2005 Prize of the Chairman of ECCJ

Challenge to Reduce Energy Conservation Intensity at a Pharmaceutical Formulating Plant

JCR Pharmaceuticals Co., Ltd., Kobe Plant
Manufacturing Management Section

◎ **Keywords: Waste heat recovery and usage**
Rationalization of conversion to electricity motive power, heat, etc. (Electric power application equipment, electric heating equipment, etc.)
Rationalization of heating, cooling and heat transfer (Air conditioning facilities, hot water supply facilities, etc.)

◎ Outline of Theme

This Kobe Plant organized a cost saving project in 2003. Since then, we, as identified above, centering around the 3rd working group of the project, have studied the possibility of cost saving by energy conservation, working with the manufacturers of equipment and outside engineers, while examining and analyzing the plant's equipment consuming gas, electricity and water. Partially because the equipment we studied was not directly linked with the production, we had not been aware of the problems, but as we studied, we realized that there were a lot of problems to be improved, so we did the reforming construction for the existing equipment based on careful planning. As a result, we could achieve both energy conservation and cost saving beyond our expectation.

◎ Implementation Period of the Said Example

April 2003 – July 2005

● Project Planning Period	April 2003 – February 2004	Total of 10 months
● Measures Implementation Period	March 2004 – March 2005	Total of 13 months
● Measures Effect Verification Period	April 2004 – July 2005	Total of 15 months

◎ Outline of the Business Establishment

- Items Produced Products for freezing and drying pharmaceutical drugs.
- No. of Employees 29
- Annual Energy Usage Amount (Average actual results for fiscal year 2001 – 2002)

Electricity	1,259,911 kWh
City gas	122,576 Nm^3 (Converted to crude oil 145.7 kl)

◎ Process Flow of Target Facility

Water purifying equipment: Fig. 2
Air compressor: Fig. 3
Manufacturing room air conditioning equipment: Fig. 4 (before reforming), Fig. 5 (After reforming)

1. Reasons for Theme Selection

Although Kobe Plant has been operating for 6 years as a pharmaceutical formulating factory making main products of the company, there were no opportunities or activities to pursue energy conservation and cost saving, because the priority of the plant was on the stable operation of the factory equipment and the quality of the products. Small and medium size companies like our company generally cannot afford to invest so much in the energy conservation as big companies do, so we tended to give up the idea. However, as unusual weather frequently happened in the world, we felt that the global warming was making its way at the global level. We thought we should contribute to the prevention of the global warming as much as possible to a medium size company. At the same time, as the corporate environment around the company became harsh, drastic cost saving became an urgent issue for the company. So we organized the cost saving project in April, 2003 and had a working group in the project implement the energy conservation activities.

2. Progress of Activities

(1) Implementation Structure

We organized the following cost saving project to be led by the Plant Manager as a leader. The examination and analysis of the possibilities of the energy conservation and cost saving of the factory equipment and the reforming construction based on the examination and analysis were implemented mainly by the 3rd working group of the project, which worked with outside engineers and equipment manufacturers having knowledge and experience of energy conservation to implement the measures.

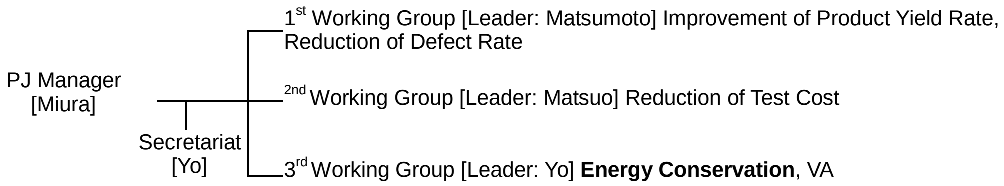

Fig. 1 Activity Organization Chart

(2) Target Settings

While the target of the cost saving project as a whole was to reduce the manufacturing cost by 200 million yen a year, the 3rd working group set up the following targets (the references are all arithmetic average of FY2001 to FY2002).

