Introduction of Fujiyama Works F3 Building

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1. Introduction

Sanyo Denki has completed construction of the F3 Building in the Fujiyama Works of our Ueda operation. This will improve efficiency by bringing together the Cooling Systems Division and Power Systems Division in order to achieve the second mid-term management plan that started in April, 1998.

After investigating plans submitted from all divisions in the first stage of this construction project under a long-term plan, we decided that the Cooling Systems Division and Power Systems Division should use the Fujiyama Works F3 Building.

We set up the Fujiyama Works F3 Building Project Committee, which consists of general managers from the Cooling Systems and Power Systems Divisions, and this Committee drew up the master plan for constructing the Fujiyama Works F3 Building based on the long-term views of the respective departments.

We asked NTT Power and Building Facilities Inc., a design and construction management company (for central management and coordination of all construction activities) to undertake construction of the Fujiyama Works F3 Building.

In this report, we introduce various unique facilities and features of the Fujiyama Works F3 Building (abbreviated as "F3 Building" in this report).

2. Outline of Building

2.1 Fujiyama Works at Ueda

The Fujiyama Works of our Ueda operation (abbreviated as "Fujiyama Works" in this report) are located in the Higashi-Shioda industrial park which is set in a rich, forested environment south of Ueda city. The F1 Building was completed in May, 1990 and the F2 Building was completed in August, 1996 with a total site area of approximately 90,000 m^2, including the production factories of the Cooling Systems Division and Power Systems Division.

2.2 Building Design Requirements

For construction of the F3 Building, we estimated the production space required by the Cooling Systems Division and Power Systems Division based on the targets of the second mid-term management plan. We determined the design requirements for the F3 Building after investigating the concept of these works for the long term, including the effective use of the land in the future, too.

Design Requirements for the Building

(a) The F3 Building shall be three stories high, and the effective works area shall be 18,000 m^2.

(b) The effective works area shall be rectangular in shape in principle.

(c) Public welfare facilities (cafeteria) shall be improved.

(d) A systematic construction method Note (1) shall be adopted to achieve high quality, low cost, and rapid construction period.

Note (1) In the systematic construction method, the shapes, dimensions, and methods of joining materials (for the foundation, steel frame, roof, walls, fixtures and so on) are standardized in advance so that the various processes (sales, design, production, and construction) are systematized. This style of construction is called systematic construction, and enables high quality, economical construction, and a short construction period .

2.3 Layout Plan

The main targets of the layout plan of the F3 Building are as follows:

(a) Use of land with scope for future plans

(b) Access to existing buildings

(c) Roads of 6 m width or more around the F3 Building

(d) Parking lot for at least 600 cars including the existing parking lot for 193 cars

The main difficulties in planning the layout of the building were how to use the slope on the west side and how to secure a parking lot. The final plan aligns the F3 Building with the F1 Building (Fig. 1) and connects the two buildings with two corridors.

2.4 Outline of Building

The F3 Building is rectangular, approximately 120 m long east-west, and 75 m north-south (excluding the cafeteria and some machinery rooms). A detached warehouse of 11m×30m is attached to the east of the building, one of 10 m×5 m to the south, one of 40 m×25 m to the north, and one of 10 m×15 m to the northwest. These facilitate carrying-in materials and shipping the completed products without being affected by the weather.

(1) Floor planning

The production space is 100 m×60 m. Staircases, windbreak rooms, elevators for passengers and loads, air conditioning machinery rooms, refreshment rooms, rest rooms, etc. are equally laid out surrounding the production space to form a type of double-skin that improves the thermal insulation, makes life more convenient for employees and rationalizes these facilities.

The pillar spans of the machining rooms are 10 m×10 m in the 1st floor and the 3rd floor, and 10 m×20 m in the 4th floor.

For details of the constitution of each floor, refer to the floor plan of each floor (Fig. 2).

(2) Elevation plan

A clean, clear impression is achieved, while harmonizing the building silhouette, construction materials, and outside colors with the F1 Building.

