Data 3-2

Final Report by Commercial Refrigerator and Showcase, etc. Evaluation Standards Subcommittee, Energy Efficiency Standards Subcommittee of the Advisory Committee for Natural Resources and Energy [Commercial Refrigerators, etc.] (Draft)

January 24, 2011

The commercial refrigerator and showcase, etc. evaluation subcommittee had deliberations on the standards of judgment for the manufacturers or importers (hereinafter referred to as “manufacturers”) concerning performance improvement of commercial refrigerators, commercial refrigerator-freezers, commercial freezers, etc. (hereinafter referred to as “commercial refrigerators, etc.”) and prepared an interim summary report as follows.

I. Commercial Refrigerators, etc.

1. Target Scope [See Attachment 1]

The commercial refrigerators, etc. as the target scope of this review shall be the electric refrigerators, etc. stipulated by JIS B 8630 as the application scope of Commercial refrigerators and freezers - Characteristics and test methods (limited to those which include one or more of HFC-125, HFC-143a and/or HFC-134a in their refrigerant), excluding “type I chilled air forced circulation refrigerators (chilled air forced circulation refrigerators the rated storage temperature’s lower limit of which is 0°C or above)”, “chilled air natural convection refrigerator-freezers” and “type I chilled air forced circulation refrigerator-freezers (chilled air forced circulation refrigerator-freezers whose chiller’s lower limit for the rated storage temperature is 0°C or above)”). However, those whose storage chamber’s height is 650 mm or lower and which are horizontal type, those which are water cooling type, those which have double sided doors, vertical freezers, those which are chilled air natural convection type, those which have a drawer of slide rail type, those which are vertical type whose height is 2,050 mm or higher, those which are exclusively for cold storage of milk, those which are horizontal type equipped with an electro-magnetic cooker and those which are modified or specially ordered are excluded from the application scope.

2. Items to be judgment standards for manufacturers

(1) Target fiscal year [See Attachment 2]

The target fiscal year for the commercial refrigerators, etc. shall be the fiscal year 2016.

(2) Target standard values [See Attachment 3 to 4]

With regard to commercial refrigerators, etc. that manufacturers ship within Japan for the target fiscal year, a weighted average of the annual energy consumption (kWh/year) calculated in (3), by the volume of shipments for each manufacturer per category in the table below shall not exceed the target standard value.

Table 1 Standard Energy Consumption Efficiency for Commercial Refrigerators and Refrigerator-freezers

Category	Type of Refrigerator	Shape	Inverter Control Motor	Calculation Formula of Standard Energy Consumption Efficiency
1A	Refrigerator	Vertical Type	There is.	$E = 0.345V_1 + 86n_R + 64d_R + 315$
1B			There isn’t.	$E = 0.766V_1 + 86n_R + 64d_R + 106$
1C		Horizontal Type	-	$E = 1.12V_1 + 70n_R + 34d_R + 237$
2A	Refrigerator-freezer	Vertical Type	-	$E = 0.872V_1 + 86n_R + 64d_R + 186n_F + 295d_F - 113$
2B		Horizontal Type	-	$E = 2.43V_1 + 70n_R + 34d_R + 157n_F + 157d_F - 183$

Note 1. The “vertical type” means those the height of which based on the external dimensions stipulated by JIS B 8630 (hereinafter referred to as “external height”) is over 1,000 mm and the door of which opens toward the front side. The same applies hereinafter.

2. The “horizontal type” means those the external height of which is 1,000 mm or lower and the door of which opens toward the front side. The same applies hereinafter.
3. E is the value of the standard energy consumption efficiency (unit: kWh/year). The same applies hereinafter.
4. V_1 is the adjusted internal volume calculated by the following formula, rounding the number after the decimal point.

   Category “1A” and “1B” $V_1 = 800/d \times V_R$

   Category “1C” $V_1 = 600/d \times V_R$

   Category “2A” $V_1 = 800/d \times (V_R + 2.48V_F) + 887$

   Category “2B” $V_1 = 600/d \times (V_R + 3.74V_F) + 336$

   However, as a result of the above mentioned calculation, if the adjusted internal volume becomes the lower limit value stipulated for each category in the following table or lower than that, then the lower limit value is used as the adjusted internal volume.

Category	Lower Limit Value
1A	500
1B	500
1C	75
2A	1930
2B	750

5. d is the depth (unit: mm) based on the external dimensions stipulated by JIS B 8630. The same applies hereinafter.
6. V_R is the rated internal volume of a chiller (unit: liter). The same applies hereinafter.
7. V_F is the rated internal volume of a freezer (unit: liter). The same applies hereinafter.
8. n_R: The number of places behind side-by-side doors of a chiller where center pillars are not installed
9. n_F: The number of places behind side-by-side doors of a freezer where center pillars are not installed
10. d_R is used as $d_R = 1$ for chillers with multiple doors (i.e. those which have doors the number of which is more than the standard number of doors stated in the following table according to the external width (W: unit, mm) stipulated by JIS B 8630) and as $d_R = 0$ for others.

Shape	External Width	Standard Number of Doors
Vertical Type	825 mm or under	2
	Over 825 mm up to 1,650 mm	4
	Over 1,650 mm	6
Horizontal Type	1,050 mm or under	1
	Over 1,050 mm up to 1,650 mm	2
	Over 1,650 mm	3

11. d_F is used as $d_F = 1$ for freezers with multiple doors and as $d_F = 0$ for others. The same applied hereinafter.

Table 2 Standard Energy Consumption Efficiency for Commercial Freezers

Category	Shape	Calculation Formula of Standard Energy Consumption Efficiency
3A	Vertical Type	$E = 1.96V_2 + 186n_F + 295d_F + 788$
3B	Horizontal Type	$E = 4.12V_2 + 157n_F + 157d_F + 349$
4A	Chest Freezer	$E = 1.16V_2 + 211$
4B	Freezer-stocker	$E = 1.39V_2 + 359$

Note 1. The “chest freezers” are those which open upward with a door which is pulled up.

2. The “freezer-stockers” are those which open upward with a door which slides leftward and rightward.
3. E is the value of the standard energy consumption efficiency (unit: kWh/year).
4. V_2 is the adjusted internal volume calculated by the following formula, rounding the number after the decimal point.

Category “3A” $V_2 = 800/d \times V_F$

Category “3B” $V_2 = 600/d \times V_F$

Category “4A” and “4B” $V_2 = V_F$

However, as a result of the above mentioned calculation, if the adjusted internal volume becomes the lower limit value stipulated for each category in the following table or lower than that, then the lower limit value is used as the adjusted internal volume.

Category	Lower Limit Value
3A	500
3B	75
4A	250
4B	50

(3) Energy consumption efficiency measurement method [See Attachment 5]

The energy consumption efficiency of commercial refrigerators, etc. shall be the annual energy consumption (kWh/year), and the measurement method shall be the method specified in JIS B 8630 as “Commercial refrigerators and freezer - Characteristics and test methods”.

As regards those with additional functions such as defrosting water-discharge forced evaporation function, forced heat-discharge function or heating and heat-retention function, the measurement can be done regarding them as standard products without additional functions.

(4) Display items and others

Items concerning the display are as follows.

1) Display items

Display items shall be as follows.

i) Product name and model name
ii) Category
iii) Rated internal volume (liter)
iv) Depth size (mm)
v) The number of places behind the side-by-side doors of a chiller where center pillars are not installed

vi) The number of places behind the side-by-side doors of a freezer where center pillars are not installed
vii) For those with multiple doors as stipulated in the paragraph (2) above, the statement that there are multiple doors.
viii) Annual energy consumption (kWh/year)
ix) Manufacturer's name

2) Compliance items
i) The energy consumption efficiency must be indicated as annual energy consumption by integers by the unit of kWh/year. In this case, the energy consumption and the allowable value must follow the stipulation of JIS B 8630 "Commercial refrigerators and freezers - Characteristics and test methods".
ii) The display items stipulated in the foregoing paragraph 1) must be displayed at noticeable places on the product. In this case, the display items must be written directly on the product or on a label made of metal or of synthetic resin which is attached to the product in a way that makes it difficult to take it away. The display items must be written in an indelible way.
iii) As regards refrigerators, etc. with additional functions which were measured as standard products without additional functions, the display must state so and that the energy consumption in actual use may be greater than the value measured.

4. Proposals for energy saving

(1) Actions of manufacturers
1) Manufacturers shall promote technological development toward energy conservation of commercial refrigerators, etc. and attempt to develop products with excellent energy consumption efficiency.
2) From the viewpoint of promoting the spread of commercial refrigerators, etc. with excellent energy consumption efficiency, manufacturers shall attempt to provide appropriate information to encourage users to select commercial refrigerators, etc. with excellent energy consumption efficiency by displaying newly chosen products in catalogues, etc.
3) Manufacturers shall endeavor not only to develop energy saving technologies suitable for a measuring method of energy consumption efficiency but also to develop energy saving technologies suitable for the actual status of the usage of users.

(2) Actions of retailers
Retailers shall not only try to sell commercial refrigerators, etc. with excellent energy consumption efficiency, but also offer appropriate information to users so that they can select commercial refrigerators, etc. with excellent energy consumption efficiency.

(3) Actions of users

Users shall attempt to not only select commercial refrigerators, etc. with excellent energy consumption efficiency but also reduce energy by using commercial refrigerators, etc. while actively using energy conservation setting.

(4) Actions of Government

1) From the viewpoint of promoting the spread of commercial refrigerators, etc. with excellent energy consumption efficiency, the government shall attempt to take necessary action such as the spread and enlightenment activities, in order to promote actions of users and manufacturers.
2) The government shall periodically and continuously check implementation of the display items by manufacturers and attempt at appropriate operation of the law so that information on energy consumption efficiency can be provided to users in correct and easily understandable manner.
3) The energy-saving standard based on the Top Runner Program is a very effective approach to energy saving of products. Therefore, the government shall make efforts to spread it internationally, by taking appropriate opportunities.

Attachment 1

Scope of the Target Commercial Refrigerators, etc.

1. Basic Idea

The commercial refrigerators, etc. as the target scope of this review shall be the electric refrigerators, etc. stipulated by JIS B 8630 as the application scope of Commercial refrigerators and freezers - Characteristics and test methods (limited to those which include one or more of HFC-125, HFC-143a and/or HFC-134a in their refrigerant), excluding “type I chilled air forced circulation refrigerators (chilled air forced circulation refrigerators the rated storage temperature’s lower limit of which is 0°C or above)”, “chilled air natural convection refrigerator-freezers” and “type I chilled air forced circulation refrigerator-freezers (chilled air forced circulation refrigerator-freezers whose chiller’s lower limit for the rated storage temperature is 0°C or above)”).

The target scope covers approximately 85% of the shipping quantity even if the following products are excluded.

2. Exclusion from Target Scope

The following products are excluded from the scope of the target commercial refrigerators, etc.

The basic concept of the exclusion is that (1) products used for special purpose, (2) products for which technical measurement methods and evaluation procedures have not been established yet and (3) products the use of which in the market is extremely rare are excluded from the target scope. The products stated in (1) above are excluded in JIS B 8630 too.

(1) Products excluded from the target scope because evaluation procedures have not been established yet.

1) Products with a refrigeration chamber of constant temperature and high humidity using its inner wall as a cooling surface (Reference 1-8 and 1-9).

Evaluation procedures for these products have not been established yet because they are special, for example, making the refrigerator inside with double stainless boxes and letting chilled air flow through the gap between the boxes to do indirect cooling, so they are excluded from the target scope.

* Estimated shipping quantity (FY2006): Approx. 6.0 thousand units

2) Horizontal type products with an opening on the top (sandwich table) (Reference 1-10)

Evaluation procedures for these products have not been established yet because they are special, i.e. making an opening on the top of the top board and putting a food container in the opening to seal it, so they are excluded from the target scope.

* Estimated shipping quantity (FY2006): Approx. 2.0 thousand units

3) Products which quickly cool and freeze food for storage at the temperature of minus 30°C or under (freezer) (Reference 1-12)

Evaluation procedures for these products have not been established yet because they are special, i.e. quickly cooling and freezing food after cooked for storage at the temperature of minus 30°C or under. And their shipping quantity is few, so they are excluded from the target scope.

* Estimated shipping quantity (FY2006): Approx. 1.3 thousand units

4) Low temperature chest freezers (Reference 1-15)

Evaluation procedures for these products have not been established yet because they are special as the temperature in the freezer is set at minus 30°C or below to make the freezing power greater than that of the standard type, and the shipping quantity is few, so they are excluded from the target scope.

* Estimated shipping quantity (FY2006): Approx. 0.8 thousand units

5) Locker type products with many independent storage chambers (Reference 1-16)

Evaluation procedures for these products have not been established yet because they are special as they are mainly used out of the kitchen, have a compressor mounted on the bottom and have many independent storage chambers controlling the temperature of all chambers, and the shipping quantity of these products is few, so they are excluded from the target scope.

* Estimated shipping quantity (FY2006): Approx. 0.5 thousand units

6) Products with a door which is pulled out (Reference 1-20)

Evaluation procedures for these products have not been established yet because they are special as they are used in the kitchen whose space is too small for the products with side-by-side doors, and the shipping quantity of these products is few, so they are excluded from the target scope.

* Estimated shipping quantity (FY2006): Approx. 0.3 thousand units

7) Products having three or more temperature setting ranges which do not overlap each other in one refrigeration box (Reference 1-21)

Evaluation procedures for these products have not been established yet because they are special as they have a cooling unit and a refrigerant pipe, etc. for refrigeration and freezing to control three different temperature zones in one unit, and the shipping quantity of these products is few, so they are excluded from the target scope.

* Estimated shipping quantity (FY2006): Approx. 0.3 thousand units

8) Products which can store the cart directly into the refrigerator (Reference 1-23)

Evaluation procedures for these products have not been established yet because they are special as they can preserve food on the cart as is, although their structure is similar to that of normal vertical products, and the shipping quantity of these products is few, so they are excluded from the target scope.

* Estimated shipping quantity (FY2006): Approx. 0.1 thousand units

9) Products with a showcase (food showcase, etc.) (Reference 1-24)

Refrigerators with a showcase for showing food at a sushi restaurant, etc. are special because an additional purpose is added to the original purpose of refrigerators which is to preserve food. So there are no evaluation procedures established for these refrigerators and their shipping quantity is few. So they are excluded from the target scope.

* Estimated shipping quantity (FY2006): Approx. 0.3 thousand units

10) Products which can be moved and use cooling storage material (cold roll box) (Reference 1-25)

Refrigerators used to bring food from the kitchen to the place where people are in a hotel or inn are special because they use cooling storage material to keep the food inside cool even if there is no power supply. So there are no evaluation procedures established for these refrigerators, and their shipping quantity is few. So they are excluded from the target scope.

* Estimated shipping quantity (FY2006): Approx. 0.1 thousand units

(2) Products which are excluded from the target scope because they are used for special application and their shipping quantity is few.

1) Horizontal type products the storage chamber's height of which is 650 mm or lower (Reference 1-7)

The height of these refrigerators is designed to be lower than that of normal horizontal refrigerators (650 mm or lower) and they are used with a cooking range placed on them or with a sink so that the kitchen space is efficiently used. However, their shipping quantity is few, so they are excluded from the target scope.

* Estimated shipping quantity (FY2006): Approx. 4.0 thousand units

2) Water cooling type products (Reference 1-18 and 1-22)

These refrigerators are used in special places such as underground malls where heat discharge is limited and their shipping quantity is few, so they are excluded from the target scope.

