F. Criteria for Operators Concerning Rationalization of Energy Use at Factories

Based on the provision of Clause 1 of Article 4 in the Law Concerning Rationalization of Energy Use (Law No. 49 of 1993), the criteria for business operators in relation to rationalization of energy use at factories are defined as described below, and shall become effective on August 1, 1993.

At the same time, Notification No. 467 of the Ministry of International Trade and Industry of October 27, 1979 (Decision on Criteria of Business Operators for Rationalization of Energy Use at Factories) shall be abolished accordingly.

I. Standards for Rationalization of Energy Use

Those who carry out business operations (hereinafter referred to as Business Operators) at their factory or operation sites (hereinafter referred to as Factory) by using energy shall strive to achieve appropriate and effective rationalization of energy use at their Factory by strictly observing the following standards as far as they are technically and economically viable.

1. Rationalization of fuel combustion

(1) Control of fuel combustion

(a) Fuel combustion shall be controlled by determining control standards for air ratios in accordance with the performance of equipment for fuel combustion (hereinafter referred to as Combustion Equipment) as well as the type of fuel applied.

(b) The control standards stated in the above (a) must be set up so that air ratio can be lowered based on the air ratio specified in the attached Table 1 (A).

(c) In case that a plural number of Combustion Equipment is to be used, control standards should be established so that heat efficiency (i.e. the ratio of calorie used for adding value of the objects in the total input calorie. This interpretation is applied to the rest of this Notification) of the entire Combustion Equipment can be improved, and the combustion load within the Combustion Equipment must be adjusted based on such standards.

(2) Measurements and records concerning fuel combustion

Control standards for each item necessary to grasp and improve fuel supply volume, temperature of exhaust gas generated from combustion, remaining oxygen volume in the exhaust gas, and other combustion conditions of fuel for each Combustion Equipment shall be established, then

these values shall be periodically measured based on such standards, and result of the measurement shall be recorded.

(3) Maintenance and inspection of Combustion Equipment

After setting up control standards, Combustion Equipment must be periodically inspected for maintenance.

(4) Measures to be taken during installation of Combustion Equipment

(a) In case that a Combustion Equipment is installed, combustion devices such as a burner should be made adjustable for the type of Combustion Equipment and fuel as well as for supplying fuel volume and air ratio in accordance with fluctuation of load and combustion conditions.

(b) When a Combustion Equipment is newly installed, its ventilation system should be made adjustable for air volume and pressure in the combustion room.

2. Rationalization of heating, cooling, and heat conduction

(1) Control of heating, cooling, and heat conduction

(a) With regard to heating equipment, cooling equipment, drying equipment, heat exchanger, etc., that employ a thermal medium such as steam, control standards for temperature, pressure, and volume of thermal medium required for transfer of heating, cooling, and conduction (hereinafter referred to as Heating, etc.) as well as temperature, pressure, and volume of supplied thermal medium should be set forth in order to avoid excessive supply of calorie through the thermal medium.

(b) As for industrial furnaces used for heating, heat treatment, etc., control standards shall be established so that thermal efficiency is improved depending on the structure of the equipment, characteristics of the heated object, pre-process or post-process of heating or heat treatment, and the Business Operator shall improve the heating pattern (i.e. pattern of changes in temperature of a heated object corresponding to lapse of time. This interpretation is applied to the rest of this Notification).

(c) Control standards for equipment used for Heating, etc., shall be set forth in relation to the volume of heated objects or cooled objects as well as their positions within the furnace in order to avoid any overloading or underloading.

(d) When more than one equipment for Heating, etc., is used, control standards shall be established so that the total thermal efficiency of the said equipment can be enhanced, and load on each equipment shall be adjusted based on such standards.

(e) In case of the process in which heating is made repeatedly, control standards shall be determined in order to reduce idling time that happens due to waiting time between processes.

(f) As for equipment for Heating, etc., that can be intermittently operated, control standards shall be established to concentrate operations.

(g) With regard to water supply to a boiler, water quality should be controlled based on the rules of the Japan Industrial Standards (JIS) B 8223 concerning Water Supply for Boilers and Water Quality for Boilers (including other rules equivalent to these rules) in order to prevent heat transfer pipes from stack with scales or precipitation of sludge.

(h) Concerning air-conditioning, control standards for heating/cooling temperature, ventilation cycle, temperature, etc., should beset forth in consideration of the building structure, the layout of equipment, the type of operation, etc., after restricting the areas to be air-conditioned.

(i) Other control of Heating, etc., shall be implemented in accordance with the control standards established with regard to temperature of heating or cooling objects, temperature, pressure, flow rate, and other items related to Heating, etc., of thermal medium such as steam.

(2) Measurements and records concerning Heating, etc.

(a) Control standards shall be set forth in connection with items necessary for recognition and improvement of situations including temperature of heating or cooling objects, temperature, pressure, and flow rate as well as other thermal transfer conditions. These elements must be periodically measured based on the standards, and such data must be recorded.

(b) Control standards should be determined for each area to be air-conditioned in relation to the items necessary for knowing temperature, humidity, and other conditions of atmosphere, and for improving efficiency of air-conditioning. Such items must be periodically measured based on the standards, and result of the measurements should be recorded.

(3) Maintenance and inspection of equipment for Heating, etc.

(a) Control standards must be established for thermal conducting surface of a boiler, industrial furnace, heat exchanger, etc., and any other parts which affect thermal conduction, in order to periodically remove dust, scales, and other adhered particles and to prevent decrease in their thermal conductive performance.

(b) By establishing control standards, air-conditioning equipment should be maintained in a good condition through measures such as periodical cleaning of filters, eliminating frost on a

thermal exchanger, removing scales stack on a condenser, and the like.

3. Prevention of heat loss by radiation, transfer, etc.

(1) Standards for thermal insulation

(a) Construction of thermal insulating facilities including pipes or other similar equipment to transport thermal medium or process fluid as well as other equipment to make Heating, etc. (hereinafter referred to as Heat Utilization Equipment) must be carried out in compliance with the provisions of JIS A 9501, Standards for Thermal and Cold Insulation Works, or other equivalent rules.

(b) The quality of fire bricks to be applied must be in compliance with the provisions of JIS R 2611, Fire Bricks, or other equivalent rules.

(c) When an industrial furnace is constructed starting from the hearth, thermal insulation measures must be taken to improve insulation performance of the furnace walls, based on the temperature values on the outer surface of furnace wall as shown in the attached Table 2 (A) (with regard to an intermittently operated furnace or other industrial furnace that is used less than 12 hours per day, the portion of outer furnace wall of which temperatures reaches more than the values enlisted in the attached Table 2 (A), or more than 50% area of the inside wall of a furnace, of which inside temperature becomes 500℃ or higher, should be made of insulating material with bulk specific gravity of 1.3 or less.). Provided an existing industrial furnace can be modified to improve its insulation capability, insulation measures should be taken in accordance with the standard values of the outside furnace temperature shown in the attached Table 2 (A).

(2) Measurements and records concerning thermal loss

Control standards shall be established for each major equipment of Heating, etc., in order to know and improve the situations of heat loss, and Business Operators shall analyze heat efficiency based on the result of measurements for temperature of outside surface of furnace wall, temperature of heating objects, exhausted gas temperature, etc. The result must be recorded.

(3) Maintenance and inspection of Heat Utilization Equipment

(a) In relation to Heat Utilization Equipment, control standards shall be established to prevent any leakage of thermal medium from a defective condition. Maintenance and inspection must be periodically conducted for such equipment based on the standards established.

(b) In relation to portions of Heat Utilization Equipment which is modified for insulation,

control standards shall be established in order to prevent heat loss by radiation. Maintenance and inspection must be periodically conducted for such equipment based on the established standards.

(c) As for steam trap, control standards shall be established to prevent leakage of steam due to its improper condition. Maintenance and inspection must be periodically conducted for such a steam trap based on the standards.

(4) Measures to be taken for installation of Heat Utilization Equipment

(a) In case of installing a new Heat Utilization Equipment, its insulation property must be enhanced by increasing the thickness of insulation materials, or application of insulation material with lower thermal conductivity, or double insulation, or the like.

(b) In case of installing a new Heat Utilization Equipment, heat loss by radiation and inlet/outlet of air should be prevented by reducing or closing the opening of Heat Utilization Equipment, or by attaching double doors to the opening of heat utilization equipment, or the like.

(c) In case of installing a new heat utilization equipment, its radiating area should be reduced by rationalizing the piping channel that transports thermal media.

4. Collection of waste heat

(1) Standards for collection of waste heat

(a) With regard to collection of waste heat from exhausted gas, control conditions for temperature of exhausted gas or waste heat collection ratio shall be established depending on the type of equipment that emits waste gas.

(b) The control standards stated in the above clause should be set forth so that a collection rate of waste heat can be improved by means of reducing temperature of the exhausted gas in comparison with the standards of the exhaust gas temperature and waste heat collection ratios shown in the attached Table (A).

(c) Collection and utilization of waste heat from a steam drain shall be implemented by establishing control standards in connection with scopes of the temperature, volume, and the type of the steam drain that collects waste heat.

(d) With regard to collection and utilization of sensible heat, latent heat, pressure, combustible component, etc., that heated solid body or fluid has, control standards shall be established for a scope of collection.

(2) Measurements and records concerning waste heat

Business Operators shall grasp situations of waste heat temperature, calorie, components of thermal medium that emits waste heat, and other factors of waste heat, establish control standards of items necessary for promoting utilization of waste heat, periodically conduct measurements based on such standards, and report the result of such measurements.

(3) Maintenance and inspection of Waste Heat Collection Equipment

Control standards must be established for heat exchangers, waste heat boilers, etc., that utilize waste heat (hereinafter referred to as Waste Heat Collection Equipment). The heat conductive surface and other portions of such equipment must be periodically cleaned based on such standards. In addition, any leaking points on the thermal medium must be overhauled to maintain efficiency of waste heat collection as well as waste heat utilization.

(4) Measures to be taken for installation of a new Waste Heat Collection Equipment

(a) When a flue gas ducting or pipe that transports waste heat from an equipment generating waste heat to a Waste Heat Collection Equipment is constructed, proper measures should be taken in order to prevent infiltration of air, to strengthen insulating property, and to keep waste heat temperature high.

(b) In case that a new Waste Heat Collection Equipment is installed, proper measures such as improvement of properties and shape of thermal conductive surface, or increase of the thermal conducive area, or the like should be taken so that the waste heat collection rate can be enhanced.

5. Rationalization of heat conversion into motive power, etc.

(1) Control of dual-purpose electricity and steam generation

(a) With regard to the operation control of more than one boiler, gas turbine, steam turbine, gas engine, diesel engine, etc., to be used for dual-purpose electricity and steam generation, control standards should be set forth in order to enhance the total efficiency corresponding to fluctuation of load.

(b) When an extraction turbine or back-pressure turbine is used for a dual-purpose electricity and steam generation, control standards shall be established in connection with the minimum value permitted to extraction pressure of the extraction turbine or backing pressure of the back-pressure turbine, then should be observed.

(2) Measurements and records concerning dual-purpose electricity and steam generation

(a) As for boilers, gas turbines, steam turbines, gas engines, diesel engines, etc., to be used

for dual-purpose electricity and steam generation (hereinafter referred to as Dual-purpose Generation Equipment), control standards shall be established. Then, thermal efficiency corresponding to fluctuation of load must be periodically measured based on such standards, and the result of measurement must be recorded.

(b) When an extraction turbine or back-pressure turbine is operated with the permissible minimum extraction pressure or backing pressure, control standards shall be set forth. Then, operation time, inlet pressure, extraction or backing pressure, outlet pressure, steam volume, etc., shall be measured based on such standards, and result of measurements shall be recorded.

(3) Maintenance and inspection of Dual-purpose Generation Equipment

In relation to Dual-purpose Generation Equipment, control standards shall be established so that thermal efficiency is maintained at a high level, and such equipment shall be periodically inspected for maintenance.

6. Prevention of electricity loss due to resistance or other reasons

(1) Control of power receiving, transformation, and distribution units

(a) Control standards for transformer shall be established in order to maintain an appropriate demand factor, while the number of units as well as distribution of load shall be appropriately considered and adjusted.

(b) In relation to appropriate deployment of power receiving and transformation units, reduction of power distribution circuit length by changing the power distribution system, proper voltage of distributed electricity, and other similar factors, control standards shall be established in order to reduce power loss in distribution.

(c) The standard for power factor at the power receiving terminal should be set at 90% or over. The power factor of the equipment enlisted in the attached Table 4 (except for equipment with less capacity than the capacity enlisted) or other transformation equipment should be improved by installation of leading power factor condensers or other methods. However, this clause is not applied if the equipment is used for an in-house auxiliary equipment of the power plant.

(d) Leading power factor condensers must be controlled by establishing standards so that they can be operated or stopped in accordance with operation of the equipment installed there.

(e) When a single-phase load is connected to a three-phase power point, control standards shall be set forth to prevent unbalanced voltage.

(f) Electric power use in the Factory should be leveled, in order to reduce the maximum electric current, by establishing control standards and making necessary adjustment concerning equipment that uses electric power (hereinafter referred to as Electrical Equipment).

(g) Moreover, in relation to control of electric supply to the Electrical Equipment, control standards shall be established for voltage, current, power factor, load rate, and demand factor in the power receiving and transformation equipment, corresponding to the type of the Electrical Equipment, operation situation, and their capacity.

(2) Measurements and records concerning power receiving, transformation, and distribution equipment

After establishing control standards, measurements should be periodically conducted for the electric consumption at the Factory as well as voltage, current, power factor, load factor, and demand factor of the receiving and transformation units and major electric distribution units, then such measurements should be periodically implemented. The result of measurements should be recorded.