The outer walls are all made of standardized panels of 10 m×1 m and the openings of the building use standardized fixtures.

(3) Cross-section plan

Considering the production facilities and the contents of the production work, and assuming that the first floor will be used for assembly lines for power supplies while the third and fourth floors will be used for assembly lines for cooling fans, the floor-to-floor heights are 6.6 m for the 1st floor, 4.8 m for the 3rd floor, and 4.4 m for the 4th floor. (The 2nd floor is used for locker rooms.)

Outline of building

Name of building	Sanyo Denki Fujiyama Works F3 Building
City planning requirement	Not required, not specified as fire prevention area
Site area	89,981.17m^2
Building area	10,470.76m^2
Total floor area	26,886.31m^2
1F	9,190.75m^2
2F	350.00m^2 Note (2)
3F	9,276.07m^2
M3F	406.50m^2
4F	7,662.99m^2
Spans of main pillars	
1,3F	10m×10m
4F	10m×20m
Maximum height of building	18.75m
Structure and size	Steel frame structure, Four-story building
Foundation	Direct foundation
Main exterior finish	
Outer wall:	Both-sided color steel platesandwiched panel
Fixtures:	Made of aluminum, Combined curtain wall of wood and aluminum
Main internal finish	(Production area)
Floor:	Floor coated with epoxy-based antistatic paint
Ceiling:	Covered by GW mats

Note (2) This building uses three floors for factory space. It is a three-story building but the locker rooms are located on the 2nd floor due to construction regulations.

3. Equipment Introduction

3.1 Equipment Plan

The equipment for the F3 Building was chosen under the following concepts.

(a)Clean system taking the environment into consideration

(b)Fundamental functions such as safety, efficiency, working environment and maintenance, shall be improved.

(c)Energy conservation

3.2 Power Supply for Products Test (500 kVA×3 systems in parallel)

This is a large-capacity static type power supply system made by Sanyo Denki. The output frequency can be varied (45 Hz to 65 Hz). (Fig. 3)

This system is installed in the power equipment room and supplies power for testing the products (mid-capacity and large-capacity uninterruptible power

supply) produced by Power Systems Division.
Our investigation focused on the following points.
(1) Countermeasures for exhaust gas and noise
Engine generators are typically used as the power supply for test laboratories, but such generators suffer problems of exhaust gas and noise.
We overcame this problem by using a large-capacity static type power supply system. However, the use of inverters generates harmonic power that flows into the commercial power line of the input side. We overcame this problem by using the high power factor converter technology of Sanyo Denki to provide a sine wave only to the input current inverter.
(2) Reduction of power consumption by feeding inverter output back to the input side
In inverter power supplies that are currently used for testing our products, electric power is consumed by the capacity of the load device. However, a 90% power reduction can be achieved by adding a new power regeneration circuit that we are developing for completion in 1999.
(3) Positioning as evaluation machine
We can test our products under various conditions (commercial tests) and hence develop products that reflect the needs of end users.

3.3 Air Compressor System
Air compressors are used to supply compressed air to production lines. We made the air compressor system part of the overall system including aspects of energy conservation, environmental conservation, and control and operation.
Before choosing the air compressor system, we investigated the following:
(a)Energy conservation
(b)Reducing environmental load by mechanical filtering of drainage
(c)Improved response to abnormalities by monitoring the system status by central monitoring equipment
(d)Ease of expansion and mutual support with the compressors of the existing building
The outside view of this system is shown in Fig. 4, the control board that controls the number of compressors is shown in Fig. 5, and the equipment structure is shown in Table 1.
To conserve energy, the system controls both the number of compressors and performs I-type control; this could be a model for future products.
The energy-saving is greater than that with general-purpose inverter control.
The electric power required for each control system is as follows.
Electric power required by each control system is shown in Fig. 6.

