

Performance Certification of Refrigerated Display Cabinets (RDC)

The European Union is currently implementing some directives on equipment intended for use in residential, service and commercial buildings. The text concerning the performance characteristics of refrigerated display cabinets according to ISO standard ISO 23953:2005, which will impose minimum efficiencies, is now being completed. To better differentiate the products, Eurovent Certification has defined energy categories based on factory audits and independent laboratory testing, and in order to ensure a realistic sizing of facilities, some coefficients for use in stores.



Sandrine Marinhas
Eurovent Certification Company (ECC)
53 rue de Turbigo – 75003 Paris
s.marinhas@eurovent-certification.com

Nomenclature

BOM	bill of material - list of components	DEC	direct electrical energy consumption, kWh/day
Eff	efficiency, kWh/day/m ²	TDA	total display area, m ²
EEl	energy efficiency index	TEC	total electrical consumption, kWh/day
REC	refrigeration electrical energy consumption (of the condensation unit), kWh/day		

Introduction

The EU heading for the 20-20-20

In December 2008, the European Union (EU) adopted an extensive set of measures intended to reduce overall energy consumption in Europe and to guarantee the EU a safe and sufficient energy supply. The aim is to achieve a 20% reduction in Europe's greenhouse gas emissions by 2020, in comparison with 1990 levels, while increasing the use of renewable energy sources by 20%.

From a practical standpoint, several actors are involved in the process of drafting and applying the texts. In the European Commission, the commissioners, appointed for five-year terms and grouped into General Directorates (DG), propose legislative texts and oversee their correct application within the EU. These proposals are based on studies performed by consultants mandated by the European Commission, who describe the market and target the best lines of improvement. The ministers of the Member States then meet to debate legislative texts

that they will adopt jointly with the Parliament (whose members, called Members of the European Parliament, are directly elected by the citizens every five years).

Reducing the energy consumption of supermarkets ...

Generally, when equipment is bought, prescribers' demands, apart from size constraints, aesthetic considerations and other budgetary criteria (sometimes predominant), increasingly tend towards energy criteria, particularly because of the incentives implemented by the Member States. For a display cabinet we will therefore consider, in the first place, the capacity of the unit used to maintain products (symbolized by M-packages simulating the products) within a given temperature range, called "temperature category". We will then examine its energy performance data: the cooling capacity, evaporation temperature, the power consumption of the cabinet and its energy efficiency.

... by means of a simplified reading of the equipment efficiency

Further on in this article, we will show the complexity of the products that interest us to demonstrate that a simplified display is necessary for the specifiers. By going beyond the simple prohibition of equipment that does not ensure a minimum efficiency, the introduction of a scale of energy efficiency classes subtly encourages buyers to invest in more economical equipment. We can, in addition, guarantee the levels announced when equipment is tested in independent laboratories, and the components of the tested cabinets can be checked against production in the factory thanks to manufacturing site audits. Finally, the implementation of common coefficients for the transposition of performance data in the laboratory to performance in the store is a step forward

towards a quicker assessment of the electrical power consumption of a facility equipped with cabinets.

Physical description of the equipment

The different categories of refrigerated display cabinets

There is a variety of refrigerated display cabinets. The first distinction consists of determining whether they house

their own condensing units or are elements of a centralised system. In this document we will focus mainly on the latter type. We will now define a breakdown into five categories according to the cross-section of the cabinet (**Figure 1**).

The standard regarding display cabinets includes a coding system consisting of three letters and a number. An 'I' or an 'R' will be used for cabinets housing their

