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 Srandard Law 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.

1.1 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 3,000 m^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.

The following table gives a specific account of buildings in Tokyo.
(Tokyo Food and Environment Guidance Center Report)

Specific Account of Buildings in Tokyo (March, 1993)

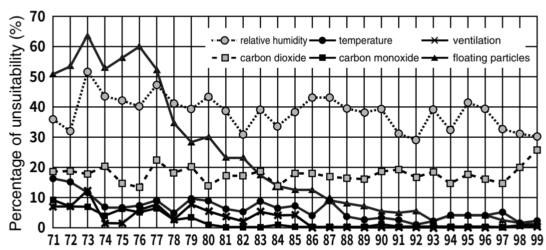
	Number of buildings	%
Offices	2,346	65.4
Shops	344	9.6
Department Stores	73	2.0
Schools	388	10.8
Inns	164	4.6
Theaters	84	2.3
Libraries	30	0.8
Museums	15	0.4
Assembly Halls	95	2.6
Art Museums	7	0.2
Amusement Centers	42	1.2
Total	3,588	100.0

Note: Excludes buildings with an expanded floor space of 3,000 to 5,000 m^2 in particular areas.

The ratio of results of the air quality measurement public inspection and the standard values that were not met (percentage of unsuitability) for the approximately 500 buildings examined in 1980 is shown in the chart at the right.

There was a large decrease in unsuitable percentages of floating particles, but there was almost no change in temperature and carbon dioxide. Values for temperature, ventilation, and carbon monoxide almost entirely cleared the standard values, and are excluded. The study from 1989 shows the item with the highest percentage of unsuitability as temperature with 37%, followed by carbon dioxide at 15%.

Percentage of unsiutability of air quality by year



(according to the Tokyo Food and Environment Guidance Center)

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 10 m 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 30 m^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.

1.2 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. (The Building Standard Law of Japan)
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	Industrial Safety and Health Act. (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 term.
7	Fatal

Effect of carbon monoxide (CO)

10,000 ppm = 1%

<table>
<tr><th>Concentration (ppm)</th><th colspan="2">Effect of concentration changes</th></tr>
<tr><td>0.01 - 0.2</td><td colspan="2">Standard atmosphere.</td></tr>
<tr><td>5</td><td>Considered to be the long-term tolerable value.</td><td rowspan="6">Apprpx. 5 ppm is an annual average value in city areas.
This value may exceed 100 ppm near roads, in tunnels and parking areas.</td></tr>
<tr><td>10</td><td>The Building Standard Law of Japan, Law for Maintenance of Sanitation in Buildings.
Environmental standard 24-hour average.</td></tr>
<tr><td>20</td><td>Considered to be the short-term tolerable value.
Environmental standard 8-hour average.</td></tr>
<tr><td>50</td><td>Tolerable concentration for labor environment.
(Japan Industrial Sanitation Association)</td></tr>
<tr><td>100</td><td>No effect for 3 hours. Effect noticed after 6 hours.
Headache, illness after 9 hours; harmful for long-term but not fatal.</td></tr>
<tr><td>200</td><td colspan="2">Light headache in the forehead in 2 to 3 hours.</td></tr>
<tr><td>400</td><td colspan="2">Headache in the forehead, nausea in 1 to 2 hours; headache in the back of head in 2.5 to 3 hours.</td></tr>
<tr><td>800</td><td colspan="2">Headache, dizziness, nausea, convulsions in 45 minutes. Comatose in 2 hours.</td></tr>
<tr><td>1,600</td><td colspan="2">Headache, dizziness in 20 minutes. Death in 2 hours.</td></tr>
<tr><td>3,200</td><td colspan="2">Headache, dizziness in 5 to 10 minutes. Death in 30 minutes.</td></tr>
<tr><td>6,400</td><td colspan="2">Death in 10 to 15 minutes.</td></tr>
<tr><td>12,800</td><td colspan="2">Death in 1 to 3 minutes.</td></tr>
<tr><td>Several 10,000 ppm
(Several %)</td><td colspan="2">This level may be found in automobile exhaust.</td></tr>
</table>

Effect of carbon dioxide (CO_2)

<table>
<tr><th>Concentration (%)</th><th colspan="2">Effect of concentration changes</th></tr>
<tr><td>0.03 (0.04)</td><td colspan="2">Standard atmosphere.</td></tr>
<tr><td>0.04 - 0.06</td><td colspan="2">City air.</td></tr>
<tr><td>0.07</td><td>Tolerable concentration when many people stay for long time.</td><td rowspan="5">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.</td></tr>
<tr><td>0.10</td><td>General tolerable concentration.
The Building Standard Law of Japan, Law for Maintenance of Sanitation in Buildings.</td></tr>
<tr><td>0.15</td><td>Tolerable concentration used for ventilation calculations.</td></tr>
<tr><td>0.2 - 0.5</td><td>Observed as relatively poor.</td></tr>
<tr><td>0.5 or more</td><td>Observed as the poorest.</td></tr>
<tr><td>0.5</td><td colspan="2">Long-term safety limits (U.S. Labor Sanitation) ACGIH, regulation of laborer offices.</td></tr>
<tr><td>2</td><td colspan="2">Depth of breathing and inhalation volume increases 30%.</td></tr>
<tr><td>3</td><td colspan="2">Work and physical functions deteriorate, breathing doubles.</td></tr>
<tr><td>4</td><td colspan="2">Normal exhalation concentration.</td></tr>
<tr><td>4 - 5</td><td colspan="2">The respiratory center 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.</td></tr>
<tr><td>8</td><td colspan="2">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.</td></tr>
<tr><td>18 or more</td><td colspan="2">Fatal</td></tr>
</table>

Note: According to Facility Check List published by Kagekuni-sha.

1.3 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 The Building Standard Law of Japan Enforcement Ordinance, the so-called “Building Management Law” for securing a sanitary environment in buildings. According to the Building Standards Law, a minimum of 20 m^3/h per person of ventilation air is required.

3. Ventilation Method

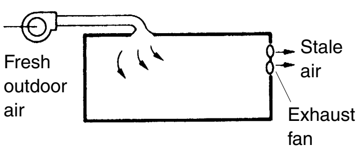
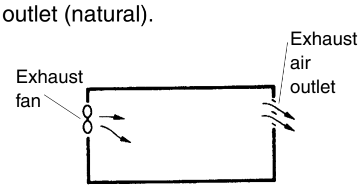
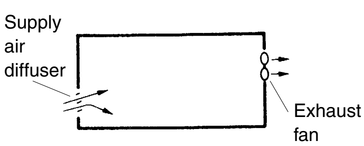
3.1 Ventilation class and selection points

An appropriate ventilation method must be selected according to the purpose.
Ventilation is composed of “Supply air” and “Exhaust air” 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 neighboring spaces can be set freely.	• An ideal design in which the supply air 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 diffuser flow to the room environment can be incorporated. • The supply and exhaust volume can be set freely according to the changes in conditions.	• Accurate supply air diffuser can be maintained. • The room pressure balance can be maintained. • The supply air diffuser 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 pressurized, the flow of odors and dust, etc., from neighboring areas can be prevented.	• The position and shape of the supply air diffuser can be set. • The temperature and humidity of the supply air diffuser flow can be set accordingly, and dust can be removed as required.	• The pressure is positive. • The supply air diffuser temperature and humidity can be adjusted, and dust treatment is possible. • The positional relation of the exhaust air outlet to the supply air 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 air diffuser (natural). 	• Local ventilation in kitchens. • Ventilation of hot exhaust air from machine room, etc. • Ventilation of humid exhaust air from indoor pools, bath-rooms, 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 air 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 air diffuser is important.

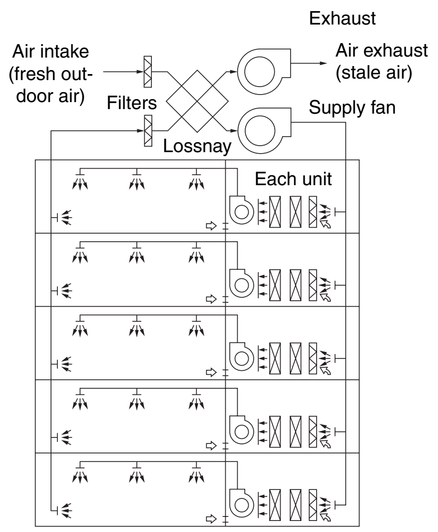
3.2 Comparison of ventilation methods

There are two main types of ventilation methods.

Centralized 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 recovery to the intake air and dust removal is performed being distribution to the building by ducts.

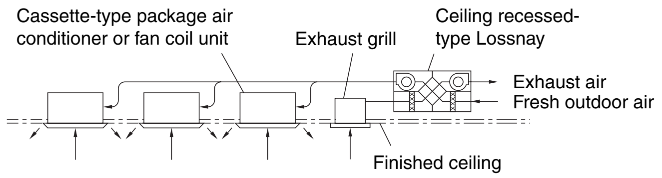
Independent zoned ventilation method
This is mainly used in small to medium sized buildings, with areas being ventilated using fresh outdoor air intakes formed of independent ventilation devices. The rate of use of this method has recently increased as independent control is becoming ever more feasible.

Centralised ventilation method

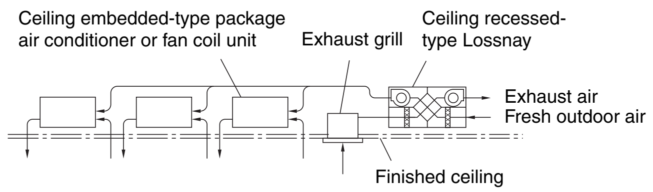


Independent zoned ventilation method

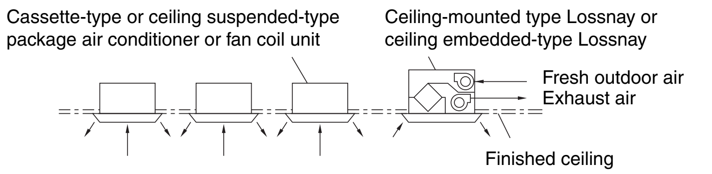
1) System operation with cassette-type air conditioner



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	• Independent equipment room is required. • Duct space is required. • Penetration of floors with vertical shaft is not desired in terms of fire prevention.	• Independent equipment 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 air 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, an accurate assessment of operating cost is difficult.	Invoicing for each zone 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 in each zone can operate the ventilator freely. • The ventilator can be operated even during off-peak hours.
Comfort	• An ideal supply air diffuser and return grille position can be selected as the supply air 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 equipment 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 the vibration generated can be dispersed.
Maintenance and management	• Centralized management is easy as it can be performed in the equipment room. • The equipment can be inspected at any time.	• Work efficiency is poor as the equipment is not centrally located. • An individual unit can be inspected only when the room it serves is vacant.
Trouble correspondence	• Large as the entire system is affected. • Immediate inspection can be performed in the equipment room.	• Limited as only independent units are affected. • Consultation with the tenant is required prior to inspection of an individual unit.

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.

4.1 Air volume

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

4.2 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: 1 mmH_2O = approx. 9.8Pa}. The wind pressure is divided into the following three types:

4.2.1 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.

4.2.2 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.

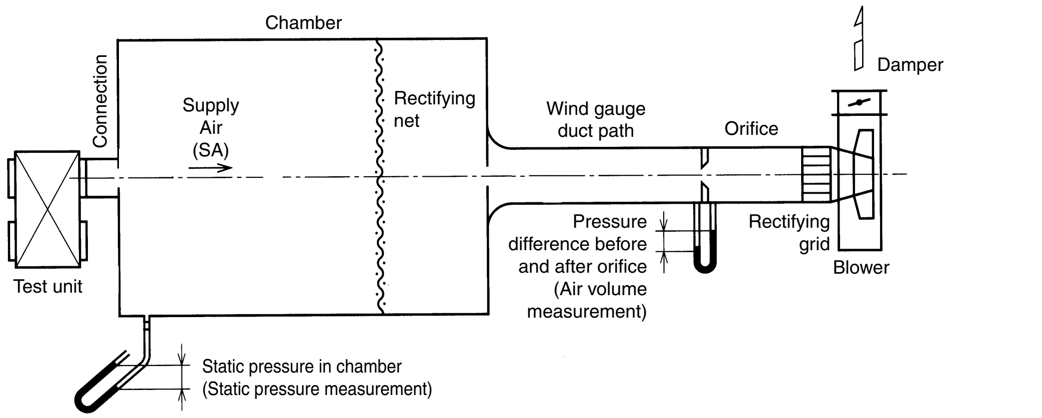
4.2.3 Total pressure

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

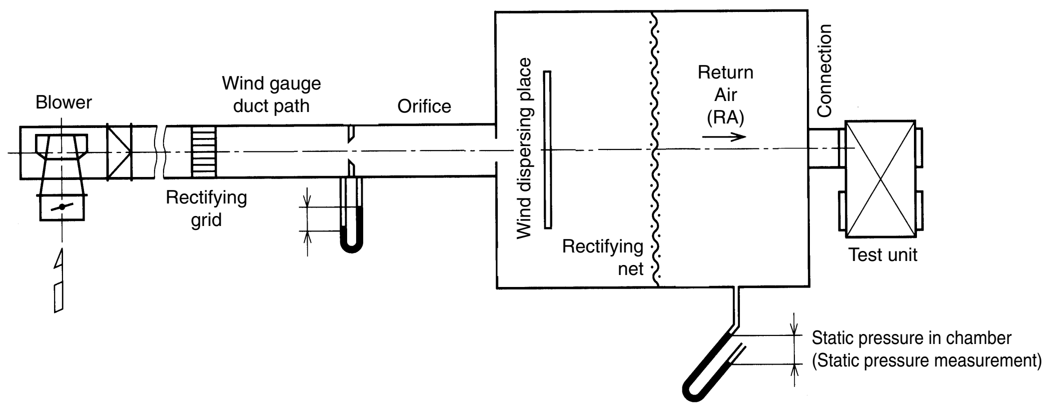
4.3 Measurement of the air volume and wind pressure

Mitsubishi measures the machine's air volume and wind pressure with a device as shown below according to the Japan Industrial Standards (JIS B 8628).

Measuring device using orifice (JIS B 8628 standards)



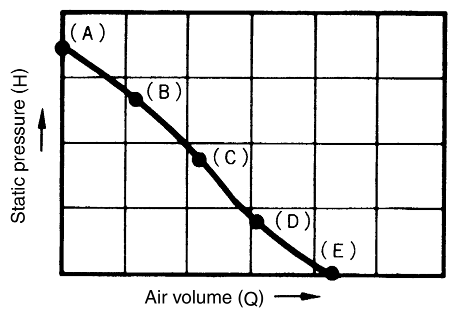
A) When measuring the supply air volume (with the orifice plate)



B) When measuring the return air volume (with the orifice plate)

Measurement method

The unit 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

5.1 How to calculate each approximate load

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

(Outdoor air load) = $\gamma \cdot Q_F \cdot (i_O - i_R)$
= 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 - 1.2 kg/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	Teatre or cinema hall
		Average	Crowded	Empty		
General design	4 - 7	0.5 - 2	0.5 - 2	5 - 8	1 - 2	0.4 - 0.6
value	5	3.0	1.0	6.0	1.5	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	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:

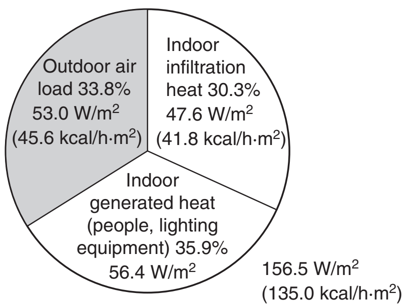
5.2 Ventilation load during cooling (in general office building)

● 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}) } Genarated 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 applies only when reheating is necessary.
(d) is the heat generated when outdoor air is mixed into part of the supply air diffuser 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		53.0 W/m^2 (45.6 kcal/h·m^2)
Indoor generated heat	People	26.4 W/m^2 (22.7 kcal/h·m^2)
	Lighting equipment	30.0 W/m^2 (25.8 kcal/h·m^2)
Indoor infiltration heat		47.6 W/m^2 (40.9 kcal/h·m^2)
Total		157.0 W/m^2 (135.0 kcal/h·m^2)

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

Cooling load per unit area

When the volume of outdoor air per person is 25 m^3/h, and the number of persons per 1 m^2 is 0.2, the cooling load will be approximately 157.0 W/m^2 (135 kcal/h·m^2).
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	85 kJ/kg (20.3 kcal/kg')	31.8 kJ/kg (7.6 kcal/kg')
	Indoors	26 °C	50%	18.7 °C	53.2 kJ/kg (12.7 kcal/kg')	

When the load per floor area of 1 m^2 with a ventilation volume of 25 m^3/h·person is calculated with the above air conditions, the following is obtained:

Outdoor air (ventilation) load = 1.2 kg/m^3 (Specific gravity of air) $\times$ 0.2 persons/m^2 (no. of persons per 1 m^2)
$\times$ 25 m^3/h·person (outdoor air volume) $\times$ 31.8 kJ/kg (7.6 kcal/kg') (air enthalpy difference indoors/outdoors)
= 190.8 kJ/h·m^2 (530 W/m^2)

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)
= 157.0 W/m^2 (135 kcal/h·m^2) – 53.0 W/m^2 (45.6 kcal/h·m^2) = 104.0 W/m^2 (89.4 kcal/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) = 63.0 W·person (54 kcal/h·person)
Latent heat (LH) = 69.0 W·person (59 kcal/h·person)
Total heat (TH) = 132.0 W·person (113 kcal/h·person)

The heat generated per 1 m^2 of floor space is

(heat generated from people)
= 132.0 W·person (113 kcal/h·person) × 0.2 person/m^2 = 26.4 W/m^2 (22.6 kcal/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 - 350 Lux, is 20 - 30 W/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)
= 104.0 – (26.4 + 30.0) = 47.6 W/m^2 (40.9 kcal/h·m^2)

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

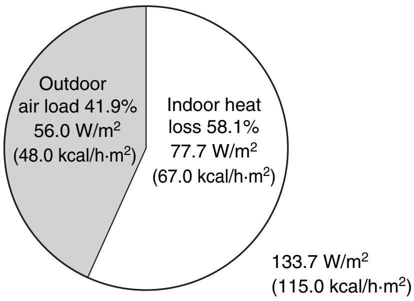
5.3 Ventilation load during heating

● 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	56.0 W/m^2 (48.2 kcal/h·m^2)
Internal heat	77.7 W/m^2 (66.8 kcal/h·m^2)
Total	133.7 W/m^2 (115.0 kcal/h·m^2)

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 = 133.7 W/m^2 (115.0 kcal/h·m^2) – 56.0 W/m^2 (48.2 kcal/h·m^2) = 77.7 W/m^2 (66.8 kcal/h·m^2)

Heating load per unit area

When the outdoor air volume per person is 25 m^3/h, and the number of persons per 1 m^2 is 0.2 persons, the approximate heating load will be approximately 133.7 W/m^2 (115 kcal/h·m^2).

● Outdoor air load

Air conditions <Standard design air conditions in Tokyo>

		Dry bulb temp.	Relative humidity	Wet bulb temp.	Enthalpy	Enthalpy difference
Heating	Outdoor air	0 °C	50%	–3 °C	5.0 kJ/kg (1.2 kcal/kg’)	33.5 kJ/kg (8.0 kcal/kg’)
	Indoors	20 °C	50%	13.7 °C	38.5 kJ/kg (9.2 kcal/kg’)	

When the load per 1 m^2 of floor area with a ventilation volume of 25 m^3/h·person is calculated with the above air conditions, the following is obtained:

Outdoor air (ventilation) load = 1.2 kg/m^3 × 0.2 persons/m^2 × 25 m^3/h·person × 33.5 kJ/kg (8.0 kcal/kg’)
= 201.0 kJ/h·m^2 (56 W/m^2)

The Lossnay recuperates approximately 70% of the outdoor air load and saves on approximately 30% of the total load.

CHAPTER 2

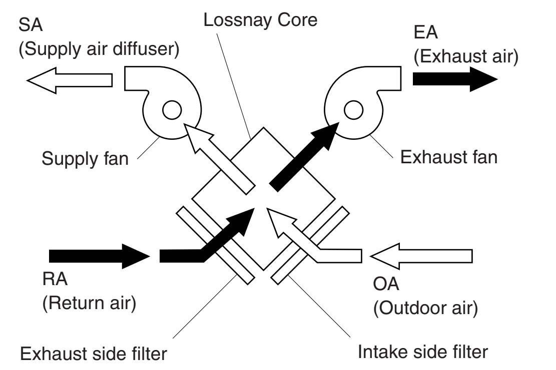
Lossnay Construction and Principle

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 recovery unit (Lossnay Core) is installed at this cross point, and recovers 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



Note: The dust 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) Dehumidifying during summer, and humidifying during winter is possible.
(4) Comfortable ventilation is possible, (the outdoor air being adjusted to the room temperature.)
(5) Effective sound-proofing.

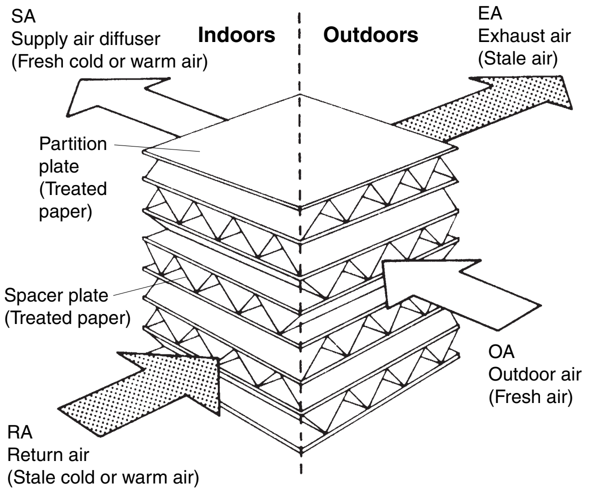
2. Construction and Principle of Core

● Simple construction

The Lossnay Core is a cross-flow total heat recovery unit 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. Lossnay is a total heat exchanger that utilizes these special properties of paper.



● Treated paper

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

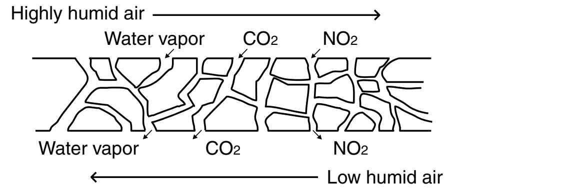
(1) The paper is incombustible and is strong.
(2) The paper has selective hydroscopicity and moisture permeability that permits the passage of water vapor only (including some water-soluble gases).
(3) The paper has gas barrier properties that does not pass gases such as CO_2.

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

Ordinary paper

Water vapor is transferred, but gas elements that are easily dissolved in water such as CO_2, NO_2 are also transferred.

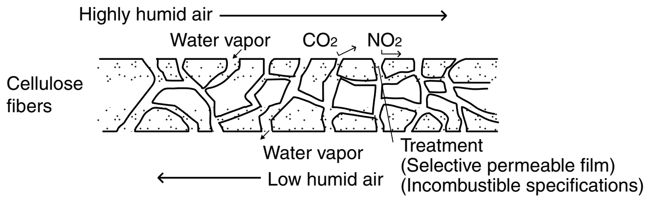
The contaminated air passes through the plates during ventilation and returns to the room.



Treated paper

Water vapor 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.



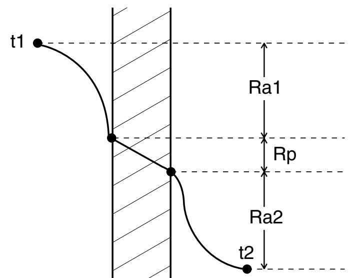
● Total heat recovery mechanism

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) Temperature (sensible heat) recovery

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 recovery 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.



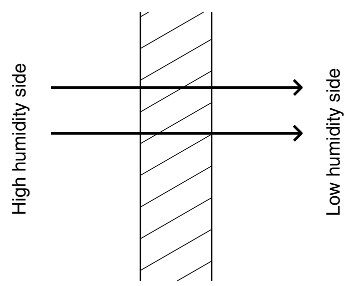
Partition plate
$Ra_1+Ra_2 \gg Rp$

Heat resistance 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) recovery

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



Partition plate

3. Calculation of the Total Heat Recovery Efficiency

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

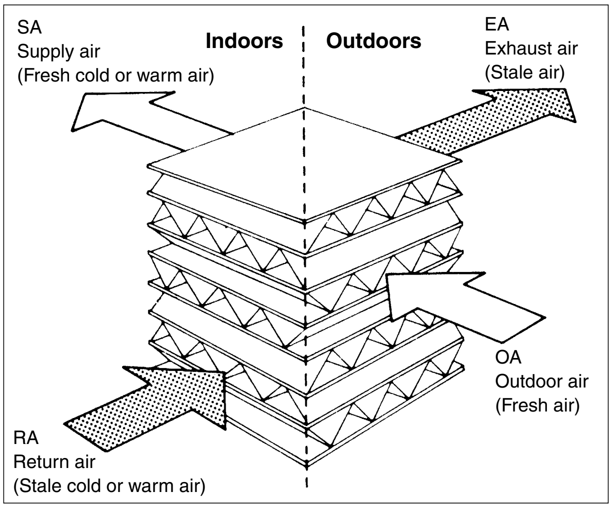
(1) Temperature (sensible heat) recovery efficiency

(2) Humidity (latent heat) recovery efficiency

(3) Enthalpy (total heat) recovery 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 recovery efficiency can be calculated with the formulas given below.
- When the supply air volume and exhaust air volume are equal, the heat recovery 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 recovery efficiency is low if the exhaust volume is lower, and high if the exhaust volume is higher.
  Refer to the Heat Recovery Efficiency Correction Curve in the applicable catalogue for more details.



Item	Formula
Temperature recovery efficiency (%)	$\eta t = \dfrac{t\,(OA) - t\,(SA)}{t\,(OA) - t\,(RA)} \times 100$
Enthalpy recovery efficiency (%)	$\eta i = \dfrac{i\,(OA) - i\,(SA)}{i\,(OA) - i\,(RA)} \times 100$

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 recovery 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.

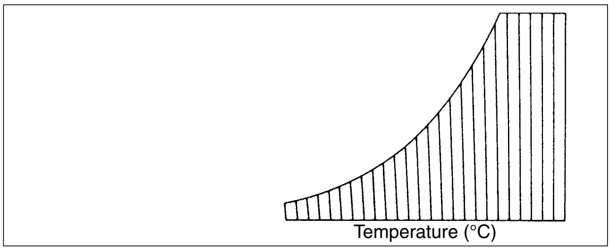
	Supply side	Exhaust side
Temperature	$t_{SA} = t_{OA} - (t_{OA} - t_{RA}) \cdot \eta t$	$t_{EA} = t_{RA} + (t_{OA} - t_{RA}) \cdot \eta t$
Enthalpy	$i_{SA} = i_{OA} - (i_{OA} - i_{RA}) \cdot \eta i$	$i_{EA} = i_{RA} + (i_{OA} - i_{RA}) \cdot \eta i$

4. What is a Psychrometric Chart?

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.

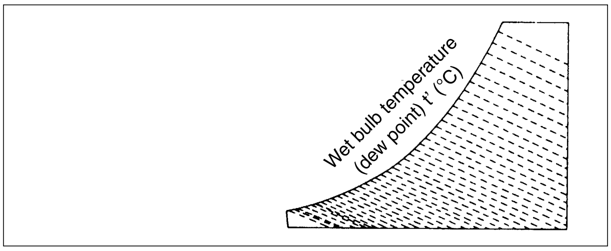
(1) Dry bulb temperature t (°C)

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



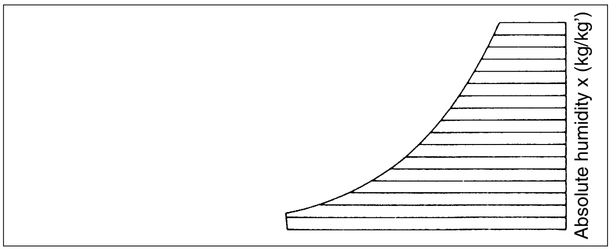
(2) Wet bulb temperature t' (°C)

When a dry bulb thermometer's heat sensing section is wrapped in a piece of wet gauze and an ample air flow (3 m/s or more) is applied, the heat applied to the wet bulb by the air and the heat of the water vapor 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')

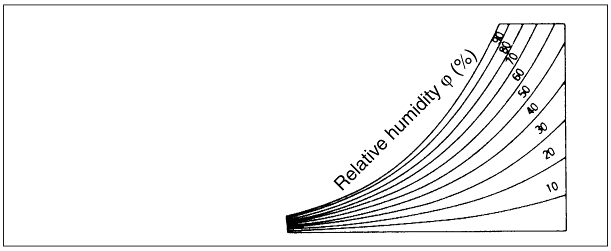
The weight (kg) of the water vapor that corresponds to the weight (kg') of the dry air in the humid air is called the absolute humidity.



(4) Relative humidity φ (%)

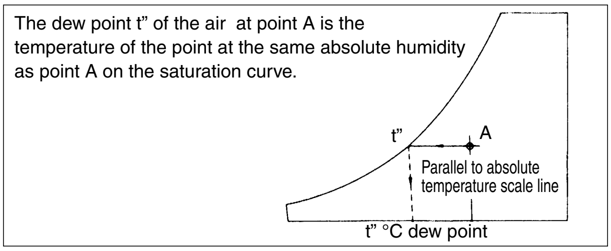
The ratio of the water vapor pressure Pw in the humid air and the water vapor pressure Pws in the saturated air at the same temperature is called the relative humidity. This is obtained with the following formula:

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



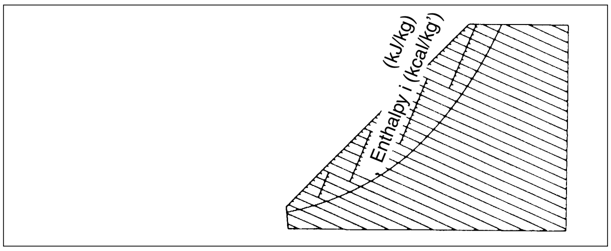
(5) Dew point t" (°C)

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.



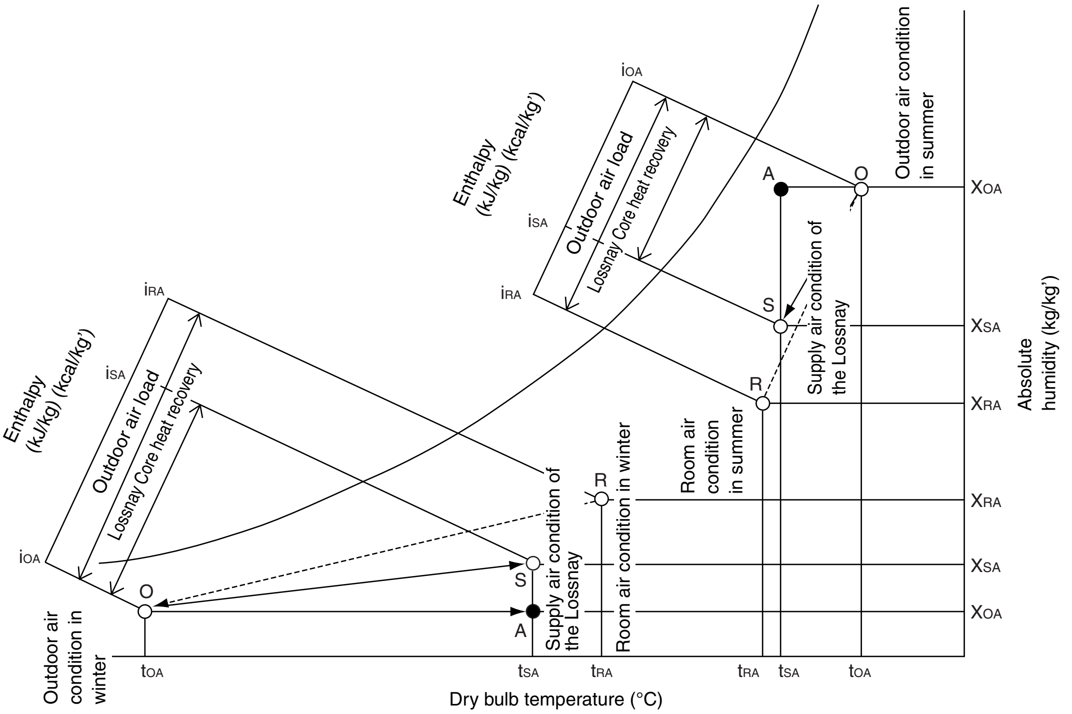
(6) Enthalpy i (kJ/kg) (kcal/kg')

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 sensible heat recovery unit is used alone and is assumed to have the same heat recovery 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: $q_T = \gamma \cdot Q \cdot (i_{OA} - i_{SA})$ [W (kcal/h)]

$= \gamma \cdot Q \cdot (i_{OA} - i_{RA}) \times \eta i$

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 = Heat recovery efficiency (%)

- Suffix meanings

OA : Outdoor air
RA : Return air
SA : Supply air

CHAPTER 3
General Technical Considerations

1. Lossnay Heat Recovery Effect

1.1 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 recovery unit), sensible heat recovery ventilation (sensible HRV) and conventional ventilators are shown below.

(1) Cooling during summer

Conditions

- Model LGH-50R type (at 50Hz, high speed)
- Ventilation rate: 500 m^3/h (specific gravity of air ρ = 1.2 kg/m^3)

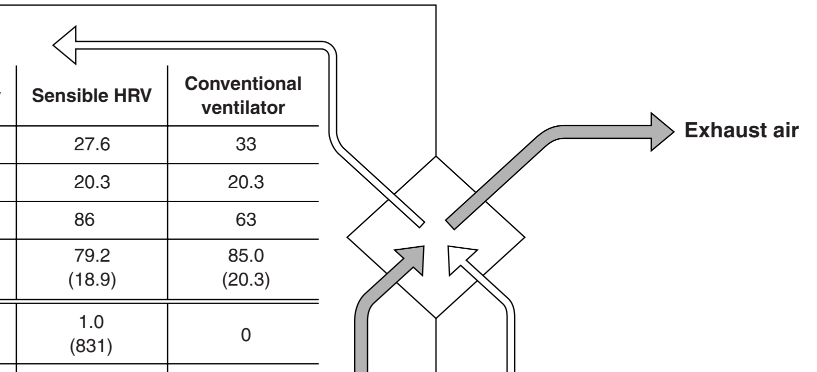
- Heat recovery efficiency table (%) (For summer)

	Lossnay	Sensible HRV	Conventional ventilator
Temperature (sensible heat)	77	77	–
Enthalpy (total heat)	61.5	18.2*	–

* Calculated volume under below conditions.

