or frosting will occur on the Lossnay Core. In this case, the intake air must be preheated.
Plot the Lossnay intake side air conditions A and B on a psychrometric chart as shown below. If the high temperature side air B intersects the saturation curve such as at C, moisture condensation or frosting will occur on the Lossnay. In this case, the air should be preheated to the temperature indicated by point A' so that point C reaches the C' point.

</td><td></td></tr>
<tr><td>12</td><td>Will tobacco nicotine and tar affect the Lossnay Core?</td><td>Tobacco smoke tends to stick to dust in the air, and when it passes through the Lossnay Core, most of the nicotine and tar will be filtered by the air filter.
However, in very smoky places (ex. pachinko parlour), or when used for a long period, the tobacco odor will accumulate and move to the intake side. In this case, the Core and filter should be replaced.</td><td>Ample filtering will not be possible with a saran net air filter.</td></tr>
<tr><td>13</td><td>What is the guideline for ventilation. (These guidelines are for Japan)</td><td>According to the Building Standard Law, a ventilation volume of 20m^3/hr·person. is required if the windows cannot be opened for ventilation.
In buildings to which the Building Management Law is applied, the carbon gas concentration must be 0.1% or less, so a ventilation of 34m^3/h·person is required. In Tokyo, the guideline is set at 25 to 30m^3/h. The required ventilation volume per person is noted below.
<table><tr><th rowspan="2">Degree of smoking</th><th rowspan="2">Application example</th><th colspan="2">Required ventilation volume (m^3/h)</th></tr><tr><th>Recommended value</th><th>Minimum value</th></tr><tr><td>Extremely heavy</td><td>Broker's office
Newspaper editing room
Conference room</td><td>85</td><td>51</td></tr><tr><td>Quite heavy</td><td>Bar
Cabaret</td><td>51</td><td>42.5</td></tr><tr><td>Heavy</td><td>Office
Restaurant</td><td>25.5
25.5</td><td>17
20</td></tr><tr><td>Light</td><td>Shop
Department store</td><td>25.5</td><td>17</td></tr><tr><td>None</td><td>Theatre
Hospital room</td><td>25.5
34</td><td>17
25.5</td></tr></table></td><td></td></tr>
</table>

<table>
<tr><th></th><th>Question</th><th>Answer</th><th>Remarks</th></tr>
<tr><td>14</td><td>Are there any places where the Lossnay cannot be used?</td><td>The Lossnay cannot be used where toxic gases and corrosive elements such as acids, alkalis, organic solvents, oil mist or paints exist.
The Lossnay cannot be used to recover the heat of air containing odors.</td><td></td></tr>
<tr><td>15</td><td>What are the soundproofing properties for music rooms and karaoke bars?</td><td>When an LGH-50R$_5^+$ was installed in a karaoke bar and the noise was measured, the following results were obtained. When the noise in the room was 96.5dB (A), the noise level at a point 30cm from the intake/exhaust grille on the outside wall was 67.5dB (A). This shows a soundproofing effect of 29.0dB (A).
The soundproofing effect when the noise level is 100dB (A) is approximately 30dB (A).</td><td>+:
Japanese domestic market model. Same model as LGH-50RS.</td></tr>
<tr><td>16</td><td>What is the short circulation of the air intake/exhaust air outlet?</td><td>The Lossnay uses the forced simultaneous supply/exhaust method so the insufficient ventilation found in standard ventilators with no air intake is not found.

Caution
(1) The fresh air supplied to the room should not short circulate being drawn back into the return grille. It should flow through the entire room.


(2) The relation of the supply and suction flows of the air conditioner must be also considered.


■ The air intake/exhaust grille on the outer wall is in the open and so there is a natural wind, with the result that short circulation will not occur easily. However, if the wind blows from the exhaust grille towards the intake grille, short circulation may occur, so these should be placed as far apart as possible.
The guideline for the distance is three times the duct diameter.
<table><tr><th>Duct diameter</th><th>L</th></tr><tr><td>ø100</td><td>300</td></tr><tr><td>ø150</td><td>450</td></tr><tr><td>ø200</td><td>600</td></tr><tr><td>ø250</td><td>750</td></tr></table>
</td><td></td></tr>
</table>

<table>
<tr><th></th><th>Question</th><th>Answer</th><th>Remarks</th></tr>
<tr><td>17</td><td>Is total operation possible with switches?</td><td>Several units can be operated with the optional control switch.</td><td></td></tr>
<tr><td>18</td><td>What is the difference between the rotary-type and static-type?</td><td>Refer to "Chapter 3 Performance comparisons with various heat exchangers and ventilators".</td><td></td></tr>
<tr><td>19</td><td>Is an inspection hole necessary?</td><td>For the ceiling embedded-type, the unit is installed in the false ceiling, so an inspection hole is required at the Core and filter removal section and fan maintenance section.
Refer to the catalog for details.</td><td></td></tr>
<tr><td>20</td><td>What must be performed during maintenance?</td><td>Periodic inspection and cleaning of the Lossnay Core and air filter is necessary. Refer to "Chapter 9 Maintenance" for details.</td><td></td></tr>
<tr><td>21</td><td>What are Class 1 ventilating facilities?</td><td>Class 1 ventilation refers to mechanical ventilation (forced simultaneous air supply/exhaust) using both intake and exhaust fans for suction feed.
All Lossnay models (with built-in air-feed fans) are Class 1 ventilators.
The ventilation method is classified in relation to the degree of natural and/or mechanical ventilation employed.
<Classification of ventilation>
<table>
<tr><th></th><th>Intake</th><th>Exhaust</th><th>Ventilation volume</th><th>Room pressure</th></tr>
<tr><td>Class 1</td><td>Mechanical</td><td>Mechanical</td><td>Random (constant)</td><td>Random</td></tr>
<tr><td>Class 2</td><td>Mechanical</td><td>Natural</td><td>Random (constant)</td><td>Positive pressure</td></tr>
<tr><td>Class 3</td><td>Natural</td><td>Mechanical</td><td>Random (constant)</td><td>Negative pressure</td></tr>
<tr><td>Class 4</td><td>Natural</td><td>Assisted natural</td><td>Limited (inconstant)</td><td>Negative pressure</td></tr>
</table></td><td></td></tr>
<tr><td>22</td><td>Can the high efficiency filter (PZ-FM)* be installed on the supply air side?</td><td>Please install the high efficiency filter only on the outside air side.
(Reason)
• If installed on the supply air side, primary dirty air will enter the Lossnay before passing through the prefilter, accelerating the element's clogging.
• Moisture prevention measures may also be required.</td><td></td></tr>
<tr><td>23</td><td>What are the anti-vibration measures for the Lossnay?</td><td>Measures are not required as a principle.
(Use BFS-30 ~ 100BK when an anti-vibration fitting is required.)</td><td></td></tr>
<tr><td>24</td><td>Can the LGH and R types be installed vertically?</td><td>Vertical installation is possible in some cases. Refer to Chapter 5 Section 11 for details.</td><td></td></tr>
</table>

* Please consult with nearest Lossnay supplier about availability of these parts.

October. 1999