Note (3) U-type control: Intake throttle valve open/close control system
Note (4) I-type control: Intake throttle valve open/close control system + reduced pressure operating system

3.4 Lighting Equipment
The main specifications of the lighting equipment are shown in Table 2. The following points regarding the lighting equipment were investigated.
(1) Energy conservation
Hf fluorescent lamps with a built-in Hf inverter are used in the 3rd and 4th floors, achieving the following savings.
(a)The number of fluorescent lamps is reduced by approx. 33% with the same illumination.
(b)The power consumption is reduced by approx. 23%.

The space is divided into blocks where one block covers an area of 20 m×10 m. (Fig. 7) Combinations of one line and two lines of fluorescent lamps in a block can be turned on and off depending on the illumination requirements at any time to reduce the power consumption.

We anticipate that this method will reduce the power consumption by 17,000 kW a year.

(2) Improving safety and maintenance

As the ceiling of the 1st floor is high, mercury vapor lamps are used in the production space and windbreak rooms.

Since mercury vapor lamps take time to start up, about 30% of the mercury vapor lamps are equipped with an optical compensator that can maintain illumination of about 50 Ix during start-up until the lamps reach the specified illumination when the main power is turned off and on due to a momentary power failure or if the power switch is turned off by mistake.

All mercury vapor lamp posts have an automatic lifter to avoid works high off the ground when inspecting or replacing the lamps.

3.5 Air Conditioning Equipment

A central heat source is used considering the power demand of the entire Fujiyama Works. Diesel (A-heavy) oil burning absorption cold/warm water generators are used as the central heat source for air conditioning. Two water generators are installed to maximize the capacity control when the air conditioning system is running at partial load, and to avoid having to stop the air conditioning system if either generator fails or during inspection.

Until 24-hour operation starts, cooling-only ceiling suspension air conditioners in the production space of each floor provide air conditioned cooling during the daytime and heating at night.

Since the ceiling of each floor is high, the intake ducts of the air conditioners are placed at floor level on each floor, and circulation fans are attached to the ceiling in the 1st floor to improve the heating efficiency.

Local exhaust units for production spaces work together with air conditioners that process outside air, so that the optimum air balance is maintained in the works.

3.6 Automated Vertical Storage and Retrieval Warehouse

An automated vertical storage and retrieval warehouse are installed on the 1st floor to make effective use of floor space and to move parts and materials efficiently and safely. (Fig. 8)

The functions of this warehouse system are as follows.

(1) Floor space is reduced by storing parts and materials vertically.
(2) Parts and materials are moved mechanically to improve safety and efficiency.
(3) Parts and materials storage is no longer commissioned to an external warehouse, but is done within the company, thus reducing storage cost as well as transportation distance and time.

These facilities have brought the following benefits.

- Storage floor space is reduced from the present 1,472 m^2 to 370 m^2.
- Reduction of two employees for moving parts and materials.
- Elimination of storage cost of external warehouse of 4,320,000 yen a month (as of June, 1998).

3.7 Others

The above sections outlined the basic points of the Equipment Plan. Following are examples under the same concept.

(1) Illumination control and air conditioning control with the security system

The illumination and air conditioning of a block are turned off automatically when the security system is turned off. This saves illumination and air conditioning costs in case workers forget to turn them off.

(2) Rest room

The illumination of the rest room is turned off automatically if forgotten. In addition, some rest rooms are equipped with hand rails for the handicapped.

(3) Chairs in cafeteria

The seating fabric of the chairs in the cafeteria do not contain any hazardous materials and so are environmentally friendly.

The fabrics are made of carbon (C) and hydrogen (H) materials having the following features.

(a)Hazardous nitrogen compounds such as ammonia (NH3) and cyanogen gas (HCN) are not generated even if burnt.

(b)The fabrics can be reprocessed and recycled easily.

(c)Most of them are easy to clean, fast-drying and are not easily soiled.

