CLEAN DEVELOPMENT MECHANISM

TOOL29

Methodological tool

Determination of standardized baselines for energy-efficient refrigerators and air-conditioners

Version 01.0

United Nations
Framework Convention on
Climate Change

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1. Introduction

1. This tool includes a methodological framework for the development of standardized baselines for energy-efficient refrigeration and air conditioning (RAC) appliances for residential application.

2. This tool provides methods to standardise parameters taking into account a variety of data formats and sources encountered in CDM host countries. In particular, the use of energy

efficiency labelling of appliances is enabled to determine the annual electricity consumption.

2. Scope, applicability, and entry into force

2.1. Scope

3. The tool is comprised of three components:[1]

   (a) Methods to develop a standardised baseline for greenfield (new sales) RAC appliances (new sales SB);

   (b) Methods to develop a standardised baseline for replacing existing refrigerators with efficient ones (replacement SB);

   (c) Methods to develop a standardised baseline for emissions from the refrigerants contained in baseline RAC equipment (refrigerant SB).

4. The tool provides guidance for the development and assessment of standardized baselines including additionality demonstration, identification of baseline scenario and determining baseline emissions.

5. The tool covers determination of baseline energy consumption factors for the RAC sector (market). For refrigerators baseline energy consumption can be determined for one or more segments of the refrigerator sector,[2] in a town/city or a region of a country or a country or a group of countries.

6. The new sales SB, the replacement SB and the refrigerant SB may be developed as three different SBs or may be combined under one SB.

2.2. Applicability

7. This tool covers the use/distribution/sale of RAC equipment for residential/household application.[3]

8. This tool should be applied in conjunction with AM00XX “Energy-efficient refrigerators and air-conditioners”.[4]

9. The tool enables using different sources of data to address data gaps and cost effective data collection without compromising the environmental integrity of estimates i.e.

[1] The methods to standardise baseline emissions for blowing agent SB is not currently included but will be appended in a future revision as the fourth component.

[2] The entire market or a segment of the market may be chosen, for example the refrigerators on a market range from 100-400 liters in size, it is possible to choose the entire range of refrigerators between 100-400 or one or more sub sets of the volume segments such as 100-150 liters, 150-200 liters.

[3] This excludes centralized and packaged RAC systems.

[4] A new methodology or a revision may be proposed by the stakeholders following the relevant procedures.

standards and labelling database (S&L database),[5] commercial marketing data provided by specialised agencies (such as the ones provided by Nielsen Company, IMS Health etc.) and manufacturers (industry) data[6] is judiciously applied depending on the availability and quality of the data. The tool requires that stepwise procedures are applied to procure data to determine the parameters required to develop the baseline emission factors (see Appendix 1 for details). It requires that the procedures of the approved "Guidelines on quality assurance and quality control of data used in the establishment of standardized baselines" is complied with.

10. The SB developed using this tool is applicable for 3 years from the date of approval.[7]

2.3. Entry into force

11. The date of entry into force is the date of the publication of the EB 97 meeting report on 1 November 2017.

3. Definitions

12. The definitions contained in the Glossary of CDM terms shall apply.

13. In addition, for the purpose of this tool, the following definitions apply:

(a) **Inventory** - a collection of records for all appliances sold in a given time period in the entire country or a given region or a city or town in a country. An inventory can be developed from one or multiple data sources with the aim of completing the coverage;

(b) **Marketing channel** - The route of movement of RAC equipment from the producer (a manufacturer) to the final consumer (e.g. a household), as an appliance gets traded between importers, wholesalers, retailers, department stores and increasingly Internet-based retailers;

(c) **Refrigerator model** - refers to a refrigerator series or type produced by a manufacturer. Refrigerators with different storage volume or different rated electricity consumption are considered as different models. Each model has an identifier code of letters and/or numbers from the manufacturer. This code is included on the nameplate and should appear in S&L databases and marketing data;

(d) **Energy Efficiency Index** (EEI) - this index is the ratio between the actual annual electricity consumption of an appliance and a standard value of annual electricity consumption for its size. The index compares energy consumption with the appliance's internal volume, to show how efficient it is for its size. This means two different-sized refrigerators can have the same energy rating. National standards and labelling systems provide the methods for determining standard annual

[5] For example, Indian BEE Star, Brazil Procel, South Korean KEMCO, China CNIS.

[6] Data collected through survey among manufacturers, where applicable including importers, wholesalers, distributors and retailers.

