U4E Model Regulation Guidelines on refrigerators – Proposed MEPS

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Scope of Products – Refrigerating appliances

REFRIGERATORS

one or more chilled compartments, generally at various temperature zones between 0˚C and 14˚C, and which may include an ice-making section

FREEZERS

one or more frozen compartments, usually between -18˚C and -6˚C

FRIDGE-FREEZERS

combination of both chilled and frozen compartment(s) in the same appliance

Type of Refrigeration System

Vapour Compression

Rated volume

10 Liters (L) and at or below **1,500 L,**

Electricity connection

powered by **electric mains** and offered for sale or installed in any application.

Exempted Products – Refrigerating appliances

Wine storage appliances

Refrigerating appliances with a direct sales function

Mobile refrigerating appliances

<u>Other Considerations:</u>

- appliances where the primary function is not the storage of foodstuffs through refrigeration,
- other products that do not meet the definition of a Refrigerator, Refrigerator-Freezer, or Freezer, and
- other refrigerating appliances different than vapor compression type.

Test methods and efficiency metrics

General Requirements

- IEC 62552-1:2015, Household refrigerating appliances - Characteristics and test methods - Part 1

Performance requirements

- IEC 62552-2:2015, Household refrigerating appliances - Characteristics and test methods - Part 2

Energy Consumption and Volume

- IEC 62552-2:2015, Household refrigerating appliances - Characteristics and test methods - Part 3

- Energy consumption is determined from measurements taken when tested as specified at 16°C and at 32°C.

Summary Annual Energy Consumption - Calculations

E_{daily} = P × 24 in Wh or $E_{daily} = P \times 24 + \frac{\Delta E_{df} \times 24}{\Delta t_{df}}$ in Wh

E_{daily} = EC_{24} = 0.5 × $E_{daily,16}$ + 0.5 × $E_{daily,32}$ in Wh per day

Annual Energy Consumption (AEC) = EC_T × (365/1000) in kWh per year

AEC_{MAX} = M x AV + N

Reference Ambient Temperature	Product Category	AEC_{Max} (kWh/year)
24°C	Refrigerators	0.163×AV+102
	Refrigerator-Freezers	0.222×AV+161
	Freezers	0.206×AV+190

$$R = \frac{AEC_{Max}}{AEC}$$

Energy Consumption Index – R

For a product to meet the high efficiency grade, the performance shall be calculated as per the equation below.

$$R = \frac{Maximum\ Annual\ Energy\ Consumption\ (AEC_{Max})}{Annual\ Energy\ Consumtion\ \ (AEC)}$$

R=1 where AEC is equivalent to AEC_{Max}

Larger **R** means higher efficiency.

Annual Energy Consumption (AEC)

Annual Energy Consumption (AEC), as calculated per the equation shall be less than or equal to Maximum Annual Energy Consumption (AEC_{Max})

$$AEC = EC_T \times (365/1000) \text{ in kWh per year}$$

EC_T is energy consumption in Wh per 24 hours based on ambient temperature T. where ECT is energy consumption in Wh per 24 hours based on ambient temperature T, rounded to nearest integer..

$$EC_T = a \times E_{16} + b \times E_{32} \text{ in Wh per day}$$

Where, E_{16} is energy consumption measured at ambient temperature 16 ℃ and E_{32} is energy consumption measured at ambient temperature 32 ℃, in accordance with IEC 62552-3

If the typical temperature where refrigerating appliances are used in the country is not known, the reference ambient temperature of 24 °C and mathematical coefficients ***a*** and ***b***

Reference Ambient Temperature (°C)	*a*	*b*
24	0.5	0.5

Optional Reference Ambient Temperatures and Coefficients a and b (MRG)

Reference Ambient Temperature (°C)	a	b
20	0.75	0.25
32	0	1.0

Maximum Annual Energy Consumption (AEC_{max})

$$AEC_{MAX} = M \times AV + N$$

Reference Ambient Temperature	Product Category	AEC_{Max} (kWh/year)
24°C	Refrigerators	0.163×AV+102
	Refrigerator-Freezers	0.222×AV+161
	Freezers	0.206×AV+190

N and **M** are modelling parameters specific to each product category with predetermined values for T=24 °C.

$$\textbf{\textit{Adjusted Volume}}$$
$$(AV) = \sum_{i=1}^{n}(V_i \times K_i \times F_i)$$

AV: Volume for the storage of foodstuff adjusted for the relative contribution to the total energy consumption according to the different temperatures of the storage compartments.

