Appendix 7

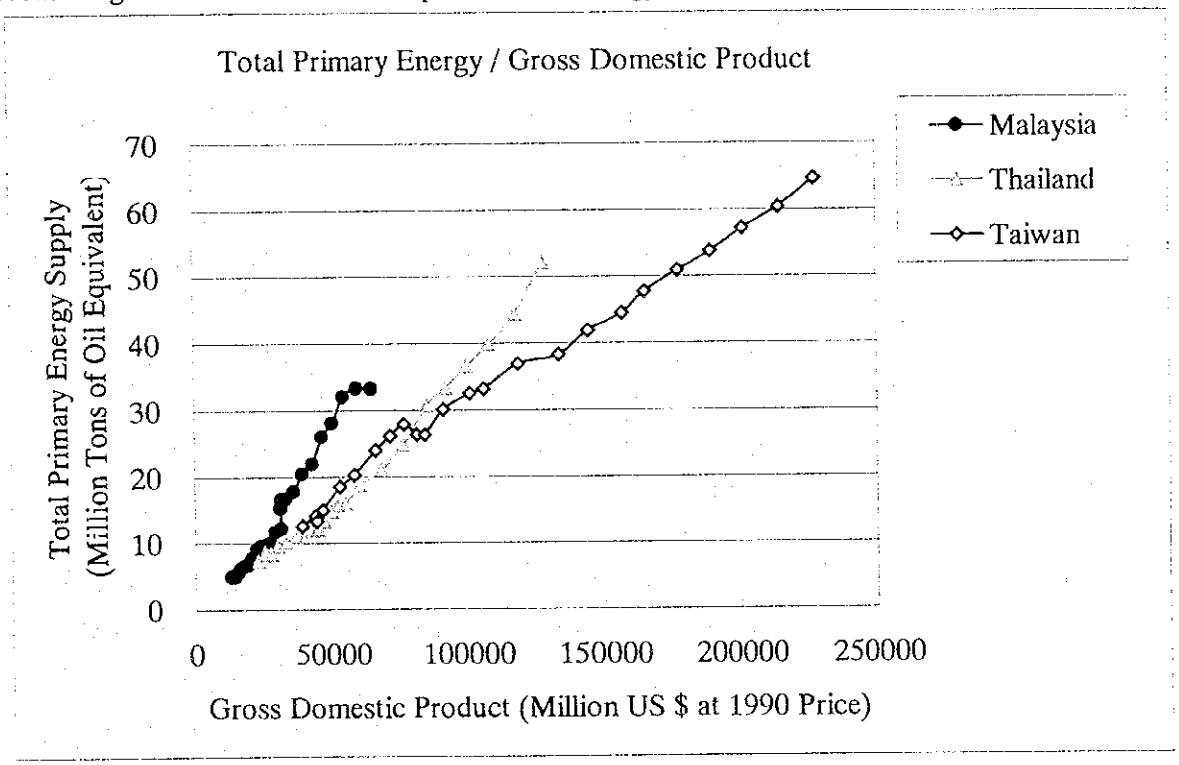
Co-generation and Ice Storage System in Malaysia

Appendix

Co-generation and Ice Storage System in Malaysia

1. The Importance of Energy Efficiency Promotion in Malaysia

The Malaysian economy has grown steadily and rapidly in the past 10 to 15 years, supported by the efforts of Malaysian people and new discovery of abundant natural resources. However, economic growth is faster than the improvement of energy efficiency in Malaysia.



The above figure shows the comparison of TPE (Total Primary Energy Supply) / GDP (Gross Domestic Product) in Malaysia, Thailand and Taiwan from 1972 to 1995. It is not so straightforward to draw some conclusion from this figure, but the following two points should be taken into consideration.

Overall energy efficiency of Malaysia is slightly inferior to Thailand and Taiwan.

Recent energy efficiency of Malaysia is improving remarkably.

Therefore continuous improvement of energy efficiency improvement will become one of main national targets of Malaysia.

2. The Characteristics of Malaysian Energy Generation and Consumption

The study team focused on the energy consuming side of the commercial and industrial sectors, but to improve overall energy efficiency in Malaysia, it is also important to look into the energy generating and distributing side.

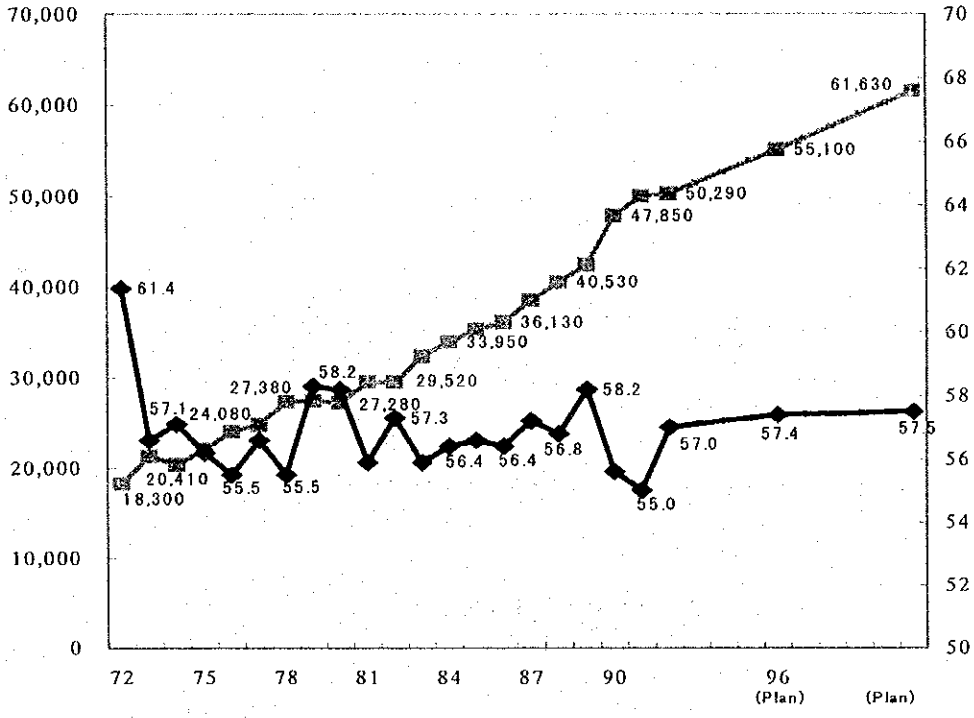
The characteristics of Malaysian energy generation and consumption are as follows compared to other countries like Japan.

1) Natural gas pipeline provides new opportunities to use different kinds of energy forms from electricity throughout the country.
2) Rapid expansion of power stations has been vital in coping with rapid increase of energy consumption.
3) In Malaysia, electricity is still the main form of energy, and about 90 % of electricity is generated form non renewable sources
4) Air-conditioning in living spaces has become common and important for comfortable life and work. As a result, the year-round demand of cold air-conditioning has increases drastically.
5) Electricity consumption during daytime is much higher than during nighttime; this situation will be worsen with the spread of air-conditioning apparatuses.

These characteristics of the energy situation make Malaysia one of the most appropriate countries for adoption of the "Co-generation System".

In Japan, the yearly average load of power stations is around 60 percent recently. During the past 20 years, plant capacity has increased drastically because of hot summers and electricity-driven modern life like air conditioning. Normalizing the consumption between night and day will contribute to the higher load of plant operation and lower investment of power plants

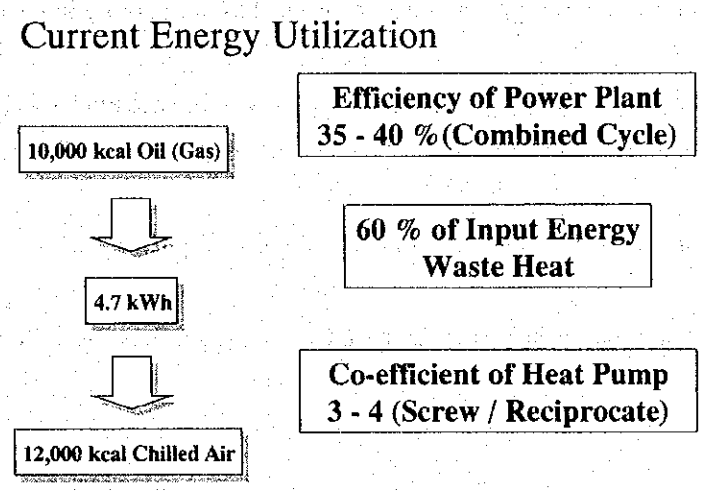
Trend of Maximum Demand and Load in Japan



3. Efficiency of Power Stations and Co-generation

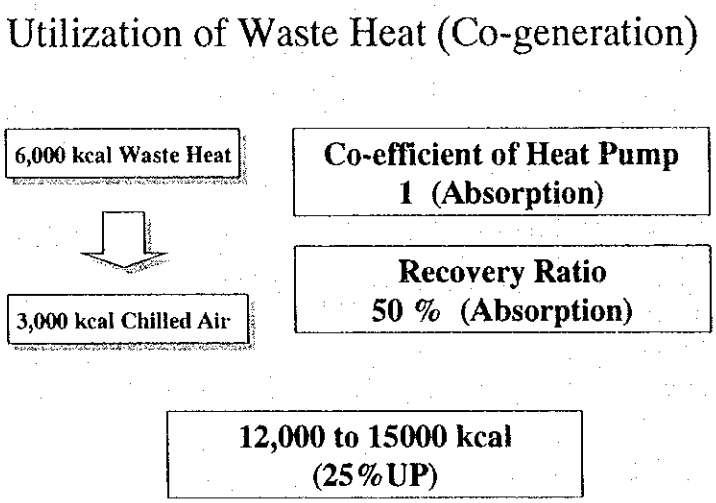
In standard power stations, energy conversion to electricity is around 40 percents of input energy, even when using a combined cycle system. The remaining 60 percent of input energy, released to air or water, is wasted. For the transformation from electricity to chilled air, a higher co-efficient of heat pumps such as screw or reciprocate compressor could be employed.

Further utilization of 60 % waste heat by low efficiency heat pumps such as ammonia-based



absorption type chillers would increase the energy recovery ratio theoretically 80 to 90 percent. But in this case, the energy co-efficient of a heat pump is one third or fourth that of a high-efficiency pump.

It seems attractive, but the problem is that the heat recovered is very low- grade energy such as low- pressure steam, hot water, ice and cold air.



Low-grade energy is difficult to handle, transport and store compared with electricity.

4. Ice Storage System (Utilization of Latent Heat by STL)

To solve the above-mentioned heat handling, a heat accumulation system using latent heat of ice has started to be introduced in many countries in Europe and Japan.

This technology's feature is that ice is produced by using cool air in night time for heat exchange and also using low cost of power in night time, and that ice is used for air cooling in the day time.

The function of ice storage by latent heat (STL) is divided into two distinct modes –charge and release – during which the modules remain virtually at a constant temperature. This system has the following advantages.

Easy operation / low maintenance cost / stable performance / long life / quick response

Compared to conventional water-based heat-storage systems, ice system has the following two merits.

1) Heat storage volume (kcal / m3) Water System: 5000-7000

	Ice System:	40000-45000
2) Installation space	Water System:	Large
	Ice System:	Small

And the below table shows a comparison of heat storage methods using ice.

Method	Ice making (%)	Features
(Ice –on-coil method) Ice is generated on the surface of the ice-making coil inside the heat storage tank	60	1. Direct expansion method results in good COP. 2. There are two types of unit assembly and on-site assembly. 3. For unit assembly, 145 – 990 RTh. 4. Measures to prevent bridging are necessary.
(Globular Nodule capsule method) Globular Nodule capsules that contain water are packed into the heat tank.	60	1. Heat exchange is substantial. 2. Shape that determines installation layout can be selected freely. 3. System is compact. System has been constructed for a hermetic sealing cycle.
(Super-cooling method) Super-cooled water is generated continuously for making sherbet-like ice.	40-60	1. Makes sherbet-like ice 2. Water is the only heat-storing material used. 3. Heat transfer characteristics during ice Making are regular. No ice-making facilities necessary inside tanks.

5. Malaysian Advantages for Adoption of Co-generation and Ice Storage System

The combination of establishing local energy centers and utilizing energy by adoption of the ice storage system in big industrial zones or residential complexes is attractive because it is possible to enjoy Malaysian's advantage (gas / always summer / tariff difference) to the maximum extent.

The merits of co-generation in independent power plant are as follows.

Additional variable cost is zero	Utilization of unused energy
Comfortable life	Prevention of global warming
Normalization of electricity consumption	Decease the speed of power plant expansion

International cooperation between Malaysia and Japan will have an important role in this area.

Chapter 8 Outline of Energy Audit

This chapter describes the selection of model institutions and factories, and the outline of energy audit.

8-1 Selection of Model Institutions and Factories

The study team and JBE&G jointly selected one institution or factory for an energy audit in each of six sub-sectors. Fourteen entities belonging to the commercial or industrial sector were selected as candidates for energy audit by JBE&G, as shown in Table 8-1. Preliminary energy audits for the selection were carried out jointly by the study team and JBE&G, and three model entities in the commercial sector and three factories in the industrial sector were selected based on the mutual understanding between the study team and JBE&G, as shown in Table 8-2.

Table 8-1 Fourteen Entities as Candidates for Energy Audits

Commercial Sector	
Hotel:	Mingcourt Vista Hotel
	Awana Genting Highlands Golf & Country Resort
	The Legend Hotel, Putra Palace
	Park Royal Hotel
Shopping Complex:	Bandar Utama City Corporation Sdn. Bhd.
	Subang Parade Shopping Centre Sdn. Bhd.
Hospital:	Hospital Seremban
	Hospital Assunta
Industrial Sector	
Cement:	Associated Pan Malaysia Cement Sdn. Bhd.
Food Processing:	Central Sugars Refinery Sdn. Bhd.
	Nestle Foods Sdn. Bhd.
Steel:	Amsteel Mills Sdn. Bhd.
	Amalgated Industrial Steel Berhad
	Southern Steel Berhad

The selection are based on the following 5 criteria.

1. Eagerness
2. Cooperation
3. Location

4. Availability of data and information
5. Advantage or disadvantage as a model factory or institution

The entities to be audited were decided on;

Table 8-2 Entities to be Audited

Commercial Sector	
Hotel:	Mingcourt Vista Hotel
Shopping Complex:	Bandar Utama City Corporation Sdn. Bhd.
Hospital:	Hospital Seremban
Industrial Sector	
Cement:	Associated Pan Malaysia Cement Sdn. Bhd.
Food Processing:	Central Sugars Refinery Sdn. Bhd.
Steel:	Amsteel Mills Sdn. Bhd.

8-2 Outline of Energy Audit

An energy audit was conducted on the six entities representing each commercial and industrial sub-sector listed in Table 8-2.

The energy audit was conducted in steps, beginning with the first field survey and then the third homework in Japan. The most essential step of the actual energy audit, the measurements, were done during the second field survey (Commercial sector) and the third field survey (Industrial sector) for each entity.

In this section, the following items are covered for the six entities.

1. Major items of each energy audit,
2. General procedure of the energy audit,
3. Overall procedure of audit and formulation of measures for energy efficiency, and comparison of unit consumption of energy with the Japanese average and trend data in the commercial sector.

8-2-1 General Procedure of the Energy Audit

The general procedure and the energy audit items in the commercial and industrial sectors are shown in Figure 8-1 and Figure 8-2. An outline of the procedure and schedule is as follows.

(1) Recognize Current Condition

The following items were investigated in steps, during the first field survey. (February and March, 1998)

1. Outline of the institution, factories and facilities
2. Operating and managing conditions
3. Total and unit consumption of energy
4. Energy management and monitoring
5. Flow sheet for major products
6. Thermal insulation of buildings
7. Experiences and plan for energy efficiency promotion
8. Energy price of fuel, electricity and others
9. Major energy consuming facilities
10. Electric power receiving
11. Others

(2) Identify Current Problems

The following items were reviewed and scrutinized during the first field survey, the first homework in Japan and the second field survey. (February, 1998 - July, 1998)

1. Problems with major energy consuming facilities and building structures
2. Already recognized problems in energy consumption
3. Items requested for energy audit
4. Major items and points of energy audit
5. Others

(3) Formulate and Prepare Energy Audit Plan

The following items were reviewed and formulated during the first homework in Japan (March and April, 1998).

1. Review and analysis of premises for energy audit
2. Formulation of detailed plan for energy audit (measurement, field investigation, deployment of measuring equipment and others)
3. Planning of personnel allocation and schedule for audit

4. Necessary preparatory work and modifications of equipment for energy audit
5. Others

(4) Conduct Energy Audit

This step was conducted in cooperation with members of JBE&G, and each entity in the second and third field survey (June - July and September - October, 1998). The major items are as follows.

1. Explanation and discussion of detailed energy audit plan with the entity
2. Confirmation of preparations (points of modification, and measurement)
3. Deployment of measuring equipment
4. Installation and calibration of measuring equipment
5. Monitoring of operating and surrounding conditions of facilities
6. Measurement and collection of records of measurements and operation
7. Confirming detailed data and specifications of subject facilities
8. Identifying problems by observing operating conditions
9. Collecting relevant data, information and records
10. Others

The measuring equipment prepared and used in the energy audit is shown in Table 8-3.

(5) Identify Problems Requiring Measures

As a result of the actual energy audit, the following items were reviewed and analyzed during the second and the third field survey, and the second and the third homework in Japan (June-November, 1998).

1. Review and analysis of measurement results
2. Review and analysis of relevant data and information
3. Identifying problems and determining the necessity for improvement
4. Scrutiny and formulation of items for improvement
5. Others

(6) Assess and Recommend Measures

As the final step of the overall energy audit, the following items were assessed and formulated during the second and the third homework in Japan (July - August and October - November, 1998). The details of this step are described in the section 8-2-3.

1. Calculation and analysis of the effect of energy saving
2. Examination and selection of proper measures

3. Estimation and prediction of measures' effectiveness
4. Overall evaluation of energy efficiency improvement measures

8-2-2 Major Items of Each Energy Audit

There are various kinds of entities, representing each commercial and industrial sub-sector. There are also various types of energy consumption, such as thermal and electrical energy. Though detailed procedures and results of each energy audit are presented in Chapters 9 through 14, major items of each energy audit are summarized here.

(1) Commercial Sector

1) Mingcourt Vista Hotel
   1. Electrical power receiving and distribution
   2. Air-conditioning system
   3. Lighting system
   4. Heat consuming facilities
   5. General energy consumption

2) Bandar Utama Shopping Complex
   1. Electrical power receiving and distribution
   2. Air-conditioning system
   3. Lighting system
   4. General energy consumption

3) Hospital Seremban
   1. Electrical power receiving and distribution
   2. Air-conditioning system
   3. Lighting system
   4. Heat consuming facilities
   5. General energy consumption

(2) Industrial Sector

1) Associated Pan Malaysia Cement
   1. Raw material grinding department (Electricity consumption)
   2. Coal drying & grinding department (Electricity & heat consumption)
   3. Cement grinding department (Electricity consumption)
   4. Burning department (Electricity & heat consumption)
   5. General energy consumption

2) Central Sugars Refinery
   1. Boiler & steam turbine generator
   2. Heat consuming facilities
   3. Steam trap system
   4. Thermal insulation system
   5. Air compressing system
   6. Hot water cooling tower
   7. Electrical power generation & distribution
   8. General energy consumption

3) Amsteel Mills
   1. Shredding (Material & energy balance)
   2. EAF & LF (Material & energy balance)
   3. CCM (Energy balance)
   4. Reheating furnace (Material & energy balance)
   5. Bar mill & wire rod mill (Material & energy balance)
   6. Electricity receiving, distribution and consumption

8-2-3 Overall Procedure of Audits and Formulation of Energy Efficiency Measures

Energy efficiency improvement measures were proposed based on the following procedure and the flow scheme shown in Figure 8-3. The first item below was completed during the second and the third field survey as mentioned above. The second to the eighth items were preformed during the second and the third homework in Japan.

(1) Energy Audit

This is the starting point for formulating measures for energy efficiency as described previously.

(2) Preparation of Energy Flow Chart

1. Calculation and analysis of energy balance
2. Preparation of energy flowchart

(3) Estimation of Unit Consumption of Energy

1. Calculation and analysis of energy consumption by each source,
2. Confirmation and calculation of the total floor area and production amount
3. Estimation of unit consumption of energy

(4) Estimation of Potential for Energy Efficiency

1. International comparison of unit consumption of energy
2. Estimation of technical potential for energy consumption
3. Utilizing the results of questionnaires answered by Malaysian entities

(5) Estimation of Cost & Benefit with Measures for Energy Efficiency

1. Selection of the proper measures
2. Estimation of the cost for measures
3. Assessment of the effect on energy efficiency
4. Estimation of the benefit of measures

(6) Selection of Proper Measures for Energy Efficiency

1. Application of proper criteria to the candidates
2. Judging priority among the measures
3. Optimization of measures

(7) Financial Analysis of Measures for Energy Efficiency

1. Estimation of investment cost of the measures
2. Estimation of running cost of the measures
3. Estimation of benefit of the measures
4. Financial analysis of the measures

(8) Recommendation of Measures for Energy Efficiency

This is the final stage of the so-called Energy Audit.