Supply air

		Lossnay	Sensible HRV	Conventional ventilator
Dry bulb temperature	(°C)	27.6	27.6	33
Absolute humidity	(g/kg')	14.8	20.3	20.3
Relative humidity	(%)	63	86	63
Enthalpy	(kJ/kg) (kcal/kg')	65.4 (15.6)	79.2 (18.9)	85.0 (20.3)
Total heat recovered	(kW) (kcal/h)	3.3 (2,809)	1.0 (831)	0
Outdoor air load	(kW) (kcal/h)	2.0 (1,749)	4.3 (3,727)	5.3 (4,558)
Outdoor air load ratio	(%)	38.5	82	100



Outdoor air

Dry bulb temperature	33°C
Absolute humidity	20.3 g/kg'
Relative humidity	63%
Enthalpy	85.0 kJ/kg (20.3 kcal/kg')

Air conditioner

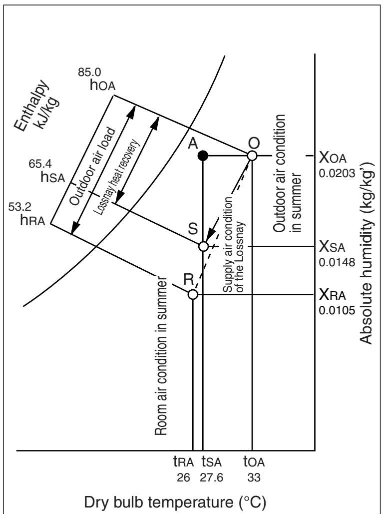
Room air

Dry bulb temperature	26°C
Absolute humidity	10.5 g/kg'
Relative humidity	50%
Enthalpy	53.2 kJ/kg (12.7 kcal/kg')

Calculation example

- Lossnay
  (Supply air diffuser temperature) t_{SA} = 33°C – (33°C – 26°C) × 0.77 = 27.6°C
  (Supply air diffuser enthalpy) h_{SA} = 85.0 – (85.0 – 53.2) × 0.615 = 65.4 kJ/kg
  Heat recovered (85.0 – 65.4) × 1.2 × 500 = 11,760 kJ/h = 3.3 kW (2,809 kcal/h)
  Outdoor air load (65.4 – 53.2) × 1.2 × 500 = 7,320 kJ/h = 2.0 kW (1,749 kcal/h)
- Sensible HRV
  (Supply air diffuser temperature) t_{SA} = 33°C – (33°C – 26°C) × 0.77 = 27.6°C
  (Supply air diffuser enthalpy) h_{SA} = 79.2 kJ/kg (18.9 kcal/kg) (from psychrometric chart)
  Heat recovered (85.0 – 79.2) × 1.2 × 500 = 3,480 kJ/kg = 1.0kW (831 kcal/h)
  Outdoor air load (79.2 – 53.2) × 1.2 × 500 = 15,600 kJ/H = 4.3 kW (3,727 kcal/h)
  [Calculated enthulpy recovery efficiency 3,480 ÷ (3,480 + 15,600) × 100 = 18.2]
- Conventional ventilator
  If a conventional ventilator is used, the heat recovered will be 0 as the supply air diffuser is equal to the outdoor air.
  The outdoor air load is:
  (85.0 – 53.2) × 1.2 × 500 = 19,080 kJ/h = 5.3 kW (4558 kcal/h)

Summer conditions



(2) Heating during winter

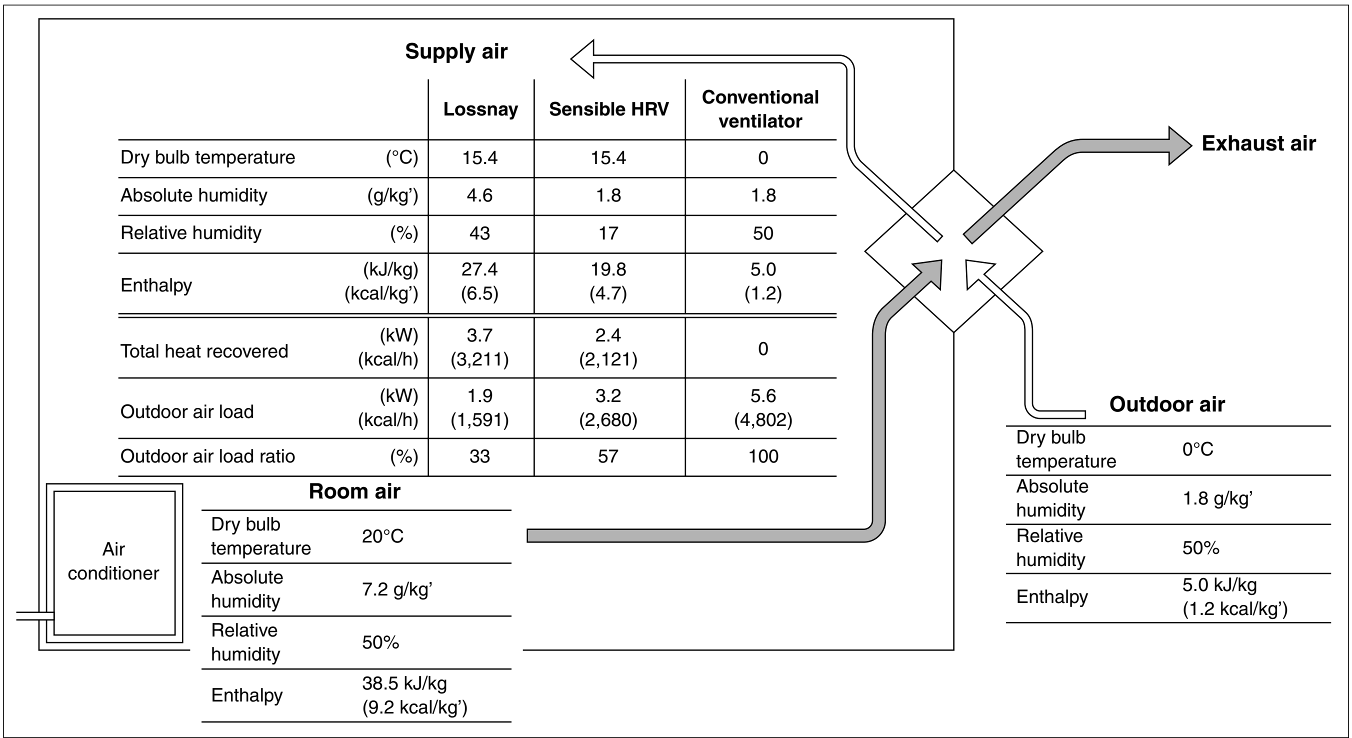
Conditions:

- Model LGH-50R type (at 50Hz, high speed)
- Ventilation rate: 500 m^3/h (Specific gravity of air ρ = 1.2 kg/m^3)

- Heat recovery efficiency table (%) (For winter)

	Lossnay	Sensible HRV	Conventional ventilator
Temperature (sensible heat)	77	77	–
Enthalpy (total heat)	67	44.2*	–

* Calculated volume under below conditions.



Supply air

		Lossnay	Sensible HRV	Conventional ventilator
Dry bulb temperature	(°C)	15.4	15.4	0
Absolute humidity	(g/kg')	4.6	1.8	1.8
Relative humidity	(%)	43	17	50
Enthalpy	(kJ/kg) (kcal/kg')	27.4 (6.5)	19.8 (4.7)	5.0 (1.2)
Total heat recovered	(kW) (kcal/h)	3.7 (3,211)	2.4 (2,121)	0
Outdoor air load	(kW) (kcal/h)	1.9 (1,591)	3.2 (2,680)	5.6 (4,802)
Outdoor air load ratio	(%)	33	57	100

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	5.0 kJ/kg (1.2 kcal/kg')

Calculation example

- Lossnay

  (Supply air diffuser temperature) t_{SA} = (20°C – 0°C) × 0.77 + 0°C = 15.4°C

  (Supply air diffuser enthalpy) h_{SA} = (38.5 – 5.0) × 0.67 + 5.0 = 27.4 kJ/kg

  Heat recovered (27.4 – 5.0) × 1.2 × 500 = 13,440 kJ/h = 3.7 kW (3,211 kcal/h)

  Outdoor air load (38.5 – 27.4) × 1.2 × 500 = 6,660 kJ/h = 1.9 kW (1,591 kcal/h)

- Sensible HRV

  (Supply air diffuser temperature) t_{SA} = (20°C – 0°C) × 0.77 + 0°C = 15.4°C

  (Supply air diffuser enthalpy) h_{SA} = 19.8 kJ/kg (4.7 kcal/kg') (from psychrometric chart)

  Heat recovered (19.8 – 5.0) × 1.2 × 500 = 8,880 kJ/h = 2.5 kW (2,121kcal/h)

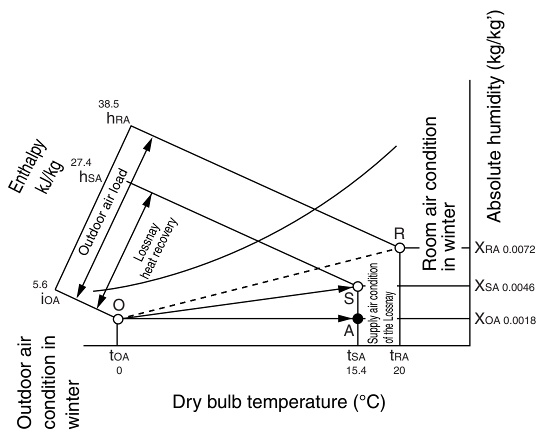
  Outdoor air load (38.5 – 19.8) × 1.2 × 500 = 11,200 kJ/h = 3.1 kW (2,681 kcal/h)

  [Calculated enthulpy recovery efficiency 8,880 ÷ (8,880 + 11,200) × 100 = 44.2]

- Conventional ventilator

  If a conventional ventilator is used, the supply air diffuser 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 – 5.0) × 1.2 × 500 = 20,100 kJ/h = 5.6 kW (4,802 kcal/h)

Winter conditions



2. Example Heat Recovery Calculation

(1) Setting of conditions
(Note: Tokyo Power, industrial power 6 kV supply)

	Units	When Heating	When Cooling
Operation time	(h/yr)	10h/day × 26 days/mo. × 5 mo./yr. = 1,300 h/yr	10h/day × 26 days/mo. × 4 mo./yr. = 1,040 h/yr
Electricity fee	(yen/kWh)	16.22	17.84
Capacity per 1 kW of electricity	(kW/kW)	3.1	2.6
Energy unit cost	(yen/kWh)	16.22/3.1 = 5.23	17.84/2.6 = 6.86

- Return air volume (RA) = 7,200 m^3/Hr
- Outdoor air volume (OA) = 8,000 m^3/Hr
- Air volume ratio (RA/OA) = 0.9
- Air conditions

Season	Winter heating					Summer cooling				
Item	Dry bulb temp. DB [°C]	Wet bulb temp. WB [°C]	Relative humidity RH [%]	Absolute humidity × [kg/kg (DA)]	Enthalpy h [kJ/kg (DA)]	Dry bulb temp. DB [°C]	Wet bulb temp. WB [°C]	Relative humidity RH [%]	Absolute humidity × [kg/kg (DA)]	Enthalpy h [kJ/kg (DA)]
Outdoors	0	–2.7	50	0.0018	5.0 (1.2)	33	27.1	63	0.0202	85.0 (20.3)
Indoors	20	13.8	50	0.0072	38.5 (9.2)	26	18.7	50	0.0105	53.0 (12.7)

(2) Selection of Lossnay model (select from treatment air volume catalogue)
- Model name: LU-160 with combination of LU-1605 × 1 unit
- Processing air volume per unit RA = 7,200 m^3/Hr, OA = 8,000 m^3 Air volume ratio (RA/OA) = 0.9
- Heat recovery efficiency : Heat recovery efficiency = 73%, Enthalpy recovery efficiency (cooling) = 62%, Enthalpy recovery efficiency (heating) = 67%
- Static pressure loss (unit-type) RA = 156.9 Pa, OA = 186.3 Pa (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)} × 0.73 (heat recovery efficiency) + 0 (outdoor air temperature) = 14.6	= 33 (Outdoor air temperature) – { 33 (outdoor air temperature) – 26 (indoor temperature)} × 0.73 (heat recovery efficiency) = 27.89
Enthalpy [kJ/kg (DA)]	= {38.5 (Indoor enthalpy) – 5.0 (outdoor air enthalpy)} × 0.67 (enthalpy recovery efficiency) + 5.0(outdoor air enthalpy) = 27.4	= 85 (Outdoor air enthalpy) – { 85 (outdoor air enthalpy) – 53.2 (indoor enthalpy)} × 0.62 (enthalpy recovery efficiency) = 65.3
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 = 0.005 kg/kg (DA) • Enthalpy = 27.4 kJ/kg (DA)	• Dry-bulb temperature = 27.89 °C • Wet-bulb temperature = 22.4 °C • Relative humidity = 62% • Absolute humidity = 0.0146 kg/kg (DA) • Enthalpy = 65.3 kJ/kg (DA)

Caution: See the psychrometric chart on the next page.

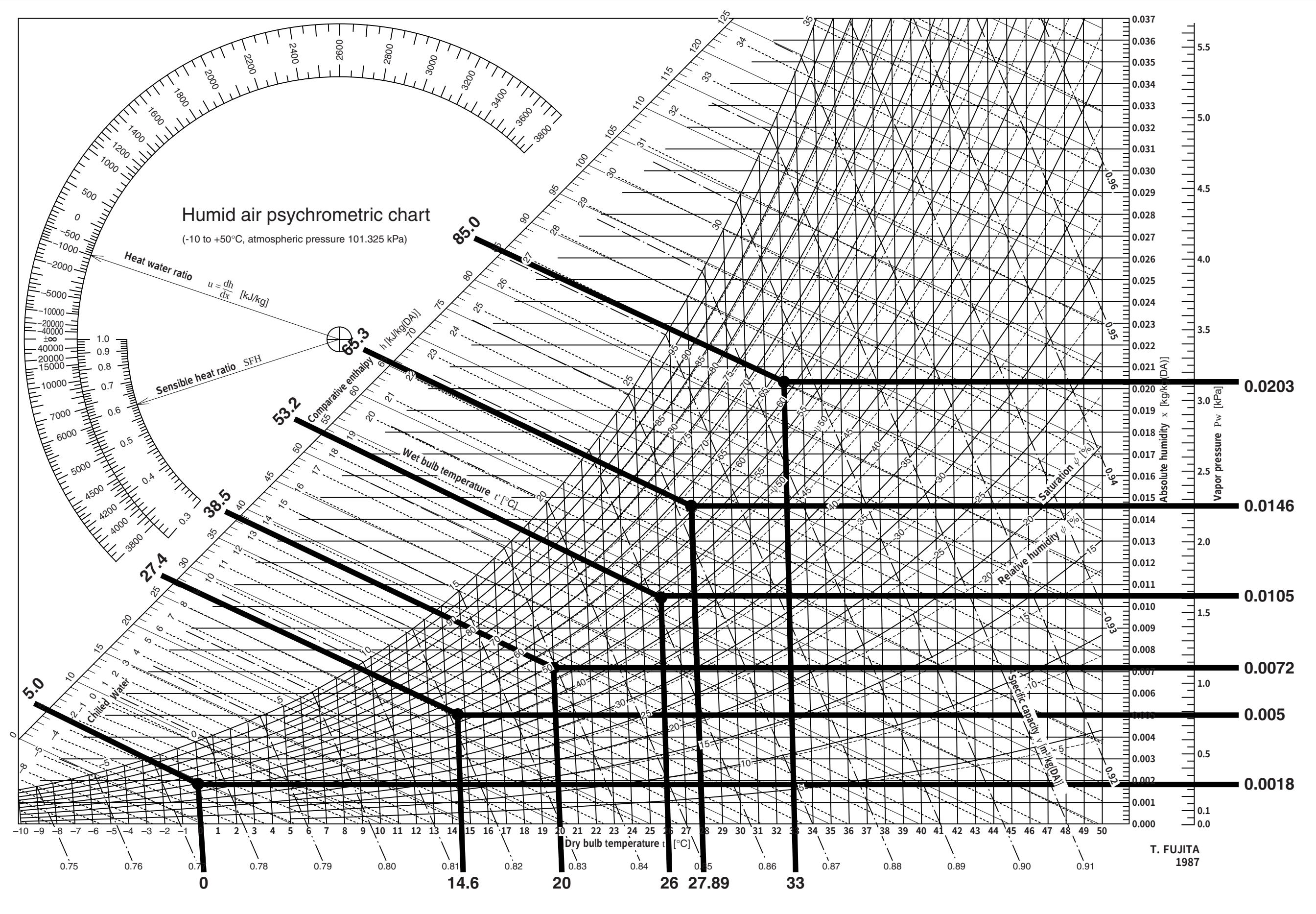
(4) Outdoor air load and heat recovered

	Heating	Cooling
Fresh air load without Lossnay (q_1)	= 1.2 (Air specific gravity) × 8,000 (outdoor air volume) × { 38.5 (indoor enthalpy) – 5.0 (outdoor air enthalpy) } = 321,600 kJ/h = 89.3 kW	= 1.2 (Air specific gravity) × 8,000 (outdoor air volume) × { 85.0 (outdoor air enthalpy) – 53.2 (indoor enthalpy) } = 305,280 kJ/h = 84.8 kW
Outdoor air load with Lossnay (q_2)	= 89.3 (Outdoor air load) (q_1) × { 1 – 0.67 (enthalpy recovery efficiency)} = 29.5kW or = Air specific gravity × outdoor air volume × (indoor enthalpy – indoor blow enthalpy)	= 84.8 (Outdoor air load) (q_1) × { 1 – 0.62 (enthalpy recovery efficiency) } = 32.2 kW or = Air specific gravity × outdoor air volume × (indoor enthalpy – indoor blow enthalpy)
Heat recovered (q_3)	= $q_1 - q_2$ = 89.3 – 29.5 = 59.8 or = Outdoor air load (q_1) × enthalpy recovery efficiency	= $q_1 - q_2$ = 84.8 – 32.2 = 56.2 kW or = Outdoor air load (q_1) × enthalpy recovery efficiency
(%) outdoor air load	• Outdoor air load = 89.3 kW = 100% • Outdoor air load with Lossnay = 29.5 kW = 33% • Heat recovered = 59.8 kW = 67%	• Outdoor air load =84.8 kW = 100% • Outdoor air load with Lossnay = 32.2 kW = 38% • Heat recovered = 52.6 kW = 62%

(5) Recovered money (power rates)

	Heating	Cooling
Yearly saved money	= Heat recovered: kW × Unit price yen/W × operation time Hr/year = 59.8 kW × 5.232 yen/kWh × (1,300hr/year) = 406,580 yen	= Heat recovered: kW × Unit price yen/W × operation time Hr/year = 52.6 kW × 6.86 yen × (1,040hr/year) = 375,269 yen
Remarks	If recovered heat is converted to electricity : heating = 59.8 kW/3.1 = 19.3 kW/h cooling = 52.6 kW/2.6 = 20.2 kW/h	

● Psychrometric chart for calculating Lossnay economical effect



The following can be determined from the above calculation results:

- Saving of 59.8 kW of the heating load, and 52.6 kW 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 400,000 yen can be saved in operation and maintenance costs during heating and 370,000 yen during cooling, for a total savings of approximately 770,000 yen. Furthermore, as 20.2 kW can be saved from the basic power rates during cooling, approximately 370,000 yen (20.2 × 1,560 yen/month × 12 months) can be saved annually.

3. Calculation of Lossnay Economical Effects

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 × [kg/kg']	Enthalpy i kJ/kg (kcal/kg')	Dry bulb temp. DB [°C]	Wet bulb temp. WB [°C]	Relative humidity RH [%]	Absolute humidity × [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: ¥ /kWh
  Cooling = Type: Electricity Cost: ¥ /kWh
  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) =
- Heat recovery efficiency : Heat recovery efficiency = %,
  Enthalpy recovery efficiency (cooling) = %,
  Enthalpy recovery efficiency (heating) = %
- Static pressure loss (unit-type) RA= mm H_2O OA = mm H_2O (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 recovery efficiency + outdoor air temperature =	= Outdoor air temperature – (outdoor air temperature – indoor temperature) × heat recovery efficiency =
Enthalpy [kJ/kg(kcal/kg)]	= (Indoor enthalpy – outdoor air enthalpy) × enthalpy recovery efficiency + outdoor air enthalpy =	= Outdoor air enthalpy – (outdoor air enthalpy – indoor enthalpy) × enthalpy recovery 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 = kg/kg (kcal/kg)	● Dry-bulb temperature = °C ● Wet-bulb temperature = °C ● Relative humidity = % ● Absolute humidity = kg/kg' ● Enthalpy = kg/kg (kcal/kg)

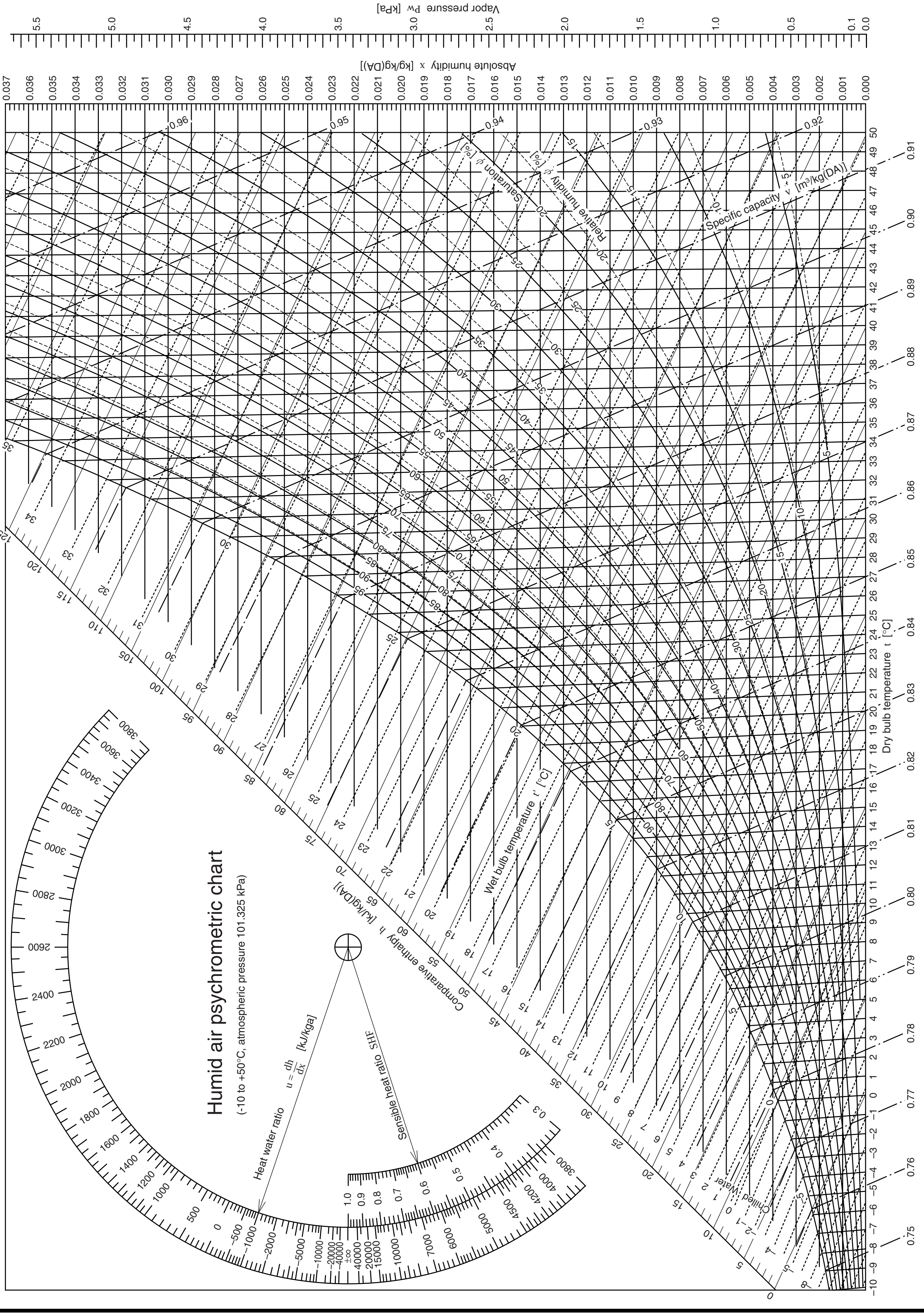
(4) Outdoor air load and heat recovery

	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 recovery efficiency) = or = Air specific gravity × outdoor air volume × (indoor enthalpy – indoor blow enthalpy)	= Outdoor air load (q_1) × (1 – enthalpy recovery 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 recovery efficiency	= $q_1 - q_2$ = – = or = Outdoor air load (q_1) × enthalpy recovery 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: kW × Unit price ¥/kWh × operation time Hr/year = kW × ¥/kWh × = Hr/year =	= Heat recovered: kW × Unit price ¥/kWh × operation time Hr/year = kW × ¥/kWh × = Hr/year =

4. Psychrometric Chart



5. 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 recovery process.

(2) Client

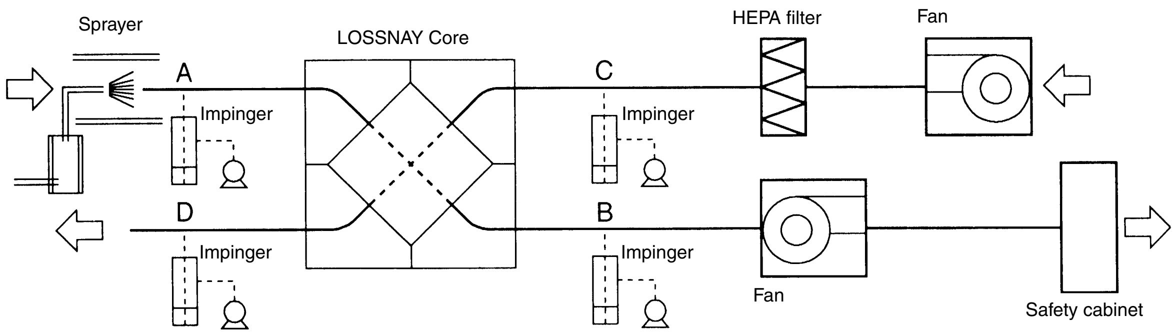
MITSUBISHI ELECTRIC CO. NAKATSUGAWA WORKS.

(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 to 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 Okada
Manager, Biological Section
Kitasato Reseaarch Center of Enviromental Seiences

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

Test No.	Test item	Residual flame (sec.)	Residual dust (sec.)	Carbonized area (cm^2)
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 item / Test No.	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 cm^2 or less

Washing test

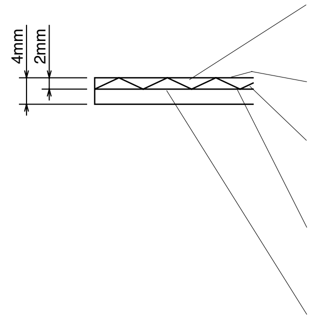
The Lossnay Core was also tested at the Japan Construction General Laboratories according to the fire retardancy test methods of thin materials for construction as set forth by JIS A 1322. The material was evaluated as Class 2 flame retardant. Details of the tests carried out are shown below.

Flame-proofing property test report

Messrs. Mitsubishi Electric Corp.,
Nakatsugawa Works

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

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

<table>
<tr><td rowspan="2">Applicant</td><td colspan="3">Company name</td><td colspan="6">Mitsubishi Electric Corp., Nakatsugawa Works</td></tr>
<tr><td colspan="3">Address</td><td colspan="6">1-3 Komanba-cho, Nakatsugawa, Gifu</td></tr>
<tr><td rowspan="4">Specimen and test body</td><td colspan="3">Specimen type</td><td colspan="2">Single-face laminated corrugated board</td><td>Product name</td><td colspan="3">Lossnay Core
(Total heat recovery unit)</td></tr>
<tr><td colspan="3">Material structure and cross-sectional diagram, etc.</td><td colspan="6">
Single-face laminated corrugated board
... Thickness: 4 mm
(Single-face corrugated board with 2 mm cell size laminated alternately at right angle)
Partition (Liner paper) Flame-proof treated paper
... Thickness: 0.085 mm, Weight: 70 g/m^2
Adhesive agent ... Vinyl acetate resin
... Weight: 30 g/m^2 (Solid)
Filler (Flute paper)
... Colored wood free paper
... Thickness: 0.093 mm, Weight: 79 g/m^2
Adhesive agent
... Vinyl acetate resin
... Weight: 30 g/m^2 (Solid)
Partition (Liner paper) Flame-proof treated paper
... Thickness: 0.085 mm, Weight: 70 g/m^2</td></tr>
<tr><td colspan="3">Test body size and thickness (mm)</td><td colspan="6">300 (Long side) × 200 (Short side) × 4 (Thickness)</td></tr>
<tr><td colspan="3">Test body direction</td><td colspan="6">The longer side is the vertical side.</td></tr>
<tr><td rowspan="2">Testing method</td><td colspan="3">Testing standards</td><td colspan="2">Pre-treatment of test body</td><td>Heating time</td><td colspan="3">Heating surface class and direction</td></tr>
<tr><td colspan="3">JIS A 1322
(45° Meckelian burner method)</td><td colspan="2">Method A
(drying method)</td><td>3 min.</td><td colspan="3">The direction of which the corrugated board fold was vertical was set as the front of the heating surface.</td></tr>
<tr><td rowspan="6">Test results</td><td colspan="3">Test date</td><td colspan="6">October 5, 1993</td></tr>
<tr><td colspan="3">Test position</td><td rowspan="2">Residual frame (sec.)</td><td rowspan="2">Residual dust (sec.)</td><td rowspan="2">Carbonized length (Vertical × Horizontal) (cm)</td><td rowspan="2">Discoloration length (Vertical × Horizontal) (cm)</td><td rowspan="2" colspan="2">Remarks</td></tr>
<tr><td>Class</td><td>Direction</td><td>No.</td></tr>
<tr><td rowspan="3">Front</td><td rowspan="3">Vertical</td><td>1</td><td>0</td><td>0</td><td>8.2 × 4.7</td><td>18.7 × 7.3</td><td colspan="2"></td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>8.4 × 4.9</td><td>24.3 × 7.8</td><td colspan="2">*1</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>7.4 × 5.0</td><td>22.0 × 8.4</td><td colspan="2"></td></tr>
<tr><td>Evaluation</td><td colspan="9">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.</td></tr>
<tr><td colspan="4">Persons in charge of testing</td><td colspan="6">Material Testing Laboratory
Laboratory chief: Hiroshi Tamura, Technicians: Shigeru Fujikawa, Nobuaki Oohiro, Tetsuya Ogawa</td></tr>
</table>

Note: 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.
The Lossnay core was tested at the Underwriters Laboratories Inc. according to the standard of UL94, Test for Flammability of Plastic Materials for Parts in Devices and Appliances, 1998.
The material was evaluated as per 5VA classified of flammability.

7. 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 center 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

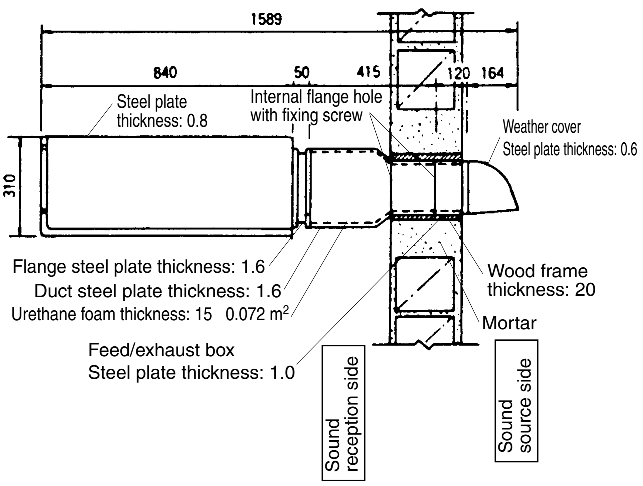
Test number		IVA-78-122
Acceptance data	:	February 22, 1979
Report	:	May 24, 1979

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

General Building Reseach 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	W 1250 × H 310 × D 1589
	Area concentration	———
	Remarks Cultures, specimen installation method at test facility	An existing hole (4000 mm × 3000 mm) was covered with a hollow concrete block with double-faced mortar (thickness 20 mm each), with a wood frame with inner dimension of 580 mm × 190 mm × 230 mm being installed. The supply/exhaust box and duct was mounted in this, and the main unit and weather cover was mounted.
	Peripheral	Oil clay was filled around the sound source sections

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



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

Testing facility		General Building Research Corporation
Client	**Address**	1-3 Komanba-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	W 580 × H 190

Measurement results				125 Hz	500 Hz	2,000 Hz
			Centre frequency	125 Hz	500 Hz	2,000 Hz
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 page 35 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

8. Change in Lossnay Core Over Time

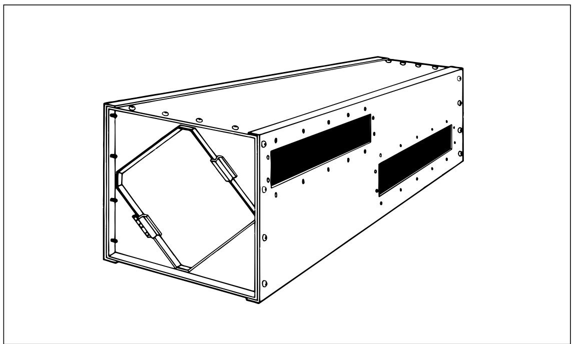
The following details show an example of a building that has installed the Lossnay units, from which it is possible to assess the change in the units over time.

8.1 Outline of building where Lossnay is installed

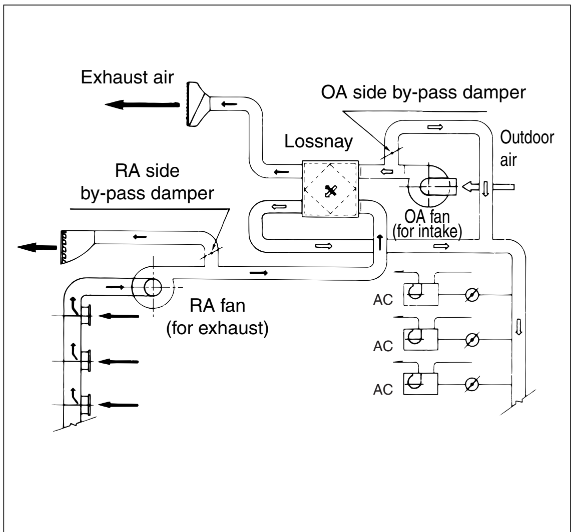
(1)	**Building name**	: Meiji Seimei, Nagoya Office/shop building 1-1 Shinsakae-machi Naka-ku, Nagoya
(2)	**No. of floors**	: 16 above ground, 2-storey penthouse, 4 basement floors
(3)	**Total floor space**	: 38,893 m^2
(4)	**Reference floor space**	: 1,388 m^2

8.2 Outline of installed ventilation equipment

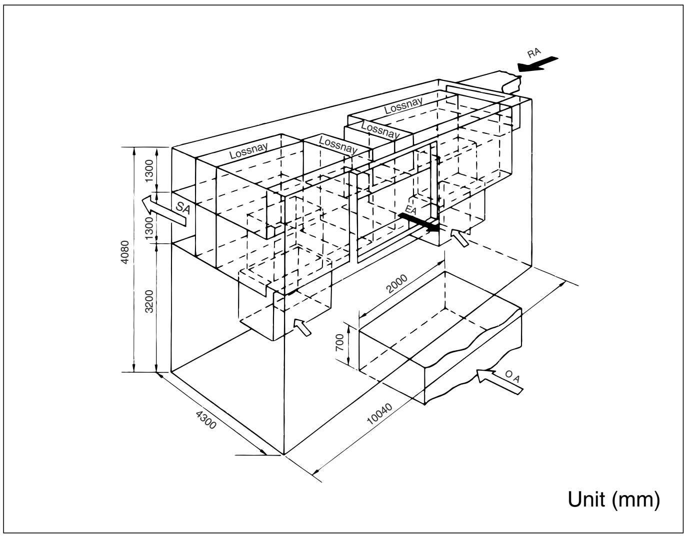
(1)	**Air handling method** **Chilling unit** **Gas direct heating/cooling boiler**	: 4 fan coil units (perimeter zone) per floor : Absorption-type 250 kT × 1 unit, turbo 250 kT × 2 units : 340 kT, heating 1400 × 10^3 kcal/h
(2)	**Ventilation method**	: Air - air total heat recovery unit "Lossnay" LS-200 × 18 units installed in penthouse. Outdoor air treatment volume 46,231 CMH, Exhaust air treatment volume 54,335 CMH.
(3)	**Lossnay outline diagram**	: LS-200 (with four Lossnay Cores)



Lossnay duct system diagram



General diagram of penthouse Lossnay chamber



8.3 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

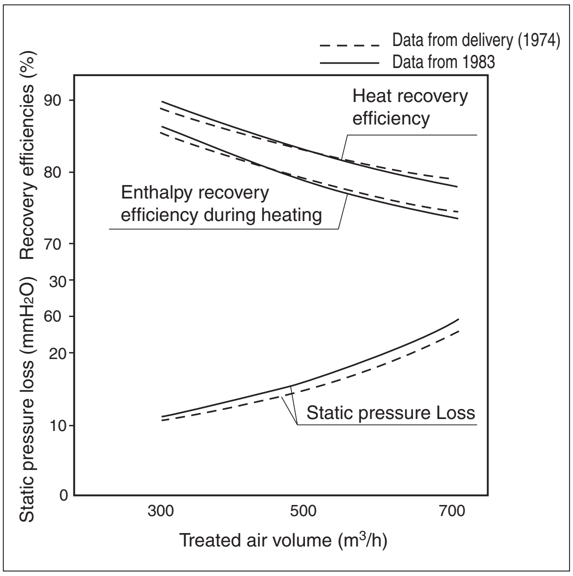
(3) Bypass operation month : Three months of April, May, June

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

8.4 Characteristics in change of Lossnay Core over time

Two Lossnay Cores 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 500 m^3/hr, and the measurement point was ±200 m^3/hr of this value.

