Department of Alternative Energy Development and Efficiency
MINISTRY OF ENERGY

SAMPLE

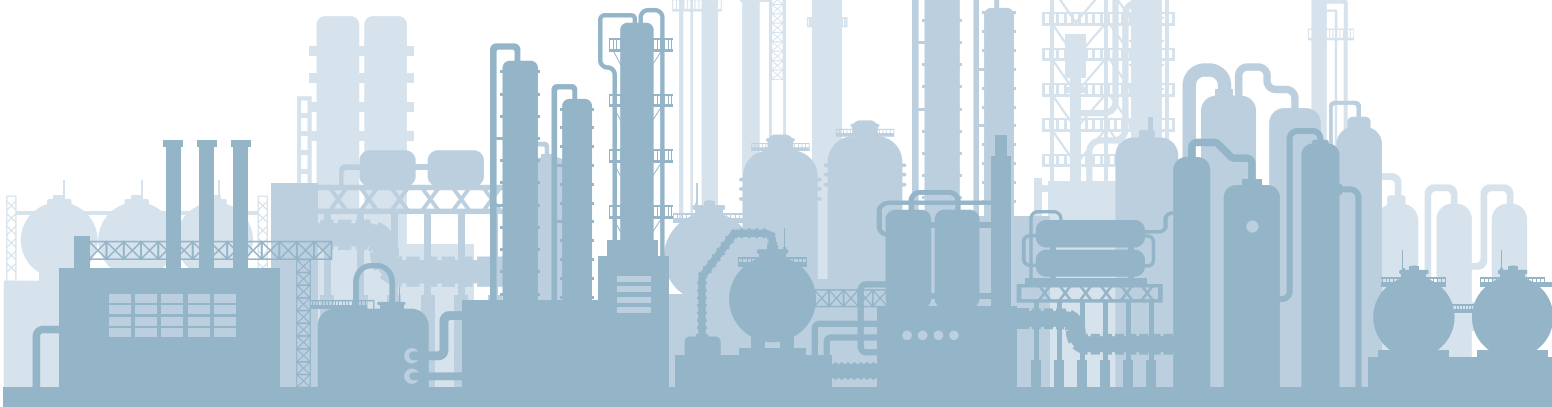
ENERGY MANAGEMENT MANUAL

BASED ON THAI'S ENERGY CONSERVATION GUIDELINE

Created By :

Department of Alternative Energy Development and Efficiency (DEDE)

Energy Conservation Center of Japan (ECCJ)



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20 February 2025
The Energy Conservation Center, Japan

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Revision	Date	Content	Create Engineer	Check Supervisor	Approve Manager
0	10 Jan. 2023	Original			
1	20 Feb. 2025	Change of furnace temp.			

EM Manual for Furnace

(based on Thai EC Guideline)

1. Facility configuration

Capacity : xx t/hr
Type of Furnace : Continuous reheating steel billet furnace, 2 series
Heat Recovery : Air preheater
Fuel : Natural gas

2. Use

Heat treatment of steel billet

3. Energy Conservation Guideline for Furnace

4. Energy Management Manual

(1) Management & control

Item	Management content	Control value, etc.	Remarks
(1) a	Set an air ratio control value (Describe concretely how to observe the state of combustion, measurement of oxygen concentration in waste gas, etc.)	1.14~1.17 (O2% 2.6~3.1)	Operation manual
(1) b	See the standard value in Table 4.1 to set the control value of the air ratio. (In this case, the control value observes the standard value. But if doesn't observe, describe the reason and consider measures.)	1.20 (O2% 3.5)	
(1) c	Manage optimum operation number of furnaces according to the load to enhance energy efficiency	In case, load of 1 unit becomes 80% or more, another unit starts.	Instruction manual
(1) d	Manage pressure and characteristic value of fuel gas. Describe to maintain the draft, operation temperature and load of the design specifications	Supply pressure 30-50kPa xx Pa oo ℃	Purchase agreement Instruction manual
(1) r	Manage the temperature of heated material to avoid excessive heat supply	1100℃	Instruction manual
(1) f	Optimize the heat pattern in the furnace		Operation manual
(1) e	Manage optimum operation speed and amount of material to enhance heating efficiency		Operation manual
(1) s	Shorten waiting time for a lot change （Describe how to shorten.）		Instruction manual

(1) h, i	Set the control values of waste heat recovery rate and flue gas temperature referring to Table 4.2 Waste heat recovery rate Flue gas temperature	 47% 250-300℃	Instruction manual
(1) j	Utilize sensible heat of steel billet by air preheater		
(1) l	Install insulation materials on outer wall of furnace, steam piping, drain piping, etc.		
(1) m	Manage the outer wall temperature of the furnace referring to Table 4.3.	Ceiling :below120℃ Side wall: below 100℃ Bottom :below120℃	Instruction manual
(1) n	Stop auxiliary motors of air supply blower, etc. which are not in use	Stop them in conjunction with main machine	Operation manual
(1) p	Adjust at optimum pressure and flow rate of blower.	xx Pa	Operation manual
(1) q	Operate motors at the rated voltage and current.	Voltage : 220V Rated current for each motor : xx A	Equipment list

(2) Measurement & Recording

Item	Measurement content	Frequency	Remarks
(2) a	Measure and record data necessary for managing combustion status and evaluating performance of combustion facility		Refer to record sheet of operation
	Fuel consumption	once/day	
	Residual oxygen	once/month	
	Temperature of flue gas	once/hour	
	CO2 and CO content in flue gas	once/month	
	Draft value	once/day	
(2) b	Measure and record data necessary for efficient heating of steel billet		Refer to record sheet of operation
	Temperature of steel billet	once/hour	
	Temperature distribution in the furnace	once/hour	
(2) c	Measure and record data necessary for evaluating waste heat recovery and use		Refer to record sheet of operation
	Air flow rate to air preheater	once/hour	
	Air temperature at inlet/outlet of air preheater	once/hour	
(2) d	Outer surface temperature of furnace : ceiling, side wall, bottom	once/month	Refer to record sheet of operation
	Calculate of furnace efficiency	once/month	
(2) e	Measure and record power consumption, voltage, current, etc.	once/day	Refer to record sheet of operation