Activity period	April, 2003 to March 2006
Energy consumption amount	30% reduction (Electricity and gas)
Cost of light and heat	10 million yen/year reduction

3. Details of Activities

To achieve the foregoing targets, we focused on 1) the water purifying equipment, 2) the air compressing equipment and 3) the manufacturing room air conditioning equipment among the operating equipment of the factory. We clarified critical points (problems) of each unit of the equipment, collecting and analyzing the operation data before improvement. Then, we implemented the measures (reforming) based on the study of the state before improvement and prediction of the effects of the measures.

Each improvement effect is an estimated value based on the operation record before and after the reforming or based on the calculation. Meanwhile, the improvement effect of the equipment as a whole is shown in Section 4 as the reduction of the light and heat cost of the factory as a whole.

1) Water purifying system

The flow chart of the water purifying system is shown in Fig. 2 below. The system uses city water as the raw material water and lets it pass through the step-down processes, i.e. active charcoal layer, RO membrane, ion exchange resin and UF membrane, to make highly pure water and use it as washing water. Meanwhile, the pure water is indirectly heated by the steam generated by the steam boiler using city gas as fuel to make pure steam (PS), which is used for heating sterilization.

a. Recovery of discharged water

Problems we focused on:

[1] To protect the UF membrane, part of the primary side water is continually discharged during production.

[2] The water in the system is discharged before taking new water.

Examination and analysis:

[1] Part of the UF primary side water which is continually discharged is usually disposed of, but we confirmed that the quality of this waste water was better than the raw material water.

[2] To maintain the quality of the processing water, the pure water was being discharged for 30 minutes after starting the water supply, but we confirmed that there was no problem in discharging the water only for 2 minutes, if it was to maintain the water quality (verification of water quality).

Measures:

[1] As shown in Fig. 2, the UF waste water pipe was added to recover the continual waste water into the raw water tank.

[2] The water discharging time was shortened to 2 minutes by changing the operation control sequence program.

Effect of improvement:

Reduction of water consumption 700 m3/year (Converted to electricity: 1,120kWh)

---- Energy conservation, cost saving

*The conversion from city water 1 m3 to electricity (kWh) was made using the CO_2 emission factor of electricity and city water, i.e. electricity 0.36 kg/kWh and city water 0.58 kg/m3, so the electricity amount of city water 1 m3 is 1.61 kWh/m3 (= 0.58 kg/m3/0.36 kg/kWh). Source: Data of Hyogo Prefecture, Global Warming Prevention Activity Promotion Center.

b Recovery of waste heat

Problems we focused on:

The high temperature drain of the steam for heating the pure water and the high-purity steam (PS) for sterilization process had been being discharged.

Examination and analysis:

To maintain the high quality of the water, the pipe line had been designed to dispose of the drain from the system, but it was confirmed that there was no problem if the high temperature drain was reused for the boiler (verification of water quality).

Also, it was confirmed that the drain could be recovered by the system pressure.

Measure:

As Fig. 2 shows, the steam drain recovery pipe was added to recover the high temperature drain into the water tank for supplying water to the boiler (recovery rate 67%).

Effect of improvement:

[1] The temperature of the water to be supplied increased by 50℃.

[2] Reduction of gas consumption 150,000 Nm^3/year (approximately 30% reduction) ---- Energy conservation

[3] Reduction of water consumption 500 m^3/year (Converted to electricity: 805 kWh) ---- Energy conservation, cost saving

2) Air compressor

Fig. 3 shows the air compressing system. Two air compressors (22 kw) had been connected in parallel, where one had been used always and the other had been used as an auxiliary machine when the load increased.

Problem we focused on:

The two air compressors connected in parallel had been operating unloaded for a long time.

Examination and analysis:

The capacity of the compressor had been too big compared with the air consumption volume, so there had been always unload state (load ratio 30% or less). And the unload characteristics of the compressor had been bad.

Measures:

As shown in the left side of Fig. 3, small compressors (7.5 kw) were added to be used always, and the existing big compressors (22 kw) were made to be auxiliary machines.