Characteristics in change of Lossnay Core over time



8.5 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 to 16 mmH_2O at 500 m^3/hr which was a 1 mmH_2O 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.

9. Comparison of Heat Recovery Techniques

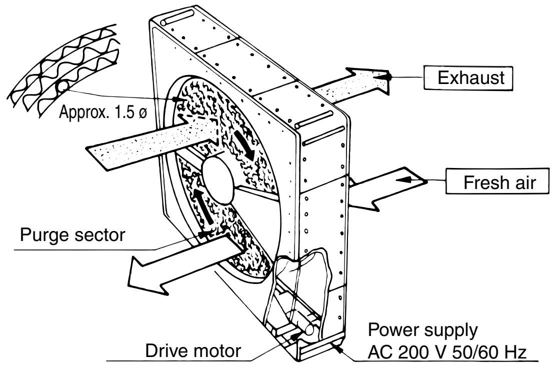
The methods by which heat recovery devices can be categorised may be considered as follows:

Basic methods of total heat exchangersa

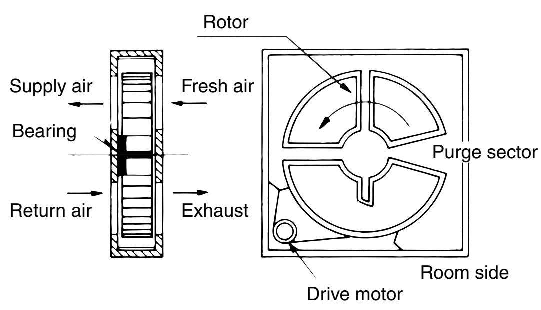
	Type	Method	Air flow	Country of development
Heat recovery principle	Static (Mitsubishi Lossnay)	Conductive transmission type	Cross-flow	Japan
	Rotary type	Heat accumulation/ humidity accumulation type	Counterflow	Sweden

9.1 Principle construction of rotary-type

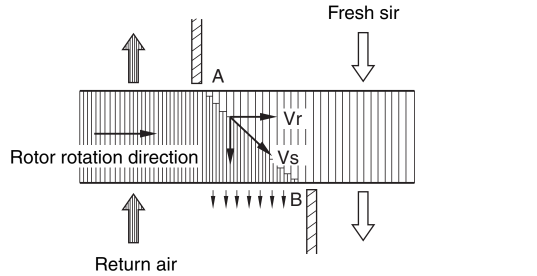
- The rotary-type heat recovery unit is composed of a rotor that has a layered honeycomb structure made of kraft paper, drive motor and housing.
  A large quantity of moisture absorbent material (lithium chloride, etc.) is applied onto the rotor, and humidity is transferred. The rotor is rotated eight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

9.2 Comparison of static-type and rotary-type heat recovery units

Item	Static-type		Rotary-type	
Construction/ principle	<Conductive transmission-type: cross-flow> Static-type transmission total heat recovery unit 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 core 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. × Supply air and exhaust airs flow into the same air passage because of the rotary-type construction.	
Moving parts	● None Fixed core		× Used (rotor driven with belt by gear motor) Rotor core (8RPM)	
Material quality	Treated paper		Treated paper, aluminum plates, etc.	
Mounting of prefilter	Required (periodic cleaning required)		Required (periodic cleaning required)	
Element clogging	● Occurs (state where dirt adheres onto element air passage surface. However, this is easily removed with a vacuum cleaner.)		× Occurs (Dust is smeared into element air passage filter.) (The dust adhered onto the core 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 core. ● Gas transmission (Ammonia : 28%, hydrogen sulfide : approx. 6.7%)		× 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. × Gas transmission (Ammonia : 45-57%, hydrogen sulfide : approx. 3.2-4%)	
Bacteria transmission rate	● Low (As air intake/exhaust are separate, transmission is low.)		× 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 core will over-absorb, causing drainage.)	
Maintenance	Core cleaning: More than once a year The core surface will clog with lint and dirt, but cleaning is easy with a vacuum cleaner. Only the two core air passage intakes need to be cleaned.		Core cleaning: Once every one to two years Cleaning is difficult as dust is smeared into core with the packing. × Gear motor for rotor drive : Periodic inspection × Rotor bearing, rotor drive belt : Periodic inspection	
Life	Core: Semi-permanent (10 years or more) (The static-type does not break.)		Core: Semi-permanent (10 years or more) (Periodic replacement is required according to the rotor bearings and core clogging.) × Rotor drive belt : Periodic replacement × 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 × Small models are difficult to design because of the rotor magnitude.	Example EV-1500
Standard treatment air volume	40 to 25,000 m^3/h	8,000 m^3/h	o 100 to 63,000 m^3/h	8,000 m^3/h
Enthalpy recovery efficiency		Temperature:77% Enthalpy Heating : 71% Cooling : 66%		74%
Pressure loss		17 mmAg		18 mmAg
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 × Poor

CHAPTER 4
Characteristics

1. How to Read the LGH Series Lossnay Characteristic Curves

1.1 Obtaining characteristics from static pressure loss

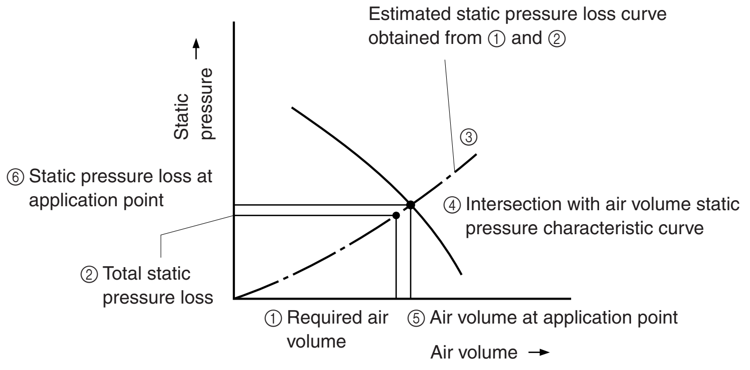
(1) Static pressure loss from straight pipe duct length (at required air volume)

(2) Static pressure loss at curved section (at required air volume)

(3) Static pressure loss of related parts (at required air volume)

⇩

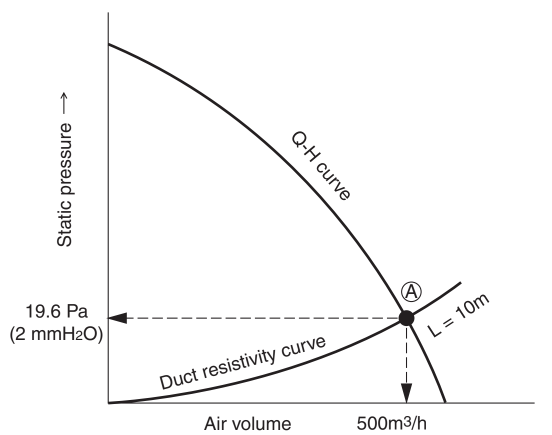
Total static pressure loss



2. Obtaining the Static Pressure Loss

2.1 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 19.6 Pa (2 mmH_2O) is applied on to point A, and the air volume is 500 m^3/h. The duct resistivity curve shows how the static pressure is applied when a duct is connected to the Lossnay. Thus, the L = 9.97 m duct resistivity curve in the diagram is the curve that shows how the static pressure is applied when a 10 m duct is connected. The intersecting point A with the Lossnay Q-H curve is the operation point.

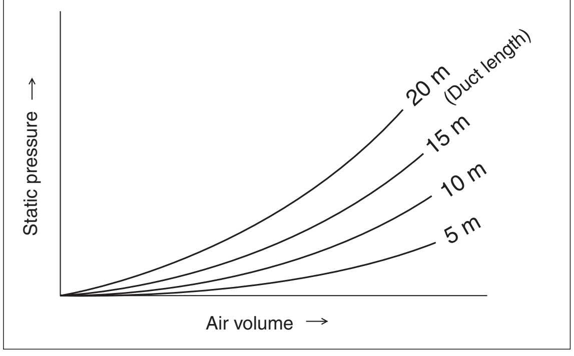


Duct resistivity curve

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



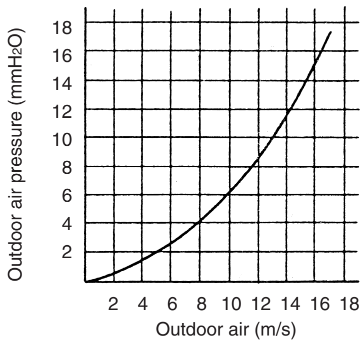
Reference

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

Pressure loss caused by outdoor air (Pa)

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

$$\begin{cases} r: \text{Air weight } 1.2 \text{ kg/m}^3 \\ v: \text{Velocity (m/s)} \end{cases}$$

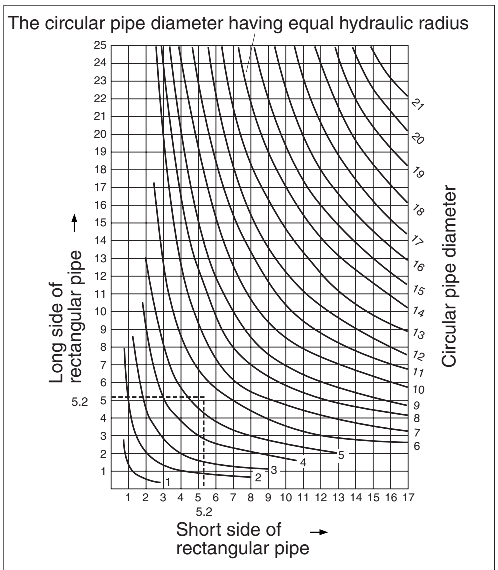


2.2 Calculation of duct pressure loss

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

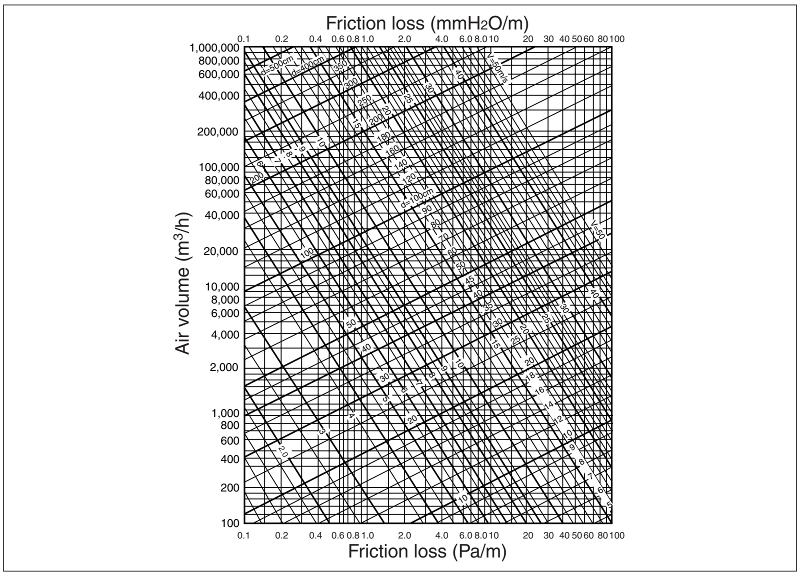


How to read Table 3

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 = 0.18 mm)

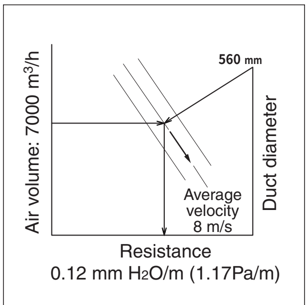


How to read Table 4

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 1 m 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 duct work is as shown using the following formula:

Circular pipe section pressure loss

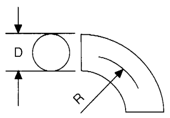
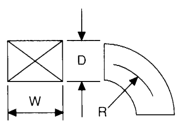
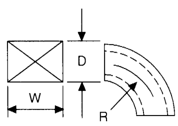
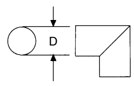
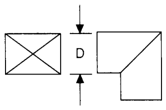
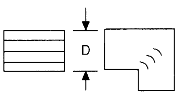
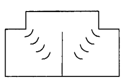
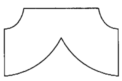
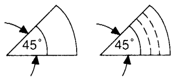
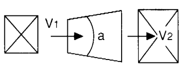
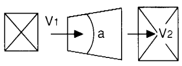
$$\Delta p = \lambda \cdot \frac{\ell}{d} \cdot \frac{\rho}{2} \cdot v^2 \text{ (Pa)}$$

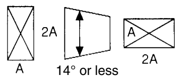
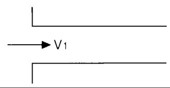
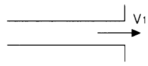
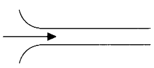
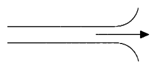
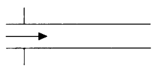
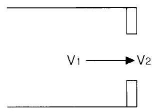
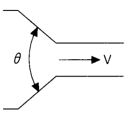
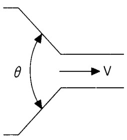
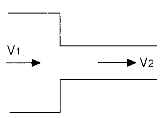
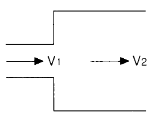
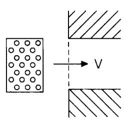
$$\Delta p = C \cdot \frac{\rho}{2} \cdot v^2 \text{ (Pa)}$$
$$= 0.6\, C \cdot v^2$$

λ : Friction resistance coefficient (smooth pipe 0.025)
C : Local loss coefficient (refer to Table 6)
d : Duct diameter (m)
ℓ : Duct length (m)
ρ : Air weight (1.2 kg/m^2)
v : Wind velocity (m/s)

(3) How to calculate curved sections

Table 6 List of pressure losses in each duct section

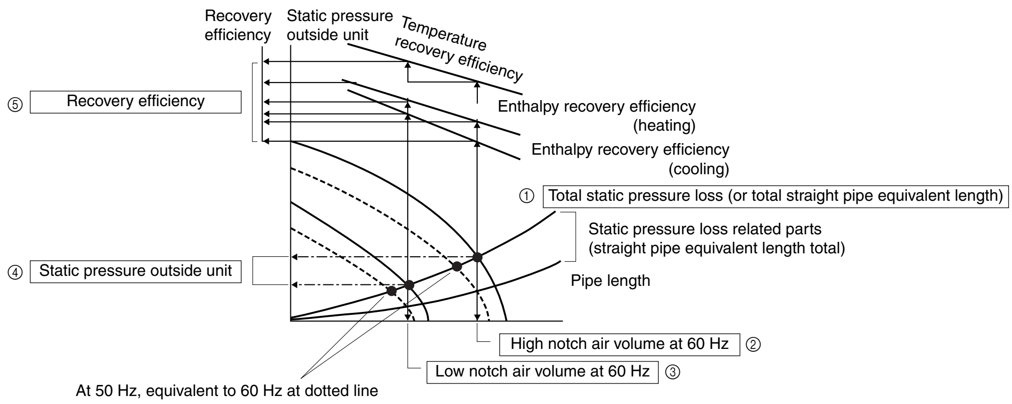
No.	Duct section	Outline diagram	Conditions	C value	Length of equivalent circular pipe
1	90° Smooth Elbow		R/D = 0.5	0.73	43D
			= 0.75	0.38	23D
			= 1.0	0.26	15D
			= 1.5	0.17	10D
			= 2.0	0.15	9D
2	Rectangular Radius Elbow		W/D R/D		
			0.5 0.5	1.30	79D
			0.5 0.75	0.47	29D
			0.5 1.0	0.28	17D
			0.5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

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	2.8	170D
			0.25	2.4	140D
			0.50	1.9	110D
			0.75	1.5	90D
			1	1.0	60D
			Loss is for V_2		
19	Pipe inlet (with circular hood)		β 20°	0.02	
			40°	0.03	
			60°	0.05	
			90°	0.11	
			120°	0.20	
20	Pipe inlet (with rectangular hood)		β 20°	0.03	
			40°	0.08	
			50°	0.12	
			90°	0.19	
			120°	0.27	
21	Abrupt contraction		V_1/V_2 = 0	0.5	30D
			0.25	0.45	27D
			0.50	0.32	19D
			0.75	0.18	11D
			Loss is for V_2		
22	Abrupt expansion		V_1/V_2 = 0	1.0	60D
			0.20	0.64	39D
			0.40	0.36	22D
			0.60	0.16	9D
			0.80	0.04	2D
			Loss is for V_1		
23	Suction inlet (punched narrow plate)		Free are ratio 0.2	35	
			0.4	7.6	
			0.6	3.0	
			0.8	1.2	

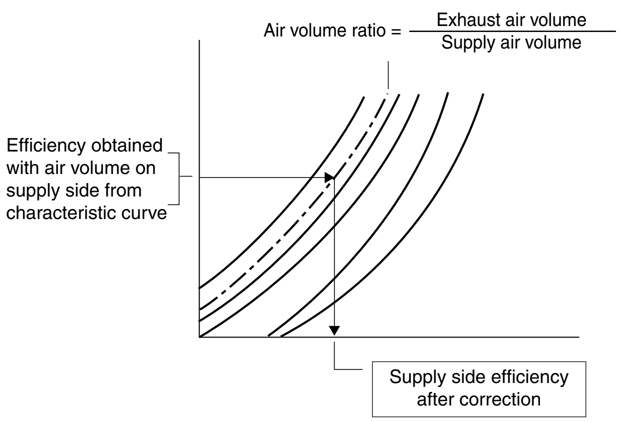
3. How to Obtain Efficiency from Characteristic Curves

3.1 Commercial-use Lossnay

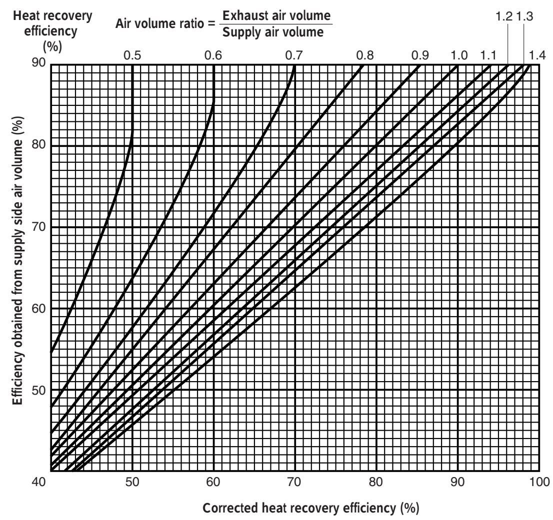
How to read Commercial-use Lossnay characteristic curve



- 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.

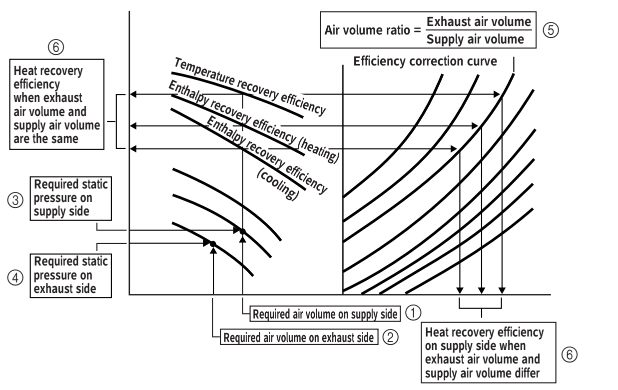


Heat recovery efficiency correction curve

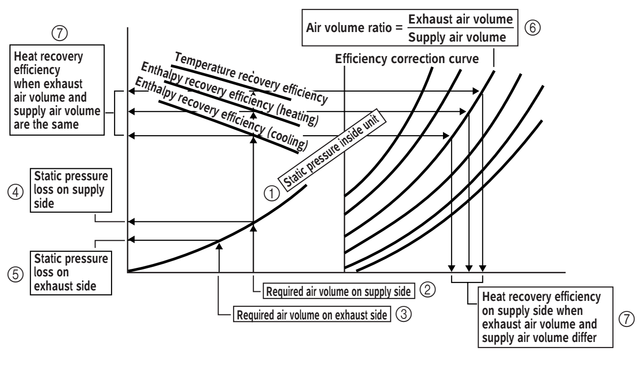


3.2 Building-use Lossnay

How to read LP type Lossnay characteristic curve



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



4. Sound

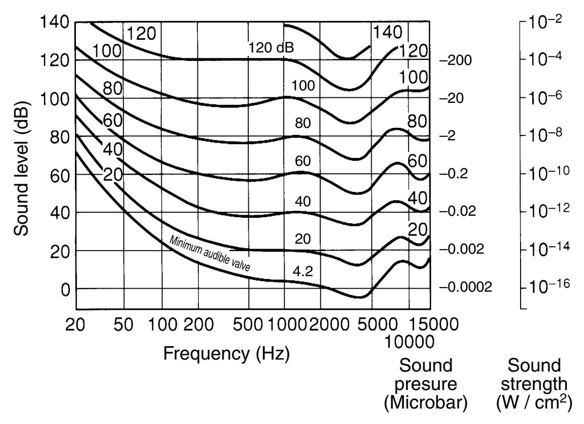
Sound is emitted when any object is excited causing it to vibrate. The object that vibrates is called the sound source, and the energy that is generated at the source is transmitted through the air to the human ear. Humans can hear the sound only when the ear drum vibrates.

4.1 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 20 Hz to 15,000 Hz which can be felt by the human ear, the strength of sound that can be felt that is equivalent to a 1,000 Hz 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 1,000 Hz is expressed. These are called units of phons. For example, the point on the 60 curve is perceived as 60 phons.

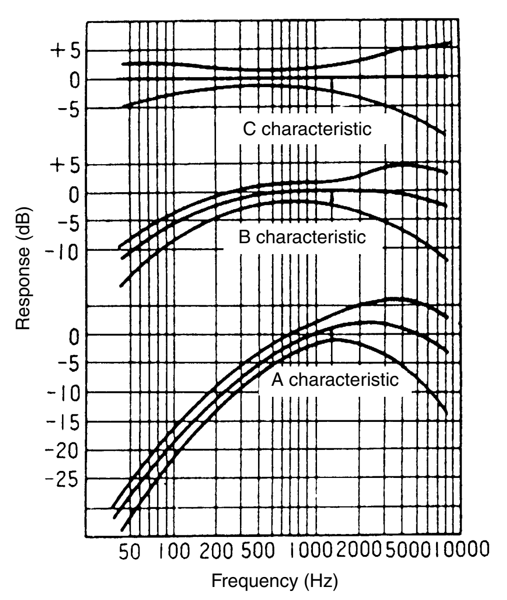
- On average, the human senses a sound that is less than 1,000 Hz as rather weak, and a sound between 2,000 to 5,000 Hz as strong.

ISO audio perception curve



4.2 How to measure sound levels

A sound level meter (JIS C1502) 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.

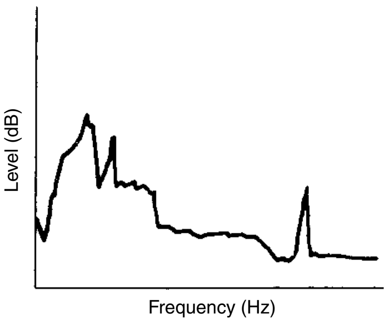


4.3 Frequency analysis of sound

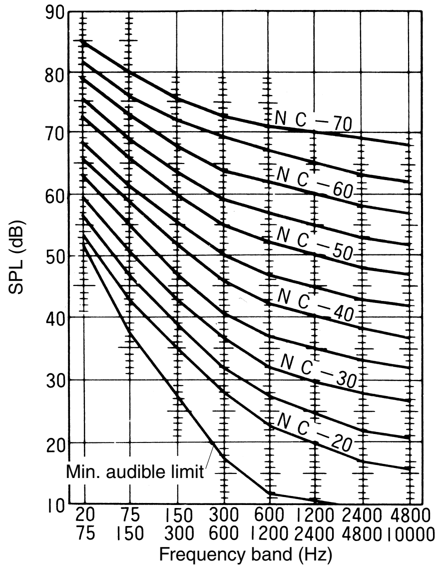
It is said that the human ear senses differently according to the frequency. However, the sound generated from a vibration is not limited to one frequency, but instead, various frequencies are generated at differing levels. This is expressed by the NC curve, which is determined according to the difficulty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

Example Continuous frequency analysis



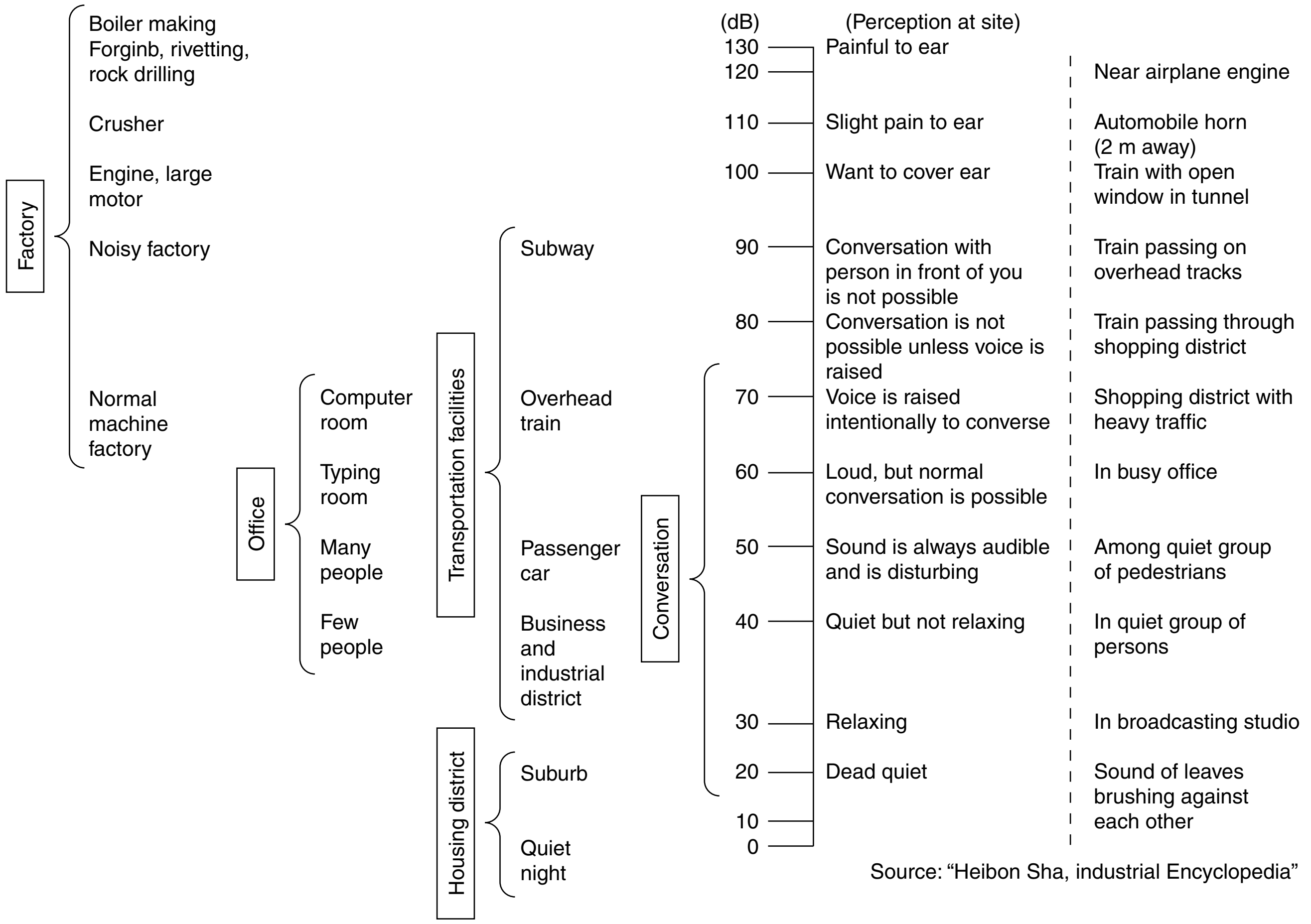
NC curve



- **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 or more

* 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



Source: “Heibon Sha, industrial Encyclopedia”

4.4 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.

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

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

2) Principal model

Consider the room shown in Figs. 1 and 2.

- Fig. 1 shows an example of the integrated main unit and supply air diffuser (and return grille). This is equivalent to the cassette-type Lossnay.
  Fig. 2 shows an example of a separated main unit and supply air diffuser (and return grille). This is equivalent to the ceiling embedded-type Lossnay.
- a is the direct sound from the supply air 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.

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

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 [$R = \overline{\alpha}S/(1 - \overline{\alpha})$]
$\overline{\alpha}$: Average sound absorption ratio in room (Normally, 0.1 to 0.2)
S : Total surface area in room [m^2]

Fig. 1

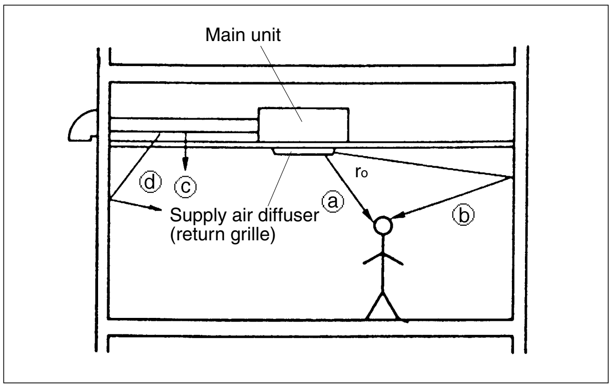


Fig. 2

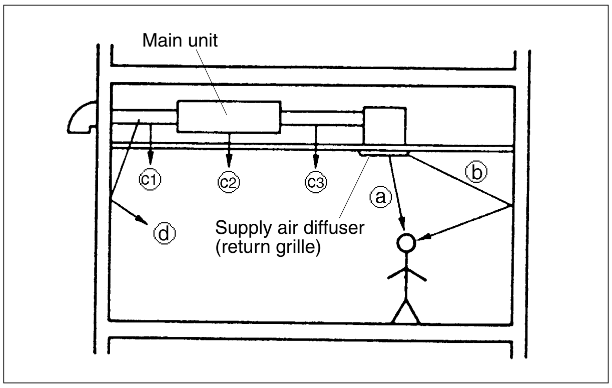
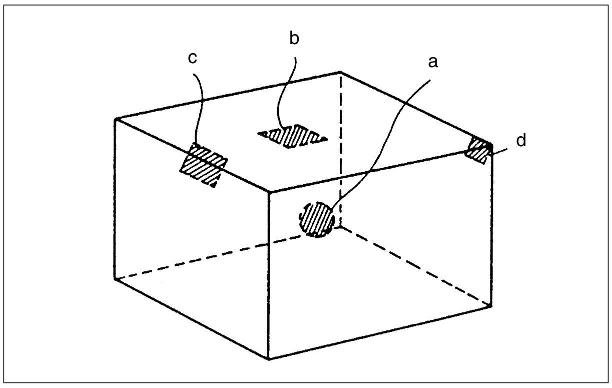


Fig. 3 (Sound source position and directivity factor Q)



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

- For the supply air 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 air 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 frequwncy band, and is combined with formula (III) for an accurate value.

(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. ø 250 → ø 150, ø 200 → ø 100)
   - 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.)

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
	1,000	26	28	26
	2,000	34	35	24
	4,000	42	39	—

Fig. 4

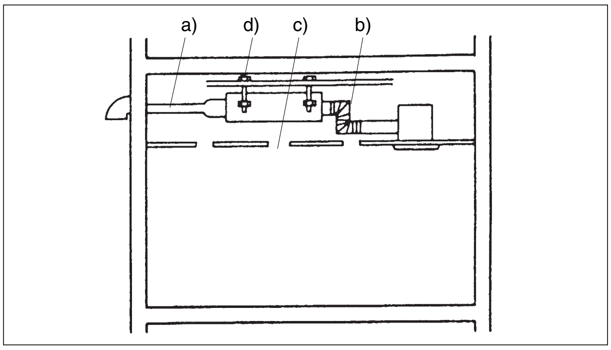
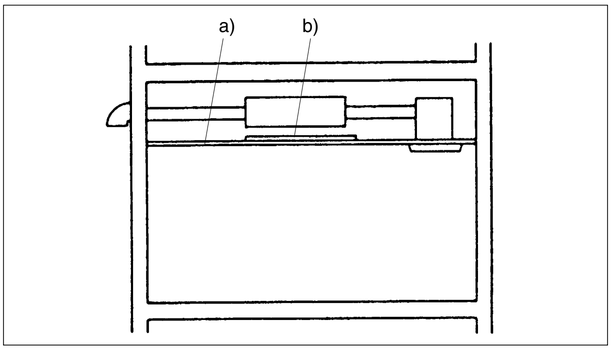


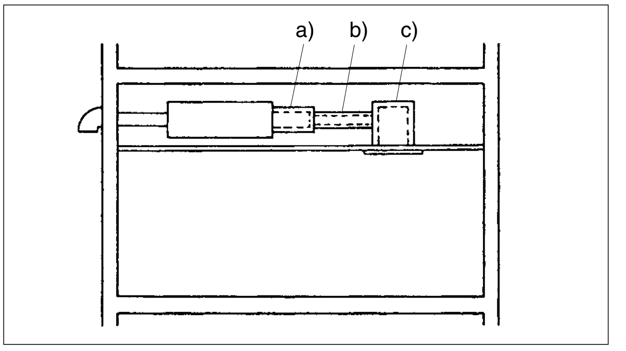
Fig. 5



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

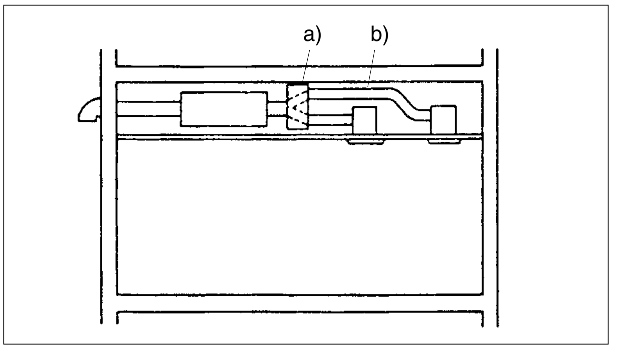
(A) If the main unit is separated from the supply air diffuser (and return grille) as shown in Fig. 6, the use of a silencer box a), silence duct b) or silence grille c) is recommended.

Fig. 6



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

Fig. 7

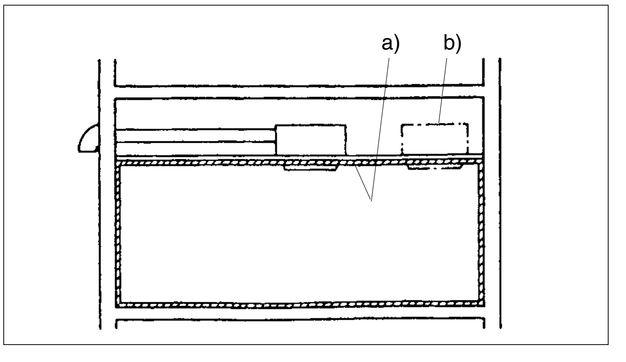


3) When supply air diffuser (and return grille) is sound source
..... part 2

(A) If the main unit and supply air 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 center of the room, but will be inadequate towards people in the corner of the room.