(3) Maintenance & inspection

Item	Maintenance content	Frequency	Remarks
(3) a	Inspection and cleaning of combustion equipment such as burner, damper, etc. Daily : Inspection of abnormal noise, vibration, combustion status, heating condition, etc. Periodic : Inspection and cleaning of burner etc.	 once/day once/month	Refer to instruction manual
(3) b	Inspection and maintenance necessary for maintaining the heating performance of heating tubes, heat exchangers, etc. Including removal of soot, scale, dirt etc. Inspection Cleaning	 once/year once/2 years (according to inspection result)	 Refer to instruction manual
(3) d	Inspect and maintain air preheater Inspection Cleaning	 once/year once/2 years (according to inspection result)	 Refer to instruction manual.
(3) c	Inspection and maintenance of insulation of outside wall of furnace and piping for hot fluid Visual inspection Maintenance:	 once/month once/year	
(3) f	Inspection and maintenance of motors for pumps and air supply facility Visual inspection of abnormal noise, vibration, etc. Overhaul and cleaning	 once/day once/year	Refer to record sheet of operation Refer to inspection report by maker

(3) g	Inspection and maintenance of clogging and leakage of fluid machine and piping Visual inspection of abnormal noise, vibration, etc. Inspection and maintenance of rotating speed and vibration of fan Visual inspection Overhaul and cleaning	 once/day once/day once/year	Refer to record sheet of operation

(4) 'Necessary measures when installing new facilities' and 'Target Component'

All items in these sections are omitted here, because they should be necessary to consider when equipment and technology are newly installed for energy efficiency improvement.

When introducing new equipment and technologies, it is necessary to set energy-saving targets, to evaluate investment effects, and to decide whether or not to introduce them.
Therefore accumulation of daily operation data necessary for the evaluation based on EM Manual is important.

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0	10 Jan. 2023	Original			
1	20 Feb. 2025	Change of room temp.			

EM Manual for Air-Conditioner (Air-conditioning system)

(based on Thai EC Guideline)

1. Facility configuration

Air handling unit (AHU) : 30,000m^3/h, 3sets
: 43,000 m^3/h, 7sets
Fan coil unit (FCU) : 17.6kW, 20sets
Secondary chilled water pump : 22kW, 4sets

The air-conditioner is composed as figured at the right.
This manual handles only **an Air-conditioning system**, namely air handling units (AHU), fan coil units (FCU), secondary chilled water pumps and their auxiliary equipment. (The area enclosed by the red line.)

2. Control system

(1) Room temperature

AHU : Room temperature is controlled by modulating the flow control valve.

FCU : Room temperature is controlled by opening and closing the solenoid valve.

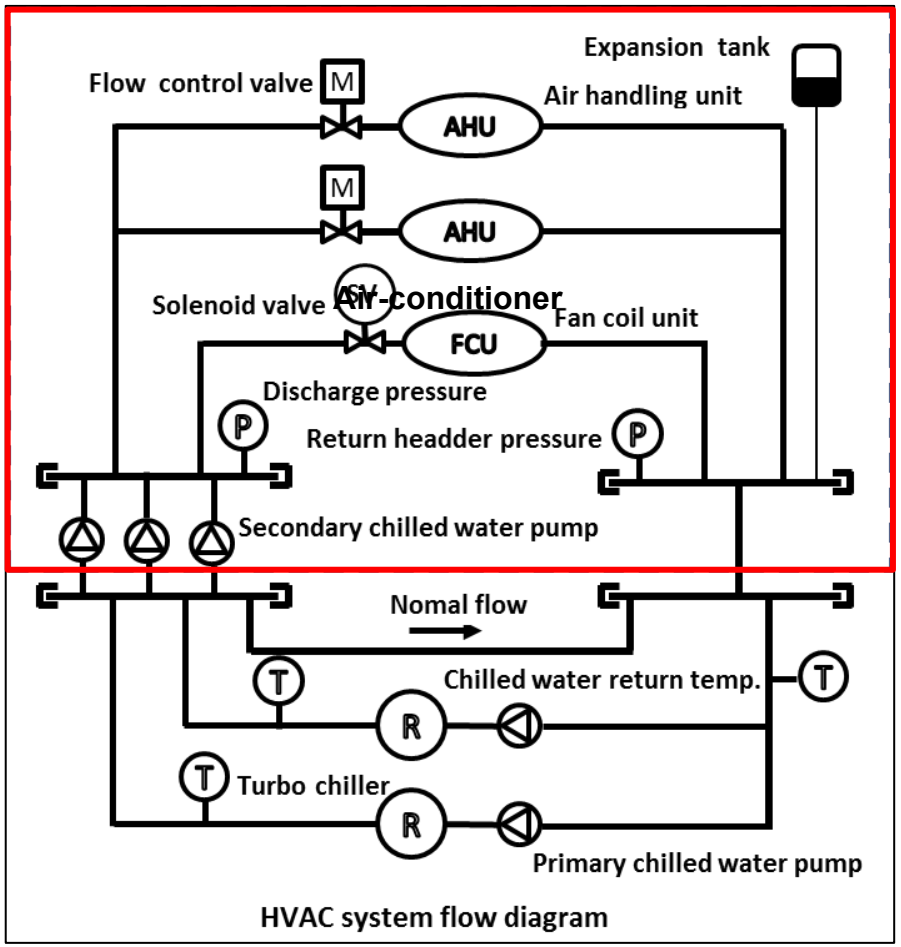
(2) Secondary chilled water pump

The number of pumps to be operated is determined to keep the discharge pressure constant.