* Estimated shipping quantity (FY2006): Approx. 0.7 thousand units

3) Products with double sided doors (Reference 1-11 and 1-17)

These refrigerators are mainly used at the border between the kitchen and the restaurant, but their shipping quantity is few, so they are excluded from the target scope.

* Estimated shipping quantity (FY2006): Approx. 2.0 thousand units

4) Vertical freezers (Reference 1-13)

These freezers are used to preserve food for school-provided lunch for the purpose of food inspection, so they are designed to pull out the container preserving food. Their shipping quantity is few, so they are excluded from the target scope.

* Estimated shipping quantity (FY2006): Approx. 1.0 thousand units

5) Products of chilled air natural convection system (Reference 1-5)

These refrigerators are cooled by natural convection of chilled air so the recovery from the temperature change in the refrigerator is slow compared with that of the forced circulation system. They are used in small spaces such as behind the counter of a coffee shop. Their shipping quantity is rapidly decreasing in these years because some manufacturers are withdrawing from making these refrigerators, so they are excluded from the target scope.

* Estimated shipping quantity (FY2006 to 2007): Decreasing from approx. 7.4 to 5.0 thousand units

6) Products with a drawer of slide rail system (drawers) (Reference 1-6)

These refrigerators adopt a drawer of slide rail system so that food can be easily put in and taken out, to be used at places where work efficiency is important, such as hotels. Their specifications are specialized for the place they are used, so they are excluded from the target scope.

* Estimated shipping quantity (FY2006): Approx. 5.0 thousand units

7) Vertical type products the height of which is 2,050 mm or higher (Reference 1-14)

These refrigerators are used not in the kitchen but mainly in the backyard of a supermarket for storing food in the place of prefabricated refrigerators. Their shipping quantity is few, so they are excluded from the target scope.

* Estimated shipping quantity (FY2006): Approx. 0.9 thousand units

8) Products used exclusively for cold storage of milk (Reference 1-19)

These are refrigerators of chilled air forced circulation system whose lower limit of the rated storage temperature is 0°C or higher. They are exclusively used to preserve milk for school-provided lunch, but their shipping quantity is few, so they are excluded from the target scope.

* Estimated shipping quantity (FY2006): Approx. 0.8 thousand units

9) Horizontal type products with an electro magnetic cooker (Reference 1-24)

These are complex refrigerators which can both preserve food and cook it on the unit. Their shipping quantity is very few, so they are excluded from the target scope.

* Estimated shipping quantity (FY2006): Approx. 0.05 thousand units

10) Products modified or specially customized

The size, the freezing capacity of the compressor or the thermal insulation performance of these refrigerators is customized for special users. If their yearly shipping quantity is less than 50 units, they are excluded from the target scope, but if they are equipped with additional functions stipulated in the measurement method, they are included in the target scope.

* Estimated shipping quantity (FY2006): Approx. 0.8 thousand units

Attachment 2

Target Fiscal Year, etc. of Commercial Refrigerators, etc.

1. In general, a considerable improvement in energy consumption efficiency of commercial refrigerators, etc. is made when a model change takes place and major model change accompanying change of the cabinet size or shape takes place approximately every 10 to 20 years. During this period, minor change takes place approximately every 5 to 6 years to improve the performance. For this reason, if an opportunity for improving the energy consumption efficiency is to be given to commercial refrigerators, etc. at least once or twice, it seems 8 to 9 years are appropriate.

   Therefore, it is appropriate to set the target year of commercial refrigerators, etc. to be the fiscal year 2016 which is 9 years after the standard fiscal year (FY2007).

2. In addition, it is expected that the improvement rate of the annual energy consumption (kWh/year) in the target fiscal year will be approximately 22.7%, based on the assumption that there will be no change from the standard fiscal year's volume of shipments and composition of each category (results of the fiscal year 2007) (approximately 26.5% for commercial refrigerators, 22.4% for commercial refrigerator-freezers and 20.7% for commercial freezers).

<Overview of Estimation>

(1) The annual energy consumption calculated from values of actual achievements of commercial refrigerators, etc. shipped in the fiscal year 2007:
Approximately 1,604 kWh/year

(2) The annual energy consumption estimated from the target standard value of commercial refrigerators, etc. to be shipped in the target fiscal year:
Approximately 1,239 kWh/year

(3) Improvement rate of the energy consumption efficiency:
(1,604 - 1,239)/1,604 x 100 = Approximately 22.7%

<Overview of Estimation: Commercial Refrigerators>

(1) The annual energy consumption calculated from values of actual achievements of commercial refrigerators shipped in the fiscal year 2007:
Approximately 912 kWh/year

(2) The annual energy consumption estimated from the target standard value of commercial refrigerators to be shipped in the target fiscal year:
Approximately 670 kWh/year
(3) Improvement rate of the annual energy consumption:
(912 - 670)/912 x 100 = Approximately 26.5%

<Overview of Estimation: Commercial Refrigerator-freezers>
(1) The annual energy consumption calculated from values of actual achievements of commercial refrigerator-freezers shipped in the fiscal year 2007:
Approximately 2,706 kWh/year
(2) The annual energy consumption estimated from the target standard value of commercial refrigerator-freezers to be shipped in the target fiscal year:
Approximately 2,099 kWh/year
(3) Improvement rate of the annual energy consumption:
(2,706 - 2,099)/2,706 x 100 = Approximately 22.4%

<Overview of Estimation: Commercial Freezers>
(1) The annual energy consumption calculated from values of actual achievements of commercial freezers shipped in the fiscal year 2007:
Approximately 1,755 kWh/year
(2) The annual energy consumption estimated from the target standard value of commercial freezers to be shipped in the target fiscal year:
Approximately 1,391 kWh/year
(3) Improvement rate of the annual energy consumption:
(1,755 - 1,391)/1,755 x 100 = Approximately 20.7%

Attachment 3

Classification of Commercial Refrigerators, etc.

1. Basic Idea

Commercial refrigerators, etc. are classified based on the principles referred to in “the basic idea concerning the preparation and revision of the standards of judgment for manufacturers, etc. to be considered in relation to the improvement of the performance of specific equipment” (the 10th Energy Efficiency Standards Subcommittee of the Advisory Committee for Natural Resources and Energy, revised on June 18, 2007) (hereinafter referred to as merely “the principles”).

In case of commercial refrigerators, etc., although the energy consumption amount per unit is greater than those for home-use, the market size of those for commercial-use is small and their shipping quantity is few. Therefore, if they are classified into too small groups, the number of products or shipping quantity of some groups becomes very few. Therefore, while using functional formulae, they are classified by fewest possible indices based on the principles.

“The basic idea concerning the preparation and revision of the standards of judgment for manufacturers, etc. to be considered in relation to the improvement of the performance of specific equipment”
- Extract –

Principle 2: The specific equipment is classified based on certain indices. The indices (basic indices) are those which are deeply related to the energy consumption efficiency, such as physical amount, functions, and they are determined considering factors which consumers use as standards when choosing products (factors representing consumers’ needs).

Principle 3: The target standard value is determined by one value or functional formula for each category of the basic indices which are possible or appropriate to aim at the same energy consumption efficiency.

Principle 4: When setting the classifications, additional functions are disregarded in principle. However, if the energy consumption efficiency of a product without an additional function is set as a target standard value and, because of this product, other products with the additional function in question are likely to withdraw from the market, despite the fact that the needs for those products are thought to be high in the market, because they cannot comply with the target standard value thus set, then it is acceptable to make another category (sheet) for those products.

Principle 5: As regards products which are expensive but excellent in energy consumption efficiency because they use high energy conservation technologies, although it is possible to classify them into separate categories, it is desirable to treat them in the same category as much as possible so that manufacturers can actively sell the products with excellent energy consumption efficiency.

Principle 6: When setting a target standard value for one category, special products are excluded. However, when studying the improvement of the efficiency realized by technology development, etc., the feasibility of the technologies of the special products thus excluded must be studied too.

2. Specific Classification Method

Commercial refrigerators, etc. shall be classified based on the following three characteristics.

1) Classification by the type of refrigerators
2) Classification by the shape
3) Classification by the use of inverter control motors

(1) Classification by the type of commercial refrigerators, etc.

Commercial refrigerators, etc. are classified[1] as follows according to the type of their storage chambers, the application and the purpose of use.

○ Refrigerators
○ Refrigerator-freezers
○ Freezers

(2) Classification by the shape

Unlike normal vertical commercial refrigerators, etc., horizontal refrigerators are mainly placed under a cooking table of a kitchen. Therefore, the space of a horizontal refrigerator allocated for its cooling device is limited, making it difficult to make the heat exchanger larger, which is effective for improving the energy conservation performance, limiting the application of energy conservation technologies in contrast to vertical refrigerators.

Chest freezers are equipped with a door which opens upward and they are used mainly to preserve frozen food in the backyard of a store. The door is opened and closed less frequently to maintain the temperature inside the freezer, so it is possible to apply thermal insulation structure to the door.

Meanwhile, in case of freezer-stockers, although their door also opens upward, the opening and closing of the door is made easy using a light sliding door, because they are used to display commodities at the selling floor of a store. Therefore, their door is not thermally insulated and the sealing performance is low, so its performance as a commercial product conflicts with the performance of an energy conservation product.

From the observation above, it can be said that commercial refrigerators, etc. have the shape which is suitable for their application and the shape deeply concerns with energy conservation performance. Therefore, they are classified as follows.

[1] In case of electric refrigerators, etc. for home-use which are already the target equipment of the Top Runner Program, electric refrigerators (refrigerators and refrigerator-freezers) and electric freezers are treated as different specific equipment. Similarly, commercial refrigerators, etc. are correctly classified into refrigerators and refrigerator-freezers, and freezers are treated as different equipment. But, as the standard values are set individually for them, they are treated same under the Energy Conservation Act. So they are expressed as “Classification” here for convenience.

○ Vertical type
○ Horizontal type
○ Chest freezer (freezer only)
○ Freezer-stocker (freezer only)

Vertical Type

Horizontal Type

Chest Freezer (freezer only)

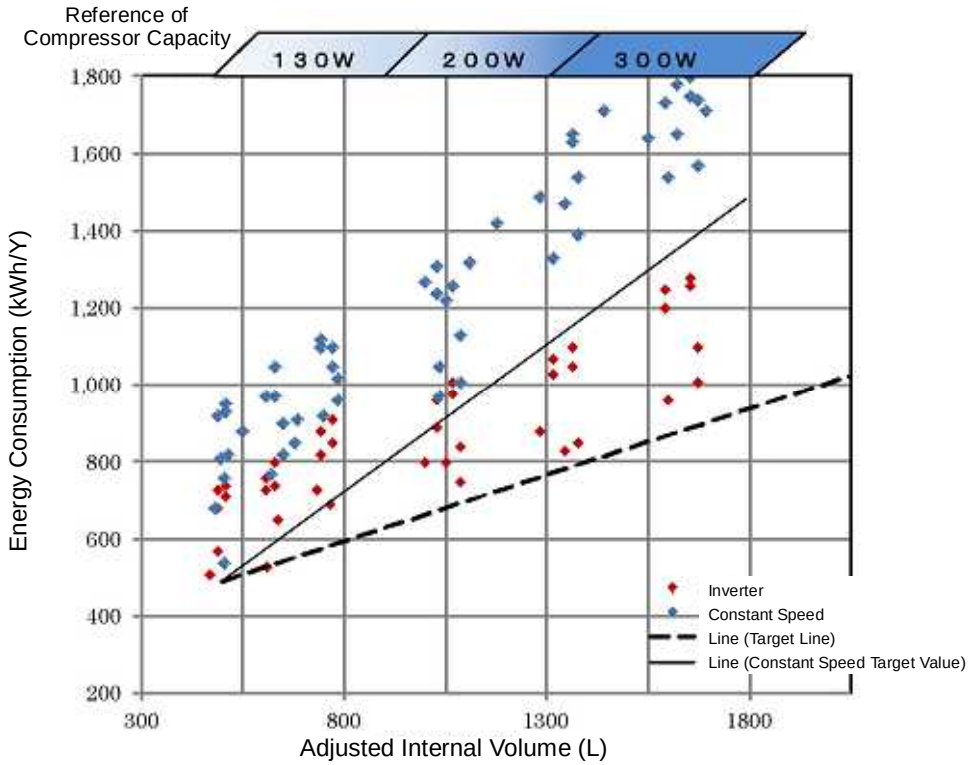
Freezer-stocker (freezer only)

(3) Classification by the use of inverter-control motors

The annual energy consumption of vertical refrigerators greatly varies depending on the use of inverters, but unlike refrigerators for home-use, inverter compressors which are optimal for each capacity are not readily lined up because the market size for these refrigerators is small. To be more specific, while constant speed compressors are being lined up meticulously from 130 to 300 W, in case of inverter compressors, there are 2 types of the same specifications, so, as far as the capacity is concerned, there is actually only one type, and business operators of commercial refrigerators have no choice other than use this inverter compressor.

Especially, in case of vertical refrigerators with small adjusted internal volume, business operators are forced to buy expensive equipment the inverter effect of which is not sufficient, which is unreasonable for them. Therefore, it was decided that the vertical refrigerators are classified by the use of inverters, and the target standard value, especially that for refrigerators with large adjusted internal volume, is set high to promote high efficiency and the spread of inverters.

Figure 3-1 Comparison between Constant Speed and 1 Inverter of Vertical Refrigerators



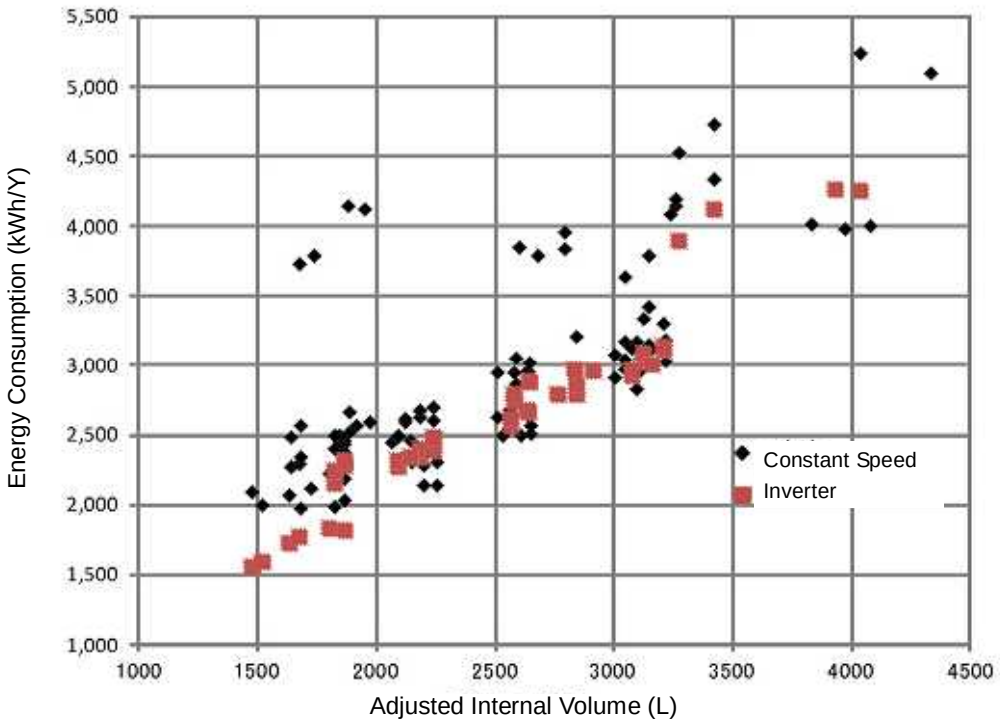
<Line-up and Effect of Compressors>

Product Type (Width mm)	600-800	900	1,200	1,500	1,800
Constant Speed Compressor (W)	130	200	200	300	300
Inverter Compressor (W)	190 (130-300)				
Energy Conservation Effect	△	△	○	◎	○

(◎: 30% or more, ○: 20-30%, △: 10-20%)

It is also possible to classify vertical refrigerator-freezers by the use of inverters, but even if an inverter is installed, except for refrigerator-freezers with two inverters, it is installed in the chiller side, not in the freezer side where annual energy consumption is greater. Therefore, although there is difference in case of refrigerator-freezers with smaller adjusted internal volume (refrigerator-freezers the freezer of which is smaller), the difference due to the use of inverters is small as a whole. So they are not classified here.