Effect of improvement:

Reduction of electricity consumption 97,000 kWh/year (76% reduction)
---- Energy conservation

3) Manufacturing room air conditioning system

As Fig. 4 shows, the air conditioning system before the reforming had been composed of No. 1 chiller and No. 2 chiller, both air cooling system. The electricity demand had reached 115 kw in the summer when heat load became the maximum and 2 chillers were operated, accounting for 35% of the contract electricity. Also, a great deal of electricity had been consumed as the air conditioning system was continually operated to maintain the clean condition.

a. Reforming of heat source machine

Problems we focused on:

[1] The electricity demand had increased in the daytime of the summer.

[2] The water of the chilled water buffer tank had become the heat load when starting the cooling.

Examination and analysis:

[1] It was expected that the electricity demand in the daytime could be reduced by approximately 90 kw by reforming the system to the heat storage system as shown in Fig. 5 to transfer the electricity for air conditioning to the nighttime.

[2] It was expected that, by adopting the ice heat storage system, the buffer function of the chilled water tank became unnecessary and only the function to absorb the portion of the water volume changed sufficed.

Measures:

[1] No.1 chilled water chiller was reformed to the brine chiller and an ice heat storage tank and associated equipment were added to make a heat storage air conditioning system. The air conditioning system after the reforming is shown in Fig.5.

[2] As Fig.5 shows, a bypass pipe bypassing the chilled water tank was added.

[3] A demand automatic control system was introduced to manage the targets according to the order of importance.

Effects of improvement:

[1] The electricity demand was reduced by 95 kw, the ratio of the use at night increased 40% and the electricity use in the summer was reduced by 47%, thus reducing the electricity cost. ---- Cost saving

[2] The time and heat amount for cooling the chilled water tank (water volume retained was 4 m^3) became unnecessary. The temperature started to reach the set chilled water temperature in a few minutes after starting the cooling, thus reducing the consumption of ice by approximately 10%. --- Energy conservation

[3] It became possible to visually know the change of the heat (change of the remaining ice volume) and correctly understand the state of the load.

b. Improvement of method for using heat source machine

Problem we focused on:

In the summer when the heat load becomes the maximum and there is shortage of the cold source of the ice heat storage tank, the electricity demand had been increased by No.1 brine chiller additionally operating at 70% load.

Examination and analysis:

The performance of No.2 chilled water chiller was better than No.1 brine chiller.

Measures:

The system was reformed so that the additional operation when melting the ice was done by No.2 chilled water chiller.

Effect of improvement:

The electricity demand was reduced by 30 kw and, also, the electricity amount was reduced by 6,480 kWh/year. ------ Cost saving, energy conservation

c. Review of management criteria for manufacturing room

Problem we focused on:

By reviewing the criteria for setting the temperature and humidity of the manufacturing room, the time for continual operation of the air conditioner and the heat load when not manufacturing must be reduced.

Examination and analysis:

When not operating, the room pressure can be maintained by the low flow rate of the outdoor air, and, when not manufacturing in the daytime, there is no problem if the temperature and humidity is raised (verification of production hygiene).

Measures:

When not operating, the room pressure was maintained by the night mode, and, when not manufacturing, the room temperature was set at 23 ± 5℃ and the room humidity was set at 50 ± 20% as targets.

Effect of improvement:

We estimate that we could reduce the ice consumption in the daytime when not manufacturing by 14%/day and the annual electricity consumption by 380,000 kWh (50%). ----- Energy conservation

4. Effects achieved after Implementing Measures

(1) Details of Measures

Measures	Total Investment Amount	Average Recovery Years
Reforming of pipe for purified water Introduction of small air compressors Reforming of heat storage system of No.1 chiller Introduction of demand automatic control system Reforming of additional operation of No.2 chiller Reforming of pipes around air conditioner's chilled water tank	10,176,859 yen	1.2 years

Effects of improvement:

The reduction of the energy use (energy conservation) and the reduction of the energy cost (cost saving) as of end of July, 2005 (August, 2004 to July, 2005) were as follows.

