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The Japan Electrical Manufacturers' Association

Japan's new motor standards and Top runner Scheme

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Background

Japan started energy management by law in 1979. The law named "Energy management based on the Act on the Rational Use of Energy" (hereafter called ECL: Energy Conservation Law) has been applied in four sectors: factories, transportation, buildings, machinery and equipment. In each section, we have been making big efforts for energy conservation. Therefore, energy intensity value which indicates the usage of energy per real GDP became world prominent level. After further studies, Ministry of Economy, Trade and Industry (METI) decided to make industrial motors target products of Top Runner Program.

Required preparation

A) Grasp of the Energy-saving effect

B) Maintenance of standards for top runner program

C) Top Runner Program for motors (Progress)

Top Runner Program for motors (Progress)

First step: FY2009: “Advisory committee concerning motor energy conservation measures” Investigation of actual condition report such as energy consumption equipment reported by the Institute of Applied Energy as a consignment business from METI. The purpose of the investigation was to estimate how much the introduction of the high efficiency motors (HEM) could inprove energy-saving effect.

Second step: FY2011～2012: Installation of Evaluation Standard Subcommittee of ECL.

1st committee was held in 13th Nov. 2011. Coverage and test method were decided.

2nd, and 3rd committee are being on the schedule. The committee will decide target year and target efficiency.

Third step: FY2012～2013: WTO／TBT Notification

: ECL and Evaluation Standard notification for motors.

A Use survey and operating conditions of motors（Ex:Major 3 equipment）

Equipment classification	Number	Mean driving time per year	The average load factor	※1 Operating Voltage / Frequency (Unit)		Life time (Unit)		Inverter motor drive proportion	Explosion proof type proportion
Pump	66,922 Unit	4,263 hours	64 %	A	18,720	A	5,340	14 %	15 %
				B	17,145	B	23,162		
				C	4,657	C	15,673		
				D	8,809	D	8,764		
				E	1,640	E	1,800		
				F	9,495	avg.	17 y.		
Compressor	14,956	3,855	58	A	7,447	A	1,495	14	5
				B	4,589	B	3,486		
				C	860	C	4,543		
				D	668	D	935		
				E	208	E	120		
				F	680	avg.	16 y.		
Blower	57,029	4,324	66	A	16,477	A	6,332	2	3
				B	15,208	B	21,758		
				C	4,606	C	15,171		
				D	9,478	D	4,869		
				E	1,670	E	1,489		
				F	5,142	avg.	15 y.		

※1 Operating Voltage / Frequency
A: 200V / 50Hz
B: 200V / 60Hz
C: 220V / 60Hz
D: 400V / 50Hz
E: 400V / 60Hz
F: 440V / 60Hz

Life time
A: Around 5 years
B: Around 10 years
C: Around 20 years
D: Around 30 years
E: Around 40 years

Source：Energy conservation equipment introduction promotion guidance business in 2009 fiscal year. Investigation business report like the energy consumption equipment realities etc. Institute of Applied Energy (JP), 2009

Reference 1

Answers were obtained from 700 offices at the Type1 designated energy management factories.

A Energy-saving effect

Reference 1

There is potential of energy conservation 155（hundred million kWh）=15.5 TWh in the case of IE3.

	Annual consumption electric energy			Energy saving effect				CO2 effect-saving	
	Standard	JIS C4212	IE3	JIS C4212		IE3		JIS C4212	IE3
	Hundred million kWh	Hundred million kWh	Hundred million kWh	Hundred million kWh	Effect proportion	Hundred million kWh	Effect proportion	Ten thousand-t.CO2	
Pump	2,805	2,755	2,713	49.8	1.8%	92.0	3.3%	169	313
* Compressor	778	778	778	0.0	0.0%	0.0	0.0%	0	0
Blower	885	865	851	19.7	2.2%	33.7	3.8%	67	115
Transporting machine	185	180	176	4.9	2.7%	8.9	4.8%	17	30
Power transmission device	108	103	101	4.8	4.5%	7.3	6.7%	16	25
Metalworking machine	332	326	321	6.4	1.9%	11.6	3.5%	22	39
Textile machinery	26	25	24	1.0	4.0%	1.5	5.8%	3	5
* Refrigerating machine	151	151	151	0.0	0.0%	0.0	0.0%	0	0
* Refrigerating machine application products	160	160	160	0.0	0.0%	0.0	0.0%	0	0
Total	5,429	5,343	5,275	86.7	1.6%	155.0	2.9%	295	527

・The CO2 exhaust unit requirement is calculated as target unit requirement 0.34kg-CO2/kWh for The Federation of Electric Power Companies from fiscal year 2008 to 2012.

・Source：Energy conservation equipment introduction promotion guidance business in 2009 fiscal year. Investigation business report like the energy consumption equipment realities etc. Institute of Applied Energy (JP), 2009

＊:Out of count because of top runner facilities.