Figure 3-2 Comparison between Constant Speed and 1 Inverter of Vertical Refrigerator-freezers



3. Summary of Classification

According to the indices described in section 2 above, the classification is made as per Table 3-1 and Table 3-2.

Table 3-1 Classification of Commercial Refrigerators and Commercial Refrigerator-freezers

Category	Type of Refrigerator	Shape	Inverter Control Motor	Shipping Quantity (Units)
1A	Refrigerators	Vertical Type	There is.	7,900
1B			There isn't.	10,594
1C		Horizontal Type	—	52,553
2A	Refrigerator-freezers	Vertical Type	—	24,501
2B		Horizontal Type	—	11,900

Note 1. The "vertical type" means those the height of which based on the external dimensions stipulated by JIS B 8630 (hereinafter referred to as "external height") is over 1,000 mm and the door of which opens toward the front side. The same applies hereinafter.

2. The "horizontal type" means those the external height of which is 1,000 mm or lower and the door of which opens toward the front side. The same applies hereinafter.

Table 3-2 Classification of Commercial Freezers, etc.

Category	Shape	Shipping Quantity (Units)
3A	Vertical Type	20,739
3B	Horizontal Type	7,500
4A	Chest Freezers	15,689
4B	Freezer-stockers	16,255

Note 1. The "chest freezers" are those which open upward with a door which is pulled up.

2. The "freezer-stockers" are those which open upward with a door which slides leftward and rightward.

Attachment 4

Target Standard Values of Commercial Refrigerators, etc.

1. Idea on Setting Target Standard Values

We shall set target standard values based on the idea of Top Runner Program. The specific policy shall be as follows:

1) A target standard value shall be set for every appropriately defined category.
2) For any category for which possible improvement of efficiency is anticipated because of future technology advancement, a target standard value shall allow for the improvement wherever possible.
3) Target standard values shall not be inconsistent among categories.

2. Specific Technologies for Improving Energy Consumption Efficiency and Possible Improvement

Before determining target standard values for commercial refrigerators, etc., the improvement of technologies expected to be applied to each category was studied. As a result, it was found that the improvement can be expected mainly from the following energy conservation technologies.

- Application of new high-tech technologies (optimal control of inverter control)
- Study and application of new thermal insulation material (vacuum thermal insulation material, etc.)
- Review of the energy conservation technologies implemented in the past and promotion of further improvement
- Efficiency improvement by changing refrigerant

This is not to say that the improvement of the energy consumption efficiency is possible because epoch-making technologies are expected to be developed but to say that it is realized by the improvement and extended application of already-existing technologies.

As regards inverters, it is important to study its possibility considering the fact that the available models of inverters provided by compressor manufacturers are limited and that the vacuum thermal insulation material does not have a sufficient energy consumption saving effect for all refrigerators.

The specific contents of the improved technologies and the feasibility of applying them to each category (Table 4-1) are as follows.

(1) Improvement of compressor's efficiency

It is being tried to improve compressor motors of refrigerators by enhancing the motor efficiency by adopting operation condensers, improving the motor efficiency by increasing the motor core's thickness, reducing the mechanical loss of the sliding section by making the motor shaft smaller, enhancing the volume efficiency by minimizing the top clearance. Furthermore, additional improvement can be expected by adopting the inverter motor the number of revolution of which can be changed, by

changing the AC motor to the DC motor, by changing the distributed winding to the concentrated winding (direct winding) and so on.

(2) Technologies for improving the performance of fans

1) High-efficiency of fan motors in refrigerators
   To change AC motors to DC brushless motors with high efficiency.
2) Improvement of efficiency of condenser's fan motors
   It is being tried to make the efficiency of condenser's fan motors high by improving the fan shape to make the air amount greater while containing the noise. As regards motors, it is expected that improvement can be made by enhancing the motor efficiency by adopting condenser motors and high efficiency DC motors.

(3) Technologies for improving efficiency of control

1) Control of dew condensation prevention heaters
   It is possible to improve the efficiency of dew condensation prevention heaters around doors with the micro-computer control by changing the control from the way which always supplies electricity to the way which controls the optimal electricity supply ratio.
2) Control of the number of revolution of compressor motors (using the inverter)
   Improvement is realized by changing the AC motor to the high efficiency DC motor and by controlling the number of revolution with the micro computer.

(4) Improvement of performance by reviewing thermal insulation structure

The thermal insulation performance can be improved by reviewing the foaming structure and the thermal insulation structure including each sealing section (unit, door, etc.) to control the heat leakage.

Table 4-1 Technologies for Improving Commercial Refrigerators, etc. and Improvement Ratio

Category	Improvement of Compressor's Efficiency	Improvement of Fan's Performance		Control of Dew Condensation Prevention Heater	Control of Frost Removal Heater	Inverter Control	Thermal Insulation Structure (Including Pillar-less)	Target Improvement Ratio (%)
		Condenser	Inside Refrigerator					
Vertical Refrigerator Inverter	○	○	-	○	○	○	○	31.1
Vertical Refrigerator Constant Speed	○	○	○	○	○	-	○	23.6
Horizontal Refrigerators	○	○	○	○	○	-	○	26.6
Vertical Refrigerator-freezers	○	○	-	○	○	○	○	26.7
Horizontal Refrigerator-freezers	○	○	○	○	○	-	○	12.3
Vertical Freezers	○	○	○	○	○	○	○	19.6
Horizontal Freezers	○	○	○	○	○	-	○	25.8
Chest Freezers	○	-	-	-	-	-	○	22.5
Freezer-stockers	○	-	-	-	-	-	○	18.8

3. Specific Calculation Formula of a Target Standard Value (Standard Energy Consumption Efficiency)

According to the categories of commercial refrigerators, the Top Runner values were obtained from the actual measurement values (FY2007) of the annual energy consumption (kWh/year), and the annual energy consumption value (kWh/year) considering the improvement up to the target fiscal year in each category was taken as the target standard value.

Meanwhile, as the annual energy consumption correlates to the internal volume, the calculation formula of a target standard value of commercial refrigerators, etc. shall be expressed by a linear function expression with the adjusted internal volume as a variable. This is the calculation formula of the standard energy consumption efficiency considering the effect of the center-pillar-less and the number of doors too. The specific values are shown in Table 4-2 and 4-3 below.

Table 4-2 Standard Energy Consumption Efficiency of Commercial Refrigerators and Commercial Refrigerator-freezers

Category	Type of Refrigerator	Shape	Inverter Control Motor	Calculation Formula of Standard Energy Consumption Efficiency
1A	Refrigerator	Vertical Type	There is.	$E = 0.345V_1 + 86n_R + 64d_R + 315$
1B			There isn't.	$E = 0.766V_1 + 86n_R + 64d_R + 106$
1C		Horizontal Type	—	$E = 1.12V_1 + 70n_R + 34d_R + 237$
2A	Refrigerator-Freezer	Vertical Type	—	$E = 0.872V_1 + 86n_R + 64d_R + 186n_F + 295d_F - 113$
2B		Horizontal Type	—	$E = 2.43V_1 + 70n_R + 34d_R + 157n_F + 157d_F - 183$

Note 1. The "vertical type" means those the height of which based on the external dimensions stipulated by JIS B 8630 (hereinafter referred to as "external height") is over 1000 mm and the door of which opens toward the front side. The same applies hereinafter.

2. The “horizontal type” means those the external height of which is 1000 mm or lower and the door of which opens toward the front side. The same applies hereinafter.
3. E is the value of the standard energy consumption efficiency (unit: kWh/year). The same applies hereinafter.
4. V_1 is the adjusted internal volume calculated by the following formula, rounding the number after the decimal point.
   Category “1A” and “1B” $V_1 = 800/d \times V_R$
   Category “1C” $V_1 = 600/d \times V_R$
   Category “2A” $V_1 = 800/d \times (V_R + 2.48V_F) + 887$
   Category “2B” $V_1 = 600/d \times (V_R + 3.74V_F) + 336$
   However, as a result of the above mentioned calculation, if the adjusted internal volume becomes the lower limit value stipulated for each category in the following table or lower than that, then the lower limit value is used as the adjusted internal volume.

Category	Lower Limit Value
1A	500
1B	500
1C	75
2A	1930
2B	750

5. d is the depth (unit: mm) based on the external dimensions stipulated by JIS B 8630. The same applies hereinafter.
6. V_R is the rated internal volume of a chiller (unit: liter). The same applies hereinafter.
7. V_F is the rated internal volume of a freezer (unit: liter). The same applies hereinafter.
8. n_R: The number of places behind side-by-side doors of a chiller where center pillars are not installed
9. n_F: The number of places behind side-by-side doors of a freezer where center pillars are not installed
10. d_R is used as $d_R = 1$ for chillers with multiple doors (i.e. those which have doors the number of which is more than the standard number of doors stated in the following table according to the external width (W: unit, mm) stipulated by JIS B 8630) and as $d_R = 0$ for others.

Shape	External Width	Standard Number of Doors
Vertical Type	825 mm or under	2
	Over 825 mm up to 1,650 mm	4
	Over 1,650 mm	6
Horizontal Type	1,050 mm or under	1
	Over 1,050 mm up to 1,650 mm	2
	Over 1,650 mm	3

11. d_F is used as $d_F = 1$ for freezers with multiple doors and as $d_F = 0$ for others. The same applied hereinafter.

Table 4-3 Standard Energy Consumption Efficiency of Commercial Freezers

Category	Shape	Calculation Formula of Standard Energy Consumption Efficiency
3A	Vertical Type	$E = 1.96V_2 + 186n_F + 295d_F + 788$
3B	Horizontal Type	$E = 4.12V_2 + 157n_F + 157d_F + 349$
4A	Chest Freezer	$E = 1.16V_2 + 211$
4B	Freezer-stocker	$E = 1.39V_2 + 359$

Note 1. The “chest freezers” are those which open upward with a door which is pulled up.

2. The “freezer-stockers” are those which open upward with a door which slides leftward and rightward.
3. E is the value of the standard energy consumption efficiency (unit: kWh/year).
4. V_2 is the adjusted internal volume calculated by the following formula, rounding the number after the decimal point.

   Category “3A” $V_2 = 800/d \times V_F$

   Category “3B” $V_2 = 600/d \times V_F$

   Category “4A” and “4B” $V_2 = V_F$

   However, as a result of the above mentioned calculation, if the adjusted internal volume becomes the lower limit value stipulated for each category in the following table or lower than that, then the lower limit value is used as the adjusted internal volume.

Category	Lower Limit Value
3A	500
3B	75
4A	250
4B	50

4. Factors of Calculation Formula of Standard Energy Consumption Efficiency

(1) Calculation formula of adjusted internal volume

1) Depth adjustment factor (vertical type: 800/d, horizontal type: 600/d)

As the feature of commercial refrigerators, etc. (except for chest freezers and freezer-stockers), as the front (door) area becomes large, the annual energy consumption tends to become larger, because even if the volume is the same, the load caused by the opening and closing of the door is large, so as the front area becomes large, the effect of heat leakage becomes large.

Meanwhile, there are thin refrigerator models with the same front area (door area) in the line-up of commercial refrigerators, etc. in order to cope with limited installation spaces.

Therefore, as Figure 4-1 shows, the standard cannot be set simply by the rated internal volume, so, as Table 4-2 shows, the correction factors were studied according to the measurement results.

To be more specific, the standard depth size was divided by the actual depth size and then multiplied by the rated internal volume to obtain the adjusted internal volume and see the correlation. As a result, it was found that they almost coincide. In other words, even if the rated internal volume becomes small as the depth size becomes small, it does not affect the annual energy consumption much.

Therefore, it was decided to calculate the adjustment factors with the following formulae.

Vertical Type : Depth Adjustment Factor = 800/d
Horizontal Type : Depth Adjustment Factor = 600/d
d: External depth size (unit: mm)

Figure 4-1 Effect of Depth Size in Vertical Refrigerators (Single Phase 600 mm, Single Phase 800 mm)

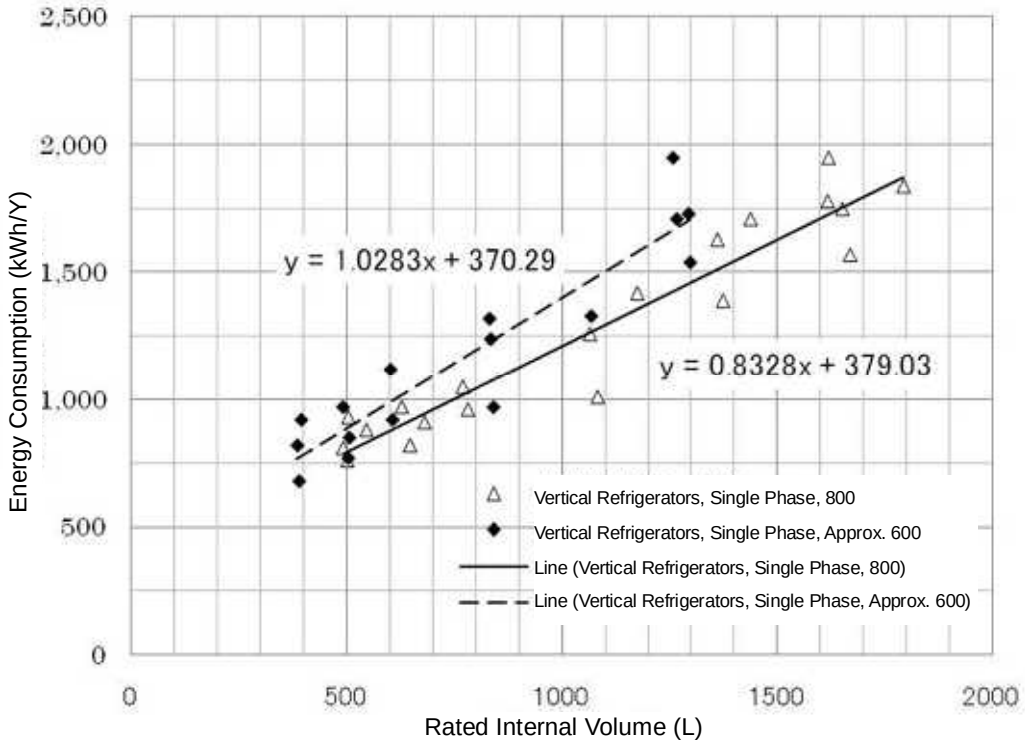
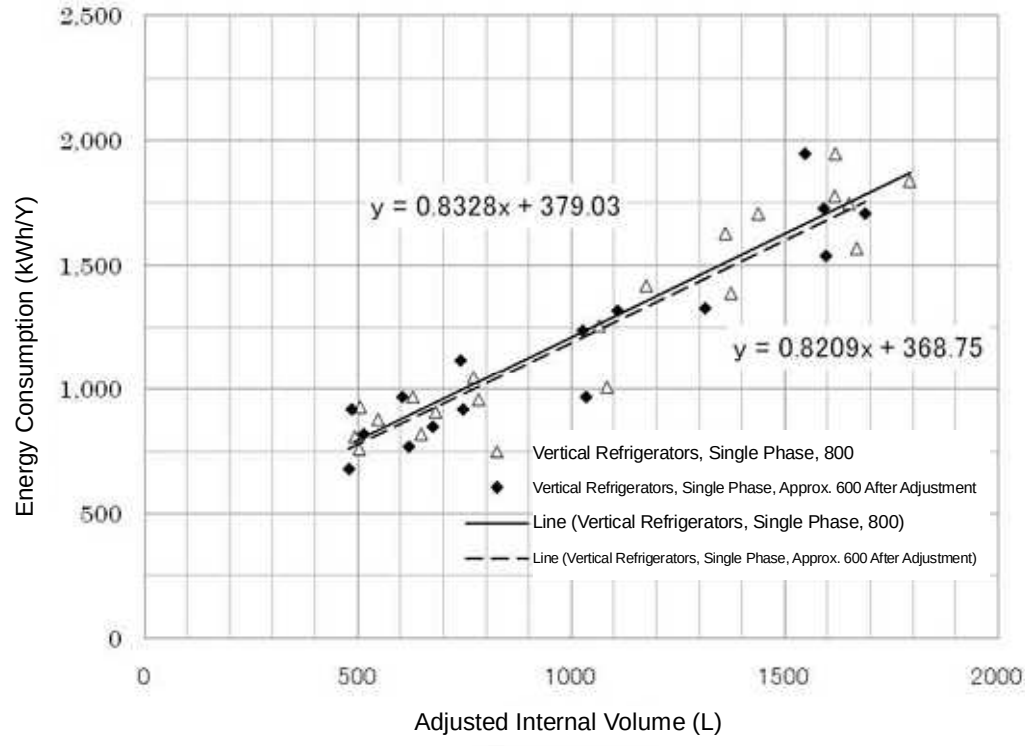