(3) Maintenance and inspection of power receiving, transformation, and distribution units

Control standards must be set forth for power receiving, transformation, and distribution units in order to keep good conditions, and inspection must be conducted for maintenance based on such standards.

(4) Measures for installation of power receiving, transformation, and distribution units

When a transformer is installed, it should match the actual necessary electric power.

7. Rationalization concerning conversion of electric power into motive power, heat, etc.

(1) Control of Electric Equipment

(a) As for equipment employing electric motive power, control standards shall be established, in consideration of its relation with electric power required at the starting, in order to reduce power loss due to idling of a motor, and such a motor must be stopped whenever it is not operated.

(b) When two or more motors are used, control standards shall be established so that an appropriate demand factor of each motor can be maintained, and adjustment of the number of motors and appropriate distribution of load should be implemented.

(c) Control standards shall be established for fluid handling machinery such as pump, fan,

blower, compressor, etc. Then, in order to reduce load on motors, outlet volume and pressure are properly adjusted by means of controlling he number of such machines, change in rotation, change in piping, impeller cut, etc., after reviewing their inlet pressures and outlet volume.

(d) Thermal efficiency of an induction furnace, electric art furnace, and electric resistance furnace should be enhanced by establishing control standards and by improving the charging method for materials to be heated.

(e) With regard to an electrolytic equipment, electric poles in appropriate shape and with properties should be adopted. Also, by establishing control standards, distance between electric poles, density of electrolytic solution, resistance at the contact point of the conductor must be appropriately controlled, so that the electrolytic efficiency can be improved.

(f) As for lighting equipment, control standards shall be set forth in compliance with the standards provided in JIS Z 9110 for Illuminant Standards or other equivalent rules. In addition, excess or unnecessary lighting should be avoided by switching off lighting properly.

(g) Moreover, concerning control of electricity use, control standards should be established and observed for voltage, current, power factor, and demand factor of each Electrical Equipment such as equipment using electric motive power, electrical heating equipment, lighting equipment, etc.

(2) Measurements and records concerning Electrical Equipment

(a) Control standards should be established in connection with voltage, current, power factor, and demand factor of each major Electrical Equipment. Then, such items shall be periodically measured, and the result must be recorded.

(b) In relation to lighting equipment, in addition to the above sub-clause (a), control standards for measurements of illuminant within a working room or the like, which uses lighting, shall be set forth. Then, such measurements shall be periodically conducted, and the result shall be recorded.

(3) Maintenance and inspection of Electrical Equipment

(a) As for equipment using electric motive power, control standards shall be established in order to reduce mechanical loss of loaded machinery (i.e. machinery of which load comes from a motor. This interpretation is applied throughout this Notification.) , power conveying units, and motors. Then, periodical inspection should be conducted for maintenance, based on such standards.

(b) In relation to fluid handling machinery such as pump, fan, blower, compressor, etc.,

control standards must be established in order to prevent leakage of fluid, and to reduce resistance within pipes to transport fluid. They must be periodically inspected for maintenance, based on such standards.

(c) Concerning electrical heating equipment or electrolytic equipment, control standards shall be established to reduce power loss by resistance at connecting points of the electric circuit, contact points of switches, etc. Then, inspection for maintenance shall be periodically conducted based on such standards.

(d) Control standards for lighting equipment must be set forth to clean lighting equipment and light source lamps, and to timely replace light source lamps.

II. Goal of rationalization of energy use

Business Operators shall strictly observe various standards described in the above chapter I, shall strive to achieve various goals set forth below within their technical and financial capabilities, and shall, through such measures, make efforts to rationalize utilization of energy with the goal to reduce the base unit of energy consumption (i.e. the value of total energy consumption used or production divided by production volume) by one percent or more in average every year at each Factory or by each Business Operator.

1. Improvement concerning energy consuming equipment, etc.

(1) Combustion equipment

(a) Business Operators shall strive to reduce the air ratio of combustion equipment with the goal to achieve the values of air ratio enlisted in the attached Table 1 (B).

(b) Combustion devices such as burner, etc., shall be reviewed so that they properly match types of the combustion systems and fuel, and that their fuel supply volumes and air ratios can be adjusted in accordance with fluctuation of the load and combustion situations.

(c) Blowers should be reviewed so that air volume and pressure in the combustion chamber can be adjusted.

(2) Heat Utilization Equipment

(a) Business Operators should review wall surfaces of industrial furnaces to enhance their emissivity by improving their properties and shapes.

(b) Business Operators should review heat conductive surfaces of equipment for Heating, etc., to enhance their thermal conductivity by improving their properties and shapes.

(c) Business Operators should review portions which are related to heat exchange of the equipment for Heating, etc., to be applied materials with higher thermal conductivity.

(d) Business Operators should review the body of industrial furnace, frames, fixtures, carriage to transport materials to be heated in order to reduce their heat capacities.

(e) Provided it is possible to heat directly materials by a direct burner or submerged combustion or other method, Business Operators should considered to heat materials directly.

(f) When heating is carried out by using multi-effect evaporator, the Business Operator should consider to enhance comprehensive thermal efficiency by increasing the number of effect evaporators.

(g) Business Operators should review distillation towers in order to enhance thermal efficiency comprehensively by reducing their reflux ratio through improving pressure in operation or increasing the number of steps or any other methods.

(h) Business Operators should consider to enhance thermal efficiency comprehensively by increasing the number of heat exchangers as well as their proper deployment.

(i) By combining an industrial furnace to be used in high temperature with an industrial furnace used in low temperature or any other ways, the Business Operator should consider to use heat at multiple stages and to enhance thermal efficiency comprehensively.

(j) Business Operators should strive to make use of heat more effectively by improving the control methods of equipment for Heating, etc.

(k) Business Operators should review processes that requires Heating, etc. repeatedly to operate them continuously, or integrate or shortening or partial elimination of the processes.

(l) When an industrial furnace is newly constructed, the Business Operator shall strive to enhance insulation of the furnace wall to satisfy the value of the attached Table 2 (B) for temperatures of outside furnace wall (with regard to an intermittently operated furnace or other industrial furnace that is used less 12 hours per day, the portion of outside furnace wall of which temperatures reach more than the value enlisted in the attached Table 2 (B), or more than 50% area of the inside wall of a furnace, of which inside temperature becomes 500℃ or higher, should be made of insulating material with bulk specific gravity of 0.75 or less.). Provided an existing industrial furnace can be modified to improve its insulation capacity, the Business Operator should make efforts to enhance insulation property of furnace wall to satisfy the value enlisted in the attached Table 2 (B) for outside surface of furnace walls.

(m) Business Operators should consider to enhance insulation of Heat Utilization Equipment by measures such as increase in thickness of insulation, application of insulation material with less thermal conductivity, double insulation layers, etc.

(n) Business Operators should consider to prevent heat loss due to radiation and inlet/outlet of air by reducing or closing opening of the Heat Utilization Equipment, or by attaching double doors to the opening of the Heat Utilization Equipment, or the like.

(o) Business Operators should review rotating portions, couples, etc. to take measures of preventing leakage of thermal medium by sealing or any other methods.

(p) Business Operators should consider to reduce the thermal radiation area by rationalizing pipe channel to transport thermal medium.

(q) Business Operators should review an open type steam utilization equipment, open type conveying equipment for high temperature materials, etc. to reduce heat loss from radiation or diffusion of thermal medium by attaching a cover or any other proper methods. However, this sub-clause is not applicable when it is necessary to cool down the materials while transporting.

(r) With regard to collection and utilization of heat from exhausted gas, Business Operators should strive to reduce temperature of exhausted gas and to enhance collection rate of exhausted heat with the goal to be achieved based on the values enlisted on the attached Table 3 (B) for exhaust gas temperature and collection rate for exhaust gas.

(s) With regard to energy generated from combustion of inflammable waste, Business Operators should collect and utilize such energy as much as possible. When such energy is collected, control standards for the scope of collection should be considered.

(3) Equipment for Waste Heat Collection Equipment

(a) In relation to flue gas ducting, pipes, etc., that transport exhaust gas from a discharging equipment for exhaust heat to an Waste Heat Collection Equipment, Business Operators should consider to take appropriate measures in order to reinforce their insulation capability and any other measures to maintain exhaust heat temperature in a high level.

(b) In order to enhance the collection rate of exhaust heat, Business Operators should consider to take proper measures including improvement of and shapes of the heat conductive surface, increase in the heat conductive area of their Waste Heat Collection equipment, and so forth.

(c) Business Operators should consider and research utilization methods of exhaust heat, depending on discharging conditions of exhaust heat.

(4) Dual-purpose Generation Equipment

In relation to extraction turbines or back-pressure turbines to be used for Dual-purpose Generation Equipment, Business Operators should consider remodeling of an extraction turbine or back-pressure turbine if its efficiency can be improved by changing their extraction or back-

pressure conditions.

(5) Electrical Equipment

(a) Aiming to keep the power factor 95% or over at a power receiving unit, Business Operators should consider to improve the power factor of the equipment shown in the attached Table 4 (except for equipment of which capacity is less than the capacities listed there) or a transformation equipment by installing a leading power condenser or other measures.

(b) As for lighting equipment, Business Operators should consider to take any proper measures such as adoption of a type of switches that can adjust illuminant, or installation of illuminant control unit or automatic switch-off device, etc., so lighting can be adjusted corresponding to daylight.

(c) Business Operators should consider to eliminate unnecessary wide-area lighting and high intensity illuminant by means of using spot lighting, change in deployment of lighting equipment, and so forth.

2. Installation of equipment to contribute to rationalization of energy use

(1) Equipment contributing to rationalization of fuel combustion

(a) Business Operators should consider to install combustion a control device in order to control air ratios in accordance with the control standards established for air ratios.

(b) In case that the required heat volume fluctuates largely, Business Operators should consider to install a heat accumulator, provided fluctuation of combustion load can be reduced to enhance thermal efficiency of the combustion equipment by installing a heat accumulator.

(2) Equipment concerning rationalization of Heating, etc.

(a) Business Operators should consider to adopt a high heat efficiency equipment when they install a heating equipment, dryer, etc., that uses a boiler, industrial furnace, heat medium such as steam.

(b) Business Operators should consider to adopt a high heat efficiency equipment such as a heat pump or the like for air-conditioning equipment.

(3) Equipment concerning rationalization of conversion of electricity into motive power, heat, etc.

(a) When an equipment using electrical motive power is operated in a situation that the load

fluctuates largely, Business Operators should consider to install a rotation control system or a similar device in order to enable to control its operation depending on changes in load.

(b) Motors should be applied in consideration of their features, types, and capacities for operational characteristics of the loaded machinery and their operation conditions, so that the motor power matches the required capacity.

(c) Electrical heating equipment should be introduced in consideration and in comparison of features of heating by combustion of fuel and electrical heating. Furthermore, Business Operators should consider to adopt an appropriate heating system for required level of temperature when they introduce an electrical heating system.

(d) As for lighting equipment, Business Operators should consider adopting high efficiency discharge lamps such as fluorescent high pressure mercury lamps, high pressure sodium lamps, metal halide lamps, high-frequency lighting fluorescent lamps, etc.

3. Utilization of excess steam, etc.

(a) When there is high temperature combustion gas or steam, that can be utilized, exists in the Factory, its Business Operator should study to utilize such gas or steam for power generation, motive power for operation, etc., in consideration of comprehensive thermal efficiency. In addition, Business Operators should consider enhancement of conversion efficiency of heat into motive power by means of co-generation as well as improvement of steam conditions.

(b) When there is excess heat, steam, etc., in a Factory that can be utilized, Business Operators should study to utilize such heat, steam, etc. at another Factory or for consumers in consideration of comprehensive thermal efficiency.

4. Optimum control of a power generation facility

In case that, in operation of a thermal power plant, reduced pressure operation is possible by applying a partial load onto a steam turbine, control standards shall be established and observed in relation to its optimization.

Table 1 (A) Standard Air Ratios (Ref. I-(1)-(b))

(1) Standard Air Ratios for Boilers

Classification		Load Ratio (unit: %)	Standard Air Ratio				
			Solid fuel		Liquid fuel	Gaseous fuel	Blast furnace gas or other by-product gas
			Fixed bed	Fluid bed			
For Electric Power Operation		75~100	-	-	1.05 ~1.2	1.05 ~1.1	1.2
Others	Hourly evaporation: 30 tons or more	50~100	1.3 ~1.45	1.2 ~1.45	1.1 ~1.25	1.1~1.2	1.2~1.3
	Hourly evaporation: 10 tons to less than 30 tons	50~100	1.3 ~1.45	1.2 ~1.45	1.2~1.3	1.2~1.3	-
	Hourly evaporation: 5 tons to less than 10 tons	50~100	-	-	1.3	1.3	-
	Hourly evaporation: less than 5 tons	50~100	-	-	1.3	1.3	-

Note: Electric Power Operation means boilers to be installed for the purpose of power generation by an electric power Business Operator (i.e. Electric Power Business Operator stipulated in the Article 2 (6) of the Electric Power Business Act).

[Remarks]

1. The values of the standard air ratios in the above Table are the figures that should be measured at the exits of boilers in a stable condition after implementation of periodical inspection and when combustion is made in a constant load.
2. Load ratios in the above Table mean turbine load ratios for boilers installed for the purpose of electric power generation, while the other ratios mean boiler load ratios.
3. Calculation of the above air ratios were worked out using the following formula, and calculation results are rounded to the nearest one decimal place in case one decimal place is shown, while rounded to the nearest two decimal places in case two decimal places are indicated.