[7] Updates may be proposed in accordance with the procedures (see <https://cdm.unfccc.int/methodologies/standard_base/new/sb4_index.html))>.

electricity consumption and require the manufacturers to test their refrigerator models by an independent laboratory. The laboratory certifies the annual electricity consumption and the Energy Efficiency Index;

(e) **Cooling capacity** - the total amount of cooling provided to an enclosed area in a specified amount of time in thermal Watts (W_{th});

(f) **Fixed speed air conditioner** - refers to air conditioners for which the compressor runs only at one speed, a certain number of rotations per unit time. The air conditioner can only be switched on or off to maintain a room temperature. In many countries there are separate Standard & Labelling systems for fixed speed air conditioners and they tend to be less efficient than others;

(g) **Inverter air conditioner** - have an inverter allowing variability and reduced speed of the compressor, so that the cooling output can be varied across a wide range. Inverter air conditioners are more expensive and efficient and have rapidly gained market share in many countries;

(h) **Energy Efficiency Ratio (EER)** - the ratio between the cooling capacity and total power input of an air conditioner model, specified in W_{th}/W_{elec}. The purpose of this ratio is the same as the Energy Efficiency Index, to allow comparing the efficiency of different appliance sizes. EER is used to define efficiency classes. EER shall be based on tests in independent laboratories applying ISO test standard ISO 5151. Minimum energy performance standards (MEPS) in most countries use an EER value as a mandatory minimum;

(i) **Seasonal Energy Efficiency Ratio (SEER)** - is derived from the EER by weighing for different part load periods of a year. It is a better indicator of electricity consumption than EER. It is a legally required parameter in many countries, reported in Btu/hr per Watt or in Watt per Watt. Most efficiency labels on air conditioners show both the EER and the SEER and the latter corresponds to the country where the air conditioner is sold. While EER and SEER correlate, it is not possible to estimate one from the other based on a conversion factor;

(j) **Coefficient of performance (COP)** - for refrigerators, the ratio of the refrigeration effect to the heat of compression. For air conditioners, in heating mode, the COP is the ratio of the heating capacity to the effective power input in Watt/Watt. Appliances with higher COP are more efficient and more expensive because the compressor and the heat exchanger are more advanced and use more expensive materials, Seasonal Coefficient of Performance (SCOP) for air conditioners is derived from the COP by weighing for different part load periods of the year;

(k) **Refrigerant** - chemicals circulating in a thermodynamic process in refrigeration or air conditioning equipment. An average air conditioner contains about one litre (about 1.2 kg) of refrigerant and an average refrigerator 0.1 litre (about 80 g). Refrigerants leak slowly out of the appliance so it needs to be refilled periodically. Air conditioners need this maintenance every one or two years, while refrigerators leak very little that they do not need refilling frequently;

(l) **Charge volume** - the amount of refrigerant filled in appliances during manufacturing. Smaller units can be hermetically sealed (with optimized brazing technology and automatic leak detection by the manufacturer), while larger units and air conditioners need to be refilled with refrigerants periodically, some up to 30% of initial charge per year;

(m) **Blowing agent** - chemical injected into Polyurethane (PUR) foam during the manufacturing of a refrigerator. The blowing agent stays in fine bubbles inside the insulating foam until the foam is mechanically destroyed when the refrigerator is disposed. Many blowing agents currently used have high GWP values and new blowing agents available have GWP values that are lower by a factor of 100;

(n) **CFC** - chlorofluorocarbons, CFC-11 and CFC-12 were dominant refrigerant and blowing agent in the 1970s and 1980s but were the main cause of the ozone hole. CFC-11 and CFC-12 are phased out under the Montreal Protocol since 2010, their production or sale is illegal. Hundreds of millions of old refrigerators still in operation in the world contain CFCs and continue to emit them;

(o) **HCFC** - hydrofluorochlorocarbons, the main application of this class of chemicals is as HCFC-22 refrigerant in air conditioners and as HCFC-141b blowing agent in insulating foams;

(p) **HFC** - hydrofluorocarbons were the main CFC replacement chemicals in the 1990s with many diverse uses.

4. Methodological procedure

4.1. Refrigerators new sales

14. Three options (i.e. approach 1 to 3) corresponding to three options to determine the baseline emissions in the methodology:[8]

(a) Approach 1 is based on the annual electricity consumption (EC) of the baseline refrigerators;

(b) Approach 2 is based on the specific annual electricity consumption (SEC) per unit volume of the baseline refrigerators;

(c) Approach 3 is based on Energy Efficiency Index (EEI) of the baseline refrigerators.

15. **Approach 1.**

$$EC_{rn,p} = (EC_{90/80,p})$$ Equation (1)

Where:

$EC_{rn,p}$	=	Baseline electricity intensity factor (kWh/refrigerator/year) of volume class *p*
p	=	Volume class of refrigerators (Refer to Data/Parameter Table 1)

[8] AM00XX "Energy-efficient refrigerators and air-conditioners" in order to calculate baseline emissions.