Figure 4-2 Effect of Depth Size in Vertical Refrigerators (Single Phase 600 mm, Single Phase 800 mm) (After Adjustment)



2) Temperature adjustment factor (A) and temperature adjustment constant (I)

Of commercial refrigerators, etc., in case of refrigerator-freezers, the load is very different between the chiller and the freezer, so, with the volume obtained by simply adding both volumes, the correlation between the volume and the energy consumption cannot be made clear.

However, if the freezer volume is converted to the refrigerator volume, the proportional correlation can be obtained between the refrigerator-freezer's volume and the load. Therefore, using the data of the refrigerator and the freezer, the factor, etc. which convert the freezer volume to the refrigerator volume was calculated to be used as the factor, etc. for obtaining the adjusted internal volume in the formula for calculating the standard energy consumption efficiency.

The specific calculation methods are as follows.

Freezer : $E_F = S_F \times V_F + I_F$

Refrigerator* : $E_R = S_R \times V_R + I_R$

E : Energy consumption

S : Slant

V : Volume

I : Intercept

Then, from $E_F = E_R$

$S_F \times V_F + I_F = S_R \times V_R + I_R$

$$\therefore\ V_R = \frac{S_F}{S_R} \times V_F + \frac{I_F - I_R}{S_R} \quad \cdots \text{(a)}$$

○Calculation of temperature adjustment factor and temperature adjustment constant for vertical products

The approximate lines based on the measurement result of vertical refrigerators and vertical freezers are shown in Figure 4-3. From the result of the approximate formula based on this measurement data, the calculation is made using (a) above.

S_F/S_R (Temperature adjustment factor: A) ≈ 2.48

$(I_F - I_R)/S_R$ (Temperature adjustment constant: I) ≈ 887

The plot and the approximate formula after the correction made by this adjustment formula are those shown in Figure 4-4. This result was incorporated into the formula for calculating the adjusted internal volume of vertical refrigerator-freezers.

Figure 4-3 Correlation between Vertical Freezers and Refrigerators

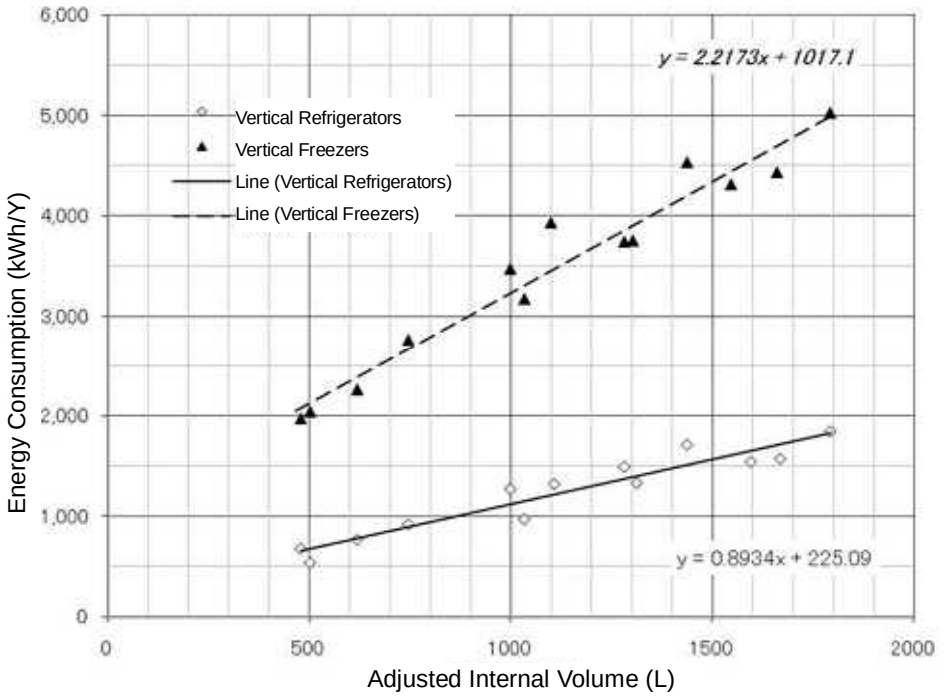
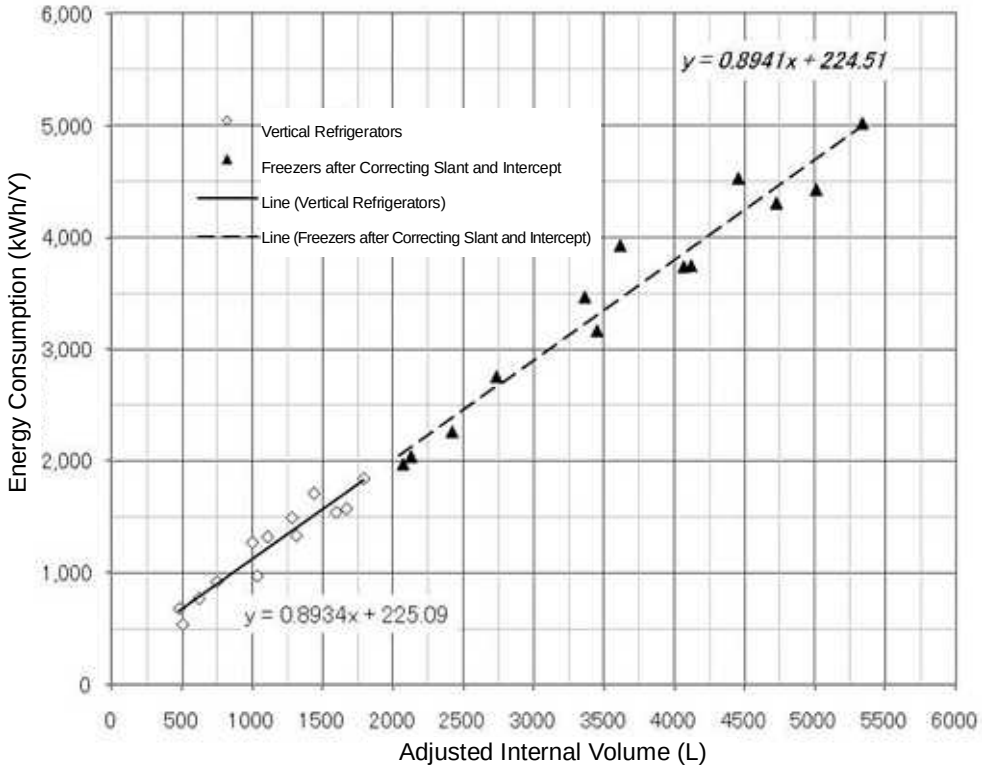


Figure 4-4 Correlation between Vertical Freezers and Refrigerators (After Correction)



○Calculation of temperature adjustment factor and temperature adjustment constant for horizontal products

The calculation for horizontal refrigerators and horizontal freezers was done the same way as the calculation for the vertical products, and the result was as follows.

S_F/S_R (Temperature adjustment factor: A) ≈ 3.74

$(I_F - I_R)/S_R$ (Temperature adjustment constant: I) ≈ 336

Figure 4-5 Correlation between Horizontal Freezers and Refrigerators

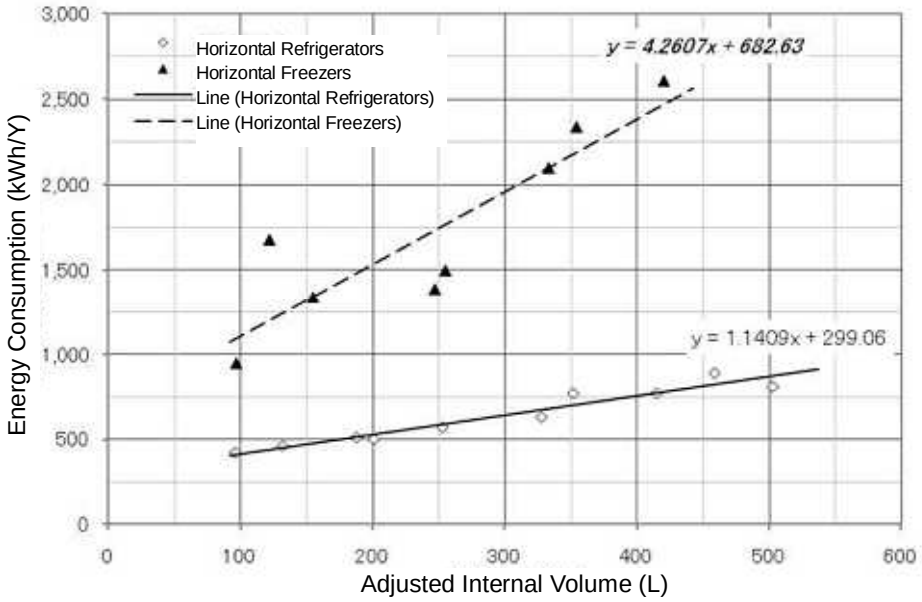
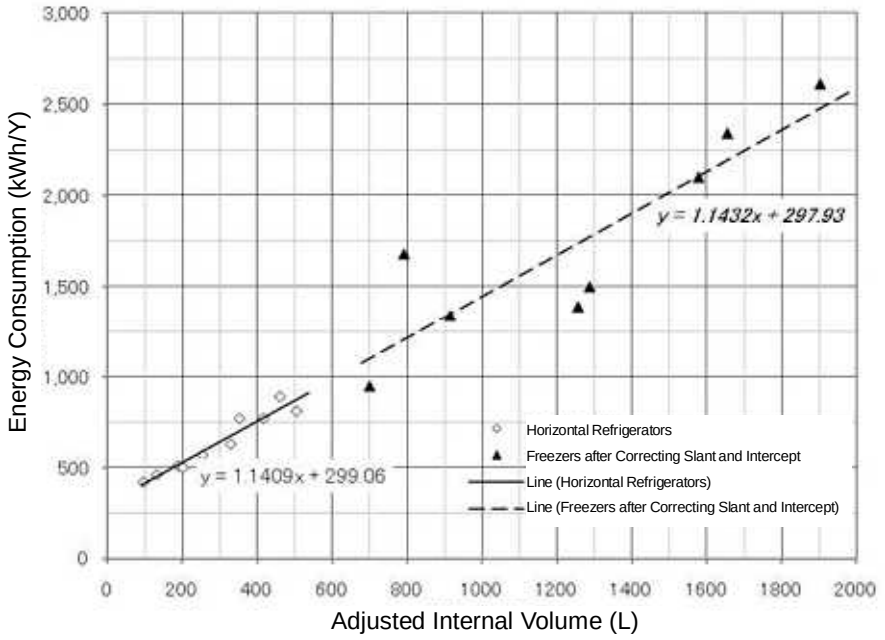


Figure 4-6 Correlation between Horizontal Freezers and Refrigerators (After Correction)



(2) Adjustment of center-pillar-less (n_R, n_F) and multiple doors (d_R, d_F)

In case of commercial refrigerators, etc., models without pillars which are otherwise placed at the center between 2 doors of the chamber are being manufactured for the reason to make it easy to put in or take out wider food (hereinafter referred to as “center-pillar-less”).

Center-pillar-less refrigerators, etc. need to make the capacity of the heater located at the center of the door bigger than that of the models with center pillars, in order to prevent dew condensation or frosting. For this reason, the energy consumption varies depending on the number of places where center pillars are not installed.

Meanwhile, kitchens which use commercial refrigerators, etc. often have constrains on their space, so if the door of a refrigerator is too big, it is difficult to open it, and it becomes the problem of the refrigerator.

Therefore, models with multiple doors are being produced, whereby the width of each door is made smaller than that of normal products and, instead, the number of doors is increased.

However, if doors are added, the number of dew condensation prevention heaters to be mounted on center pillars must be increased, which in turn causes the energy consumption to increase.

Still, if either of center-pillar-less products or multiple door products are not supplied, it is likely to block the consumer’s needs, so it was decided to correct the standard energy consumption efficiency of those products.

For the difference in the energy consumption used for each correction, the difference of multi-door products or center-pillar-less products is was, and the difference of comparable products with standard specifications was calculated, and the average value was calculated.

However, since the improvement of the energy consumption efficiency cannot be expected from simple addition, the addition value estimating the improvement of the energy consumption was taken. Each addition value was calculated as follows.

<Center-pillar-less (one place)>

Vertical refrigerators	: 86 kWh/year
Vertical freezers	: 186 kWh/year
Horizontal refrigerators	: 70 kWh/year
Horizontal freezers	: 157 kWh/year

<Multiple doors>

Vertical refrigerators	: 64 kWh/year
Vertical freezers	: 295 kWh/year
Horizontal refrigerators	: 34 kWh/year
Horizontal freezers	: 157 kWh/year

○About center-pillar-less

➢ With pillars

➢ Center-pillar-less

◇Refrigerators making the opening wider so that big plates or boxes can be easily put in and taken out

The photo is the example of the refrigerator the pillar-less number of which is $n_R = 2$.