(4) Heat insulating efficiency of system building

The outer wall panels of the building are made of colored steel sandwiched by hard urethane foam. The insulating efficiency of this outer wall is high and the energy consumption of the air conditioners is reduced by at least 10% compared with the ordinary ALC outer wall.

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4. Overview of the Respective Areas

4.1 Production Area

The 1st floor is used for assembling and inspecting middle- and large-capacity power supplies. The 3rd floor is used for assembling the blades of "DC SAN ACE" and "SAN ACE MC" and inspecting "SAN ACE MC". The 4th floor is used for assembling and inspecting "DC SAN ACE".

The specifications of each floor are determined based on the above layout plan.

(1) 1st floor

The following considerations of the 1st floor were investigated.

(a)Crane

- Based on the mass and size of our products, we selected a crane having the rated load of 2.8 tons. The lifting height is 4 m above the floor, and the effective height of the crane is 5,130 mm above the floor including maintenance space.
- Two cranes, which can move 100 m, are installed in the east and west sides for the production lines of our middle-capacity power supplies. Three cranes, which can move 20 m, are installed in the south and north sides for the production lines of our large-capacity power supplies.
- Low-noise overhead cranes were selected to avoid disturbing the upper floors with noise and vibration during crane travel.
- The mechanical stoppers are fixed by welding or bolts. There is a drop-safe wire in case the stoppers fail when the crane hits them.
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(b)Illumination, ducting, cable rack and air piping

Illuminations, ducts and racks are installed between the effective height of cranes and the ceiling so as not to prevent crane travel. However, the dedicated air conditioning duct for cooling and the power cable rack for inspection cannot be placed in the same area and so are located in a safe position that does not prevent crane from running.

(c)Secondary power supply

The secondary power supply distribution panel is 500 mm long, which is the same as the distance between pillars, and has no protrusions that could impede layout of the assembly line.

(d)Trench for inspection wires

The final products are connected with the inspection equipment by high-voltage wires. Routing these high-voltage wires on the floor would be dangerous, so the wires are routed in a trench on the inspection floor.

Inside the works

(2) 3rd floor

The following considerations of the 3rd floor were investigated.

(a)Illumination, ducting, cable rack and air piping

The height of the ceiling is 4,625 mm, and the height of illuminations and others are set at 3,000 mm or higher due to the size of products and the equipment for production and inspection. This height allows sufficient space without giving a sense of claustrophobia.

(b)Secondary power supply

A factory line is mainly used for supplying power to production and inspection equipment. The secondary power supply distribution panel board is located along the outer walls of the works so as not to impede the production line. In addition, some 2,000 studs are installed in the ceiling for attaching the factory line in case the layout is changed.

(3) 4th floor

The following considerations of the 4th floor were investigated.

(a)Illumination, ducting, cable rack and air piping

To maximize the heat insulation, the ceiling height of the 4th floor is 3,500 mm, and the illuminations are attached to the ceiling directly. The air conditioning ducts and the air piping are installed in the ceiling. Since local exhaust ducts cannot be equipped in the ceiling, the ducts are installed away from the ceiling 2,900 mm above the floor. The cable rack is 3,000 mm above the floor, but is 2,750 mm high at the crossing with the local exhaust duct. The height of around 3,000 mm and the ceiling give a comfortable feeling like the 3rd floor.

(b)Secondary power supply

This is the same as the secondary power supply in the 3rd floor.

4.2 Cafeteria and Terrace

The 3rd floor has a staff cafeteria that protrudes from the building and a terrace with wooden decking from which staff can view the Shioda-daira plateau.

Since the rest of the building is a somewhat "hard" environment, the cafeteria is designed to provide a spacious, quiet "soft" area for staff to relax. A roomy feeling has been achieved by surrounding the cafeteria by a roof garden in the technology center, and by certain additional features.

The staff cafeteria that protrudes from the building has a high ceiling and wide openings. The curtain wall is a combination of wood and aluminum (glue-laminated red oak) rather than ordinary aluminum, thus improving the insulation and feeling of comfort. The seating fabric of the chairs in the cafeteria is easy to clean, and 30% of all tables are square, allowing free layout of chairs.