These procedures should be systematically executed in stages to obtain final recommendations for the improvement of energy efficiency in each entity.

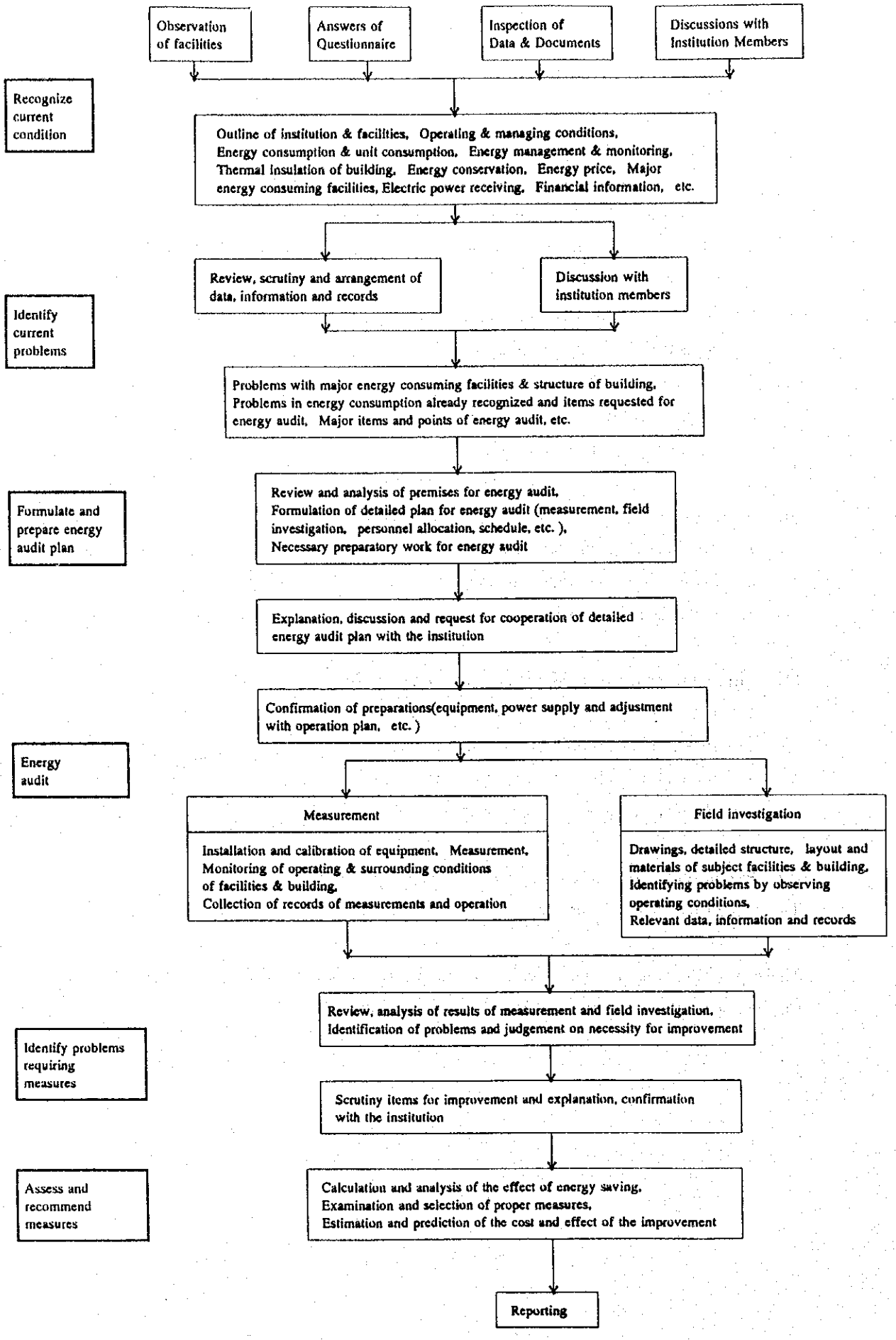


Figure 8-1 General Energy Audit Procedure (Commercial Sector)

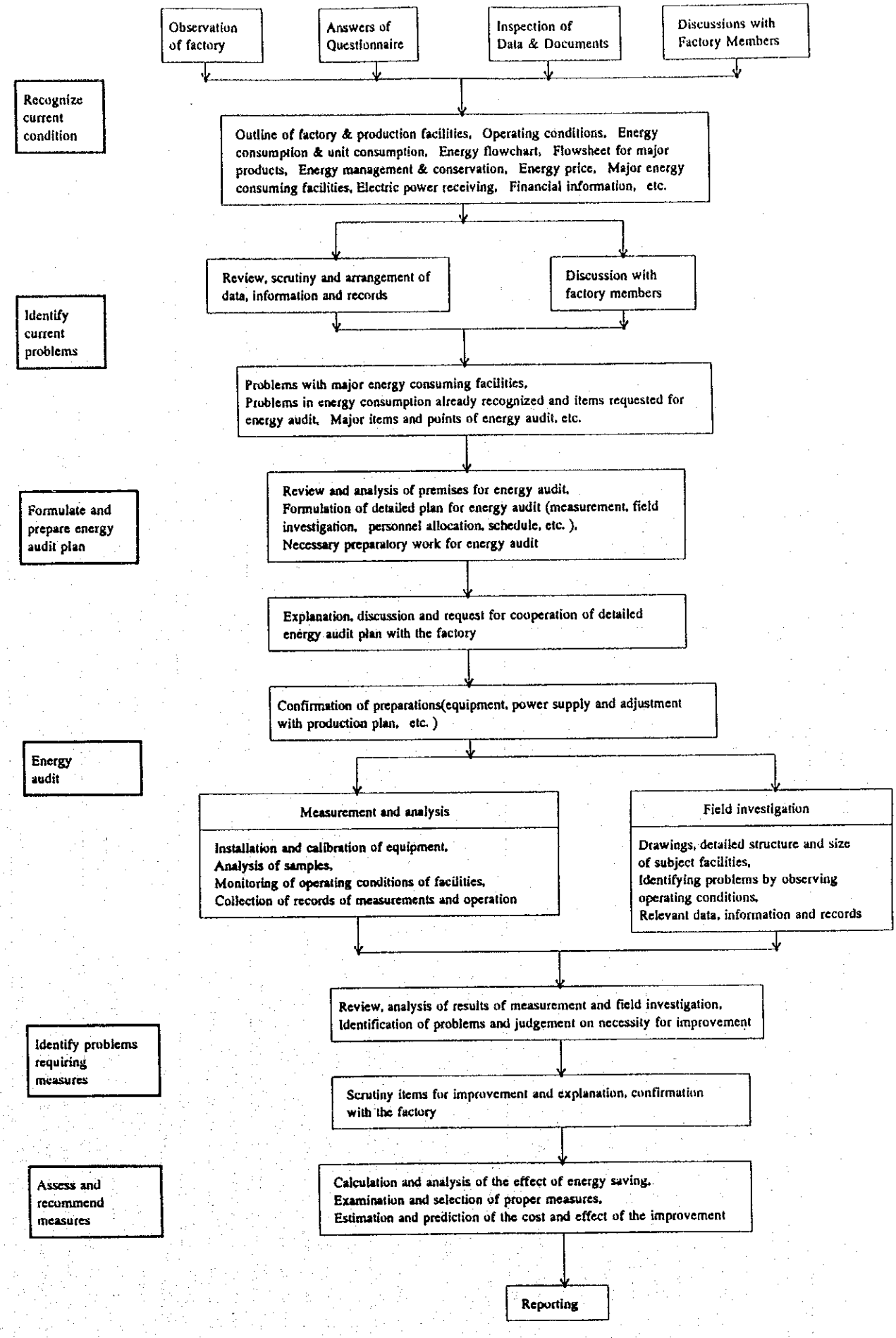


Figure 8-2 General Energy Audit Procedure (Industrial Sector)

Table 8-3(1) List of Equipment for Measurement used in Each Entity

Measuring Equipment	Hotel	Shopping	Hospital	Cement	Food	Steel	Remarks
1. Ultrasonic flowmeter (3sets) 1. Measurable Materials: Liquid (BFW, Fuel Oil) 2. Measurement Range, m/s: -16 - +16 3. Operating Temperature, ℃: -40 - +100 4. Measurable Tube Size, mm ID: 25 – 350 5. Indicator: Digital (English & Figure)	X	X	X		X		
2. Hot wire anemometer (6sets) 1. Measuring Items: Wind Velocity, Wind Temp. 2. Measurable Materials: Air, Exhaust Gas 3. Measurement Range(Wind Velocity), m/s: 0 – 50 4. Measurement Range(Wind Temp.), ℃: 0 – 500 5. Indicator: Digital	X	X	X	X			
3. Pitot tube gas flowmeter (1unit) 1. Type, Number of Pitot Tube: L-Type(4), Western Type(4) 2. Measurable Materials: Flue Gas 3. Measurement Range, m/s: 0 – 20 4. Measurable Tube Size, mm ID: 25 –300 5. Indicator: Digital (△P, Static Pressure)				X	X		
4. Eddy current flowmeter (3sets) 1. Measurable Materials: Steam 2. Measurement Range, Reynolds Number: 5,000 - 7,000,000 3. Measurable Temperature Range, ℃: -40 – 300 4. Size, Number of Flowmeter: 25A (3), 40A (3), 50A (3)							
5. Oxygen content meter for exhaust gas (4sets) 1. Measurement Range (O_2 Content), Vol. %: 0 – 25 2. Indicator: Digital	X		X	X	X	X	
6. CO, CO_2 content meter for exhaust gas (4sets) 1. Measurable Materials: CO, CO_2 2. Measurement Range, Vol. %: CO (0 - 5/15), CO_2 (0 - 5/15) 3. Standard Gas: 800ppm CO + 12% CO_2 + N_2 (3.4 l)	X	X	X	X	X	X	
7. Pre-treatment unit for sampling of exhaust gas (4sets) 1. Treated Materials: Combustion Exhaust Gas 2. Drying Capacity, ℃: 1.5 - 2 (1.5 l/min.) 6 - 8 (5 l/min.).				X	X	X	

Table 8-3(2) List of Equipment for Measurement used in Each Entity

Measuring Equipment	Hotel	Shopping	Hospital	Cement	Food	Steel	Remarks
8. Sampling tube for exhaust gas (1unit) 1. Number of Metallic Pipes: Cantal (5), SUS316 (20) 2. Number of Tubes: Silicon (10), Teflon (10 + 10)				X	X	X	
9. Surface thermometer (2sets) 1. Measurement Range, ℃: -50 - 600 2. Indicator: Digital	X	X	X	X	X	X	
10. Thermoelectric pyrometer for exhaust gas (1unit) 1. Type- K (40Sets), Measurement Range, ℃: 0 - 1000 2. Type- R (10Sets), Measurement Range, ℃: 0 - 1300				X	X	X	
11. Suction pyrometer (2sets)							
12. Radiant pyrometer for lower temperature (2sets) 1. Measurement Range, ℃: -30 - 1200 2. Indicator: Digital				X		X	
13. Radiant pyrometer for higher temperature (2sets) 1. Measurement Range, ℃: 600 – 3000 2. Indicator: Digital				X		X	
14. Bar thermometer (5sets) 1. Measurement Range, ℃: -20 – 100	X	X	X	X	X	X	
15. Temperature-humidity meter (10sets) 1. Measurement Range, ℃: -20 – 50	X	X	X		X	X	
16. Multi-channel recorder with memory (6sets) 1. Measurement Points: 20 2. Measurement Range, Voltage: 20 mV - 50 V				X	X	X	
17. Temperature-humidity-pressure recorder (1set) 1. Measurement Range (Temp.), ℃: -20 - 50 2. Measurement Range (Humid.), %: 0 - 100 3. Measurement Range (Pres.), mb: 940 - 1046	X	X	X		X	X	
18. Note-type personal computer with Color Printer (2sets): COMPAQ (16MB)	X	X	X	X	X	X	
19. Electric conductivity meter (2sets) 1. Measurement Range, (lower), μS/cm: 0 - 20 2. Measurement Range, (higher), mS/cm: 0 - 200	X		X		X		
20. pH meter (2sets) 1. Measurement Range, pH: 0 - 14	X		X		X		

Table 8-3(3) List of Equipment for Measurement used in Each Entity

Measuring Equipment	Hotel	Shopping	Hospital	Cement	Food	Steel	Remarks
21. Pressure gauge (steam: 5sets, air: 2sets) 1. Pressure, Number (Steam), atg: 20 (2), 50 (2), 70 (1) 2. Pressure, Number (Air), atg: 20 (2)							
22. Pressure meter for furnace (2sets) 1. Measurable materials: Air, Combustion Exhaust Gas 2. Measurement Range, mmH_2O: -50 - +50 3. Indicator: Digital					X		
23. Pressure transmitter for steam (3units) 1. Measurable Materials: Steam 2. Measurement Range, (kg/cm2), Number: 0 - 50 (3), 0 - 20 (3), 0 - 10 (3)							
24. Voltage-Ampere-Watt meter (5sets) 1. Measurement Range, V: 150/300/600 2. Measurement Range, A: 20/50/100/200/500 3. Measurement Range, KW: 300/600/900	X	X	X	X	X	X	
25. Clip-on AC powermeter (3sets) 1. Rated Voltage, Vrms: 200/600 2. Rated Current, mA/dgt: 10 3. Rated Power, W/dgt: 10	X	X	X	X	X	X	
26. Rotation speed meter (2sets) 1. Measurement Method: Photo-electric Reflection 2. Measurement Range, rpm: 30 - 99990							
27. Lux meter (2sets) 1. Measurement Range, lux: 0 - 19999	X	X	X				
28. Electric tester (2sets) 1. DC Voltage, V: 300m/3/30/300/1000 2. AC Voltage, V: 3/30/300/750 3. DC Current, A: 300μ/3000μ/30m/300m/10 4. AC Current, A: 300μ/3000μ/30m/300m/10 5. Electric Resistance, Ohm: 300/3K/30K/300K/3M/30M	X	X	X	X	X	X	
29. Low Voltage electric tester (5sets) 1. Operating Voltage, V: 50 - 600	X	X	X	X	X	X	
30. Gloves for thermal insulation (5sets) 1. Material: Alumi-carbon Keblar 2. Heat proof Temperature, ℃: 350							

Table 8-3(4) List of Equipment for Measurement used in Each Entity

Measuring Equipment	Hotel	Shopping	Hospital	Cement	Food	Steel	Remarks
31. Glass for prevention from light (10sets) 1. Size, cm: 5 x 10							
32. Camera (1set): CANON EOS KISS (Auto/35mm)							
33. Gloves for electric insulation (5sets)	X	X	X	X	X	X	
34. Electric code for connection (1unit) 1. Electric Code: 6sets, Length (30m) 2. Tool Set: 3sets 3. Flashlight : 5sets 4. Scale: 2sets, Length (10m) 5. Ultra-sonic Distance Meter: 2sets 6. Others	X	X	X	X	X	X	
35. Stop watch (2sets)						X	
36. Hand cart for measuring equipment (4sets) 1. Size, mm: W480 x H840 x L740	X	X	X	X	X	X	
37. Stand for measuring equipment (3sets) 1. Size, mm: W600 x H700 x L1500							
38. Transformer (1set) 1. Capacity, KVA: 5 2. Inlet Condition: 3Phase, 240V, 3Lines 3. Outlet Condition(1): Single Phase, 240V, 2Lines, 2KVA 4. Outlet Condition(2): Single Phase, 100V, 2Lines, 3KVA							
39. Watt transducer (2sets) 1. Rated Input: 3Phase, 4Lines, 1000W, 100V/5A 2. Rated Output: 0 - 1 mA, DC							
40. AC Ampere transducer (2sets) 1. Rated Input: 5A, AC 2. Rated Output: 0 - 1 mA, DC							
41. AC Voltage transducer (2sets) 1. Rated Input: 110V, AC 2. Rated Output: 0 - 1.1 mA, DC							
42. Watt transducer (2sets) 1. Rated Input: 3Phase, 3Lines, 1000W, 110V/5A 2. Rated Output: 0 - 1 mA, DC							

Table 8-3(5) List of Equipment for Measurement used in Each Entity

Measuring Equipment	Hotel	Shopping	Hospital	Cement	Food	Steel	Remarks
43. Invalid Watt transducer (2sets) 1. Rated Input: 3Phase, 3Lines, Lag1000 - Lead1000, r110V/5A 2. Rated Output: Lag - Lead -0.5mA - +0.5mA, DC							
44. Steam Trap Checker					X		Additional .
45. Orifice Flow Meter Sets 1. 3 B 2. 8B					X X		ditto
46. CO, CO2 Content Meter for Exhaust Gas	X		X	X	X	X	ditto
47. Transformer	X		X	X	X	X	ditto

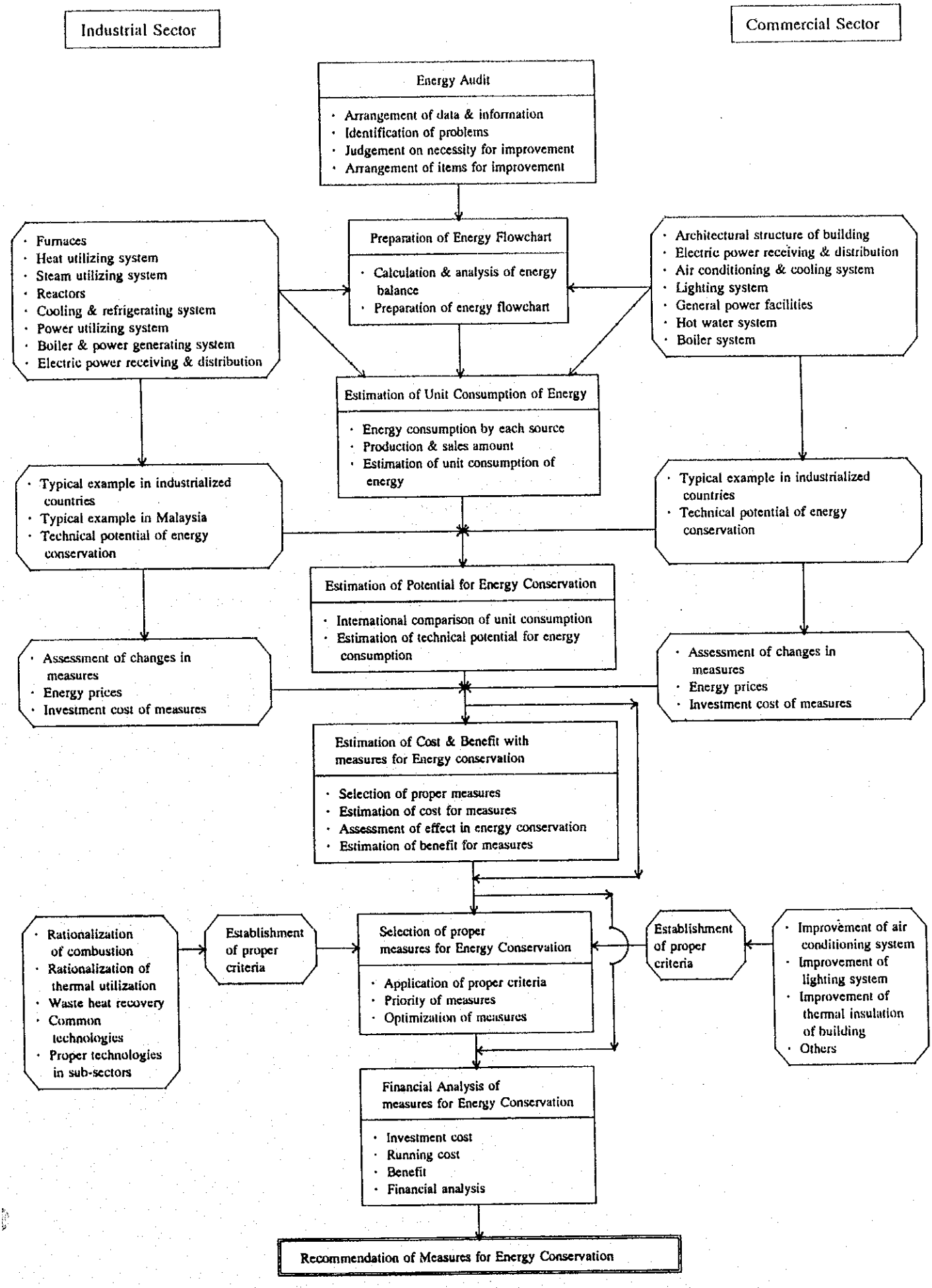


Figure 8-3 Overall Procedure of Energy Audit and Formulation of Measures for Energy Efficiency Promotion

8-2-4 General Procedure for Energy Audit

The general procedure and questionnaire for an energy audit are summarized in this section.