   Air ratio = 21/(21- Density of oxygen in exhaust gas (%))
4. The values of standard air ratios in relation to pulverized coal firing type boilers shown in the column of fixed bed boilers using solid fuel are 1.2 to 1.3 for electric power Business Operators, and 1.2 to 1.3 for the others (this is restricted to the boiler of which evaporation volume is 10 tons to less 30 tons).
5. With regard to boilers that use mixture of two or more different types of fuels, a standard air ratio of fuel that has a higher mixed fuel burning ratio (i.e. mixed fuel burning ratio based on

calorie power) is applied.

6. The values of standard air ratios in the above Table are not applied to the air ratios of the following boilers:
   (a) Small boilers defined in Article 1 (4) of the Enforcement Ordinance of the Labor, Safety, and Hygienic Act
   (b) Boilers that were modified for the purpose of changing fuel type after the installation
   (c) Boilers that use mixed fuels with industrial waste such as wood chips, barks, sludge, etc.
   (d) Boilers that burn black liquor
   (e) Boilers that burn disposed tires
   (f) Boilers that exclusively burn by-product gas of which calorie power is less than one cubic meter per 900 kilo calorie under normal conditions (i.e. one kilo cubic meter per 3,765.6 kilo joule under normal conditions)
   (g) Boilers for the purpose of incinerating harmful gas
   (h) Boilers using exhaust heat
   (i) Boilers using thermal medium other than water
   (j) Boilers of which air inlet system is to take open air
   (k) Boilers that are under a periodical inspection or not used regularly. Also, boilers used for development, research, or prototype
   (l) Boilers that were installed on or before December 31, 1979 and of which nominal air ratios do not satisfy the standard air ratios

(2) Standard Air Ratios for Industrial Furnace (Ref. I- 1 (1) (b))

Classification	Standard Air Ratio		
	Furnace Type		
	Continuous type	Intermittent type	Remarks
Melting furnace for metal casting	1.3	1.4	
Continuous billet heating furnace	1.25	-	
Metal heating furnace other than continuous billet heating furnace	1.25	1.35	
Metal heat treatment furnace	1.25	1.3	
Oil heating furnace	1.25	-	
Heat decomposition furnace and reforming furnace	1.25	-	

Cement kiln	1.30	-	
Lime kiln	1.30	1.35	
Drying furnace	1.3	1.5	Only for combustion unit of burner

[Remarks]

1. The values of standard air ratios shown in the above Table are the air ratios that should be measured at the air exit of furnaces operating with a load close to the standard after implementation of inspection and overhauling.
2. The volumes of the standard air ratios are not applied to air ratios of the following industrial furnaces:
   (a) furnaces using solid fuel (except for furnaces exclusively use pulverized coal)
   (b) furnaces of which rated capacities (combustion performance of the fuel for burner) are less than 50 liter per hour (when converted to heavy oil)
   (c) furnaces that require specific environment for the purpose of oxidation or deoxidation
   (d) furnaces of which door is needed to be opened often, or of which burner must be ignited and extinguished frequently
   (e) Furnaces that require diluted air, or furnaces for the purposes of maintaining heat pattern or leveling temperature in the furnace
   (f) furnaces that exclusively burn by-product gas of which calorie power is less than one cubic meter per 900 kilo calorie in normal condition (i.e. one kilo cubic meter per 3,765.6 kilo joule in normal condition)
   (g) furnaces that are under a periodical inspection or not used regularly. Also, boilers used for development, research, or prototype
   (h) industrial furnaces built with materials of which quality is degraded in high temperature, so they need cooled diluted air
   (i) and furnaces that incinerate inflammable waste.

Table 1 (B) Targeted Air Ratios (Ref. II-1-(1) (a))

(1) Targeted Air Ratios Concerning Boilers

Classification		Load Ratio (unit: %)	Targeted Air Ratio				
			Solid fuel		Liquid fuel	Gaseous fuel	Blast furnace gas or other by-product gas
			Fixed bed	Fluid bed			
Others	For Electric Power Operation	75~100	-	-	1.05 ~1.1	1.05 ~1.1	1.15~11.2
	Hourly evaporation: 30 tons or more	50~100	1.2 ~1.3	1.2 ~1.25	1.05 ~1.15	1.05 ~1.15	1.2~1.3
	Hourly evaporation: 10 tons to less than 30 tons	50~100	1.2 ~1.3	1.2 ~1.25	1.2 ~1.25	1.2 ~1.25	-
	Hourly evaporation: 5 tons to less than 10 tons	50~100	-	-	1.2 ~1.3	1.2 ~1.25	-
	Hourly evaporation: less than 5 tons	50~100	-	-	1.2 ~1.3	1.2 ~1.25	-

Note: Electric Power Operation means boilers to be installed for the purpose of power generation by an electric power Business Operator.

[Remarks]

1. The values of the targeted air ratios in the above Table are the figures that should be measured at the exits of boilers in a stable condition after implementation of periodical inspection and when combustion is made in a constant load.
2. Calculation of load ratios and air ratios are based on Remarks 2 and 3 of Table 1 (A) (1).
3. The values of the targeted air ratios in relation to the pulverized coal firing type boilers in the column of fixed bed boilers using solid fuel are 1.15 to 1.25 for electric power Business Operators, and 1.2 to 1.25 for the others (restricted to boilers of which evaporation volume is 10 tons to 30 tons).
4. The values of the targeted air ratios concerning boilers that burn black liquor shall be between 1.2 and 1.3 when the load ratio is 50% to 100%.
5. With regard to boilers that use mixture of two or more different types of fuel, targeted air ratios of fuel with higher mixed fuel burning ratios are applied.
6. The values of targeted air ratios in the above Table are not applied to the air ratios of the following boilers. However, Business Operators shall consider to control the air ratios pursuant to the above Table as far as it is possible.

(a) Small boilers defined in Article 1 (4) of the Enforcement Ordinance of the Labor, Safety, and Hygienic Act

(b) Boilers that use mixed fuel with industrial waste such as wood chips, barks, sludge, etc.

(c) Boilers that burn disposed tires

(d) Boilers that exclusively burn by-product gas of which calorie power is less than one cubic meter per 900 kilo calorie under normal conditions (i.e. one kilo cubic meter per 3,765.6 kilo joule under normal conditions)

(e) Boilers for the purpose of incinerating harmful gas

(f) Boilers using exhaust heat

(g) Boilers of which air inlet system is to take open air

(h) Boilers that are under a periodical inspection or not used regularly. Also, boilers used for development, research, or as a prototype

(2) Targeted Air Ratios for Industrial Furnace (Ref. I- 1 (1) (b))

Classification	Targeted Air Ratio		
	Furnace Type		
	Continuous type	Intermittent type	Remarks
Melting furnace for metal casting	1.25	1.3	
Continuous billet heating furnace	1.2	-	
Metal heating furnace other than continuous billet heating furnace	1.2	1.3	
Metal heat treatment furnace	1.2	1.3	
Oil heating furnace	1.25	-	
Heat decomposition furnace and reforming furnace	1.25	-	
Cement kiln	1.25	-	
Lime kiln	1.25	1.35	
Drying furnace	1.3	1.5	Only for combustion unit of burner

[Remarks]

1. The values of targeted air ratios shown in the above Table are the air ratios that should be measured at air exit of furnaces operating with load close to the standard after implementation of inspection and overhauling.
2. The volumes of the targeted air ratios are not applied to air ratios of the following industrial furnaces. However, Business Operators shall consider to control the air ratios pursuant to the

above Table as far as it is possible.

(a) Furnaces of which rated capacities (combustion performance of the fuel for burner) are less than 50 liter per hour (when converted to heavy oil)

(b) Furnaces that require a specific environment for the purpose of oxidation or deoxidation

(c) Furnaces of which door is needed to be opened often, of which burner must be ignited and extinguished frequently

(d) Furnaces that require diluted air for the purposes of maintaining heat pattern or leveling temperature in the furnace

(e) Furnaces that exclusively burn by-product gas of which calorie power is less than one cubic meter per 900 kilo calorie under normal conditions (i.e. one kilo cubic meter per 3,765.6 kilo joule under normal conditions)

(f) Furnaces that are under a periodical inspection or not used regularly. Also, boilers used for development, research, or as a prototype

(g) Industrial furnaces built with materials of which quality is degraded in high temperature, so they need cooled diluted air.

Table 2 (A) Standard Temperature on Outside Surface of Furnace Wall

(Ref. I-3-(1)-(c))

Inner Furnace Temperature (unit: ℃)	Standard Temperature on Outside Furnace Wall Surface (unit: ℃)		
	Ceiling	Side wall	Bottom facing to outside atmosphere
1,300℃ or higher	140	120	180
1,100℃ to 1,299℃	125	110	145
900℃ to 1,099℃	110	95	120
Less than 900℃	90	80	100

[Remarks]

1. The values of the standard temperature of outside surface of furnace wall are the required average temperatures of the outside wall surfaces of furnaces (excluding irregular portions) during regular operations at 20℃ outside atmosphere.
2. The values of the standard temperature of outside surface of the furnace wall shown in the above Table are not applied to the temperature of outside surface of the following industrial furnace wall.

(a) Furnaces of which rated capacities (combustion performance of the fuel for burners) are less than 50 liter per hour (when converted to heavy oil)

(b) Furnaces of which walls are forcibly cooled

(c) Rotary type kiln

(d) Furnaces to be used for development, researches, and as a prototypes

Table 2 (B) Targeted Temperature on Outside Surface of Furnace Wall

(Ref. II-1- (2)-(l))

Inner Furnace Temperature (unit: ℃)	Targeted Temperature on Outside Furnace Wall Surface (unit: ℃)		
	Ceiling	Side wall	Bottom facing to outside atmosphere
1,300℃ or higher	120	110	160
1,100℃ to 1,299℃	110	100	135
900℃ to 1,099℃	100	90	110
Less than 900℃	80	70	90

[Remarks]

1. The values of the standard temperatures of outside surface of furnace wall shown in the above Table are the required average temperatures of the outside wall surfaces of furnaces (excluding irregular portions) during regular operations at 20℃ of the outside atmosphere.
2. The values of the standard temperatures of outside surface of furnace wall shown in the above Table are not applied to the temperature of outside surface of the following industrial furnace wall. However, Business Operators shall consider to improve insulation of furnace walls in accordance with the above Table where it is possible.

(a) Furnaces of which rated capacities (combustion performance of the fuel for burners) are less than 50 liter per hour (when converted to heavy oil)

(b) Furnaces of which walls are forcibly cooled

(c) Rotary type kiln

(d) Furnaces to be used for development, researches, or as a prototypes

Table 3 (A) Standard Exhaust Gas Temperatures and Standard Collection ratios of Exhaust Heat (Ref. I-4-(1) (b))

(1) Standard Exhaust Gas Temperatures Concerning Boilers

Classification		Standard Exhaust Gas temperature (unit: ℃)				
		Solid fuel		Liquid fuel	Gaseous fuel	Blast furnace gas or other by-product gas
		Fixed bed	Fluid bed			
For Electric Power Operation		-	-	145	110	200
Others	Hourly evaporation: 30 tons or more	200	200	200	170	200
	Hourly evaporation: 10 tons to less than 30 tons	250	200	200	170	-
	Hourly evaporation: 5 tons to less than 10 tons	-	-	220	200	-
	Hourly evaporation: less than 5 tons	-	-	250	220	-

Note: Electric Power Operation means boilers to be installed for the purpose of power generation by an electric power Business Operator.

[Remarks]

1. The values of the standard exhaust gas temperatures shown on the above Table are the exhaust gas temperatures that should be measured at the exits of a boiler (i.e. the applicable exit in case that an equipment for collection and utilization, or a smoke and soot removal equipment is installed as an environmental measures) when combustion is made with 100% load ratio (i.e. loading factor on a turbine for boilers installed for the purpose of power generation, while loading factor on boilers for other cases) at 20℃ of inlet air temperature measured at the air entrances of the boiler after implementation of a periodical inspection is made.
2. The standard exhaust gas temperature concerning solid fuel type fixed bed boilers that use pulverized coal shall be 150℃ for boilers of electric power Business Operators, and 200℃ for other cases (restricted to boilers of which evaporation is more than 30 tons for more per hour, or from 10 tons to 30 tons).
3. In relation to boilers of which evaporation volume is less ten tons per hour, the standard exhaust gas temperature of boilers that have no equipment to collect exhaust heat shall be 320℃ for boilers using liquid fuel, and 300℃ for boilers using gaseous fuel.
4. The values of temperatures shown in the above Table are not applied to the exhaust gas

temperature of the following types of boilers:

(a) Small boilers defined in Article 1 (4) of the Enforcement Ordinance of the Labor, Safety, and Hygienic Act

(b) Boilers that were modified for the purpose of changing fuel after installation

(c) Boilers that use mixed fuel with industrial waste such as wood chips, barks, sludge, etc.

(d) Boilers that burn black liquor

(e) Boilers for the purpose of incinerating harmful gas

(f) Boilers using exhaust heat or remaining heat

(g) Boilers using thermal medium other than water

(h) Boilers of which air inlet system is to take open air

(k) Boilers that are under a periodical inspection or not used regularly. Also, boilers used for development, research, or prototype.