Fig. 8

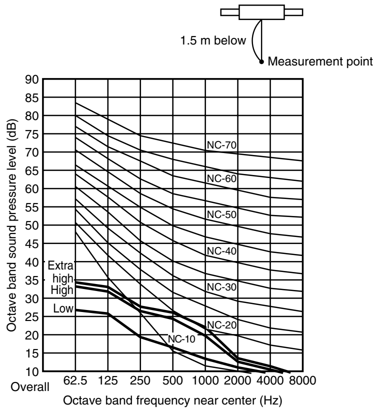


5. NC Curves (LGH-RX3 Series)

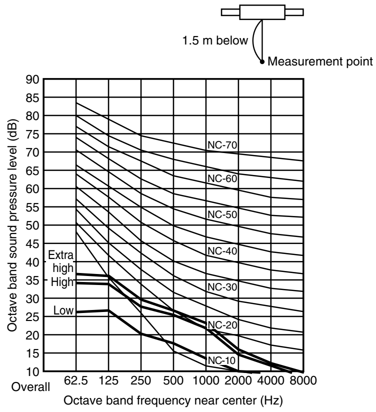
● Ceiling embedded-type

LGH-15RX3

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

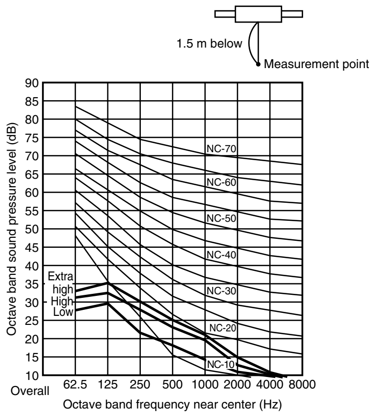


Background noise : 25 dB or less (A range)
Measurement site : Anechoic chamber
Operation conditions : Lossnay ventilation

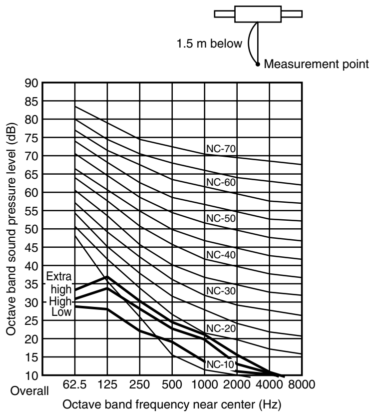


LGH-20RX3

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

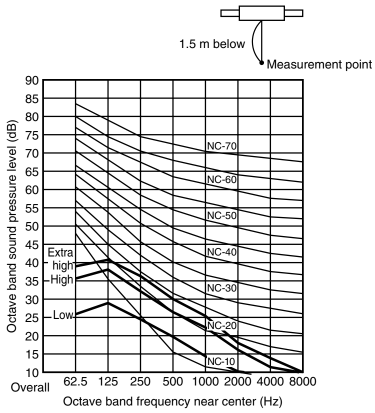


Background noise : 25 dB or less (A range)
Measurement site : Anechoic chamber
Operation conditions : Lossnay ventilation

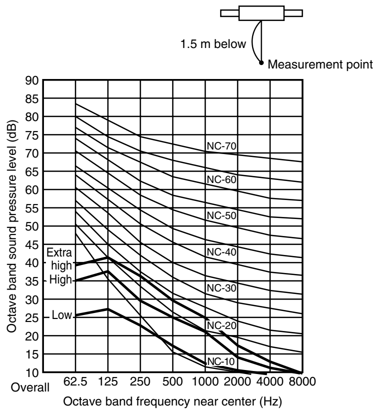


LGH-35RX3

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

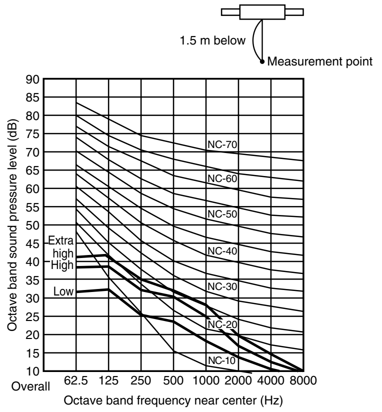


Background noise : 25 dB or less (A range)
Measurement site : Anechoic chamber
Operation conditions : Lossnay ventilation

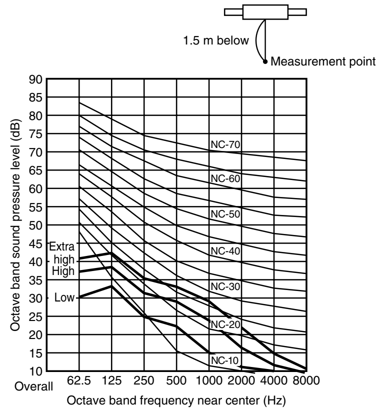


LGH-50RX3

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

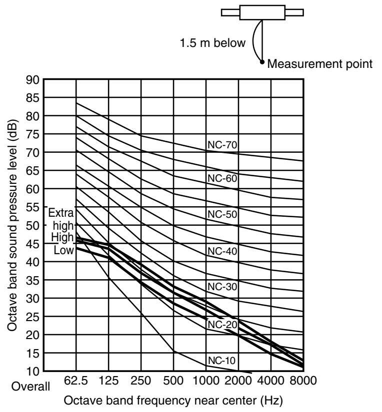


Background noise : 25 dB or less (A range)
Measurement site : Anechoic chamber
Operation conditions : Lossnay ventilation

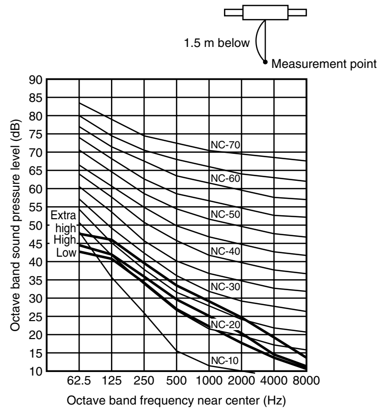


LGH-80RX3

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

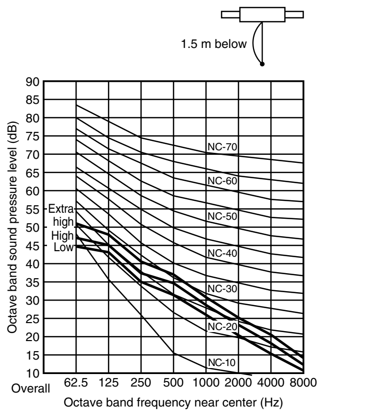


Background noise : 25 dB or less (A range)
Measurement site : Anechoic chamber
Operation conditions : Lossnay ventilation

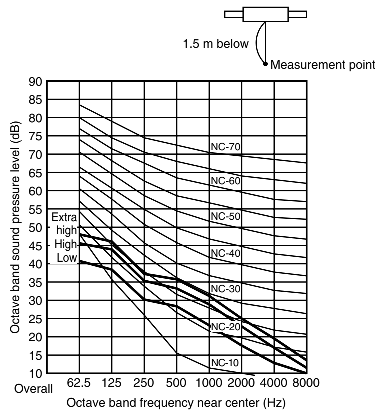


LGH-100RX3

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

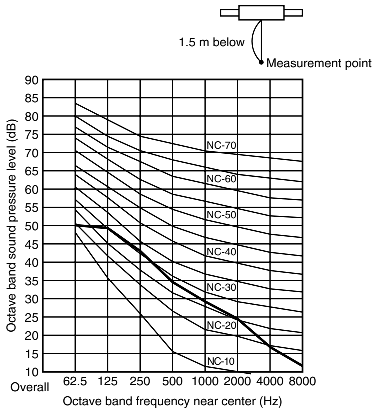


Background noise : 25 dB or less (A range)
Measurement site : Anechoic chamber
Operation conditions : Lossnay ventilation

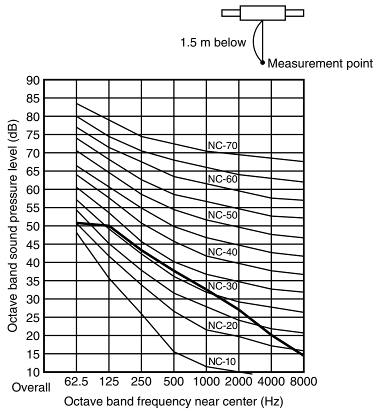


LGH-150RX3

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

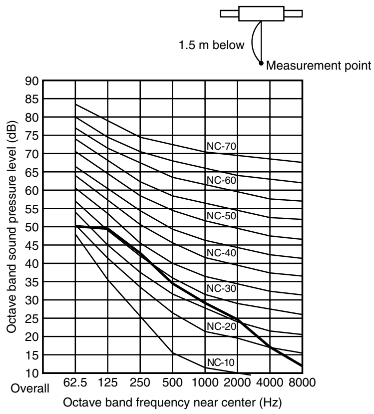


Background noise : 25 dB or less (A range)
Measurement site : Anechoic chamber
Operation conditions : Lossnay ventilation

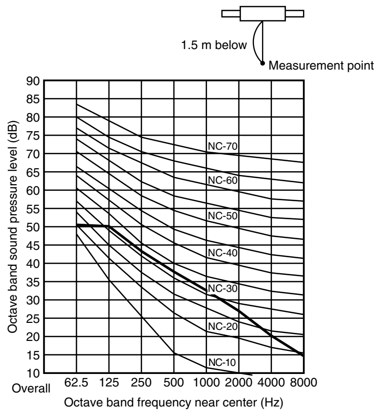


LGH-200RX3

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



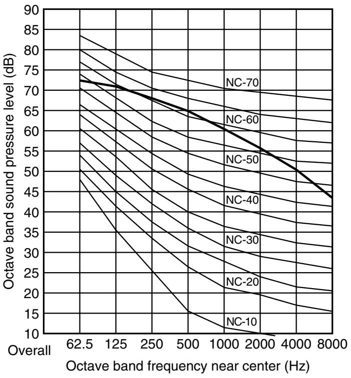
Background noise : 25 dB or less (A range)
Measurement site : Anechoic chamber
Operation conditions : Lossnay ventilation



● Lossnay Pack-type for Buildings

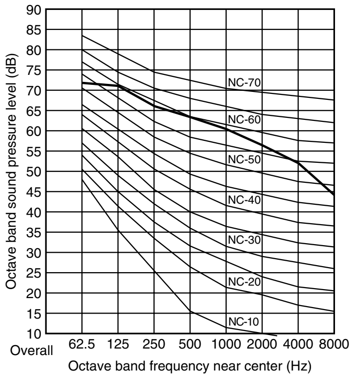
LP-200B

Background noise : 51 dB (A range)
Measurement site : Fan test operation site
Measurement position : 1.5 m from the front center of the unit, 1 m above the floor
Operation conditions : Lossnay ventilation



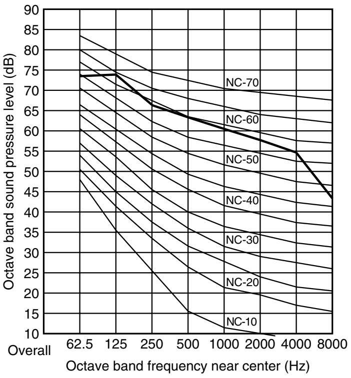
LP-350B

Background noise : 51 dB (A range)
Measurement site : Fan test operation site
Measurement position : 1.5 m from the front center of the unit, 1 m above the floor
Operation conditions : Lossnay ventilation



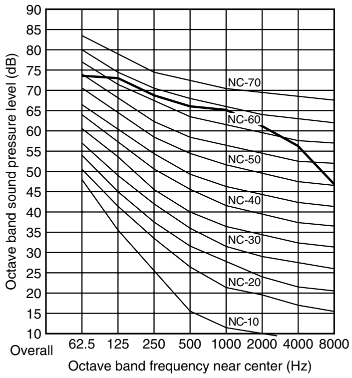
LP-500B

Background noise : 51 dB (A range)
Measurement site : Fan test operation site
Measurement position : 1.5 m from the front center of the unit, 1 m above the floor
Operation conditions : Lossnay ventilation



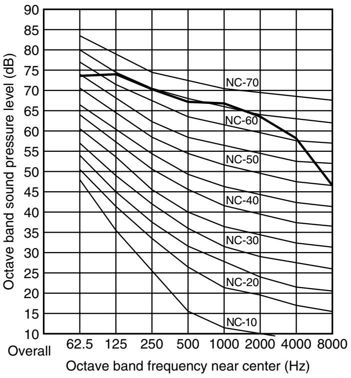
LP-750B

Background noise : 51 dB (A range)
Measurement site : Fan test operation site
Measurement position : 1.5 m from the front center of the unit, 1 m above the floor
Operation conditions : Lossnay ventilation



LP-1000B

Background noise : 51 dB (A range)
Measurement site : Fan test operation site
Measurement position : 1.5 m from the front center of the unit, 1 m above the floor
Operation conditions : Lossnay ventilation



6. List of Models

6.1 Model specifications

Type			Model	Air volume (m³/h)			Power supply	Connection duct diameter or embedded dimensions	Application			Applicable No. of people
				Extra-high	High	Low			Installa-tion site	Building example	Application site example	
Industrial <Lossnay>	Ceiling embedded-type		LGH-15RX3	150/150	150/150	120/110	Single-phase 220 to 240 V / 50 Hz 200V / 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-25RX3	250/250	250/250	180/160	Same as above	ø150				8 - 13
			LGH-35RX3	350/350	350/350	230/210	Same as above	ø150				11 - 18
			LGH-50RX3	500/500	500/500	350/300	Same as above	ø200				16 - 25
			LGH-80RX3	800/800	800/800	670/660	Same as above	ø250				26 - 40
			LGH-100RX3 -50 / 60	1,000/1,000	1,000/1,000	870/720	Same as above	ø250				33 - 50
			LGH-150RX3	1,500/1,500	1,500/1,500	1,340/1,320	Same as above	ø350				50 - 75
			LGH-200RX3 -50 / 60	2,000/2,000	2,000/2,000	1,740/1,440	Same as above	ø350				66 - 100
	Ceiling exposed-type		LGH-50E5	—	490/480	300/260	Single-phase 50/60Hz	ø200 or 210 × 590		School, shop, welfare facility, hall	Office, conference room, etc.	16 - 25
Building <Lossnay>	Lossnay Pack		LP-200B	1,000 - 2,900			Three-phase 50 or 60 Hz	250 × 350	Machine room installation	Government agency, office building, hospital, welfare facility, hall, shop, school, hotel	Office, conference room, hall	40 - 145
			LP-350B	2,000 - 5,000			Same as above	325 × 400			Office, conference room, hall, library	80 - 250
			LP-500B	4,000 - 7,000			Same as above	405 × 500			Office, hall, library, pachinko parlour	160 - 350
			LP-750B	4,000 - 10,000			Same as above	405 × 540 1200 × 540			Office, theatre, library, pachinko parlour	160 - 500
			LP-1000B	6,000 - 13,000			Same as above	405 × 540 1200 × 540			Office, theatre	240 - 650
	Lossnay Unit	Vertical-type	LUT-2302 - 2308	2,000 - 28,000			—	—		Government agency, office building, hospital, welfare facility, hall, shop, school, hotel	Office, conference room, hall, library, pachinko parlour, theatre	185 - 920
			LUT-3002 - 3008	3,000 - 36,000			—	—				240 - 1200
		Horizon tal-type	LU-80,160,500	300 - 7,000			—	—				30 - 250
			LU-1602 - 1606	1,200 - 13,200			—	—				130 - 480
			LU-502 - 505	4,000 - 35,000			—	—				400 - 1250
Industrial <Lossnay>	Moisture resistant		LUP-80, 160, 500	500 - 6,000			—	—		Hotel, pension, welfare facility, sports facility, factory	Large bath, heated pool, drying equipment	—
			LU-1602 - 1606	1,600 - 14,400			—	—				—
			LUP-502 - 505	4,000 - 35,000			—	—				—

6.2 List of material colours for Industrial Lossnay

Model	Colour		Outside		Heat recovery unit				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-15RX$_3$	—	—	Molten galvanized steel plate	—	Incombustible treated paper	145 × 145 × 546	1.7 kg	1	—	—	—
LGH-25RX$_3$	—	—	Molten galvanized steel plate	—	Incombustible treated paper	171 × 171 × 322	1.2 kg	2	—	—	—
LGH-35RX$_3$	—	—	Molten galvanized steel plate	—	Incombustible treated paper	198 × 198 × 387	2.0 kg	2	—	—	—
LGH-50RX$_3$	—	—	Molten galvanized steel plate	—	Incombustible treated paper	198 × 198 × 458	2.3 kg	2	—	—	—
LGH-80RX$_3$	—	—	Molten galvanized steel plate	—	Incombustible treated paper	267 × 267 × 440	3.8 kg	2	—	—	—
LGH-100RX$_3$	—	—	Molten galvanized steel plate	—	Incombustible treated paper	267 × 267 × 553	4.8 kg	2	—	—	—
LGH-150RX$_3$	—	—	Molten galvanized steel plate	—	Incombustible treated paper	267 × 267 × 440	3.8 kg	4	—	—	—
LGH-200RX$_3$	—	—	Molten galvanized steel plate	—	Incombustible treated paper	267 × 267 × 553	4.8 kg	4	—	—	—
LGH-50E$_5$	5Y 8.5/1	Y-62	Steel plate	Melamine baked finish	Incombustible treated paper	178 × 198 × 1,129	8.0 kg	1	—	—	—

Model	Blades		Filter				Insulation material	Product usage conditions		
	Material	Shape, diameter	Material	Dimensions	Q'ty	Filtering efficiency	Material	Ambient temperature	Exhaust air conditions (RA)	Supply air conditions (OA)
LGH-15RX$_3$-E	ABS resin	Centrifugal fan ø180	Prefilter 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(-15)°C to +40°C RH80% or less
LGH-25RX$_3$-E	ABS resin	Centrifugal fan ø180	Prefilter NP/400	658 × 151 × 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(-15)°C to +40°C RH80% or less
LGH-35RX$_3$-E	ABS resin	Centrifugal fan ø220	Prefilter NP/400	789 × 175 × 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(-15)°C to +40°C RH80% or less
LGH-50RX$_3$-E	ABS resin	Centrifugal fan ø220	Prefilter NP/400	931 × 178 × 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(-15)°C to +40°C RH80% or less
LGH-80RX$_3$-E	Steel plate	Centrifugal fan ø245	Prefilter NP/400	895 × 238 × 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(-15)°C to +40°C RH80% or less
LGH-100RX$_3$-E	Steel plate	Centrifugal fan ø245	Prefilter NP/400	1,122 × 238 × 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(-15)°C to +40°C RH80% or less
LGH-150RX$_3$-E	Steel plate	Centrifugal fan ø245	Prefilter NP/400	895 × 238 × 15	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(-15)°C to +40°C RH80% or less
LGH-200RX$_3$-E	Steel plate	Centrifugal fan ø245	Prefilter NP/400	1,122 × 238 × 15	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(-15)°C to +40°C RH80% or less
LGH-50E$_5$	ABS resin	Centrifugal fan ø200	Prefilter NP/400	(Intake side) 1,129 × 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(-15)°C to +40°C RH80% or less

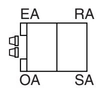
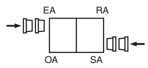
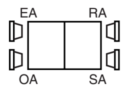
6.3 List of material colours for Building Lossnay

Model	Colour		Outside		Heat recovery unit			
	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: 1.6 t	Polyester powder	Incombustible treated paper	□ 550 × 487	22 kg	2
LP-350B	5Y 6.5/1	N-E6	Steel plate Thickness: 1.6 t	Polyester powder	Incombustible treated paper	□ 550 × 487	22 kg	3
LP-500B	5Y 6.5/1	N-E6	Steel plate Thickness: 1.6 t	Polyester powder	Incombustible treated paper	□ 550 × 487	22 kg	4
LP-750B	5Y 6.5/1	N-E6	Steel plate Thickness: 1.6 t	Polyester powder	Incombustible treated paper	□ 550 × 487	22 kg	6
LP-1000B	5Y 6.5/1	N-E6	Steel plate Thickness: 1.6 t	Polyester powder	Incombustible treated paper	□ 550 × 487	22 kg	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 fan	Prefilter NP/400	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 fan	Prefilter NP/400	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 fan	Prefilter NP/400	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 fan	Prefilter NP/400	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 fan	Prefilter NP/400	505 × 531 × 20	16	Gravitational method 85%	Self-extinguishing urethane foam	-10°C to +40°C RH80% or less

Model	Colour		Outside		Heat recovery unit				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: 1.6 t	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: 1.6 t	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: 1.6 t	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: 1.6 t	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: 1.2 t	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: 1.2 t	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: 1.6 t	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: 1.2 t	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: 1.2 t	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: 1.6 t	Polyester powder	Polypropylene resin	□ 550 × 495	32 kg	4	—	-10°C to +80°C RH100%
LSM-150	7.5BG 6/1.5	B-8001	Steel plate Thickness: 1.2 t	Melamine baked finish	Aluminum	□ 300 × 481.8	25 kg	2	—	-10°C to +160°C RH100%

6.4 List of industrial/business Lossnay accessories

<table>
<tr><th>Model</th><th>Accessories</th><th>Duct packaging site</th></tr>
<tr><td>LGH-15RX3</td><td rowspan="6">● Duct connection flanges . . . . × 4
● Mounting screws . . . . × 34
● Washers . . . . × 32
● Protective cover . . . . × 1 <For installing upside down>
● Lossnay connection cable . . . . × 1
● IB . . . . × 1
● IM . . . . × 1</td><td rowspan="4">
* Top view. There is a space between the EA side and the OA side.</td></tr>
<tr><td>LGH-25RX3</td></tr>
<tr><td>LGH-35RX3</td></tr>
<tr><td>LGH-50RX3</td></tr>
<tr><td>LGH-80RX3</td><td rowspan="2">2 are inserted on top of each other at the SA and EA openings, in the opposite direction.
* Top view.
</td></tr>
<tr><td>LGH-100RX3</td></tr>
<tr><td>LGH-150RX3
LGH-200RX3</td><td>● Mounting screws . . . . × 18
● Duct connection flange . . . . × 4 <double flanges at SA and EA sides>
● Protective cover . . . . × 1 <For installing upside down>
● Lossnay connection cable . . . . × 1
● IB . . . . × 1
● IM . . . . × 1</td><td>
* Top view. One is inserted at each opening in the opposite direction.</td></tr>
<tr><td>LGH-50E5</td><td>Round duct connection flange: 2, slave unit fixing plate: 1</td><td rowspan="8"></td></tr>
<tr><td>LP-200B</td><td>Touch-up paint</td></tr>
<tr><td>LP-350B</td><td>Touch-up paint</td></tr>
<tr><td>LP-500B</td><td>Touch-up paint</td></tr>
<tr><td>LP-750B</td><td>Touch-up paint, M6 nut: 6, M6 washer: 6</td></tr>
<tr><td>LP-1000B</td><td>Touch-up paint, M6 nut: 6, M6 washer: 6</td></tr>
<tr><td>LUT-2302, 2303</td><td>Upper connection fitting: 2, lower connection fitting: 2,
M8 screw: 8, M10 screw: 4, M10 washer: 4, packing: 3</td></tr>
<tr><td>LUT-3002, 3003</td><td>Upper connection fitting: 2, lower connection fitting: 2,
M8 screw: 8, M10 screw: 4, M10 washer: 4, packing: 3</td></tr>
</table>

CHAPTER 5
System Design Recommendations

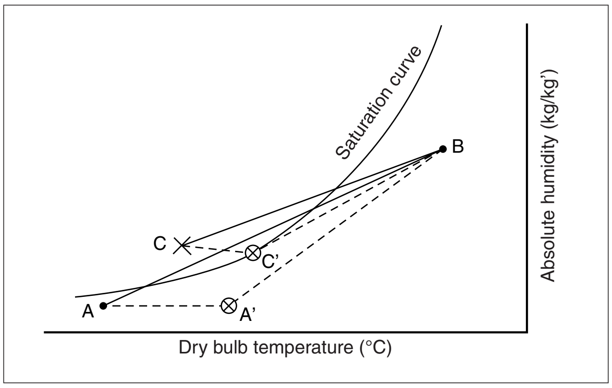
1. Lossnay Usage Conditions

		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.
Facility 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:

1.1 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'.



1.2 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)

1.3 Use in other special conditions

- **The Lossnay cannot be used where toxic gases and corrosive element's 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 11 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

<table>
<tr><th>Measurement conditions</th><th>Gas</th><th>Air volume ratio
Q_{SA}/Q_{RA}</th><th>Exhaust air concentration
C_{RA} (ppm)</th><th>Supply air concentration
C_{SA} (ppm)</th><th>Transmission rate
(%)</th><th>Max. workplace concentrations
(ppm)</th></tr>
<tr><td rowspan="21">Measurement method
• Chemical analysis with colorimetric method for H_2SO_4, HCHO
• Ultrasonic method with gas concentration device for CO, SF_6
• Infrared method with gas concentration device for CO_2
• Gas chromatography for others
The fans are positioned at the air supply/exhaust suction positions of the element
Measurement conditions:
27°C, 65% RH
* OA density for CO_2 is 600 ppm.</td><td>Hydrogen fluoride</td><td>1.0</td><td>36</td><td><0.5</td><td>- 0</td><td>0.6</td></tr>
<tr><td>Hydrogen chloride</td><td>1.0</td><td>42</td><td><0.5</td><td>- 0</td><td>5</td></tr>
<tr><td>Nitric acid</td><td>1.0</td><td>20</td><td><0.5</td><td>- 0</td><td>10</td></tr>
<tr><td>Sulfulic acid</td><td>1.0</td><td>2.6 mg/m^3</td><td>- 0 mg/m^3</td><td>- 0</td><td>0.25</td></tr>
<tr><td>Trichlene</td><td>1.0</td><td>85</td><td>2.5</td><td>2.9</td><td>200</td></tr>
<tr><td>Acetone</td><td>1.0</td><td>5</td><td>0.13</td><td>2.5</td><td>1,000</td></tr>
<tr><td>Xylene</td><td>1.0</td><td>110</td><td>2.5</td><td>2.3</td><td>150</td></tr>
<tr><td>Isopropyl alcohol</td><td>1.0</td><td>2,000</td><td>50</td><td>2.5</td><td>400</td></tr>
<tr><td>Methanol</td><td>1.0</td><td>41</td><td>1.0</td><td>2.4</td><td>200</td></tr>
<tr><td>Ethanol</td><td>1.0</td><td>35</td><td>1.0</td><td>2.9</td><td>1,000</td></tr>
<tr><td>Ethyl acetate alcohol</td><td>1.0</td><td>25</td><td>0.55</td><td>2.2</td><td>400</td></tr>
<tr><td>Ammonia</td><td>1.0</td><td>70</td><td>2</td><td>2.9</td><td>50</td></tr>
<tr><td>Hydrogen sulfide</td><td>1.0</td><td>15</td><td>0.44</td><td>2.9</td><td>10</td></tr>
<tr><td>Carbon monoxide</td><td>1.0</td><td>71.2</td><td>0.7</td><td>1.0</td><td></td></tr>
<tr><td>Carbon dioxide</td><td>1.0</td><td>44,500</td><td>1,400</td><td>1.8</td><td></td></tr>
<tr><td>Smoke</td><td>1.0</td><td>–</td><td>–</td><td>1 - 2</td><td></td></tr>
<tr><td>Formaldehyde</td><td>1.0</td><td>0.5</td><td>0.01</td><td>2</td><td>0.08</td></tr>
<tr><td>Sulfur hexaflouride</td><td>1.0</td><td>27.1</td><td>0.56</td><td>2.1</td><td></td></tr>
<tr><td>Skatole</td><td>1.0</td><td>27.1</td><td>0.56</td><td>2.0</td><td></td></tr>
<tr><td>Indole</td><td>1.0</td><td>27.1</td><td>0.56</td><td>2.0</td><td></td></tr>
<tr><td>Toluene</td><td>1.0</td><td>6.1</td><td>0.14</td><td>2.3</td><td></td></tr>
</table>

⚠ **CAUTION**

The above does not apply to the moisture resistant total heat recovery unit.

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

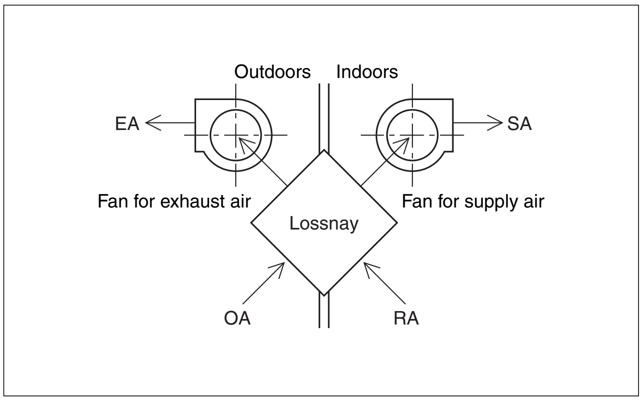
Main generation site	Gas name	Molecular formula mist	Gas vapour odor	Non-toxic/ toxic/	Sulubility in water		Max. workplace concentration	Useability of Lossnay
					mℓ/mℓ	g/100g		
Chemical plantor chemical laboratory	Sulfuric acid	H_2SO_4	Mist	Found		2,380	0.25	×
	Nitric acid	HNO_3	Mist	Found		180	10	×
	Phosphoric acid	H_3PO_4	Mist	Found		41	0.1	×
	Acetic acid	CH_3COOH	Mist	Bad odor		2,115	25	×
	Hydrogen chloride	HCl	Gas	Found	427	58	5	×
	Hydrogen fluoride	HF	Gas	Found		90	0.6	×
	Sulfur dioxide	SO_2	Gas	Found	32.8		0.25	△
	Hydrogen sulfide	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	Vapor	Found	Soluble		200	△
	Ethanol	CH_3CH_2OH	Vapor	Found	Soluble		1,000	△
	Ketone		Vapor	Found	Soluble		1,000	△
Toilet	Skatole	C_9H_9N	Gas	Bad odor	Minute			○
	Indole	C_9H_7N	Gas	Bad odor	Minute			○
	Ammonia	NH_3	Gas	Bad odor	635	40	50	×
Others	Nitric monoxide	NO			0.0043		50	○
	Ozone	O_3				0.00139	0.1	○
	Methane	CH_4			0.0301			○
	Chlorine	Cl_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			○

Note: 1. Water soluble gases and mists cannot be used because the amount that is transmitted with the water is too great.
2. Acidic gases and mists cannot be used because these will accumulate in the Core and cause damage.
3. The above does not apply to the moisture resistant total heat recovery unit.

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

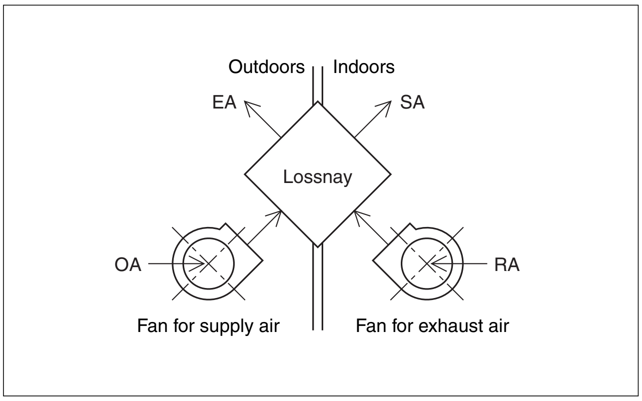
The following four methods can be used for when setting the Lossnay supply and exhaust fans around the Lossnay Core. When using the LU and LUT models, methods a or b should be used in respect of both the Lossnay Core air leakage and effective air ventilation. Use method c if air leakage to the RA or 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



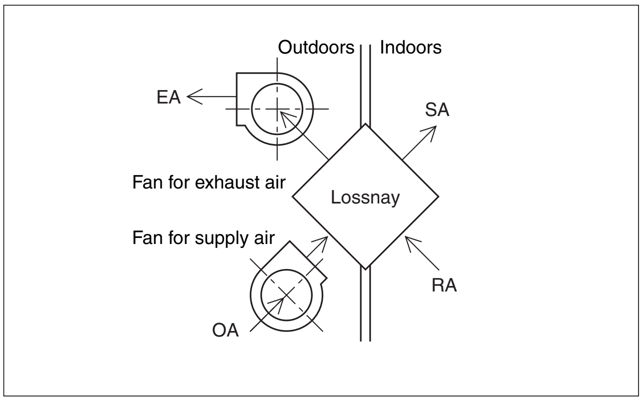
If the static pressure difference between SA and RA and between EA and OA is 50mmAq, the air leakage rate will be 2.5%, and 3.4%. This value is of no problem for most standard uses.

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



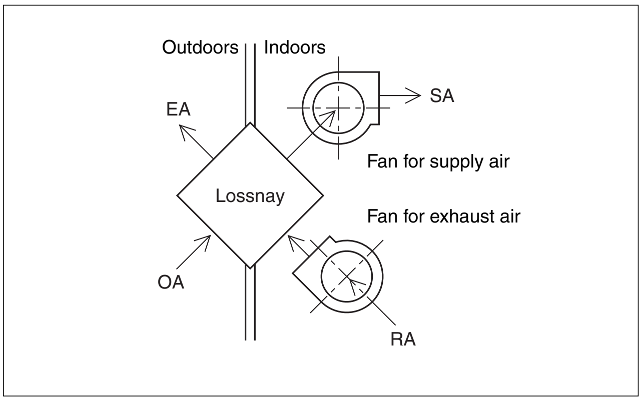
The air leakage rate is the same as in system a.

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

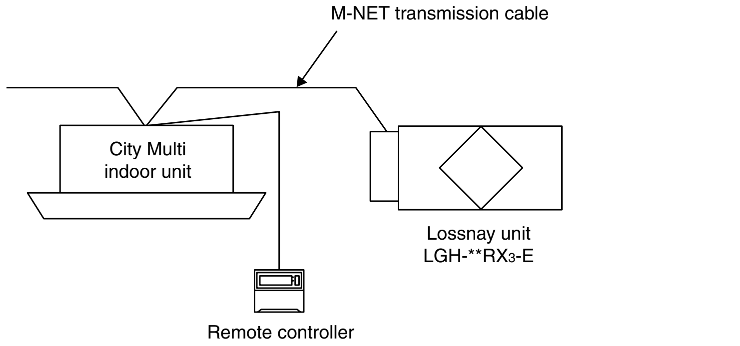


In this case, the intake side pressure (OA-SA) will be negative, and the exhaust side pressure (RA-EA) will be positive, so the amount of air leakage to the intake side will be the greatest. If the static pressure difference between OA and RA is 50 mmAq, the air leakage rate will be 10.5%, and 13.0%.
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.

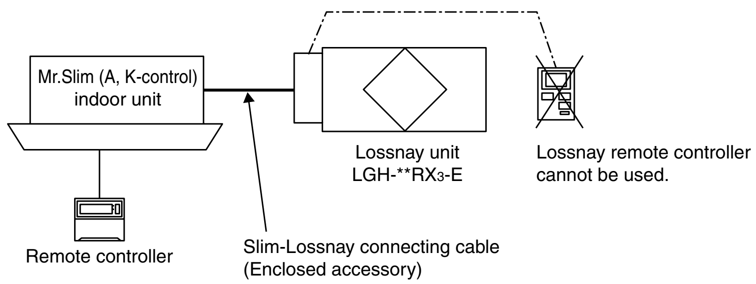
9. Combined Operation with other Air Conditioners

Connecting the Lossnay can configure the following system.

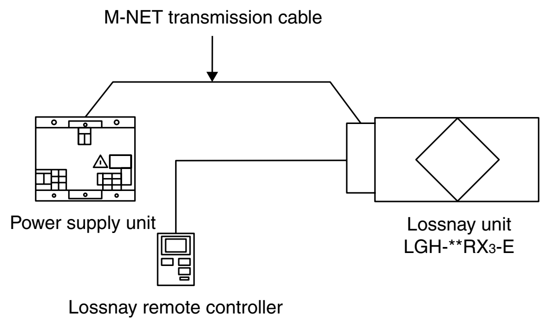
Interlocked with City Multi



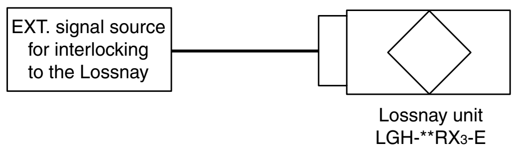
Interlocked with Mr. Slim



Independent Lossnay Unit (Not interlocked with City Multi or Mr. Slim systems.)



Interlocked with external unit (BMS)



10. Automatic Ventilation Switching

Effect of Automatic Ventilation Mode

The automatic damper mode automatically provides the correct ventilation for the conditions in the room. It eliminates the need for troublesome switch operations when setting the Lossnay ventilator to “By-pass” ventilation. The following shows the effect “By-pass” ventilation will have under various conditions.