Cost of light and heat: 15.37 million yen/year (Original target: 10 million yen/year reduction)

[Breakdown]

Electricity: Consumption 38% reduction (Energy conservation),
cost 43%reduction (Cost saving)

Gas: Consumption 60% reduction (Energy conservation),
cost 60%reduction (Cost saving)

City water: Consumption 53% reduction, cost 56％reduction (Cost saving)

Energy amount intensity: 55% reduction (Energy amount intensity per production lot)

CO_2 emission amount: 340 t/year reduction (46% reduction compared with the emission before implementing measures)

*The conversion to CO_2 emission amount was made using the CO_2 emission factor of electricity, gas and city water, i.e. electricity 0.36 kg/kWh, gas 2,288 kg/m^3 and city water 0.58 kg/m^3, to calculate each reduction amount. Source: Data of Hyogo Prefecture, Global Warning Prevention Activity Promotion Center

5. Summary

We wanted to contribute to the prevention of the global warming as much as possible to us as a medium-size company and we also wanted to save our production cost, so we started our energy conservation activities. As a result, we invested 10.177 million yen in total for the activities and recovered it approximately in a year, reducing CO_2 emission by 46% and achieving the monetary energy conservation amount of 15.37 million yen.

Although this was the first energy conservation activity for this Kobe Plant, we were satisfied with the achievement which was beyond out expectation. In the meantime, we regret that we had been using the equipment without noticing the loss. Anyway, we learned a lot and obtained valuable experience through the activities toward the energy conservation and cost saving. We especially came to have the following feelings through the activities. We hope these are useful clues for you studying the energy conservation.

1) The energy conservation starts from [1] understanding the present situation correctly, [2] asking yourself why the current operation is the best and [3] boldly reviewing the conventional wisdom or custom, for example, by checking the existing manual to see if there is loss or not.
2) Many of the factory facilities are likely to be planned and built with excessive capacity

compared with actual load to realize safe operation without considering energy conservation or optimal operation. Therefore, there are a lot of energy conservation possibilities throughout the factory facilities.

3) By installing the ice heat storage air conditioning system, it became possible to visualize the change of the heat load as the change of the remaining ice volume. So everybody became interested in the saving of the ice as the sign of the energy conservation.

4) The staff members in charge of energy conservation were persistent in their mission. We made their enthusiasm and the cooperation of all the people throughout the factory known to everybody and the top management. We also expressed the effects of the energy conservation numerically and reported it to everybody and the top management and made them interested in the activities. These actions made our activities successful.

5) When doing energy conservation activities, we often encounter the situation in which we have to distinguish waste from necessary extra capacity, but it is difficult for us to do it with the limited knowledge and experience of the factory staff members. To make up our inability, it is worth studying the possibility of asking reliable outside engineers to help us or participate in out activities.

6. Future Plans

(1) Activities to be continued in Kobe Plant

To continue the energy conservation activities, we are to examine and study the following issues.

1) Air compressor system

Small compressors (7.5 kw) newly added and existing compressors (22 kw) are still operating with low load rate. It is not optimal operation, so we will study the possibility of quantitative control and pressure control and the capacity of the air tank. We also review the air compressor’s cooling tower and chilled water pump.

2) Air conditioning system

The capacity of the brine pump and the chilled water pump is excessive, so we will study the possibility of using invertors.

(2) Deployment in Other Factories and throughout Our Company

Based on the experience we had in Kobe Plant, we want to promote our energy conservation activities in other factories and throughout our company.