(1) Outline of Procedure

1. Recognize Current Condition utilizing Questionnaire and Interview
2. Identify Current Problems
3. Formulate and Prepare Energy Audit Plan
4. Conduct Energy Audit
5. Identify Problems Requiring Measures
6. Assess and Recommend Measures

In the case of simplified audit, the third and fourth items can be omitted.

(2) Questionnaire of Energy Efficiency

Energy efficiency questionnaires for the commercial and industrial sectors are shown in Tables 8-4, 8-5 and 8-6.

Table 8-4 General Questionnaire

Outline of institution	Name of institution Address, contact person, telephone number and facsimile number President, institution manager and energy manager Type of institution (private / public) and capital Organization chart and number of employees Number of managing staff and energy-related managing staff Total area and floor area of institution Number of floors, rooms and others Layout of buildings, equipment and facilities Major services Trends in annual sales (service) amount 1) Total services 2) Each major service History of institution Position in commercial sub-sector Financial information of institution 1) Balance sheet 2) Statement of profit and loss
Energy consumption	Capacity of major services Trends in number of clients (patients) Plan for increasing service capacity Service activities Annual service hours, days and weeks 1) Employee working hours (preparation, actual service, settlement) Operation and management of the institution 1) Staff for operation and management 2) Management of facilities (ledger, items for management, levels of management, judgement for maintenance) Trends in annual energy consumption by type of energy Trends in unit price of energy by type of energy Changes in energy consumption by type of energy (monthly, daily) Tariff system of electricity Operation cost of the institution

Energy consumption	Details of major energy-consuming facilities 1) Architectural structure and drawings of buildings 2) Drawings of energy systems (electricity receiving, air conditioning, lighting, etc.) 3) List of facilities and equipment (capacity, number, specification, history of maintenance) Air conditioning system 1) Central or individual conditioning 2) Capacity (cooling, heating, output of installed equipment) 3) Thermal insulation condition of buildings - Method of thermal insulation (building shell: roofs and walls) - Solar shading, air-tightness of sashes and doors 4) Ventilation - Regulative standards (temperature, humidity, CO_2, air current) - Method of ventilation (intake volume of air. etc.) - Utilization of inlet /outlet heat exchangers 5) Operating conditions - Energy consumption of major equipment - Operation mode, operating hours and effective controlling system 6) Zoning condition - Consideration for optimal zoning 7) Energy conveying system (air, water, coolant) - Thermal insulation method - Utilization of efficient equipment (inverter etc.) Lighting system 1) Operating condition - Illumination standard for each use - Type of appliance (stabilizer: magnetic or inverter) - Specification, electricity consumption and efficiency of appliance Sanitation, water supply and drainage 1) Water condition - Utilization of treated water and rain water - Water quality standards of city water and well water - Laws and regulations for facilities of water supply and drainage - Method of water supply and drainage (receiving vessel, purificatory cistern) - Reuse of drainage

Energy consumption	2) Operating conditions of sanitary facilities - Promotion of water conservation system, equipment - Introduction of inverter controlling system (pump, etc.) - Utilization of power-saving motors 3) Hot water supply facilities - Heat source of hot water supply facilities - Volume, temperature and uses of hot water - Waste heat recovery Boiler system 1) Types of boilers - Capacity, number, uses and energy consumption 2) Efficiency of boilers - Volume and temperature of exhaust gas, combustion efficiency Elevators and escalators 1) Operating condition - Number, speed rate, loading weight, controlling system - Energy consumption, number of customers when in use, method of use Electrical power receiving and distributing facilities 1) Type and voltage of electrical power receiving - Single line (regular use): Receiving Voltage kV - Double lines (regular / spare): ditto kV - Loop-type distribution system: ditto kV - Spot-network system: ditto kV - Others: ditto kV 2) Operating conditions - Primary / secondary voltage and type of transformer (oil, mold) - Demand factor of transformers - Utilization of amorphous-type transformer - Problems of harmonics - Existence of adjustment for power factor (high or low voltage side) - Imbalance among phases, voltage reduction by loss in main line - Regulation for fluctuation of supply voltage

Energy management / conservation and others	Establishment of target for energy conservation Systematical activities for energy management in the organization Energy management utilizing data and records 1) Managing methods - Items of monitoring, control and measurement - Trend data of monitoring, control and measurement Education and training of employees for energy management Maintenance management of buildings and facilities 1) Frequency of equipment maintenance, facilities and buildings 2) Maintenance conditions - Scope and contents of maintenance - Maintenance staff (permanent staff only, permanent staff and consignor, consignor only) Schedule / plan of period / long-term maintenance Measures carried out for energy conservation and their effects Planning measures for energy conservation and their expected effects (co-generation, heat storage, solar system, etc.) Economic condition of institution and commercial sub-sector Problems in promotion of energy efficiency Environmental pollution management 1) Working condition 2) Waste gas 3) Waste water (including sewage) 4) Waste solids Related laws and regulations 1) Related laws and procedures for allowance of new buildings 2) Related laws and procedures for allowance of renewal & retrofitting 3) Related laws and regulations for maintenance of facilities 4) Laws and regulations for environmental control 5) Regulations and methods of treatment for industrial wastes
Outlines of energy audit	Problems in architectural structure of buildings Problems in major energy-consuming equipment and facilities Major problems in energy consumption Requesting items for energy audit Items to note for schedule of energy audit Items to note for implementation of energy audit

Preparation for energy audit	Drawings of target equipment, facilities and buildings for energy audit Detailed structure and size of target equipment, facilities and buildings for energy audit Items to note for arrangement of measuring equipment for energy audit
Confirmation of installation of equipment for energy audit	Necessary procedure of approval for installation of measuring equipment, such as flow meters and pressure gauges etc. Possible measuring equipment owned by institution for energy audit Installed instruments in facilities for energy audit

Table 8-5 Individual Questionnaire of Commercial Sector

Hotel	Scale of institution Number of floors, guest rooms Utilization rate of guest rooms Energy-consuming equipment in guest rooms Unit consumption of energy per guest room Existence of banquet halls, total area and area of each banqueting halls
Hospital	Contents and scale 1) Department types 2) Number of beds, utilization rate of beds 3) Number of doctors and nurses 4) Nursing system 5) Daily and weekly service hours 6) Number of out patients Types of major energy-consuming medical instruments 1) Name of major energy-consuming instruments 2) List of major energy-consuming instruments (number and rated capacity)
Shopping complex	Name, and number of owners and tenants Method of financing plan for renewal and repair Items & contents of repair restrictions (noise, vibration, etc.) Facilities in common spaces List of tenants (type of service, area and number of employees) Monthly, weekly and daily service hours in each section Monthly, daily and hourly number of customers

Table 8-6 Individual Questionnaire of Industrial Sector

Cement	Trends of specific heat and specific power consumption of major products - Specific heat consumption of kiln & cooler (kcal/kg-clinker) - Specific power consumption of kiln, raw mill and cement mill (kWh/ton-cement) Properties of major materials and fuel - Chemical composition of raw meal, clinker and cement - Physical properties of cement - Properties of fuel (heavy oil, natural gas, coal, etc.) Actual operation data - Raw material grinding department - Clinker burning department - Cement grinding department
Food processing (sugar refinery)	Design and operational concept of co-generation system Properties of fuel (heavy oil, natural gas, coal, etc.) Actual operation data - Process unit - Boiler & steam turbine generator system
Iron and steel	Monthly operating parameters of Electric Arc Furnace (EAF) 1) Nominal capacity of EAF and transformer capacity 2) Material balance of main raw materials and products 3) Production parameters of EAF 4) Material balance of auxiliary raw materials 5) Utility balance of EAF and Ladle Furnace (LF) 6) Material balance of electrode and refractory 7) Working time, operation & non-operation hours of EAF 8) Material balance of by-products Properties of fuel (heavy oil, natural gas, coal, etc.)

8-2-5 Comparison of Unit Consumption with Japanese Average and Trend Data in the Commercial Sector

The trends and average data of energy consumption in the commercial sector in Japan are shown in Table 8-7 for the reference purpose. The table clearly shows the improvement of energy consumption in Japan as a result of efforts to overcome the first (1973) and the second (1979) oil crises. This shows that the price of energy was a very severe problem for each entity and they made concerted efforts to overcome such energy crises.

The year of 1997 figures of Malaysian entities that were audited this time are also shown for comparison in this section.

(1) Shopping Complex (Bandar Utama)

1. More than double the average Japanese value of unit energy consumption
2. Established in 1995, equipped with a very modern cooling system (ice storage system), and has a large floor area
3. Low story (4 floors) with two wings on left and right, the surface area per volume is very large

(2) Hotel (Mingcourt Vista)

1. About 18% larger than Japanese average value of unit energy consumption
2. Of nearly average age and floor area in comparison with Japanese hotels

(3) Hospital (Hospital Seremban)

1. About 22% less than Japanese average value of unit energy consumption
2. Nearly 50% of wards are not air-conditioned, natural ventilation is widely adopted, open-type building
3. Customer demand for air-conditioning will become an important issue.

(4) Major Differences between Malaysia and Japan

When compared to Malaysian entities, the following differences ought to be considered:

1. The climate is definitely different
   Malaysia: Two seasons (Cooling only).
   Japan: Four seasons (Heating and Cooling),
2. Shapes of buildings
   Malaysia: Land is not limited and lower story buildings are allowed

(Surface area per volume is large)

Japan: Land is limited and buildings are compact

(Surface area per volume is small)

3. Awareness of energy efficiency

Malaysia: Energy exporting country

Japan: One of the largest energy importing countries in the world

4. Database in Japan

Based on annual reports of energy consumption with floor area of 2,000m^2 or more, thus small and old buildings are included in the average figure

Table 8-7 Trends of Unit Consumption of Energy in the Commercial Sector

Units: ①Consumption (10^{10}kcal/year), ②Floor area (million m^2), ③Unit consumption (10^3kcal/m^2·year)

Year	Office buildings			Department & Super			Hotel			Hospital			Sector total		
Japan	①	②	③	①	②	③	①	②	③	①	②	③	①	②	③
1967	1,679	96	174.9	70	3	233.3	1,925	31	621.0	1,388	25	555.2	10,890	467	233.2
1972	3,787	137	**276.4**	173	5	**346.0**	4,101	40	**1,025.3**	2,975	33	**901.5**	21,733	631	**344.4**
1975	4,322	167	**258.8**	273	9	**303.3**	4,398	48	**916.3**	3,035	37	**820.3**	23,989	754	**318.2**
1978	4,788	190	**252.0**	347	11	**315.5**	4,379	52	**842.1**	3,216	42	**765.7**	26,753	862	**310.4**
1980	4,566	204	**223.8**	344	12	**286.7**	3,928	55	**714.2**	3,061	45	**680.2**	26,033	936	**278.1**
1985	5,154	248	207.8	379	13	291.5	3,749	65	576.8	3,268	55	594.2	28,524	1,103	258.6
1990	6,916	313	221.0	502	15	334.7	4,106	77	533.2	4,235	65	651.5	36,011	1,286	280.0
1994	7,933	379	209.3	651	19	342.6	5,340	87	613.8	4,435	72	616.0	41,773	1,453	287.5
1996	7,900	403	**196.0**	690	20	**345.0**	5,578	90	**619.8**	4,454	76	**586.1**	43,189	1,524	**283.4**
(Annual figures in 1997)				**14.00**	**0.192**	**730.1**	**2.602**	**0.0351**	**741.7**	**1.800**	**0.0397**	**454.6**			
Entities energy audited				**Bandar Utama**			**Mingcourt Vista**			**Hospitsal Seremban**					
Share in Japan (%)															
1980	17.5	21.8		1.3	1.3		15.1	5.9		11.8	4.9		100.0	100.0	
1990	19.2	24.4		1.4	1.2		11.4	6.0		11.8	5.0		100.0	100.0	
1996	18.3	26.4		1.6	1.3		12.9	5.9		10.3	5.0		100.0	100.0	
Growth rate in Japan (%/year)															
90/80	4.2	4.4	-1.26	3.9	2.7	1.56	0.4	3.3	-2.88	3.3	3.6	-0.43	3.3	3.2	0.07
96/90	2.2	4.3	-1.98	5.4	4.5	0.51	5.2	2.7	2.54	0.8	2.7	-1.75	3.1	2.9	0.20

Chapter 9 Hotel

Mingcourt Vista Hotel, a typical Kuala Lumpur hotel founded in 1984, is a 14 storey building with 447 rooms. The hotel has various kinds of energy-consuming equipment that are being utilized in the commercial sector, such as facilities using electricity, fuel oil, chilled water, hot water and steam. Accordingly, the study team has conducted an energy audit concerning the various types of energy consumption.

9-1 Outline of Hotel

9-1-1 Major Characteristics of Hotel

(1) Operation Mode of Hotel

1) Days of operation per annum

The hotel operates 365 days per year. Thus it is open throughout the year.

2) Operation Mode of Facilities

There are three types of operation modes depending on the facilities: batch, semi-batch and continuous, corresponding to the characteristics of each facility.

3) Maintenance Mode of Facilities

Routine maintenance work is carried out. A spare unit is installed in the main facility. Maintenance of special facilities such as the lifts, chillers, boiler, kitchen equipment and the fire prevention system is performed by the manufacturers or approved maintenance companies.

(2) General Characteristics of Energy Consumption

1) Forms of Energy

Electricity: All electricity for normal use is being received from an external electric company. It accounts for about 84 % of the total energy cost.

Diesel Oil: Fuel for steam boilers, hot water boilers and emergency power generators

LPG: Fuel for cooking

2) Utilization of Electricity, Steam, Chilled Water and Hot Water

Electricity: All the power in the air-conditioning system, lifts, refrigerators, water supply system, etc., as well as the lighting fixtures, depend on electricity.

Steam: Heating in the hotel laundry
Chilled Water: AHU (air-handling unit for air-conditioning)
Hot Water: Use in cookery, sanitary facilities, baths, the pool and so on

3) Electric Power

1.	Charging System: (Tariff)	There are two prices, corresponding to peak load (daytime 8:00-22:00), and off-peak load (midnight 22:00-8:00).
2.	Specifications:	Voltage is 11 kV. Transformer capacity is 1.5 MVA for each of the 2 units, which are in continuous operation.

(3) Services

1)	Accommodation:	447 Rooms, including 30 suite rooms
2)	Multipurpose facilities:	Ballroom for banquets, cocktail parties and, theatrical performances, and meeting rooms
3)	Dining facilities:	Restaurants, coffee house, bars and lounges
4)	Business Center:	Secretarial, courier, fax, photocopying, and personal computer services
5)	Recreational facilities:	Swimming pool, tennis court, sauna, gymnasium
6)	Other services:	Laundry, limousine service, car parking, beauty & hair salon, others

(4) Features of Hotel

The hotel is qualified as four-star. The hotel has been in operation for fourteen years. The structures of the building and main facilities were constructed in 1984 and have not yet been remodeled. They are a little old from the standpoint of energy efficiency compared with modernized hotels and buildings in Malaysia.

9-1-2 Details of Hotel

1)	Name of the hotel:	Mingcourt Vista International Hotel
2)	Address:	Jalan Ampang, 50450 Kuala Lumpur. Telephone: 60-03-2618888, 60-03-2619066 Fax: 60-03-2646857
3)	President:	Mr. George Tang
	Key person:	Resident manager, Mr. Joshua Gan

MINGCOURT VISTA HOTEL KUALA LUMPUR – ORGANIZATION CHART

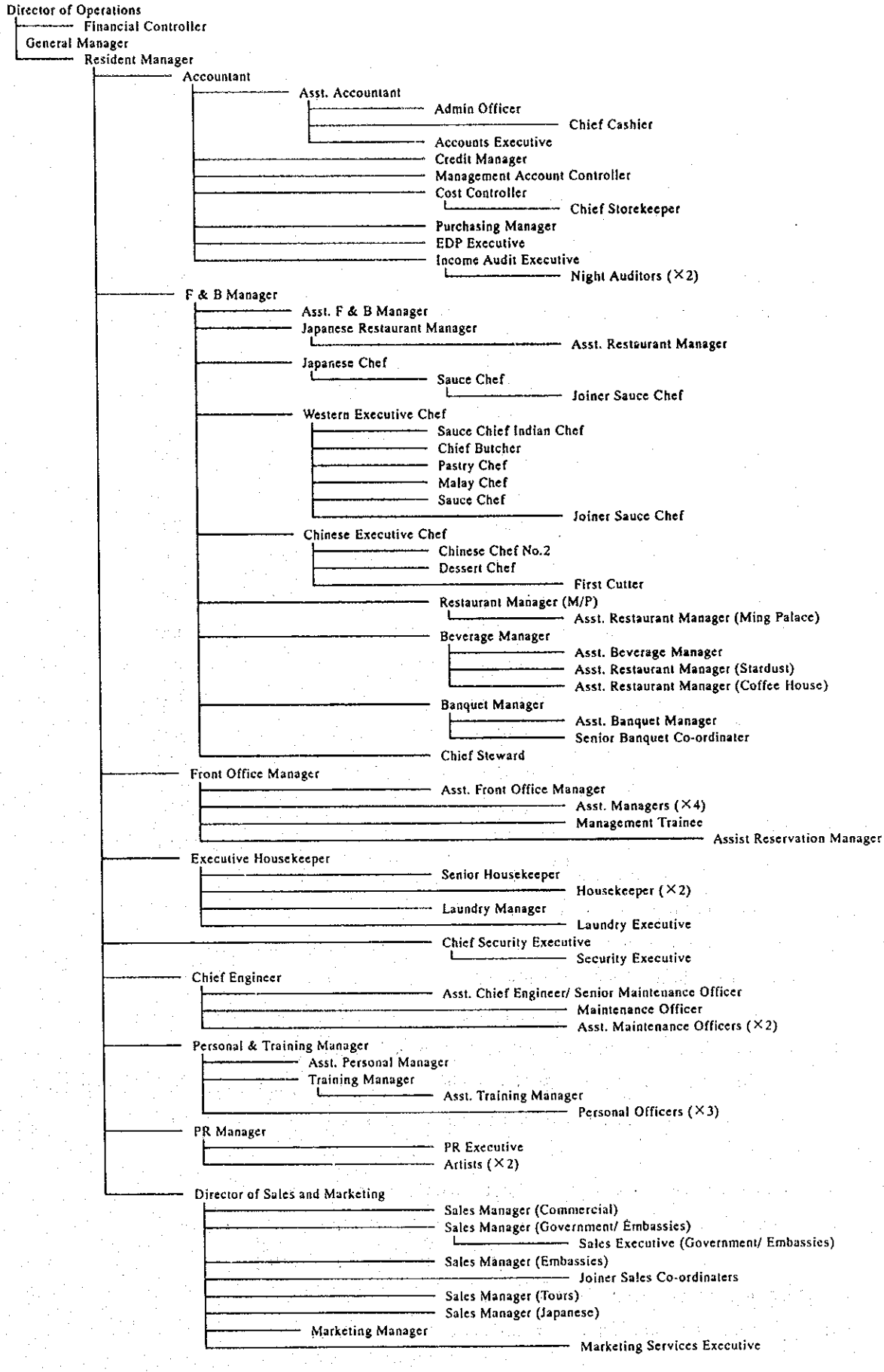


Figure 9-1 Organization Chart

4) Type of Hotel: Private: A member of The MUI Group

5) Organization chart is shown in Figure 9-1.

6) Number of employees: 297

7) Number of managing staff: 12

8) Number of energy-related engineers: 20

9) Total area of the hotel estate (m^2): 7,800

10) Building area (m^2) : Total area of each floor 35,100

Basement	5,500
Ground Floor	3,500
1st Floor	3,500
2nd Floor	2,600
3rd Floor	2,320
4th Floor	2,280
5th Floor	2,200
6th Floor	2,100
7th Floor	2,000
8th Floor	1,980
9th Floor	1,780
10th Floor	1,760
11th Floor	1,710
12th Floor	1,710
(Roof	1,710)

11) Number of floors, rooms, others : 14 floors, 447 rooms, many others

12) Layout of building is shown in Figure 9-2.

13) Major services and their respective capacities are shown in Table 9-1.