3. Use

Air conditioning for a factory building (work room and clean room) and an office

4. Energy Conservation Guideline for Air-conditioner (Thai EC Guideline)



HVAC system flow diagram

5. Energy Management Manual

(1) Management and control

Item	Management content	Control value, etc.	Remarks
(1) a	Set air-conditioning areas Set the control items such as the room temperature, and other parameters in the work room and clean room, etc.	Operating time work room 8:00～17:00 clean room 9:00～17:00 Room temperature work room 25℃ clean room 24℃ Room humidity clean room 40～60% Ventilation work room 800～1,200ppm (CO_2 content in the room) clean room class 7 (ISO standard)	Operation manual
(1) b	Set the control items such as the room temperature, and other parameters in the office area.	Operating time 8:00～18:00 Room temperature 27℃ Room humidity any Ventilation 800～1,200ppm (CO2 content in the room)	Operation manual

(1) e	Implement optimal operation of the cooling water temperature, chilled/warmed water temperature and pressure according to the seasonal changes of the outdoor air conditions	Temperature of chilled water at inlet of AHU 7℃ (Summer) 9℃ (Other seasons)	Operation manual
(1) f	Implement optimal operation of the secondary chilled water pumps according to the load changes. The pumps are managed by automatic multiple units control.	Pressure of the discharge header: 0.3MPa (constant)	Operation manual
(1) h	Stop operation during no-load time such as at night and on holidays. (Specifically define "when unnecessary.")	Operating time work room 8:00～17:00 clean room 9:00～17:00	Operation manual
(1) n	When there are multiple motors, operate the optimal number of them in line with a load.	Automatic multiple units control of the secondary chilled water pumps is adopted	Refer to (1) f
(1) i	Adjust at optimum pressure and flow rate of water feed pump and air supply fan. -Fresh air intake damper in AHU is adjusted to keep a room CO_2 content constant. -Other dampers in AHU are also adjusted to keep room CO2 content constant. -Secondary chilled water pumps are operated by automatic multiple units control .	CO2 content : 800～1,000ppm Damper openings (%) are as follows. -Discharge damper = Fresh air intake damper -Return air damper = 100% - discharge damper -Pressure of the discharge header: 0.3MPa(constant)	Operation manual About adjustment of fresh air intake damper opening, refer to [Notes No1]. Refer to (1) f

(1) j	Operate motors at the rated voltage and current.	Receiving voltage： 250V±13V Operating current: Under rated value	Managing values should be described in the record sheet of operation

(2) Measurement and recording

Item	Measurement content	Frequency.	Remarks
(2) a	Measure and record the items required for control and evaluation of optimal air-conditioning as followings.		Refer to record sheet of operation
	-Room temp., humidity and outdoor air temp.	once/day	
	-CO_2 contents in a room	once/week	
	Measure and record the items required for improving the efficiency of the overall HVAC system.		
	-Inlet and outlet temperature of the chilled water to/from the AHUs	once/day	
	-Inlet and outlet temperature of the cold air to/from the AHUs	once/day	
	-The opening value of the flow control valves	once/day	
	-The pressure loss of the air filter of the AHUs	once/day	
	-The voltage and ampere of the air supply and return fans of the AHUs	once/day	

(2) b	Measure and record the items required for reducing electrical losses **of motors.** -Secondary chilled water pumps voltage and current -Discharge and return header pressure of the secondary chilled water pumps	 once/day once/day	Refer to record sheet of operation
(2) b	Measure and record the items required for evaluating efficiency **of pumps**. -Pump flow rate (Estimating from the characteristic curve is also OK) -Discharge pressure of the pump -Suction pressure of the pump -Power consumption (or voltage and current are acceptable) -Evaluate the efficiency of secondary chilled water pumps	 once/day once/day once/day once/day once/month	Refer to [Notes No2.]
(2) b	Measure and record the items required for calculate the SPCs of air supply and return **fans**. -Air flow rate -Power consumption (or voltage and current are acceptable)	 once a month once a month	

(3) Maintenance & Inspection

Item	Maintenance content	Frequency	Remarks
(3) a	Inspect and maintain the AHUs to be good operating conditions. -Inspection of heat exchanger -Cleaning of heat exchanger and filter. -Inspection of pulley belt, revolution balance of running fan, and wear of bearing, etc. Maker's maintenance Own maintenance	 once/year twice/year (Filter's maintenance interval is depending on inspection result)	 Refer to instruction manual. Refer to order form.
(3) b	Inspect and maintain the AHU automatic control system to be good operating conditions. Maker's maintenance	 once/year	
(3) d	Inspect and maintain insulation of AHUs, FCUs, duct and piping for chilled water. Visual inspection Maker's maintenance	 once/month once/year	
(3) f	Inspect and maintain motors for pumps and air supply facility. Visual inspection of abnormal noise,	 once/day	Refer to record sheet of operation Refer to inspection

	vibration, etc. Overhaul and cleaning	 once/year	report by maker
(3) g	Inspect and maintain clogging and leakage of piping and ducting. Visual inspection : once/day Overhaul and cleaning : once/year	 once/day once/year	

(4) 'Necessary measures when installing new facilities' and 'Target Component'

All items in these sections are omitted here, because they should be necessary to consider when equipment and technology are newly installed for energy efficiency improvement.

When introducing new equipment and technologies, it is necessary to set energy-saving targets, to evaluate investment effects, and to decide whether or not to introduce them.
Therefore accumulation of daily operation data necessary for the evaluation based on EM Manual is important.

[Notes]

No1. (1) i : As the fresh air intake damper opening of the AHU is often left at the initial adjusting, if it is deemed inappropriate, adjust it properly.