(2) Standard Collection Ratios of Exhaust Heat Concerning Industrial Furnace (Ref. I-4-(1)-(b))

Exhaust Gas Temperature (unit: ℃)	Classification of Capacity	Standard Collection Rate of Exhaust Heat (unit: %)
Less than 500	A • B	25
500 to 599	A • B	25
600 to 699	A B C	35 30 25
700 to 799	A B C	35 30 25
800 to 899	A B C	40 30 25
900 to 999	A B C	45 35 30
1,000 or higher	A B C	45 35 30

Note:

1. Exhaust gas temperature refers to the temperature measured at the exhaust gas exit of the furnace chamber and the entrance of the recuperator.
2. Capacity classification is made in the following manner:

(A) The rated capacity is 20 million kilo calorie (83.68 million kilo joule) or more per hour.

(B) The rated capacity is 5 million kilo calorie (20.92 million kilo joule) or more, and less than 20 million kilo calorie (83.68 million kilo joule) per hour.

(C) The rated capacity is 1 million kilo calorie (4.184 million kilo joule) or more, and less than 5 million kilo calorie (20.92 million kilo joule) per hour.

[Remarks]

1. The values of the standard collection ratios of the exhaust heat shown in the above Table should be observed as the ratios of collected caloric power against the sensible heat power of exhaust gas discharged from a furnace chambers when combustion is made with load close to the rated capacity.
2. The values of the standard collection ratios of exhaust heat shown in the above Table are applied to any industrial furnaces constructed on and after January 1, 1980.
3. The values of the standard collection ratios of the exhaust heat shown in the above Table are not applied to the collection ratios of the following industrial furnaces:

(a) Furnace of which rated capacity is less than one million kilo calorie (4.184 kilo joule)

(b) Furnaces that need a specific environment for the purpose of oxidation or deoxidation

(c) Furnaces incinerating by-product gas of which calorie power is one cubic meter per 900 kilo calorie (3,765.6 kilo joule) under normal conditions

(d) Boilers that are under a periodical inspection or not used regularly. Also, boilers used for development, research, or as a prototype.

Table 3 (B) Targeted Exhaust Gas Temperatures and Targeted Collection Ratios of Exhaust Heat (Ref. II-1-(2) (r))

(1) Targeted Exhaust Gas Temperatures Concerning Boilers

Classification		Targeted Exhaust Gas Temperature (unit: ℃)				
		Solid fuel		Liquid fuel	Gaseous fuel	Blast furnace gas or other by-product gas
		Fixed bed	Fluid bed			
For Electric Power Operation		-	-	135	110	190
Others	Hourly evaporation: 30 tons or more	180	170	160	150	190
	Hourly evaporation: 10 tons to less than 30 tons	180	170	160	150	-
	Hourly evaporation: 5 tons to less than 10 tons	-	300	200	180	-
	Hourly evaporation: less than 5 tons	-	320	220	200	-

Note: Electric Power Operation means boilers to be installed for the purpose of power generation by an electric power Business Operator.

[Remarks]

1. The values of the targeted exhaust gas temperatures shown on the above Table are the exhaust gas temperatures that should be measured at the exits of boilers (i.e. the applicable exit in case that an equipment for collection and utilization, or a smoke and soot removal equipment is installed as an environmental measures) when combustion is made with 100% load ratio (i.e. loading factor on a turbine for a boiler installed for the purpose of power generation, while loading factor on boilers for other cases) at 20℃ of inlet air temperature at the air entrances of the boilers after implementation of a periodical inspection is made.
2. The targeted exhaust gas temperature concerning solid fuel type fixed bed boilers that use pulverized coal shall be 140℃ for boilers of electric power Business Operators, and 160℃ for other cases (restricted to boilers of which evaporation is more than 30 tons or more per hour, or from 10 tons to 30 tons).
3. The targeted value of exhaust gas temperature concerning boilers that incinerate black liquor shall be 180℃.

4. With regard to boilers that use mixture of two or more different types of fuels, the targeted air ratio of fuel with a higher mixed fuel burning ratio is applied.
5. The values of temperatures shown in the above Table are not applied to the exhaust gas temperature of the following types of boilers. However, Business Operators shall consider to reduce exhaust gas temperature in accordance with the above Table where it is possible.
   (a) Small boilers defined in Article 1 (4) of the Enforcement Ordinance of the Labor, Safety, and Hygienic Act
   (b) Boilers that use mixed fuel with industrial waste such as wood chips, barks, sludge, etc.
   (c) Boilers for the purpose of incinerating harmful gas
   (d) Boilers using exhaust heat or remaining heat
   (e) Boilers of which air inlet system is to take open air
   (f) Boilers that are under a periodical inspection or not used regularly. Also, boilers used for development, research, or as a prototype

(2) Targeted Collection Ratios of Exhaust Heat Concerning Industrial Furnaces

(Ref. II-1-(2)-(r))

Exhaust Gas Temperature (unit: ℃)	Classification of Capacity	Standard Collection Rate of Exhaust Heat (unit: %)	Reference	
			Exhaust gas temperature (unit: %)	Remaining air heat temperature (unit: %)
Less than 500	A • B	30	300	165
500 to 599	A • B	30	365	200
600 to 699	A	35	400	270
	B	30	435	230
	C	25	470	195
700 to 799	A	35	460	310
	B	30	505	265
	C	25	545	220
800 to 899	A	40	480	395
	B	35	525	345
	C	30	575	295
900 to 999	A	50	430	550
	B	40	535	440
	C	35	590	385
1,000 or higher	A	50		
	B	40	-	-
	C	35		

Note:

1. Exhaust gas temperature refers to the temperature measured at the exhaust gas exit of the furnace chamber and the entrance of the recuperator.
2. Capacity classification is made in the following manner.
   (A) The rated capacity is 20 million kilo calorie (83.68 million kilo joule) or more per hour
   (B) The rated capacity is 5 million kilo calorie (20.92 million kilo joule) or more, and less than 20 million kilo calorie (83.68 million kilo joule) per hour
   (C) The rated capacity is 1 million kilo calorie (4.184 million kilo joule) or more, and less than 5 million kilo calorie (20.92 million kilo joule) per hour

[Remarks]

1. The values of the targeted collection ratios of exhaust heat shown in the above Table should be observed as the ratios of collected calorie power against the sensible heat power of exhaust gas discharged from a furnace chambers when combustion is made with load close to the rated capacity.
2. The values of the targeted collection ratios of exhaust heat shown in the above Table are not

applied to the exhaust heat collection ratio of the following industrial furnaces. However, Business Operators shall consider to improve exhaust heat collection ratio in accordance with the above Table.

(a) Furnaces of which rated capacity is less than one million kilo calorie (4.184 kilo joule)

(b) Furnaces that need a specific environment for the purpose of oxidation or deoxidation

(c) Furnaces incinerating by-product gas of which calorie power is one cubic meter per 900 kilo calorie (3,765.6 kilo joule) under normal conditions

(d) Boilers that are under a periodical inspection, or not used regularly. Also, boilers used for development, research, or as a prototype

3. The values of exhaust gas temperatures and remaining air heat temperatures shown above as reference are the temperatures of exhaust gas when exhaust gas is collected at the targeted ratio of exhaust heat, and the temperatures of remaining air heat when air is preheated with the applicable collected exhaust heat, respectively, which were worked out in the following conditions:

(a) Temperature drops by 60℃ due to heat loss by radiation during transfer from the exit of furnace to the heat exchanger for air preheat, and other factors

(b) Heat radiation from the heat exchanger is 5%.

(c) The fuel is liquid fuel (equivalent to heavy oil)

(d) Outside atmosphere is 20℃.

(e) Air ratio is 1.2.

Table 4 Equipment to improve power factor (Ref. I-6-(1)-(c) and II-1-(5)-(a))

Equipment	Capacity (unit: kW)
Squirrel cage induction motor	100
Wound-rotor induction motor	100
Crucible induction furnace	100
Channel induction furnace	100
Vacuum induction furnace	100
Electric arc furnace for steel making	-
Rocking electric arc furnace	-
Flush bat welder (except for portable type)	10
Electric arc welder (except for portable type)	10
Rectifier	10,000

[Remarks]

Equipment that are difficult to be applied due to safety such as explosion- proof or other factors are excluded.

G. Regulations Concerning Tests and Supply of Certificates for Energy Controllers

Article 1. Definition

The terms used in this Ordinance are based on the terms used in the Law Concerning Rational Use of Energy (hereinafter referred to as Law).

Article 2. Certification

The certification by the Minister of International Trade and Industry (hereinafter referred to as Certification) stipulated in the clause 1 .2 of Article 8 of the Law are to be granted to those who completed the Energy Control Training course (hereinafter referred to as Training) implemented by the Minister of International Trade and Industry or the organization designated by the Minister of International Trade and Industry.

Article 3. Training

1. The Training consists of the Heat Management Training and the Electricity Management Training.
2. The eligible persons who can take the Training are those who fall into one of the items listed in the right column for each segment stated in the left column. In addition, eligible persons who take the Heat Management Training must be those who have been engaged in the actual operations regarding rationalization of Fuels use for three years or longer, while eligible persons who take the Electricity Management Training must be those who have engaged in the actual operations regarding rationalization of electricity use for three years or longer.
3. The date and location of the Training conducted, and other information necessary for implementation of the Training shall be notified on an official gazette in advance.

Article 4. Application for Certification

Persons who wish to take the Training must submit an Application for Certification in Form No.1 to the Minister of International Trade and Industry through the Director of the Regional Bureau of International Trade and Industry who has jurisdiction over the location where the applicant is to take the Training.

Article 5. Grant of the Certificate to those who are certified

1. With regard to the persons who are certified, the Minister of International Trade and

Industry shall grant the Certificates of Heat Controller to those who completed the Heat Management Training, and the Certificates of Electricity Controller to those who completed the Electricity Management Training respectively.

2. The form of the Certificate of Energy Controller (hereinafter referred to as Certificate) is based on Form No.2.

Article 6. Application for grant of the Certification

A person who wishes for the Certificate to be granted as a proof he/she successfully passed the Energy Controller Examination (hereinafter referred to as the Examination) that is conducted by the Designated Examination Institution must submit an Application for Grant of Certification of Form No.3 to the Minister of International Trade and Industry through the Director of the Regional Bureau of International Trade and Industry who has jurisdiction over the address of the applicant.

Article 7. Grant of the Certificate to the successful applicants

The Minister of International Trade and Industry shall grant the Certificates of Heat Controller to those who passed the Examination of Heat Management Controller and have engaged in the actual operations in relation to rationalization of Fuel use for one year or longer, and the Certificates of Electricity Controller to those who passed the Examination of Electricity Management Controller and have engaged in the actual operations in relation to rationalization of electricity use for one year or longer.

Article 8. Application for re-issuance of the Certificate

1. A person who wishes for the Certificate to be reissued because it has deteriorated, damaged or lost must submit an Application for Re-issuance of the Certificate of Energy Controller to the Ministry of International Trade and Industry through the Director of the Regional Bureau of International Trade and Industry who has jurisdiction over the address of the applicant.
2. In case that such an application is made because the Certificate has been deteriorated or damaged, the applicable Certificate must be attached to the above Application.

Article 9. Subjects of the Examination

1. The Examination shall be implemented at least once a year in the style of a written test of the subjects for each segment listed below:

Classification	Test Subject
Examination for Heat Management Controller	General theory, laws, and order based on laws of heat management
	Thermodynamics
	Heat conductivity and flow of fluid
	General theory on fuels, test methods for fuels, combustion theory, calculation for combustion, combustion methods, and combustion equipment
	Measurement and control
	Heat utilizing equipment, etc. (i.e. limited to boiler and its relevant equipment, steam power plant, steam transportation/storage/drain collection equipment, industrial furnace, distilling equipment, evaporation/condensing equipment, dryer, heating equipment, heat exchanger, dry distillation/gasfication equipment, freezing/air-conditioning equipment, internal combustion engine, gas turbine, and materials for heat-related equipment)
Examination for Electricity Controller	General theory, laws, and order based on laws for electricity management
	Electric theory and control theory
	Electric distribution in factories
	Electrical equipment
	Application of electric motors
	Electrical heating, electrochemistry, lighting, and air-conditioning

2. The date and location of the Examination conducted, and other information necessary for implementation of the Training shall be notified on an official gazette in advance.

Article 10. Announcement of the successful applicants

The examinees who passes the Examination shall be announced on an official gazette.

Article 11. Application of Designated Examination Institution

1. Organizations that wish to be designated in accordance with Clause 2 (2) of Article 8 of the Law must submit an Application describing the following items to the Minister of International Trade and Industry:
   (1) Name and address
   (2) Name and address of the office at which the Examination is carried out
   (3) The date to start the Examination
2. The above mentioned application must be attached with the following documents:
   (1) the certificate of incorporation or donation performance and the attested copy of corporate registration
   (2) the list of assets and the balance sheet of the business fiscal year immediate before the fiscal year of application
   (3) the statement of earning of the business fiscal year immediate before the fiscal year of

application

(4) and the document describing names and personal histories of the directors.

Article 12. Report on change in the Designated Examination Institution, etc.

1. When the Designated Examination Institution changes its name, address or location of the office at which the Examination is implemented, it must submit a report describing the following items to the Minister of International Trade and Industry:

(1) the new name, address or location of the Designated Examination Institution or the office at which the Examination is to be implemented after the change

(2) the effective date of such change

(3) and the reason for the change.

2. When the Designated Examination Institution is to open a new office or close the existing office to implement the Examination, it must submit a report describing the following items to the Minister of International Trade and Industry:

(1) the name and location of the office to be opened or closed

(2) the date to start the Administration of the Examination at the newly opened office, or the date to finalize the Administration of the Examination at the closing office

(3) the reason to open or close such office.

Article 13. Application for authorization of the Rules for Administration of the Examination

When the Designated Examination Institution wishes to receive the authorization described in the first part of Clause 5 (1) of Article 12 of the Law, it must submit a written application together with the Rules for Administration of the Examination.