14) History of the hotel: 1984 - constructed

Operating for 14 years

15) Positioning in commercial sub-sector: Ranked as four star class

16) Trends in number of clients: As a guideline, room occupancy percentage is from 46 to 83.

17) Plans for business expansion are not considered at present.

18) Service activities

a) Annual service hours, days: 24 hours a day, 365 days a year

b) Employee working hours: Weekdays 9.00-17.00, Saturday 9.00-13.00

(Shift system: 24 hours- 3 shift)

19) Operation and management of the hotel

a) Operation and maintenance personnel are shown in Table 9-2.

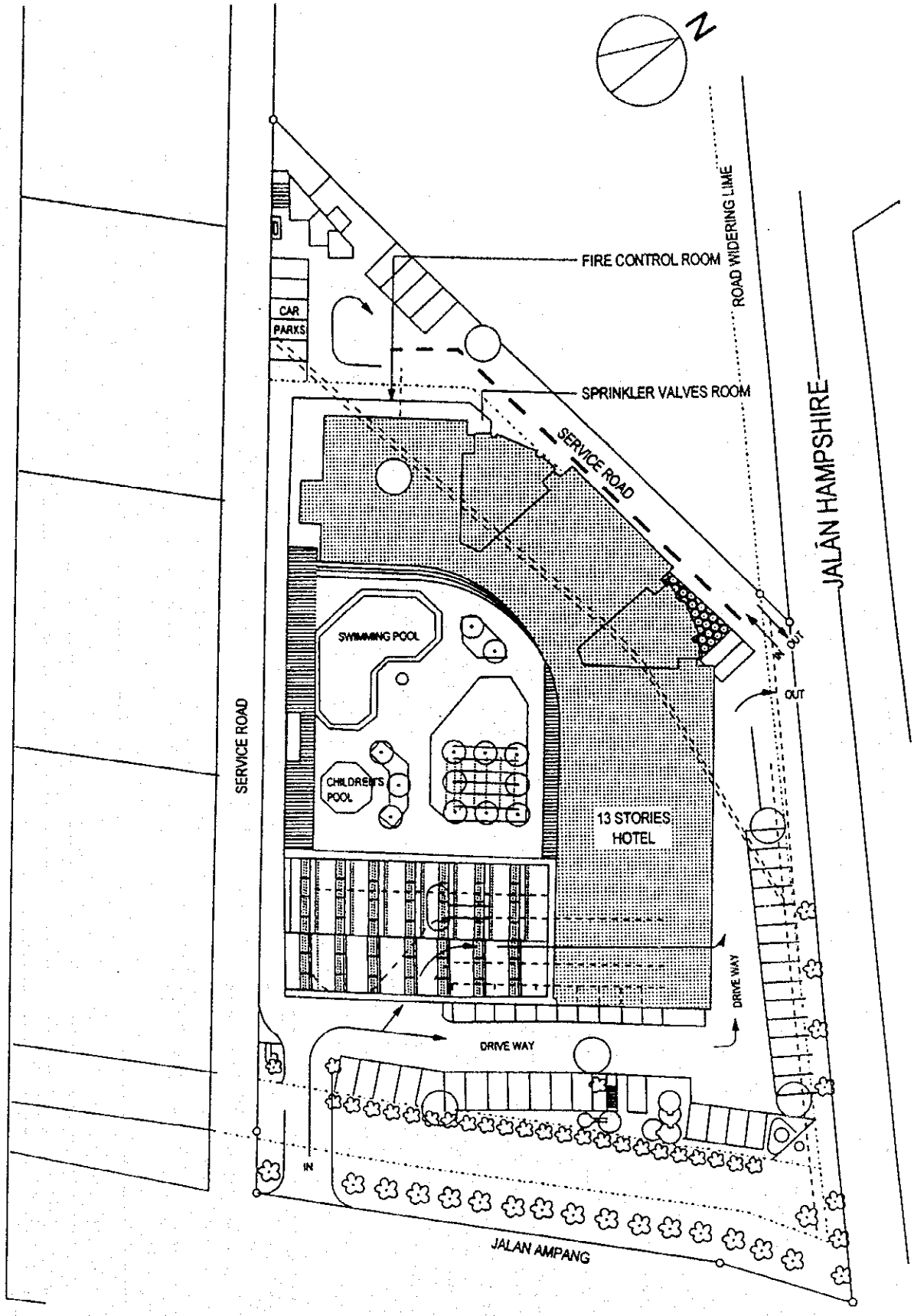


Figure 9-2 Layout of Building

Table9-1 Major Services

Accommodation
- 447 rooms including 1 Presidential suite, 4 Asean Suites, 19 Executive Suites, 6 Terrace Suites
  All rooms have individually controlled air-conditioning, IDD telephone, piped-in music, radio, coffee and tea making facilities, minibar, remote control color T.V. with in-house video movies, private bath with shower, hair dryer and telephone extension
- Electricity: 230/240 volts AC
- Check-out time: 12 noon
- No extra charge for children (maximum two) under 12 years old sharing room with parents

Taipan Club
2 floors of gracious living with a private lounge where guests can enjoy butler service, complimentary Continental breakfast, unlimited coffee and tea, evening cocktails with snacks.

Business Center
Opens daily. Provides secretarial, courier, facsimile, telex, photocopying and personal computer services.

Restaurants and Bars
- Dondang Sayang Coffee House
- Ming Palace Chinese Restaurant
- Kamogawa Japanese Restaurant
- Stardust Music Lounge
- Kencana Lounge

Recreational Facilities
- swimming pool & landscaped garden
- children's wading pool
- sun deck
- gymnasium
- tennis court
- sauna and steambath

Services and Facilities
- 24-hour room service
- non-smoking floors
- laundry and valet service
- travel and tour desk
- limousine service/ car rental
- florist/ gift shop/ drug store
- beauty and hair salon
- baby sitting service
- doctor on call
- safe deposit box (complimentary)
- credit cards: Amex, Visa, Diners Club, MasterCard, JCB Card
- ample parking facilities
- foreign exchange

Visitor's Information
- Currency: Ringgit Malaysia (RM)
- Language: National language is Bahasa Malaysian
  English, Chinese and Indian dialects are widely spoken
- Weather: hot, humid and sunny all year
  Temperatures ranging from 22℃ to 32℃. Wettest season between October and January.

Convention Capacities

ROOM	MEASUREMENTS	BANQUET	COCKTAIL	CLASS ROOM	THEATRE	U-SHAPE	BOARDROOM
Ming Crystal Ballroom 1st Floor	750 sq.m. (40m x 18.3m)	500 (with stage) 600 (without stage)	700	400	700	-	-
Ming 1	84 sq.m.	40	50	30	60	20	16
Ming 2							
Ming 3	160 sq.m.	110	130	60	120	40	40
Ming 4							
Ming 5	28 sq.m.	-	-	10	20	-	12
Ming 6	28 sq.m.	-	-	10	20	-	12
Ming 7	28 sq.m.	-	-	10	20	-	12
Ming 8	28 sq.m.	-	-	10	20	-	12
Ming 9	28 sq.m.	-	-	10	20	-	12

Table 9-2 Staff for Operation and Maintenance

	Permanent staff	Consignor	Night duty
Management of facilities	20	boiler,	2
Security management	7	kitchen, lift, chiller	3
Cleaning	50	management	4

2) Management of facilities:

1. A ledger is used for operations management.
2. Items for management include observation of operating conditions for main facilities, and recording of status, etc.
3. Level of management is determined by a daily inspection system.
4. Judgement for maintenance is based on the inspection of facilities by the makers.

(20) Changes in energy consumption by energy form (monthly, daily)

1. Changes in monthly consumption volume of each energy form are small.
2. The hotel does not check the hourly consumption volume of each energy form.
3. LPG is supplied in 50 kg cylinders.
4. Diesel oil is supplied by lorry.
5. Electricity is wholly supplied by cable from the electric company through electric power meters. The transaction amount of electricity received is decided monthly by the meters. There are three emergency generators, which are usually on stand-by.
6. Water is supplied by pipeline from the city water company through flow meters. The transaction amount of city water received is decided every two months by integrating flow meters. There is no water well in the hotel.

(21) Electricity tariff system:

A tariff system exists for the supply of hotel electricity. It consists of peak load (08:00 ~22:00 supply) and off-peak load (22:00 ~ 08:00 supply).

(22) Hotel operation costs

Energy costs, and repair and maintenance costs of the hotel are shown in Table 9-3. Other operating costs are not available.

Table 9-3 Energy and Repair & Maintenance Costs

(kRM)

Month-Year	Energy Cost	Repair & Maintenance Costs
January – 1997	184	62
February – 1997	177	58
March – 1997	182	42
April –1997	188	52
May – 1997	206	63
June – 1997	183	61
July – 1997	204	64
August – 1997	216	107
September – 1997	215	76
October – 1997	214	74
November – 1997	225	62
December – 1997	139	127
Total	2,333	848

(23) Architectural structure

Examples of the building's drawings are shown in Figure 9-3: Ground Floor Plan and Figure 9-4: 5th Floor Plan.

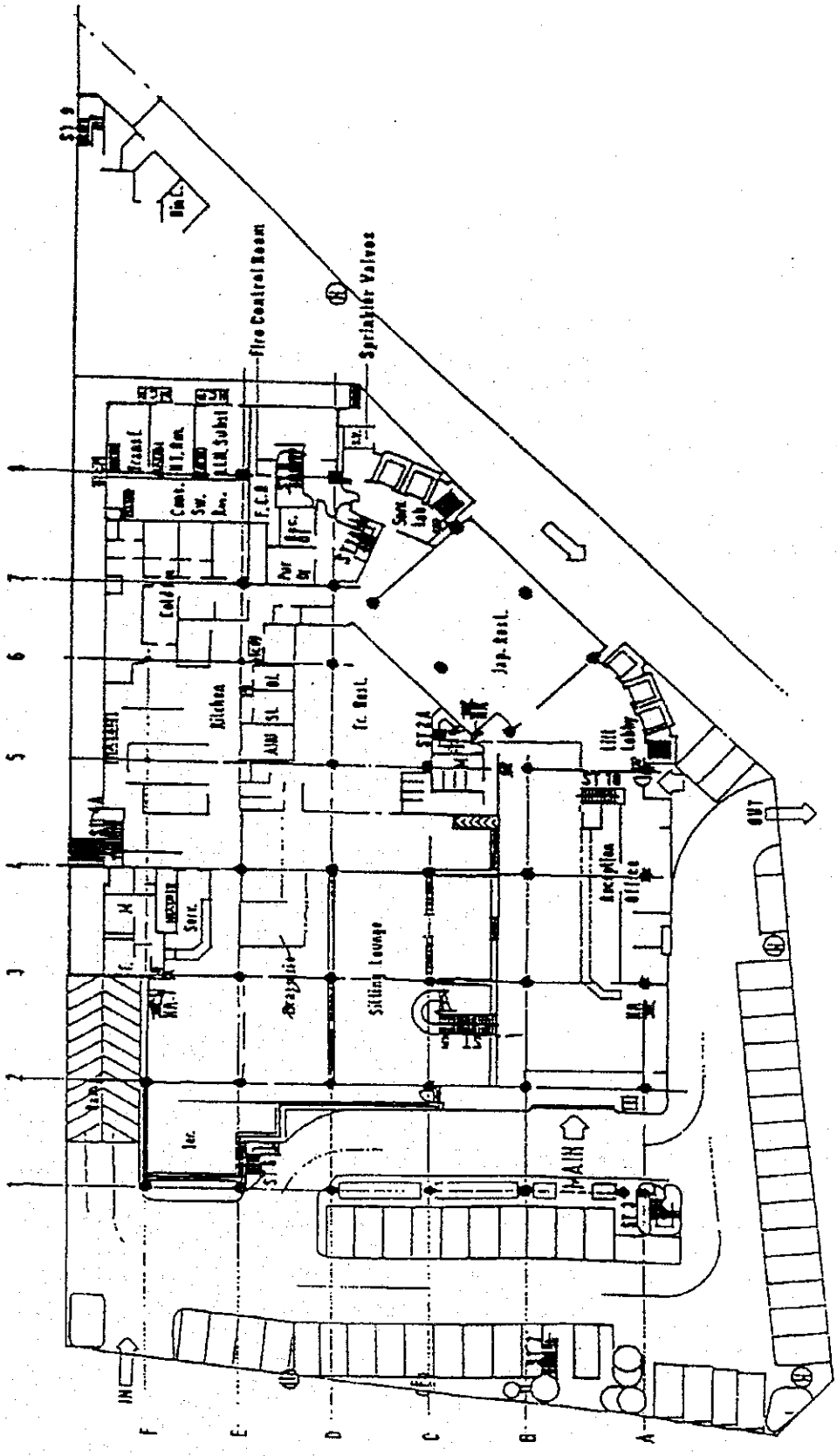


Figure 9-3 Ground Floor Plan

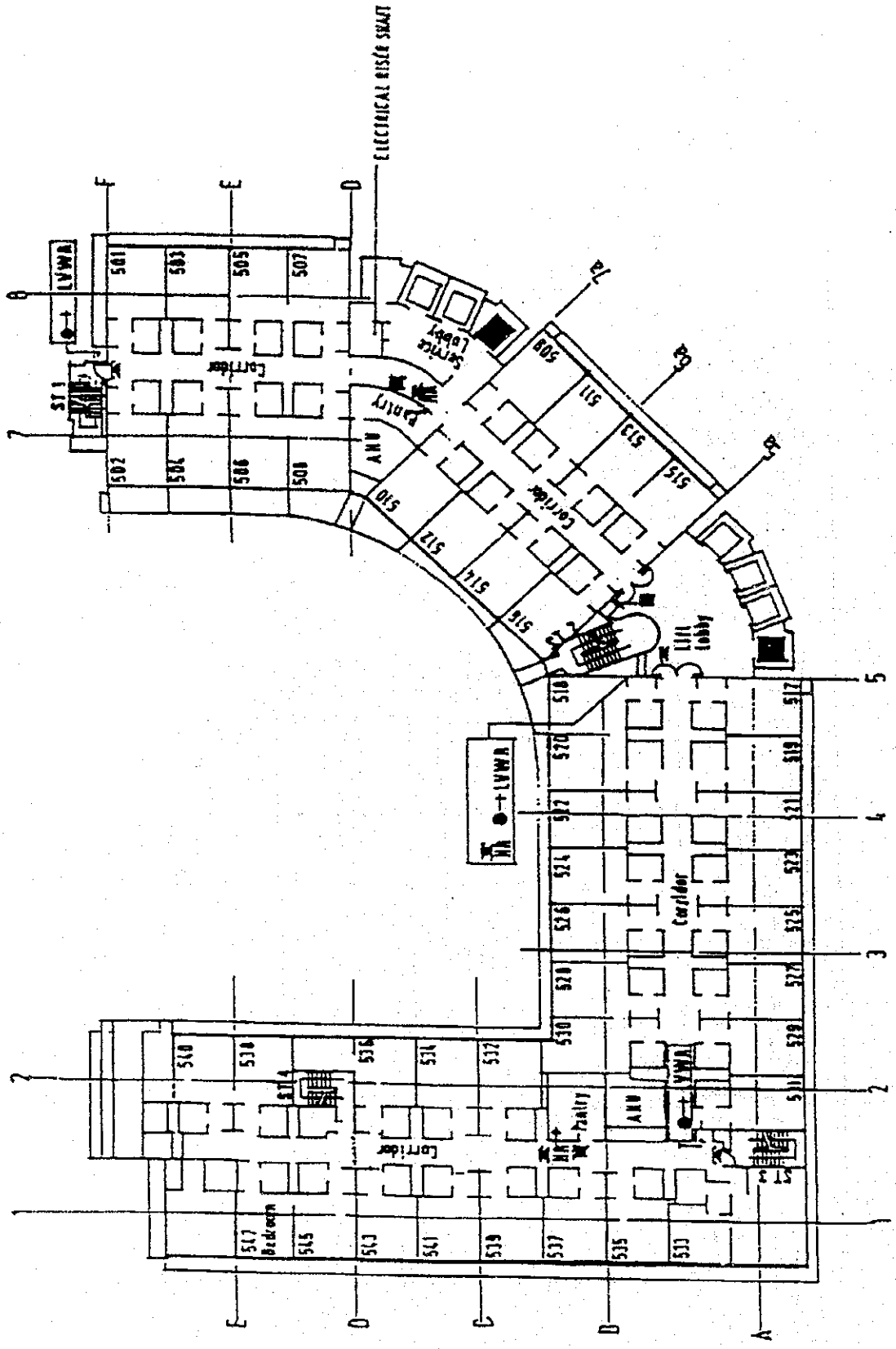


Figure 9-4 5th Floor Plan

(24) Air-conditioning system

1) The air-conditioning system is a centralized system.

2) Capacity :

Chiller: 350 USRT – 3 unit

AHU: 3 HP – 7 unit, 5HP – 19 unit, 7.5 HP – 6 unit, 10 HP – 3 unit,

15 HP – 5 unit, 20 HP – 1 unit, 25 HP – 1 unit

Total capacity is 311 HP. This number includes 15 HP for the stand-by unit.

3) Thermal insulation measures of the building

The building uses no specific thermal insulation.

Neither solar shading, nor airtight sashes and doors are installed.

4) Ventilation

a) Regulation values in respect to indoor environmental conditions are N.A.

b) The method of ventilation is a centralized system. There are an induced air blower, an exhaust air blower and fans in each AHU.

c) There is an inlet / outlet heat exchanger.

5) Operating conditions

a) Operation mode is continuous and operating hours are 24 per day.

b) There is no control system for the main blowers. For other fans, operation is regulated by On/off.

6) Per-zone air adjustment system

An air adjustment system is employed according to certain types of zones.

7) Energy transfer system (air, water, chilled water)

a) Thermal insulation is used only for chilled water, hot water and steam pipe line.

b) Inverters and other energy-conserving facilities are not employed.

(25) Lighting equipment

a) Illumination criteria are not available.

b) Fluorescent lighting stabilizers are of magnetic type.

(26) Sanitation, water supply and drainage.

1) Water supply conditions

a) Recycling of used water and rainwater is not carried out.

b) Water quality standards of city water is not available.

c) Laws and regulations for water supply and drainage facilities are not available.

d) The method of water supply is a receiving tank and head tank supply system.

e) Drainage is not recycled in the hotel.

2) Sanitary facilities

a) Water conservation systems and equipment are not yet fully utilized.

b) An inverter-based control system has not yet been introduced.

c) Power-saving motors are not used.

3) Hot water supply facilities

a) Hot water is produced in hot water boilers by burning diesel gas oil.

b) Hot water is supplied for rooms, kitchens, the pool, etc. Its temperature is from 65℃ to 90℃.

4) Recovery of hot water waste heat is not carried out.

(27) Boiler system

1) The steam boiler and hot water boiler type is an internal fired horizontal smoke boiler.

2) The control system is on / off operation based on the outlet temperature of hot water and outlet pressure of steam.

3) Steam boiler and hot water boiler efficiency have not been checked yet.

(28) Lift

1) Operating conditions are shown in Table 9-22.

2) Loading weights for guest use and service use are 2,550 lb. and 3,000 lb, respectively.

3) Energy consumption is not measured.

(29) Electrical power receiving and distributing facilities

1) The electrical power receiving system is a single line system.

2) Receiving voltage is 11 kV.

3) Primary and secondary voltage are 11 kV and 415 V, respectively.

4) The transformer type is an oil-immersed transformer.

5) Transformer load rate is extremely low because two transformer units are normally in operation.

6) A condenser is installed in the low voltage side distribution line to improve the power factor.

7) There are regulations for fluctuation of supply voltage, and the range of fluctuation is +5% to - 5 %.

8) Three emergency electric generators are installed, each with a capacity of 400 kW.

9-2 Outline of Energy Audit

In order to conduct an energy audit for the hotel, taking readings of data was the first essential step and the formulation of an energy balance the second. The results of the energy audit, including evaluation, analysis and the recommendations for improvements of energy efficiency, are described. In this section the following locations for measurements were selected due to their relatively large energy consumption.

Major items of energy audit for this hotel were as follows:

1. Electrical power receiving and distribution
2. Air-conditioning system
   (1) Mechanical performance
   (2) Environmental conditions
   (3) Electricity consumption
3. Lighting system
4. Heat-consuming facilities
5. General energy consumption

Details are shown in Sec. 9-4.

9-3 Schedule of Energy Audit

The energy audit for the hotel was carried out from June 2 to 13, 1998. This included preparation for the measurements and preliminary discussion of the measurement results.
An outline of the schedule follows:

(1) Preparatory Stage

2 June (Tue.): Transportation and preparation of measuring equipment.
Explanation, discussion and confirmation of the audit plan.