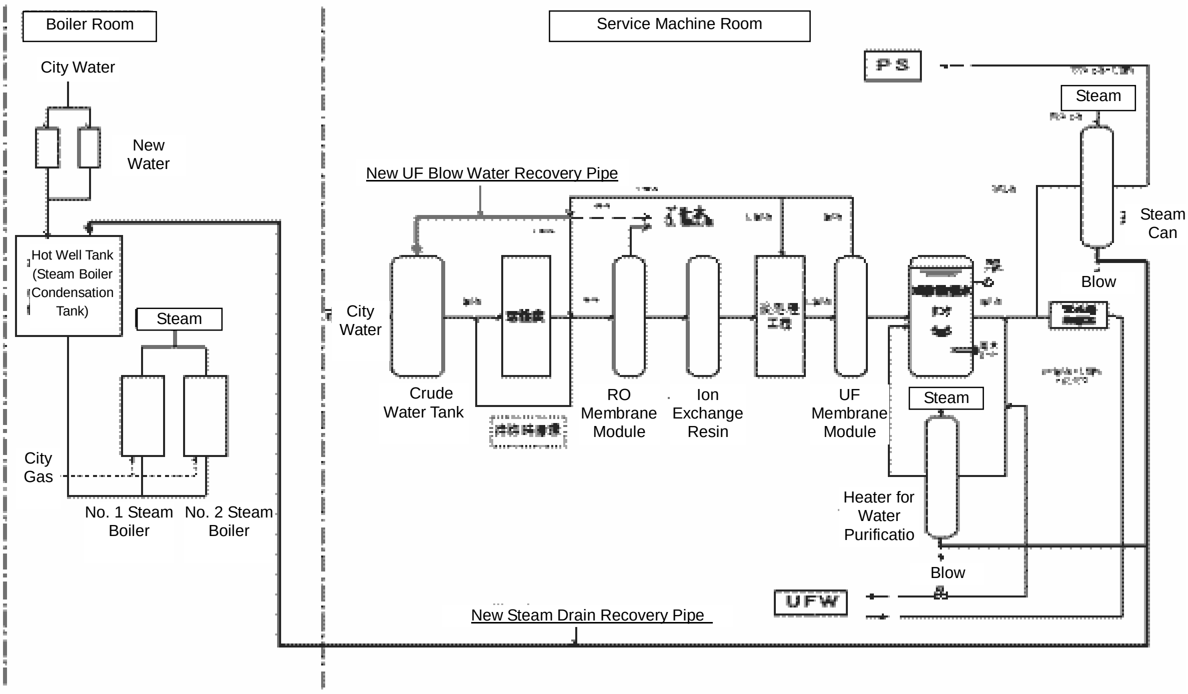

Fig. 2 Water Purifying System

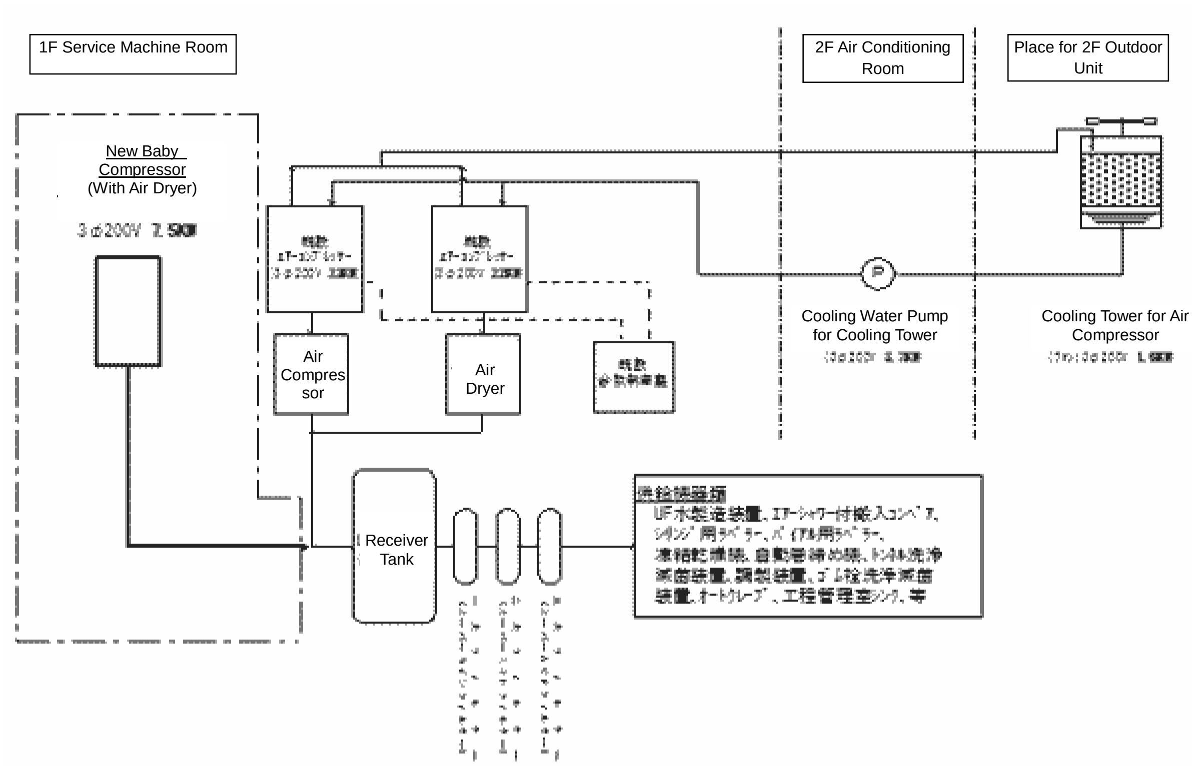