Article 14. Items to be described in the Rules for Administration of the Examination

The items to be stipulated in the Rules for Administration of the Examination stated in Clause 5(12) of Article 12 of the Law shall be as follows:

(1) item concerning the implementation method of the Examination

(2) tem concerning the method to receive the charges

(3) item concerning issuance and re-issuance of the qualification certificates

(4) item concerning non-disclosure requirements for knowledge obtained through the Administration of the Examination

(5) item concerning preservation of record books and documents in connection with the Administration of the Examination

(6) and any other items necessary for carrying out the Administration of the Examination.

Article 15. Application for authorization of change in the Rules for Administration of the Examination

When the Designated Examination Institution wishes to receive the authorization described in the latter part of Clause 5 (1) of Article 12 of the Law, it must submit an application including the following items to the Minister of International Trade and Industry:

(1) items to be changed
(2) effective date for the change
(3) and the reason for such change.

Article 16. Application for authorization of suspension or discontinuance of the Administration of the Examination

When the Designated Examination Institution wishes to have an authorization based of Clause 6 of Article 12 of the Law, it must submit an application describing the following items to the Minister of International Trade and Industry:

(1) The scope of the operation concerning the Administration of the Examination to be suspended or discontinued
(2) The date to suspend or discontinue a part of or the entire operations concerning the administration of the Examination, and the period to suspend a part of or the entire operations of the Administration of the Examination
(3) The reason to suspend or discontinue a part of or the entire operations of the Administration of the Examination.

Article 17. Application for authorization of selection and dismissal of directors

When the Designated Examination Institution wishes to have an authorization based on Clause 8 of Article 12 of the Law, it must submit an application describing the following items to the Minister of International Trade and Industry:

(1) Name and personal history of the director to be selected or dismissed
(2) The reason for selection or dismissal.

Article 18. Requirements for the Examiners

The requirements stipulated in the Ordinance of the Ministry of International Trade and Industry based on Clause 2 of Article 12 of the Law, the Examiner must be the person who falls in one of the following conditions:

(1) the person who are or have been a professors or an assistant professor for the subject in relation to use of Fuels or electricity at a university or college defined in the School Education Act, or

(2) the person who has completed the regular curriculum of science at a university or an upper professional college defined in the School Education Act, and has an experience of engaging in the research on use of Fuels or electricity at a research institute that is established by the government or a local public entity or a corporation established based on the provisions of the Article 34 of the Civil Law Act, or other organization equivalent to them, or

(3) the person who is regarded to have knowledge and experience equivalent to the person described in the above Sub-clause (2) or ones who have better knowledge and experience in connection with rationalization of energy use.

Article 19. Report on selection or dismissal of an Examiner

1. The Designated Examination Institution that reports based on the provision in the first part of Sub-clause 10 (3) of Article 12 of the Law must submit a report describing the name and personal history of the Examiner for the Energy Controller (hereinafter referred to as Examiner) described in the Sub-clause 1 of the said Article, the subject of the Examination in charge, and the reason for selection to the Minister of International Trade and Industry.

2. Whenever a name of an Examiner changes, or the subject that an Examiner is in charge changes, or an Examiner is dismissed, it must be reported to the Minister of International Trade and Industry within 15 days of the effective date.

Article 20. Report on result of the Examination

When an Examination is implemented, the Designated Examination Institution must submit the list with names, dates of birth, addresses, and the Certificate numbers of the successful examinees in Form No. 5, Report on the Examination Result, for each segment to the Minister of International Trade and Industry.

Article 21. Items to be recorded in the record book

The items to be recorded in the record book that is defined in Sub-clause 1 of Article 12.14 of the Law are as follows:

(1) names of successful examinees
(2) date of birth of the successful examinees
(3) addresses of the successful examinees
(4) certificate numbers
(5) and classification of the Examination they passed.

Article 21.2 Preservation of records in a electromagnetic medium

1. When the items enlisted in the above clause are recorded using an electromagnetic method (methods beyond human perception using such means as electronics or magnetic method), and such records can be immediately displayed on a computer or other devices when necessary, such a medium can be replaced for record books with the said information defined in Sub-clause 2 of Article 12.14 of the Law.

2. When the data are recorded in accordance with the provision of the above Clause (1), the Designated Examination Institution shall strive to ensure the standards stipulated by the Minister of International Trade and Industry.

Article 22. Preservation of the record books

The record books stipulated in the Ordinance of the Ministry of International Trade and Industry made in accordance with Clause 2 of Article 12.14 of the Law must be preserved until the Administration of Examination becomes discontinued.

Article 23. Transfer, etc. of the Administration of Examination

If the Designated Examination Institution does what is defined in Sub-clause 2 of Article 12.15 of the Law, it must carry out the following items:

(1) to transfer the Administration of Examination to the Minister of International Trade and Industry.

(2) to transfer the record books and other documents concerning the Administration of Examination to the Minister of International Trade and Industry.

(3) and other items that the Minister of International Trade and Industry deems necessary.

Article 24. Public announcement

The Minister of International Trade and Industry shall publicly announce the items, listed in the right columns of the Table below, on a official gazette, when one of the situations enlisted in the left column of the same Table arises:

In case designation stated in Sub-clause 2 of Article 8.2 of the Law is made	(1) Name of the Designated Examination Institution and location of its main office (2) The scope of the Administration of Examination permitted (3) The date of designation

In case the authorization stated in the Article 12.6 is made	(1) Name of the Designated Examination Institution that suspends or discontinues a part of or the entire Administration of Examination, and location of its main office (2) The scope of the Administration of Examination to be suspended or discontinued (3) The date to suspend or discontinue a part of or the entire Examination Administration (4) The period if a part of or the entire Administration of Examination is suspended
When the designation is cancelled due to the provision of Article 12.13 of the Law, or when the Designated Examination Institutions ordered to suspend a part of or the entire Administration of Examination in accordance with the Clause 2 of the same Article.	(1) Name of the Designated Examination Institute and the location of its main office (2) The date the designation is cancelled, or the date when a part of or the entire Administration of Examination is suspended (3) In case that a part of or the entire Administration of Examination is ordered for suspension, the scope of the suspended Administration of Examination as well as its period
When the Minister of International Trade and Industry implements a part of or the entire Administration of Examination directly in accordance with the provision of Clause 1 of Article 12.15 of the Law	(1) The date when a part of or the entire Administration of Examination is to be implemented (2) The scope and period of the Administration of Examination to be implemented
When the Minister of International Trade and Industry decides not to implement a part of or the entire Administration of Examination, which had been carried out by the Minister, in accordance with the provision of Clause 1 of Article 12.15	(1) The date it is decided not to implement a part of or the entire Administration of Examination (2) The scope of the Administration of Examination decided not to be implemented

Additional Clauses (March 9, 1984)

1. This Ordinance shall be executed on the date of the promulgation.
2. The Rules for Grant of the Energy Controller (Ordinance No. 51 of Ministry of International Trade and Industry of 1979) is abolished.
3. Until June 30, 1985, in addition to the persons who fall into the provision of the Article 2, those who have been engaged in operations of heat management, described in Clause 1 of Article 3 of the Heat Management Act before its abolition in accordance with Clause 3 of the Additional Rules of the Law, for three years or longer, and completed the Training

concerning Heat Management defined in Article 12.2 of the Law.

Additional Clause (March 20, 1987)

This Ordinance shall be executed on April 1, 1987.

Additional Clause (January 25, 1996)

This Ordinance shall be executed on the day of its promulgation.

Table (Concerning Article 3)

Classification	Eligible persons who can take the Training
Training of heat management	(1) Persons who completed the curriculum of mechanical engineering or chemical engineering or metal engineering at a junior college, a professional school, or a former professional school defined by the old Professional School Act, or other equivalent school, and graduated such a school (2) Persons who are granted the Class A Gas Chief Engineer Certification or the Class B Gas Chief Engineer defined in Clause 1 of Article 32 of the Gas Business Act (the Law No. 51 of 1954) (3) Engineers defined in Clause 1 of Article 2 of the Engineer Act (the Law No. 25 of 1983) (limited to persons who successfully passes the second examination on machinery or chemistry or metal engineering) (4) Persons who are granted the Certificate of the Class I Boiler and Turbine Chief Engineer or the Class II Boiler and Turbine Chief Engineer defined in Clause 1 of Article 54 of the Electricity Enterprises Act (the Law No. 170 of 1964) (5) Persons who are granted the Special Class Boiler Engineer defined in Clause 1 of Article 97 of the Safety Rules for Boilers and Pressure Containers (the Ordinance No. 33 of the Ministry of Labor of 1972)
Electricity Management Training	(1) Persons who completed the curriculum of electric engineering at a junior college, a professional school, or a former professional school defined by the old Professional School Act, or other equivalent school, and graduated such a school (2) Engineer defined in Clause 1 of Article 2 of the Engineer Act (the Law No. 25 of 1983) (limited to persons who successfully passes the second examination on electric engineering) (3) Persons who are granted the Certificate of Class I Chief Electric Engineer or Class II Chief Electric Engineer or Class III Chief Electric Engineer defined in Clause 1 of Article 54 of the Electricity Enterprises Act (persons who has the Certificate of the Class III Chef Electric Engineer are limited to ones who have been engaged in the actual operations concerning rationalization of electricity use for two years or longer after the Certificate was granted.)

Chapter 7 Standards and Guidelines for Promotion of Energy Efficiency

This chapter describes standards and guidelines for the promotion of energy efficiency.

7-1 Energy Efficiency Standards

After conducting energy audits in the commercial and industrial sectors of Malaysia, it is evident that the application of current Japanese standards to the commercial sector would be rather difficult compared to the industrial sector.

The reasons for this are as follows:
(1) In the context of Japanese standards, a more in-depth investigation of the construction standards of existing buildings is necessary, since they include revision concerning heat loss, etc; (2) old buildings have old facilities of low energy efficiency, but it is rather difficult to replace such facilities with modern ones under present economic conditions; and (3) the energy price difference between Malaysia and Japan makes energy investment in Malaysia less feasible.

Though Japanese standards were established on the basis of technical and economic appropriateness and are supported by every commercial sub-sector in Japan, they could be applied as a basis for setting long-term standards for Malaysia, by making adjustments for climate and other environmental differences.

Accordingly, it seems realistic to apply Japanese standards and guidelines to Malaysia in a step-by-step manner.

The following is an outline of the plan.

1. Target : To attain the current level of energy efficiency in Japan within ten years
2. Periods and duration : Preceding term of 4 years and latter term of 6 years
3. Preceding four years: Soft approach (Management, operation and maintenance)
4. Latter six years:
   - Application of current Japanese standards to new facilities
   - Application of energy efficiency standards to existing facilities requiring relatively small investment
   - In the case of equipment renovation, standards equivalent to those for new equipment could be applied.

On the other hand, the necessity and technological level of energy efficiency in the industrial sector seems more advanced compared to the commercial sector. And the promotion of energy efficiency in soft aspects such as management, operation and maintenance is an important management target. However, there are still old types of energy-consuming facilities whose energy efficiency is markedly different from new ones.

In terms of also strengthening the international competitiveness of Malaysian products, the application of Japanese standards and guidelines are considered to be highly significant.

In the case of the industrial sector, it is recommended that the standards portion of Japanese criteria be adopted in the preceding four years and the targeted portion in the latter six years.

	Category	Preceding 4 years	Latter 6 years
Commercial sector	New	Soft aspects (management, operation and maintenance)	Current Japanese standards
	Existing		Minimizing investment
	Renovation		Current Japanese standards
Industrial sector		Standards portion of Japanese criteria	Targeted portion of Japanese criteria

7-1-1 International Comparison of Energy Efficiency Standards

For proper establishment of Malaysian energy efficiency standards, the study team surveyed the situation of two developing countries, Thailand and Turkey, for reference. Table 7-1 shows the simplified result of comparison. In this table, currently proposed Malaysian Standards are also described. Japanese standards, which form the basis of this study report, and cover almost all aspects of energy efficiency in industrial and commercial sectors, are not described here.

Turkey has no energy efficiency standards for the time being. However, they are trying to establish them in near future. On the other hand, Thailand passed a law including energy efficiency standards in 1992.

Compared to the proposed standards of Malaysia, Thai's standards specify the efficiency of electrical equipment. The New Building Code of Thailand also specifies only the energy efficiency of electrical equipment installed in the buildings.

Table 7-1 International Comparison of Energy Standards

Categories	Items	Malaysia (Planned)	Thailand	Turkey
Commercial Sector	Air-Conditioner		water-cooled Air Conditioner	Standards are not included in the regulations for the rational use of energy. The Turkish government, with the collaboration of the Energy Conservation Coordination Board, is planning to prepare guidelines for the rational use of energy in the following fields. 1. Improvement of fuel combustion 2. Improvement of heating, cooling, heat transfer, etc. 3. Prevention of heat loss 4. Recovery and utilization of waste heat 5. Improved conversion from heat to power 6. Prevention of electricity loss 7. Improved conversion from electricity to power
			Air-cooled Air Conditioner	
			Package Unit	
			Window/Split Type	
	Lighting System		Fluorescent Tube	
	Building Code		New Commercial Building Code	
			Air-conditioned Efficiency	
			Lighting Efficiency	
Industrial Sector	Motor System		Variable Speed System	
			High Efficiency Motor	
			Single-and Three-Phase Induction Motor	
Electrical Appliance	Energy-Consuming Items	Freezers		
		Clothes Washers		
		Lamps		
		Transformer		
		Thermal Storage Water Heater		
		Television		
		Video Monitors		
		Vacuum Cleaners		
	Scheduled Products	Ballasts for Fluorescent Lamps		
		Fans(Box/Ceiling/Sand/Table/ Wall)		
		Refrigerators		
		Room Air Conditioners		

The study team appreciates such trends as establishing the standards of electrical equipment as the initial step of energy efficiency promotion activities. And this could be easy to control by asking electrical equipment manufacturers, users and traders to obey the regulations. In addition, manufacture of electrical equipment is a major industrial area in Malaysia, so energy efficiency promotion of electrical equipment could render considerable impact on other industrial and commercial areas.