No2. (2) b : Calculation of pump efficiency

$$\eta = (Q \times \Delta p) \div W \qquad (1)$$

where η : pump efficiency (-)

Q : water flow rate (m^3/s)

Δp : differential pressure (kPa)

= discharge pressure – suction pressure

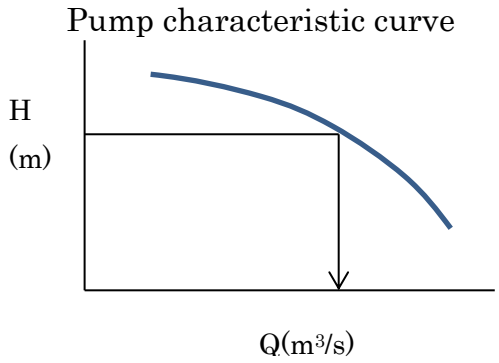
W : power consumption of the pump (kW)

If the water flow rate Q isn't measured, it's estimated from pump characteristic curve as follows.

The first, calculate the total differential head H by the equation (2), and then get the water flow rate Q from the figure presented below.

$$H = 0.102 \times \Delta p \qquad (2)$$

where H : total differential head (m)



Next, if power consumption of the pump isn't measured, calculate it from the equation (3).

$$W = \sqrt{3} \times V \times I \times \cos\theta \qquad (3)$$

where W : power consumption (kW)

V : voltage (kV)

I : current (A)

$\cos\theta$: power factor (-) Get from motor characteristic curve.

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0	10 Jan. 2023	Original			
1	20 Feb. 2025	Change of chilled water temp.			

EM Manual for Air-conditioner (Heat source system)
(based on Thai EC Guideline)

1. Facility configuration

Centrifugal chiller (motor driven) : 500RT, 2sets
Cooling tower : 500RT, 2sets
Cooling water pump : 37kW, 2sets
Cooling tower fan : 7.5kW, 4sets
Primary chilled water pump : 30kW, 2sets

The air-conditioner is composed as figured at the right.
This manual handles only **a Heat source system**, namely centrifugal chillers, primary chilled water pumps and their auxiliary equipment include cooling towers, cooling water pumps.
(The area enclosed by the red line.)

2. Control system

(1) Centrifugal chiller's output

Centrifugal chiller is controlled to keep the chilled water leaving temperature constant by manipulating the centrifugal compressor's suction vane.

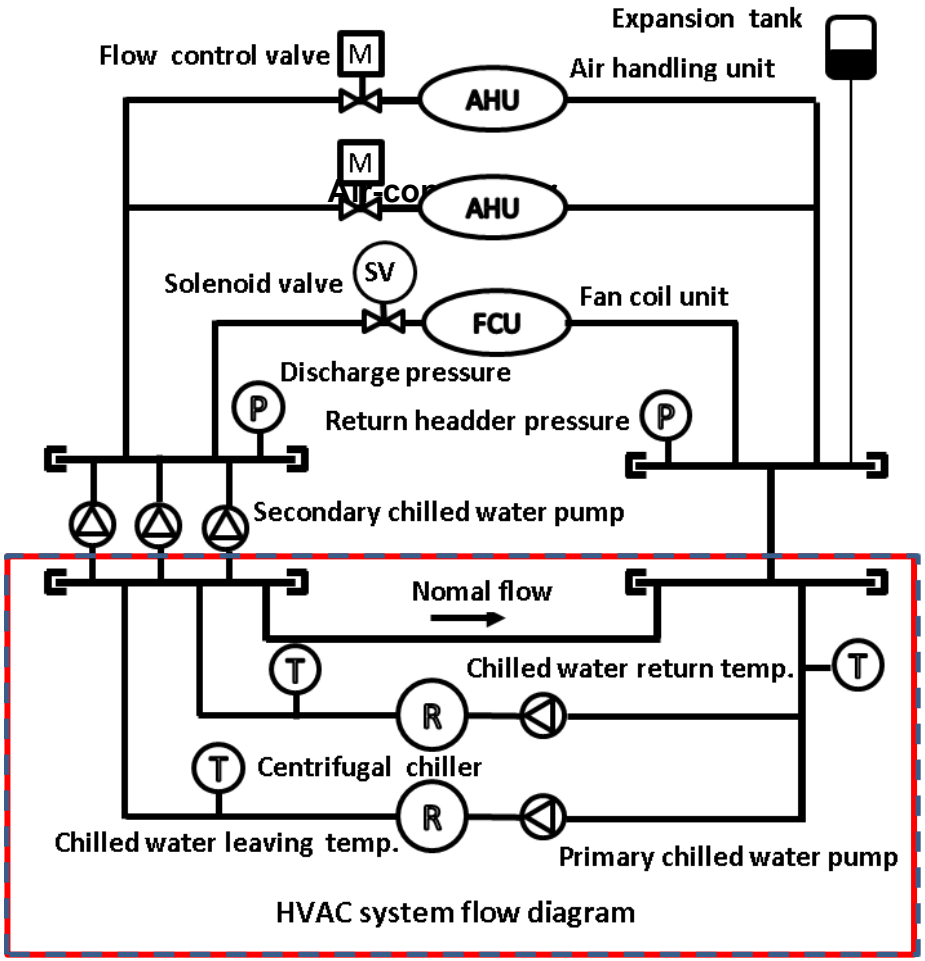
(2) Centrifugal chiller Automatic multiple units control

The number of chillers to be operated is determined to keep the chilled water return temperature constant with some differential.