V_i is volume in *i*th compartment,

F_i is frost adjustment factor.

F=1.1 for frost-free (automatic defrost) is applied only to frozen food compartments.

F=1.0 is applied to all other compartments and manual defrost frozen food compartments.

K_i is volume adjustment factor (thermodynamic factor) as calculated per the equation below;

$$K = \frac{T_1 - T_c}{T_1 - T_2}$$

T_1 is reference ambient temperature, T_2 is temperature of fresh-food compartment (4 ℃), and T_c is temperature of the individual compartment concerned.

Reference Temperature	Fresh food compartment	Frozen food compartment	
T_1=24°C	K=1 (T_2=4°C)	T_c=-6°C	K=1.50
		T_c=-12°C	K=1.80
		T_c=-18°C	K=2.10

Maximum Annual Energy Consumption (AEC_{max})

Reference Temperature	Product Category	AEC_{Max} (kWh/year)
20°C	Refrigerators	0.134×AV+84
	Refrigerator-Freezers	0.188×AV+137
	Freezers	0.175×AV+161
32°C	Refrigerators	0.220×AV+137
	Refrigerator-Freezers	0.288×AV+210
	Freezers	0.268×AV+247

Maximum Annual Energy Consumption for Optional Reference Temperatures

Examples of Volume Adjustment Factor (K) Calculation (MRG)

Reference Temperature	Fresh food compartment	Frozen food compartment	
T_1=24°C	K=1 (T_2=4°C)	T_c = -6°C	K=1.50
		T_c = -12°C	K=1.80
		T_c = -18°C	K=2.10
T_1=20°C	K=1 (T_2=4°C)	T_c = -6°C	K=1.63
		T_c = -12°C	K=2.00
		T_c = -18°C	K=2.38
T_1=32°C	K=1 (T_2=4°C)	T_c = -6°C	K=1.36
		T_c = -12°C	K=1.57
		T_c = -18°C	K=1.79

Energy Performance Grade Requirements

Grade	Refrigerators	Refrigerator-Freezers	Freezers
High Efficiency	R ≥ 1.50	R ≥ 1.50	R ≥ 1.50
Intermediate	1.25 ≤ R < 1.50	1.25 ≤ R < 1.50	1.25 ≤ R < 1.50
Low Efficiency	1.00 ≤ R < 1.25	1.00 ≤ R < 1.25	1.00 ≤ R < 1.25

$$R = \frac{AEC_{Max}}{AEC}$$

- **R=1:** Lowest efficiency but comparable with international best practices identified at the time of the Guidelines development.
- **R=1.25:** the intermediate performance tier between the low and high requirements in the Guidelines. For refrigerators and freezers, this level will be roughly comparable with the EU 2024 levels (p5 U4E Guidelines Supporting Information).
- **R>1.5:** high-efficiency tier in the Guidelines where highly efficient products are assessed to meet

Refrigerant & Foam Blowing Agent Requirements

- Requirements for ozone depletion potential (ODP) and global warming potential (GWP) over a 100-year time horizon.

- Refrigerant designation (ISO 817:2014, Refrigerants - Designation and safety classification),

- Safety requirements (IEC 60335-2-24:2020, Household and similar electrical appliances - Safety - Part 2-24: Particular requirements for refrigerating appliances, ice-cream appliances and ice makers.