However, as a study in Malaysia focusing on overall energy efficiency of the commercial and industrial sectors, the energy efficiency of electrical equipment plays a rather small part of total consumption. Therefore, the present standards of Thailand, proposed standards of Malaysia and situation of Turkey could not be adopted as a model of Malaysian standards.

The capacity of Malaysia to tackle higher standards of energy efficiency is easier than these two countries, because of rapid economic growth and industrial maturity. For these reasons, it is recommended that the target of energy efficiency in Malaysia be Japan.

Current standards of energy efficiency in Japan have been cultivated over the past twenty-five years through the efforts and cooperation of the government and private sector. Malaysia's adoption of various current standards in Japan is rather difficult to realize concurrently. So the study team extended the time span to ten years instead of twenty-five years as in the case of Japan.

7-1-2 Commercial Sector (Preceding 4 years)

The following three categories of standards could be easily adopted in Malaysia, because these focus on soft aspects and require nil or minimal investment. Therefore it is possible to apply them as standards of the preceding four years.

1. Lighting intensity (Table 7-2)
2. Room environment (Table 7-3)
3. Electricity standards (Table 7-4)

Recommended Malaysian standards are described in the following tables.

Table 7-2 Lighting Intensity

Unit : Lux

Hotel	Reception (Front desk)	750-1,500
	Porch, office, kitchen, desk in guest room, washing basin	300-750
	Banquet hall	200-500
	Hall, restaurant	150-300
	Lobby, restroom	100-200
	Corridor, staircase, guest room, bath room	75-150
Shopping center	Show window locations, demonstration corner	1,500-3,000
	Information desk, standards display areas	1,000-1,500
	Important parts of facilities, discount selling corner, consulting corner	750-1,000
	Cash registers, escalator entrances, packing desk	750-1,000
	Elevator hall, escalator, normal area	500-750
	Normal floor (higher floor), normal demonstration corner, negotiating room	300-500
	Reception room	200-300
	Restroom, toilet, stair case, corridor	150-200
Hospital	Operating room	50-1,500
	Conference room, out patient room, office room, entrance hall, emergency treatment room, delivery room, laboratory, pharmacy, library, nurse room	300-750
	Dinning room, service room, examination room, isotope room	200-500
	Nursery, records room, waiting room	150-300
	Ward, X-ray room, bath room, sterilizing room	100-200
	Anesthesia room, rehabilitation room, changing room, washroom, laundry	75-150
Office	Office, design room, entrance hall	750-1,500
	Reception room, waiting room, elevator hall	200-500
	Electricity room, machine room	300-750
	Reception area	300-750
	Corridor, staircase	100-200
	Tea room	75-150

Table 7-3 Room Environment

Temperature	Temperature setting Temperature difference during cooler operation	26℃-28℃ Temperature difference between inside and outside should be 7℃
Humidity Wind velocity		40-70% Below 0.5 m/s
Suspended solid		Below 0.15 mg/m^3
CO		Below 10 ppm
CO_2		Below 1,000 ppm

Table 7-4 Standards of Electricity Load

Demand ratio of transformer	Maximum electricity(kW)/Capacity(kW) x 100 : Maximum 80 % Below 60 % is recommended.
Load of transformer	Average electricity(kW)/Maximum demand(kW) x 100 : Above 60 % is recommended.

7-1-3 Commercial Sector (Latter 6 Years)

In this section, energy efficiency criteria are specified for heat loss through walls and windows of buildings, air-conditioning systems, ventilation systems, lighting systems and hot water systems. A detailed calculation of energy efficiency and a comparison between standards and calculated values are required. And if energy efficiency is lower than the standards, it will be necessary to adopt appropriate measures according to the guidelines described in the next section.

(1) Prevention of Heat Loss through External Walls, Windows and Others

By keeping the perimeter annual load (PAL) within the standards value, high energy efficiency could be achieved. As the standards value depends largely on the size of building and location, Japan values can not be applied for Malaysia. Taking into account the Malaysian environment and climate, further study is required.

$$PAL = \frac{\text{Annual heat load of the indoor peripheral spaces (Mcal/Year)}}{\text{Total floor area of peripheral spaces } (m^2)}$$

Forms of heat that should be taken into consideration include the heat penetration, sunlight, heat generated internally and heat input or loss caused by air intake.

(2) Effective Utilization of Energy in Relation to Air-conditioning Equipment

The energy consumption coefficient of air-conditioning (CEL/AC) is used to determine the level of energy efficiency. Unlike PAL, the Japanese standard could be applied in Malaysia.

$$\text{CEC/AC (Coefficient of Energy Consumption for Air Conditioning)} = \frac{\text{Annual energy consumption of air-conditioners (Mcal/Year)}}{\text{Virtual air-conditioning load of building (Mcal/Year)}}$$

(Virtual air-conditioning load) = (Intake air) + (Heat penetration)
+ (Sunlight) +(Heat generated internally) +(Others).

The heat of intaken open air based on the amount calculated by the following equations.

Hotel or Inn	V=3.9 Af
Hospital	V=4.0 Af
Shopping center	V=20 Af / N

V, Af and N in the above equations represent the following respective values.

V	Intake volume of open air (unit: cubic meters per hour)
Af	Floor area (unit: square meters)
N	Floor area per capita for each situation (unit: cubic meters)

The standard values of CEC/AC for various types of buildings are listed in Table 7-5.

(3) Effective Utilization of Energy in Relation to Lighting Apparatus

The energy consumption coefficient of lighting (CEC/L) is used to determine the level of energy efficiency.

$$\text{CEC/L (Coefficient of Energy Consumption for Lighting)} = \frac{\text{Annual energy consumption of lighting system (kcal/Year)}}{\text{Virtual energy consumption of lighting system (kcal/Year)}}$$

The volume of virtual energy consumption for lighting is calculated by the following equation.

$$Es = Ws \times A \times T \times Q1 \times Q2 / 1000$$

In this equation, Es, Ws, A, T, Q1 and Q2 represent the following respective values.

Es	Amount of virtual electricity consumption for lighting (unit: kWh)	
Ws	Standard electricity consumption (unit: watts per square meter)	
A	Floor area (unit: square meters)	
T	Annual lighting hour (unit: hours)	
Q1	Factors in the following for each type of lighting apparatus	
	(Lighting apparatus with special measures to control glare)	1.3
	(Others)	1.0
Q2	Factors in the following for purpose of use and luminous intensity	
	(Sales rooms of shop selling goods or office room)	L / 750
	(Classroom of a school)	L / 500
	(Others)	1.0
	In this, L represents the nominal luminous intensity (unit: lux)	

The standard values for CEC/L for various types of buildings are listed in Table7-5.

(4) Effective Utilization of Energy in Relation to Hot Water Supply Systems

The energy consumption coefficient of hot water (CEC/HW) is used to determine the level of energy efficiency.

$$\text{CEC/HW (Coefficient of Energy Consumption for Hot Water Supply)} = \frac{\text{Annual energy consumption of hot water system (kcal/Year)}}{\text{Virtual load of hot water system (kcal/Year)}}$$

The virtual hot water supply load is calculated by the following equation.

$$L = V \times (T1 - T2)$$

In this equation, L, T1 and T2 represent the following respective values.

L	Virtual hot water supply load (unit: kilocalories)
V	Volume of used hot water (unit: liters)
T1	Temperature of hot water used (unit: °C)
T2	Temperature of hot water for each location (unit: °C)

The standard values for CEC/HW for various types of buildings are listed in Table7-5.

(5) Effective Utilization of Energy in Relation to Elevators

The energy consumption coefficient of elevators (CEC/EV) is used to determine the level of energy efficiency.

$$\text{CEC/EV (Coefficient of Energy Consumption for Elevators)} = \frac{\text{Annual energy consumption of elevators (kcal/Year)}}{\text{Virtual energy consumption of elevators (kcal/Year)}}$$

The volume of virtual energy consumption for elevators is calculated by multiplying the amount of virtual electricity consumption by the transport capacity factor.

The amount of virtual electricity consumption is calculated by the following equation.

$$Es = L \times V \times Fs \times T / 860$$

Es	Amount of virtual electricity consumption (unit: kWh)	
L	Carrying load (unit: kilograms)	
V	Rated speed (unit: meters per minute)	
Fs	Factors shown in the following for rated speed	
	(120 m per minute or faster)	1 / 35
	(Slower than 120 m per minute)	1 / 20
T	Annual operation hours (unit: hours)	

The transport capacity factors are to be calculated by the following equation.

$$M = A1 / A2$$

M	Transport capacity factor	
A1	Standard transport capacity for respective conditions of the applicable building in the following:	
	(Building exclusively occupied by a single company)	0.25
	(Other cases)	0.20
A2	Planned transport capacity calculated by dividing the transportable number of passengers in five minutes by the number of people who use the elevators.	

The standard values of CEC/EV for various types of buildings are listed in Table 7-5.

Table 7-5 Standard Value for Energy Efficiency in New Buildings

	Hotel	Hospital	Shopping	Office	School
1. PAL	Detailed study is required taking into account Malaysian environment and climate.				
2. CCEC/AC	2.50	1.70	1.50	1.50	1.50
3. CCEC/L	1.20	1.20	1.00	1.00	1.00
4. CCEC/HW	1.60	--	--	--	--
5. CCEC/EV	--	--	--	1.00	--

7-1-4 Industrial Sector (Preceding four years)

Malaysia, one of the most industrialized countries in Asia, seems somewhat behind in the promotion of energy efficiency. However, judging from the steady achievements of industrialization and the national character, it would not be so difficult for Malaysian industries to absorb the methods of energy efficiency promotion that advanced countries, in the area of energy-efficiency promotion, have cultivated by long-term research and development works. For that purpose, energy consciousness at management level is the most important factor. Consequently, it seems possible for the standards portion of Japanese criteria to be adopted in the preceding four years and the targeted portion in the latter six years.

Energy Efficiency Standards concerning the following items are stipulated.

1. Rationalization of fuel combustion system
2. Rationalization of heating, cooling and heat transfer system
3. Prevention of heat loss due to radiation and transmission
4. Recovery and utilization of waste heat
5. Rationalization of systems to convert heat into motive power
6. Prevention of electric power loss due to resistance and other factors
7. Rationalization of systems to convert electricity into motive power, heat, etc.

(1) Rationalization of Fuel Combustion Systems (Combustion Facilities)

1) Air ratio

The owner of a facility should manage the air ratio according to management standards specified by the type of combustion equipment and the fuel used therein. Table 7-6 and Table 7-7 show the typical air-ratio standards for boilers and industrial furnaces.

Table 7-6 Typical Air-ratio Standards of Boilers

Categories	Load (%)	Standard Air Ratio Figures				
		Solid Fuel		Liquid Fuel	Gaseous Fuel	Blast Furnace Gas, etc.
		Fixed Bed	Fluidized Bed			
Utilities	75-100	--	--	1.05-1.20	1.05-1.10	1.20
Others						
Generated Steam 30 t/h≦	50-100	1.30-1.45	1.20-1.45	1.10-1.25	1.10-1.20	1.20-1.30
10 ≦ <30 t/h	50-100	1.30-1.45	1.30-1.45	1.20-1.30	1.20-1.30	--
5 ≦ <10 t/h	50-100	--	--	1.30	1.30	--
< 5 t/h	50-100	--	--	1.30	1.30	--

Table 7-7 Standard Air Ratio Figures for Furnaces

Categories	Standard Air Ratio figures		
	Types of Furnaces		
	Continuous	Batch	Remarks
Melting Furnace for Metal Casting	1.30	1.40	
Heating Furnace for Continuous Steel Casting	1.25	--	
Metal Heating Furnace other than for Continuous Steel Casting	1.25	1.35	
Metal Heat Treatment Furnace	1.25	1.30	
Petroleum Heating Furnace	1.25	--	
Thermal Cracking & Reforming Furnace	1.25	--	
Cement Kiln	1.30	--	
Coal Calcining Furnace	1.30	1.35	
Drying Furnace	1.30	1.50	Combustion area only

2) Measurement and recording

Fuel feed rate etc., should be measured and recorded periodically by setting management criteria.

3) Maintenance and inspection

Combustion facilities should be maintained and inspected periodically by setting management criteria.

4) Others

When combustion facilities are newly constructed, a combustion system that can control fuel feed rate and air ratios should be introduced.

(2) Rationalization of Heating, Cooling and Heat Transfer Systems (Heat Utilizing Facilities)

1) Management standards

Table 7-8 shows management standards of heating, cooling and heat transfer systems.

Table 7-8 Management Standards of Heating, Cooling and Heat Transfer Systems

Facilities	Management standards	Purpose
Heater, cooler, dryer, heat exchanger using heating agent such as steam	Temperature, pressure and quantity of heating agent, both of necessary and supplied ones	Avoid excess supply of heating agent
Industrial furnace for heating and heat treatment	Establishment of management standards in accordance with the structure of facility, characteristics of heating agent, procedure of pre-treatment and post-treatment	Improvement of heating pattern
Heating facility	Quantity and location of materials heated or cooled	Avoid excess load or insufficient load
Multi-heating facility	Improve overall heat efficiency	Optimization of load
Process of repeated heating		Reduction of idling time for waiting
Facility of batch operation		Centralized operation
Boiler feed water	Quality control of water	Prevention of scale accumulation and sludge precipitation on heat transfer surface

2) Measurement and record

Temperature of heated materials, etc., should be measured and recorded periodically by setting management criteria.