(1) Reduces cooling load

If the air outside is cooler than the air inside the building during the cooling season (such as early morning or at night), “By-pass” ventilation will draw in the cooler outside air and reduce the cooling load on the system.

(2) Cooling using outdoor air

During cooler seasons (such as between spring and summer or between summer and fall), if the people in a room cause the temperature of the room to rise, “By-pass” ventilation draw in the cool outside air and use it as is to cool the room.

(3) Night purge

“By-pass” ventilation can be used to release hot air from inside the building that has accumulated in buildings a business district during the hot summer season.

(4) Office equipment room cooling

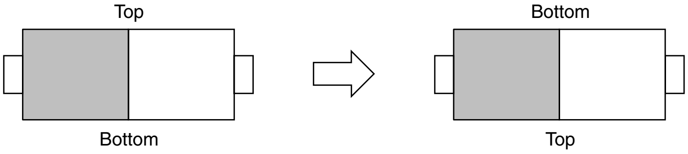
During cold season, outdoor air can be drawn in and used as is to cool rooms where the temperature has risen due to the use of office equipment.
(Only when interlocked with City Multi and Mr. Slim indoor unit)

11. Vertical Installation of LGH Series

Installation of ceiling embedded-type industrial Lossnay

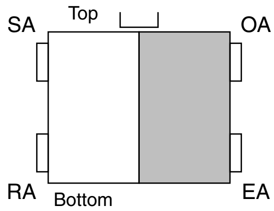
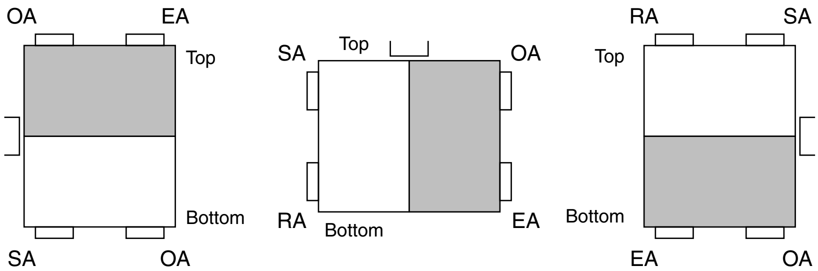
11.1 Top/bottom reverse installation

All LGH-RX3 models can be installed in reverse.



11.2 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-15RX3 LGH-25RX3	
LGH-35RX3 LGH-50RX3 LGH-80RX3 LGH-100RX3	

(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.)

11.3 Slanted installation

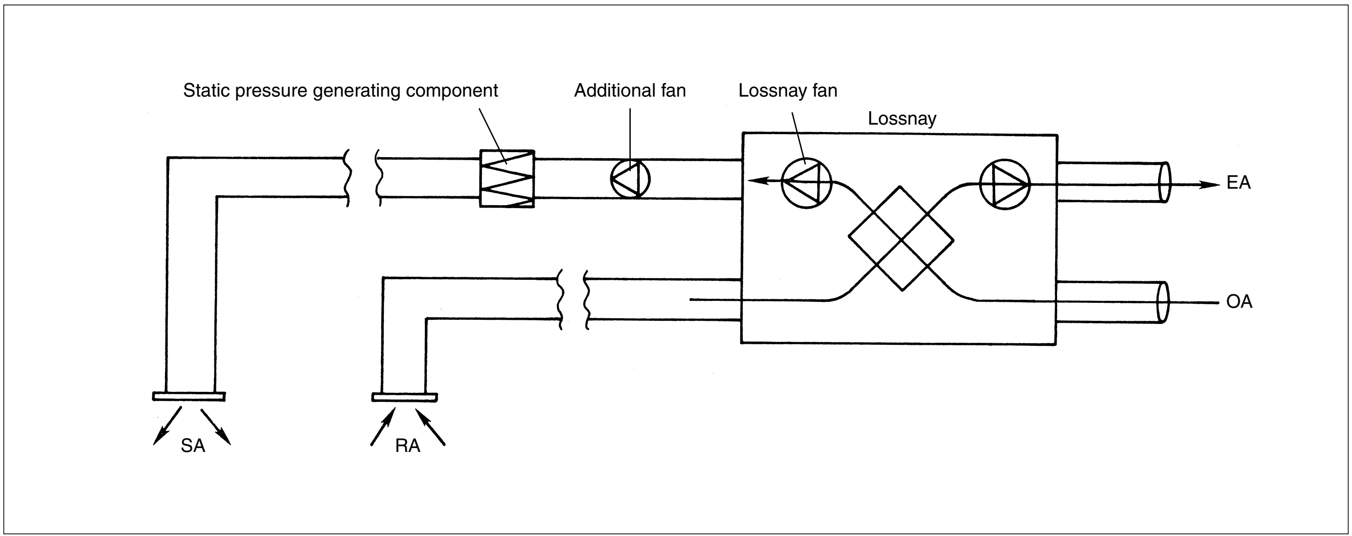
Slanted installation is not possible.

Special note

The LGH-RX3 model was conventionally designed for being embedded in the ceiling. If possible, vertical installation should be avoided in regard to construction and maintenance.

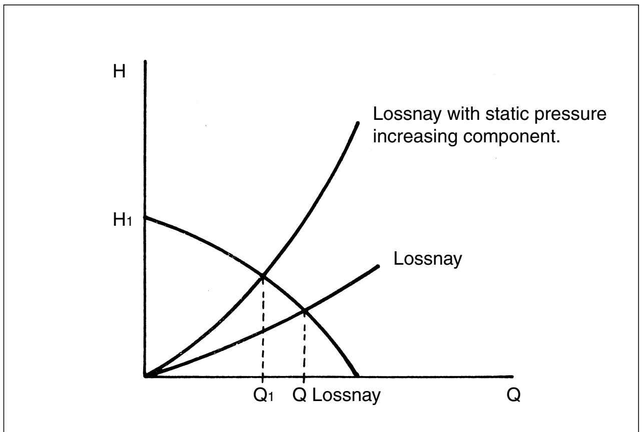
12. Installation of Supplementary Fan Devices After Lossnay Unit

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.

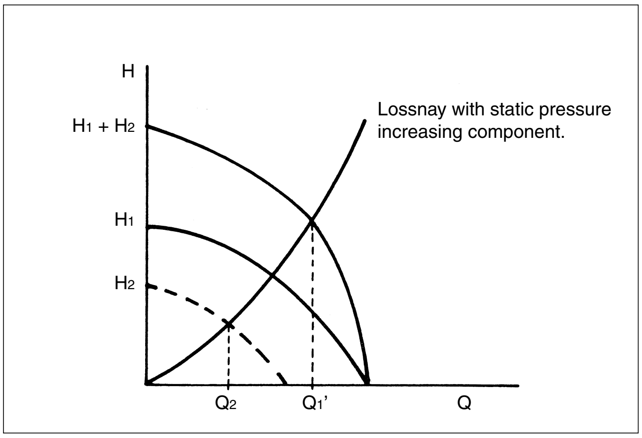


For such an installation care should be taken to avoid undue stress on the fan motors. Referring to the diagrams below, so long as $Q_1' \geq Q_2$, there is no adverse effect on the motors. This is generally such in the majority of cases.

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

1.1 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 centrifugal fan.

Setting outline

- Building form : Basement floor SRC (Slab Reinforced Concrete), 8 floors above ground S construction
  Total floor space 30,350 m^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 centrifugal fan

1.2 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

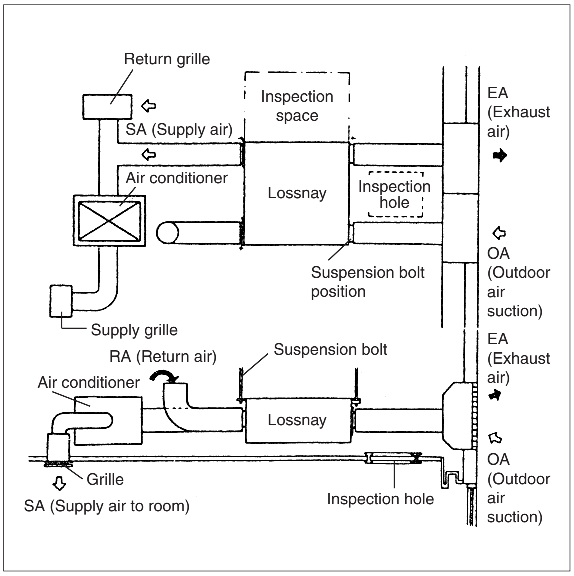
(4) Energy conservation

1.3 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.

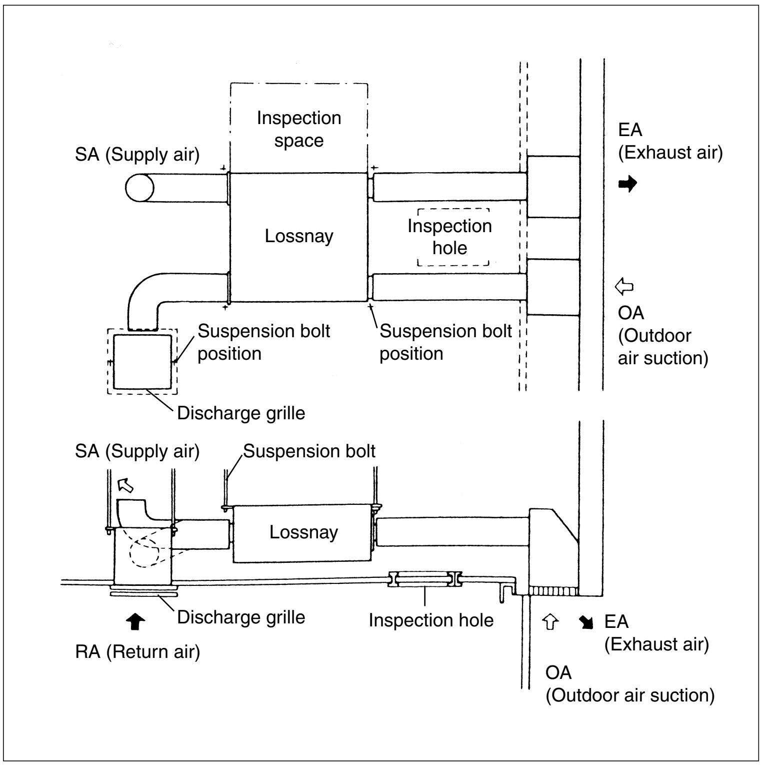
Installation state of office system air conditioning system – The air supplied from the Lossnay is introduced into the intake side of the air conditioner, and the room stale air is directly removed from the inside of the ceiling.



(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 centrifugal 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.

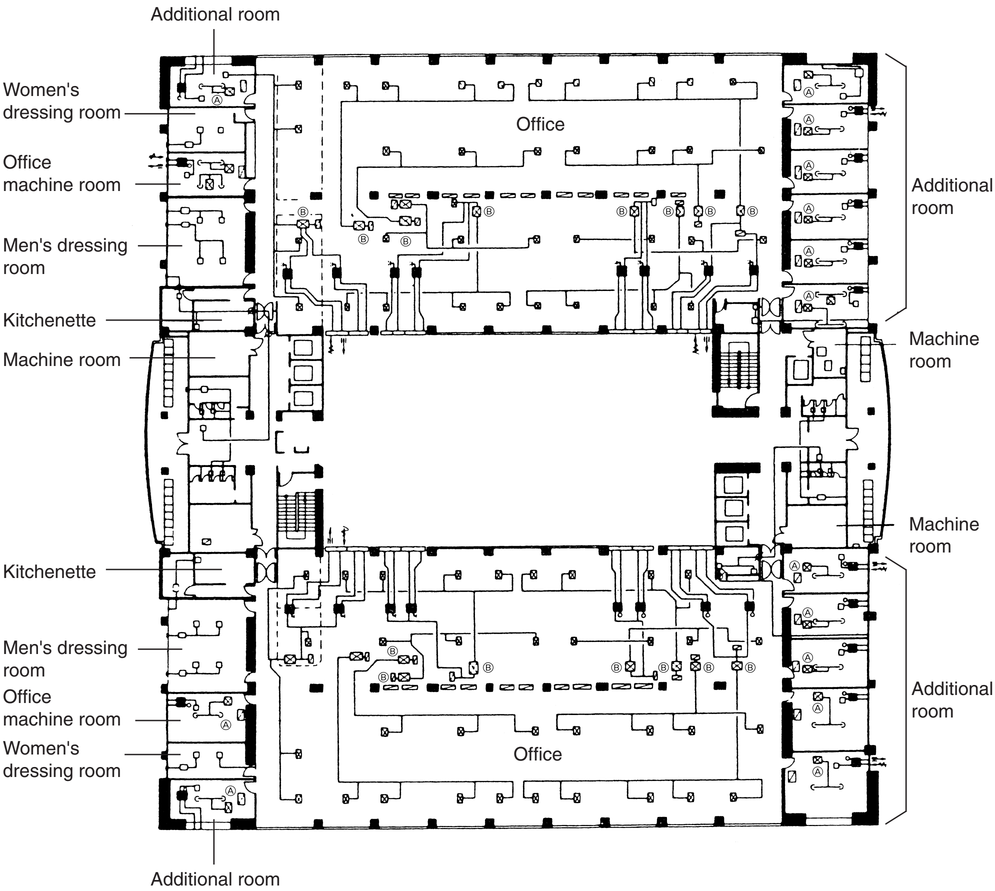


- A gallery will be constructed on the outer wall for the outer wall exhaust air outlets to allow for blending in with the exterior.

Reference floor air conditioner system layout

= Lossnay Ⓐ Air-cooling heat pump air conditioner

Ⓑ 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.

1.4 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

2.1 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 : 862.2 m^2
- Total floor area : 7,093 m^2
- No. of floors : Basement, above ground 8, penthouse 1
- Application per floor : Basement .... Parking area
  Ground floor .... Large hall
  1 to 5 .... Offices
  6 to 7 .... Special rooms

2.2 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	Refur-bishing	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

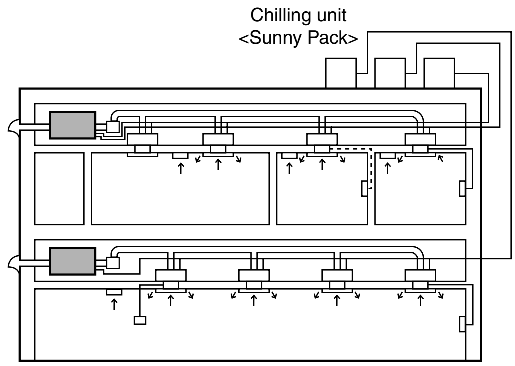
2.3 Proposed details

A) General floors

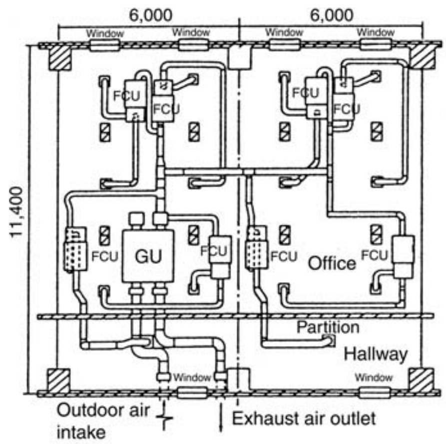
An independent dispersed-type control system incorporating an air cooling heat pump chiller and cassette-type fan coil unit for cooling and heating is used. This can cater for load fluctuations resulting from increases in office automation systems or changes in partitions hence requiting independent control of each module zone (approx. 70 m^2). Outdoor-Air Processing unit 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 Outdoor-Air Processing unit 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

: Air intake
: Supply diffuser
FCU : Fan coil unit
GU : Outdoor-Air processing unit

2.4 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 Outdoor-Air Processing unit, 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

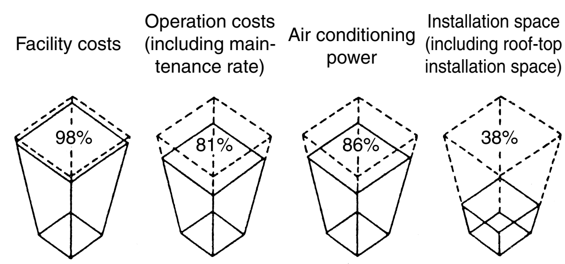
The ventilation functions have been unitised with the Outdoor-Air Processing unit, and all air conditioner units can be unitised allowing construction to be reduced.

(5) Simple architecture layout

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

	New air conditioning system	Conversional air conditioning system
Heat source equipment	Air-cooling heat pump chiller	Air-cooling heat pump chiller
Air Conditioner	Outdoor air treatment unit Outdoor-Air Processing unit (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 convertional air conditioning system as 100



Compaarison with conventional air conditioning system

2.5 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

3.1 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 : 6,334 m^2 (B1 to 8F)
- Application per floor : B1: Storage, machine room
  GF, 1F : Bank
  2F, 3F : Theatre, concert hall
  4F to 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 centrifugal fan

3.2 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.)

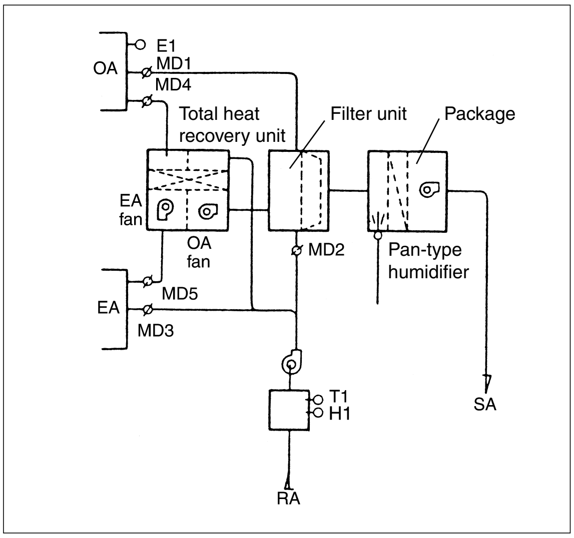
(2) Maintainability is poor when the system is too dispersed.

(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



3.3 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

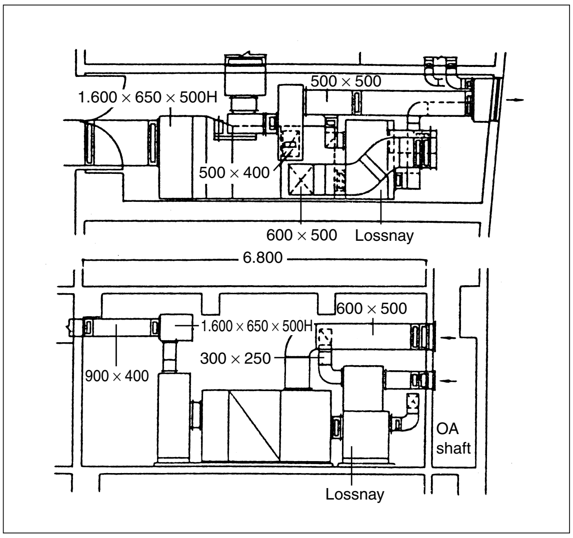
As an air conditioning system for each floor unit, a package air conditioner and Lossnay LP is combined in the machine room to handle the interior load and ventilation, and a ceiling suspended cassette-type package to handle the perimeter.
The toilet and kitchenette are ventilated with a straight centrifugal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

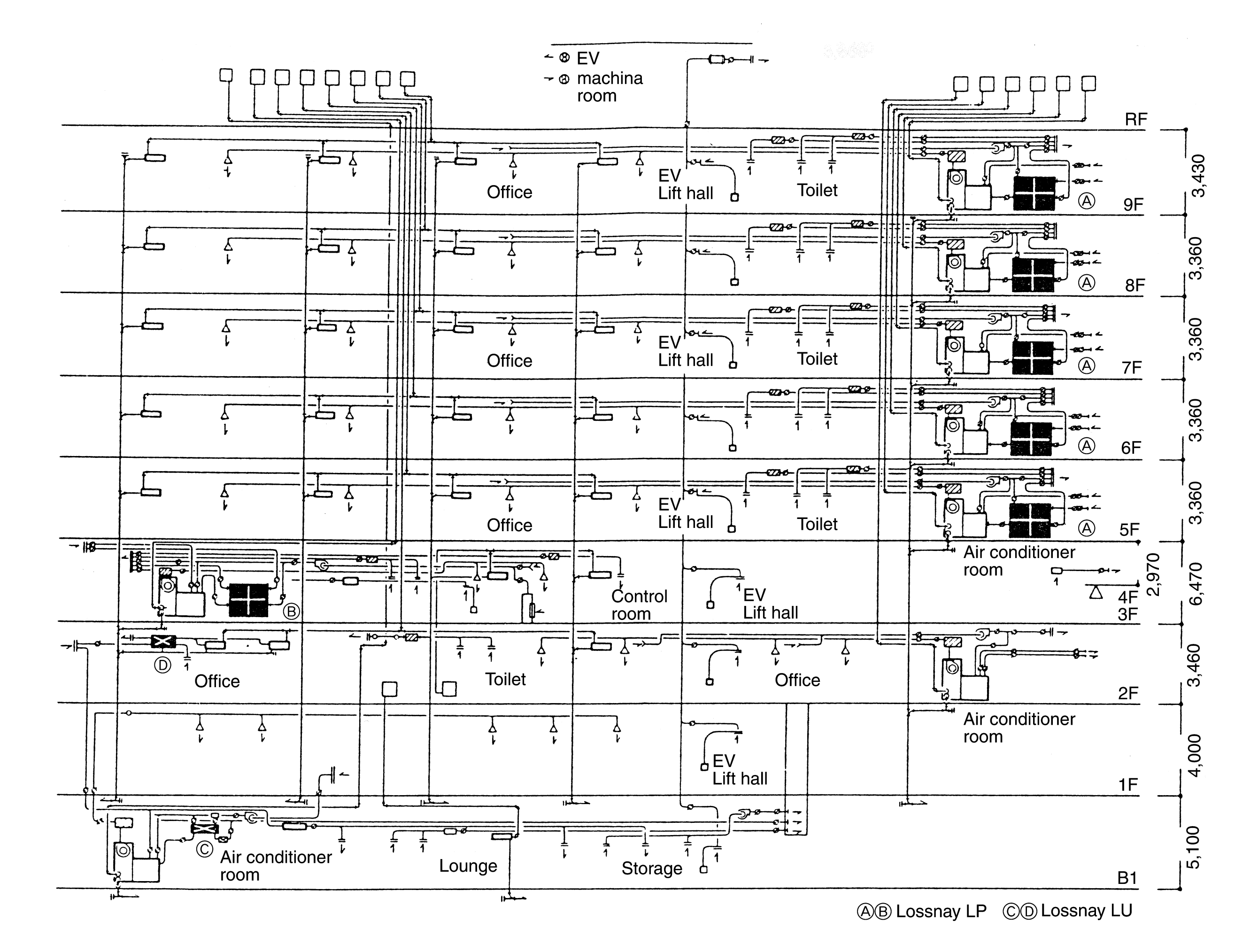
Independent use is possible with the ceiling suspended-type air-conditioner and ceiling suspended cassette-type Lossnay.

- **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



3.4 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

4.1 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 : 552 m^2 (B1 to 5F)
- Application per floor : B1: Parking area
  GF to 5F: Office
- Air conditioning : Package air conditioner
- Ventilation : Ceiling embedded-type and cassette-type Lossnay, straight centrifugal fan, duct ventilation fan.

4.2 Current topics

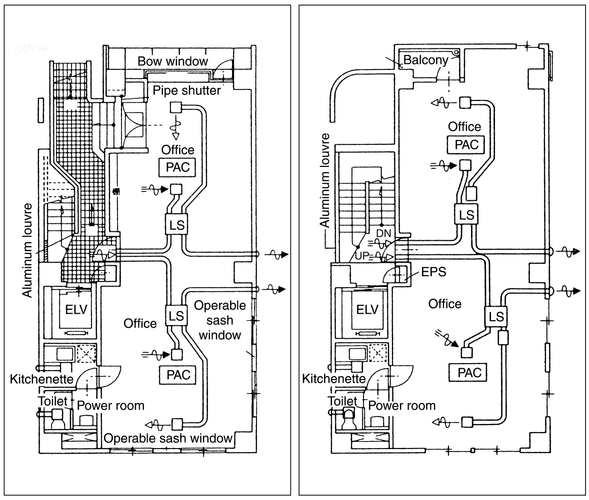
(1) Three sides of the building are surrounded by other buildings, and windows cannot be installed. (Dependency on mechanical ventilation is high.)

(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.

GF layout **1F to 5F layout**



PAC : Package air conditioner
LS : Lossnay

4.3 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.

4.4 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

5.1 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

5.2 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

5.3 Plan proposals

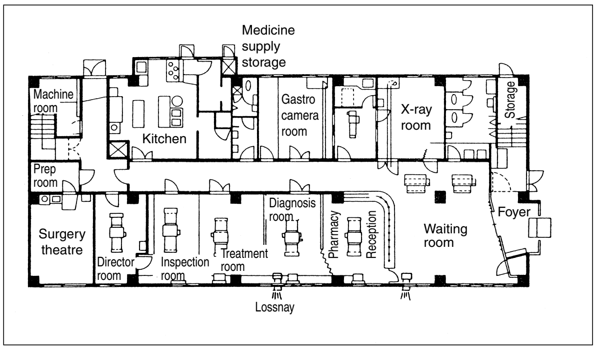
(1) Air conditioning

- 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.

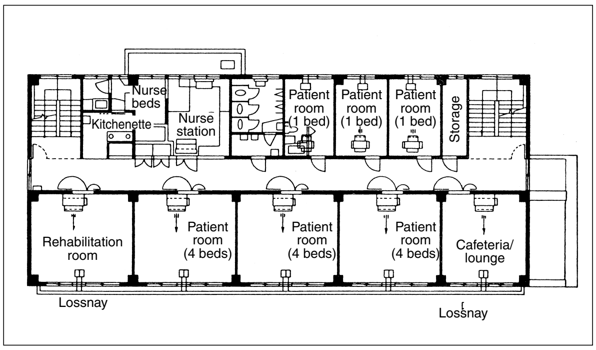
(2) Ventilation

- **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.

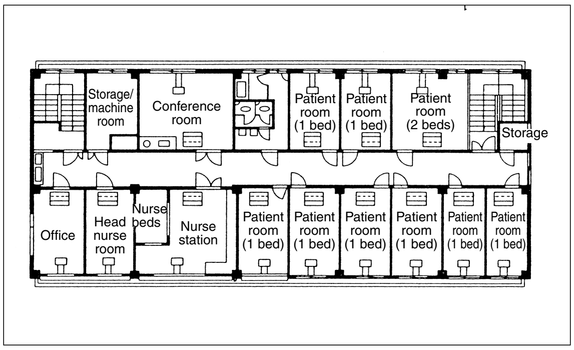
GF layout



1F layout



2F layout



5.4 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

6.1 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.

6.2 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.

6.3 Building outline

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

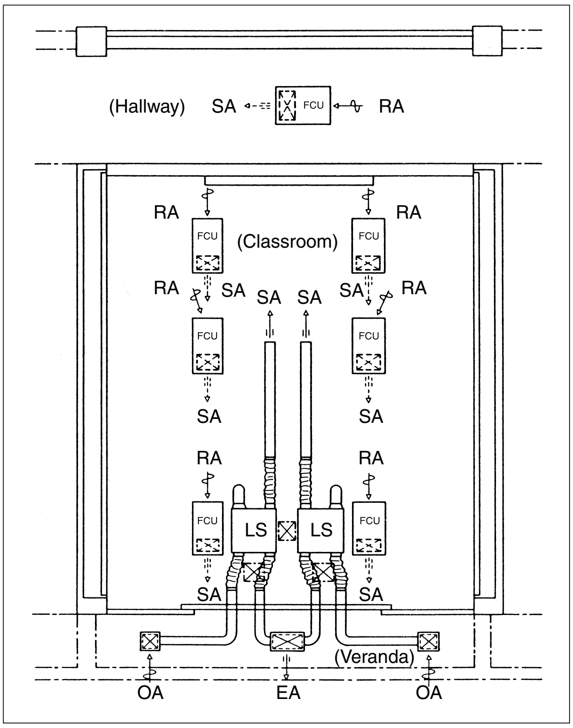
6.4 Plan details

(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 recovery unit, energy is saved and soundproofing is realised.

Classroom layout



6.5 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.

6.6 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 recovery unit is mainly used in consideration of the energy saved during air conditioning and the high soundproofing properties.

7. Hotels (convention halls, wedding halls)

7.1 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.

7.2 Current systems and problem points

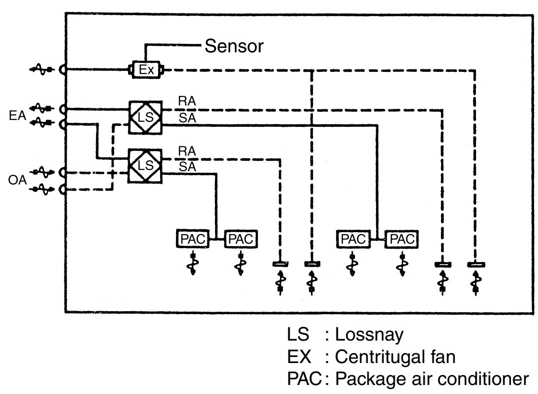
CO and CO_2 permissible values, removal of odors, and tobacco smoke are often considered as standards for ventilation and often the ventilation is set at 30 m^3/h·person to 35 m^3/h·person. Several outdoor air introduction-type package air conditioners or air handling unit facilities are often used,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

7.3 Plan details

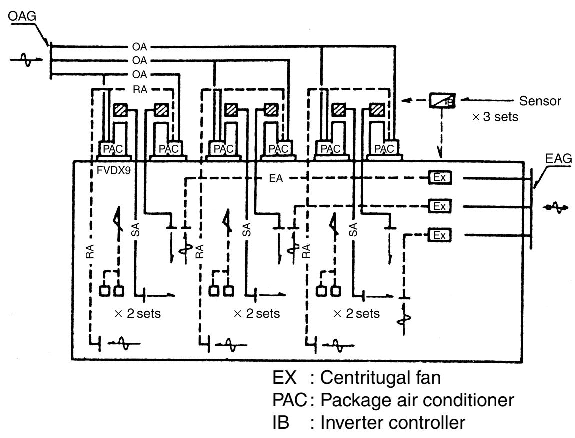
This proposed plan has two examples with the use of a Lossnay as a ventilator for total heat recovery in the air conditioned conference room, and the use of several outdoor air type package air-conditioners for convention and banquet halls.

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

7.4 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)

8.1 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: 385 m^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

8.2 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.

8.3 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

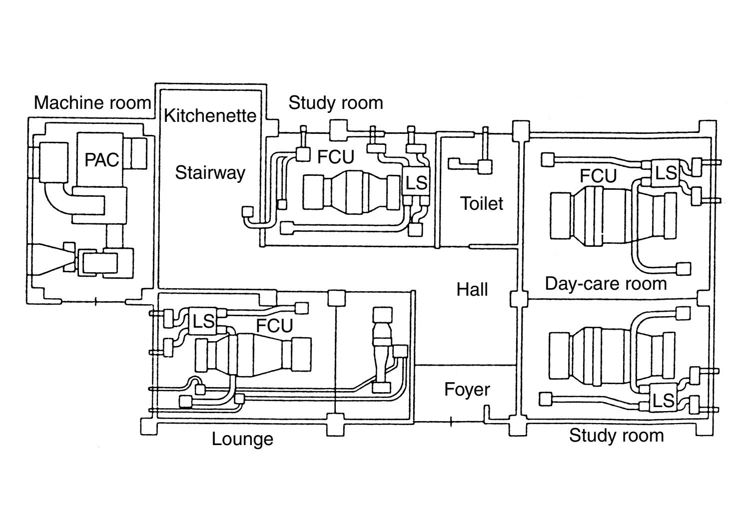
1) A ceiling embedded-type Lossnay is used in each room, and a silence chamber, silence-type supply/return grille, silence duct, etc. is incorporated on the outer wall to increase the total soundproofing effect.

8.4 Effect

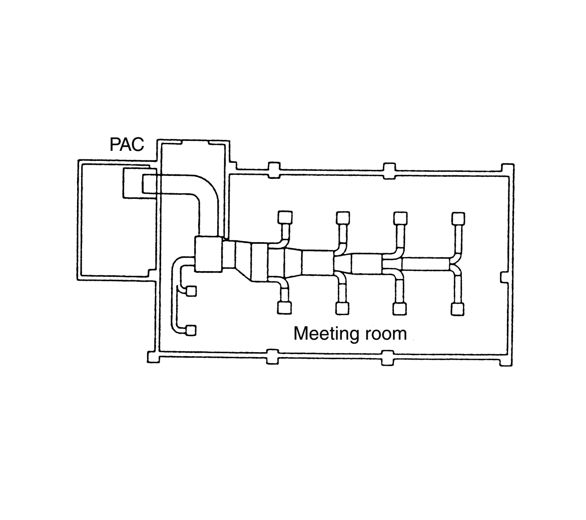
(1) Operation is possible without special knowledge, so management is easy.
(2) Operation is possible according to each room's needs, and is thus energy-saving.
(3) Soundproof ventilation is possible with the separately installed ventilators.
(4) Energy saving ventilation is possible with the heat recovery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

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

GF layout



1F layout



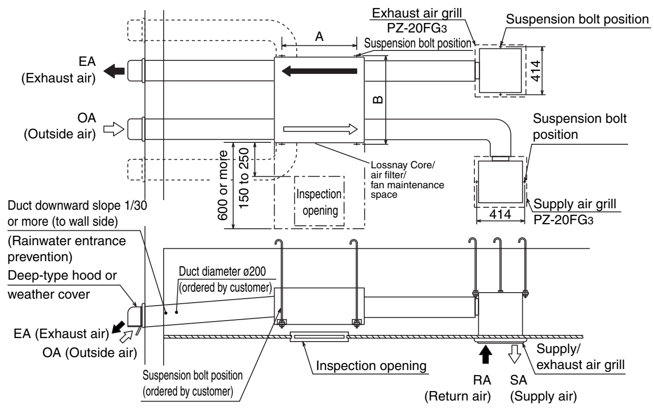
CHAPTER 7

Installation Considerations

1. LGH-Series Lossnay Ceiling Embedded-Type (LGH-RX3 Series)

LGH-15 · 25 · 35 · 50 · 80 · 100RX3 models

■ **Installation diagram**



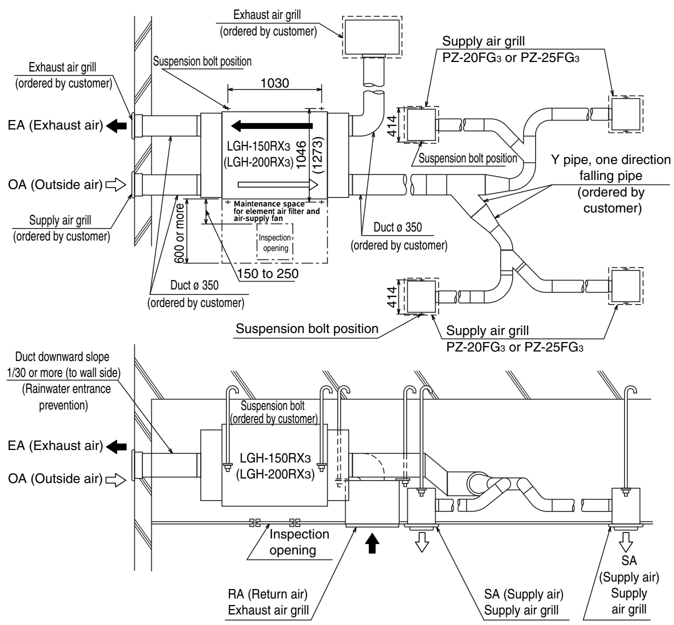
Unit (mm)

- Always leave inspection holes (□ 450 or □ 600) on the air filter and Lossnay Core removal side.
- Always insulate the two ducts outside the room (intake air and exhaust air ducts) to prevent frosting.
- It is possible to change the direction of the outside air ducts (OA and EA side).
- It is possible to attach a suspension bolt.
- Do not install the vent cap or round hood where it will come into direct contact with rain water.