○About multiple doors (Example of the vertical refrigerator the width of which is 1,500 mm)

<The model with standard number of doors>

<The model with multiple doors>

The photo is the example of multiple doors: $d_R = 1$

Table 4-4 Standard Number of Doors

Shape	External Width	Standard Number of Doors
Vertical Type	825 mm or under	2
	Over 825 mm up to 1,650 mm	4
	Over 1,650 mm	6
Horizontal Type	1,050 mm or under	1
	Over 1,050 mm up to 1,650 mm	2
	Over 1,650 mm	3

5. Calculation Formula for Standard Energy Consumption Efficiency

As mentioned in Section 2 above, in case of commercial refrigerators, etc., the development of epoch-making technologies is not expected, but, instead, the effect realized by the improvement and extended application of already existing technologies is great.

If the efficiency was enhanced to the level of the Top Runner product in each category, approximately 18% of improvement would be realized only by that.

If the improvement must be made further than the level of the Top Runner based on the principles, much improvement is expected in the constant speed (without inverter control motor) because it is being changed to the inverter control.

Note that the category 2A includes 2-inverter models.

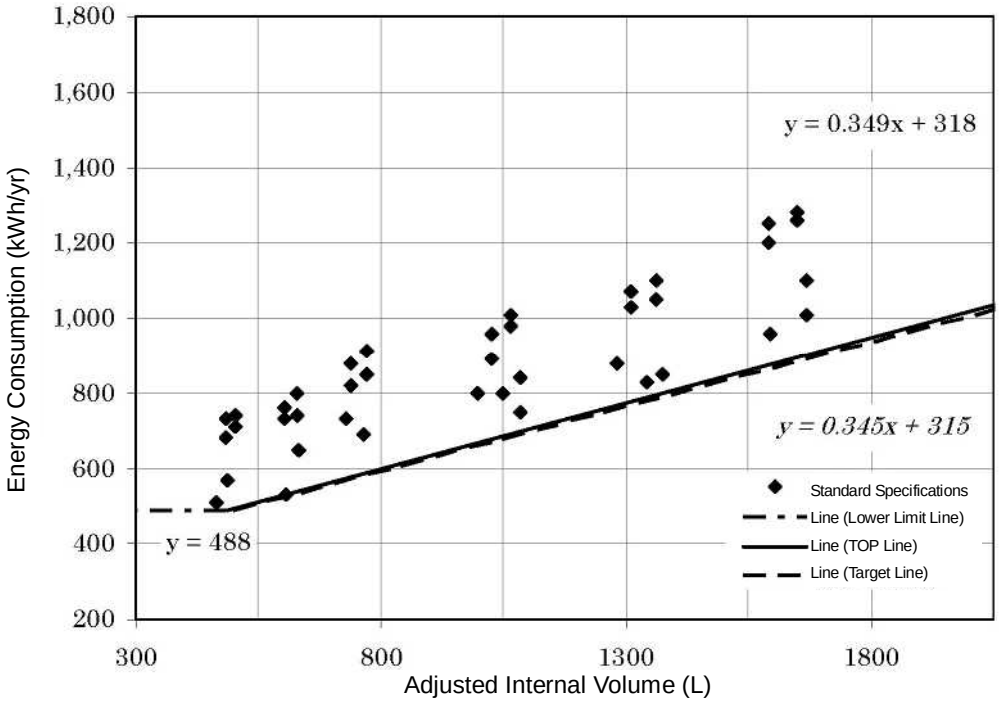
2-inverter models are noted for their high energy consumption efficiency but their shipping quantity is still few. So if the standard was made using 2-inverter models as Top Runner, the product price would become high, making the supply of commercial refrigerators, etc. difficult. Therefore, based on the principle 5, the spread rate of 2-inverter models is estimated to be approximately 5% (FY2007 achievement: approx. 1%) and the target standard value of the category 2A is lowered.

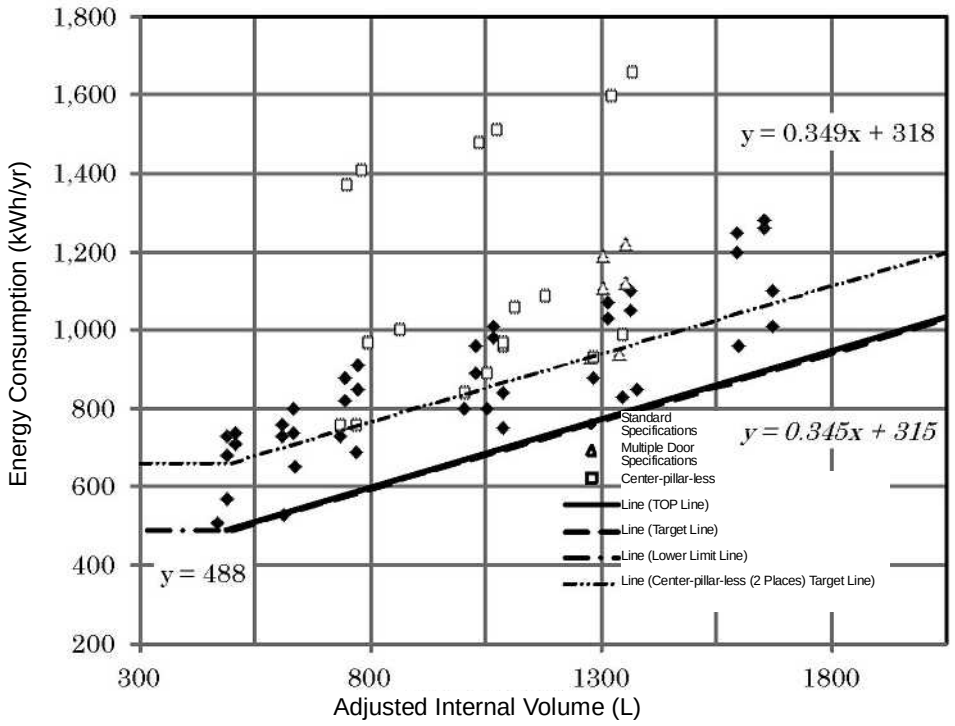
Table 4-5 Improvement of Each Category

Category	Type	FY2007 Quantity Sold (Units)	Energy Consumption (MWh/Y)	Top Runner Energy Consumption (MWh/Y)	Top Runner Improvement Ratio	Target Fiscal Year Energy Consumption (MWh/Y)	Target Fiscal Year Improvement Ratio
1A	Vertical Refrigerators, Inverter	7,900	8,158	5,911	27.5%	5,620	31.1%
1B	Vertical Refrigerators	10,594	13,958	11,919	14.6%	10,666	23.6%
1C	Horizontal Refrigerators	52,553	42,673	32,525	23.8%	31,335	26.6%
2A	Vertical Refrigerator-freezers	24,501	69,360	56,058	19.2%	50,860	26.7%
2B	Horizontal Refrigerator-freezers	11,900	29,155	25,755	11.7%	25,556	12.3%
3A	Vertical Freezers	20,739	68,805	60,372	12.3%	55,330	19.6%
3B	Horizontal Freezers	7,500	14,340	10,905	24.0%	10,640	25.8%
4A	Chest Freezers	15,689	13,539	10,488	22.5%	10,488	22.5%
4B	Freezer-stockers	16,255	8,957	7,276	18.8%	7,276	18.8%
	Total	167,631	268,945	221,208	17.7%	207,772	22.7%

(1) Vertical refrigerators (with inverter)

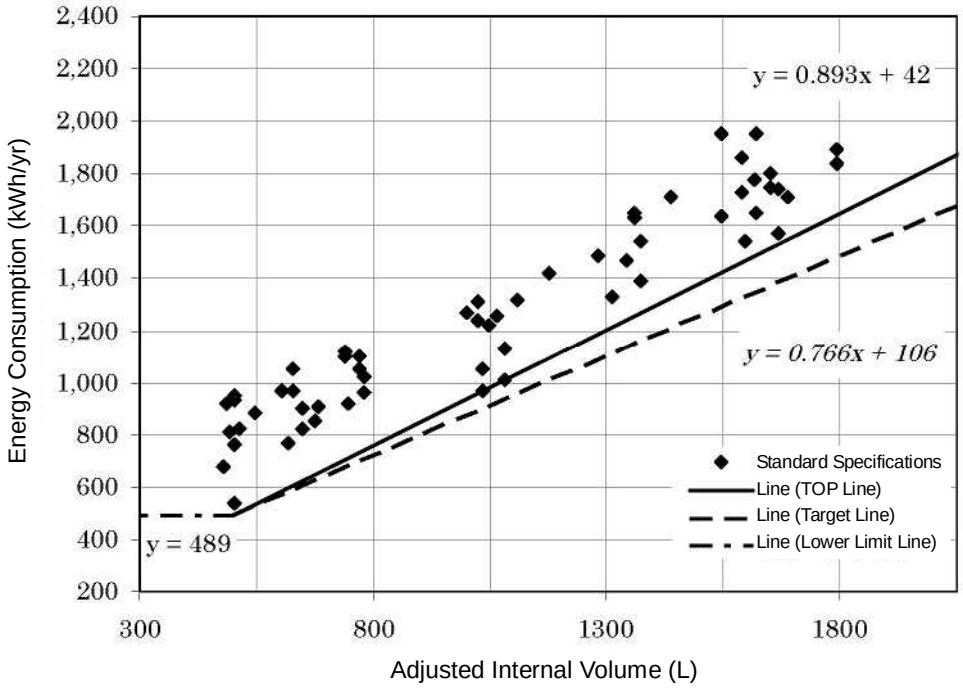
$E = 0.345V_1 + 86n_R + 64d_R + 315$

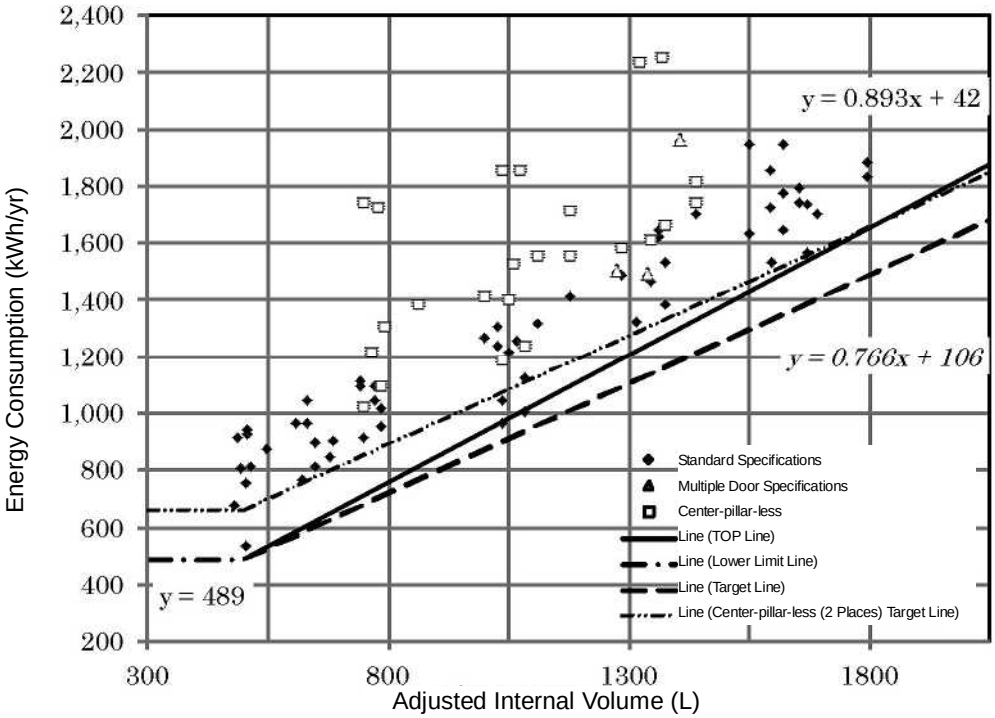




(2) Vertical refrigerators (without inverter)