3. Use

Heat source of an air-conditioner for a factory building (work room and clean room) and an office

4. Energy Conservation Guideline for Air-conditioner (Thai EC Guideline)



5. Energy Management Manual

(1) Management and control

Item	Management content	Control value, etc.	Remarks
(1) e	Set cooling water and chilled water temperatures to improve the overall energy efficiency to the seasonal changes of the outdoor air conditions. -Cooling water temperature (The temperature is controlled by modulating the opening of the 3-way control valve which is installed inlet of the cooling tower.) -Chilled water outlet temperature	 Low limit: 20℃ (Outlet of the cooling tower, namely inlet of the centrifugal chiller) Summer 7℃ Others 9℃	Operation manual Refer to [Notes No1.]
(1) c	Formulate the control standards for optimal number of operating chillers according to outside air conditions and load changes. -Centrifugal chillers are managed by automatic multiple units control to keep chilled water return temp constant with some difference.	. Set-points are as follows Summer 9.5℃～12℃ Others 11.5℃～14℃	Operation manual Refer to [Notes No2.]
(1) g	Insulate the cold surface of drum and piping to protect heat loss.		
(1) h	Stop operation during no-load time such as at night and on holidays.	Operating time Week day 8:00～18:00	Operation manual

	(Specifically define "when unnecessary.")	Sat., Sun. and holidays：stop	
(1) j	Operate motors at the rated voltage and current. Receiving voltage： Centrifugal compressor Auxiliary machinery Operating current: Centrifugal compressor Cooling water pump Cooling tower fan Primary chilled water Pump	 440V±22V 250V±13V Under 620A Under 120A Under 35A Under 100A	Managing values should be described in the record sheet of operation

(2) Measurement and recording

Item	Measurement content	Frequency	Remarks
(2) a	Measure and record the items required for improving the efficiency of the overall HVAC system. Outdoor air temp. dry bulb and wet bulb Cooling water inlet/outlet temp. Discharge and suction pressure of the centrifugal compressors Voltage and current of the motor of the centrifugal compressors	 once/day once/day once/day once/day	Refer to record sheet of operation

	Discharge pressure of the cooling water pumps Discharge pressure of the primary chilled water pumps Chilled water flow rate Power consumption of the centrifugal compressors Calculation of COP The COP obtained here is evaluated by comparing with the performance graph presented by the manufacturer, taking into consideration of the operating conditions such as temperature of cooling water and chilled water.	once/day once/day once/day once/day once/month	 Refer to [Notes No3.] COP : Coefficient of Performance
(2) b	Measure and record the items required for reducing electrical losses for motors. Voltage and current of motors for cooling water pump, cooling tower fan and primary chilled water pump	 once/day	Refer to record sheet of operation
(2) b	Measure and record the items required for evaluating efficiency of cooling water pumps and primary chilled water pumps. -Flow rate of the pumps	 once/day	Refer to record sheet of operation

	(Estimating from the characteristic curve is also OK) -Discharge pressure of the pumps -Suction pressure of the pumps -Power consumption (or voltage and current are acceptable) -Evaluate the efficiency of the pumps.	once/month	Refer to [Notes No4.]

3) Maintenance & Inspection

Item	Maintenance content	Frequency	Remarks
(3) a	Inspect and maintain the primary HVAC equipment to be good operating conditions. Centrifugal chiller operation check, performance check inspection	Maker's maintenance: once/year Others, according to manufacturer's inspection criteria	Refer to instruction manual. Refer to the order form.
(3) B	Inspect and maintain the primary HVAC equipment control system to be good operating conditions.	Maker's maintenance: once/year	
(3) c	Inspect and maintain insulation of centrifugal chiller and piping for chilled water.	Visual inspection: once/month Maker's maintenance : once/year	

(3) f	Inspect and maintain motors for cooling water pumps, primary chilled water pumps and cooling tower fans.	Visual inspection of abnormal noise, vibration, etc.: once/day Overhaul and cleaning: once/year	Refer to record sheet of operation Refer to inspection report by maker
(3) g	Inspect and maintain clogging and leakage of cooling water and chilled water piping.	Visual inspection : once/day	

(4) 'Necessary measures when installing new facilities' and 'Target Component'

All items in these sections are omitted here, because they should be necessary to consider when equipment and technology are newly installed for energy efficiency improvement.

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Therefore accumulation of daily operation data necessary for the evaluation based on EM Manual is important.

[Notes]

No1. (1) e : Cooling water temperature

For a centrifugal chiller, the lower the cooling water temperature, the better the performance (COP). However, there is a limitation on stable operation for the centrifugal chiller, so it is necessary to manage not to be below a certain temperature. That is, this control is a protection circuit during intermediate and winter seasons when the outside-air wet-bulb temperature is low.

No2. (1) c : Automatic multiple units control

The number of centrifugal chillers to be operated is determined as follows.

When the chilled water return temp. is bellow 9.5℃ (11.5℃), the number of chillers should be decreased

When the chilled water return temp. is over 12.0℃ (14.0℃), the number of chillers should be increased

Note: Figures of the temperature are for summer and those in parentheses are other seasons.

No3. (2) a : Calculation of COP (Coefficient of Performance)

COP is calculated by the following equation.

$$COP = R \div W \quad (1)$$

$$R = Qc \times (Tw1 - Tw2) \times cp \quad (2)$$

Where R : Cooling capacity (kW)

W : Cooling power consumption(kW)

Qc : Chilled water flow rate (L/s)

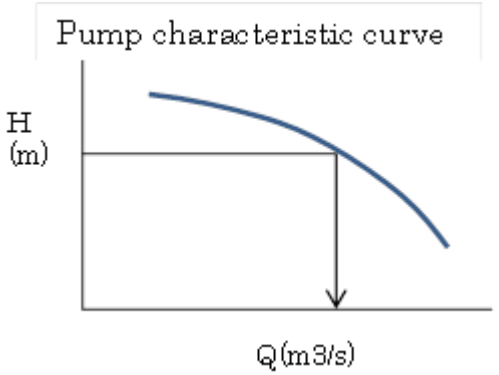
Tw1 : Chilled water inlet temperature to the chiller (℃)