(2) Energy Audit

3 June (Wed.): Adjustment of measuring equipment,
Confirmation of measuring points

4 June (Thurs.): Installation and adjustment of measuring equipment for electricity receiving and chiller unit

5 June (Fri.): Measurement of electricity consumption at transformers and distributors
Measurement around chillers and cooling towers

6 & 7 June (Sat. & Sun.): Analysis of the results

8 June (Mon.): Measurement of electrical current at distributors, temperature of chilling water in AHUs and illumination intensity
Preparation for measurement around hot water boilers, steam boilers and calorifiers

9 June (Tue.): Measurement of electrical current in the sub-distribution room and environmental room conditions
Measurement around hot water boilers, steam boilers and calorifiers

10 June (Wed.): Removal of measuring equipment at electricity receiving points, main transformers and chillers
Measurement of electricity consumption of lifts and environmental room conditions
(illumination intensity, air flow and temperature)
Measurement around hot water boilers, steam boilers and calorifiers.

11 June (Thu.): General field survey of major energy consuming facilities
Measurement of temperature, humidity and CO_2 content outdoors and on the ground floor
Input of trend data and equipment lists

12 June (Fri.): Field survey of AHU, data analysis and evaluation reconfirmation of equipment specifications
Input of trend data, preparation of reports, and repackaging of measuring equipment.

(3) Discussion of Preliminary Results

13 June (Sat.): Preliminary evaluation of the results and recommendation on improvements of energy efficiency
Transportation of measuring equipment.

Table 9-4 shows the detailed schedule for measurement.

9-4 Outline of Measuring Items, Points and Measuring Equipment

To calculate and evaluate the current condition of energy consumption and to develop an energy balance, measurements described below for the main energy audit items were conducted according to the schedule.

(1) Electrical Power Receiving and Distribution

1. HV receivers: Trend data of voltage, amperage, kW and power factor
2. HV distributors: Trend data of voltage, amperage, kW and power factor
3. LV distributor: Voltage and amperage

(2) Air-conditioning System

1. Chillers: Inlet/outlet water temperature, voltage, amperage, kW and power factor
2. Cooling towers: Inlet/outlet water temperature and water flow rate
3. Air Handling Units(AHUs): Voltage and amperage of AHUs, flow rate and temperature of air and inlet/outlet temperature of chilled water
4. Blowers and fans: Air flow rate, voltage and amperage
5. Fan coils: Temperature and humidity
6. Air heat exchangers: Exhaust/fresh air, inlet/outlet temperature and air flow rate
7. Air-conditioned area: Temperature, humidity and CO_2 content
8. Air-conditioned rooms: Temperature and humidity
9. Outdoor condition: Temperature, humidity and CO_2 content

(3) Lighting System

1. Common space: Illumination intensity
2. Rooms: Illumination intensity

(4) Heat-consuming Facilities

1. Hot water boilers: Flow rate and properties of fuel oil; flow rate and temperature of Boiler Feed Water(BFW); temperature of generated hot water; and temperature and O_2, CO, CO_2 content of flue gas
2. Calorifiers: Temperature of hot water
3. Steam boilers: Fuel oil flow rate; temperature, electric conductivity and pH of BFW; temperature and pressure of generated steam
4. Thermal insulation: Surface temperature of boilers

(5) General Energy Consumption

1. Overall electricity consumption
2. Overall fuel oil consumption

(6) Field Investigation

1. Review of equipment list
2. Investigation of drawings
3. Observation of operating conditions, equipment and facilities

Details of measured items, points and measuring equipment are shown in Table 9-5.

Table 9-4 (1) Detailed Schedule for Measurement (Hotel)

Measuring Items	Working Day									
	1	2	3	4	5	6	7	8	9	10
0. Preparation & Discussion of the Plan	x	x								
1. Electrical Power Receiving and Distribution (1) HV Receivers (Voltage, Amperage & Power Factor)			x	x	x	x	x			
(2) HV Distributors (Voltage, Amperage & Power Factor)				x	x	x	x			
(3) LV Distributors (Voltage & Amperage)			x	x	x	x	x			
2. Air-conditioning System **2.1 Mechanical Performance** (1) Chillers (Chilled Water: Inlet/Outlet Temp.)			x	x	x					
(2) Cooling Tower (Cooling Water: Inlet/Outlet Temp. & Flow rate)			x	x						
(3) Air Handling Units 1) Suction Air (Temperature, & Flow Rate) 2) Delivery Air (Temperature)								x		
(4) Blowers and Fans 1) Suction or Delivery Air (Flow Rate)								x		
(5) Fan Coils 1) Delivery Air (Temperature & Humidity)							x	x		
(6) Air Heat Exchanger 1) Suction Side (Inlet/Outlet Temp. & Flow Rate) 2) Delivery Side (Inlet/Outlet Temp. & Flow Rate)								x		
2-2 Environmental Conditions (1) Area to be conditioned 1) Spaces (Temp., Humid., Air Flow & CO/CO_2)							x	x		
(2) Rooms to be conditioned 1) Rooms (Temp., Humid. & Direction of Air Flow)						x	x			
2-3. Electricity Consumption (1) Chillers, AHU, Blowers (Volt., Amperage & Power Factor)					x	x	x			

Table 9-4 (2) Detailed Schedule for Measurement (Hotel)

Measuring Items	Working Day									
	1	2	3	4	5	6	7	8	9	10
3. Lighting System										
(1) Main Part of Buildings Each Space & Room (Lux)					x		x			
4. Heat-consuming Facilities										
(1) Hot Water Boiler and Steam Boiler					x	x	x			
1) Fuel Oil (Flow Rate & Properties)										
2) Boiler Feed Water (Flow Rate, Temperature)										
3) Generated Steam & Hot Water (Temperature & Pressure)										
4) Flue Gas (Temp., O_2, CO, CO_2)										
(2) Calorifiers					x	x	x			
1) Hot Water (Temperature)										
(3) Thermal Insulation (Surface Temp. of Steam Boilers)					x	x	x			
5. General Energy Consumption			x	x	x	x	x	x	x	x
(1) Electricity										
(2) Fuel										
6. Field Investigation			x	x	x	x	x	x	x	x
(1) Preparation of Equipment List										
(2) Investigation of Drawings										
(3) Observation of Operating Condition										
7. Summarization & Reporting									x	
8. Review and Discussion										x

Table 9-5 (1) Outline of Measurements for Energy Audit (Hotel)

Major Items of Energy Audit & Subject Items and Points	Measurement or Estimate	Available Equipment of Measurement			
		Required Equipment	Hotel	JICA	Local Labo.
1. Electrical power receiving & distr-					
ibution					
(1) HV Receivers (Sub-station)					
① Voltage	M	Clamp on power hitester, control panel	x	x	
② Amperage	M	ditto	x	x	
③ Power factor	M	ditto	x	x	
(2) HV Distributors (Main circuit)					
① Voltage	M	Clamp on power hitester, control panel	x	x	
② Amperage	M	ditto	x	x	
③ Power factor	M	ditto	x	x	
(3) LV Distributors (Control unit)					
① Voltage	M	Clip-on AC powermeter		x	
② Amperage	M	ditto		x	
2. Air-conditioning system					
2-1. Mechanical performance					
(1) Chillers					
① Water temperature (inlet/outlet)	M	Bar & Surface thermometer, T.G.	x	x	
(2) Cooling towers					
① Water temperature (inlet/outlet)	M	Bar & Surface thermometer, T.G.	x	x	
② Flow rate of water	M	Ultra-sonic flow meter		x	
(3) Air handling units (AHU)					
1) Suction air					
① Temperature	M	Surface thermometer, Anemometer		x	
② Flow rate	M	Hot wire anemometer		x	
2) Delivery air					
① Temperature	M	Surface thermometer, Anemometer		x	
(4) Blowers & fans					
① Flow rate	M	Hot wire anemometer		x	
② Temperature	M	Surface thermometer, Anemometer		x	
③ Electricity consumption	M	Clip-on AC powermeter		x	

Table 9-5 (2) Outline of Measurements for Energy Audit (Hotel)

Major Items of Energy Audit & Subject Items and Points	Measurement or Estimate	Available Equipment of Measurement			
		Required Equipment	Hotel	JICA	Local Labo.
(5) Fan coils					
1) Delivery air					
① Temperature	M	Temp.- humid. recorder		x	
② Humidity	M	ditto		x	
(6) Air heat exchangers					
1) Suction/delivery					
① Inlet/outlet temperature	M	Surface thermometer, Anemometer		x	
② Air flow rate	M	Hot wire anemometer		x	
2-2. Space condition					
(1) Area to be conditioned					
1) Spaces					
① Temperature	M	Temp.-humid. recorder		x	
② Humidity	M	ditto		x	
③ Air flow	M	Hot wire anemometer		x	
④ CO/CO_2 contents	M	CO, CO_2 content meter		x	
2) Rooms					
① Temperature	M	Temp.- humid. meter		x	
② Humidity	M	ditto		x	
③ Direction of air flow	M	Observation			
2-3. Electricity consumption					
(1) Chillers, AHU, blowers					
① Voltage	M	Clamp on power hitester, control panel	x	x	
② Amperage	M	ditto	x	x	
③ Power factor	M	ditto	x	x	
3. Lighting system					
(1) Main part of the building					
① Illumination intensity	M	Lux meter		x	
4. Heat consuming facilities					
(1) Hot water boilers					
1) Fuel oil					
① Flow rate	E				

Table 9-5 (3) Outline of Measurements for Energy Audit (Hotel)

Major Items of Energy Audit & Subject Items and Points	Measurement or Estimate	Available Equipment of Measurement			
		Required Equipment	Hotel	JICA	Local Labo.
1) Fuel oil (LFO)					
② Properties (Spgr., LHV, CHN)	M	S.G. Meter, Elementary analyzer, etc.			x
2) Boiler feed water					
① Flow rate	M	Ultra-sonic flow meter		x	
② Temperature	M	Surface thermometer & T.G.	x	x	
3) Generated hot water					
① Temperature	M	Surface thermometer & T.G.	x	x	
4) Flue gas					
① Temperature	M	Exhaust gas tester		x	
② $O_2/CO/CO_2$ contents	M	ditto		x	
(2) Calorifiers					
1) Hot water					
① Temperature	M	Surface thermometer & T.G.	x	x	
(3) Steam boilers					
1) Fuel oil (LFO)					
① Flow rate	E				
② Properties	M	Same as hot water boilers			x
2) Boiler feed water					
① Temperature	M	Surface thermometer & T.G.	x	x	
② Properties	M	Electric cond. meter & pH meter		x	
3) Generated steam					
① Temperature	M	Surface thermometer & T.G.	x	x	
② Pressure	M	Pressure gauges	x		
(4) Thermal insulation (Boilers)					
① Surface temperature	M	Surface thermometer		x	
5. General energy consumption					
(1) Electricity	M	Clamp on power hitester		x	
(2) Fuel oil	Trend data	Operation records & data	x		
6. Field investigation					
(1) Observation	Observation				
(2) Investigation of existing data	Review	Existing drawings and data	x		

9-5 Measurements Results

As mentioned before, measurements described below were conducted to calculate and evaluate the current condition of energy consumption and to develop an energy balance.
The measurement results are as follows.

9-5-1 Electricity

(1) Single Line Diagram

Figure 9-5 shows a single line diagram of the hotel. There is one 11kV incoming line from TNB. There are two transformers, each with a capacity of 1.5MVA, which reduce voltage from 11kV to 415V. At the 415V line, there are two normal banks and one emergency bank. Power is normally supplied from a TNB line, being automatically switched to the Diesel Alternator in emergency cases. The Diesel Alternator specification is; 400kW capacity, 415V output, 3-phase, 0.8 power factor, and 1,500rpm. The measuring points are shown by the numbers from 1 to 10 in Figure 9-5.

(2) Results of Power Consumption Measurements

Trend data for electricity consumption measured at the power receiving point is shown in Table 9-6. The total electricity consumption on 7 June was 21,451 kWh/d. The electricity consumption during the peak period based on the TNB tariff system was 14,280 kWh/d and the off-peak period consumption was 7,171 kWh/d. The proportion of off-peak consumption was 33.4 percent.
(Proportion of off-peak consumption = off-peak consumption / total consumption $\times$ 100)

The maximum and minimum demand were 1,087 kW and 662 kW, respectively, and the average was 894 kW.
The load factor was 82.2 percent. (Load Factor = average / max. demand)
The load factor in 1997, calculated by energy consumption, was 86.3 percent. Both values are almost the same.
(Load Factor in 1997) = (average electricity in '97 / demand) $\times$ 100

$$= \{9{,}568 \text{ Wh/Y} \times 10^3 / (24 \text{ h/d} \times 365 \text{ d/Y}) / 1{,}265 \text{ kW}\} \times 100$$

$$= 86.3 \%$$

As shown in Figure 9-9, there is a large difference in electricity demand between the off-peak period and peak of about 400kW.

(3) Data on Power Receiving

1) Voltage and Frequency

Figure 9-6 and Figure 9-8 show the voltage and frequency at the power receiving point. The voltage and frequency are relatively stable.

2) Effective Power, Reactive Power and Apparent Power

Figure 9-7 shows effective, reactive and apparent power. Trend data for these show a large difference of electric power between the peak and off-peak periods.

3) Power Factor at Power Receiving

As shown in Figure 9-9, the power factor ranged from 0.86 to 0.92. During peak period, electricity demand was high, however the power factor was low. On the other hand, high power factor and low electricity demand were observed during the off-peak period.

(4) 1.5MVA Transformer Data

1. Table 9-7 and Table 9-8 show the measuring results of the voltage, amperage, frequency, electricity and power factor for the 1.5MVA No.1 transformer and No.2 transformer.
2. Figure 9-10 shows that the electricity of No.1 transformer was stable.
3. Figure 9-11 shows that the electricity of No.2 transformer and power factor differed largely between peak and off-peak periods. During peak period, electricity demand was high, however the power factor was low. On the other hand, a high power factor but low electricity demand were observed during off-peak period.

(5) Data on the Feeder

1. Table 9-9, Table 9-10 and Table 9-11 show the results of measurement on voltage, amperage, frequency, electricity and power factor for the Normal Riser N1, N2 and N3.
2. Figure 9-12 is a trend curve of electricity and power factor for the Normal Riser N1.
3. Figure 9-13 is a trend curve of electricity and power factor for the Normal Riser N2.
4. Figure 9-14 is a trend curve of electricity and power factor for the Normal Riser N3. It shows that there is a large difference in the electricity of the Normal Riser N3 during peak and off-peak periods.
5. Table 9-16 shows the results of amperage measurements for each distribution board.

(6) Data on the Chiller Plant

1. Table 9-12 and Table 9-13 show the results of voltage, amperage, frequency, electricity and power factor measurements for chiller No.1, No.2 and No.3.
2. Figure 9-15 shows the trend curve of electricity and power factor for chiller No.1 and chiller No.2.
3. Figure 9-16 is the trend curve of electricity and power factor for the chiller No.3. It shows that there is a large difference in the electricity of chiller No.3 between peak and off-peak periods.

(7) Data on Lifts

1. Table 9-14 and Table 9-15 show the results of voltage, amperage, frequency and electricity measurements for passenger and service lifts.
2. Figure 9-17 is a trend curve of electricity for the passenger lifts and Figure 9-18 is that for the service lifts.

9-5-2 Illumination Intensity and Environmental Conditions

(1) Illumination Intensity

Illumination intensity on the ground floor, 1st floor, 2nd floor and 3rd-12th floors in the hotel is shown in Figure 9-19-(1), Figure 9-19-(2), Figure 9-19-(3), Figure 9-19-(4), respectively. The measured values at points shown on the figures are within a reasonable level. The value at location 5 in Figure 9-19-(1) was extremely high, 722 lux, due to the contribution of sunlight at the measurement point, which is an open space under a skylight.

(2) Room Temperature

Guest room, corridor, public space, chiller room, electric room, kitchen, steam boiler room, hot water boiler room and elevator operation room temperatures are shown in Figure 9-19-(1), Figure 9-19-(2), Figure 9-19-(3), Figure 9-19-(4), Figure 9-24-(1), Figure 9-24-(2) and Figure 9-24-(3). The trend data of office, room and atmospheric temperatures during a squall are shown in Table 9-18. The measured temperatures at the above locations were a little low, ranging from 22℃ to 26℃. The temperatures in the laundry and steam boiler rooms were too high, ranging from 32℃ to 34℃.

(3) Air Velocity in the Hotel

Air velocity in public space, corridors, lounges and the hotel kitchen is shown in Figure 9-19-(1), Figure 9-19-(2), Figure 9-19-(3), Figure 9-19-(4) and Figure 9-24-(1), respectively. These data

were below 0.5 m/s, within a reasonable range except for the air velocity in the kitchen.

(4) Humidity and CO_2 Content in the Hotel

Relative humidity, dry bulb temperature and wet bulb temperature are shown in Table 9-17. The relative humidity was in the range from 74 percent to 83 percent, which was rather high. CO_2 content in the lobby and atmosphere are shown in Table 9-17. The value in the lobby was rather low, but that in the atmosphere was too high. The value for the atmosphere might be inaccurate because its measuring point was located near the car park.

(5) Air Heat Exchanger

Temperature and velocity of fresh air and used air around the total heat exchanger are shown in Figure 9-24-(3). Soiling was observed on the surface plate in the heat exchanger. Soiling as severe as that in the heat exchanger was observed in the Air Handling Unit (AHU).

9-5-3 Chilled Water System

(1) Chiller

Inlet and outlet temperatures of chilled water for No.2 chiller and No.3 chiller are shown in Figure 9-20 (No.1 chiller is a stand-by). Flow rate could not be measured because there was neither a permanent flow meter in the unit nor any possibility of installing the meter recently prepared by JICA. One chiller unit was running for 24 hours and another unit was running from around 10 am to 10 pm.

(2) Cooling Tower

Inlet and outlet temperatures of cooling water of the No.2 chiller and No.3 chiller are also shown in Figure 9-20, together with their flow rates.

9-5-4 Hot Water System

(1) Hot Water Boiler

Figure 9-21 shows inlet/outlet temperatures and flow rate of primary water to the hot water boiler, as well as flue gas composition and temperature. Oxygen content in flue gas was from 0.6 to 0.8 vol. %. This shows that the excess air ratio of the boiler is about 1.03, which is too low. The situation was relatively good, although an incomplete combustion might be partially conducted. Flue gas temperature was from 284℃ to 308℃. The temperature was relatively high compared to the standard value of 250℃. Trend data of flow rate and trend data for cut-

in/cut-off time of boiler burning operation, and comments on boiler operation, are shown in Figure 9-22.

(2) Calorifier

There are four calorifier units. Inlet and outlet temperatures of secondary water in each unit of the calorifier are shown in Figure 9-21. Some units were on stand-by.

9-5-5 Steam Boiler System

Figure 9-23 shows the surface temperature of the boiler, the condensate tanks and the pipe line in the boiler system; the temperature and pressure of steam; and the fuel oil consumption rate. Electrical conductivity of the boiler feed water was at the normal level as shown in Figure 9-23, compared with the typical technical guide lines in Japan.

Schedules of specifications for the main energy consuming facilities and equipment are shown in Appendix 9.