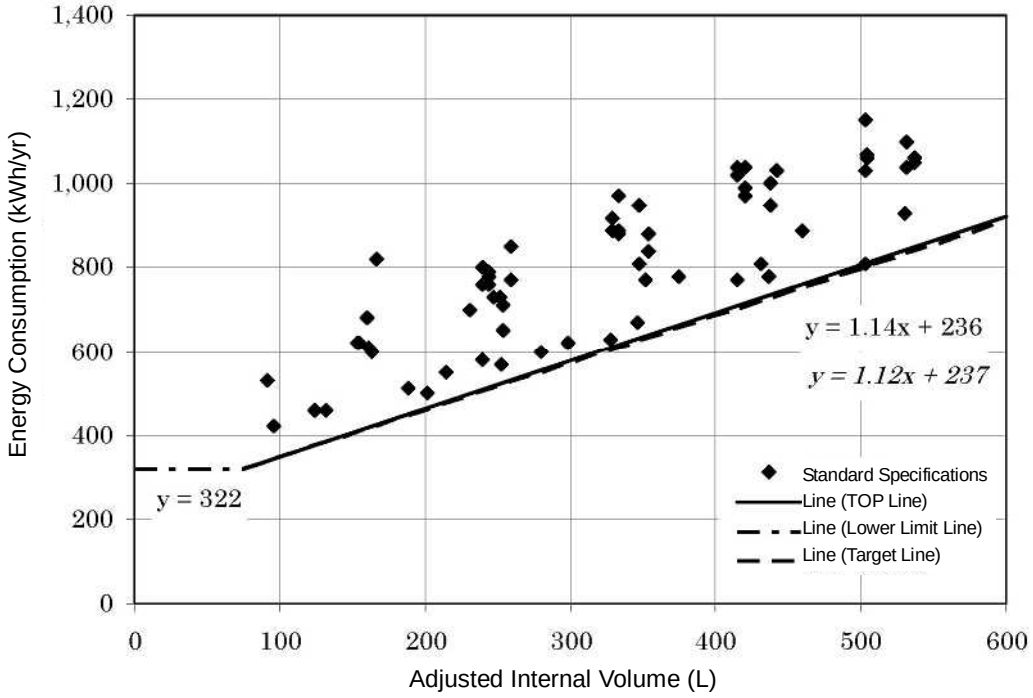
$E = 0.766V_1 + 86n_R + 64d_R + 106$

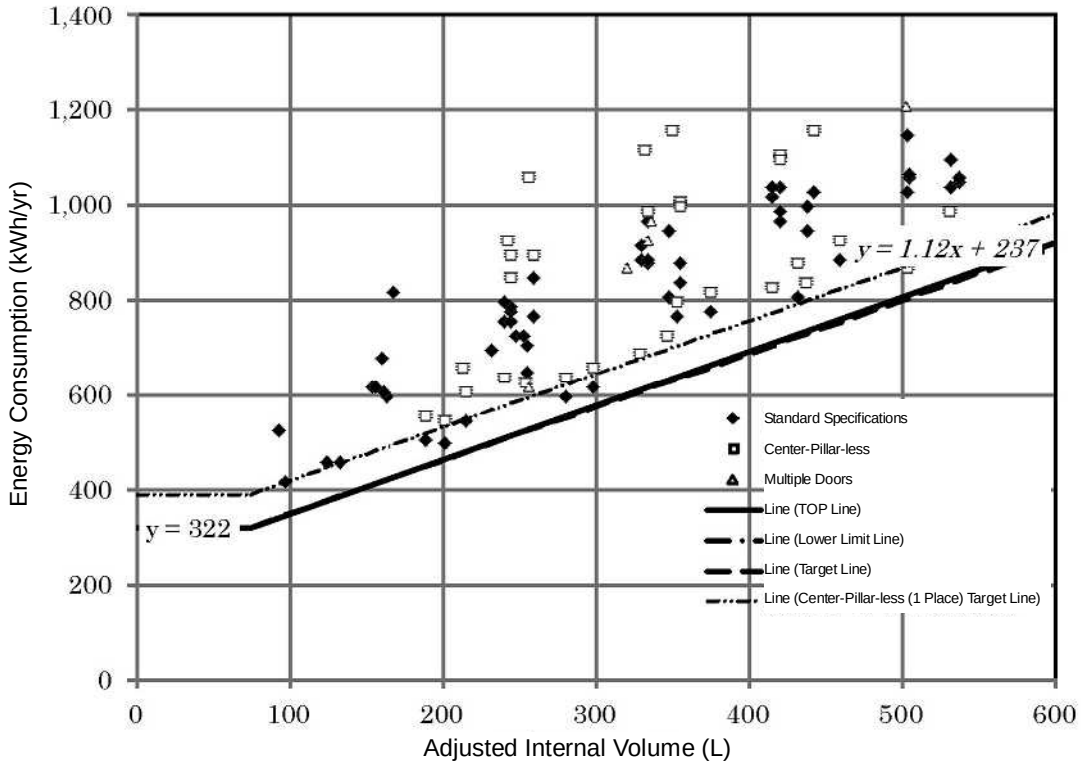




(3) Horizontal refrigerators

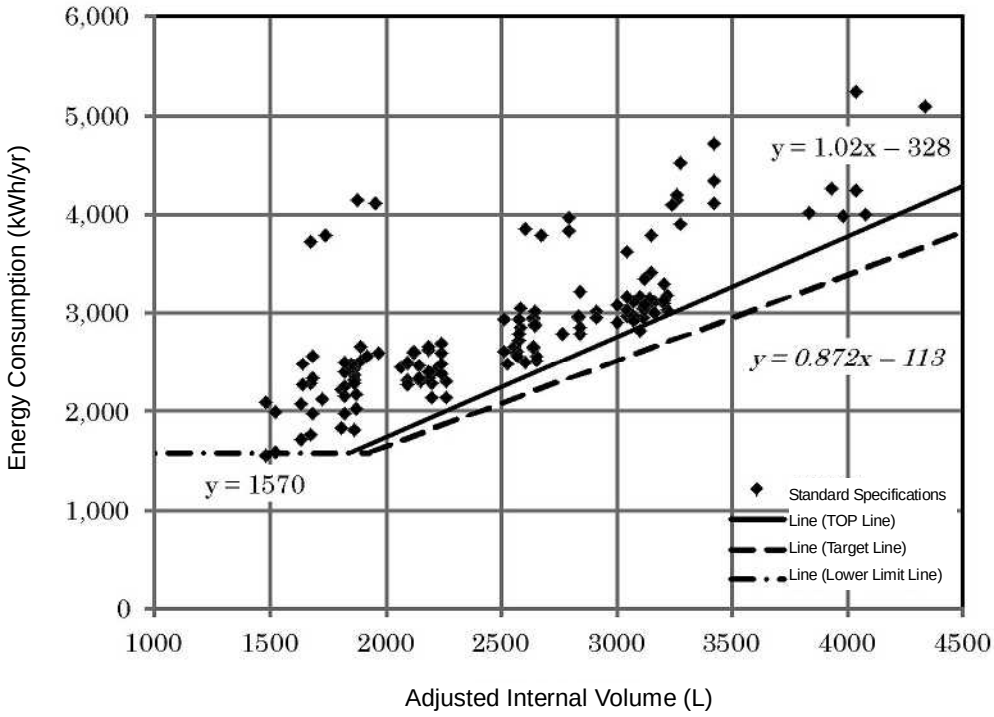
$E = 1.12V_1 + 70n_R + 34d_R + 237$

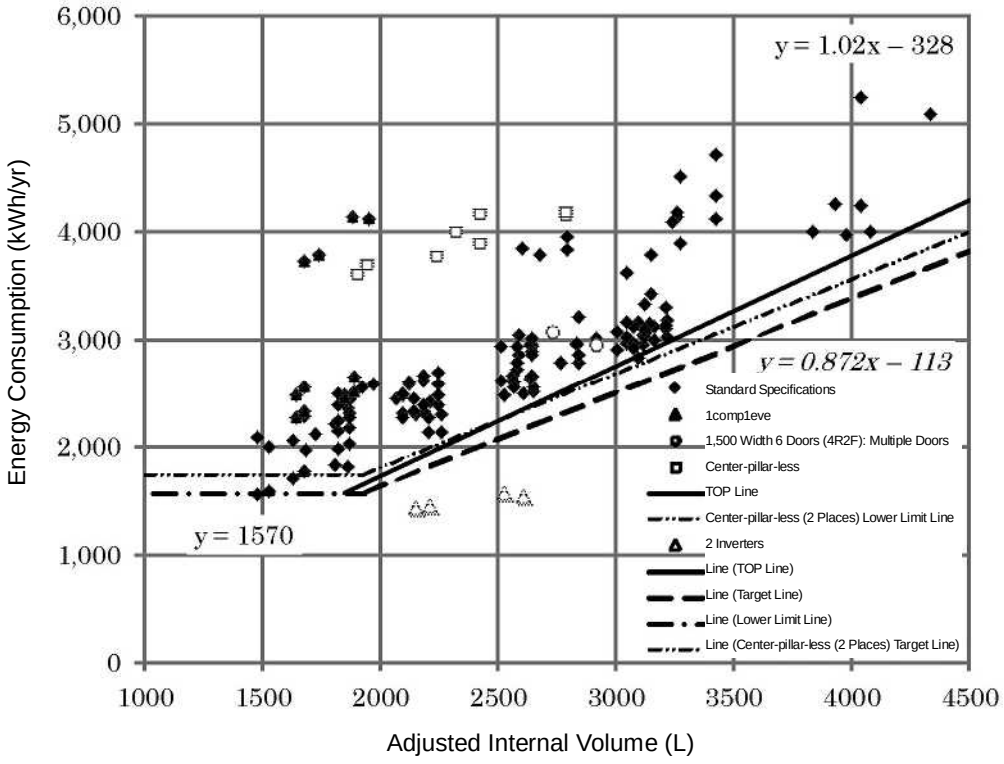




(4) Vertical refrigerator-freezers

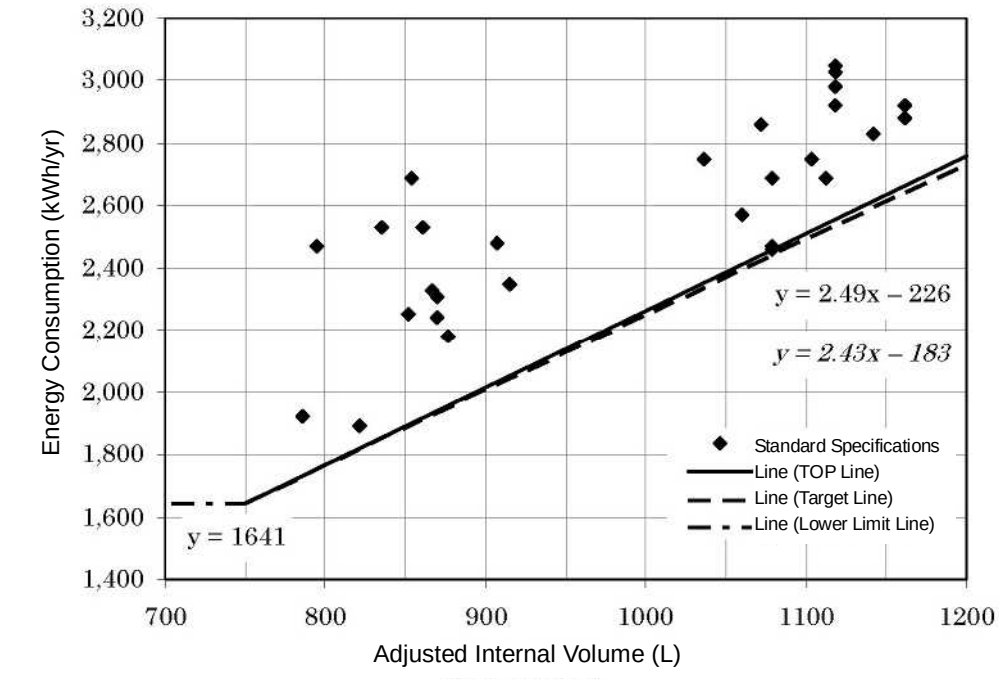
$E = 0.872V_1 + 86n_R + 64d_R + 186n_F + 295d_F - 113$

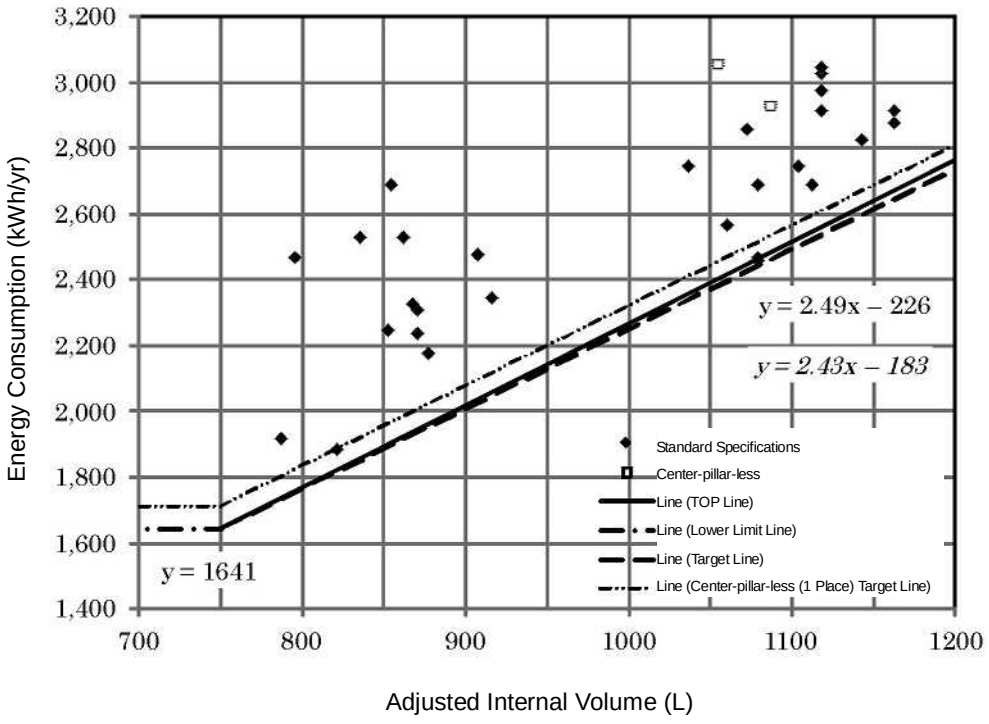




(5) Horizontal refrigerator-freezers

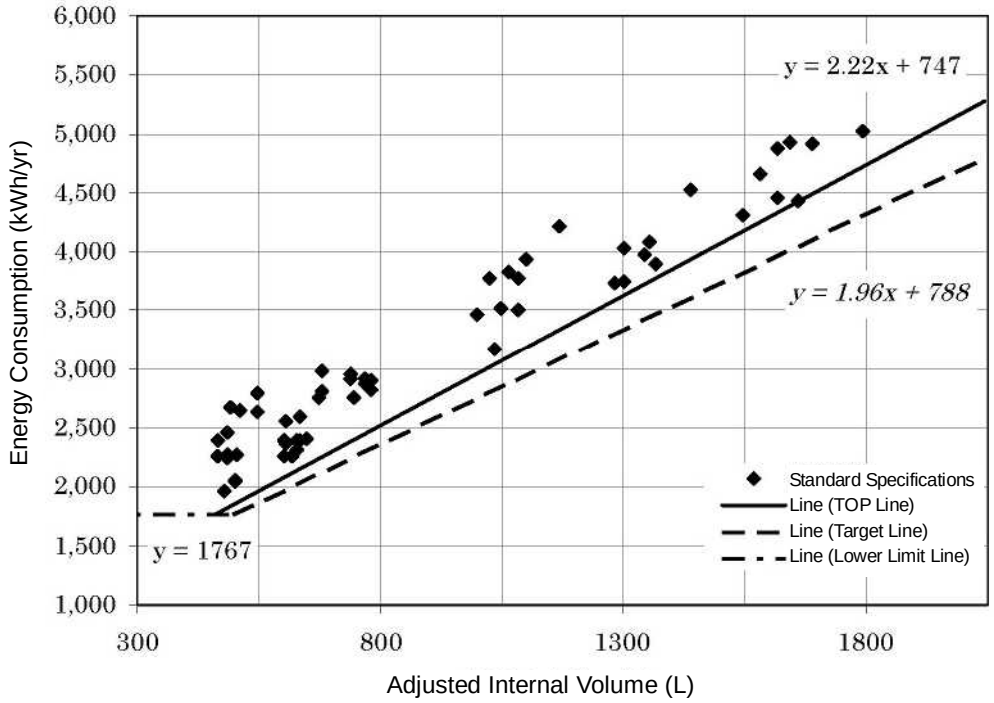
$E = 2.43V_1 + 70n_R + 34d_R + 157n_F + 157d_F - 183$