The terrace with wooden decking and the cafeteria in the mezzanine facing the atrium were located for convenience, and the wooden chairs in the mezzanine and the central stairs and the ceilings are designed to break up the uniform space that lacks variety.

Since the size of the cafeteria in the conventional F1 Building was limited to allow for two shifts of workers, and the number of seats and space between them were inadequate, staff were not satisfied. Therefore, we created a spacious area as a form of public welfare.

The number of seats was calculated as follows:

Total number of people using the cafeteria	: 600
Assumed actual usage (business trips and absenteeism)	: 90%
Usage type	: 2 rotations
Seat margin	: 15%

Required number of seats

$$=(600\times0.9\div2)\div(1-0.15)=317.6$$

There are therefore 356 seats in total (320 seats in the 3rd floor and 36 seats in the mezzanine), with 1.5 square meters per seat, which is roomy (design index), allowing the free layout of chairs for enjoying relaxed conversation and the good views.

4.3 Refreshment Rooms

The refreshment rooms located on each floor help reduce fatigue and refresh the mind and body during lunch break and recess.

4.4 Smoking Rooms

Smoking rooms with air conditioning and a ventilator are located in all of the refreshment rooms. Smoking is prohibited in this building except the smoking rooms, so these rooms are particularly popular with smokers.

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5. Conclusion

Construction of Sanyo Denki's Fujiyama Works F3 Building started in February 1997 and took 18 months to complete. Much time was spent in designing the basic concept. The purpose of the project was not to construct just a building, but rather to define the purpose of the building, and then create appropriate facilities and equipment to serve that purpose.

The F3 Building has at last been completed, in line with the corporate philosophy of "We SANYO DENKI make the dreams of people come true for the happiness of people in cooperation with people" and in line with the second mid-term management plan.

We would like to express our sincere appreciation to all people both inside and outside the company who worked hard to help design and complete the building.

Kazuo Imai
Joined company in 1969.
Environment Management Division
Worked on environment management after working on production engineering and planning.

Noboru Masuzawa
Joined company in 1968.
Power Systems Division, Quality Control Section
Worked on inspection and quality control for static type power supply system.

Fukutoshi Hisamoto
Joined company in 1961.

Environment Management Division
Worked on environment management after working on quality control for rotating type power supply system.

Norio Arai
Joined company in 1983.
Production Engineering Division
Worked on production engineering after working on P−board technology and parts engineering.

Table 1 Equipment structure

Equipment name	Quantity	Specifications	Remarks
Screw compressor	6	$6.1m^3/min$ $7kgf/cm^2$ 37kW	
Air tank	1	3,000L	
Air dryer	3	$29.6m^3/min$ $7kgf/cm^2$ 9.9kW	
Line filter	1	$73.2m^3/min$	
Micro mist filter	1	$73.2m^3/min$	
Air flowmeter	1	Max. $2,500Nm^3/h$ $10m^3/pulse$	
Drain master	2	Max. 34L/h When the concentration of oil is 150 mg/L, the concentration of waste liquid should be 5 mg/L or less.	Analytical value of hexane sampling material
Step roller II	1	Max. 8 machines	Control board for controlling the number of compressors (Fig. 5)

Table 2 Specifications of lighting equipment

Floor	Illumination (lx)	Lighting tool	Quantity	Power consumption (W) per lamp	Power consumption (kW) while all lamps are on
1	900	Mercury lamp	360	415	149.4
3	500	Fluorescent lamp	896	98	87.8
4	500	Fluorescent lamp	910	98	89.2
				Total	326.4