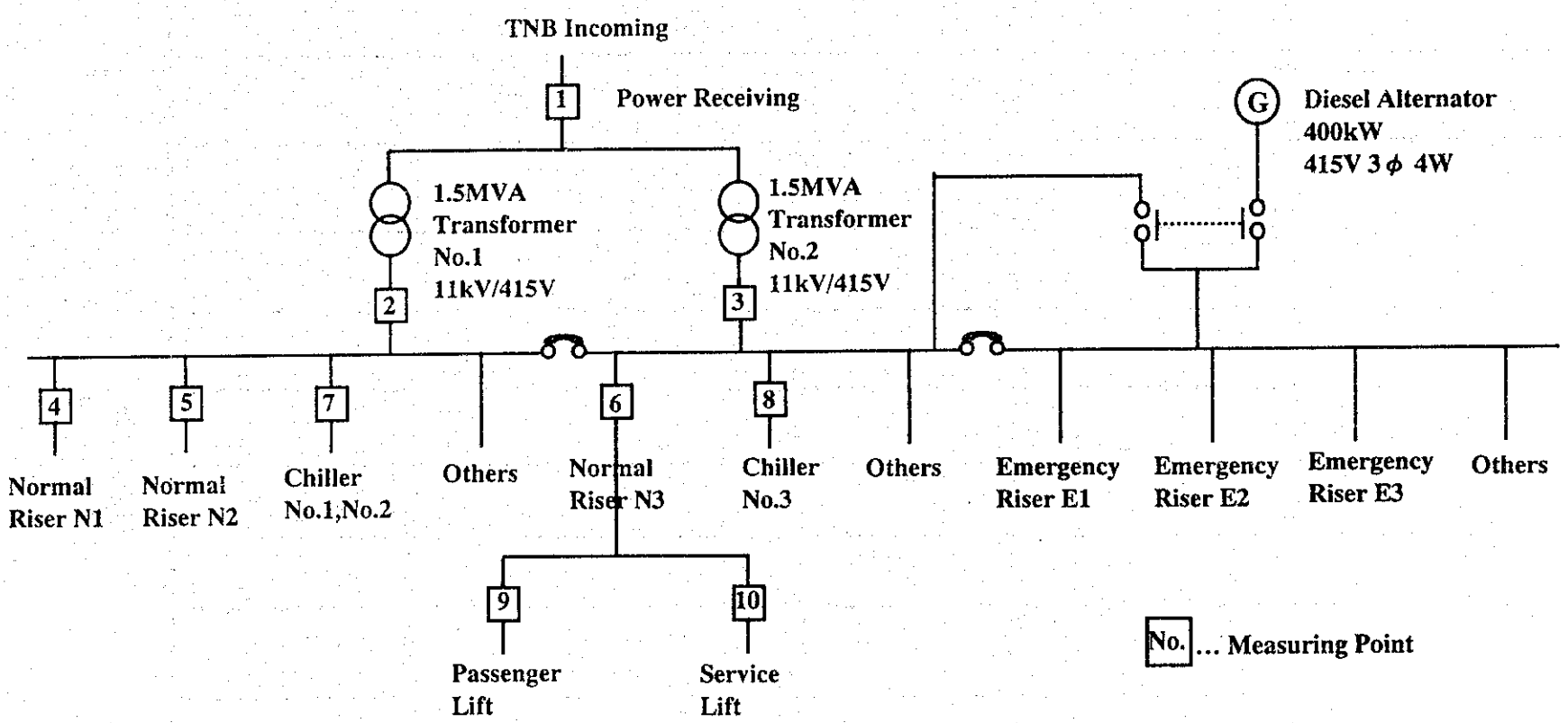


Figure 9-5 Single Line Diagram

Table 9-6 Power Receiving

DATE	TIME	Voltage [kV]		Current [A]				Frequency	Effective Power	Reactive Power	Apparent Power	Power Factor
		V1	V2	I1	I2	I3	Ave.	[Hz]	[MW]	[Mvar]	[MVA]	
7-Jun	1:00:00	11.293	11.292	36.78	38.00	39.13	37.97	50.01	0.7585	0.3146	0.8212	0.924
7-Jun	2:00:00	11.395	11.391	36.00	38.26	38.56	37.61	50.11	0.6765	0.2822	0.7332	0.923
7-Jun	3:00:00	11.464	11.463	35.91	36.93	38.03	36.96	49.98	0.6777	0.2886	0.7367	0.920
7-Jun	4:00:00	11.438	11.436	34.77	35.56	37.29	35.87	50.05	0.6623	0.2774	0.7181	0.922
7-Jun	5:00:00	11.463	11.470	36.76	37.58	38.43	37.59	50.11	0.6626	0.2826	0.7204	0.920
7-Jun	6:00:00	11.425	11.425	36.16	37.68	38.61	37.48	49.99	0.6828	0.2837	0.7395	0.923
7-Jun	7:00:00	11.394	11.393	41.67	43.07	44.54	43.09	49.98	0.7186	0.3165	0.7856	0.915
7-Jun	8:00:00	11.214	11.196	50.33	52.19	54.48	52.33	50.08	0.7833	0.3821	0.8718	0.898
7-Jun	9:00:00	11.295	11.280	52.57	55.02	57.02	54.87	49.95	0.9753	0.5438	1.1169	0.873
7-Jun	10:00:00	11.254	11.241	49.65	51.56	53.02	51.41	49.96	0.8972	0.4923	1.0236	0.877
7-Jun	11:00:00	11.341	11.320	62.30	64.42	66.29	64.34	49.93	1.0228	0.5719	1.1721	0.873
7-Jun	12:00:00	11.315	11.304	60.55	63.10	62.91	62.19	49.99	1.0780	0.6113	1.2395	0.870
7-Jun	13:00:00	11.350	11.327	61.89	63.76	63.64	63.10	49.94	1.0800	0.6156	1.2433	0.869
7-Jun	14:00:00	11.352	11.332	62.66	64.94	65.40	64.33	49.98	1.0870	0.6163	1.2496	0.870
7-Jun	15:00:00	11.378	11.364	60.60	62.29	62.58	61.82	50.00	1.0830	0.6204	1.2483	0.868
7-Jun	16:00:00	11.389	11.375	49.97	51.95	52.61	51.51	49.97	0.9223	0.5232	1.0605	0.870
7-Jun	17:00:00	11.402	11.390	52.00	55.18	54.27	53.82	50.01	0.9640	0.5479	1.1090	0.869
7-Jun	18:00:00	11.396	11.386	50.22	52.25	52.49	51.65	49.99	0.9853	0.5668	1.1370	0.867
7-Jun	19:00:00	11.286	11.273	63.52	68.52	66.70	66.25	49.99	1.0631	0.6048	1.2233	0.869
7-Jun	20:00:00	11.396	11.387	63.69	66.31	69.99	66.66	49.95	1.0838	0.6256	1.2515	0.866
7-Jun	21:00:00	11.451	11.499	58.28	59.95	60.38	59.54	50.01	1.0198	0.5960	1.1813	0.863
7-Jun	22:00:00	11.405	11.399	55.01	56.73	56.72	56.15	49.94	1.0183	0.5789	1.1715	0.869
7-Jun	23:00:00	11.240	11.233	41.69	44.15	44.10	43.31	49.99	0.7853	0.3695	0.8681	0.905
7-Jun	24:00:00	11.379	11.369	40.44	42.16	43.07	41.89	50.10	0.7638	0.3289	0.8319	0.918

Total Consumption	21,451 [kWh]	Max. Demand	1,087 [kW]
Peak Consumption	14,280 [kWh]	Min. Demand	662 [kW]
Off-Peak Consumption	7,171 [kWh]	Ave. Demand	894 [kW]
Share of Off-Peak Consumption	33.4 [%]	Load Factor	82.2 [%]

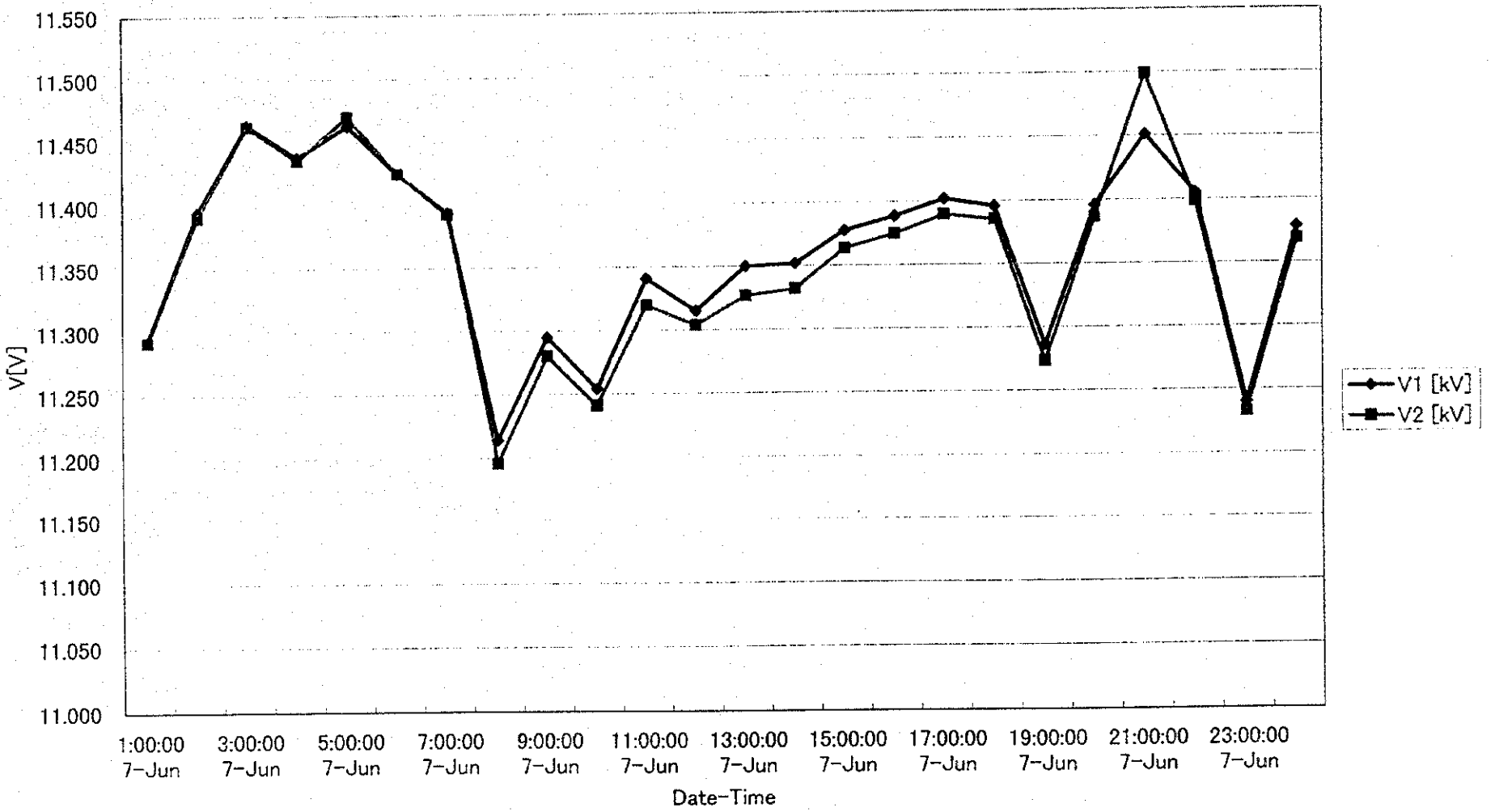


Figure 9-6 Power Receiving (Voltage)

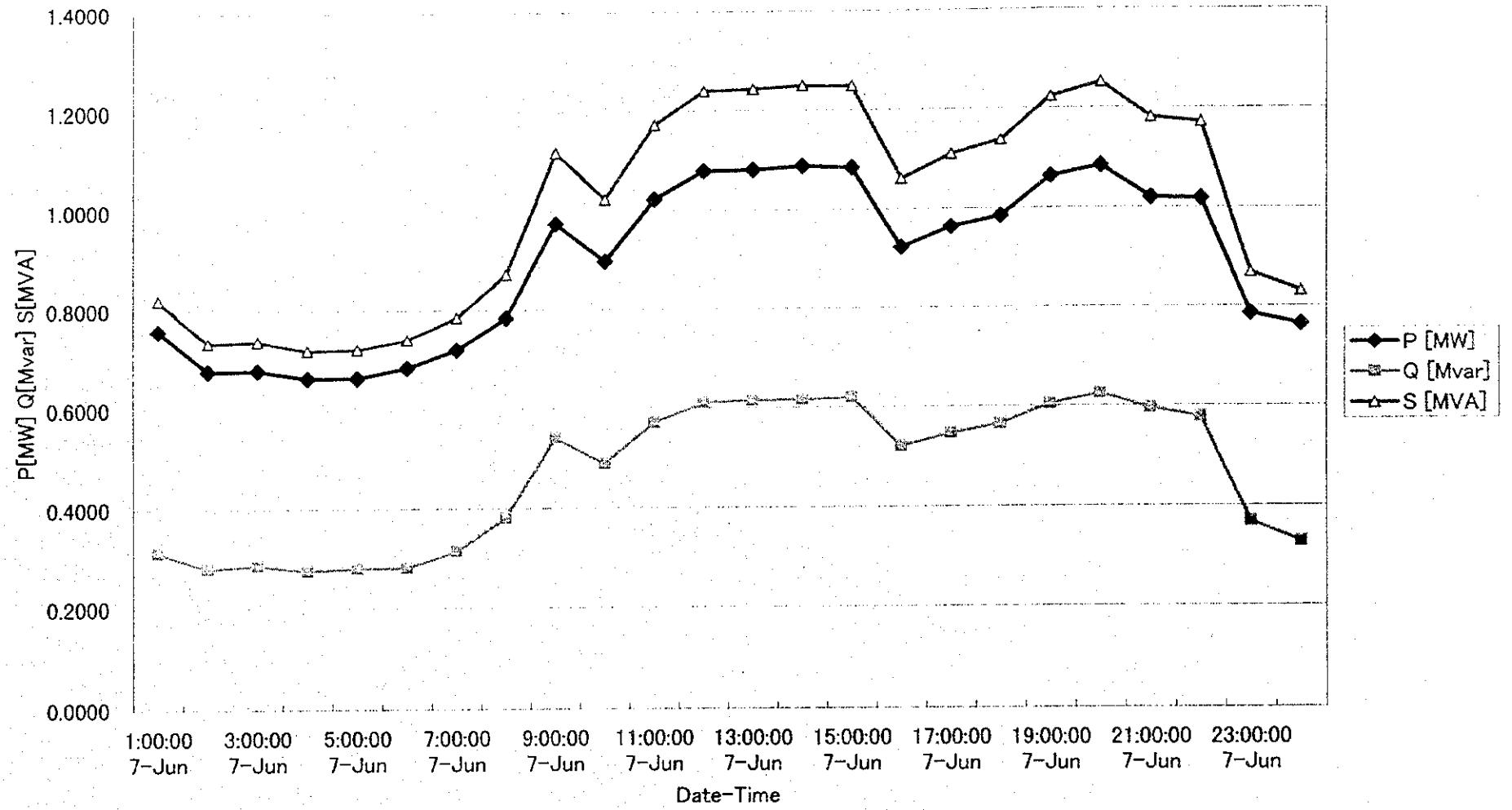


Figure 9-7 Power Receiving (Electricity)

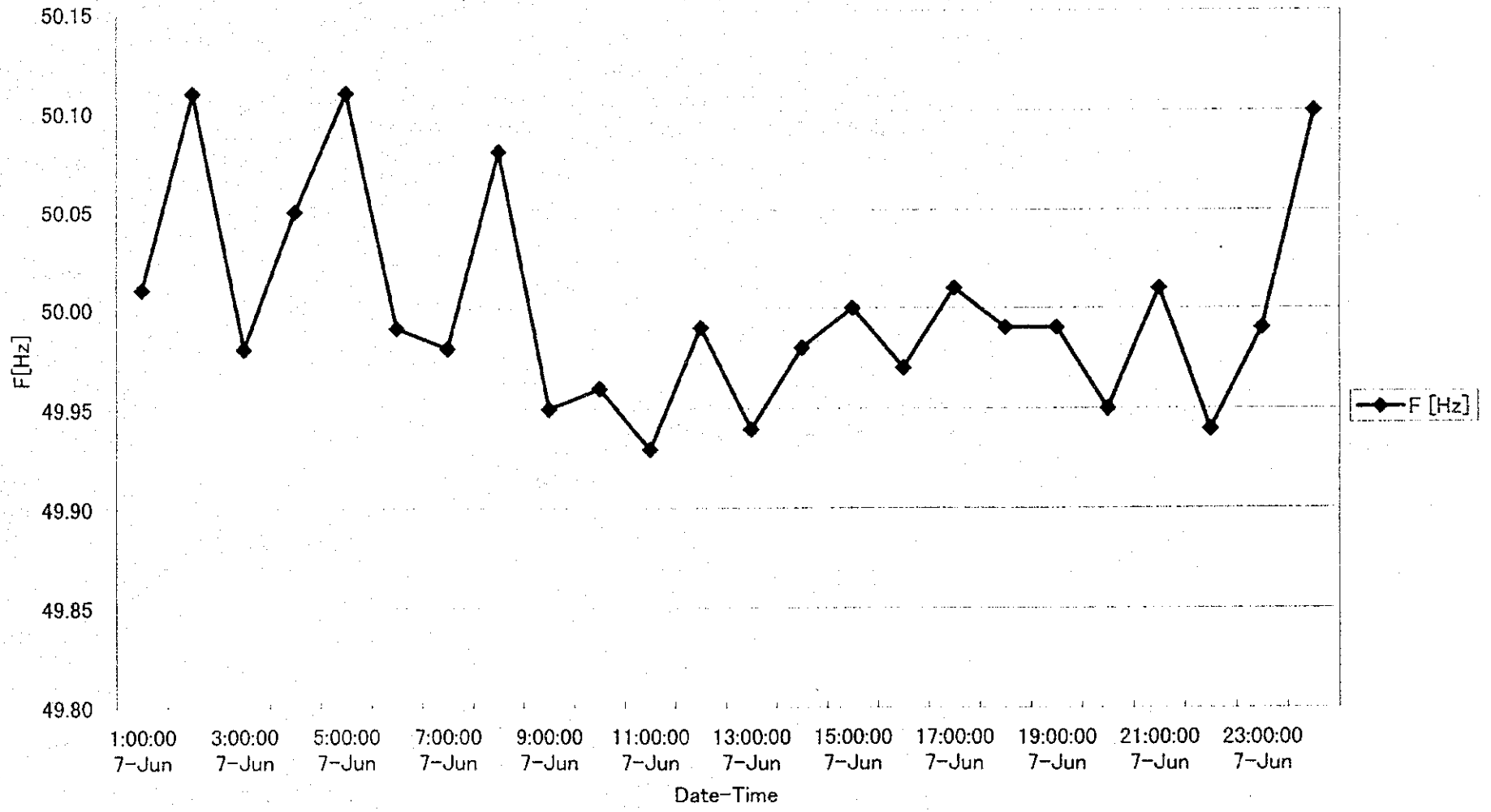


Figure 9-8 Power Receiving (Frequency)

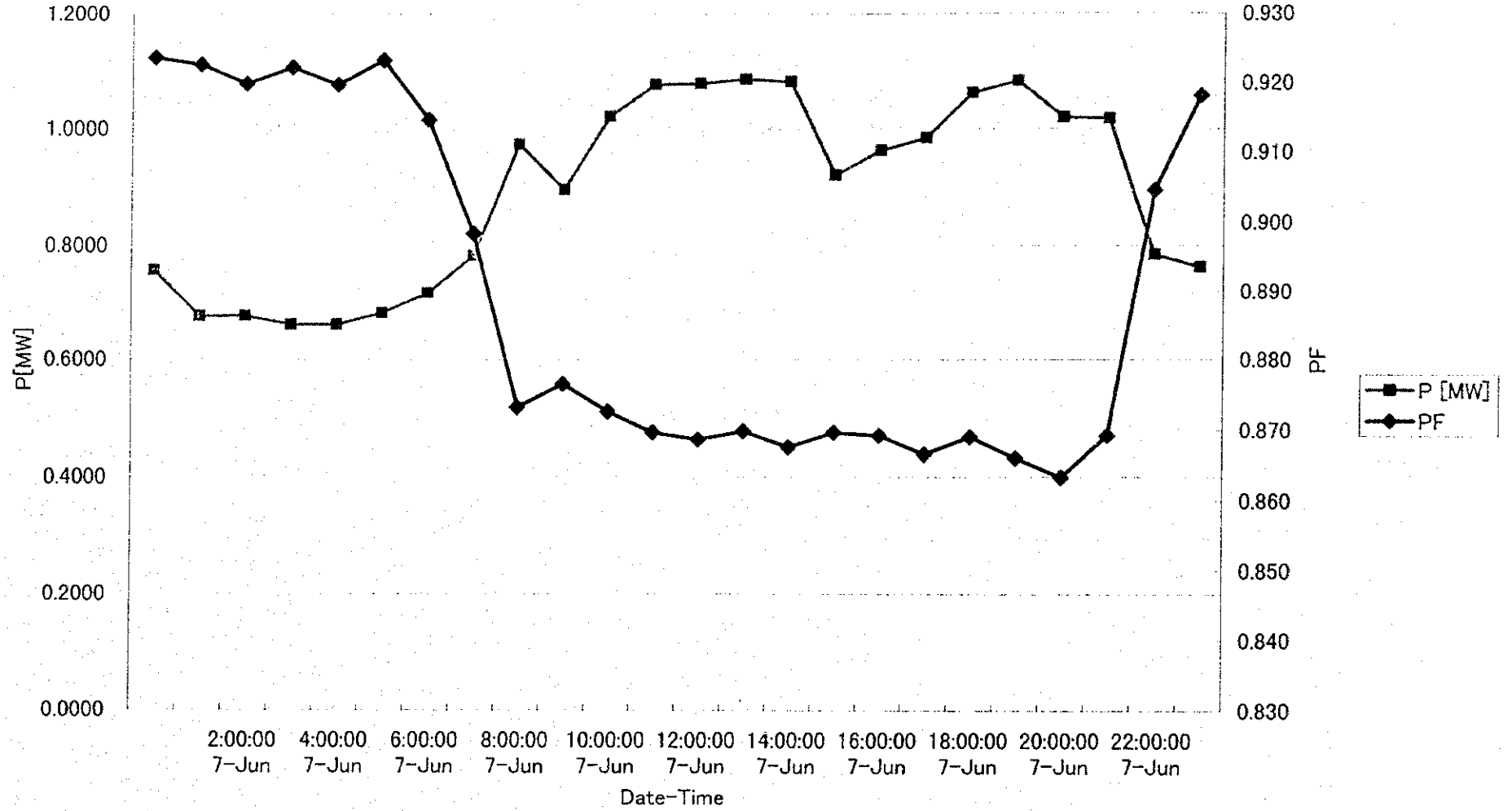


Figure 9-9 Power Receiving (Electricity-Power Factor)