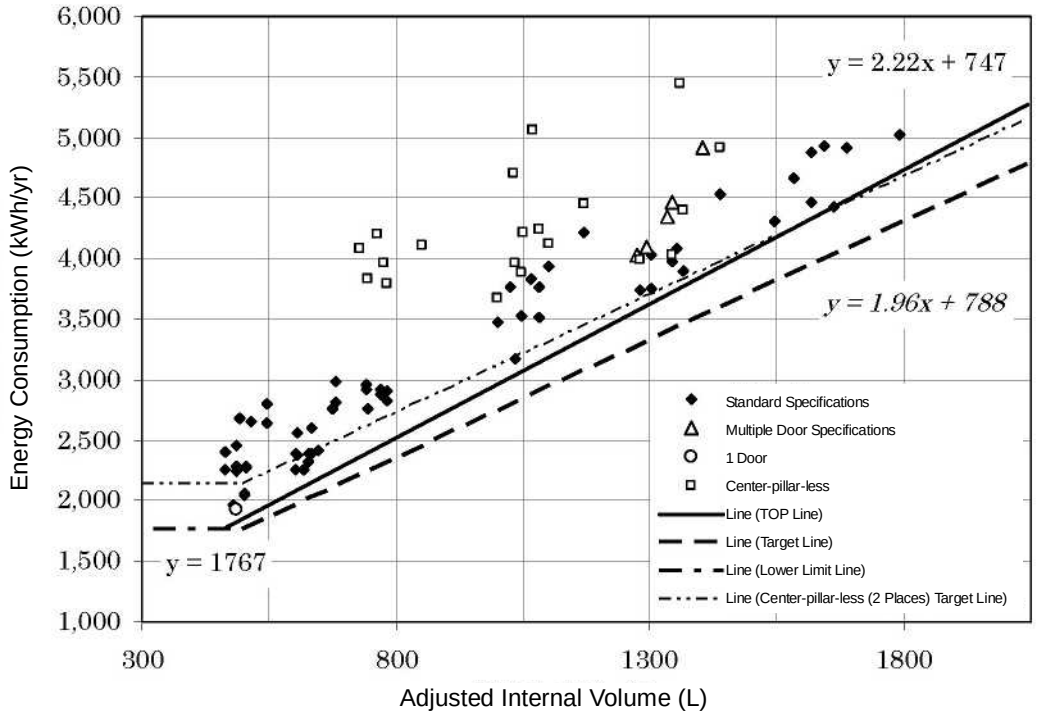




(6) Vertical freezers

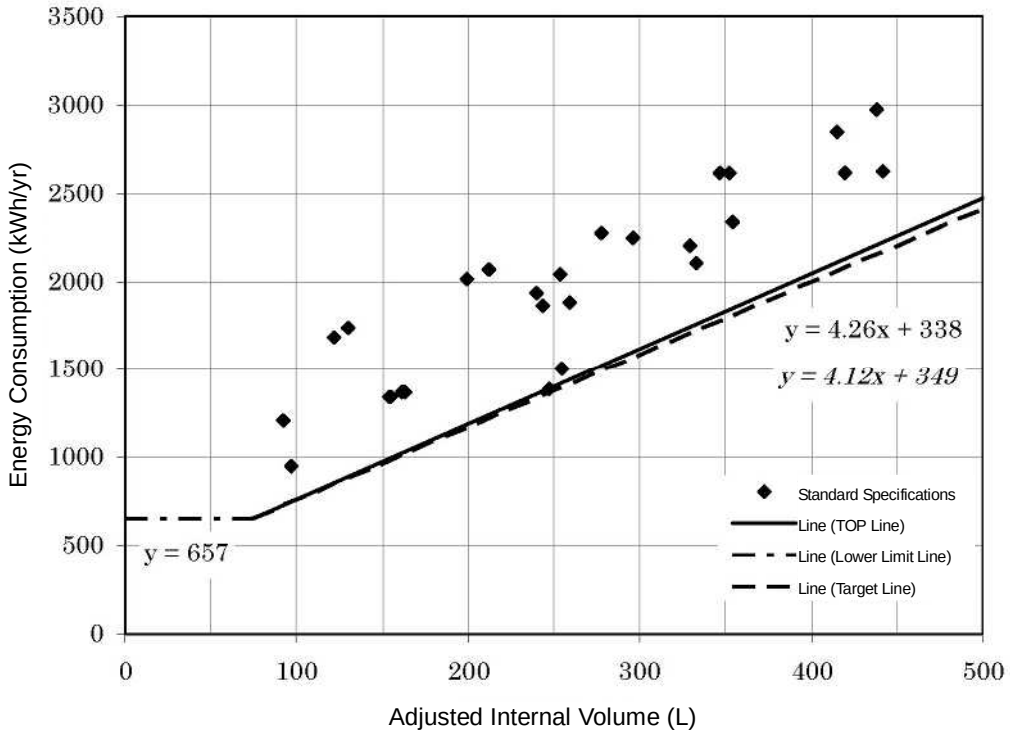
$E = 1.96V_2 + 186n_F + 295d_F + 788$

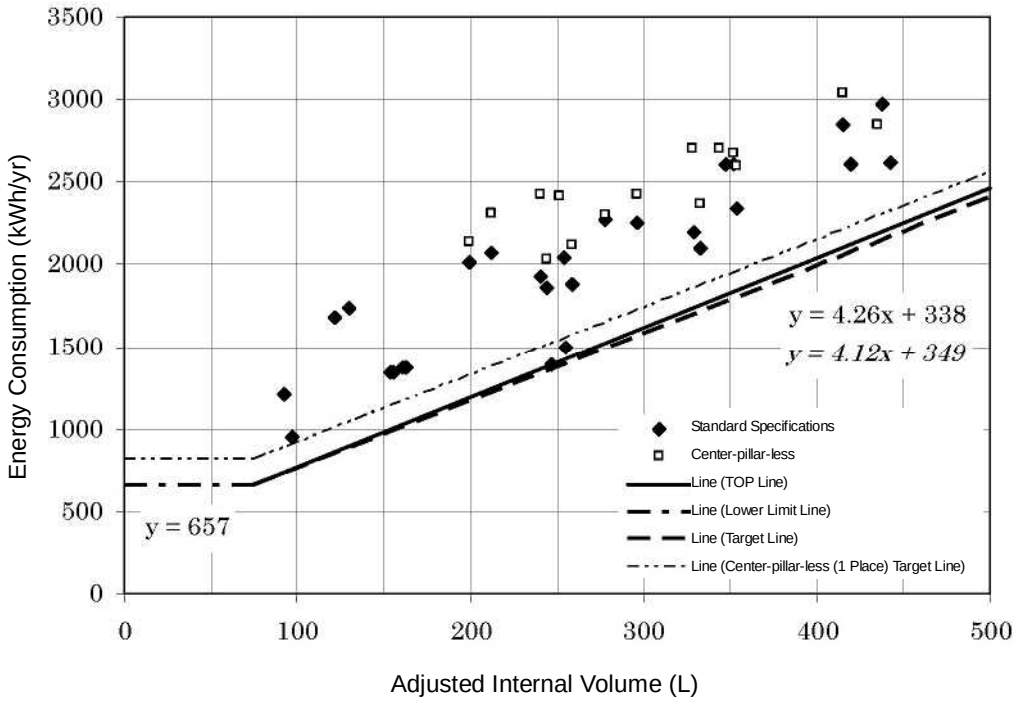




(7) Horizontal freezers

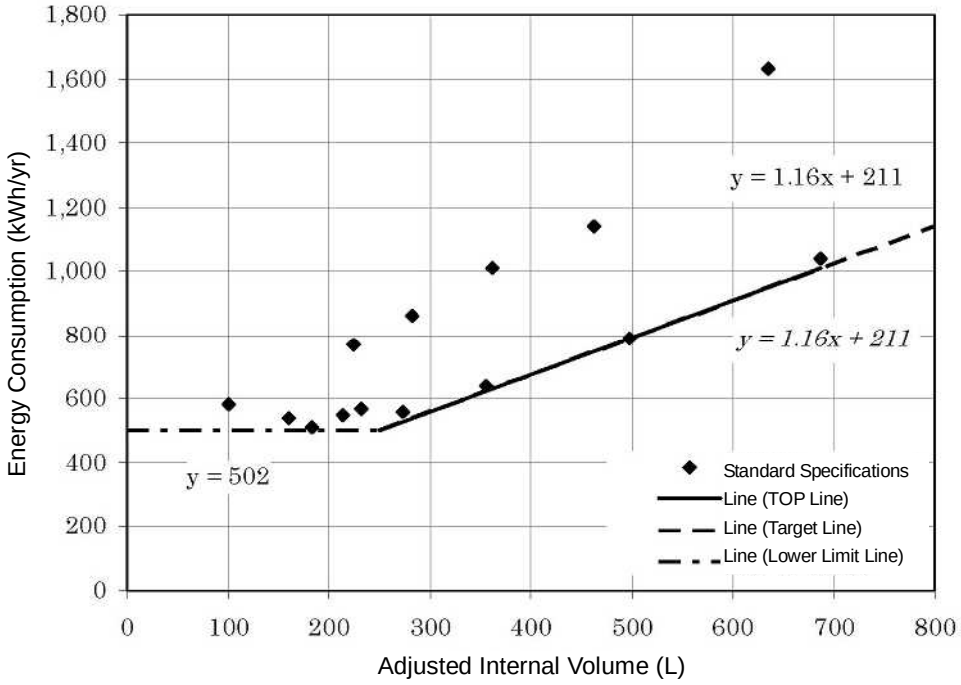
$E = 4.12V_2 + 157n_F + 157d_F + 349$





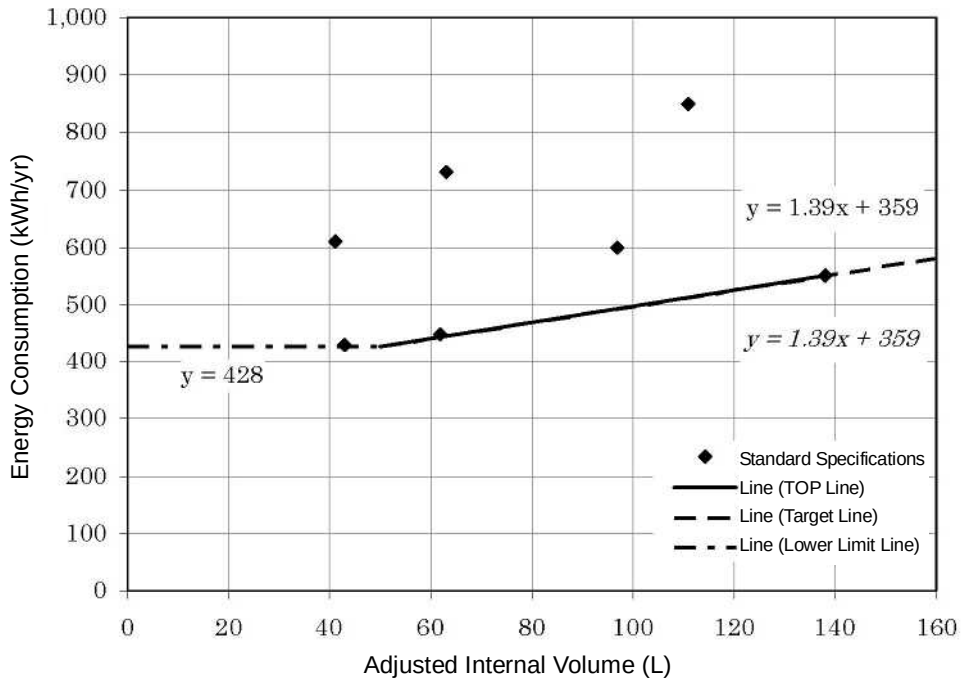
(8) Chest freezers

$E = 1.16V_2 + 211$



(9) Freezer-stockers

$E = 1.39V_2 + 359$



Attachment 5

Energy Consumption Efficiency of Commercial Refrigerators, etc. and Measurement Method

1. Basic Idea

As regards electric refrigerators, etc. for home-use which have been designated as the specific product of the Top Runner Standard since 1999, the “annual energy consumption” measured by the method stipulated in JIS C 9801 “Household Refrigerating Appliances - Characteristics and test methods” has been adopted to judge their energy consumption efficiency.

As regards commercial refrigerators, etc. too, the same as refrigerators, etc. for home-use, it is appropriate to take up the annual energy consumption as a practical index for judging their energy consumption efficiency.

So JIS B 8630 “Commercial refrigerators and freezers - Characteristics and test methods” is basically adopted.

2. Specific Energy Consumption Efficiency and Measurement Method

The energy consumption efficiency for commercial refrigerators, etc. shall be annual energy consumption (kWh/year), and the measurement method shall be the annual energy consumption measured by the method stipulated by JIS B 8630 “Commercial refrigerators and freezers - Characteristics and test methods”.

However, in case of refrigerators, etc. with additional functions such as defrosting water discharge forced evaporation function, forced heat discharge function or heating function, it is acceptable to measure them as standard products without additional functions.

Attachment 6

Commercial Refrigerator and Showcase, etc. Evaluation Standards Subcommittee, Energy Efficiency Standards Subcommittee of the Advisory Committee for Natural Resources and Energy
Background of Holding

First Subcommittee Meeting (July 16, 2008)
- Disclosure of the Commercial Refrigerator, Showcase, etc. Evaluation Standards Subcommittee
- Current situation of commercial refrigerators, showcases, etc.
- Scope of commercial refrigerators, etc. to be covered
- Energy consumption efficiency of commercial refrigerators, etc. and its measurement method

Second Subcommittee Meeting (February 12, 2009)
- Scope of showcases to be covered
- Energy consumption efficiency of showcases and its measurement method

Third Subcommittee Meeting (May 25, 2010)
- Proposed revision of the scope of commercial refrigerators, etc. to be covered and of the measurement method
- Classification of commercial refrigerators, etc. for setting targets
- Target fiscal year and target standard value for commercial refrigerators, etc.

Fourth Subcommittee (July 6, 2010)
- About interim report (proposal)

Attachment 7

Commercial Refrigerator, Showcase, etc. Evaluation Standards Subcommittee, Energy Efficiency Standards Subcommittee of the Advisory Committee for Natural Resources and Energy

List of Members

Chairman	Eiji HIHARA	Professor specialized in Environmental Studies, Graduate School of Frontier Sciences, University of Tokyo (until the second meeting)
	Masao GOTO	Professor, Department of Marine Electronics and Mechanical Engineering, Faculty of Marine Technology, Tokyo University of Marine Science and Technology (appointed as chairman at the third meeting)
Members	Chikai AOI	Chairman of Refrigeration Application System Technical Committee, The Japan Refrigeration and Air Conditioning Industry Association (changed to Kawai from the third meeting)
	Hideki KAWAI	Chairman of Refrigeration Application System Technical Committee, The Japan Refrigeration and Air Conditioning Industry Association (appointed as member at the third meeting)
	Shinichiro UTO	Japan Franchise Association
	Hiroyuki KUDOU	General Manager of Technology, The Energy Conservation Center, Japan (changed to Inoue from the third meeting)
	Mamoru INOUE	General Manager of Technology, The Energy Conservation Center, Japan (appointed as member at the third meeting)
	Haruki SATO	Professor, Department of System Design Engineering, Faculty of Science and Technology, Keio University
	Akio TANAKA	Planning and Research Manager, Jyukankyo Research Institute, Inc.
	Yoshihiko BABA	Member of Social and Environmental Committee, Japan Supermarkets Association (changed to Hasegawa from the fourth meeting)
	Tadashi HASEGAWA	Member of Social and Environmental Committee, Japan Supermarkets Association (appointed as member at the fourth meeting)
	Tetsuo MUNAKATA	Manager of Heat and Fluid Group, Energy Technology Research Institute, Advanced Industrial Science and Technology (changed to Takeuchi from the second meeting)
	Hiroshi TAKEUCHI	Deputy Manager of Energy Technology Research Institute, Advanced Industrial Science and Technology (appointed as member at the second meeting)
	Yoshio WATABE	Chairman of Showcase Technical Committee, The Japan Refrigeration and Air Conditioning Industry Association

Reference 2

Current State of Commercial Refrigerators, etc.

➢ Current State of Commercial Refrigerators, etc.

1. Definition of Commercial Refrigerators, etc.

(1) Overview

Commercial refrigerators, etc. are used in kitchens of restaurants, hotels, food supply facilities, etc. As they are designed to cope with the restrictions of the space available in the kitchen they are installed in, there are many types of them. There is also a type which is made by modifying a general-purpose type to make it most suitable for specific commercial use.

The difference between commercial refrigerators, etc. and refrigerators for home-use is not only that the size and the internal volume of the former are large but also that the doors of the former are opened and closed very frequently and the specifications of the former are designed to have sufficient cooling capacity even if ambient temperature increases as combustion equipment around commercial refrigerators, etc. is used. (While the internal volume of refrigerators, etc. for home-use is up to approximately 550L, that of commercial refrigerators, etc. is up to approximately 2,000L.)

Meanwhile, the specifications of the temperature inside commercial refrigerators, etc. are roughly classified according to the use as refrigerators or freezers. In general, the inner temperature is approximately -6°C in case of refrigerators and approximately -20°C in case of freezers. Refrigerator-freezers are products which can set two or more inner temperatures in one enclosure divided by a partition.

(2) Product classification

Commercial refrigerators, etc. are classified into 4 types, i.e. “vertical type”, “horizontal type”, “chest freezers” and “stocker type”, according to their usage and shape.

1) Vertical type

This type is used mainly in kitchens of hotels, food supply facilities, etc., because it can make its internal volume per area it is installed in larger. The internal volume ranges approximately from 300L to 1,800L.

2) Horizontal type

This type is featured by a work table placed on its top while making its height approximately 800 mm, so its internal volume per area it is installed in is smaller than that of the vertical type.