Fig. 3 Air Compressor System

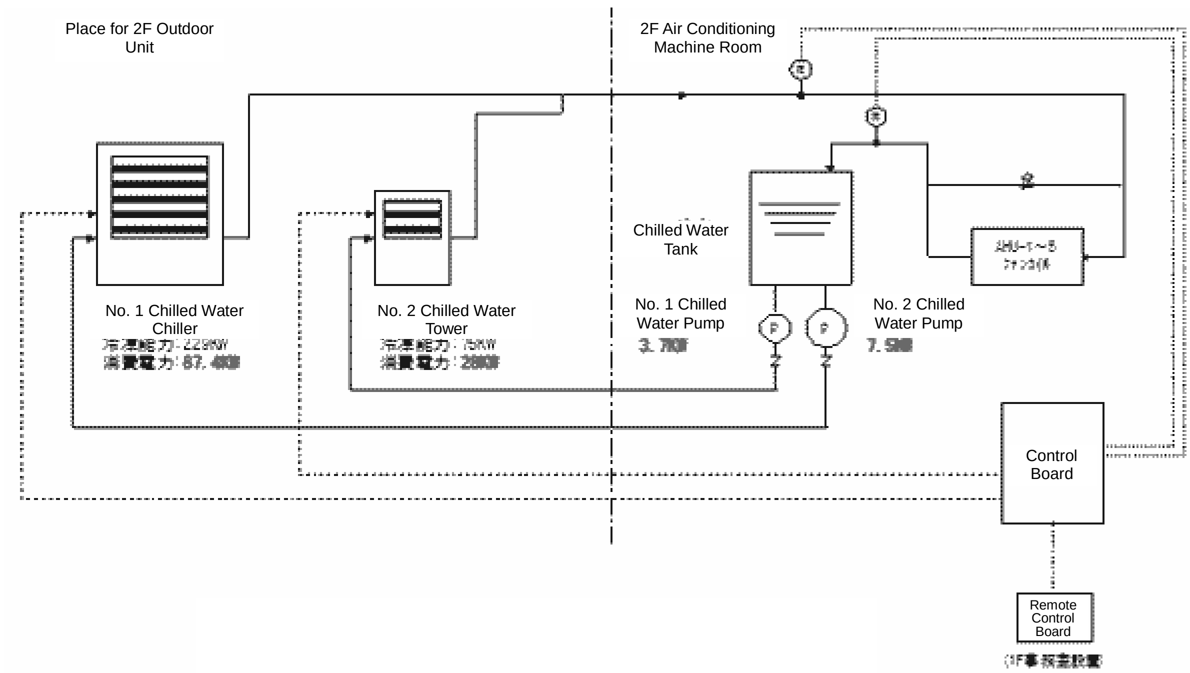

Fig. 4 Manufacturing Room Air Conditioning System (Before Reforming)