Tw2 : Chilled water outlet temperature from the chiller (℃)

Cp : specific heat of the water (= 4.186 kJ/kg/K)

W: Power consumption of the centrifugal compressor (kW)

Here, when the water flow rate is not actually measured, this is estimated from the performance curve of the pump. First, the total head H (m) is obtained from the differential pressure at the pump gate.



$$H = 0.102 \times \Delta p \qquad (3)$$

Where H : total differential head (m)

Δp : pressure differential (kPa)

= discharge pressure – suction pressure

Next, if power consumption of the compressor isn't measured, it's calculated from the equation (4).

$$W = \sqrt{3} \times V \times I \times \cos\theta \qquad (4)$$

Where W: power consumption (kW)

V: voltage (kV)

I: current (A)

cosθ: power factor (-) Get from motor characteristic curve.

No4. (2) b : Calculation of pump efficiency

Pump efficiency is calculated by the following equation.

$$\eta = (Q \times \Delta p) \div W \qquad (5)$$

Where η : pump efficiency (-)

Q: pump flow rate (m3/s)

Δp: pressure differential (kPa)

= discharge pressure – suction pressure

W: power consumption (kW)

Further, when the flow rate Q and the power consumption W are not actually measured, this is estimated from the above equations (3) and (4).

Reference

Centrifugal chiller specifications, centrifugal chiller instruction manuals, air conditioning system operation instructions, etc. are quoted to this EMM.

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0	10 Jan. 2023	Original			
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EM Manual for Air Compressor

1. Facility configuration

Type of compressor : Oil Free Screw-type, 3 units
Compressed air volume : 6,000 m^3/h
Discharge pressure : 0.55 MPa
Motor capacity : 800kW
Rated voltage : 6,600V

2. Use

Compressed air is supplied for instrument system and driving equipment in the manufacturing process.

3. Energy Conservation Guideline for Motor of Air compressor

4. Energy Management Manual

(1) Management & Control

Item	Management content	Control value, etc.	Remarks
(1) A	- Stop operation during no-load time such as at night and on holidays.	Stop the compressor 20 minutes after shutdown	Operation manual
(1) B	- Operate the optimal number of compressors in line with a load. - Controlled by setting the operation sequence of air compressors based on the system pressure.	Air demand: automatic multiple-units control system 0.50 MPa -> 1 Unit 0.47 MPa -> 2 Unit 0.45 MPa -> 3 Unit	Operation manual
(1) C	- Control discharge pressure and discharge flow rate of compressor in line with the load. - If discharge pressure becomes higher than usual, check pressure and flow rate at the use end. - If discharge flow rate is excessive than demand anytime, consider to change compressor to appropriate volume one. - If pressure drop becomes larger than usual, check block of piping and supply route. - If there are fluctuations in pressure on the demand side, consider installing an air accumulator.	Discharge pressure: 0.55 MPa Pressure at use end: More than 0.5 MPa	Operation manual

(1) F	Control the rated voltage and current of an electric motor. - Voltage - Current - Power - Power consumption	 6,600V 52 A 700kW xxxxx kWh	Instruction manual of equipment

(2) Measurement & Recording

Item	Measurement content	Frequency	Remarks
(2) A	Measure and record items necessary for appropriate motor operation to prevent electricity loss. - Voltage, - Current - Power - Power consumption	 twice/day twice/day twice/day once/day	Refer to record sheet of operation
	Measure and record items necessary for evaluating SPC of the compressor. - Suction and discharge pressure of compressor - Flow rate of air - Voltage, Current, Power consumption - Operation hour Calculate SPC of compressor	 twice/day twice/day twice/day, once/day twice/day once/month	Refer to record sheet of operation

	Measure and record items (refer SPC) necessary for evaluating air supply condition - differential pressure of the filter - pressure drop in the supply system of the compressed air - pressure at the use end	 twice/day twice/day twice/day	

(3) Maintenance & Inspection

Item	Maintenance content	Frequency	Remarks
(3) A	Inspection and maintenance of motor, compressor and air supply facility Visual inspection of abnormal noise, vibration, etc. Overhaul and cleaning	 twice/day once/month	Refer to record sheet of operation. Refer to inspection report by maker.
(3) B	Inspection and maintenance of clogging and leakage of piping Visual inspection	 once/day	
	Inspect and clean air filters. Replace them based on the degree of clogging.	once/week every time necessary	Refer to record sheet of operation
	Undertake an overhauling of air compressors.	once/10,000hours	Refer to maker's recommendation
	Remove moisture accumulated to avoid moisture carryover.	once/day	Refer to record sheet of operation
	Conduct leakage tests periodically and plug off the compressed air leakages.	once/month	Refer to record sheet of operation

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Sample of EM Manual for Boiler

(based on Thai EC Guideline)

1. Facility configuration

Vaporization capacity : 10t/h (1 unit)
Number of units : 3 units (tube-type)
Design pressure : 0.9MPa
Fuel : Natural gas
Main Facilities : Air preheater, Economizer, Air supply fan, Recovery tank of steam condensate (1 unit each)
Feed water pump (6 units)

2. Use

Generated steam is supplied to manufacturing process for heating, dryer, hot water supply, air purge, etc.