3) Chest freezers

As the door of chest freezers is positioned on the top of the freezer body, the inner temperature is not affected much by the opening and closing of the door, so they can store a lot of frozen food, etc. under a stable temperature.

4) Stocker type

This type has a top sliding door, so, the same as chest freezers, the inner temperature does not change much, therefore it is mainly used to store frozen food.

Figure 2 Vertical Type Refrigerator, etc.

Figure 3 Horizontal Type Refrigerator, etc.

Figure 4 Chest Freezer

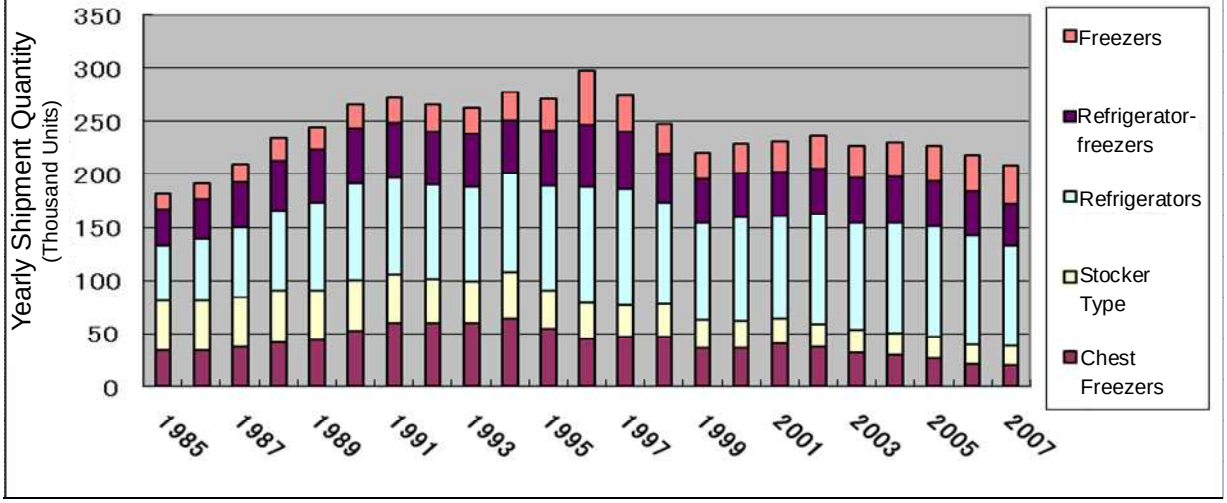
Figure 5 Stocker Type

2. Shipment Quantity of Commercial Refrigerators, etc. and Its Tendency

(1) Domestic shipment

The domestic shipment quantity of commercial refrigerators, etc. tended to increase since the later part of the 1980s as the convenience store and restaurant industry developed, peaking in FY1996 with the shipment quantity of approximately 300 thousand units, boosted, in part, by the special demand caused by O-157 epidemic. After that, the shipment quantity tended to remain the same or decrease and that of FY2007 was approximately 210 thousand units.

(Figure 1) Transition of Shipment Quantity of Commercial Refrigerators, etc. (Unit: Thousand Units)

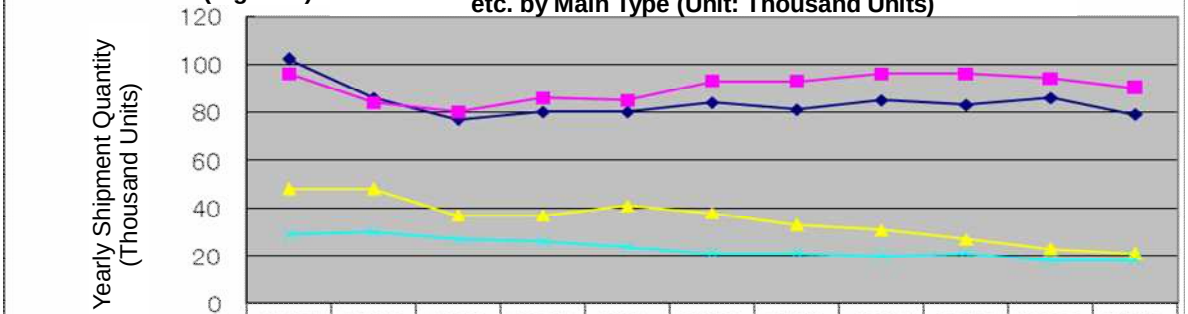


Information Source: The Japan Refrigeration and Air Conditioning Industry Association. The same for the data hereafter.

(2) Shipment quantity by type

As regards the yearly shipment quantity by type, the ratios of the vertical type and the horizontal type are large and they remained the same since 2000, i.e. 90 thousand units in case of the horizontal type and 80 thousand strong units in case of the vertical type. Meanwhile, that of chest freezers and stocker type continues to be approximately 20 thousand units respectively.

(Figure 6) Transition of Shipment Quantity of Commercial Refrigerators, etc. by Main Type (Unit: Thousand Units)



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Vertical Type	102	86	77	80	80	84	81	85	83	86	79
Horizontal Type	96	84	80	86	85	93	93	96	96	94	90
Chest Freezers	48	48	37	37	41	38	33	31	27	23	21
Stocker Type	29	30	27	26	24	21	21	20	21	18	18
Total	275	248	221	229	230	236	228	232	227	221	208

(3) Main manufacturers

Orion Machinery Co., Ltd., SANDEN Corporation, SANYO Electric Co., Ltd., Daiwa Industries Ltd., Toshiba Carrier Corporation, Hitachi Appliance, Inc., Fukushima Industries Corp., Fujimak Corporation, Hoshizaki Electric Co., Ltd., Panasonic Corporation

3. Functional Characteristics Required by Use Application

(1) In case of commercial refrigerators, etc., functional characteristics which are different from those of refrigerators, etc. for home-use are required for their cooling speed and thermal insulation performance.

1) Quick cooling function

- As doors of commercial refrigerators, etc. are frequently opened and closed, the function for quickly cooling the increased inner temperature is required.
- In case of freezers, etc., the function for quickly cooling down hot objects to a preset temperature is required.

2) High thermal insulation performance

High thermal insulation performance is required to maintain the inside of refrigerators, etc. at a preset temperature in the kitchen, etc. where the ambient temperature is high.

(2) In case of commercial refrigerators, etc. other than chest freezers and stocker type, there are many types which are individually designed and made according to the requirements of users because they are installed in a limited space. They are made by the combination of approximately 400 basic types with optional design, so they are typical multiple-type, small-production products.

(3) For kitchens of hotels or fast food restaurants and for the food or foodstuff processing and selling business, shape and functions as exampled below are requested according to the use application.

- Horizontal type (drawer): To enhance work efficiency or the efficiency of the management of foodstuff, the door is made like a drawer instead of making side-by-side doors and food is directly put in the inner container.

- Constant temperature and high humidity type: The temperature does not change much and the humidity is high, so food can be kept fresh. Besides, it is not necessary to wrap foodstuff.

- Double sided doors: Doors are made at the front side and the rear side of the refrigerator to provide food in one-way, i.e. from the kitchen side to the customer side.

- There are products modified to enhance the cooling capacity by selecting compressors to be mounted according to the frequency of opening and closing of doors and things to be put in the refrigerator.

Usage of Commercial Refrigerators, etc.

	Business Type	Usage and Purpose	Characteristics of Equipment
Food Service	Schools	Preservation of foodstuff, preservation of diet food	Front and rear door type, cart delivery type
	Hospitals		
	Welfare facilities		
	Food service centers		
Safety	Public health centers	Preservation of diet food	
Transpor-tation	Courier service, postal service	Preservation of food to be delivered	Vehicle-mounted type
Agriculture	Producers	Preservation of bacteria, preservation of produce	
	Production Associations	Preservation of crops	
Fishery	Markets	Refrigeration and retention of freshness, freezing preservation	Dedicated containers
Food Processing	Bread-making	Preservation and fermentation of dough	Constant temperature, high humidity type
	Confectionery-making		
	Noodle-making	Preservation and fermentation of noodle	
	Meat factories	Preservation and fermentation of foodstuff and processed food	
	Vegetable processing factories	Preservation of foodstuff, processed food and seasoning	
Restaurants	Hotels Restaurants Wedding halls Funeral halls Event halls Golf courses	Preservation of foodstuff and cooked food	Glass door type Hotel bread container type Constant temperature, high humidity type Center-pillar-less type Sandwich type Drawer type Quick freezing type Drain water evaporation type
	Ship restaurants		
	Railway restaurants		
	Noodle restaurants	Preservation of noodle-stuff and foodstuff	
	Ramen shops		
	Steak houses	Preservation of foodstuff such as meat, vegetables, etc.	
	Hamburger shops		Sandwich type
	Sushi restaurants	Preservation of sushi-stuff	
Rental	Hospitals, homes for elderly people	Room rental	Refrigeration locker type
Sales	Preservation rooms behind convenience stores	Preservation of foodstuff, food to be sold or delivered	
	Preservation rooms behind supermarkets		
	Food selling sections of department stores		

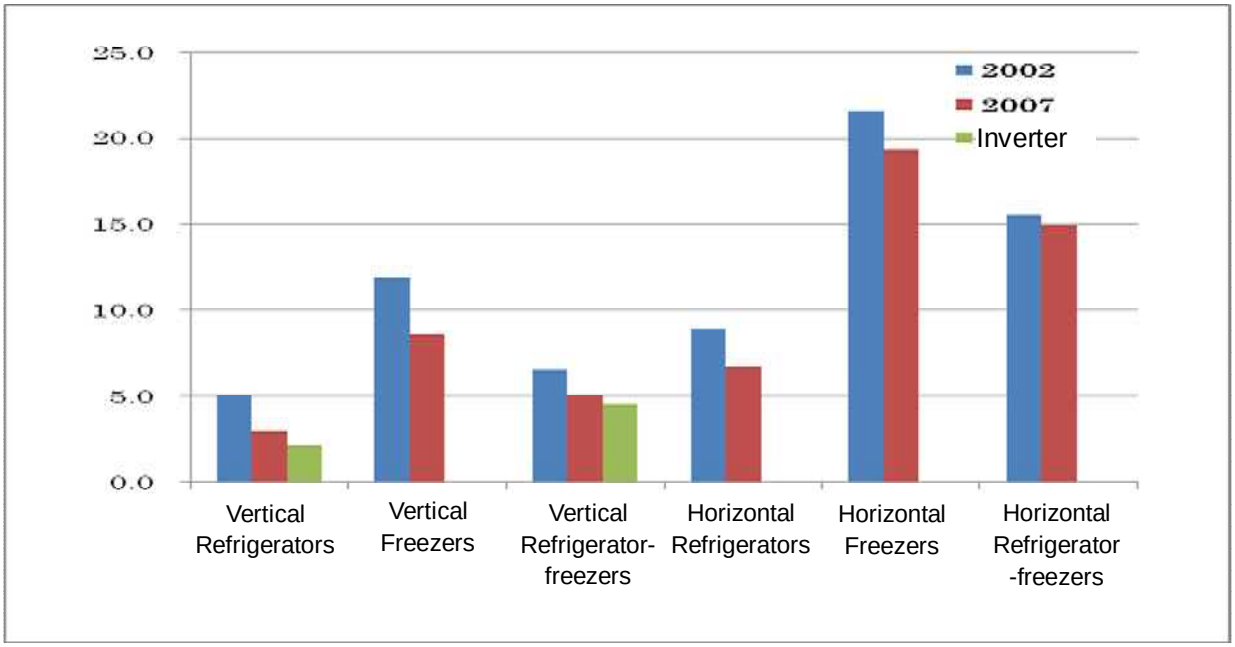
4. Transition of Energy Consumption Efficiency

After the 3rd Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change in 1997 (COP3), the electricity consumption was greatly reduced thanks to the development of energy conservation technologies by manufacturers.

To further promote energy conservation, high efficiency DC motors started to be used for fan motors and the efficiency of compressors was enhanced by improving the

processing accuracy of sliding parts in recent years. As a result, the energy conservation of typical models was improved by 20 to 40% in case of the vertical type and by 4 to 25% in case of the horizontal type during the period between 2002 and 2007, and it was further improved by 20 to 30% by the use of inverters.

Transition of Energy Consumption Efficiency



(Note) Information Source: From the result of electricity consumption test implemented for typical models.
Estimation of the Japan Refrigeration and Air Conditioning Industry Association.

5. Technical Activities to Enhance Energy Conservation

(1) Improvement of compressor's efficiency

It is being tried to improve compressor motors of refrigerators by enhancing the motor efficiency by adopting operation condensers, improving the motor efficiency by increasing the motor core's thickness, reducing the mechanical loss of the sliding section by making the motor shaft smaller, enhancing the volume efficiency by minimizing the top clearance. Furthermore, additional improvement can be expected by adopting the inverter motor the number of revolution of which can be changed, by changing the AC motor to the DC motor, by changing the distributed winding to the concentrated winding (direct winding) and so on.

(2) Technologies for improving the performance of fans

1) High-efficiency of fan motors in refrigerators

To change AC motors to DC brushless motors with high efficiency.

2) Improvement of efficiency of condenser's fan motors

It is being tried to make the efficiency of condenser's fan motors high by improving the fan shape to make the air amount greater while containing the noise. As regards motors, it is expected that improvement can be made by enhancing the motor efficiency by adopting condenser motors and high efficiency DC motors.

(3) Technologies for improving efficiency of control

1) Control of dew condensation prevention heaters

It is possible to improve the efficiency of dew condensation prevention heaters around doors with the micro-computer control by changing the control from the way which always supplies electricity to the way which controls the optimal electricity supply ratio.

2) Control of the number of revolution of compressor motors (using the inverter)

Improvement is realized by changing the AC motor to the high efficiency DC motor and by controlling the number of revolution with the micro computer.

6. Measures to Be Taken and Issues to Be Solved for Energy Conservation Hereafter

Energy conservation technologies relating to commercial refrigerators, etc. basically concern the improvement in three fields, i.e. cooling technologies, thermal insulation technologies and control technologies.

So far, improvement and innovation have been made to compressor structure, fan motors and thermal insulation structure and main energy conservation technologies have already been incorporated in products, so it seems that the promotion of those energy conservation technologies will be the core of the energy conservation activities from now on.

The followings are some of the examples conceived as specific energy conservation activities in the future.

(1) Application of new high-tech technologies (optimal control of inverter control)

(2) Study and application of new thermal insulation material (vacuum thermal insulation material, etc.)

(3) Review of the energy conservation technologies implemented in the past and promotion of further improvement

(4) Efficiency improvement by changing refrigerant

7. Transition of Energy Conservation Technologies

	87-96	97	98	99	00	01	02	03	04	05	06	07
Compressors	- High efficiency - Adoption of rotary compressors						• Introduction of high efficiency compressors				• Adoption of inverters	
Condensers	- Large models - Improvement of efficiency											
Evaporators											• Improvement of evaporation efficiency	
Defrosting Heaters											• Electricity conservation	
Doors	- Improvement of air layer of gaskets								• Optimization by the control of door frame			
Fan motors inside refrigerators			• Intermittent operation of fans inside refrigerators (horizontal type)								• Revolution control Adoption of DC motors	
Condenser Fan Motors							• Change from magnetic pole induction motors to condenser-run-motors				• Adoption of DC motors	

Heaters	• Input reduction when defrosting (glass tube heaters, horizontal type)
Control	- Micro computer control
Others	- U trap drain