Table 9-7 1.5MVA Transformer No.1

DATE	TIME	Voltage	Current	Frequency	Effective Power	Reactive Power	Apparent Power	Power Factor
		[V]	[A]	[Hz]	[kW]	[kvar]	[kVA]	
7-Jun	1:00:00	238.22	710.4	49.99	487.08	199.86	526.50	0.925
7-Jun	2:00:00	240.58	691.7	50.08	459.42	188.88	496.71	0.925
7-Jun	3:00:00	241.82	678.1	49.98	456.69	194.55	496.41	0.920
7-Jun	4:00:00	241.42	682.0	50.07	451.41	194.43	491.52	0.918
7-Jun	5:00:00	241.82	689.9	50.06	452.49	194.73	492.60	0.919
7-Jun	6:00:00	241.10	703.6	50.00	461.22	196.41	501.30	0.920
7-Jun	7:00:00	239.79	751.8	49.99	473.40	199.83	513.87	0.921
7-Jun	8:00:00	236.54	768.7	50.07	498.06	201.24	537.21	0.927
7-Jun	9:00:00	237.39	796.6	49.95	492.27	214.20	536.88	0.917
7-Jun	10:00:00	237.03	783.6	49.94	515.94	224.64	562.74	0.917
7-Jun	11:00:00	239.21	724.1	49.94	505.02	225.90	553.35	0.913
7-Jun	12:00:00	238.65	750.6	49.93	481.86	213.03	526.86	0.915
7-Jun	13:00:00	238.82	736.0	49.93	477.18	213.87	522.93	0.913
7-Jun	14:00:00	239.15	717.1	49.98	473.76	211.50	518.82	0.913
7-Jun	15:00:00	239.60	758.5	49.98	485.94	220.56	533.67	0.911
7-Jun	16:00:00	239.57	802.3	49.98	512.67	233.52	563.40	0.910
7-Jun	17:00:00	240.02	787.6	50.01	503.49	227.64	552.57	0.911
7-Jun	18:00:00	240.10	786.1	50.00	494.16	228.27	544.23	0.908
7-Jun	19:00:00	237.59	761.0	49.99	505.80	220.62	551.97	0.916
7-Jun	20:00:00	240.43	724.1	49.96	501.06	222.00	548.07	0.914
7-Jun	21:00:00	241.34	726.4	50.01	473.34	207.03	516.60	0.916
7-Jun	22:00:00	240.40	698.8	49.92	470.34	202.44	512.10	0.918
7-Jun	23:00:00	236.99	721.5	49.98	474.93	196.80	514.20	0.924
7-Jun	0:00:00	239.94	726.3	50.10	485.76	199.68	525.30	0.925

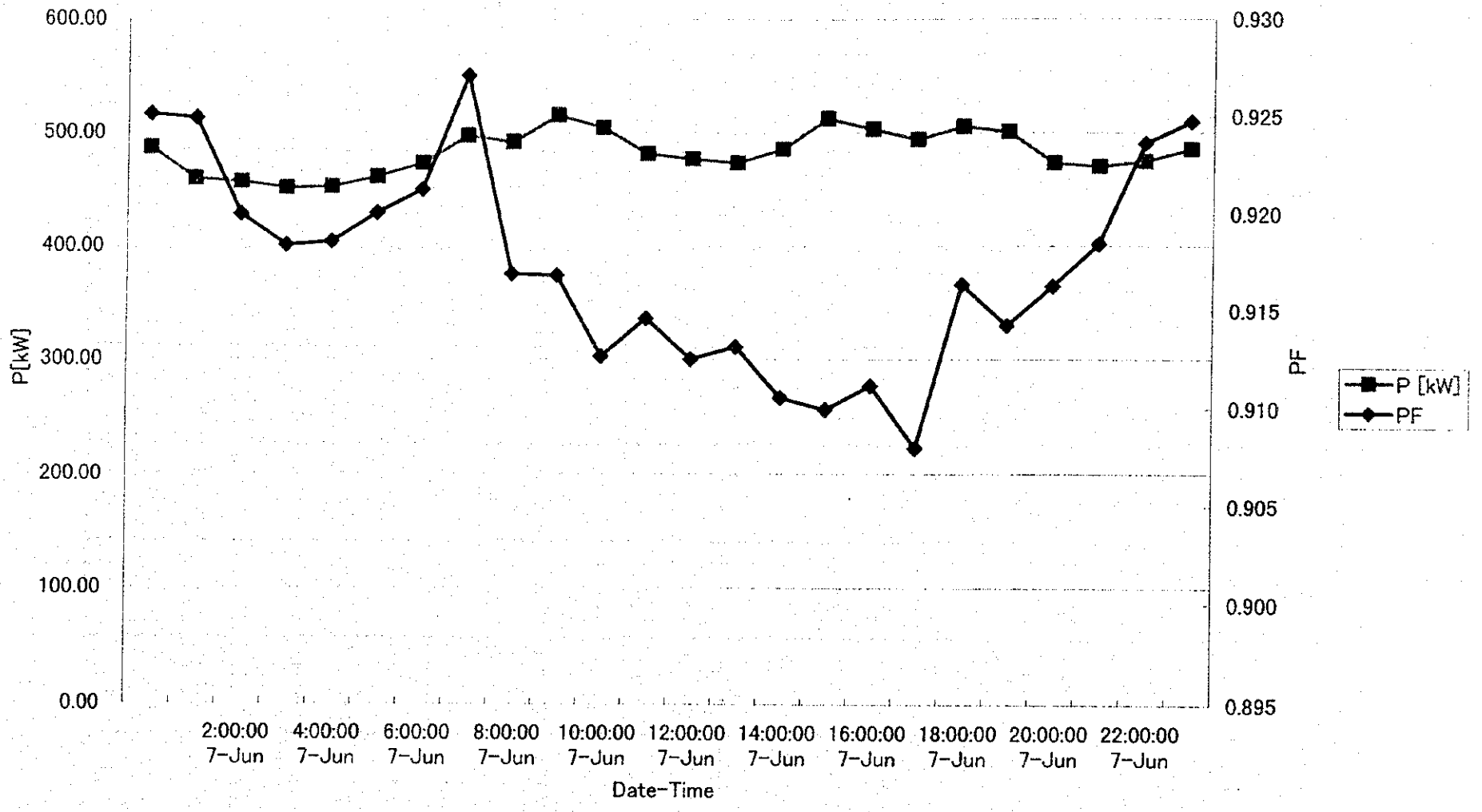


Figure 9-10 1.5MVA Transformer No.1 (Electricity-Power Factor)

Table 9-8 1.5MVA Transformer No.2

DATE	TIME	Voltage	Current	Frequency	Effective Power	Reactive Power	Apparent Power	Power Factor
		[V]	[A]	[Hz]	[kW]	[kvar]	[kVA]	
7-Jun	1:00:00	241.41	286.6	50.00	255.93	52.38	261.54	0.979
7-Jun	2:00:00	243.22	280.8	50.08	208.32	33.84	211.35	0.986
7-Jun	3:00:00	244.99	292.8	49.98	217.41	33.09	220.17	0.987
7-Jun	4:00:00	244.74	279.9	50.06	207.90	24.90	209.67	0.992
7-Jun	5:00:00	244.75	293.3	50.11	210.06	31.20	212.64	0.988
7-Jun	6:00:00	244.45	286.4	49.99	215.40	26.91	217.38	0.991
7-Jun	7:00:00	242.35	368.3	49.93	239.16	53.34	246.27	0.971
7-Jun	8:00:00	236.76	618.4	50.06	270.51	109.89	292.32	0.925
7-Jun	9:00:00	238.87	572.8	49.94	462.06	244.74	523.20	0.883
7-Jun	10:00:00	238.23	556.3	49.96	360.12	191.43	408.09	0.882
7-Jun	11:00:00	237.20	982.3	49.95	494.52	262.71	560.34	0.883
7-Jun	12:00:00	237.81	866.5	50.02	575.58	307.71	652.83	0.882
7-Jun	13:00:00	237.80	916.6	49.95	581.40	309.12	658.62	0.883
7-Jun	14:00:00	237.05	980.6	49.98	584.79	308.58	661.32	0.884
7-Jun	15:00:00	238.94	859	50.01	573.18	304.83	649.35	0.883
7-Jun	16:00:00	241.28	538.6	49.98	394.62	210.39	447.36	0.882
7-Jun	17:00:00	240.54	626.3	50.00	442.95	236.46	502.41	0.882
7-Jun	18:00:00	241.26	548.5	50.00	471.15	251.34	534.36	0.882
7-Jun	19:00:00	235.99	933.3	49.98	532.08	293.43	607.83	0.875
7-Jun	20:00:00	238.06	1040.2	49.97	564.30	306.30	642.21	0.879
7-Jun	21:00:00	240.18	841.5	50.00	526.38	299.10	605.52	0.869
7-Jun	22:00:00	240.16	763.3	49.95	527.07	290.01	601.74	0.876
7-Jun	23:00:00	239.51	382.5	49.99	283.65	104.40	302.70	0.937
7-Jun	0:00:00	242.76	364.3	50.10	251.55	64.83	260.19	0.967

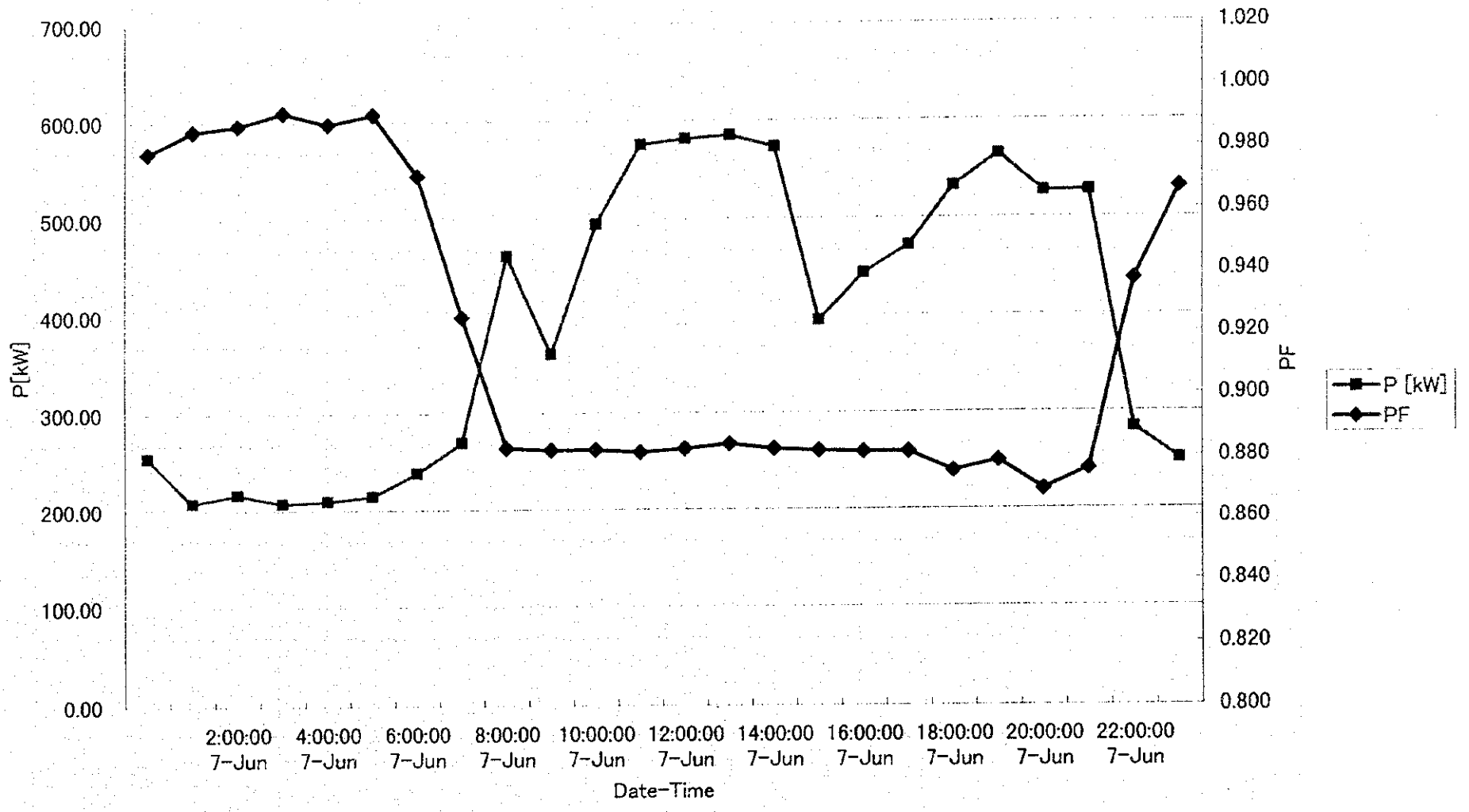


Figure 9-11 1.5MVA Transformer No.2 (Electricity-Power Factor)

Table 9-9 Normal Riser N1

DATE	TIME	Voltage [V]			Current [A]			Frequency	Effective Power	Reactive Power	Apparent Power	Power Factor
		V1	V2	V3	I1	I2	I3	[Hz]	[kW]	[kvar]	[kVA]	
4-Jun	12:00	237.80	237.47	237.67	63.20	55.50	50.20	50.09	113.8	44.4	122.0	0.932
4-Jun	13:00	239.00	238.28	238.44	67.60	58.70	51.50	50.07	118.7	46.0	127.2	0.933
4-Jun	14:00	236.39	235.75	235.93	64.80	60.20	54.60	49.94	118.0	37.7	126.4	0.934
4-Jun	15:00	240.66	240.14	240.25	62.90	61.30	55.10	49.97	121.2	47.0	130.1	0.932
4-Jun	16:00	241.78	241.29	241.64	67.50	71.90	51.30	50.03	125.5	48.0	134.3	0.935
4-Jun	17:00	237.03	236.51	236.84	62.60	63.90	57.00	50.10	126.2	45.6	134.2	0.941
4-Jun	18:00	241.81	241.54	241.70	65.70	77.20	58.90	50.07	133.0	47.6	141.1	0.942
4-Jun	19:00	236.39	236.23	236.02	79.20	80.20	62.90	49.98	147.6	45.6	154.4	0.956
4-Jun	20:00	237.23	237.18	237.28	69.10	78.30	57.00	50.02	144.0	41.9	150.0	0.960
4-Jun	21:00	239.28	239.17	239.10	82.00	79.30	63.80	49.97	148.1	43.2	154.2	0.960
4-Jun	22:00	239.27	239.24	239.24	80.00	80.60	62.30	50.00	152.4	42.8	158.3	0.963
4-Jun	23:00	241.31	241.33	241.34	65.60	63.00	60.90	50.02	130.2	46.7	138.2	0.942
5-Jun	0:00	239.87	239.86	240.02	61.00	60.40	56.20	50.04	120.6	39.1	126.7	0.952
5-Jun	1:00	240.93	240.90	241.21	58.50	51.20	51.80	50.06	107.8	38.0	114.2	0.943
5-Jun	2:00	242.51	242.71	242.39	57.60	48.20	38.90	50.08	97.2	35.2	103.3	0.941
5-Jun	3:00	238.79	239.00	239.05	57.90	47.00	42.20	50.01	97.3	34.2	101.5	0.959
5-Jun	4:00	239.14	239.43	239.43	57.40	44.20	37.30	50.03	94.9	34.8	101.0	0.939
5-Jun	5:00	239.94	240.68	240.36	57.20	43.80	41.70	50.09	95.2	33.8	100.9	0.943
5-Jun	6:00	238.68	238.62	238.75	58.60	65.10	50.00	50.02	105.2	37.2	111.7	0.942
5-Jun	7:00	241.77	241.73	242.13	66.10	76.60	53.40	50.04	133.2	41.5	139.6	0.954
5-Jun	8:00	238.17	237.90	238.14	66.10	63.90	55.80	49.95	126.1	42.4	133.1	0.948
5-Jun	9:00	238.98	238.65	238.79	55.90	59.90	53.00	49.98	110.9	41.0	118.2	0.938

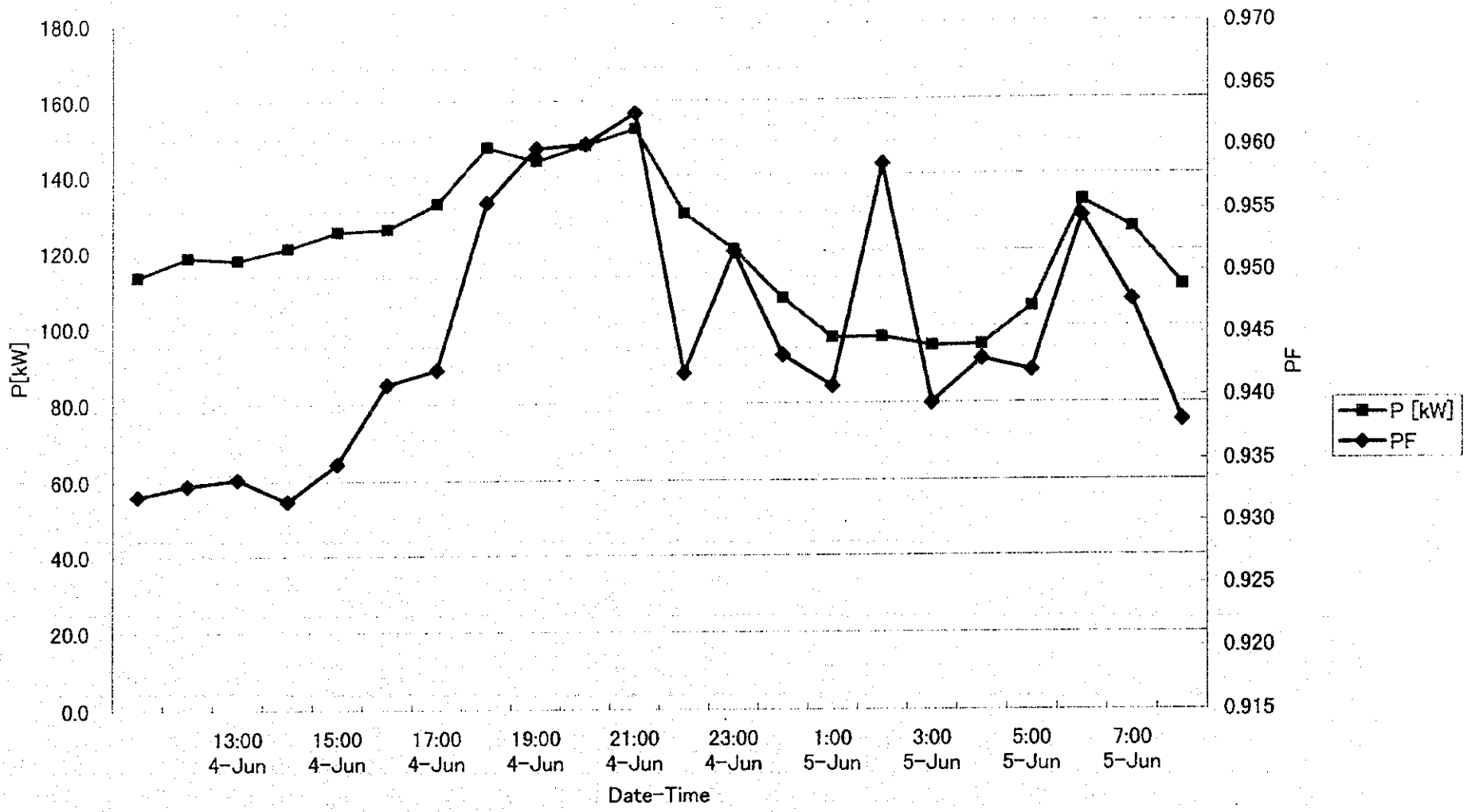


Figure 9-12 Normal Riser N1 (Electricity-Power Factor)