B

Maintenance of standards for top runner program

Required preparation

・JIS C 4034-30(2011/01/20):IEC 60034-30 Rotating electrical machines-Part 30: Efficiency classes of single-speed, three-phase, cage-induction motors (IE-code).

・JIS C 4034-2-1(2011/01/20):IEC 60034-2-1 Rotating electrical machines-Part 2-1: Methods for determining losses and efficiency from tests of single-speed, three-phase, cage-induction motors.

・JIS C XXXX(waiting for target efficiency):Low-voltage three-phase squirrel-cage induction motors.

C

Decided items in 1st committee

(Installation of Evaluation Standard Subcommittee of ECL)

1. Coverage of the motor.

Coverage of the motor, regulated by ECL as a top runner product is discussed basically in the scope of JIS C 4034-30. The features of the motor are listed as follows.

a) Rated frequency(based frequency):50Hz±5%, 60Hz±5%,and could be drive both 50Hz±5% and 60Hz±5%

b) Single speed

c) Rated voltage: Up to 1000V

d) Rated output: Between 0.75kW and 375kW

e) Poles: 2P 4P 6P

f) Duty type: S1(continuous duty) or S3(intermittent periodic duty).

g) Capable of operating direct on-line

But there are some exceptional items and applied items.

1) Motors completely integrated into a machine(for example pump, fan and compressor) that can not be tested separately from the machine.

*Motors with flanges, feet and/or shafts with special mechanical dimensions are included

2) Inverter drive motors are out of scope in JIS C 4034-30.

*If these motors could operate direct on-line, they are included in the coverage.

Coverage of the motor regulated by ECL as a top runner product.

Coverage

JIS C 4034-30

Rotating electrical machines-Part 30 : Efficiency classes of single-speed, three-phase, cage-induction motors (IE code).

Exception items

(1) Special insulation (①③)
(2) Δ–人 starting (①③)
(3) Marine motors (③)
(4) Submersible motors (①②③)
(5) Explosion proof motors (①③)
(6) High slip motors (①③)
(7) Water gate motors (①③)
(8) Canned motors (①③)
(9) Low temperature environments (①②)

※Reason of exception
①Special use.
②Testing method is not established technically.
③Small-market.

Inverter drive motors are out of scope, but based frequency range 50Hz±5% or 60Hz±5% are included.

Exception items

(10) External fan cooling.

Exceptional items

These motors are excluded in this regulation. Exclude terms and conditions are as follows.

①Used for special use.
②Testing method is not established technically.
③Too much small population in the market.

(1) Special insulation (①③)

Thermal class : 180H, 200N, 220R, 250. (JIS C 4003, IEC60085).

Shipment number (FY2008) : 1,304pcs (Shipment rate : 0.03%)
Shipment number (FY2009) : 1,022pcs (Shipment rate : 0.06%)

(2) Delta–star starting (①③)

Special motors used for weaving machine, they needs huge starting torque.

Shipment number (FY2008) : 2,518pcs (Shipment rate : 0.06%)
Shipment number (FY2009) : 1,910pcs (Shipment rate : 0.11%)

(3) Marine motors (③)

Special construction for standing vibration, corrosion, moisture – resistant in the use of ship or marine building.

Shipment number (FY2008) : 17,000pcs (Shipment rate : 0.38%)
Shipment number (FY2009) : 13,584pcs (Shipment rate : 0.81%)

Exceptional items

(4) Submersible motors (①②③)

Motors operating in the liquid.

Shipment number (FY2008): 45,264pcs (Shipment rate : 1.02%)

Shipment number (FY2009): 44,355pcs (Shipment rate : 2.64%)

(5) Explosion proof motors (①③)

Motors specifically built for operation in explosive environments.

Shipment number (FY2008): 33,855pcs (Shipment rate : 0.76%)

Shipment number (FY2009): 26,558pcs (Shipment rate : 1.58%)

(6) High slip motors (①③)

Motors specifically built for operation in high slip speed as follows.

a) Output range over 0.75kW up to 110kW : 5% over

b) Output range over 110kW up to 375kW : 3% over

Shipment number (FY2008): 5,818pcs (Shipment rate : 0.13%)

Shipment number (FY2009): 3,020pcs (Shipment rate : 0.18%)

(7) Water gate motors (①③)

Motors specifically built for operation in driving water gate.

Shipment number (FY2008): 160pcs (Shipment rate : 0.004%)

Shipment number (FY2009): 137pcs (Shipment rate : 0.01%)

Exceptional items

(8) Canned motors (①③)

Motors specifically built for its stator or rotor covered by metallic material, for airtight.

Shipment number (FY2008) : 22pcs (Shipment rate : 0.0005%)

Shipment number (FY2009) : 25pcs (Shipment rate : 0.001%)

(9) Low temperature environments (①②)

Motors specifically built for operation in the ambient temperature under -20℃.