3. Energy Conservation Guideline for Boiler (Thai EC Guideline)

4. Energy Management Manual

(1) Management & Control

Item	Management content	Control value, etc.	Remarks
(1) a	Quality of boiler feed water	pH : 7～9 Electrical conductivity: less than 400 mS/m ＠25℃	Notification on boiler feed water (B.E.2549)
(1) b	Maintain proper dryness of steam.		Operation Manual
(1) c	Set an air ratio control value (Describe concretely how to observe the state of combustion, measurement of oxygen concentration in waste gas, etc.)	Air ratio : less than 1.1 (O_2% : less than 1.9%)	Operation manual
(1) g	When set the air ratio, refer to Table 3.1 of standard value for O_2%. (If the standard value cannot be observed, describe the reason.)	less than 2%	
(1) d	Manage optimum operation number of multiple boilers according to steam load. Control the pressure at discharge header	Less than 8t/h 1 unit 8t/h - 16t/h 2units More than 16t/h 3units 0.8MPa±0.05MPa	Operation manual
(1) e	Set the control value of the waste gas temperature.	Control value 160℃	
(1) h	When set the waste gas temperature, refer to Table 3.1 of standard value for it. (If the standard value cannot be observed, describe the reason.)	No more than 60℃ higher than the steam temperature.(?) Standard value : 170℃	This description is unclear.

(1) f	Recover steam condensate from the determined area. Control the quality of recovered water at the same level as boiler feed water.		Refer to (1) a
(1) i	Install insulation materials on outer wall of furnace, steam piping, drain piping, etc. Check temperature of outer surface of furnace.	 xx ℃	Refer to the Manual of Dept. of Industrial Works. (B.E.2535)
（1） j℃	Recover waste heat from exhaust gas as much as possible by economizer, air preheater, etc. Control temperature of air at outlet of preheater. Control temperature of boiler feed water at outlet of economizer.	 xx ℃ oo ℃	
(1) k	Describe to maintain operation conditions such as furnace inside temperature and pressure, etc. according to the specification of instruction manual. Manage pressure and characteristic value of fuel gas.	Inside temperature:900℃ Inside pressure:35kPa Supply pressure: 30-50kPa	Instruction manual Purchase agreement
(1) l	If steam is not used, close the valve of the supply piping.	In case no use for more than 1 day	Operation manual
(1) m	Operate motors at the rated voltage and current. -for boiler water feed pumps -for combustion air supply fan	Rated voltage : 200V Rated current for each motor	Equipment list

(1) n	Stop auxiliary equipment such as motor, etc. which are not in use.	Stop them in conjunction with main machine.	Operation manual
(1) o	Operate appropriate number of pump units according to the flow rate of feed water.		Operation manual
(1) p	Adjust feed water pumps at optimum pressure and flow rate. If one motor equipped with a variable speed control device, describe operation priority of pumps. Adjust combustion air supply fan at optimum pressure.	Pressure : 1.2MPa Flow rate : depending on required amount Air supply pressure :0.1 MPa	Operation manual
(1) q, r	Set the control value of the pressure and temperature of generated steam Pressure of steam used for boiler itself, for example fuel heating, feed water heating, pipe heating, etc.	0.8MPa 0.2MPa	Operation manual
(1) s	Describe the utilization measure of heat recovered from blowdown water.		Operation Manual

(2) Measurement & Recording

Item	Measurement content	Frequency.	Remarks
(3) a	Waste gas temperature	once/day	Refer to record sheet of operation
	Temperature of supply air and feed water at the outlet of waste heat recovery equipment	once/day	
	Temperature of blow down water, if heat is recovered.	once/day	
	Recovered amount of steam condensate	once/day	
(2) b	Outer surface temperature of boiler : ceiling, side wall	once/week	Refer to record sheet of operation
(2) c	Measure and record items necessary for managing and evaluating fuel combustion such as boiler efficiency.		Refer to record sheet of operation
	Evaluation of boiler efficiency	once/month	
	Fuel consumption	once/hour	
	Temperature of exhaust gas and flue gas	once/hour	
	Residual O_2 content (or air ratio) in flue gas	once/month	
	CO_2 and CO content in flue gas	twice/year	
	Internal pressure in the furnace	once/day	
	Measure and record items necessary for efficiently supplying steam such as generated steam amount, pressure, etc.		Refer to record sheet of operation
	Generated steam amount	once/hour	
	Steam pressure	once/day	
	Amount, temperature and quality (pH, Si, etc.) of feed water	once/day	

(2) d	Measure and record for motor applied equipment Voltage, current, power consumption, etc. of motors Total differential head, flow rate, fluid pressure, etc. of pumps Evaluate pump efficiency	 once/day once/day once/month	Refer to record sheet of operation
(2) e	Inlet pressure and temperature of steam header	once/hour	Refer to record sheet of operation

(3) Maintenance & Inspection

Item	Maintenance content	Frequency.	Remarks
(3) a	Inspection and cleaning of combustion facilities such as burner, etc. Daily : Inspection of abnormal noise, vibration, combustion status (state of flame), heating condition, leak of heat, etc. Periodical : Inspection and cleaning of burner etc.	 once/day once/month	Refer to instruction manual and operation manual
(3) b	Inspection and maintenance of economizer, air preheater, etc. Inspection of heat exchanger Cleaning of heat exchanger Inspection of recovery equipment of steam condensate	 once/year once/2 years (according to inspection result) once/year	Refer to instruction manual.

(3) c	Inspection and maintenance of insulation of outside wall of boiler and piping for hot fluid Visual inspection Maintenance and repair	 once/month once/year	
(3) d	Inspection of clogging and leakage of steam traps Visual inspection Maintenance	 once/week once/year	Refer to manual of steam traps
(3) e	Inspection and maintenance of motors for pumps and air supply facility Visual inspection of abnormal noise, vibration, body temperature, etc. Overhaul and cleaning	 once/day once/year	Refer to record sheet of operation and inspection report by maker
(3) f	Inspection and maintenance of clogging and leakage of pumps and piping Visual inspection of abnormal noise, vibration, body temperature, etc. Overhaul and cleaning	 once/day once/year	

(3) g	Inspection and maintenance necessary for maintaining the heating performance of heating tubes, heat exchangers, etc. including removal of soot, scale, dirt etc. Inspection Cleaning	 once/year once/2 years (according to inspection result)	Refer to instruction manual and operation manual

(4) 'Necessary measures when installing new facilities' and 'Target Component'

All items in these sections are omitted here, because they should be necessary to consider when equipment and technology are newly installed for energy efficiency improvement.