3) Maintenance and inspection

Boilers and other heat-utilizing facilities should be maintained and inspected periodically by setting management criteria.

(3) Prevention of Heat Loss Due to Radiation and Transmission (Heat-Utilizing Facilities)

1) Management standards

Table7-9 shows management standards for the prevention of heat loss due to radiation and transmission. Table 7-10 describes surface temperature standards of furnace wall.

Table7-9 Prevention of Heat Loss Due to Radiation and Transmission

Items	Measures
Transporting pipe of heating agent and heat-using facility	Thermal insulation works of heat-utilizing facilities should be executed according to standards.
Fire-proof brick	Fireproof brick works of heat-utilizing facilities should be executed according to standards.
Outer surface temperature of industrial furnace	Refer Table-7-10

Table 7-10 Surface Temperature Standards of Furnace Wall

Internal Temperature of Furnace (℃)	Standards Surface Temp. of Furnace Wall (℃)		
	Ceiling	Side Wall	Exposed Bottom
1,300 ≦	140	120	180
1,100 ≦ < 1,300	125	110	145
900 ≦ < 1,100	110	95	120
< 900	90	80	100

2) Measurement and record

Heat loss conditions should be measured and recorded periodically by setting 'management criteria.

3) Maintenance and inspection

To prevent heat loss, etc., maintenance and inspection should be executed periodically by setting management criteria.

(4) Recovery and Utilization of Waste Heat (Waste Heat Recovery System)

1) Energy standards

The waste heat recovery ratio should be increased to a 'standard figure' by setting management criteria. Standard figures for the temperature of boiler exhaust gas and the waste heat recovery ratio of furnaces are shown in Tables7-11 and 7-12.

Table 7-11 Standard Temperatures of Boiler Exhaust Gas

Categories	Standard Figures for Temperature of Exhaust gas (℃)				
	Solid Fuel		Liquid Fuel	Gaseous Fuel	Blast Furnace Gas, etc.
	Fixed Bed	Fluidized Bed			
Utilities	--	--	145	110	200
Others					
Generated Steam 30 t/h≦	200	200	200	170	200
10 ≦ <30 t/h	250	200	200	170	--
5 ≦ <10 t/h	--	--	220	200	--

Table 7-12 Standard Waste Heat Recovery Ratios of Furnaces

Exhaust Gas Temperature (℃)	Categories by Capacity	Standard Ratio of Waste Heat Recovery (%)
< 500	A & B	25
500 ≦ < 600	A & B	25
600 ≦ < 700	A	35
	B	30
	C	25
700 ≦ < 800	A	35
	B	30
	C	35
800 ≦ < 900	A	40
	B	30
	C	25
900 ≦ < 1,000	A	45
	B	35
	C	30
1,000 ≦	A	45
	B	35
	C	30

Notes (1) Category A: Rated Capacity is above 20 million kcal/h.
B: Rated Capacity is above 5 million kcal/h and below 20 million kcal/h.
C: Rated Capacity is above 1 million kcal/h and below 5 million kcal/h.

(2) Waste Heat Recovery Ratio:
Ratio of Recovered Heat to Sensible Heat of Exhaust Gas from Furnace

2) Measurement and record

Temperature, heat duty and heated materials, etc. should be measured and recorded periodically by setting management criteria.

3) Maintenance and inspection

Facilities of waste heat recovery should be maintained and inspected periodically by setting management criteria.

(5) Rationalization of Systems to Convert Heat into Motive Power (Co-generation System)

1) Energy standards

Table 7-13 shows standards for rationalization of systems to convert heat into motive power.

Table 7-13 Rationalization of Systems to Convert Heat into Motive Power

Items	Measures
Co-generation such as boiler, gas turbine, gas engine, diesel engine	Improve overall efficiency depending on load change
Utilization of extract turbine and back pressure turbine in co-generation system	Decrease back pressure of extract turbine and back pressure turbine

2) Measurement and record

Periodical measurement and recording of energy efficiency corresponding to load change are required.

3) Maintenance and inspection

A co-generation system should be maintained and inspected periodically by setting management criteria.

(6) Prevention of Electric Power Loss Due to Resistance and Other Factors

1) Energy standards

Table7-14 shows standards for prevention of electric power loss due to resistance and other factors.

Table7-14 Prevention of Electric Power Loss Due to Resistance and Other Factors

Items	Measures
Transformer	Maintain proper demand ratio Adjust number in operation and proper load distribution
Receiving and distributing facilities	Shorten route of wire distribution and adopt proper electricity voltage, by appropriate layout and modification of distribution method. (Decreasing distribution loss)
Power factor	Above 90%

2) Measurement and record

Electricity consumption, etc. should be measured and recorded periodically by setting management criteria.

3) Maintenance and inspection

The electricity receiving and distribution system, etc. should be maintained and inspected periodically by setting management criteria.

(7) Rationalization of Systems to Convert Electricity into Motive Power, Heat, etc.

1) Energy standards

Table 7-15 shows standards for rationalization of systems to convert electricity into motive power, heat, etc.

Table 7-15 Energy Standards

Items	Measures
Power facilities	Stop during non-operation
Multiple-operation of motors	Adjust number in operation and proper load allocation
Pump, fan, blower, compressor	Control of number in operation, rotation control; rearrange piping and impeller cut after reviewing utilization pressure and outlet quantity
Lighting	Set up management standards Reliable extinguishing of lights to avoid excess and unnecessary lighting
Use of electricity	Set up management standards of voltage, current, power factor and demand ratio

2) Measurement and record

Voltage and others should be measured and recorded periodically by setting management criteria.

The illumination intensity of the lighting system should be measured and recorded additionally.

3) Maintenance and inspection

Table 7-16 shows maintenance and inspection measures.

Table 7-16 Maintenance and Inspection

Items	Measures
Power plant	Periodical maintenance and inspection to decrease mechanical loss of loaded machines and motive power transmission parts
Pump, fan, blower and compressor	Periodical maintenance and inspection for prevention of fluid leakage and decreasing piping resistance
Lighting	Proper cleaning and replacement of lighting apparatus and lamps

7-1-5 Industrial Sector (Latter 6 years)

After realization of the promotion plan of the preceding four years, Malaysia would establish the energy-consciousness, sufficient human resources and technical capability in industrial management to challenge more severe standards of energy efficiency. The following are current targeted standards of Japan and could be realized using the guidelines described in the next section.

(1) Combustion Facility

1) Air ratio

Target air ratios for boilers and furnaces are shown in Table 7-17 and Table 7-18.

Table 7-17 Target Air Ratios for Boilers

Categories	Load (%)	Target Figure of Air Ratio				
		Solid Fuel		Liquid Fuel	Gaseous Fuel	Blast Furnace Gas, etc.
		Fixed Bed	Fluidized Bed			
Utilities	75-100	--	--	1.05-1.10	1.05-1.10	1.15-1.20
Others						
Generated Steam 30 t/h≦	50-100	1.20-1.30	1.20-1.25	1.05-1.15	1.05-1.15	1.20-1.30
10 ≦ <30 t/h	50-100	1.20-1.30	1.20-1.25	1.20-1.25	1.20-1.25	--
5 ≦ <10 t/h	50-100	--	--	1.20-1.30	1.20-1.25	--
< 5 t/h	50-100	--	--	1.20-1.30	1.20-1.25	--

Table 7-18 Target Air Ratios for Industrial Furnaces

Categories	Target Figures of Air Ratios		
	Types of Furnaces		
	Continuous	Batch	Remarks
Melting Furnace for Metal Casting	1.25	1.30	
Heating Furnace for Continuous Steel Casting	1.20	--	
Metal Heating Furnace other than Continuous Steel Casting	1.20	1.30	
Metal Heat Treatment Furnace	1.20	1.30	
Petroleum Heating Furnace	1.25	--	
Thermal Cracking & Reforming Furnace	1.25	--	
Cement Kiln	1.25	--	
Coal Calcining Furnace	1.25	1.35	
Drying Furnace	1.30	1.50	Combustion Area only

2) Air ratio control

Adoption of air ratio control by adjusting fuel supply in accordance with combustion facilities, type of fuel, load and burning performance, is required.

3) Ventilation

Adjustable ventilation by air quantity and furnace pressure is needed.

(2) Rationalization of Heating, Cooling and Heat Transfer Systems

1) Improvement of facilities

Table 7-19 shows measures of improvement of facilities for rationalization of heating, cooling and heat transfer systems.

Table 7-19 Improvement of Facilities

Items	Measures
Furnace wall	Increase radiation rate by improving performance and shape
Transferring surface	Increase radiation rate by improving performance and shape
Heat exchange	Adopt higher heat coefficient material
Furnace, stage, apparatus and cart	Decrease heat capacity
Direct burner / Combustion in liquid	Adopt if possible
Heating by multi-stage effective evaporator	Increase number of stages to get higher overall efficiency

Distillation column	Decrease reflux ratio by appropriate operating pressure and increasing number of stages
Heat exchanger	Improve heat efficiency by expansion and proper configuration of heat exchangers
Industrial furnace	Multi-stage utilization of heat by combination of high temperature and low temperature furnaces
Processes requiring repeated heating, etc.	Adopt continuous process, combining process, shortening process or slimming process
Insulator	Increase thickness Adopt low heat transfer coefficient Double insulator
Openings of heat utilization facilities	Decrease number of opening parts Double door
Rotating or connecting parts of heat utilization facilities	Prevent leakage by sealing
Transferring piping of heat agent	Decrease radiating surface by route rationalization
Steam utilization facilities and transferring facilities of high temperature material	Decrease heat loss by placing cover over

2) Management standards

Targeted temperatures of furnace outer surface are shown in Table 7-20.

Table7-20 Targeted Temperatures of Furnace Outer Surface

Internal Temperature of Furnace (℃)	Target Figures of Surface Temp. of Furnace Wall (℃)		
	Top	Side Wall	Exposed Bottom
1,300 ≦	120	110	160
1,100 ≦ < 1,300	110	100	135
900 ≦ < 1,100	100	90	110
< 900	80	70	90

(3) Recovery and Utilization of Waste Heat (Waste Heat Recovery System)

1) Improvement of facilities

It is important to make efforts to increase ratio of heat recovery to 'target figure'. Table 7-21 shows measures of improvement of facilities for recovery and utilization of waste heat.

Table 7-21 Improvement of Facilities

Items	Measures
Chimney or piping transferring waste heat	Keep waste temperature high by preventing air leakage and strengthening insulator
Waste heat recovery facilities	Improve performance of heat-transferring surface and shape Increase heat-transferring area
Waste heat	Study effective utilization of heat

2) Recovery standards

Target temperatures of exhaust gas from boilers and waste heat recovery ratio of industrial furnaces are shown in Tables 7-22 and 7-23.

Table 7-22 Targeted Flue Gas Temperature of Boilers

Categories	Target Temperature of Exhaust gas (℃)				
	Solid Fuel		Liquid Fuel	Gaseous Fuel	Blast Furnace Gas, etc.
	Fixed Bed	Fluidized Bed			
Utilities	--	--	135	110	190
Others					
Generated Steam 30 t/h≦	180	170	160	150	190
10 ≦ <30 t/h	180	170	160	150	--
5 ≦ <10 t/h	--	300	200	180	--
< 5 t/h	--	320	220	200	--

Table 7-23 Targeted Waste Heat Recovery Ratios of Industrial Furnaces

Exhaust Gas Temperature (℃)	Categories by Capacity	Target Ratio of Waste Heat Recovery (%)	Waste Gas Temp.(℃) (for Reference)	Preheated Air Temp.(℃) (for Reference)
< 500	A & B	30	300	165
500 ≦ < 600	A & B	30	365	200
600 ≦ < 700	A	35	400	270
	B	30	435	230
	C	25	470	195
700 ≦ < 800	A	35	460	310
	B	30	505	265
	C	35	545	220
800 ≦ < 900	A	40	480	395
	B	35	525	345
	C	30	575	295
900 ≦ < 1,000	A	50	430	550
	B	40	535	440
	C	35	590	385
1,000 ≦	A	50	--	--
	B	40	--	--
	C	35	--	--

Notes (1) Category A: Rated Capacity is above 20 million kcal/h
B: Rated Capacity is above 5 million kcal/h and below 20 million kcal/h
C: Rated Capacity is above 1 million kcal/h and below 5 million kcal/h
(2) Waste Heat Recovery Ratio:
Ratio of Recovered Heat to Sensible Heat of Exhaust Gas from Furnace

(4) Rationalization of Systems to Convert Heat into Motive Power (Co-generation System)

Extract turbine or back pressure turbine

If an extracting or backpressure condition of steam is possible, study of modification to the turbine should be considered.

(5) Power plant

Table 7-24 shows measures for improvement of power plant.

Table 7-24 Improvement of Power Plant

Items	Measures
Installation of condenser	Power factor should be above 95% at receiving point
Lighting	Intensity-adjustable switches Control lighting intensity Automatic switch-off
Local lighting Reallocation of lighting apparatuses	Avoid unnecessary lighting over wide area Avoid high-intensity lighting

7-2 General Guidelines for Promotion of Energy Efficiency

7-2-1 Procedure for Promotion of Energy Efficiency

To achieve the standards mentioned in Section 7-1, it is effective to apply guidelines developed by advanced countries in the area of energy efficiency. The guidelines specified below could be adapted not only to the three industrial and three commercial sectors, but also other sectors. And the guidelines could serve as a basic technological structure of the Malaysian Energy Center.