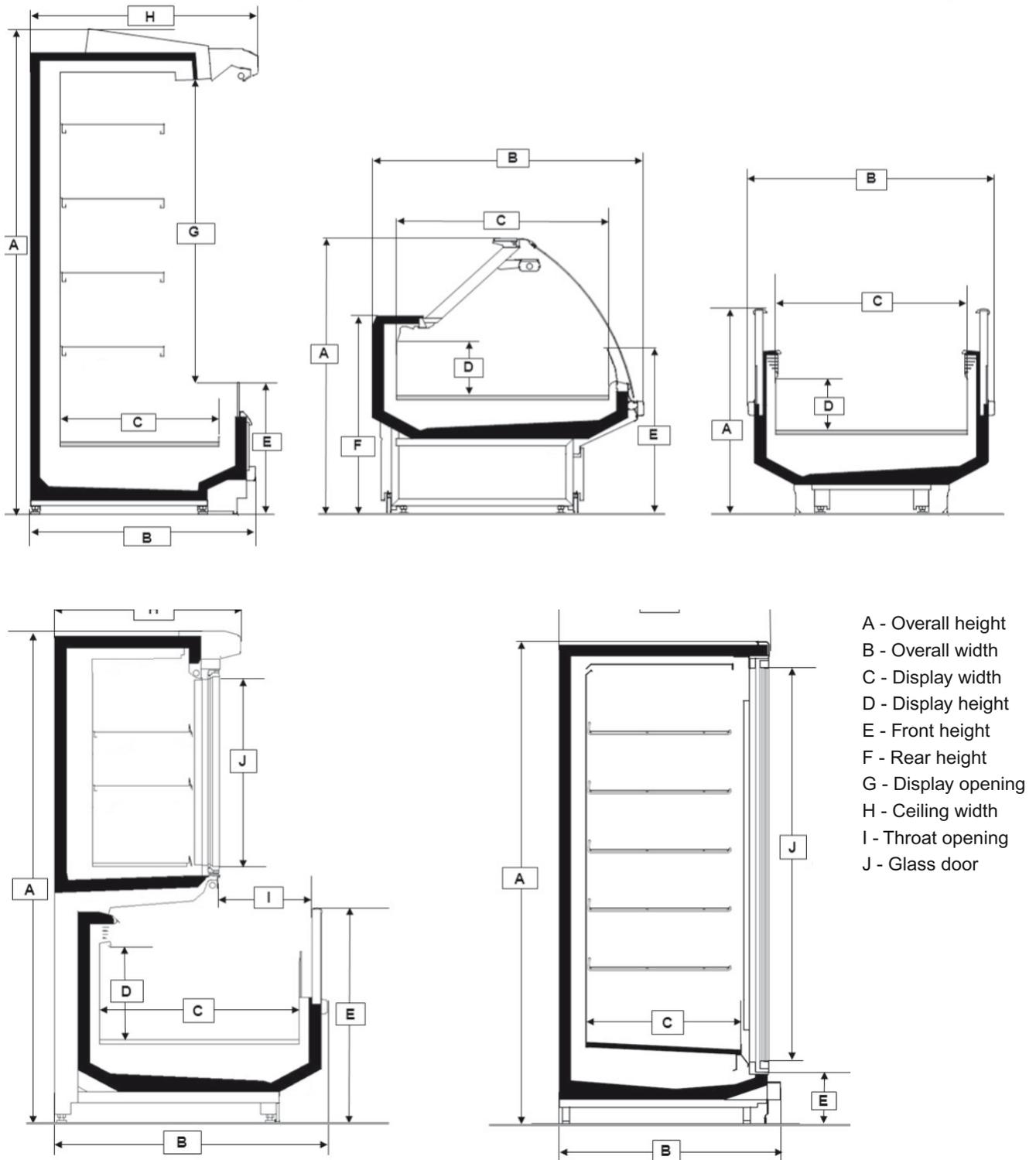


Figure 1. Kinds of cabinets and dimensions certified for (a) verticals and semi-verticals open, (b) service counters, (c) islands (d) combi-freezers and (e) verticals and semi-verticals with doors.

Table 1. The 100 Pre-defined categories and Basic Model Groups of Remote RDCs.

Category 1: Vertical or semi-vertical cabinets with doors (RVC4, RVF4)						
Height [mm]	Depth [mm]	Chilled or Frozen	Loading	Number of shelves	Lighted shelves	
≤1800	≤900	Chilled	any	any	N(o)	
1800–2150	900–1000	Frozen				
>2150	>1000					TOTAL 18
Category 2: Vertical and semi-vertical open (RVC1, RVC2, RVC3)						
Height [mm]	Depth [mm]	Frontal height [mm]	High depth	Loading	Night cover	Lighted shelves
≤1800	≤900	≤250	>700	any	Y if available	N
1800–2150	900–1000	250–440	≤700			
>2150	>1000	>440				TOTAL 54
Category 3: Islands (RHF3, RHF4, RHF5, RHF6, RHC3, RHC4, RHC5, RHC6)						
Outside depth [mm]	Glass front	Sliding panels	Loading depth	Temperature range	Lighted shelves	Night cover
≤1400	Y (Yes)	Y	any	any	N	Y if available
1400–1700	N	N				
>1700						TOTAL 12
Category 4: Counters (RHC1, RHC2, RHC3, RHF1)						
Presentation length [mm]	Chilled or frozen	Superstructure				
	Chilled	Traditional open				
≤930	Frozen	Traditional closed				
>930		Self-service				TOTAL 12
Category 5: Combined (YF1, YF2, YF3, YF4)						
Height [mm]	Glass front height	Sliding panels	Light: N at back	Chilled or Frozen		
≤2150	any	Y	N	Chilled		
>2150		N				TOTAL 4

condensing units ('I' for Integral) or remote condensing ('R': Remote). An 'H' or a 'V' will indicate whether the cabinets are horizontal (H) or vertical (V), followed by a 'C' or an 'F' to identify cabinets intended for refrigerated products (Chilled: C) or frozen goods (Frozen: F). Finally, a number completes the description by giving even more information on the structure.