(10) External fan cooling.

Motors specifically built for inverter drive, with cooling methods ICX16. (see IEC 60034-6)

Shipment number (FY2008) : 25,611pcs (Shipment rate : 0.58%)

Shipment number (FY2009) : 20,528pcs (Shipment rate : 1.22%)

Total shipment rate above exception motors are as follows.

(FY2008) :3.0%, (FY2009) :6.6%.

Test method

Test method is defined from JIS C 4034-2-1. (IEC 60034-2-1) Only one method is allowed by ECL to determine efficiency equal to IEEE 112 method B.

The measurement for the three-phase induction motor operated direct on-line is conducted by the method prescribed by JIS 4034-2-1, and the method has the procedures with the lowest uncertainty.

However, if the motor prescribed by 5.1.3 of JIS C4034-40” Rotating electrical machines- Part30: Efficiency classes of single-speed, three-phase, cage induction motors. (IE code)” has the auxiliary equipment, the efficiency test is conducted without the auxiliary equipment unless it is the essential part of the motor.

Additionally, the motor designed exclusively for inverter-drive is tested direct on-line , instead of using the inverter.

Energy efficiency and Measurement method (Reference)

Calculating stray-load losses by a load test with torque measurement.

Indirect method

- **Couple the motor to a load machine with a torque meter.**
- **Determination of losses and summing up total loss P_T.**
- **Calculating indirectly efficiency, subtracting total loss P_T from input.**

Efficiency (%) $= (P_1 - P_T) / P_1 \times 100$ **P_1:Input power**

Total losses $P_T =$

Load losses	+	**Additional-load losses**	+	**Constant losses**
Caluculated from observed data at rated load test.		Calculated from observed data at load curve test.		Calculated from observed data at no-load test.

Energy efficiency and Measurement method (Reference)

Load losses

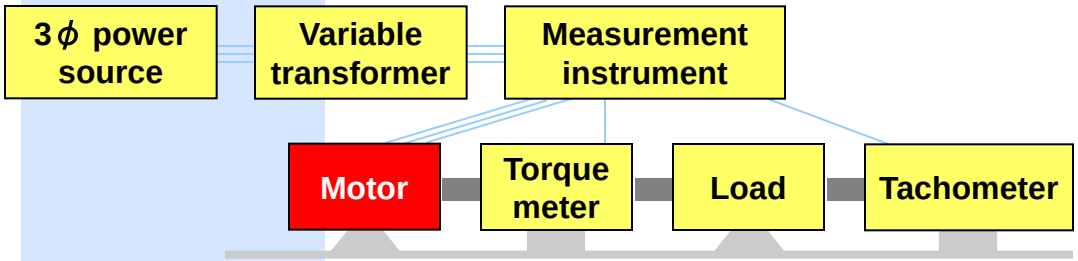
・Sum of the excitation winding losses.
・Calculated from voltage, current, resistance, and etc prescribed by JIS, at rated output after reaching the condition of the thermal equilibrium.

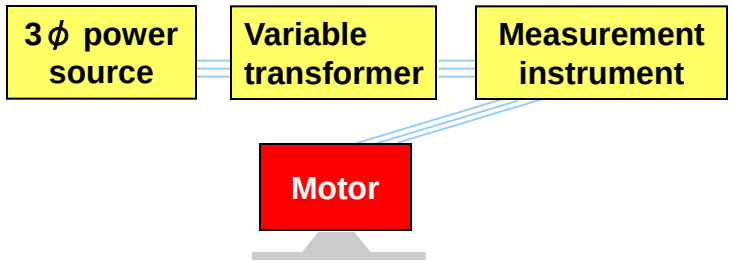
Additional-load losses

・Losses caused by load current.
・Apply the load to the machine at six load points.
・Caluculated form voltage, current, resistance, and etc, prescribed by JIS at the thermal equilibrium.

Constant losses

・Sum of the iron losses, friction losses and wind age loss, and etc.
・Calculated form current, resistance, and etc, prescribed by JIS at no-load and at several reduced voltage points.





Conclusions
Thank you for your attention!!

A wide variety of conservation of energy measures have been executed from ECL enactment since 1979 in Japan, and they works to some extent. However, there is still potential of energy conservation 15.5TWh in the point of use of HEM.

・1st committee was held in Nov. 2011, in order to make industrial motors target products of Top Runner Program. Coverage and test method were decided.

・2nd committe which will decide target year and target efficiency is on the schedule.

References

1. Takeshi Obata, The Japan Electrical Manufacturer's Association(JEMA), Japan, Motor drive and Energy Conservation Activities in Japan, EEMODS'2011
2. Energy conservation equipment introduction promotion guidance business in 2009 fiscal year. Investigation business report like the energy consumption equipment realities etc. Institute of Applied Energy (JP), 2009