Air volume (m^3/h)	Model	Dimension	
		A	B
150	LGH-15RX3	700	641
250	LGH-25RX3	700	765
350	LGH-35RX3	790	906
500	LGH-50RX3	790	1,048
800	LGH-80RX3	1,030	1,036
1000	LGH-100RX3	1,030	1,263

LGH-150 · 200RX3

■ **Installation diagram**



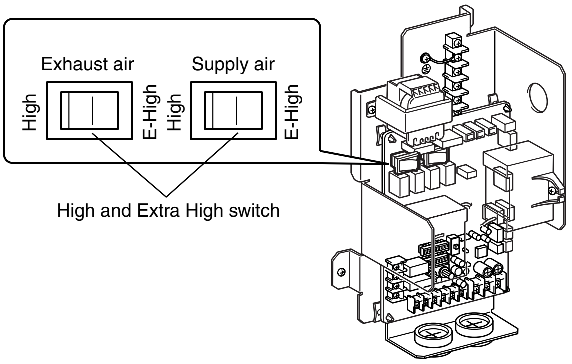
Unit (mm)

- Always leave inspection holes (□ 450 or □ 600) on the air filter and Lossnay Core removal side.
- Always insulate the two ducts outside the room (intake air and exhaust air ducts) to prevent frosting.
- If necessary, order a weather cover to prevent rain water from direct contact or entering the unit.

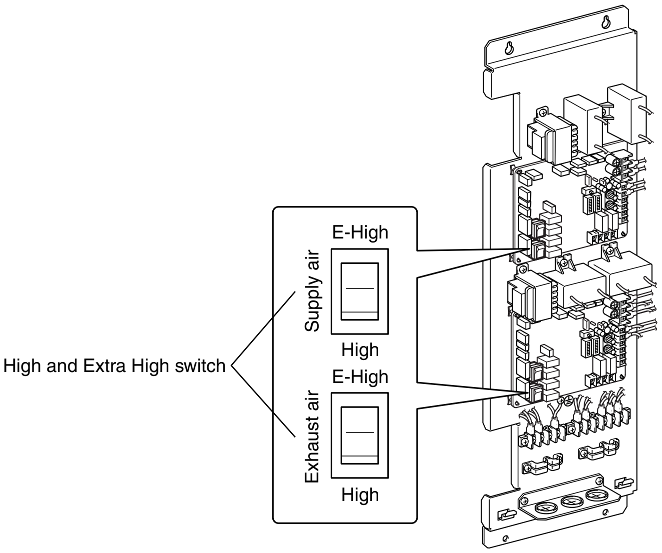
(1) The ceiling embedded-type: 150 · 250 · 350 · 500 · 800 · 1000 · 1500 and 2000 m^3/h types are available. Select an adequate model according to the room size, air volume for the application and noise levels.

(2) The LGH-15 · 25 · 35 · 50 · 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.

LGH-15 · 25 · 35 · 50 · 80 · 100RX3



LGH-150 · 200RX3



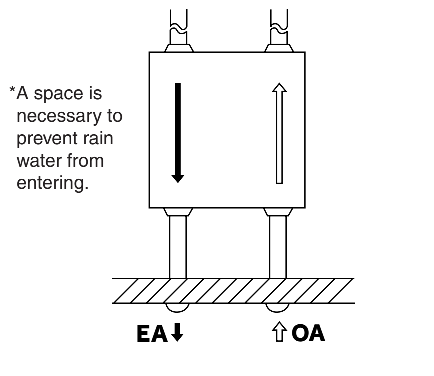
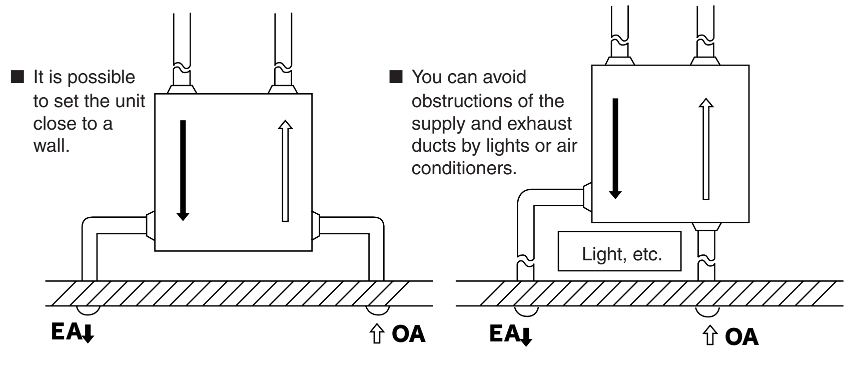
(3) The units have a low-noise design, however, for further noise reduction a silencer-type supply/return grille (PZ-FG-type) for supply/return air in the room, a silencer box (PZ-SB-type) for reducing the air sound into the room, and a flexible silencer (PZ-SD-type) are available.

Silencing effect of each part

	Model	Silencing effect	Application models	Duct diameter
Supply/return grille	PZ-10FG3	3 dB	LGH-15RX3	ø100
	PZ-15FG3	4 dB	LGH-25RX3	ø150
	PZ-20FG3	4 dB	LGH-35 · 50RX3	ø200
	PZ-25FG3	4 dB	LGH-80 · 100RX3	ø250
Silencer box	PZ-20SB2	6 dB	LGH-35 · 50RX3	ø200
	PZ-25SB2	6 dB	LGH-80 · 100RX3	ø250
Flexible silencer	PZ-10SD	22 dB	LGH-15RX3	ø100
	PZ-15SD	21 dB	LGH-25RX3	ø150
	PZ-20SD	20 dB	LGH-35 · 50RX3	ø200
	PZ-25SD	18 dB	LGH-80 · 100RX3	ø250

1.1 Selecting Duct Attachment Direction

You can choose between two directions for the outside duct (OA, EA) piping direction, to improve construction.

Standard Construction	Construction with the Direction Changed
	

1.2 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.

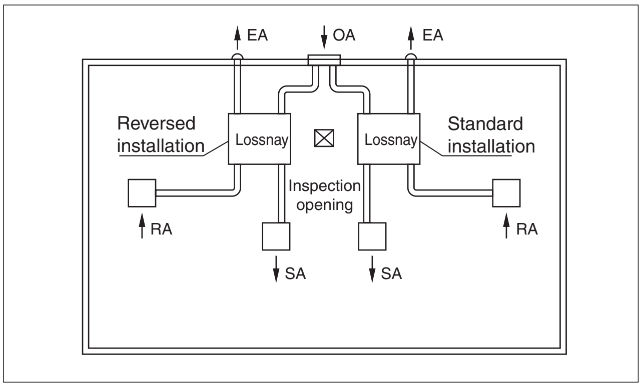
(3) Enforce measures to prevent rain water from entering.
- ● Apply a slope of 1/30 or more towards the wall to the two ducts outside the room (intake air and exhaust air ducts).
- ● Do not install the vent cap or round hood where it will come into direct contact with rain water.

(4) Use the optional parts “control switch” (Ex. PZ-41SLB, etc.) for the RX3-type.
A centralised controller can also be used.

1.3 Installation applications

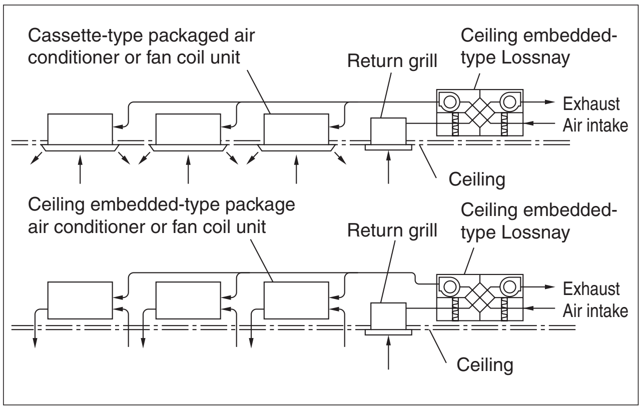
(1) Combined installation of two units

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

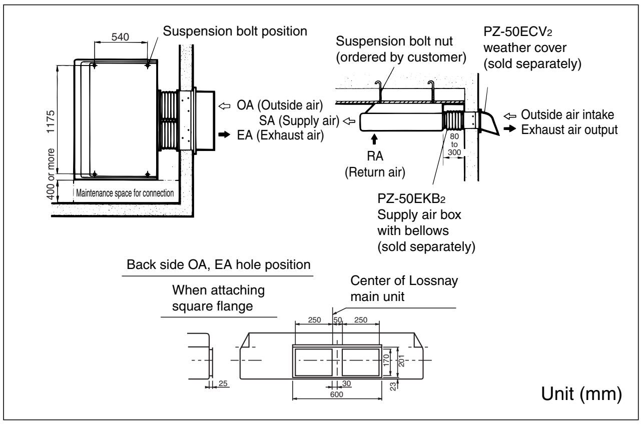
Air conditioning systems with independent dispersed multiple unit air-conditioners are increasing due to merits such as improved controllability, energy conservation and space saving.
For these types of air conditioning systems, combined operation of the dispersed air conditioners with the Lossnay, is possible.



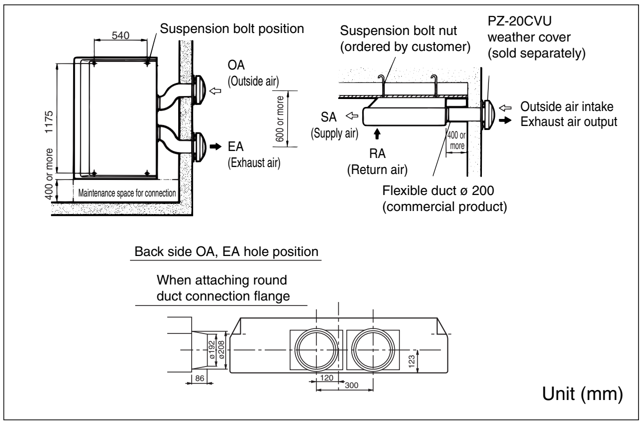
2. Business Lossnay Suspended Exposed-Type

(1) Leave at least a 400 mm maintenance space at the right side of the main unit for connection of the control switch and power to the main unit.

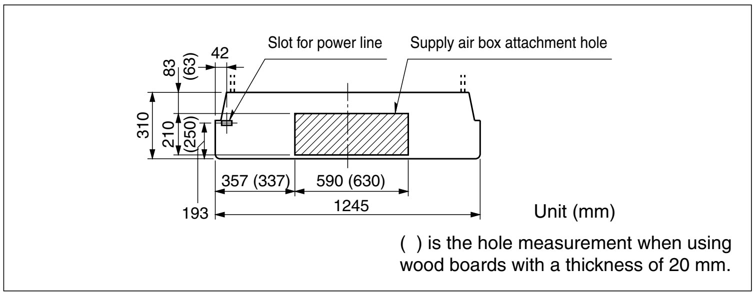
When attaching square duct



When attaching round duct

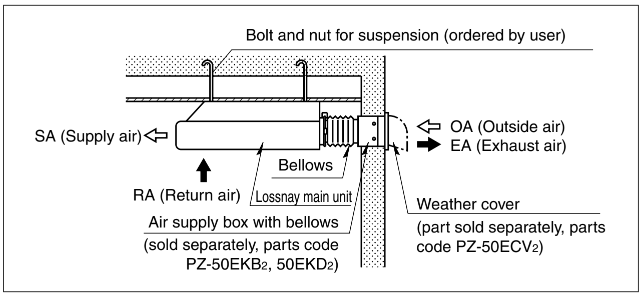


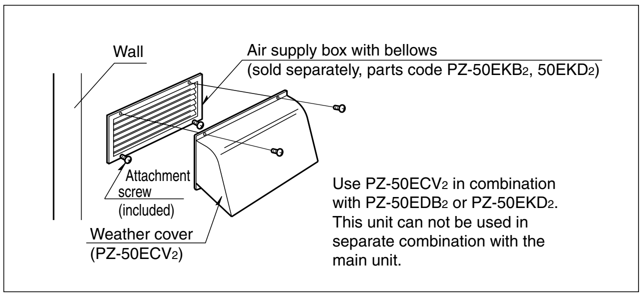
(2) When the installation position is decided, make a hole in the wall for the supply air box with bellows. See the following unit regarding the size and position in relation to the Lossnay main unit.



(3) If using wood boards for installation, make wood boards that match the hole size dimensions for wood boards shown in the illustration above. In this case, make the size of the hole in the wall such that wooden boards of the dimensions given above can fit through.

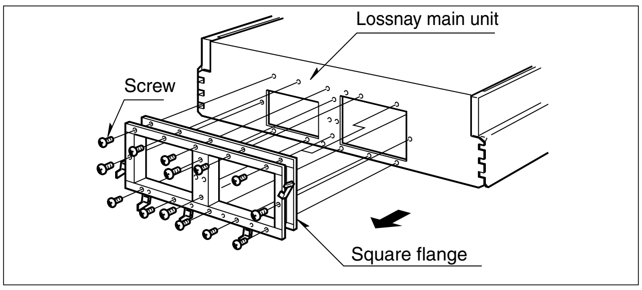
(4) Use the extension bellows (PZ-50EJ2) or the extension duct if the space between the flange of the main unit and the bellows connection area of the supply air box with bellows is more than 200 mm.

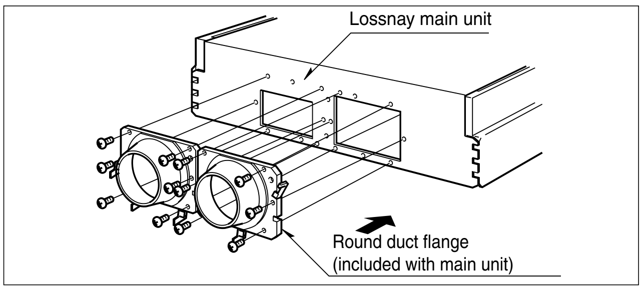




⚠ CAUTION

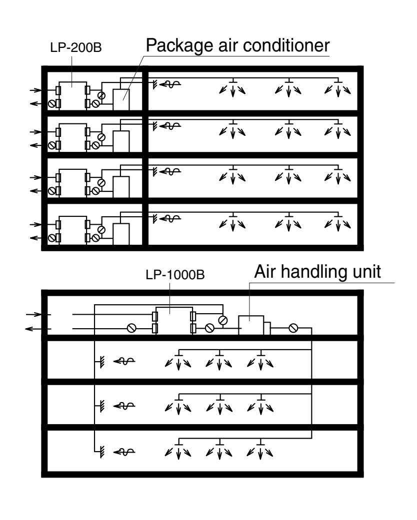
When connecting round ducts, remove the square flange, and attach the round ducts as shown below.



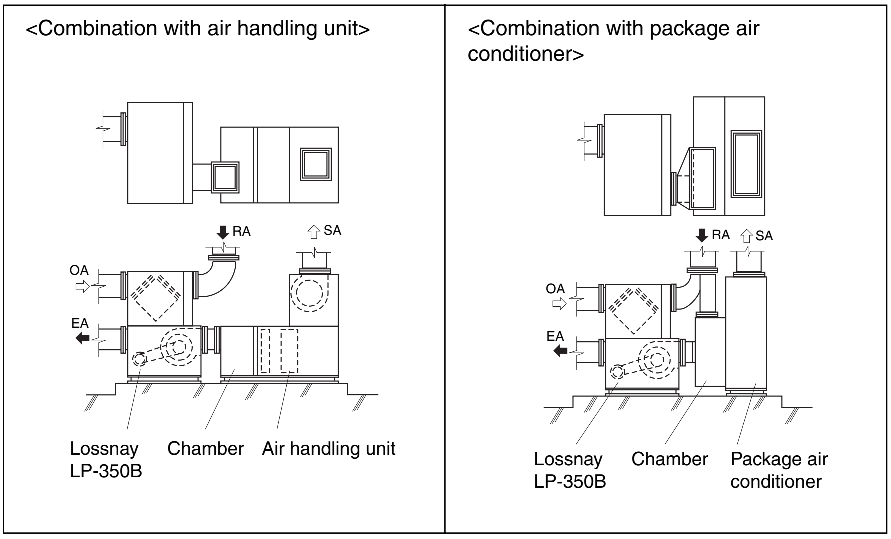


3. Building Lossnay Pack-type (LP-200B · 350B · 500B · 750B · 1000B)

System concept diagram



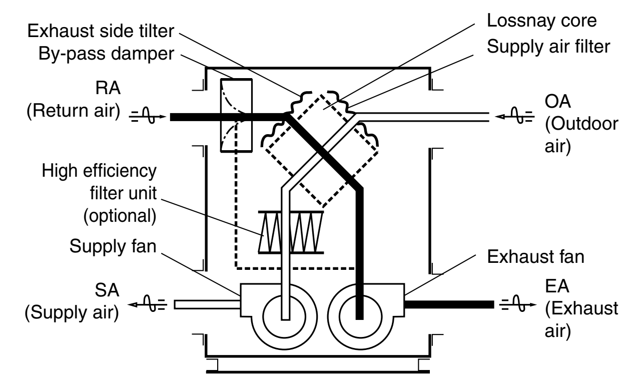
Installation examples



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

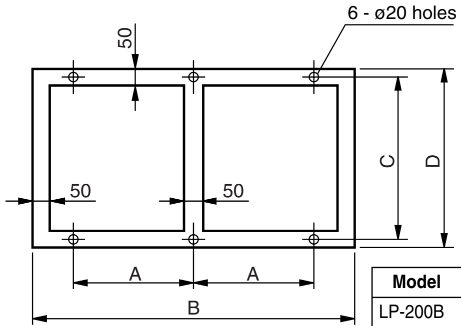
(2) Select an adequate model according to the building size, air volume for application and static pressure of outside unit.

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.

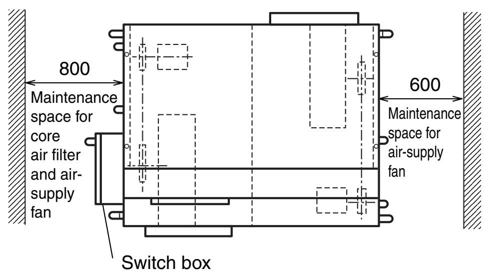
3.1 Main unit base installation surface diagram



Unit (mm)

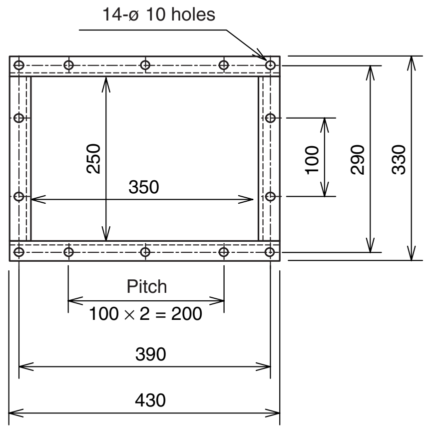
Model	A	B	C	D
LP-200B	500	1230	950	1000
LP-350B	700	1560	1120	1170
LP-500B	950	2070	1230	1280
LP-750B	950	2070	1230	1280
LP-1000B	950	2070	1350	1400

3.2 Maintenance space



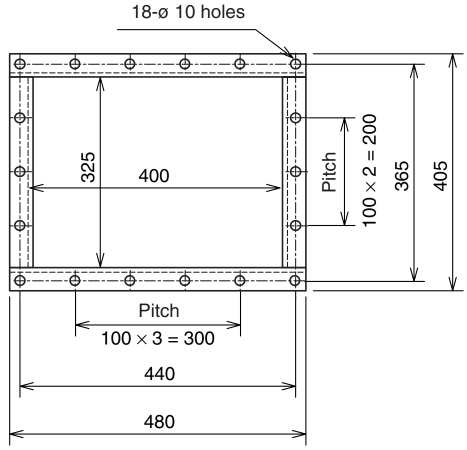
3.3 Flange dimensions

LP-200B



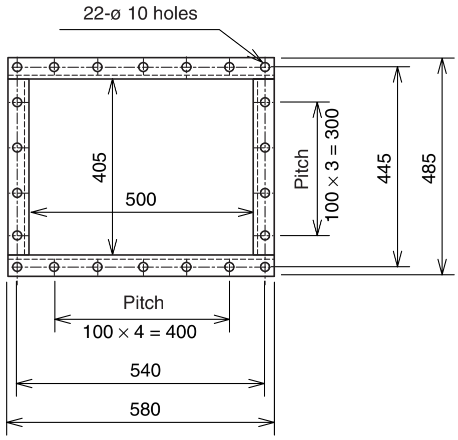
Unit (mm)

LP-350B



Unit (mm)

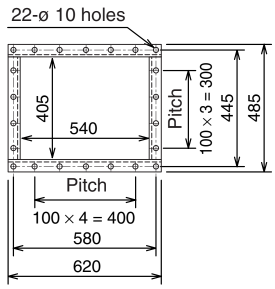
LP-500B



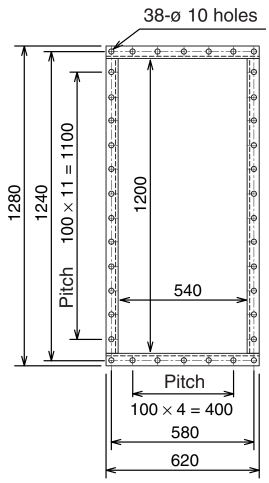
Unit (mm)

LP-750B · 1000B

■ **Supply flange details**



■ **Return flange details**

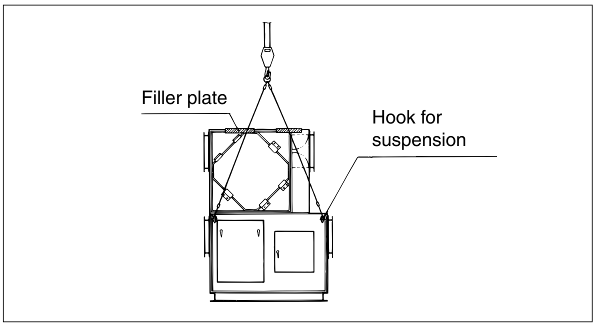


Unit (mm)

3.4 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.

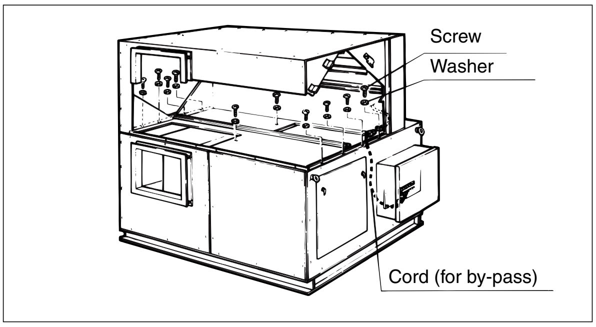


Weight when disassembled Unit (kg)

	Top (Core 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.



(2) LP-750B · 1000B

- This product is shipped in two parts and assembled at the installation site.
- Always lift the Core 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 core 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 Core chamber from inside.

Weight when disassembled Unit (kg)

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

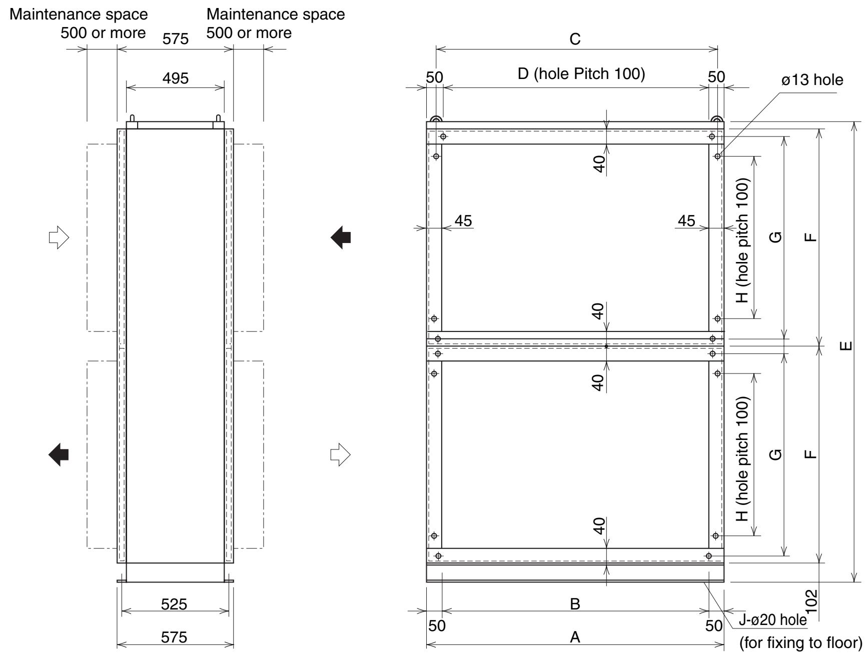
4. Building Lossnay Unit Vertical-type (LUT-2302 · 2303 · 3002 · 3003)

4.1 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 Core'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	1440	4
	LUT-3003	1500	1400	1450	1400	3132	1500	1460	1400	6

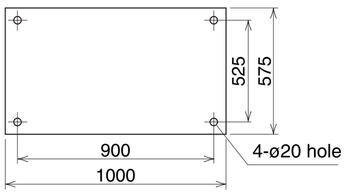


Unit (mm)

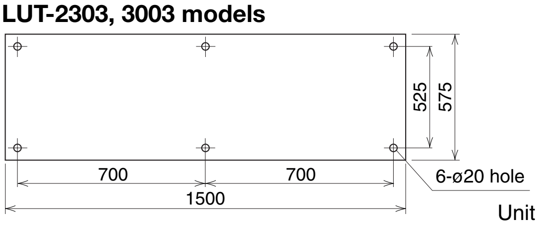
4.2 Main unit installation surface diagram

■ **Single-type floor installation surface diagram**

LUT-2302, 3002 models



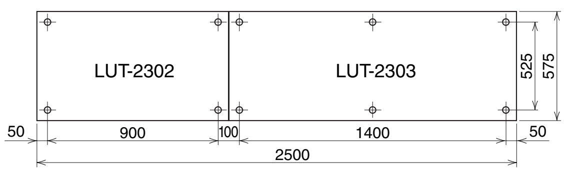
LUT-2303, 3003 models



Unit (mm)

■ **Combination-type floor installation surface diagrams (Example)**

For LUT-2305

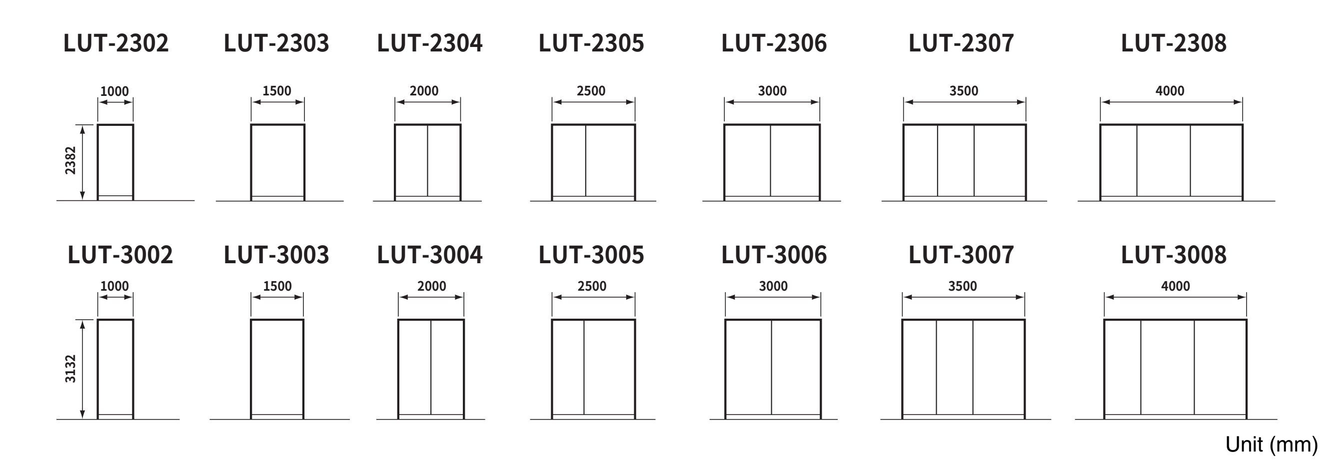


Unit (mm)

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

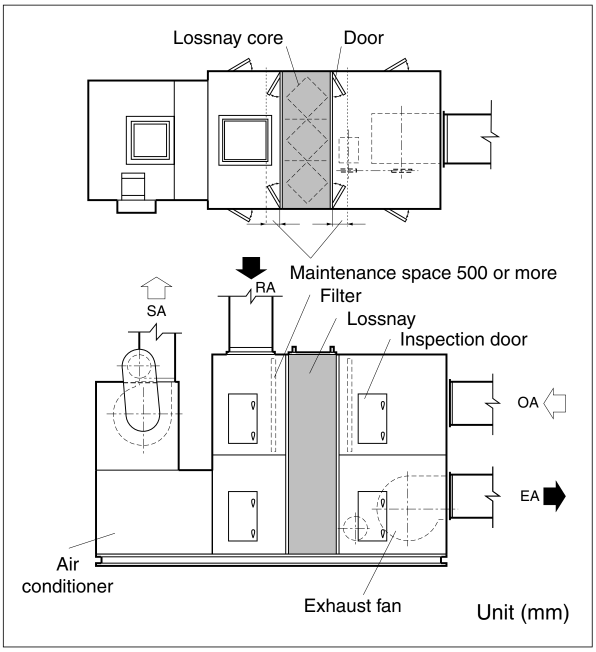
4.3 Combination dimensions

- 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.)



4.4 Maintenance space

- The Lossnay Core is cleaned from the intake/exhaust chamber sides.
  Allow an inspection space of 50 cm 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.



4.5 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

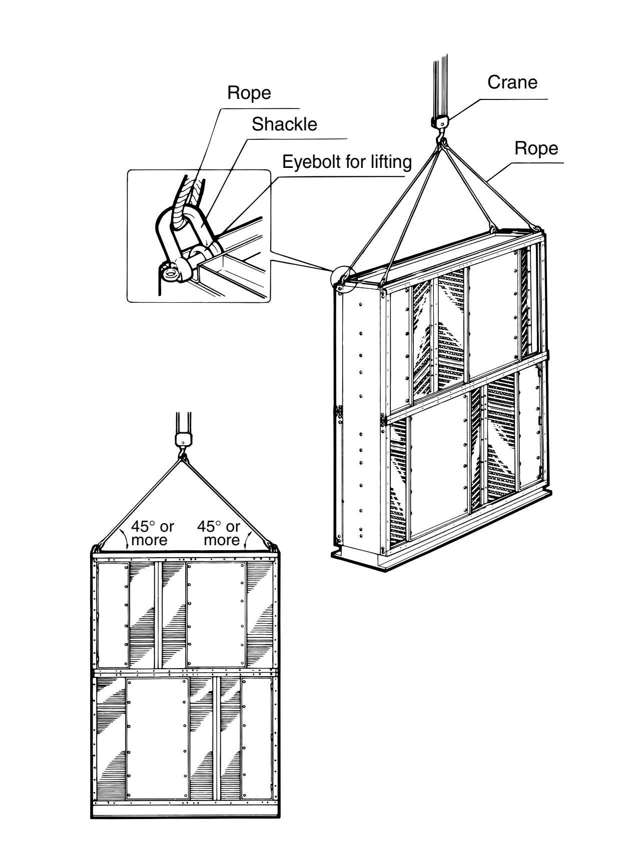
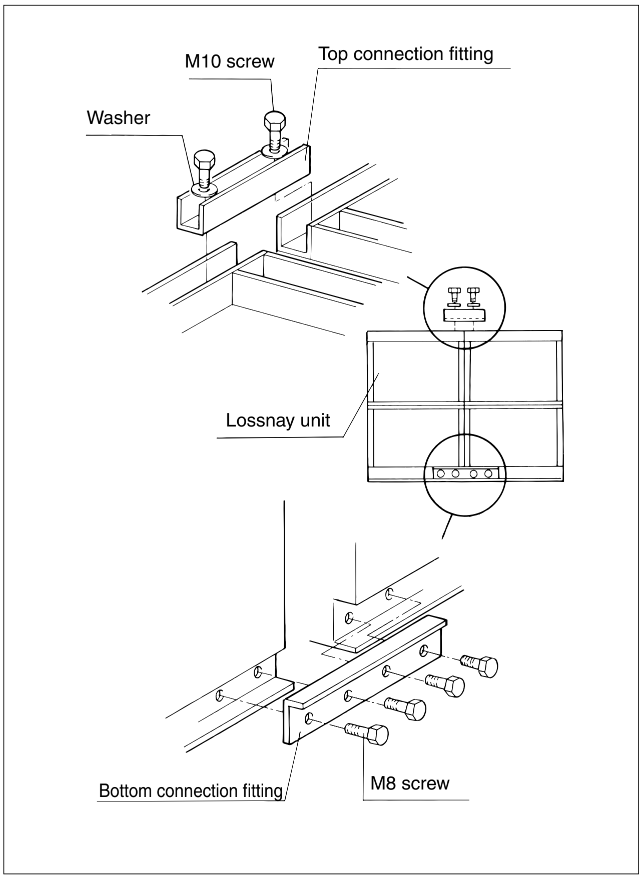
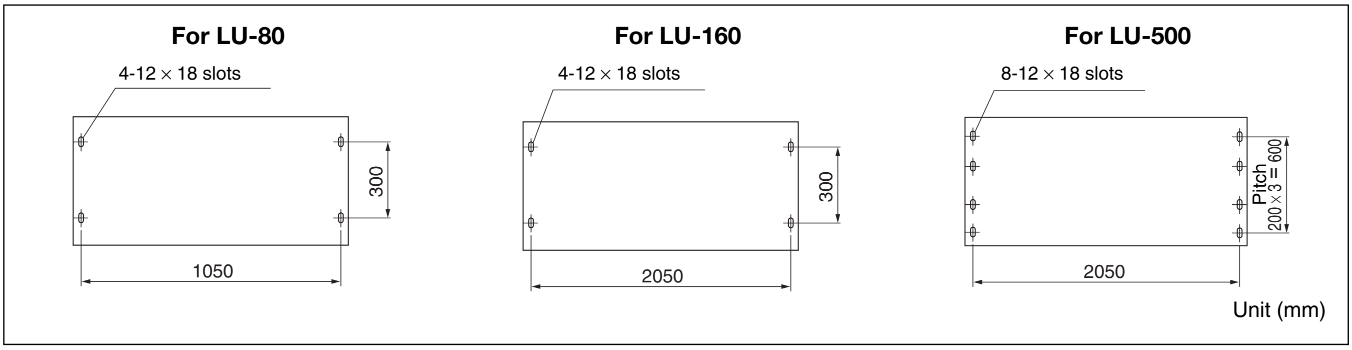