Table 9-10 Normal Riser N2

DATE	TIME	Voltage [V]			Current [A]			Frequency	Effective Power	Reactive Power	Apparent Power	Power Factor
		V1	V2	V3	I1	I2	I3	[Hz]	[kW]	[kvar]	[kVA]	
4-Jun	12:00	238.54	237.94	238.03	47.50	54.70	62.20	50.08	114.1	29.2	117.8	0.968
4-Jun	13:00	239.41	238.69	238.78	36.00	56.20	60.00	50.06	108.4	26.2	111.5	0.972
4-Jun	14:00	237.13	236.07	236.23	41.40	59.80	61.70	49.94	110.0	26.9	113.4	0.970
4-Jun	15:00	241.46	240.64	240.80	48.70	57.80	63.80	49.98	118.2	118.2	122.4	0.966
4-Jun	16:00	242.51	241.89	242.02	50.30	56.10	62.50	50.04	119.2	119.2	123.2	0.967
4-Jun	17:00	237.67	236.76	237.10	44.10	56.70	63.60	50.09	117.2	117.2	121.0	0.969
4-Jun	18:00	242.35	241.76	242.09	48.10	63.70	64.20	50.06	123.2	123.2	126.5	0.974
4-Jun	19:00	236.96	236.40	236.40	60.80	63.20	74.80	50.00	130.6	130.6	132.7	0.984
4-Jun	20:00	237.76	237.24	237.43	63.10	67.10	79.00	50.02	144.4	144.4	147.5	0.979
4-Jun	21:00	240.15	239.58	239.56	67.30	52.90	95.30	49.97	154.4	154.4	157.7	0.979
4-Jun	22:00	240.12	239.69	239.76	63.60	67.60	82.50	50.00	155.2	155.2	158.2	0.981
4-Jun	23:00	242.02	241.57	241.57	78.30	77.50	86.50	50.02	169.0	169.0	172.6	0.979
5-Jun	0:00	240.62	240.32	240.57	54.80	68.10	63.00	50.04	142.3	142.3	146.0	0.975
5-Jun	1:00	241.22	240.98	241.32	52.70	65.80	65.20	50.01	130.2	130.2	134.4	0.969
5-Jun	2:00	242.98	242.94	242.91	48.80	54.00	58.40	50.05	114.5	114.5	117.6	0.973
5-Jun	3:00	239.52	239.46	239.48	50.20	53.00	54.00	49.99	111.1	111.1	114.2	0.973
5-Jun	4:00	239.79	239.80	239.76	45.60	57.50	55.40	50.03	109.3	109.3	112.6	0.971
5-Jun	5:00	240.80	240.68	240.72	46.30	54.30	55.30	50.07	107.5	107.5	110.4	0.974
5-Jun	6:00	239.19	238.78	238.95	44.40	59.10	58.20	50.01	109.1	109.1	112.6	0.969
5-Jun	7:00	242.25	241.86	242.29	50.70	62.70	64.70	50.04	122.4	122.4	125.4	0.976
5-Jun	8:00	238.66	237.93	238.31	52.40	61.40	64.50	49.94	124.6	124.6	127.8	0.975
5-Jun	9:00	239.54	238.73	239.03	53.30	64.70	67.40	50.00	121.8	121.8	125.5	0.970

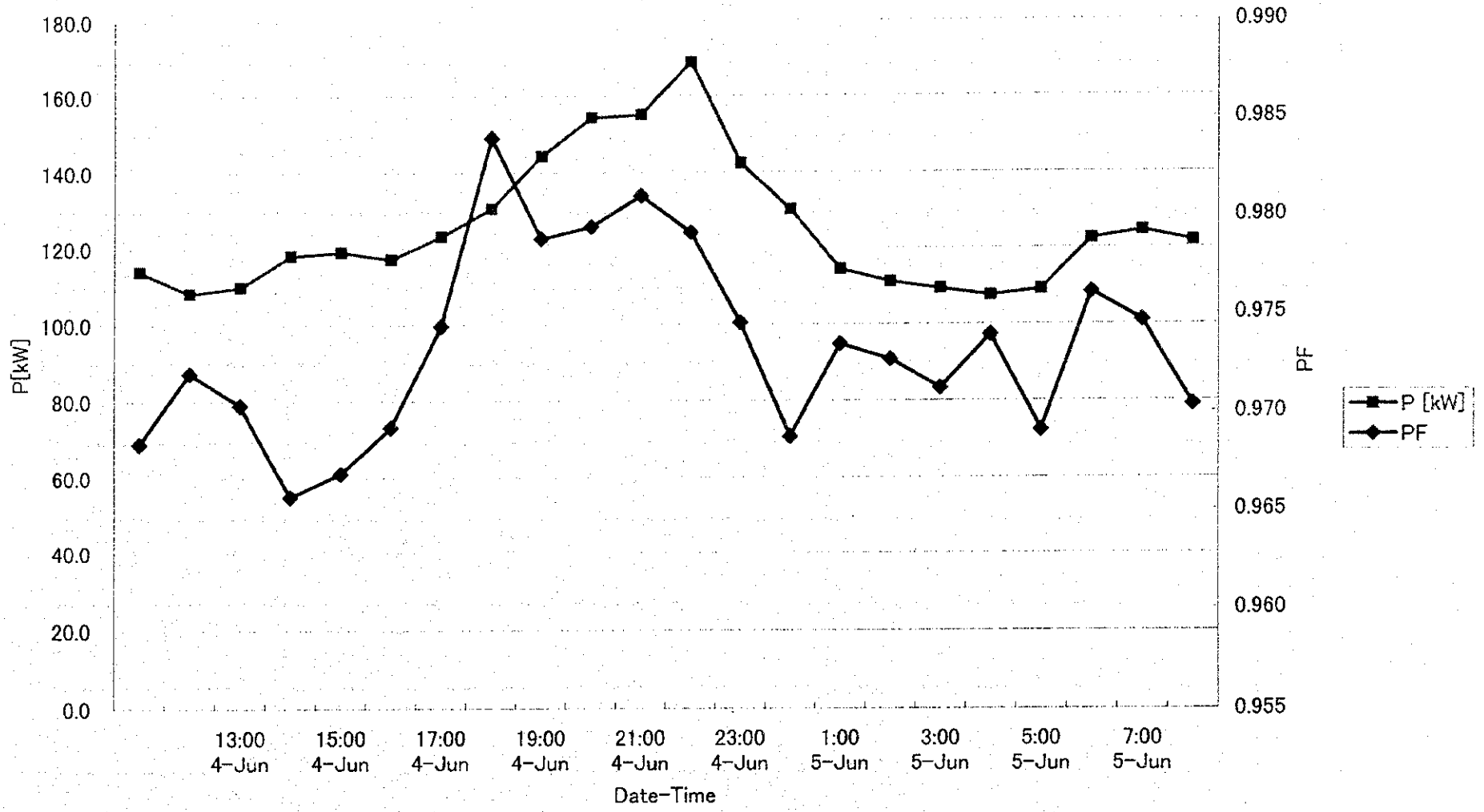


Figure 9-13 Normal Riser N2 (Electricity-Power Factor)

Table 9-11 Normal Riser N3

DATE	TIME	Voltage [V]			Current [A]			Frequency	Effective Power	Reactive Power	Apparent Power	Power Factor
		V1	V2	V3	I1	I2	I3	[Hz]	[kW]	[kvar]	[kVA]	
4-Jun	12:00	235.37	234.99	235.55	228.5	244.5	269.7	50.06	456.4	364.8	585.1	0.780
4-Jun	13:00	235.84	235.49	236.03	232.3	243.4	271.4	50.06	497.2	361.9	616.0	0.807
4-Jun	14:00	233.21	232.60	233.65	304.3	336.7	297.5	49.95	461.8	365.5	589.7	0.783
4-Jun	15:00	238.43	237.52	238.48	206.4	242.0	261.2	49.97	454.1	377.3	591.2	0.768
4-Jun	16:00	238.77	238.05	239.10	263.9	295.1	268.6	49.98	380.2	322.1	498.7	0.762
4-Jun	17:00	237.95	237.71	238.17	204.2	224.9	247.6	50.08	441.0	368.0	575.3	0.767
4-Jun	18:00	238.98	238.95	239.45	213.7	251.2	262.9	50.05	433.3	349.6	557.3	0.778
4-Jun	19:00	233.29	233.15	234.17	288.9	315.3	272.2	50.01	424.7	334.3	540.7	0.785
4-Jun	20:00	234.15	234.68	235.43	213.1	233.3	237.2	50.05	421.2	353.0	550.2	0.766
4-Jun	21:00	236.19	236.76	237.37	171.5	175.9	213.6	50.04	316.1	295.0	432.8	0.730
4-Jun	22:00	239.54	239.39	239.59	143.7	172.9	182.0	49.98	307.2	273.1	411.7	0.746
4-Jun	23:00	241.56	240.49	242.11	206.0	240.8	200.3	49.99	295.7	297.1	420.2	0.704
5-Jun	0:00	241.80	241.39	242.01	115.9	145.5	150.8	50.03	245.9	243.8	346.4	0.710
5-Jun	1:00	242.44	242.28	242.77	112.2	137.4	133.7	49.98	209.4	204.6	292.9	0.715
5-Jun	2:00	244.48	244.28	244.84	116.3	139.2	138.6	50.00	206.3	226.9	307.0	0.672
5-Jun	3:00	240.93	240.88	241.42	106.6	137.8	135.1	50.08	212.2	207.7	297.2	0.714
5-Jun	4:00	240.37	240.51	240.95	104.0	128.0	120.1	49.99	186.6	177.8	257.9	0.724
5-Jun	5:00	241.23	241.25	241.76	104.8	133.5	130.7	50.00	192.6	192.5	272.4	0.707
5-Jun	6:00	240.25	240.27	240.49	106.5	126.8	126.9	49.98	190.2	197.5	274.4	0.693
5-Jun	7:00	241.92	241.37	241.43	277.9	363.6	338.9	50.06	260.6	248.8	361.1	0.722
5-Jun	8:00	239.78	239.24	239.74	168.6	202.3	186.8	49.95	328.8	286.2	436.9	0.753
5-Jun	9:00	239.39	238.26	238.72	213.5	310.7	312.9	50.02	344.6	280.4	444.8	0.775
5-Jun	10:00	238.52	237.40	238.41	204.8	242.4	211.5	50.06	350.8	281.3	450.7	0.778

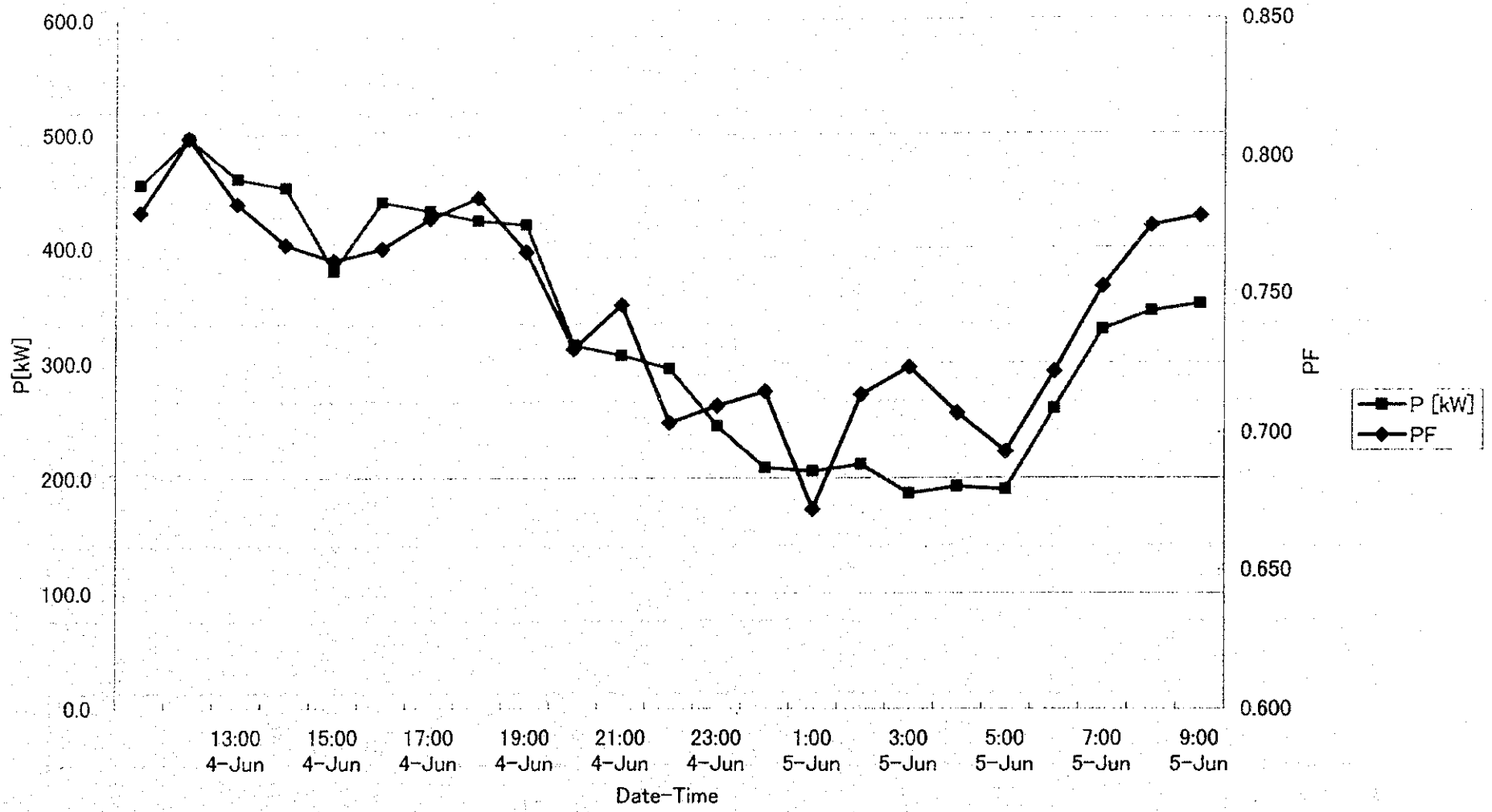


Figure 9-14 Normal Riser N3 (Electricity-Power Factor)

Table 9-12 Chiller No.1,No.2

DATE	TIME	Voltage	Current	Frequency	Effective Power	Reactive Power	Apparent Power	Power Factor
		[V]	[A]	[Hz]	[kW]	[kvar]	[kVA]	
7-Jun	1:00:00	235.96	497.5	50.03	331.80	111.45	350.01	0.948
7-Jun	2:00:00	237.99	492.8	49.99	333.63	112.59	352.14	0.947
7-Jun	3:00:00	239.79	486.2	49.98	331.80	115.74	351.42	0.944
7-Jun	4:00:00	239.28	489.1	50.07	329.34	115.14	348.90	0.944
7-Jun	5:00:00	239.60	492.4	50.10	329.43	115.47	349.05	0.944
7-Jun	6:00:00	238.58	485.6	50.02	328.98	115.14	348.54	0.944
7-Jun	7:00:00	237.78	490.0	50.00	325.95	114.66	345.57	0.943
7-Jun	8:00:00	232.91	608.2	50.04	335.70	114.15	354.66	0.947
7-Jun	9:00:00	235.68	506.8	49.93	318.90	111.99	337.92	0.944
7-Jun	10:00:00	234.79	512.1	49.92	340.41	118.41	360.42	0.944
7-Jun	11:00:00	237.16	449.9	50.00	328.77	114.00	348.15	0.944
7-Jun	12:00:00	236.32	455.9	50.02	304.83	108.27	323.46	0.942
7-Jun	13:00:00	237.18	453.6	49.97	305.16	108.84	324.00	0.942
7-Jun	14:00:00	236.82	455.8	49.97	305.52	108.90	324.36	0.942
7-Jun	15:00:00	237.56	448.8	49.97	303.99	108.66	322.83	0.942
7-Jun	16:00:00	237.26	512.1	50.00	325.50	115.98	345.54	0.942
7-Jun	17:00:00	237.78	503.0	50.01	324.90	116.55	345.15	0.941
7-Jun	18:00:00	237.84	502.7	49.99	321.66	116.22	342.03	0.940
7-Jun	19:00:00	235.94	464.1	50.01	321.60	114.00	341.22	0.943
7-Jun	20:00:00	238.33	454.6	49.96	308.25	111.12	327.69	0.941
7-Jun	21:00:00	239.43	451.5	50.00	304.44	122.16	323.97	0.940
7-Jun	22:00:00	238.71	448.5	49.97	303.54	96.54	322.14	0.942
7-Jun	23:00:00	235.02	491.9	49.93	318.81	109.26	337.05	0.946
7-Jun	24:00:00	237.43	492.9	50.09	329.73	111.27	348.00	0.947

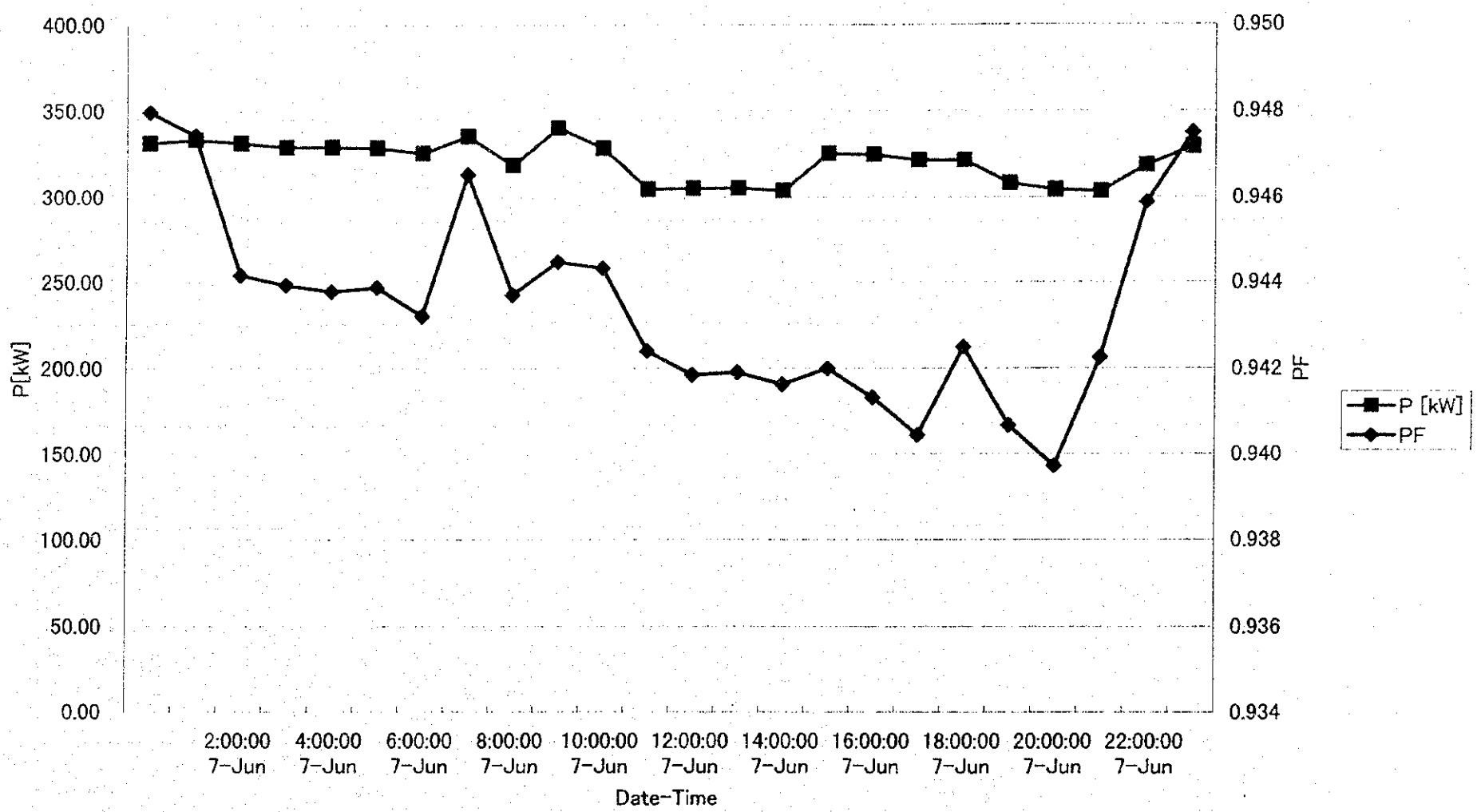


Figure 9-15 Chiller No.1,No.2 (Electricity-Power Factor)