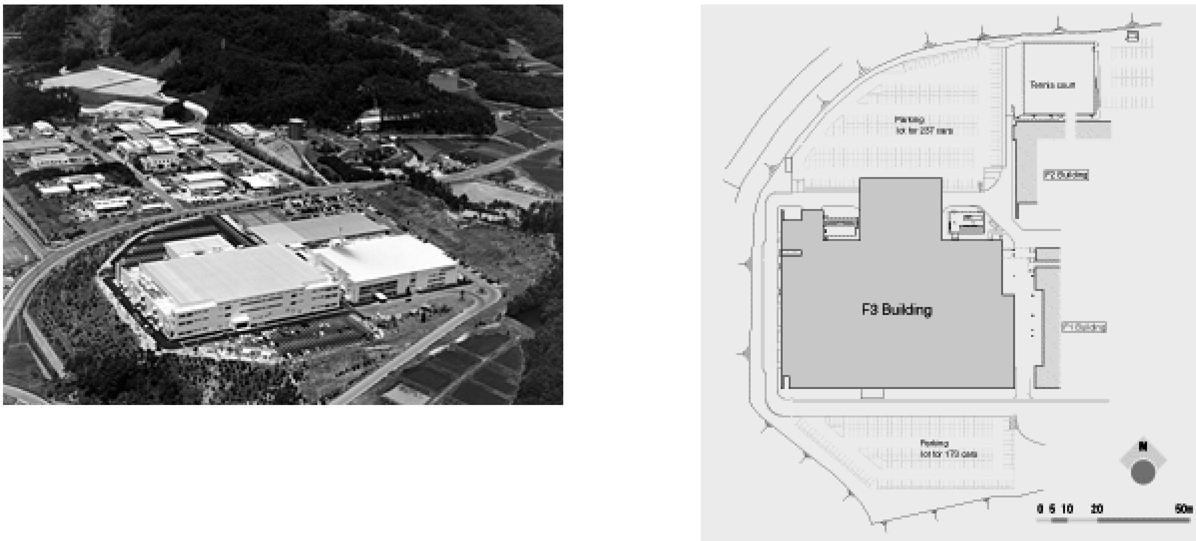

Fig. 1 Layout of Fujiyama Works

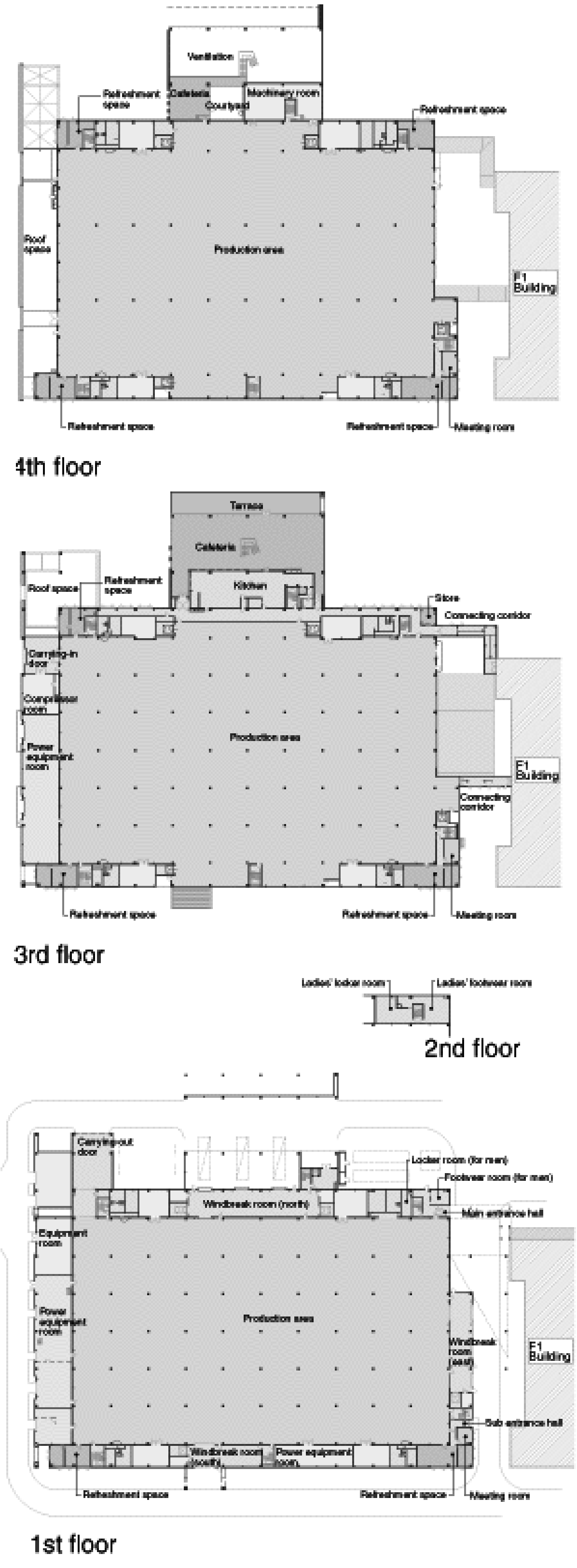

Fig. 2 Floor plan of each floor

Fig. 3 Power supply for products test

Fig. 4 Outside view of air compressor system

Fig. 5 Control board for controlling the number of compressors

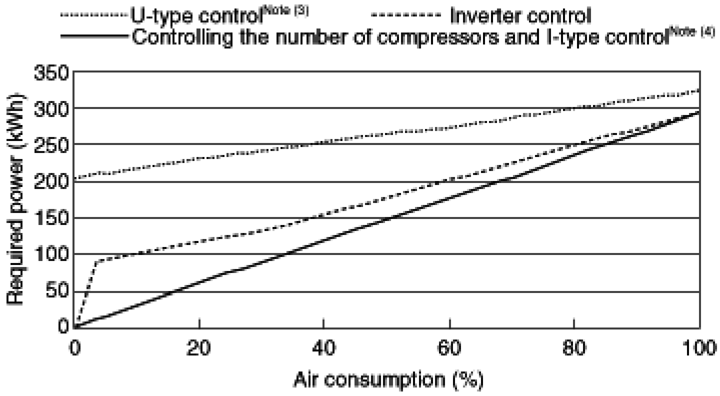