Fig. 2

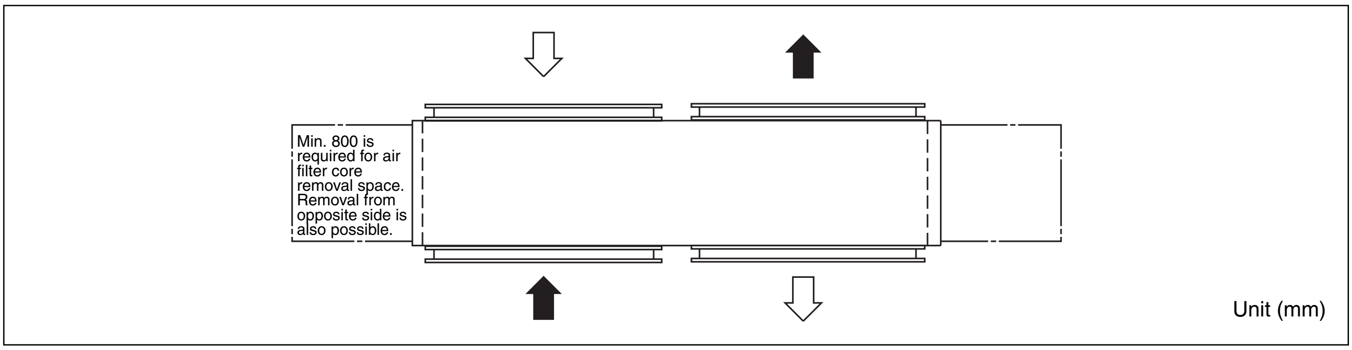


5. Building Lossnay Unit Horizontal-type (LU-80 · 160 · 500)

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



5.2 Maintenance space

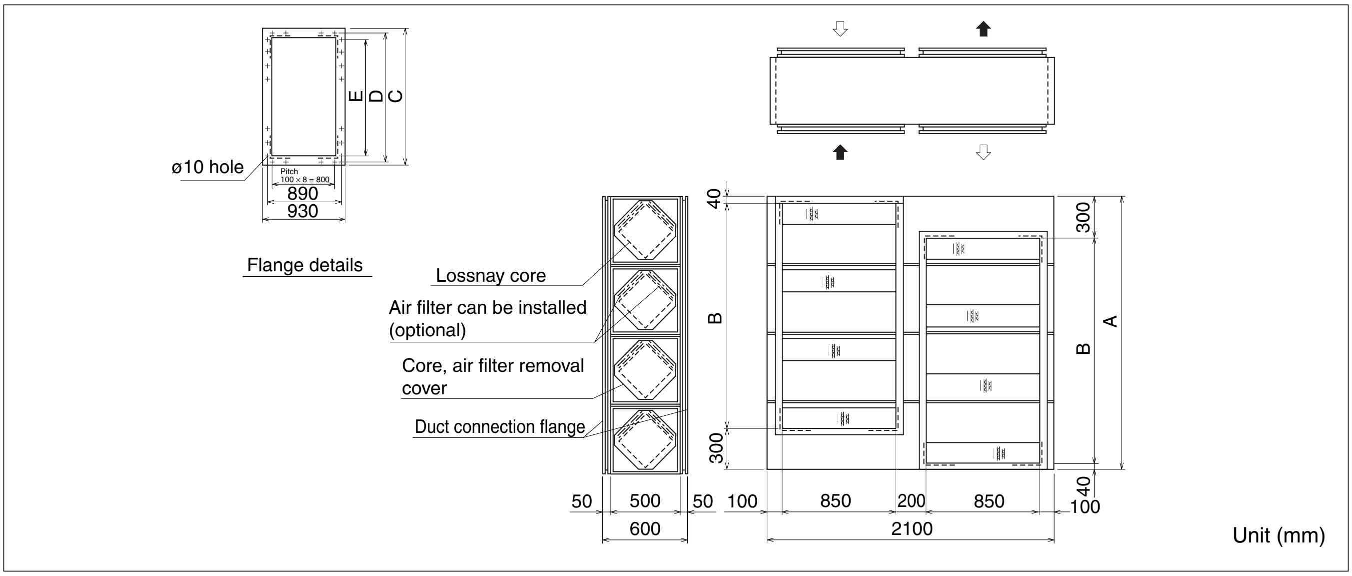


5.3 Combination dimensions and flange dimensions

LU-1602 · 1603 · 1604 · 1605 · 1606

Unit (mm)

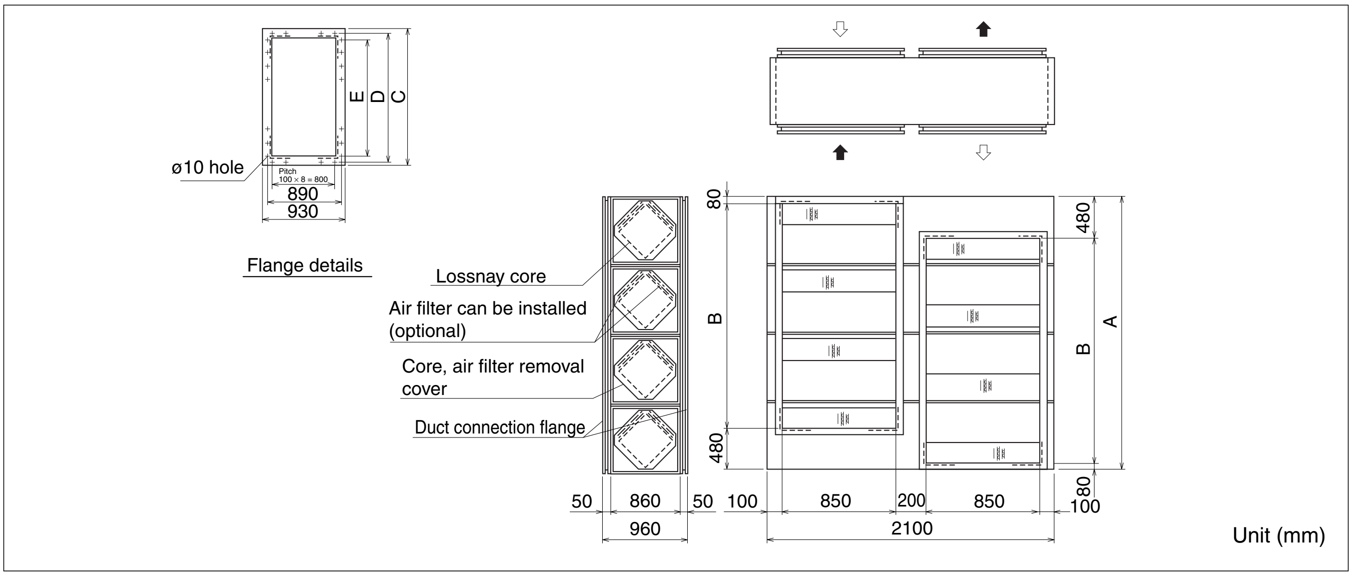
	A	B	C	D	E
LU-1602	1010	670	750	710	Pitch 100 × 6 = 600
LU-1603	1520	1180	1260	1220	Pitch 100 × 10 = 1000
LU-1604	2030	1690	1770	1730	Pitch 100 × 16 = 1600
LU-1605	2540	2200	2280	2240	Pitch 100 × 20 = 2000
LU-1606	3050	2710	2790	2750	Pitch 100 × 25 = 2500



LU-502 · 503 · 504 · 505

Unit (mm)

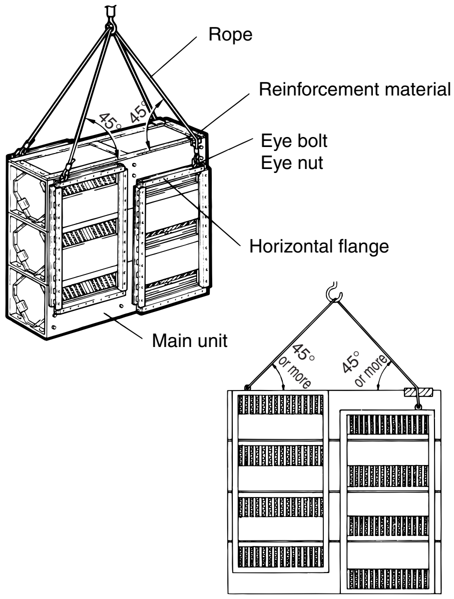
	A	B	C	D	E
LU-502	1730	1170	1250	1210	Pitch 100 × 10 = 1000
LU-503	2600	2040	2120	2080	Pitch 100 × 20 = 2000
LU-504	3470	2910	2990	2950	Pitch 100 × 27 = 2700
LU-505	4340	3780	3860	3820	Pitch 100 × 36 = 3600



5.4 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

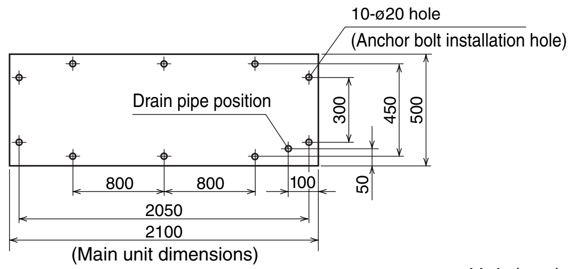
This unit has indoor specifications and cannot be installed in sites where it will come into contact with rain water or in high temperature, high humidity locations.

6. 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.)

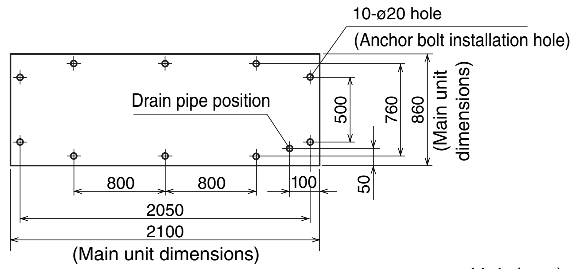
6.1 Combination-type installation surface diagram (anchor bolt installation position, drain pipe position)

For LUP-160 combination



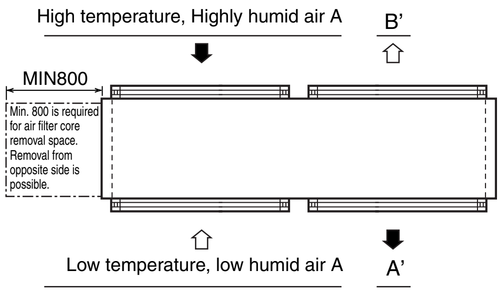
Unit (mm)

For LUP-500 combination



Unit (mm)

6.2 Maintenance space

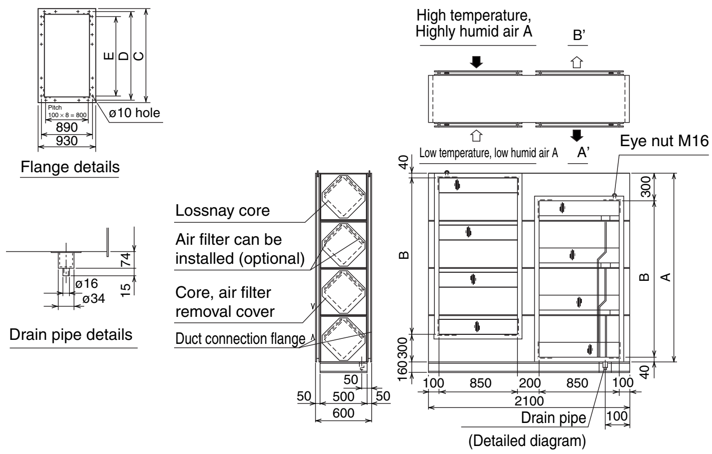


Unit (mm)

6.3 Combination dimensions and flange dimensions

LUP-1602 · 1603 · 1604 · 1605 · 1606 Unit (mm)

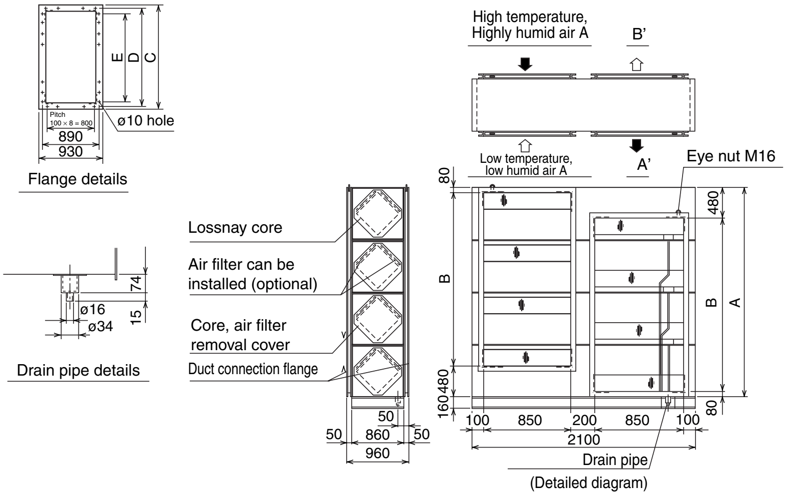
		A	B	C	D	E
LUP-160-type set parts	LU-1602	1010	670	750	710	Pitch 100 × 6 = 600
	LU-1603	1520	1180	1260	1220	Pitch 100 × 10 = 1000
	LU-1604	2030	1690	1770	1730	Pitch 100 × 16 = 1600
	LU-1605	2540	2200	2280	2240	Pitch 100 × 20 = 2000
	LU-1606	3050	2710	2790	2750	Pitch 100 × 25 = 2500



Unit (mm)

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

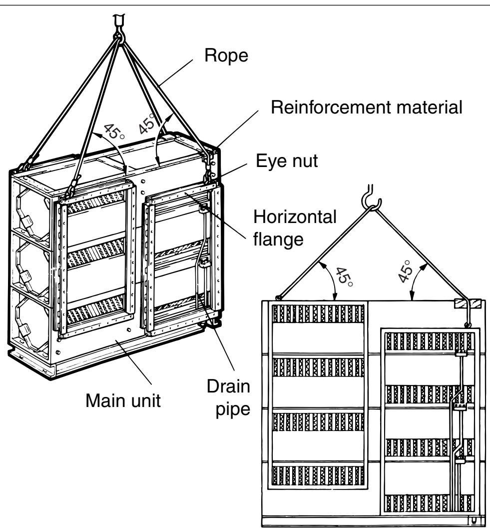


Unit (mm)

6.4 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.



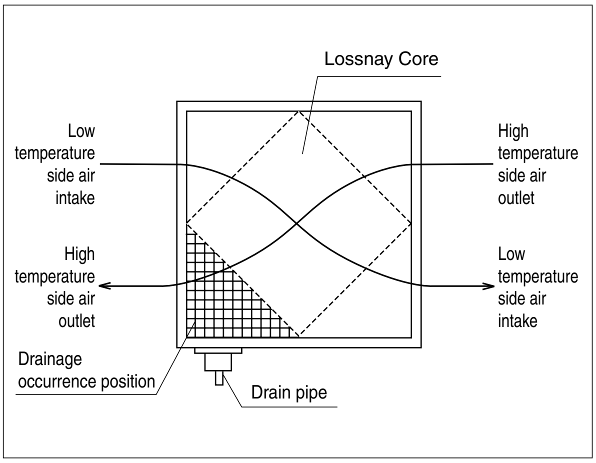
⚠ Caution

- 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.

6.5 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 800 mm 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

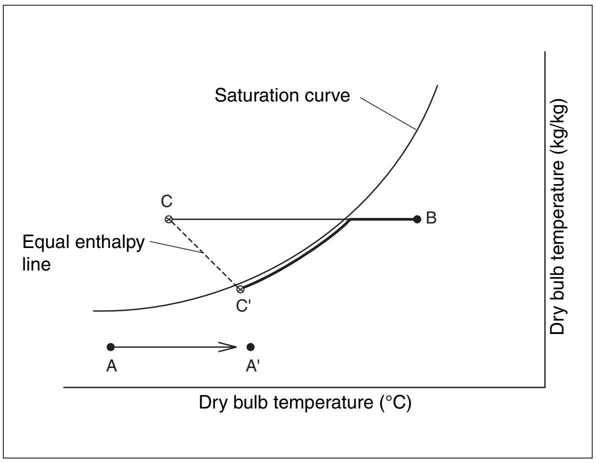
Always mount the optional air filter (PZ-80F, PZ-500F) to the air suction sides (intake and return sides) of the Lossnay Core to prevent the Core from clogging.

- 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 room 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

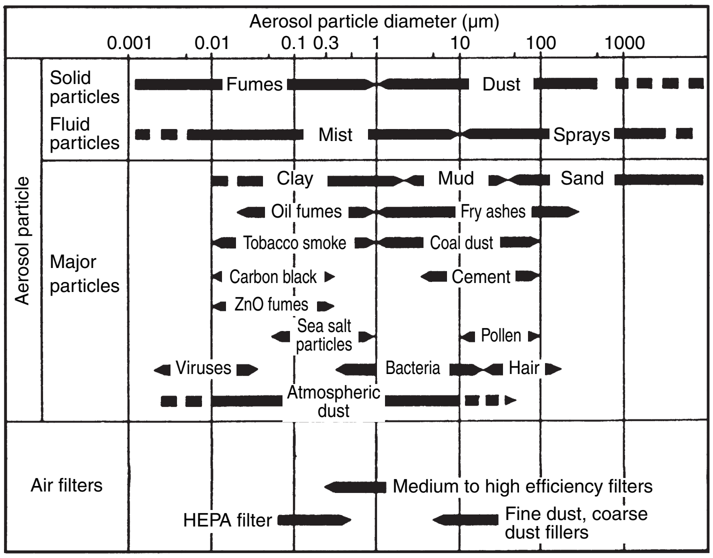


Table 2 Major dust concentrations

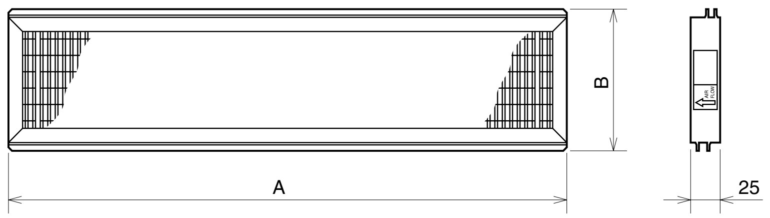
Type	Reference data	
Outdoor air floating dust concentration	Large city	0.1 - 0.15 mg/m^3
	Small city	0.1 mg/m^3 or less
	Industrial districts	0.2 mg/m^3 or more
Indoor dust concentration	General office	10 mg/h per person
	Stores (product vending stores)	5 mg/h per person
	Applications with no tobacco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

Remarks:
1. The core diameter of outdoor air dust is said to be 2.1 μm, and the 11 types of dust (average diameter 2.0 μ) 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 0.72 μm. The 14 types of dust (average 0.8 μm) 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·h (including non-smokers)
   Smoking length of cigarette : Approx. 4 cm
   Amount of dust generated by one cigarette : Approx. 10 mg/cigarette

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

Filter type (Measurement method / Tested dust)		Applicable model	AFI Gravitational method	ASHRAE Colorimetric method	Countingh method (DOP method)		Application
			Compound dust	Atomspheric dust	JIS 14 types DOP 0.8 µm	DOP 0.3 µm	
Pre-filter	NP/400	Commercial Lossnay (LGH)	82%	8% - 12%	5% - 9%	2% - 5%	Protection of heat recovery element
High efficiency filter	Model PZ-15RFM - 100RFM	Optional Part for model LGH-15RX3 - 200RX3	99%	65%	60%	25%	Assurance of sanitary environment (According to Building Management Law)
	Model PZ-25FMY Model PZ-15FM - 100FM	Humidifer High efficiency filter unit	99%	65%	60%	25%	
	Model PZ-200FM - 1000FM	Optional part for models LP-200B - 1000B High efficiency filter unit	100%	65%	65%	40%	
	Model PZ-200FH - 1000FH		100%	90%	90%	75%	

3.1 High-Efficiency Filter (Optional Parts)



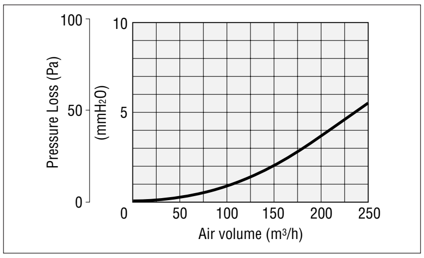
Model		PZ-15RFM	PZ-25RFM	PZ-35RFM	PZ-50RFM	PZ-80RFM	PZ-100RFM
Dimension (mm)	A	554	330	395	466	448	561
	B	121	147	174	174	236	236
Number of filters perset		1	2	2	2	2	2

Note: This is one set per main body.

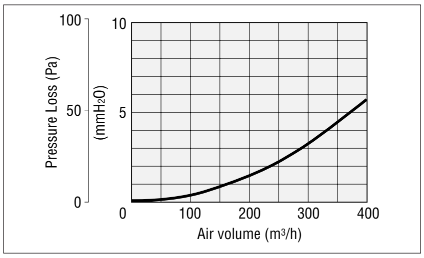
3.2 Pressure Loss

■ **Pressure Loss Characteristics**

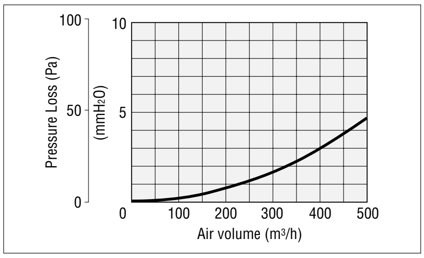
PZ-15RFM



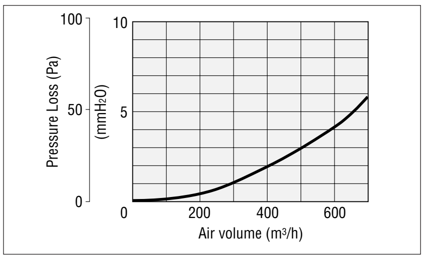
PZ-25RFM



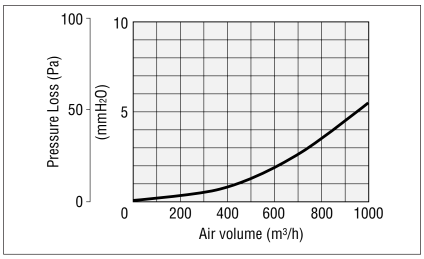
PZ-35RFM



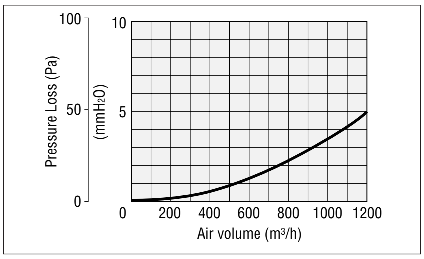
PZ-50RFM



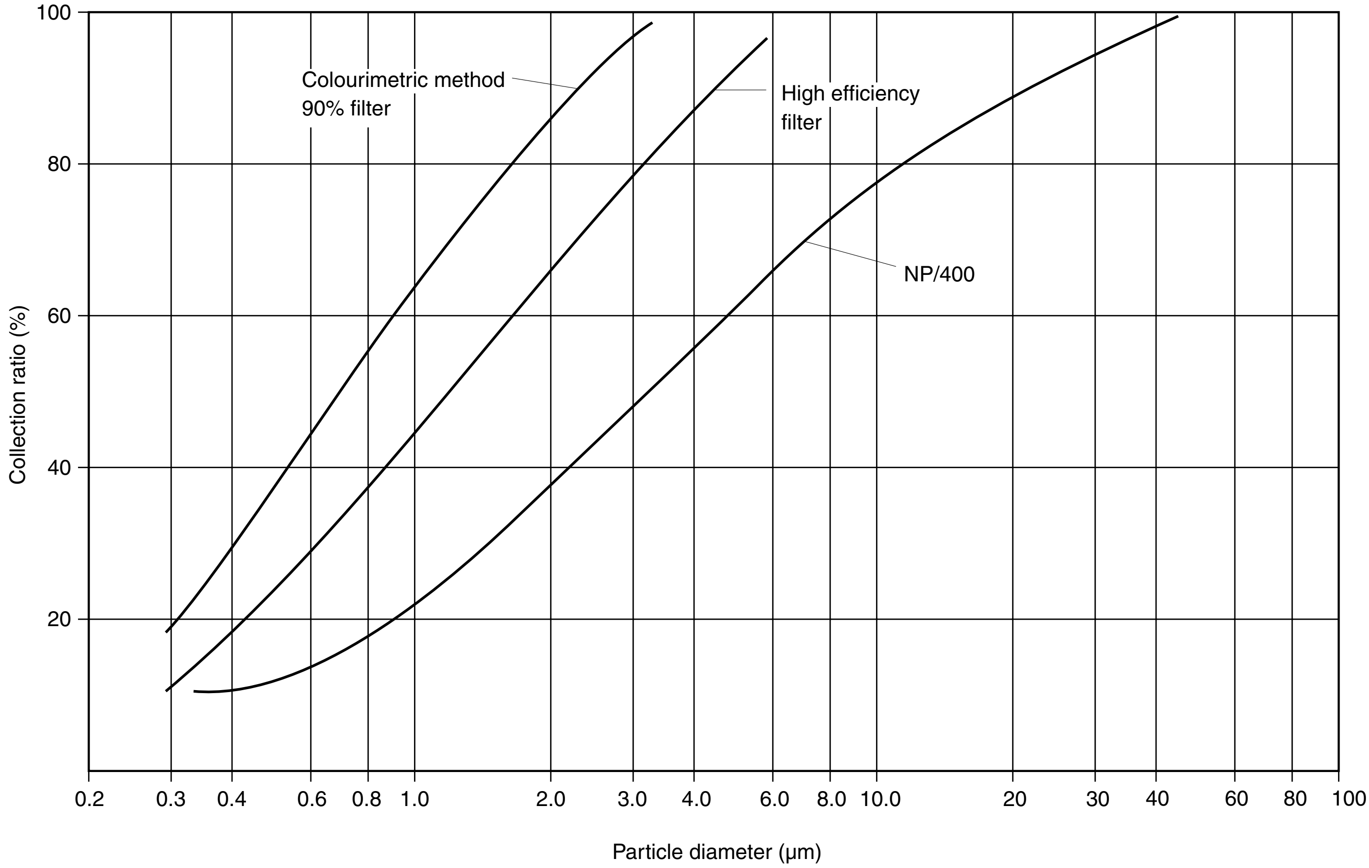
PZ-80RFM



PZ-100RFM



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

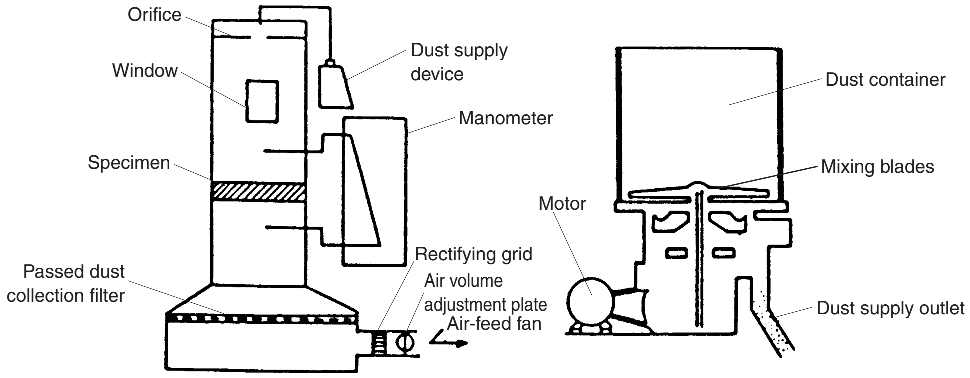
The gravitational, colorimetric and counting methods used for measuring dust collection efficiency each have differing features and must be used according to the application of the filter.

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 contamination of reduction in degree of contamination	Electrostatic dust percentage of (for air conditioning)
DOP Counting method	Diameter of dicoctyl-phthate small drop particles: 0.3 μm	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	Pre-filter 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
Pre-filter 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	Pre-filter
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 (10 μm or more). The measurement method is determined by the gravitational ratio of the dust amount on the in-flow side and out-flow sides.

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



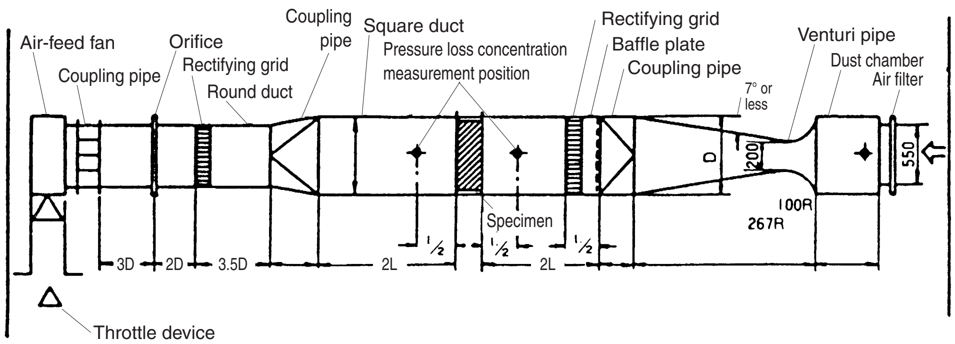
Performance test device

Example of dust supply device

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.

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

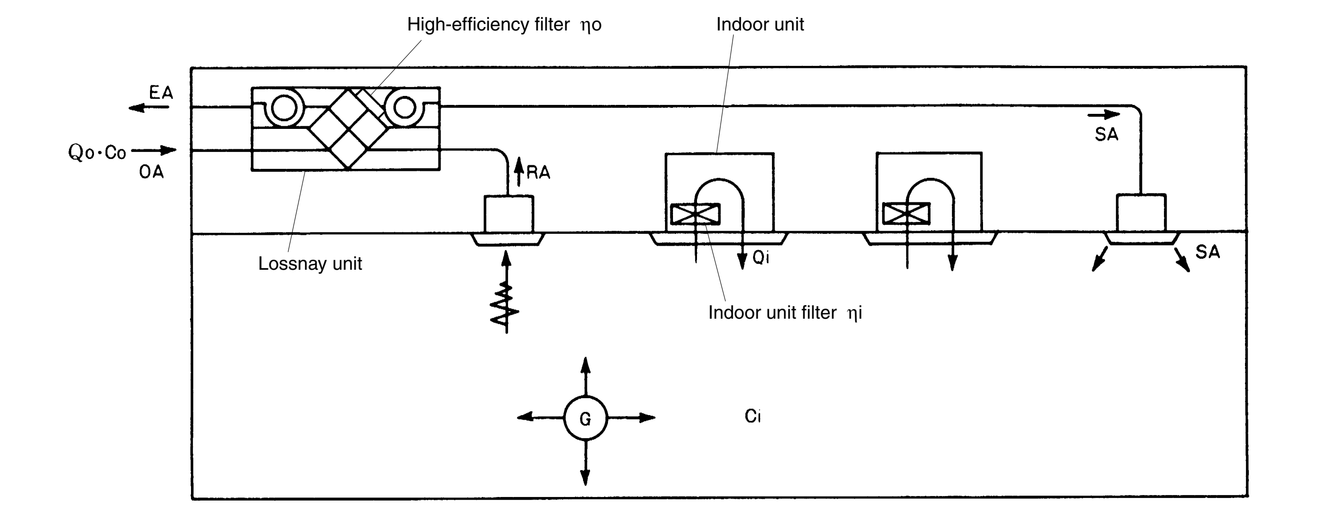


Unit (mm)

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 amount (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 C_i 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 ho 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
100 m^2 (Office)	20 persons	25 m^3/h per person × 20 persons = 500 m^3/h	15,700 W (13,500 kcal/h)	13,374 W (11,500 kcal/h)

● Equipment used

Lossnay + humidifer 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	3,710 W (3,190 kcal/h)	3,907 W (3,360 kcal/h)	500 m^3/h	65% (colorimetric method)

Fan coil unit	Model	Cooling capacity	Heating capacity	Air volume	Filtering efficiency
	LH-600CR-B3F (with high efficiency filter) 2 units	5,338 W (4,590 kcal/h)	8,664 W (7,450 kcal/h)	17 m^3/min	65% (colorimetric method)

Calculation

Intake volume	$Q_o = 500\ m^3/h$
Indoor unit air volume	$Q_i = 17 \times 2 \times 60 = 2{,}040\ m^3/h$
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	$C_o = 0.1\ mg/m^3$
Amount of dust generated in room	G = amount of dust generated per person × no. of persons in room = 10 mg/h·person × 20 persons = 200 mg/h

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

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

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

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

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

CHAPTER 9

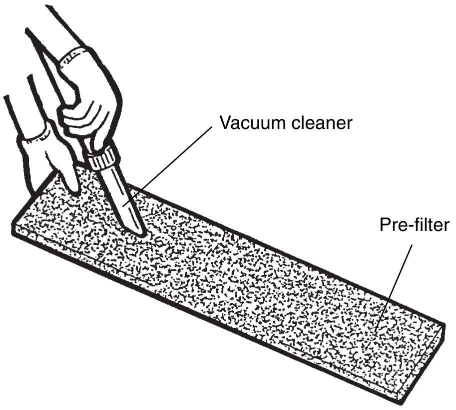
Service Life and Maintenance

1. Service Life

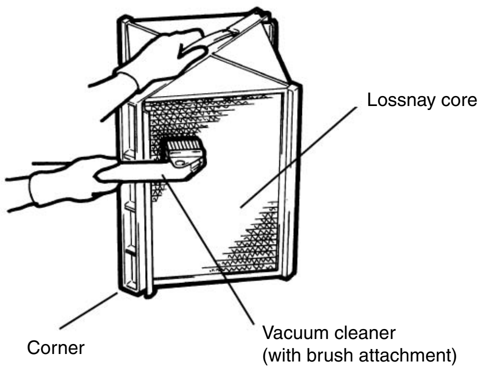
The Lossnay Core has no moving parts. This stationary design eliminates vibration troubles and also permits greater installation flexibility. In addition, chemicals are not used in the heat recovery system. Performance characteristics remain constant throughout the period of service.
A lifetime test, currently in progress and so far reaching 17,300 hours, has revealed no evidence of either reduction in heat recovery 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.
(This explanation is not a guarantee of the service life of the product.)

2. Cleaning the Lossnay Core and Pre-filter

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 core to 98 to 100% of the original figure. A brush should not be used for cleaning because it may trap the dust in the core 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



Do NOT wash in water.



CHAPTER 10
Ventilation Standards in Each Country

1. Ventilation Standards in Each Country

1.1 Japan

Table Summary of Laws Related to Ventilation

<table>
<tr><th>Item / Related Laws</th><th>Acceptable Range</th><th>Room Environment Standard Values</th><th>Reference pages</th></tr>
<tr><td>Law for Maintenance of Sanitation in Buildings</td><td>Buildings of at least 3,000 m^2 (for schools, at least 8,000 m^2)</td><td>If a central air quality management system or mechanical ventilation equipment is installed, comply with the standard target values shown in the table below.
<table>
<tr><td>Impurity volume of floating particles</td><td>less than 0.15 mg per 1 m^3 of air</td></tr>
<tr><td>CO rate</td><td>Less than 10 ppm. (Less than 20 ppm when outside supply air has a CO rate of more than 10 ppm.)</td></tr>
<tr><td>CO_2 rate</td><td>Less than 1,000 ppm.</td></tr>
<tr><td>Temperature</td><td>1) Between 17°C and 28°C
2) When making the room temperature cooler than the outside temperature, do not make the difference too great.</td></tr>
<tr><td>Relative humidity</td><td>40% - 70%</td></tr>
<tr><td>Ventilation</td><td>less than 0.5 m/sec</td></tr>
</table></td><td>Applicable buildings are buildings designed to serve a specific purpose. See page 123 for details.</td></tr>
<tr><td>The Building Standard Law of Japan</td><td>Buildings with requirements for ventilation equipment
1) windowless rooms.
2) rooms in theaters, movie theaters, assembly halls, etc.
3) kitchens, bathrooms, etc.
Rooms with equipment or devices using fire.</td><td>Central air quality management system ventilation capacity and characteristics
Effective ventilation capacity $V \geqq 20Af/N(m^3)$
Af: floor space (m^2), N: floor space occupied by one person
Characteristics: Generally satisfy the table below.
<table>
<tr><td>Impurity volume of floating particles</td><td>less than 0.15 mg per 1 m^3 of air</td></tr>
<tr><td>CO rate</td><td>Less than 10 ppm.</td></tr>
<tr><td>CO_2 rate</td><td>Less than 1,000 ppm.</td></tr>
<tr><td>Temperature</td><td>1) Between 17°C and 28°C
2) When making the room temperature cooler than the outside temperature, do not make the difference too great.</td></tr>
<tr><td>Relative humidity</td><td>40% - 70%</td></tr>
<tr><td>Ventilation</td><td>less than 0.5 m/sec</td></tr>
</table></td><td>Applicable buildings are buildings with requirements for ventilation equipment. See pages 115, 116 for details and valid ventilation capacity calculation methods.</td></tr>
<tr><td>Industrial Safety and Health Act</td><td>Offices where workers work.
(Office sanitation regulated standards)</td><td>For general ventilation, the effective ventilation area opening is at least 1/20 of the floor space and the ventilation equipment installed gives a CO density of 50 ppm and CO_2 density of 5,000 ppm or less. If a central air quality management system or mechanical ventilation equipment is installed, comply with the standard target values shown in the table below.
<table>
<tr><td>Impurity volume of floating particles</td><td>Air (1 atmospheric pressure, 25°C) less than 0.15 mg per 1 m^3 of air</td></tr>
<tr><td>CO rate</td><td>Less than 10 ppm. (Less than 20 ppm when outside supply air has a CO rate of more than 10 ppm.)</td></tr>
<tr><td>CO_2 rate</td><td>Less than 1,000 ppm.</td></tr>
<tr><td>Air flow in room</td><td>Air speed in room is less than 0.5 m/s, and air taken into the room does not blow directly on or reach specific workers.</td></tr>
<tr><td>Heat and humidity conditions</td><td>Heat between 17°C - 28°C
Relative humidity 40% - 70%</td></tr>
</table></td><td>See pages 123, 124 for details.</td></tr>
</table>

1.2 The Building Standard Law of Japan (Building Standards Legal Enforcement Ordinance)

Legal article 28, clause 2 Regulation 20, clause 2,3,4 Regulation 129, clause 2,3
Notice from Ministry of Contruction No. 1826, 1970

1.2.1 Types of ventilation equipment that should be installed for special buildings.

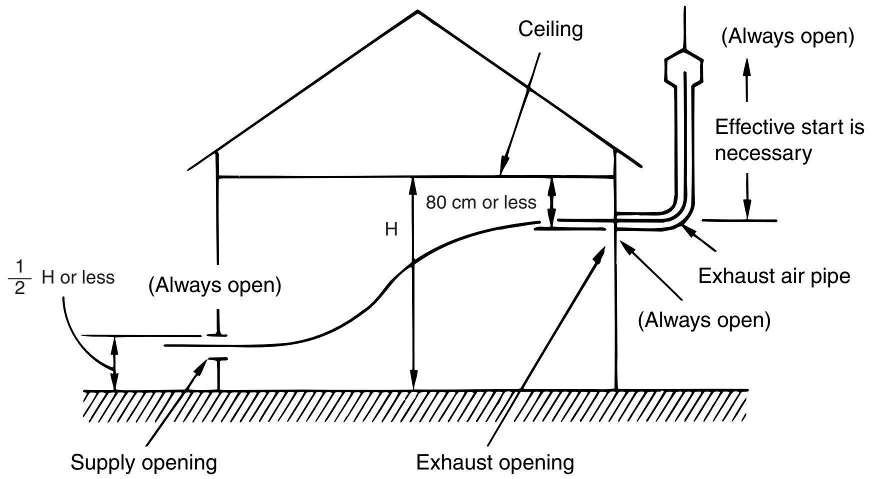
Types of ventilation equipment that should be installed for special buildings.