7-2-2 Guidelines for Promotion of Energy Efficiency

(1) Commercial Sector (Table 7-25)

General guidelines on formulation of measures for energy efficiency in existing buildings are classified into the following major categories:

1. Architectural structure of buildings (long range target)
2. Renovation and expansion of facilities (long range target)
3. Operation & maintenance management, life-style and others (short range target)

(2) Industrial Sector (Table 7-26)

General checkpoints on formulation of measures for energy efficiency in the industrial sector are classified into the following major categories:

1. Improvement of fuel combustion in combustion equipment
2. Improvement of heating, cooling, heat transfer, etc., in heat-consuming equipment
3. Prevention of heat loss due to radiation, conduction, etc., from heat-consuming equipment

4. Recovery and utilization of waste heat
5. Improvement of conversion from heat to power in combined heat and power generation equipment
6. Prevention of electricity loss due to resistance, etc., in electrical equipment
7. Improved conversion from electricity to power, heat, etc., in electrical equipment

Short range target (Proceeding 4 years)

Measures for improvement of operations and maintenance, and renovations with small investment.

Long range target (Latter 6 years)

Measures for improvements, renovations and modification, or installation.

Table 7-25 General Guidelines for Promotion of Energy Efficiency in Commercial Sector(1/4)

Building Structure	Buildings	Thermal Insulation	Renovate walls and around windows Renovate roofs and floors Introduce thermal insulation in glass windows
		Shelter from the sun	Install paper screens and sliding shutters Install blinds and curtains Install louvers, eaves and penthouses Renovate glass windows (thermal ray absorption, adjusting films, etc.) Install sprinklers and water storage system on roofs
		Prevention against draft	Renovate front doors Introduce weather strips and airtight windows Repair slits and renovate weather strips on walls
		Lighting	Install reflecting louvers and eaves Conversion to light colored interior finishing
		Ventilation	Renovate sashes to make open windows
		Passive solar function	Install attached greenhouses Renovate around windows to collect heat
Renovation and expansion	Air-conditioning	Waste heat recovery	Overall air heat exchanger Heat pump Heat recovery from exhaust gas and waste water Heat recovery from cooling water from chillers Reutilize return air from air-conditioning
		Heat source	Conversion to regenerative type Renovate regenerative system Alternate energy source and heat sink Alternate chiller types Utilize electricity during night time Adopt solar type air-conditioning Improve operation controlling system of heat source

Table 7-25 General Guidelines for Promotion of Energy Efficiency in Commercial Sector (2/4)

Renovation and expansion	Air-conditioning	Heat conveying	Conversion to Variable Air Volume (VAV) system Conversion to Variable Water Volume (VWV) system Reinforce thermal insulation of ducts and piping Reduce static pressure of fans by renovation of ducts Alternate efficient fans and pumps Increase temperature difference and decrease flow rate
		Air –conditioning	Review zoning conditions and increase number of zoning divisions Alternate air-conditioning system Introduce control system for suction air Improve air distribution Conversion to efficient speed control system Improve control system and expand control zone
		Prevention of draft	Adjust room pressure
	Hot water supply	Hot water supply	Improve hot water supply system Reinforce thermal insulation Improve drainage and sanitation system
	Lighting	Optimum lighting	Add control for illumination intensity
		Restriction of zone	Divide wiring circuit of lighting system Automatic on-off system by timer-switch Individual switches for each lighting appliance
		Efficient lighting	Introduce sectional lighting Change to efficient lamps Renovate or alternate lighting appliances
	Electricity	Power factor control	Introduce power factor control system
		Demand control	Adopt demand control system Reduce contracted or maximum demand
	Lift	Control	Adopt inverter control

Table 7-25 General Guidelines for Promotion of Energy Efficiency in Commercial Sector (3/4)

Operation /maintenance /management /living style and others	Operation management	Suction air control	Reduce suction air volume Abolish air intake during start-up Adjust suction air according to CO_2 content
		Optimum air-Conditioning	Frequent manual control Automatic control Alternate setting temperature for water and air supply
		Temperature and humidity	Alternate setting temperature & humidity Adjust or introduce control by schedule of atmospheric air Relax temperature & humidity conditions during off-time
		Restriction of operation	Air-conditioning stoppage in unoccupied rooms Reduce operating hours and stop air-conditioning during overtime Local air-conditioning
		Operation management	Adjust setting temperature & pressure for heat source Conduct or adjust control for operating number of heat sources in operation Adjust volume of regenerative vessels Control & adjust fans and pumps in operation
		On-off control of lighting system	Reduce excess lighting in working space Reduce and restrict lighting hours before working time
		Hot water	Abolish hot water supply Reduce & restrict time & scope Lower temperature Cut-off boilers and hot water vessels according to water temperature
		Power system	Thin out operation of elevators and escalators

Table 7-25 General Guidelines for Promotion of Energy Efficiency in Commercial Sector (4/4)

Operation /maintenance /management /living style and others	Maintenance management and others	Maintenance management	Inspect and repair air-leakage in ducts Clean air-conditioner coils & filters Clean chiller, condensers & evaporators Inspect & repair automatic control instruments Repair and exchange low efficiency equipment Reinforce monitoring system by increasing measuring equipment Clean lighting appliances and exchange aged lamps Increase lighting efficiency by cleaning inner surfaces of rooms
		Living style	Extinguishing lights and thin out lighting in corridors and halls Turn lighting switches on/off Extinguish lights around windows Regular opening / closing of blinds Regular closing of front & stairwell doors Frequent opening / closing of windows Publication and request for energy conservation to residents

Table 7-26 General Guidelines for Promotion of Energy Efficiency in Industrial Sector (1/8)

Improvement of fuel combustion	Burner selection	Type Size Turn down ratio Maintenance Cleaning tip
	Better atomization	Fuel temperature Viscosity Proportion of atomizing air or steam to fuel Fuel pressure Dispersion reagent Emulsified fuel
	Prevention of air intrusion	Furnace pressure control Reduce opening Double door Sealing Shorten door open time
	Advanced automatic control	Fuel air ratio control by oxygen content in exhaust gas Fuel air ratio control by carbon oxide content in exhaust gas Fuel air ratio cascade control Fuel air ratio cross limit control
	Load leveling	Optimum load sharing Operation unit number control Steam accumulator
	Increase flame temperature	Combustion with enriched oxygen Gas atomized fuel oil combustion Fluid bed combustion

Table 7-26 General Guidelines for Promotion of Energy Efficiency in Industrial Sector (2/8)

Improvement of heating, cooling and heat transfer	Heating in industrial furnaces	Optimum heating temperature	Setting work standards
		Search for best heat pattern	Temperature distribution Heating velocity Improve flow of gas in furnace
		Optimum load	Optimum load on furnace bed Load sharing to multiple facilities Load leveling
		Improve furnace shape	
		Decrease heat content of furnace body	Lighten weight
		Increase of flame emissivity	
		Direct heating	Modify to direct firing
	Heating by steam	Adjust steam pressure to proper level	
		Perfect air purge	
		Improve direct steam injection	
	Heat transfer	Decrease of heat transfer resistance	Prevention of scaling Sludge deposit Boiler feed water quality control Chemicals injection Optimum blow off of boiler water Remove Condensate film Defrosting Clean heat transfer surface Soot blowing Filter cleaning
		Improve heat transfer coefficient	High-speed gas flow Jet heating High-speed burner Fluid bed heat transfer Mist cooling

Table 7-26 General Guidelines for Promotion of Energy Efficiency in Industrial Sector (3/8)

Improvement of heating, cooling and heat transfer	Heat transfer	Heat exchange system	Increase number of heat exchangers Minimize energy loss
		Advanced heat exchanger	High heat conductivity material Shape of heat transfer tube Heat exchanger tube arrangement Enlarge heating surface Fin plate Buffer plate Turbulence accelerator
		Start/stop time optimization	Adjust operation plan
	Operation	Decrease load	Air conditioning (temperature, rate of air circulation) Utilize of holding heat of material from previous process Shorten waiting time between processes Shorten furnace idling time Lot concentration Distillation (optimum reflux ratio, selection of feed or extraction tray)
		Improve control method	Decrease margin
	Process	Automation	
		Heat utilization as cascade	Multiple effect evaporator Vapor recompression Increase distillation trays Plant integration Inter-factory energy pooling
		Separation process	Mechanical separator instead of heating process Separation through membrane Adsorption, Extraction Supercritical separation

Table 7-26 General Guidelines for Promotion of Energy Efficiency in Industrial Sector (4/8)

Improvement of heating, cooling and heat transfer	Process	Improve layout	Shorten transport distance Prevent complicated transport Decrease idling time through shortening of transport route
		Operating reactor under less extreme conditions	Improve catalyzer Improve reagent Bio reactor
		Change product specification	Avoid providing quality that surpasses market requirement Material not requiring heat treatment in next process
		Change raw material	Recycle
		Upgrade	Shorten operating time by increasing electric power
		Modify to continuous process	
		Modify to high speed process	
		Process simplification	Hot charge
		Use high-efficiency devices	
Prevention of heat loss due to radiation, conduction, etc	Prevention of leakage		Inspection and repair Selection and maintenance of steam trap Reinforce seals of rotary parts and joints
	Reduce heat radiation surface area		Improve steam piping route Remove unnecessary pipe Shut main valve of unused pipe Insert blind plate
	Insulation		Insulate at flange and valve Use heat insulating material of low heat conductivity Lower emissively of insulator cover Setting cover / Lid Maintenance of insulator Use lightweight heat insulation material for batch furnace (bulk specific gravity <1.3)

Table 7-26 General Guidelines for Promotion of Energy Efficiency in Industrial Sector (5/8)

Prevention of heat loss due to radiation, conduction, etc	Prevent heat loss by exhaust of internal gas	Reduce size of openings Close openings Mount doors on openings Shorten door open time
	Optimum boiler water blow	
Recovery and utilization of waste energy	Source of waste energy	Exhaust gas / Air Exhaust water / liquid / condensate Hot solid / product / ash Mechanical energy (water head) Unused pressure Combustible gas Natural energy (solar energy)
	Usage	Heating material Heat air for combustion or process Preheat boiler feed water Preheat fuel (oil / gas) Steam generation, Power generation Electricity generation Air conditioning
	Measures	Heat exchanger Heat pipe Fluid bed (suspension preheater) Heat pump Heat transport medium Waste heat boiler Vacuum evaporation type water heater Turbine (steam / organic reagent)

Table 7-26 General Guidelines for Promotion of Energy Efficiency in Industrial Sector (6/8)

Improvement of conversion from heat to power	Increase energy efficiency		Steam condition upgrade
			Combined system
			Co-generation
			Recover drive power at depressurization of steam
	Operation improvement in power plant		Improve of turbine
			Nozzle shape
			Vacuum maintenance of turbine condenser (cleaning, water temperature)
			Optimize power plant use
			Variable pressure operation according to load
			Auxiliary equipment load control
			Revolution
			Optimize back and extraction pressure
			Peak shift (use of electricity during midnight hours and holidays, heat storage as ice)
	Improve engine efficiency		
	Rational operation of steam ejector		Optimize number of stages
			Steam pressure
			Supplement by means of vacuum pump
Prevention of electricity loss by resistance	Power transportation		Higher voltage
	Wiring	Minimize length	Arrange receiving facility and load adjustment
			Improve wiring route
			Improve wiring way
			Optimize wire size
			Balance loads between 3-phase
	Transformer		Optimum capacity
			Load allotment, adjust number of operating units
			Connection method
			Cut off when not in use

Table 7-26 General Guidelines for Promotion of Energy Efficiency in Industrial Sector (7/8)

Prevention of electricity loss by resistance	Facilities using electricity		Minimize resistance at contact point
	Improve power factor		Install condenser (capacitor) Power factor control by synchronous generator Avoid low load running of motor
	Operation		Reduce peak demand (Low leveling, demand control)
Improvement of conversion from electricity to power, heat, etc	Motor		High efficiency type Optimum capacity
	Power transmission		Improvement of transmission Transmission belt (material / relaxation degree) Lubrication control
	Operation		Maintain rated voltage Prevent idling Intermittent running
	Fluid transportation	Reduce load	Decrease flow (preventing leakage) Reduce pipe resistance (streamline pipe route, cleaning pipes) Lower suction temperature Selection of transport measures High-efficiency devices Impellers Movable blades
		Optimize equipment capacity	Modify shape of impeller
		Control	Rotation speed control Unit number control
	Electric heating		Hot charge Comparative study between electric and other heating methods

Table 7-26 General Guidelines for Promotion of Energy Efficiency in Industrial Sector (8/8)

Improvement of conversion from electricity to power, heat, etc	Air conditioning	Reduction of load Shape/structure/direction/surroundings of building Induction of outdoor air Total enthalpy heat exchange Prevent outdoor air invasion (automatic doors / curtains) Optimum rate of air circulation Insulation Isolation of heat generating body Lighting facilities Localized air conditioning Zoning (setting different conditions by zone) Far infrared ray heating	
		Ventilation	Lower flow resistance in duct Filter cleaning, fan rpm control Optimum size of humidifier nozzle
		Operation	Cooling water temperature control Water quality control in cooling tower line Clean heat exchanger
	Lighting	Optimum illumination intensity	
		More energy efficient interior finishing of room	Wall color
		Improve lighting fixture arrangements Utilize daylight Switch off of unnecessary Lamps Illumination control Clean fixtures Replace bulbs at proper intervals	
		High efficiency facilities	Lamp