Fig. 6 Electric power required by each control system

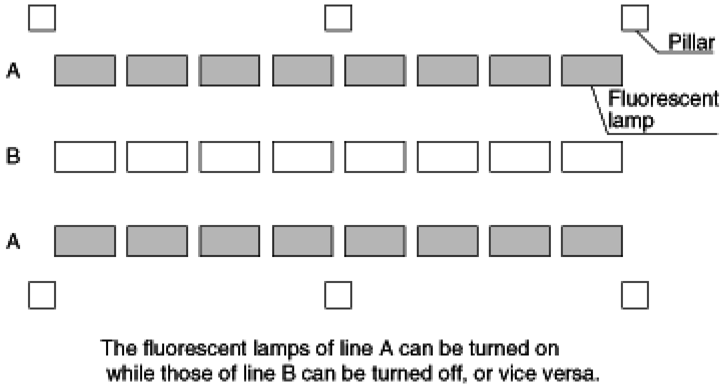

Fig. 7 Layout of lighting equipment per block and the illuminated zones

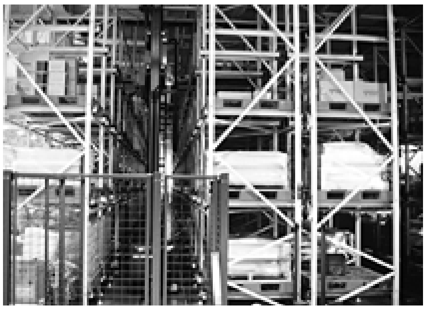

Fig. 8 Automated vertical storage and retrieval warehouse

Rest room

Inside the works

Cafeteria and Terrace

Refreshment Rooms