



Test procedures, measurements and standards for refrigerators and freezers

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1 Definition of Energy Efficiency of refrigerators and freezers

A standard definition of energy consumption and a test procedure to measure it are necessary for market transparency and to apply policies. Electricity consumption by refrigerators and freezers is measured in accordance with four main test standards in different world regions.

A standard definition of the daily or annual specific energy consumption per unit is necessary to compare energy consumption of refrigerators and freezers and a test procedure is needed to measure this specific energy consumption. The definition and the test procedure together form a **test standard**. Such a standard makes it possible to introduce minimum energy performance standards and energy labels (read more in the bigEE Policy Guide, section on appliances).

Based on the measured specific energy consumption, energy efficiency of refrigerators and freezers is defined as the degree of electricity consumption per equivalent volume and functional performance in comparison to a reference appliance. This relationship between an individual appliance and the reference appliance is often called the energy efficiency index. The standard energy consumption of the reference appliance is often expressed as a function of the volume.

2 Different test standards

The four main test standards adopted almost worldwide are the ISO/IEC¹, AS/NZS, JISC and the ANSI/AHAM.

Table 1 gives an overview of their main characteristics and differences.

Testing Parameters	AS/NZS	ANSI/AHAM	ISO/IEC	JISC
Selection of countries applying the test standards	Australia/ New Zealand India (uses a variant)	USA	Brazil China EU and many others	Japan
Ambient air temperature	32 °C	32.3 °C	25 ± 0.5 °C (temperate, extended- temperate & sub-tropical) 35 ± 0.5 °C (tropi- cal)	15 °C & 30 °C (Weighted con- sumption is taken, 73 % at 15 °C and 27 % at 15 °C)
Relative Humidity	Not specified	Not specified	Max. 75 %	75 ± 5 % for 30 °C, 55 ± 5 % at 15 °C
Fresh food compartment temperature	3 °C	3 °C all refrig- erators, less than 7.22 °C for refrigerator- freezers	5 °C	4 °C
Freezer compartment temperature (for frozen food storage only)	-15 °C	-15 °C for re- frigerator- freezers, -17.8 °C for separate freezers	-18 °C	-18 °C
Loading	No	75% loading of freezers of non frost-free units and of all types of separate freezer units	Loaded freezers (touching the walls)	Natural convec- tion system- only freezers, Frost-free sys- tems- both fresh food compart- ment and freez- er

¹ ISO/IEC: The leading international standard-setting bodies for energy tests are the International Organization for Standardization (ISO), which mainly focuses on mechanical performance, and its sister organization, the International Electro technical Commission (IEC), which mainly focuses on electrical performance.

Testing Parameters	AS/NZS	ANSI/AHAM	ISO/IEC	JISC
Door openings	No	No	No	Natural convection system- No, Frost-free systems- Yes: 35-times/day at 8 min intervals- food compartment & 8- times/day at an interval of 40 min- freezer
Volume & Measurement methodology	Gross volume, using adapted ISO methodology	Storage volume, using ANSI/AHAM methodology	Storage volume, using ISO methodology	Storage volume, using ISO methodology

Table 1: General testing conditions under the main standards (Source: Bansal and Kruger, CLASP, Harrington (2001, 2009), Government of Australia) and examples of labels based on the standards

The ISO, ANSI/AHAM, the AS/NZS and the JISC test standards are the four main distinct types of test standards. Australia and New Zealand use the harmonised test standard AS/NZS; the US uses the DOE test based on ANSI/AHAM test standard which is used across North America; Japan uses the JISC standard, the key elements of which are similar to the ISO standard.

Brazil and the EU have both based its test standard on ISO. China also uses standards based on ISO and so does Hong Kong, while Chinese Taipei uses a slight variation. However, India has adopted the Australian AS/NZS standard, until it develops its own test standard, which will continue to have conditions similar to those of AS/NZS.

The ANSI/AHAM standard has the highest ambient temperature requirements at 32.3 °C while the ISO standard has the least at 25 °C. JISC is the only test standard which uses an average of two temperatures, 15 °C and 30 °C. JISC and ISO both use higher fresh food compartment temperatures of 5 °C, while the rest use 3 °C. However, JISC and ISO have the lowest specified freezer temperatures at -18 °C. JISC is the only test standard that specifies door openings during testing.

Why different test standards?

Energy efficiency standards and labels are based on energy consumption values obtained from test standards adopted by different countries. Geographic, climatic and cultural differences among countries exist which therefore necessitates different regional test standards. Interest in making measurement methods better reflect local conditions and available appliance models has led many countries to develop national standards.

The differences in test conditions lead to different energy consumption values recorded and this makes it difficult to compare the results obtained from different test standards. The energy consumption awarded through testing is only a rough indicator of the actual energy consumption of a unit. Variable factors, such as ventilation, ambient temperature etc. are responsible for the differences between actual and test conditions and the corresponding energy consumption values.

Therefore, test standards should adopt conditions, which reflect the existing in-field conditions to a reasonable extent, as well as procedures, which account for the effect of user behaviour on refrigerator energy consumption.

The main factors affecting energy consumption during testing are the specified ambient temperature, compartment temperatures and the door openings. Other differences in test standards such as loading, performance tests, methodologies adopted to determine compartment temperature and energy consumption also have an indirect impact on the measured energy consumption but these indirect effects are relatively less significant and difficult to quantify.

3 Comparison of energy consumption data in accordance with different test standards

Electricity consumption data, measured in accordance with different test standards, can be converted, so direct comparison is possible.

A direct comparison of the results obtained from the various energy consumption test standards is not possible as test conditions are not the same. But conversion formulas have been developed, which take into account the different test conditions and by this allow - not an *exact* but *approximated* conversion value. In the following tables the conversion factors are displayed. The columns represent the numerator while the row represents the denominator of the ratio. (e.g. for refrigerators, $E_{ISO}/E_{AS/NZS} = 0.6787$)

For all refrigerators	AS/NZS	ANSI/AHAM	ISO	JISC ¹
AS/NZS	1,0000	1,0111	0,6787	0,5213
ANSI/AHAM	0,9890	1,0000	0,6713	0,5156
ISO	1,4734	1,4897	1,0000	0,9563
JISC ¹	1,9181	0,8122	1,0457	1,0000

Table 2: Conversion factors for refrigerators (Source: Anjali Bhide 2010 after Bansal and Kruger 1995)

For refrigerator-freezer combinations	AS/NZS	ANSI/AHAM	ISO	JISC ¹
AS/NZS	1,0000	1,0081	0,9046	0,7520
ANSI/AHAM	0,9919	1,0000	0,8973	0,7460
ISO	1,1055	1,1144	1,0000	0,8313
JISC ¹	1,3297	1,3405	1,2029	1,0000

Table 3: Conversion factors for refrigerator-freezers (Source: Anjali Bhide 2010 after Bansal and Kruger 1995)

For all-freezers	AS/NZS	ANSI/AHAM	ISO	JISC ¹
AS/NZS	1,0000	1,0972	0,9046	0,7520
ANSI/AHAM	0,9114	1,0000	0,8245	0,6854
ISO	1,1055	1,2129	1,0000	0,8313
JISC ¹	1,3297	1,4589	1,2029	1,0000

Table 4: Conversion factors for freezers (Source: Anjali Bhide 2010 after Bansal and Kruger 1995)

From the ratios it appears that for the same refrigerator unit tested under different test standards:

1. Labelled energy consumption reported under the ANSI/AHAM should be higher than the results obtained under the AS/NZS test standard.
2. Labelled energy consumption reported under the AS/NZS should be higher than the results obtained under the ISO test standard.

4 References

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