Special buildings where installation is required	Types of ventilation equipment
(1) Windowless rooms (Effective windows for ventilation have an opening with an area of at least 1/20 of the floor space)	Natural ventilation equipment (Caution 1) Mechanical ventilation equipment (Caution 2) Central air quality management ventilation system (Caution 3)
(2) Rooms in theaters, movie theaters, viewing halls, public halls, assembly halls	Mechanical ventilation equipment Central air quality management ventilation system
(3) Kitchens, bathrooms, and other places where stoves, heaters, or other devices or equipment using fire are used.	Natural ventilation equipment Mechanical ventilation equipment

Note: 1. The area effective for ventilation is the area that is actually open. This area is about 1/2 the area of a sliding window, or almost the entire area of a rotating window.
2. For calculation (1) above, any rooms separated by sliding paper doors, etc., are counted as 1 room whenever they are opened.
3. For (3): 1) Rooms where only airtight combustion devices that do not give off polluting waste gases, and devices of the type that draw air directly from the outside for combustion installed in the rooms.
2) As an exception, for kitchens with a total floor space of less than 100 m^2 in a residence, where the total heat capacity of the combustion devices is less than 41,860.5 kJ, the effective opening area must be at least 1/10 of the floor space, or at least 0.8 m^2.

⚠ Caution

1. This does not refer to what is generally called natural ventilation; rather a ventilation device that depends on a draft developed by wind speed, density difference (natural strength) from an always opened supply air opening, exhaust air opening, or exhaust pipe.
2. Ventilation supplied by equipment under mechanical power (often a supply fan, exhaust fan) means one of the following combinations:
   Supply fan + exhaust fan (Type 1 ventilation equipment)
   Supply fan + exhaust opening (Type 2 ventilation equipment)
   Exhaust fan + supply opening (Type 3 ventilation equipment).
   The name in the brackets depends on district regulations, etc.
   Air conditioners that bring in fresh air are classified as air supply fans.
3. For a building with a height of more than 31 m, and that is required to install an emergency elevator, etc., the air control device's control operation conditions must be able to be monitored from the central management room. (This is the same for buildings under 31 m with mechanical ventilation devices). If the building is under 31 m, it does not necessarily need to be controlled from the central management room. Controlling from an air quality device room is sufficient.



1.2.2 About ventilation capabilities, etc.

For regular buildings, omitting central air quality management devices, there are no regulations regarding ventilation capabilities and such. (For regular buildings with central air management devices, the characteristics that the device should have are the same as for buildings designed for a special purpose). The capabilities and such demanded for buildings designed for special purposes are shown below.

(1) Natural ventilation device dimensions (omitted)

(2) Effective ventilation capacity of mechanical ventilation devices

When installed in windowless rooms

- Effective ventilation capacity of mechanical ventilation devices when installed in windowless rooms

$$V = \frac{20Af}{N}$$

V: effective ventilation capacity (m^3/h)
Af = S-20s (m^2)
S: Room floor space (m^2)
s: effective ventilation area (m^2)
N: Actual conditions applying to floor space occupied by one person (m^2)

$$N \begin{cases} = \frac{S}{n} & \left(\text{when } \frac{S}{n} \leqq 10\right) \\ = 10 & \left(\text{when } \frac{S}{n} > 10\right) \end{cases}$$

n: Occupancy of room

* The capabilities of supply/exhaust devices must be considered with respect to overall pressure loss in the ventilation path.

When installed in rooms intended for use by assemblies

- Effective ventilation capacity of mechanical ventilation devices when installed in rooms intended for use by assemblies

$$V = \frac{20Af}{N}$$

V: effective ventilation capacity (m^3/h)
Af = S (m^2)
S: Room floor space (m^2)
N: Actual conditions applying to floor space occupied by one person (m^2)

$$N \begin{cases} = \frac{S}{n} & \left(\text{when } \frac{S}{n} \leqq 3\right) \\ = 3 & \left(\text{when } \frac{S}{n} > 3\right) \end{cases}$$

n: Occupancy of room

When installed in rooms where combustion devices are used

- Effective ventilation capacity of mechanical ventilation devices when installed in rooms where combustion devices are used

$$V \geqq 40\ kQ$$

V : effective ventilation capacity (m^3/h)
k : unit of volume of theoretical waste gas per combustion volume (See “Theoretical waste gas volume”on the next page.)
Q : Volume of fuel consumed in actual conditions

⚠ Caution

Simple ventilation or simple air exchange does not mean supplying fresh air (O: 21%, N: 79%) to a room with no environmental hindrances. Therefore, when effective ventilation is converted into regular mechanical ventilation capacity, it becomes at least 40 m^3/person·h, so caution is necessary.

Theoretical waste gas volume

Fuel type			Theoretical waste gas volume per unit (m^3/kJ)	Theoretical waste gas volume (m^3/m^3)
Name of fuel		Heat produced (kJ / m^3)		
City Gas	13A	46,000	0.000258	11.87
	12A	40,000	0.000258	10.32
	5C	19,000	0.000258	4.90
	L1	21,000	0.000258	5.42
	L2	21,000	0.000258	5.42
	L3	15,000	0.000258	3.87

Fuel type		Theoretical waste gas volume
Name of fuel	Heat capacity	
LP gas (mainly propane)	50,000 kJ/kg	12.90 m^3/kg
Butane/Air gas	29,000 kJ/ m^3	7.33 m^3/m^3
Kerosene	40,000 kJ/kg	12.10 m^3/kg

(3) Ventilation capacity and characteristics of central air quality management devices

Effective ventilation capacity V ≧ 20Af/N (m^3)
However, As = S (room's total floor space) (m^2) N: Floor space occupied by one person in actual condition (equals 10 when actual value is over 10).
Characteristics: Generally satisfy the table below.

Central air quality management system ventilation capacity and characteristics

Impurity volume of floating particles	less than 0.15 mg per 1 m^3 of air
CO rate	Less than 10 ppm.
CO_2 rate	Less than 1,000 ppm.
Temperature	1) Between 17°C and 28°C 2) When making the room temperature cooler than the outside temperature, do not make the difference too great.
Relative humidity	40% - 70%
Ventilation	less than 0.5 m/sec

⚠ Caution

1. When cooling, keep the temperature difference at 7°C or less.
2. This table applies to regular buildings (under 31 m) when central air quality management system is installed.

Note: The volume of CO_2 given off by humans is about: 0.01 m^3/hr
when sleeping 0.02 to 0.05 m^3/hr
during regular work 0.08 m^3/hr during heavy exercise.

The formula generally used to calculate the necessary ventilation capacity to keep CO_2 density levels under accepted limits is given below.

$$y = \frac{k}{p-q} \times 100$$

y : required ventilation (m^3/h) . . . . . . per 1 person
k : CO_2 given off by one person each hour
p : acceptable level of CO_2 in the room (%)
q : density of CO_2 in fresh air (usually about 0.03% to 0.04%)

The N value showing floor space occupied by one person is calculated by a general rule, and can not be uniformly regulated. However, the numerical values provided by JIS A3302 (Sewage purification tank management disposal by number of people calculation table, separated by the intended use of the building) allow some references to be drawn. This N value is created from the above-mentioned JIS A3302, which was completed for Tokyo, but this table can be treated as a reference for the entire country.

Ventilation device N value (floor space occupied by one person in actual conditions)
(Building administrative use criteria)

	Building use	People calculated per unit	Space occupied by one person (m^2)	
1	Public hall, Assembly hall	Number of people that can be held at one time	0.5 m^2 - 1.0 m^2	
2	Theater, Movie theater, Stage		0.5 m^2 - 1.0 m^2	
3	Gymnasium		0.5 m^2 - 1.0 m^2	
4	Inn, Motel, Hotel		10 m^2	
5	Day-laborers' lodgings, Dormitory		3 m^2	
6	Youth hotel, Youth home	Number of people that can be held at one time	—	
7	Hospital, Sanitarium, Hospital for infectious diseases		4 m^2 - 5 m^2	
8	Clinic, Doctor's office		5 m^2	Room floor space
9	Shop, Market		3 m^2	Floor space of the sales area
10	Market, Pawn shop		3 m^2	Room floor space
11	Department store		2 m^2	
12	Food/drink shop, Restaurant, Coffee shop		3 m^2	Floor space of the sales area
13	Cabaret, Beer hall, Bar		2 m^2	
14	Billiard room, Table tennis hall, Dance hall, Bowling alley		2 m^2	
15	Pachinko parlor, Go parlor, Mah johng parlor		2 m^2	
16	Day care center, Nursery school, Elementary school	Number of people that can be held at one time	—	
17	Junior High school, High school, University, all types of schools		—	
18	Library		3 m^2	
19	Office		5 m^2	Floor space of the work area
20	Factory, Office, Systems Management room	Number of staff members	—	
21	Laboratory, Testing Laboratory	Number of people that can be held at one time	—	
22	Public bathhouse		4 to 5 m^2	Floor space of the bathing area
23	Corridor		10 m^2	
24	Hall		3 to 5 m^2	
25	Restroom		$30m^3/h \cdot 1\ m^2$	(Ventilation capacity)
26	Washroom		$10\ m^3/h \cdot 1\ m^2$	
27	Electrical storage room, etc.		$35m^3/h \cdot 1\ m^2$	
28	Automobile garage		$35m^3/h \cdot 1\ m^2$	

1.2.3 When accommodated people are present

Joint ventilation method *1
Pressure ventilation method *2 } 35 m^3 /h·person

However, when adjusting h·person and humidity (note: during air adjustment), you can figure 1/2 of this value. (Note: In other words, the value 35 m^3 /h·person expresses value when performing maintenance on the room environment, depending to a certain degree on the outside air taken in.)

⚠ Caution

*1 Method for supply air fan + exhaust air fan combination
*2 Method for supply air fan only

Suction ventilation method (Exhaust air fan only method)
3. (I) When supplying outside air directly to the room .... 35 m^3 /h·person
3. (II) When outside air enters the room from a corridor, etc., ... 45 m^3 /h·person

1.2.4 When accommodated people are not present

No.	Room	Ventilation method			Notes
		1 and 2. outside air volume (m^3 /h, m^2)	3. (I) exhaust air volume (m^3 /h, m^2)	3. (II) exhaust air volume (m^3 /h, m^2)	
1	Private room	8	8	10	Night-duty room, bed room, living room, private business room, etc., with floor space smaller than that of public rooms
2	Office	10	10	12	Sales room, office
3	Personnel/Staff room	12	12	15	Utility room, Guard room, Telephone room, Reception, Break room
4	Display room	12	12	15	Exhibit room
5	Cosmetics room	12	12	15	Hair-cutting room
6	Sales floor	15	15	20	Department store sales floor, inside sales room
7	Work room	15	15	20	Craft room without much dust, printing room, delivery room, packing room, unpacking room
8	Break room	15	15	20	Lounge, Waiting room, Visitors room, Anteroom
9	Recreation room	15	15	20	Game room, Ballroom
10	Smoking room	20	20	25	Room used at the same time for smoking at a new industry
11	Small meeting room	25	25	30	Small conference room
12	Cafeteria (for sales)	25	25	30	General cafeteria, coffee shop, drinking place
13	Cafeteria (not for sales)	20	20	25	Place supplied for specific people
14	Kitchen	60	60	75	Includes cafeteria for sales
15	Kitchen	35	35	45	Does not include cafeteria for sales
16	Pantry	25	25	30	Includes cafeteria for sales
17	Pantry	15	15	20	Does not include cafeteria for sales
18	Boiler room	—	15	15	
19	Dressing room	—	10	10	Changing room, Dressing room
20	Check room	—	10	10	Coat room, Room where the check person is
21	Bathroom	—	30	30	For use of many people at once
22	Bathroom	—	20	20	For a private home
23	Restroom	—	30	30	With many toilets
24	Restroom	—	20	20	For a private home
25	Washroom	—	10	10	Wash room
26	Projection booth	—	20	20	
27	Dusty or smelly room	—	30	30	
28	Room where poisonous or flammable gas is emitted or could be emitted	—	35	35	Storage batter room, Auto garage
29	Dark room	—	20	20	Dark room for developing pictures
30	Room with mechanical or electrical devices (At least 15 m^2)	—	10	10	Machine room, Electric supply room

1.2.5 Standards when the ventilation equipment goes through the fire prevention section

Ministry of Construction Noice No. 1579 (28 December, 1974)

Building Standards Legal Enforcement Ordinance No. 12, Section 16

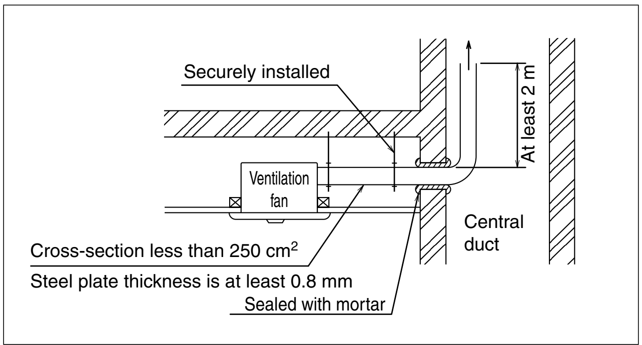
In a notice from the Ministry of Construction regarding laws related to the ventilation in medium and high rise apartment buildings, generally if the air path of the ventilation, etc., goes through the fire prevention section of a fireproof structure, a fireproofing damper device must be installed. However, in the cases of the following classifications, it is not necessary to install a fireproofing damper.

(1) When a kitchen, sun terrace, etc., ventilation device's duct goes through a secure hole in the section

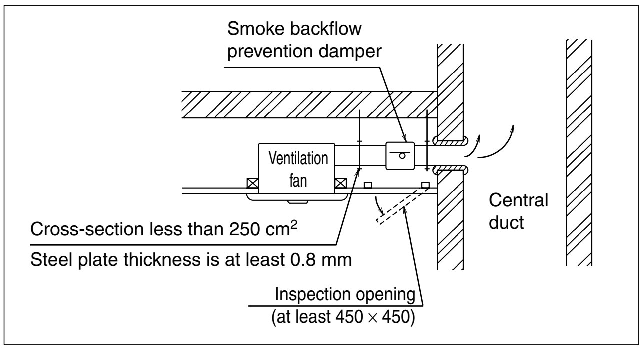
Conditions

- The duct is steel plated and the plate thickness is at least 0.8 mm.
- There is a 2 m rising section in the central duct, or there is a smoke backflow prevention damper installed.
- The part of the duct actually going through is less than 250 cm^2.
- The main structure is securely fixed when installed.
- The gap around the piercing section of the duct is sealed with mortar, etc.
- The top of the central duct is open to the outside air, or ventilation fan is installed.
- The central duct and piping ducts are not used for purposes other than ventilation.

With a 2 m rising duct



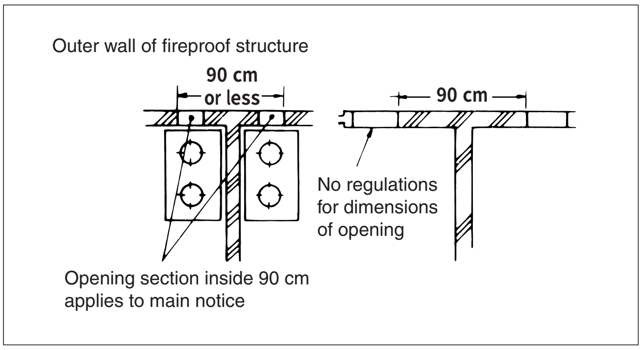
With a smoke backflow prevention damper installed



(2) When the outer wall of the fireproof structure is pierced

Conditions

- The duct is steel plated and the plate thickness is at least 0.8 mm.
- The main structure is securely fixed when installed.
- The gap around the piercing section of the duct is sealed with mortar, etc.
- The part of the duct actually going through is less than 250 cm^2.
- The opening to the outside air has a shutter attached to the 0.8 mm or more thickness steel plating that can be shut at any time.

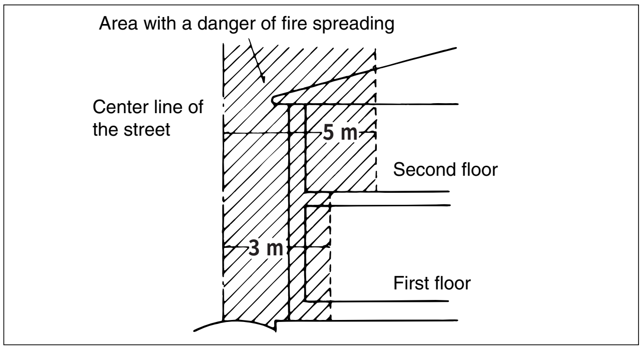


(3) When there is danger of fire spreading in the fire prevention area

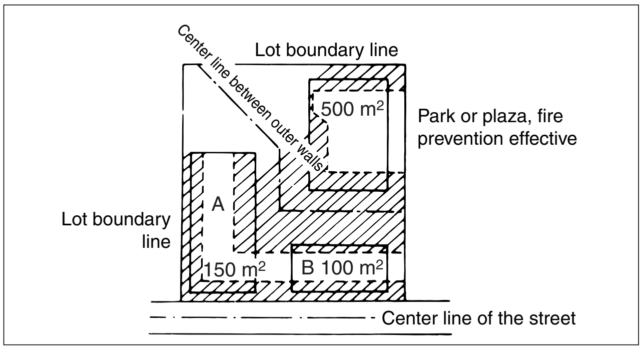
By law, a fire prevention structure must be constructed if there is a danger of fire spreading from the opening section in the outer wall (Article 2, clause 6).

Sections with a danger of fire spreading

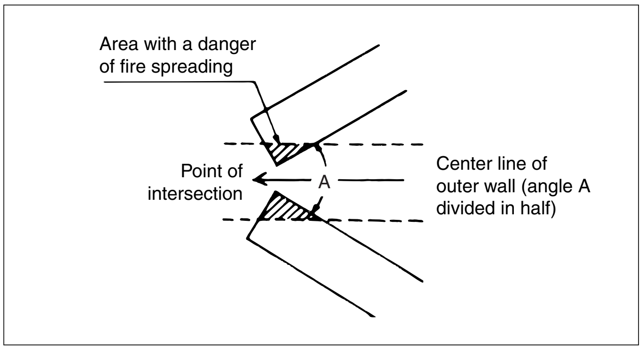
1) When there are two or more buildings on the same premises from the lot boundary line and from the center line of the street, the area less than 3 m from the center line of the outer wall of the first floor, and less than 5 m from the center line of the outer wall of the second floor are sections with a danger of fire spreading.



2) When there are two or more buildings on the same premises and the total extended area is less than 500 m^2, consider them as one building and measure from the center of the space between the outer walls. In the illustration below, A and B have a total area of less than 500 m^2, so they are considered one building.



3) When two buildings on a slant towards each other, draw a line dividing in half the angle created by the extended lines from the outer walls, and consider that the center line of the outer wall.



* In the case above, if it faces a park, plaza, river or other open space, water surface, or fireproof structure, it is not considered and area with a danger of fire spreading.

1.3 Law for Maintenance of Sanitation in Buildings (Laws regarding the protection of a sanitary environment in buildings)

If the total extended area designated in a building for specific use (See Caution 1) is more than 3,000 m^2 (according to Article 1 of the regulations in the School and Education Laws, this area designated for specific use for schools is 8,000 m^2 , see Caution 2), the measures necessary to maintain good environmental and sanitary conditions, including areas other than air quality environment such as supply/waste water processing, cleaning, and prevention of mice and insects, are regulated by the regulations applied to such buildings.

⚠ Caution

Caution 1. Buildings designated for a specific use include

1. New industry, department store, assembly hall, library, natural history museum, art museum, or amusement center
2. Shop or office
3. Schools other than those designated by Article 1 of the regulations in the School and Education Law (including laboratories).
   * As explained above, buildings classified under Article 1 of the regulations in the School and Education Law are considered buildings for specific purposes.
4. Inns
   "Cooperative housing" is another example shown in these regulations, but when the cooperative housing is not sharing an air control system, the management of the air environment should be left to the individual resident, and is therefore not included as an object of this law.

Caution 2. Article 1 of the regulations in the School and Education Law. According to this law, school refers to elementary schools, junior high schools, high schools, universities, technical schools, schools for the blind, schools for the deaf, schools for the handicapped, and nursery schools.

With the many controls previously noted, only when a central air quality management device (purification, temperature and humidity control, air flow adjustment) or a mechanical ventilation device (purification, air flow adjustment), only most of the target values shown below need to be met with respect to the maintenance of air environment quality.

Impurity volume of floating particles	less than 0.15 mg per 1 m^3 of air
CO rate	Less than 10 ppm. (Less than 20 ppm when outside supply air has a CO rate of more than 10 ppm.)
CO_2 rate	Less than 1,000 ppm.
Temperature	1) Between 17°C - 28°C 2) When making the room temperature cooler than the outside temperature, do not make the difference too great.
Relative humidity	40% - 70%
Ventilation	less than 0.5 m/s

Please also note that for general buildings that are not classified as buildings designed for a specific purpose, when that building is used or utilized by a large number of people, the building should be maintained in compliance with the standards shown above.

1.4 Industrial Safety and Health Act

These laws include many categories that in the past were covered independently in relation to labor safety and sanitation. The included items that should be complied with, in addition to those related to air adjustment such as waste air figured per one laborer, ventilation, dust removal, air flow, and heat and humidity control, are boiler construction, manufacture, use, operator certification, certification of workers carrying out the construction of the air adjustment device, or the safety of working on scaffolding or other high places. However, because here we are dealing only with those items with a deep relation to air adjustment planning, there is a demand for another chance for research.

1.4.1 Office Sanitation Standard Regulations

The following points about ventilation, etc., of the office (see Caution 2) where workers (see Caution 1) work are established. (Indoor work other than in offices is according to the Labor Safety and Sanitation Regulations).

⚠ Caution

Caution 1. Workers as defined by the labor laws does not refer to types of occupations, but people who work in offices or indoor workplaces, (including public officials), and are paid wages. However, this does not apply in cases where only relatives are using the office or working out of the home.

Caution 2. In this office, other than general office work (including related writing or filing), working in a room for a card line hand held typewriter or other mechanical work equipment is included. However, factories, or work places with one area free-standing or separated work area are not classified as offices or work places under this regulation. (Places where people work that are not covered by this law are subject to the Labor Safety and Sanitation Law).

Regular ventilation

There must be an opening directly to the outside air (See Caution 1), and it must have an opening section of at least 1/20 of the total floor space, otherwise a ventilation device is required (See Caution 2). Furthermore, the density of carbon monoxide (CO) in the room must be under 50 ppm, and the density of carbon dioxide (CO_2) must be under 5,000 ppm.

⚠ Caution

Caution 1. Openings facing corridors, lobbies, etc., are not included.

Caution 2. Natural ventilation devices, as stated in "Ventilation," Item 9, section 2-1 of the Buildings Standards Law, includes air quality adjustment devices (as long as they are capable of drawing in fresh air) as well as mechanical ventilation devices.

The formula generally used to calculate the necessary ventilation capacity to keep CO_2 density levels under accepted limits is given below.

$$y = \frac{k}{p-q} \times 100$$

y : required ventilation (m^3/h) per 1 person

k : CO_2 given off by one person each hour (usually 0.02 m^3 to 0.05 m^3)

p : acceptable level of CO_2 in the room (%)

q : density of CO_2 in fresh air (%) (usually about 0.03% to 0.04%)

This formula only deals with carbon dioxide exhaled by people. When gas using devices or other combustion devices are being used in the room, it is necessary to check the amount of carbon dioxide given off by the device and add, and check the amount of air needed by the device and add.

Standards when a central air quality management system (See Caution 1)

In the Office Sanitation Standard Regulations, which differ from the Building Standards Law, whether or not a central air quality management system or other such system must be installed is not stated (in other words, it is dealt with in other laws), but if a central air quality management system or other such system is installed, adjust the device so that the air supplied to the room (See Caution 2) complies with the standards shown below.

Impurity volume of floating particles	Air (1 atmospheric pressure, 25°C) less than 0.15 mg per 1 m^3 of air
CO rate	Less than 10 ppm. (Less than 20 ppm when outside supply air has a CO rate of more than 10ppm.)
CO_2 rate	Less than 1,000 ppm.
Air flow in room	Air speed in room is less than 0.5 m/s, and air taken into the room does not blow directly on or reach specific workers.
Heat and humidity conditions	Heat between 17°C - 28°C Relative humidity 40% to 70%

⚠ Caution

Caution 1. Air quality management systems (devices that can purify air, adjust temperature, humidity, and air flow for the supply air) and mechanical ventilation devices (devices that can purify air and adjust air flow for the supply air) are defined as devices that can control the supply air to all rooms uniformly from a centralized location.

Caution 2. Air expelled from the exhaust air opening is not room air. This classification range includes air that is actually expelled from the exhaust opening, or air that is in the exhaust opening or the duct leading to the exhaust opening.

1.4.2 Industrial Safety and Health Regulations

The following regulations apply to the ventilation of indoor work spaces other than offices.

Ventilation

There must be an opening directly to the outside air, and it must have an opening section of at least 1/20 of the total floor space. However, if a ventilation device with enough capacity is installed, this is not necessary.

Speed of the air flow

When the temperature of the indoor work space is under 10°C, workers must not be exposed to an air flow faster than 1 m/s during ventilation.

Other

For indoor work spaces that contain devices which give off gas, steam, dust particles, or a lot of heat; closure of the source, installation of a localized exhaust device or an overall ventilation device, or some other such measure is necessary.

2. U.S.

ASHRAE standard 62 - 1999

Application	Outdoor air recommendation	Occupancy
Dry Cleaner	30 cfm/person	30 people/100 m^2
Dining room	20 cfm/person	70 people/100 m^2
Bars	30 cfm/person	100 people/100 m^2
Kitchens	15 cfm/person	20 people/100 m^2
Hotel bedroom	30 cfm/room	—
Hotel living room	30 cfm/room	—
Hotel lobby	15 cfm/person	30 people/100 m^2
Casino	30 cfm/person	120 people/100 m^2
Office space	20 cfm/person	7 people/100 m^2
Conference room	20 cfm/person	50 people/100 m^2
Smoking lounge	60 cfm/person	70 people/100 m^2
Bowling alley (seating area)	25 cfm/person	70 people/100 m^2

3. U.K.

CIBSE

Application	Outdoor air			Smoking
	Recommended	Minimum		
	Per person	Per person	Per m^2	
Factories	8 l/s /person	5 l/s /person	0.8 l/s / m^2	None
Offices (open plan)	8 l/s /person	5 l/s /person	1.3 l/s / m^2	Some
Shops, department stores and supermarkets	8 l/s /person	5 l/s /person	3.0 l/s / m^2	Some
Theatres	8 l/s /person	5 l/s /person	—	Some
Dance halls	12 l/s /person	8 l/s /person	—	Some
Hotel bedrooms	12 l/s /person	8 l/s /person	1.7 l/s / m^2	Heavy
Laboratories	12 l/s /person	8 l/s /person	—	Some
Offices (private)	12 l/s /person	8 l/s /person	1.3 l/s / m^2	Heavy
Residences (average)	12 l/s /person	8 l/s /person	—	Heavy
Restaurant (cafeteria)	12 l/s /person	8 l/s /person	—	Heavy
Cocktail bars	18 l/s /person	12 l/s /person	—	Heavy
Conference rooms (average)	18 l/s /person	12 l/s /person	—	Some
Residence	18 l/s /person	12 l/s /person	—	Heavy
Restaurant	18 l/s /person	12 l/s /person	—	Heavy
Board rooms executive offices and conference rooms	25 l/s /person	18 l/s /person	6.0 l/s / m^2	Very Heavy
Corridors	N/A	N/A	1.3 l/s / m^2	N/A
Kitchens (domestic)	N/A	N/A	10.0 l/s / m^2	N/A
Kitchens (restaurant)	N/A	N/A	20.0 l/s / m^2	N/A
Toilets	N/A	N/A	10.0 l/s / m^2	N/A

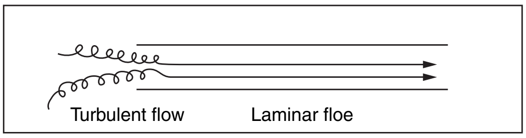
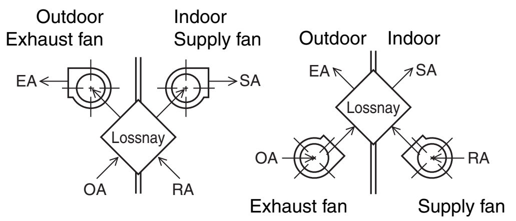
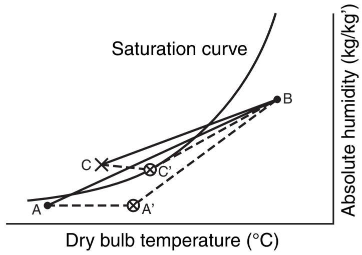
CHAPTER 11
Lossnay Q and A

	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 recovery 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 recover 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. 13 m^2 room with five people, a ventilation volume of 100 m^3/h is required. The amount of power consumed in this case is approximately 45 W, and the amount of heat recovered during cooling is approximately 600 kcal/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>Between 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 43,000 yen per year. The initial costs can be suppressed down to a 59,000 yen increase when comparing the air conditioner, Lossnay, and ventilator (fixed- price base).

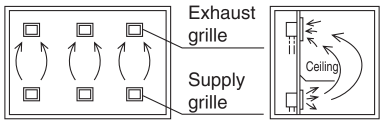
Calculation conditions
Cooling:
Room temperature/humidity 26°C, 50%
Outdoor air temperature/humidity 32°C, 70%
Heating:
Room temperature/humidity 20°C, 50%
Outdoor air temperature/humidity 0°C, 50%
Building:
General office facing south on middle floor 100 m^2
Cooling load (room) 104 W/m^2
Heating load (room) 77.7 W/m^2
Ventilation volume: 500 m^3/h
Without Lossnay:Straight lock fan BFS-50SU . . . . 2 units
With Lossnay:Lossnay LGH-50RX3 . . . . 1 unit
Cooling/heating load (W):
<table>
<tr><th rowspan="2"></th><th colspan="3">Without Lossnay</th><th colspan="3">With Lossnay</th></tr>
<tr><td>Room</td><td>Outdoors</td><td>Total</td><td>Room</td><td>Outdoors</td><td>Total</td></tr>
<tr><td>Cooling</td><td>10400</td><td>5560</td><td>15960</td><td>10400</td><td>2340</td><td>12740</td></tr>
<tr><td>Heating</td><td>7770</td><td>5630</td><td>13400</td><td>7770</td><td>2140</td><td>9910</td></tr>
</table>

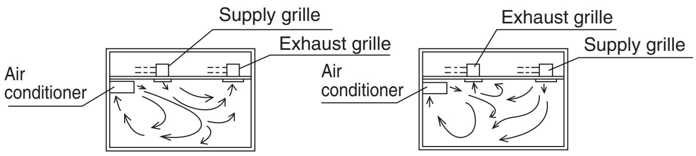
Air conditioner:
Without Lossnay : Ceiling-suspended cassette-type air conditioner PLZ-J140KA9G9 . . . . 1 unit
With Lossnay : PLZ-J112KA9G9 . . . . 1 unit
Operation time:
Cooling 10 hours/day, 26 days/month, 4 months/year, operation ratio 0.7
Heating 10 hours/day, 26 days/month, 5 months/year, operation ratio 0.7
Power costs (Tokyo Power special industrial power 6 kV supply)
Summer 16.15 yen /kWh, Other 14.65/kWh</td><td>There are also "savings in maintenance cost", "ventilation functions", "soundproofing effects" as well as "comfort" and "safety" which are not visible.</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: $100 \times 30\% \times 1/3 \times 7\% = 0.7\%$. 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 recovery method.)</td><td><Gas/smoke transmission rate>
CO : 1%
CO_2 : 2%
H_2S : 3%
NH_3 : 3%
Smoke : 1% - 2%
<Conditions>
(Supply and exhaust fans installed for suction feed. Standard treatment air volume.)</td></tr>
</table>

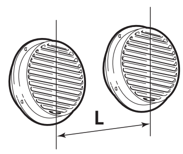
	Question	Answer	Remarks
8	Can the Lossnay be used for hospital air conditioning?	According to the results obtained from the test performed by the Tokyo University Hospital (Inspection Centre, Prof. Kihachiro Shimizu), as the supply air and exhaust air pass through different passages, transmission of bacteria from exhaust side to supply side is low. They found: 1) Bacteria does not propagate in the Lossnay Core. 2) Even if bacteria accumulated in the Lossnay, it died off in approximately two weeks.	
9	Since the entry to the Lossnay Core 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 50 mmAq, 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.	
11	Can the Lossnay be used in extreme cold climates (-10°C or lower)?	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. 	

<table>
<tr><th></th><th>Question</th><th>Answer</th><th>Remarks</th></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 The Building Standard Law of Japan, a ventilation volume of 20 m^3/hr·
person is required if the windows cannot be opened for ventilation.
In buildings to which the Law for Maintenance of Sanitation in Buildings is applied, the carbon gas concentration must be 0.1% or less, so a ventilation of 34 m^3/h·
person is required. In Tokyo, the guideline is set at 25 to 30 m^3/h.l
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>Teatre
Hospital room</td><td>25.5
34</td><td>17
25.5</td></tr>
</table>
</td><td></td></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 Core's 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 96.5 dB (A), the noise level at a point 30 cm from the intake/exhaust grille on the outside wall was 67.5 dB (A). This shows a soundproofing effect of 29.0 dB (A).
The soundproofing effect when the noise level is 100 dB (A) is approximately 30 dB (A).</td><td>+:
Japanese domestic market model.
Same model as LGH-50RX$_3$.</td></tr>
</table>

<table>
<tr><th></th><th>Question</th><th>Answer</th><th>Remarks</th></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>
<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 recovery units 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>
</table>

<table>
<tr><th></th><th>Question</th><th>Answer</th><th>Remarks</th></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 Core’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 to 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.

MEMO

MITSUBISHI ELECTRIC CORPORATION

2001.03 <MEE>