By defining groups by sizes and common characteristics, we arrive at 100 preconfigured definitions, called basic model groups (BMG) (Table 1 [1]). When manufacturers declare two representative cabinets per basic model group, it is considered that this corresponds to 80% of the market.

The characteristics that influence energy performance

At this point we should identify, for each configuration, the characteristics of the representative cabinet component by component. Indeed, the interior fittings and accessories have a by no means negligible influence on the refrigerating behaviour of the cabinet and, consequently, on its energy efficiency. This nomenclature (called Bill

of Material or BOM) will be made possible by the precise description of the elements listed below:

- the cross-section of the cabinet, the configuration of shelves – if any, thus defining the useful display area (in other words, the container)
- the air flow configuration
- the lighting
- the night cover, if included
- the doors or sliding doors, in the case of closed cabinets
- the evaporator(s) and the associated fan(s)
- the defrost system

In the case of cabinets that house their condensing units, a compressor, a condenser with fan(s) and a condensation water discharge system would also be added.

Energy performance of the display cabinets under test conditions

The test conditions

Eight sets of test conditions are defined at the international level in ISO standard 23953:2005 for the determination

Table 2. "Climate 3" test conditions according to ISO standard 23953:2005.

Test chamber climate	Dry bulb Temperature (°C)	Relative humidity	Dew point [°C]	Absolute humidity $lg_{water/kg_{dry\ air}}$
Climate 3	25	60	16.7	12

Table 3. The temperature categories according to ISO standard 23953:2005.

		3L1	3L2	3L3	3M0	3M1	3M2	3H2
θ_b – the lowest temperature of the coldest package must be higher than or equal to	[°C]	-	-	-	-1	-1	-1	-1
θ_h – the highest temperature of the warmest package must be lower than or equal to	[°C]	-15	-12	-12	4	5	7	10
θ_b – the lowest temperature of the warmest package must be lower than or equal to	[°C]	-18	-18	-15	-	-	-	-

of the performance characteristics of a display cabinet. The set that most closely resembles the conditions of a store in Europe is number 3, whose data are defined in **Table 2**.

Temperature classes

In order to be able to certify a given temperature category, the equipment is tested according to the methods described by ISO standard 23953:2005 under the aforementioned conditions. The products are simulated by using packages called M-Packages, and the testing personnel make sure that their temperature stays within the ranges given in **Table 3**.

The performance characteristics

When the cabinets with remote condensing units are tested, the refrigeration electrical energy consumption *REC* (of the condensing set) is determined as well as the direct electrical energy consumption *DEC* from which the total electrical consumption *TEC* is deduced, with (it should be noted that for self-contained condensing cabinets the equation is $REC = 0$ and $TEC = DEC$ which includes the compressor energy):

$$TEC = REC + DEC \tag{1}$$

The next step is to determine the efficiency of the equipment under laboratory conditions; the efficiency corresponds to the consumption divided by the display area (Total Display Area) TDA:

$$Eff = TEC / TDA \tag{2}$$

It will be noted that the lower the Eff value, the more efficient the cabinet. It will thus be considered more as a standardised consumption than as an efficiency rating as such. In order to classify the cabinets among themselves, the following Energy Efficiency Index (EEI) has been defined:

$$EEI = \frac{\left(\frac{TEC}{TDA}\right)_{measured}}{\left(\frac{TEC}{TDA}\right)_{reference}} \times 100 \tag{3}$$

Table 4. The reference values for energy efficiency by cabinet type.