When introducing new equipment and technologies, it is necessary to set energy-saving targets, to evaluate investment effects, and to decide whether or not to introduce them.
Therefore accumulation of daily operation data necessary for the evaluation based on EM Manual is important.

Document No. ooo-xxxxx					
Revision	Date	Content	Create Engineer	Check Supervisor	Approve Manager
0	10 Jan. 2023	Original			
1	20 Feb. 2025	Change of heating temp.			

EM Manual for Electric Heater

(based on Thai EC Guideline)

1. Facility configuration

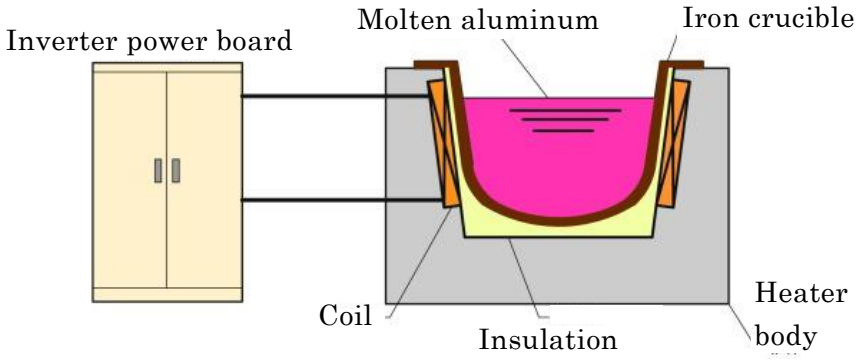
Type of Heater : IH heating
Number of units : 3 units
Capacity : 200kg
Temperature : Holding temp. 670℃

2. Use

Aluminum melting and holding heater

3. Energy Conservation Guideline for Thai Industry

Electric Heater



IH type aluminum melting and holding heater
(Source : https://www.fujielectric.co.jp/)

4. Energy Management Manual

(1) Management & control

Item	Management content	Control value, etc.	Remarks
(1)a	In order to increase thermal efficiency, the optimum loading amount and arrangement of the heated material are controlled to avoid overloading or underloading.	Filling weight: Maximum 200kg	Work instruction
(1)b	In order to improve thermal efficiency, the three heating heaters are managed with the optimal number of units in operation depending on the load.	In case, load of 1 unit becomes 80% or more, the next unit starts.	Operation manual
(1)c	Reduce waiting time when heating repeatedly or switching lots		Work instruction
(1)d	In case of intermittent operation, production is consolidated to reduce energy losses during heater start-up.		Work instruction
(1)e	In order to reduce power loss, improve the method of filling the heated material and prevent no-load operation.		Operation manual
(1)f, k	Manage the rated voltage and rated current of the heater to reduce power loss.	Voltage : xx V Current : oo A	Operation manual
(1)g	Optimize the heat pattern in the heater		Operation manual
(1)h	Control the temperature of heated objects	600 ℃	Operation manual
(1)i	Install insulation materials on surfaces of heater outer walls and piping		Boilers with Liquid Medium Manual (Dept of Industrial Works B.E. 2535)
(1)j	The temperature of the surfaces of heater outer wall shall be controlled based on Table 5-1.	Ceiling: below 90℃ Side wall :below 80℃	Work instruction
(1)l	Turn off the heater when it is not needed (Describe specific cases		Work instruction

	when it is not necessary.).		
Add.	Controlling the temperature inside the heating furnace	650 ℃	Work instruction
Add.	Utilizing waste heat by recovering latent heat and sensible heat from the heated object ・Preheating the object, etc. (pre-heat temperature)	 150 ℃	Operation manual

(2) Measurement & Recording

Item	Measurement content	Frequency	Remarks
(2)b	Measurement of items necessary for managing and evaluating the efficiency of heater -Production volume, power consumption, etc.	 once/hour	Record sheet
(2)c	Measurement of items necessary for managing and evaluating the efficiency of heater - Furnace temperature, furnace outer wall temperature, temperature of heated objects, etc.	 once/hour	Record sheet
(2)d	Measurement of voltage and current of heater	once/hour	Record sheet
(2)e	Measurement for items related to waste heat utilization -Temperature of heated items before and after processing	 once/rot	Record sheet

(3) Maintenance & inspection

Item	Maintenance content	Frequency	Remarks
(3)a	Inspection and records required to reduce resistance losses on wiring and switchgear contact in heater Daily : Visual inspection of wiring and switches for abnormalities, etc. Periodic : Inspection and cleaning	 once/day once/month	Inspection manual

(3)d	Inspections and records required to maintain the insulation performance of the heater outer wall, etc. Daily : Visual inspection Periodic : Inspection and cleaning	 once/year once/years (according to inspection result)	Inspection manual
(3)e	Inspection and recording of substation equipment Daily : Visual inspection of abnormality Periodic : Inspection and cleaning	 once/day once/year	Inspection manual
(3)f	Inspections and records required to maintain the performance of waste heat recovery equipment Daily : Visual inspection Periodic : Inspection and cleaning	 once/day once/year	Inspection manual

(4) 'Necessary measures when installing new facilities' and 'Target Component'

All items in these sections are omitted here, because they should be necessary to consider when equipment and technology are newly installed for energy efficiency improvement.

When introducing new equipment and technologies, it is necessary to set energy-saving targets, to evaluate investment effects, and to decide whether or not to introduce them.
Therefore accumulation of daily operation data necessary for the evaluation based on EM Manual is important.