



Domestic Refrigerated Appliances Actions and Assumptions: USA FTC Data

The aim of this document is to detail the actions and assumptions made in interpreting and processing the data specified above during the mapping and benchmarking of domestic refrigerated appliances. It is designed to be read in parallel with the “Summary Overall Mapping and Benchmarking Approach to Domestic Refrigerated Appliances”. Section numbers in each document should align.

1 Overview of the mapping and benchmarking outputs for domestic refrigerated appliances

No data specific actions.

2 The mapping and benchmarking process for domestic refrigerated appliances

2.1 Data Cleaning and Pre-processing

2.1.1 Data cleaning

- a. To revert to “as tested” unit energy consumption, reported chest freezer energy consumption has been multiplied by 1/0.7, and upright and compact freezer energy consumption has been multiplied by 1/0.85.
- b. Volumes converted to litres (declared x 28.3168466)

In FTC data, model volumes are provided as aggregated values (i.e. a total of fresh and frozen compartments). These compartment volumes have been split into separate fresh and frozen volumes based on a regression analysis conducted by Lawrence Berkley National Laboratories. The values of the slope and intercept for each product type derived from the regression analysis are shown in the table below:

US product type	Slope	Intercept
1	1.0816	0
2	1.0874	0
3	1.1591	0
4	1.2318	0
5	1.1863	0
5A	1.1872	0
6	1.1863	0
7	1.2349	0
11	1.1288	0
12	1.1037	0
13	1.1855	0
14	1.1539	0

Based on the US categories (defined in 2.1.2), the values in this table were used to convert total product volumes to adjusted volumes. Subtracting the total volume from the adjusted volume gives the “freezer adjustment volume”. The “freezer adjustment volume” can then be used to calculate *actual* freezer volume by simple multiplication of the “freezer adjusted volume” by the inverse of the freezer thermodynamic volume adjustment factor, e.g. for the frozen compartment of refrigerator-freezers the multiplication factor would be $1/(1-1.63)$. Fresh compartment volume is then calculated simply as total volume minus freezer volume.

2.1.2 Pre-processing

The pre-processing of data:

- a. Allocation of US, Mapping and Benchmarking and EU product types. This allocation was based on the “Refrigerator Type Description” field. Allocation for the Refrigerators and Freezers Data sets as follows:

Type Code	Refrig Type Description	USA type ¹	Mapping and Benchmarking Category	EU type	Configuration
BF-A	Refrigerator/Freezer - Bottom Freezer - Automatic Defrost	5 or 15	Fridge/Freezer	7	Freezer Bottom
BF-P	Refrigerator/Freezer - Bottom Freezer - Partial Defrost	2 or 12	Fridge/Freezer	7	Freezer Bottom
BI-A	Refrigerator with Bottom Freezer, Auto Defrost, Thru the Door Ice	5A (assumed as 5)	Fridge/Freezer	7	Freezer Bottom
CF-M	Chest Freezer & All Others - Manual Defrost	10 or 18	Freezer only	9	Chest
SD-A	Refrigerator Only - Single Door - Automatic Defrost	3 or 13	Refrigerator with Freezer	4	Not Applicable
SD-M	Refrigerator Only - Single Door - Manual Defrost	1 or 11	Refrigerator with Freezer	4	Not Applicable
SR-A	Refrigerator/Freezer - Single Door - Automatic Defrost	3 or 13	Fridge/Freezer	7	Freezer Bottom
SR-M	Refrigerator/Freezer - Single Door - Manual Defrost	1 or 11	Refrigerator with Freezer	7	Not Applicable
SS-A	Refrigerator/Freezer - Side by Side - Automatic Defrost	4 , 14 or 7	Fridge/Freezer	7	Side-by-Side
TF-A	Refrigerator/Freezer - Top Freezer - Automatic Defrost	3 or 13	Fridge/Freezer	7	Freezer Top
TF-M	Refrigerator/Freezer - Top Freezer - Manual Defrost	1 or 11	Fridge/Freezer	7	Freezer Top
TF-P	Refrigerator/Freezer - Top Freezer - Partial Defrost	2	Fridge/Freezer	7	Freezer Top
UF-A	Upright Freezer - Automatic Defrost	9 or 17	Freezer only	8	Upright
UF-M	Upright Freezer - Manual Defrost	8 or 16	Freezer only	8	Upright
Partial Defrost	Refrigerator/Freezer - Unknown - Partial Defrost	2 or 12	Fridge/Freezer ²	7	Unknown
Manual Defrost	Refrigerator/Freezer - Unknown - Manual Defrost	1 or 11	Fridge/Freezer	7	Unknown

- b. Subsequent to the allocation of product types in the table above, and the volume analysis described in 2.1.1 c., any model that had a freezer volume of less than 14 litres was reallocated to EU type 1 and M&B type "refrigerator only".

The pre-processing of data:

- c. Compartments within the various US unit types were allocated to one of mapping and benchmarking compartment categories based on the table below (note this table also gives the assumed test temperatures for each compartment for each product type under US test conditions)

¹ Note that a number of units have been allocated two potential "USA types". In general this is where the unit may be "standard" or "compact", but there is insufficient data available to differentiate. However, for the purposes of the mapping and benchmarking analysis, both standard and compact units are grouped with no differentiation; therefore the model is assumed to be "standard". Where more than two types of product are shown, this relates to the potential combinations of products based on a defrost type which is unknown. In these cases, assumptions default to automatic defrost (which dominates the US market). These types are shown in bold font in the table.