Type of cabinet	Temperature category	TEC/TDA reference value	
	3H	6.2	
	3M2	6.7	
	3M1	7.2	
	RHF1	3L3	21.0
	RHC3,	3H	5.5
		3M2	5.8
	RHC4	3M1	6.2
	RHF3,	3L1	15.0
		3L2	14.0
	RHF4	3L3	13.0
	RHC5,	3H	4.3
		3M2	4.7
	RHC6	3M1	5.0
	RHF5,	3L1	12.0
		3L2	11.2
	RHF6	3L3	10.4
	RVC1,	3H	10.1
	RVC2,	3M2	12.3
		3M1	13.4
	RVC3,	3M0	14.5
		3H	13.8
	RVF1	3M2	16.0
3L3		29.0	
	RVF4	3L1	28.5
	RVC4	3H	6.1
		3M2	7.4
		3M1	8.0
		3M0	8.7
	RYF3	3L2	30.0
	RYF4	3L3	29.0
		3L2	28.5
		3L3	27.6

The reference data correspond to arbitrary values determined statistically after gathering sales data from major manufacturers on the European market. These data allow the establishing of an energy label, as shown in **tables 4 & 5**, using the classic lettering already used by the well known labels for electrical appliances such as washing machines or refrigerators.

Table 5. The energy efficiency categories based on EEI.

Energy efficiency index EEI	Energy efficiency category	Energy efficiency index EEI	Energy efficiency category
$EEI < 55$	A	$100 \leq EEI < 110$	E
$55 \leq EEI < 75$	B	$110 \leq EEI < 125$	F
$75 \leq EEI < 90$	C	$125 \leq EEI$	G
$90 \leq EEI < 100$	D		

Mastered processes, well-sized supermarkets, minimum efficiency, efficient label

To provide customers with a guarantee of the best efficiency levels and, more generally, to increase the transparency of the data on the European market, Eurovent Certification (ECC) independently certifies more than 50 000 references for 20 kinds of products in the ventilation, air conditioning and refrigeration fields [2]. The certification of refrigerated cabinets covers several international brands, some of which have been certified for ten years now. The principle underlying this certification is the annual inspection (audit) of production facilities as well as testing in independent laboratories every six months. The purpose of the audit is to ensure that the products turned out by the factories perfectly match the declared characteristics of the models. During the visit, the auditor checks the production line and reviews recent orders to verify their compliance. By regularly testing the finished units according to the terms of ISO standard 23953:2005 and its amendments, the auditors ensure that the efficiency levels are in phase with those indicated in the catalogues. The entire process is an active and efficient means of ensuring that a B-labelled cabinet will not turn in performance data equivalent to those of a D.

Since May 2010, the performance data have been published in a new format in which they are uniformly transposed to represent the conditions in a store. Indeed, in the supermarkets the refrigerated cabinets are placed together in such a way that the ambient conditions are less homogeneous but milder than those stipulated in the standard, as shown schematically in **Figure 2**. The efficiency shown is thus closer to actual conditions and the facilities are thus better sized, reducing the overall energy bill.

With the goal of reducing energy consumption in the EU, the European Commission relies on directives

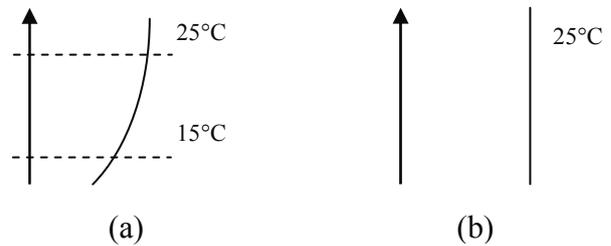


Figure 2. Simplified depiction of the ambient temperature conditions in a store (a) compared to temperature conditions in a laboratory.

which must subsequently be transposed or directly applied by all of the Member States. Among its tools, the “ErP” directive (Eco-design for Energy related Products) 2009/125/EC defines the minimum energy efficiencies, or Labelling, for energy labelling [3]. Each product family (for example: televisions, light bulbs, etc.) is covered by a “Lot” [4]: refrigerated display cabinets have been studied in the framework of “Lot 12”. The implementing measures are still being drafted, after several delays, but the efficiency thresholds can be foreseen. According to these thresholds, the G-class cabinets might be prohibited on the European market. Moreover, the implementation of an energy label will give rise, among the manufacturers, to better efficiency. Thus, the prescribers will select more efficient units.

References

[1] S. Marinhas, Operational Manual and Rating Standard for the Certification of Remote Refrigerated Display Cabinets, Eurovent Certification (2010).
 [2] <http://www.eurovent-certification.com>
 [3] S. Marinhas et al., Air-conditioning, air handling and refrigeration equipment: European-wide certification, standards and European directives on energy efficiency, *Rehva Journal*, vol. 18 (2010), 31-34.
 [4] http://ec.europa.eu/enterprise/policies/sustainable-business/ecodesign/index_en.htm 3E