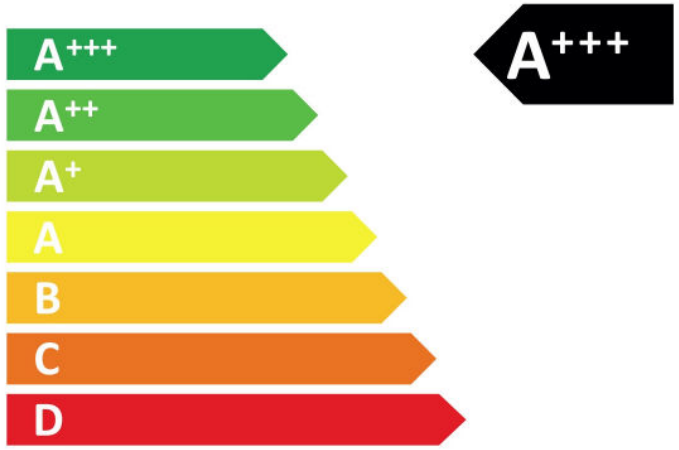
Product Class	GWP	ODP
All types	20	0

Energy Labelling - Energy Labelling Guidance for Lighting and Appliances

The purpose of energy labelling is to **help overcome an informational market barrier to energy efficiency**, wherein **consumers of energy-using equipment are unaware of the energy performance of the equipment** they purchase and thus are **unable to take this aspect into account in their procurement decisions**.

TYPES OF ENERGY LABELS:

1. Comparative energy labels (More common)



- **Show how efficient a product is compared to other products on the market** and use a scale to indicate where the efficiency of a product is positioned within the spectrum.
- The scale enables consumers to see the spread in performance that may be observed in the market and where each product is positioned within this scale.
- More effective at transforming markets
- comparative labels are generally mandatory

2. Endorsement energy labels.

- Labels that indicate formal recognition (or endorsement) of a product.
- Endorsement labels are voluntary
- Endorsement labels therefore need to be heavily promoted
- Incentives are often included,

Product Information

- All representations of energy performance shall indicate that the performance rating is based on the measurement according to [test standard name], an indicative value, and not representative of actual annual energy consumption in all situations.

- The original equipment manufacturer shall provide an energy label to the importer, product retailer, or installer before the product enters the market.

Refrigerators
1) Model name / serial number 2) Type of unit [refrigerator, refrigerator-freezer, or freezer] 3) Country where the product was manufactured 4) Volume of the different compartments and an indication of whether they are frost-free 5) Rated performance grade 6) Yearly energy consumption in kWh at ambient temperature in ˚C or ˚F 7) Reference ambient temperature[s] used in performance rating 8) Refrigerant and foam-blowing designation in accordance with ISO 817 or ASHRAE 34, including ODP and GWP.

Comparison of MEPS Requirements

	Model Regulation Guidelines/SADC-EAC	ECOWAS 2017	Ghana 2022
Scope	✓ 10L – 1500L ✓ 3 categories • Refrigerators • Refrigerator-Freezers • Freezers	✓ Up to 1500 ✓ 10 categories • Refrigerators • Refrigerator-Freezers • Freezers	✓ 10L - 1500L ✓ 10 categories ✓ Household and Commercial: • Refrigerators • Refrigerator-Freezers • Freezers
Reference test methods - Standards	IEC 62552 (1,2,3): 2015	IEC 62552 (1,2,3): 2015	IEC 62552 (1,2,3): 2015
Reference Ambient Temperature	**24 ^{O}C** *Other options* 20 ^{O}C, 32^{O}C (Energy consumption measurements at 16°C and 32°C)	• Subtropical (ST)- 16° C to + 38° C (+25 ^{O}C) • Tropical (T) + 16° C to + 43° C (+32^{O}C) (Energy consumption measurements at 16°C and 32°C)	• ST - Subtropical from 16° C to + 38° C (+25 ^{O}C) • T - Tropical from + 16° C to + 43° C (+32^{O}C) Energy consumption measurements at 16°C and 32°C)
Energy performance metrics	$R = \frac{AEC_{max}}{AEC}$	$EEI = \frac{AEC}{SAEC} x100$	Star Rating based on: $EEI = \frac{AEC}{SAEC} x100$
Minimum energy performance requirements	R = 1 (3 tiers)	ST. : EEI≤70 T. : EEI≤80	7 – Star: EEI<22 to 1 – Star : 70≤EEI≤85
Refrigerant requirements	GWP = 20 ODP = 0	NA	NA

Open discussion

Contact

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