² Note these units could be refrigerators with freezer compartments. However, this is not possible to categorise from the data available and the units are assumed to be Fridge/Freezer combinations.

EU Categorisations	Fresh Comp Temp	Frozen Comp Temp	Compartment Allocations for Fresh, Frozen and "Other Compartment" Volumes (T=degC)					
			14 > T > 5	5 >= T > 0	T = 0	0 > T => -6	-6 > T => -12	-12 > T => -18
Refrigerators	3.33C	-9.44C ³		Fresh			Frozen	
Refrigerators with Freezers	7.22C	-9.44C		Fresh			Frozen	
Fridge Freezers	7.22C	-15C		Fresh				Frozen
Freezers		-17.77C						Frozen

2.2 Production of Graphical Mapping Outputs

Local adjusted volume test methodology used:

$$\text{Total Adjusted Volume} = \text{Volume fresh} + n * \text{Volume frozen}$$

Where

USA Classification	n
Refrigerators (excluding all refrigerators)	1.44
Fridge-Freezers	1.63
Freezers	1.73
All Refrigerators	1

2.3 Normalisation

2.3.1 Normalisation Overview

No data specific actions.

2.3.2 Allocation of declared UEC to compartments

The adaptation of the EU methodology used in this analysis requires knowledge of compartment defrost type. It is also possible that we will use information on climate class, whether or not the unit is built in and whether or not the unit has an ice maker in a separate specific piece of benchmarking analysis. These characteristics of each model were allocated based on the "Refrigerator Type Description" field as follows:

³ US regulations do not specify a standardized compartment temperature for the freezer compartment of an "all-refrigerator" units, therefore the actual temperature during tests could vary. However, a nominal temperature of -9.44 has been allocated based on the freezer temperature of "refrigerators" to enable benchmarking with other countries. This is *likely* to lead to a slightly lower unit energy consumption per litre in comparison with other countries.

Type Code	Refrig Type Description	Defrost Type	Built-in
BF-A	Refrigerator/Freezer - Bottom Freezer - Automatic Defrost	All Compartments Automatic	Unknown
BF-P	Refrigerator/Freezer - Bottom Freezer - Partial Defrost	Fresh Compartment Automatic	Unknown
BI-A	Refrigerator with Bottom Freezer, Auto Defrost, Thru the Door Ice	All Compartments Automatic	Unknown
CF-M	Chest Freezer & All Others - Manual Defrost	All Compartments Manual	Unknown
SD-A	Refrigerator Only - Single Door - Automatic Defrost	All Compartments Automatic	Unknown
SD-M	Refrigerator Only - Single Door - Manual Defrost	All Compartments Manual	Unknown
SR-A	Refrigerator/Freezer - Single Door - Automatic Defrost	All Compartments Automatic	Unknown
SR-M	Refrigerator/Freezer - Single Door - Manual Defrost	All Compartments Manual	Unknown
SS-A	Refrigerator/Freezer - Side by Side - Automatic Defrost	All Compartments Automatic	Unknown
TF-A	Refrigerator/Freezer - Top Freezer - Automatic Defrost	All Compartments Automatic	Unknown
TF-M	Refrigerator/Freezer - Top Freezer - Manual Defrost	All Compartments Manual	Unknown
TF-P	Refrigerator/Freezer - Top Freezer - Partial Defrost	Fresh Compartment Automatic	Unknown
UF-A	Upright Freezer - Automatic Defrost	All Compartments Automatic	Unknown
UF-M	Upright Freezer - Manual Defrost	All Compartments Manual	Unknown
Partial Defrost	Refrigerator/Freezer - Unknown - Partial Defrost	Fresh Compartment Automatic	Unknown
Manual Defrost	Refrigerator/Freezer - Unknown - Manual Defrost	All Compartments Manual	Unknown

Whilst installation type is not listed in the data for all models, the table below⁴ shows that majority of models in the USA market are freestanding.

Sum of Domestic Unit Shipments Combined DOE Product Class	B, Free Stand	Year		
		2005	2006	2007
1 and 2	B	0.0%	0.1%	0.0%
	F	0.6%	0.3%	0.2%
4	B	0.9%	0.8%	0.7%
	F	0.9%	0.9%	0.7%
5	B	0.0%	0.0%	1.3%
	F	0.0%	0.0%	16.7%
5 and 19	B	1.1%	1.7%	0.0%
	F	2.6%	16.3%	0.0%
7	B	1.0%	1.8%	1.5%
	F	61.7%	55.3%	51.5%
8 and 10	B	11.5%	8.7%	9.2%
	F	11.5%	9.4%	8.8%
9	B	0.3%	0.3%	0.5%
	F	7.2%	3.6%	2.8%
13	B	0.1%	0.1%	0.1%
	F	0.0%	0.1%	0.0%
14 and 15	B	0.0%	0.0%	4.9%
	F	0.0%	0.0%	0.0%
19	B	0.3%	0.4%	0.5%
	F	0.2%	0.1%	0.4%
Wine Cooler	B	0.3%	0.4%	0.5%
	F	0.2%	0.1%	0.4%

Market Share Product Class Data for Built-ins (Selected Product Classes)

⁴ AHAM R-F shipment and efficiency data submission to DOE January 16, 2009

2.3.3 Normalisation of “compartment EC” for test temperature variations and calculation of normalised UEC

The assumed test temperatures for each compartment for each product type are given in the table in section 2.1.2 b).

External test temperature is 32.2°C

2.3.4 Calculation of Normalised UEE

No data specific actions.

2.3.5 Calculation of normalised EEI

No data specific actions.