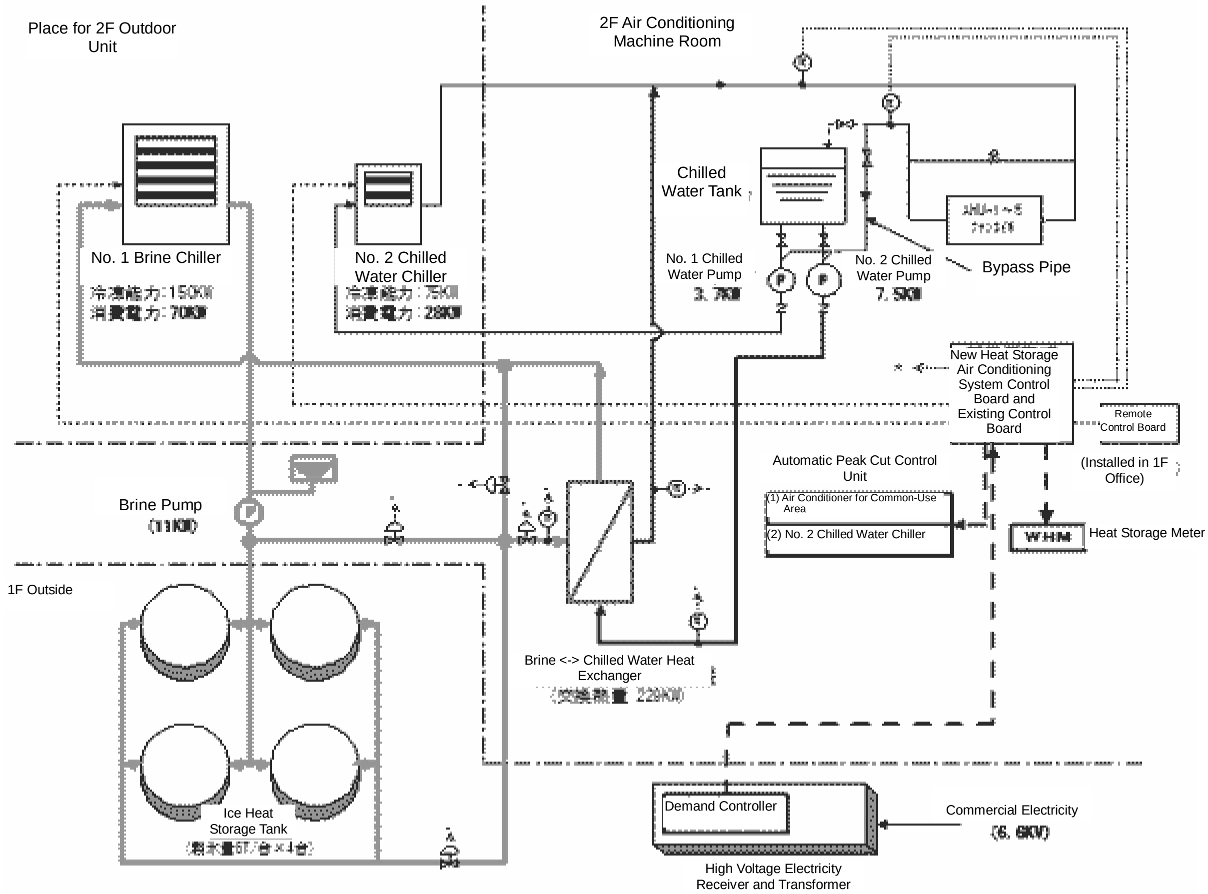

Fig. 5 Manufacturing Room Air Conditioning System (After Reforming)