$EC_{90/80,p}$	=	90th or 80th per centile of baseline refrigerator units of volume class *p* sold in the reference period sorted from highest to lowest annual electricity consumption (kWh/yr) (Refer Data/Parameter Table 1 and Appendix 2. Data quality requirements apply as per Appendix 2 to apply the 80th percentile value)

16. **Approach 2.**

$$SEC_{rn,q} = (SEC_{90/80,q}) \quad \text{Equation (2)}$$

Where:

$SEC_{rn,q}$	=	Baseline electricity intensity factor (kWh/litre /year) of volume class *q*
$SEC_{90/80,q}$	=	90th or 80th per centile of specific annual electricity consumption per unit volume of baseline refrigerator models of volume class *q* sorted from highest to the lowest specific annual electricity consumption in the reference period (kWh/litre/year) (Refer Data/Parameter Table 2 and Appendix 2. Data quality requirements apply as per Appendix 2 to apply the 80th percentile value.)
q	=	Volume class of refrigerators (Refer to Data/Parameter Table 2)

17. **Approach 3.**

$$EEI_{rn,r} = \frac{EEI_{90/80,r}}{100} \quad \text{Equation (3)}$$

Where:

$EEI_{rn,r}$	=	Baseline Energy Efficiency Index (dimensionless) of volume class ‘r’
$EEI_{90/80,r}$	=	90th or 80th per centile of Energy Efficiency Index of the baseline refrigerator models in the reference period sorted from highest to the lowest Energy Efficiency Index (number) (Refer Data/Parameter 3 and Appendix 2. Data quality requirements apply as per Appendix 2 to apply the 80th percentile value)
r	=	Volume class of refrigerators (Refer to Data/Parameter Table 3)

18. When only the efficiency class is reported but not the actual EEI values per refrigerator (as in the case of some commercial marketing data sources), take the midpoint of lowest and highest EEI of the class to which the refrigerator model belongs to. Using the mid-value of EEI is conservative because appliances are often designed to be just below the efficiency class limit.[9]

19. When information from different refrigerator test standards are to be used, it shall be applied using the conversion factor provided in Appendix 1, Table 2 and Table 3.

[9] For example, label class “A” for EU is between EEI 55 – 42 and most models in this class have EEI of 53 to 54. (lower values indicate higher efficiency).

20. EEI for refrigerator models for volume class *r* that are not included in a S&L database shall be calculated using the following equation to enhance the data coverage where the S&L data base has not been updated in the last three years (see Appendix 2).

$$EEI_r = \frac{EC_r}{SAE_r} \times 100$$ Equation (4)

Where:

EEI_r	=	Energy Efficiency Index of Refrigerator models for volume class *r* not included in the S&L database (number)
EC_r	=	Actual Electricity consumption of Refrigerator models for volume class *r* not included in the S&L database (kWhr/year)
SAE_r	=	Standard annual electricity consumption of the refrigerator models for volume class r in the reference period that are not included in S & L database

21. The standard annual electricity consumption SAE_r for volume class *r* (kWhr/year) is calculated as:[10]

$$SAE_r = V_{eq} \times M + N$$ Equation (5)

Where:

V_{eq}	=	Equivalent volume of a refrigerator (L)
M, N	=	Factors for calculating the standard annual electricity consumption for each category of refrigerators (derived from national or applicable international standard (e.g. EU regulation 1060/2010 and in China GB-12021.2-2008)

22. The equivalent volume of a refrigerator is calculated as:[11]

$$V_{eq} = \left(\sum V_i \times TF \times FF\right) \times CC \times BI$$ Equation (6)

Where:

V_i	=	Volume of compartment *I of* volume class *r*, typically a fresh food or a freezer compartment (L)
TF	=	Thermodynamic factor for the design temperature in the compartment derived from national or applicable international standard (e.g.EU regulation 1060/2010 and in China GB-12021.2-2008)
FF	=	For Frost-free apply 1.2, otherwise apply 1.0
CC	=	Climate class, for T class apply 1.2, for ST class apply 1.1, otherwise 1.0

[10] Commonly used empirical relation in most metrics around the world including EU and Chinese metrics.

[11] Most commonly used empirical relation, some national efficiency metrics apply a small variation of this equation.

BI = Built-in refrigerators under 58cm width 1.2, otherwise 1.0

4.1.1. Data and parameters

Data / Parameter table 1.

Data / Parameter:	$\boldsymbol{EC_{90/80,p}}$
Data unit:	kWh/refrigerator/yr
Description:	90^{th} or 80^{th} per centile of baseline refrigerator units of volume class *p* sold in the reference period sorted from highest to the lowest annual electricity consumption
Source of data:	• Standard & Labelling database; (b) Commercial marketing data; (c) Manufacturers (industry) data; • Collect model specifications and sales data. Apply stepwise procedures of Appendix 1 for each volume class *p*. Data used shall not be older than three years. Use the most recent data vintage that is at least one-year long; • Volume class *p*: Range of volume class shall be less than or equal to 40 L, for example, a volume class can be from 100 liters to 140 liters
Measurement procedures (if any):	Step 1: Sort the refrigerator units sold for each volume class *p* in the reference period from the highest to the lowest annual electricity consumption; Step 2: Identify the 80^{th} and 90^{th} percentile. Data quality requirements apply as per Appendix 2 to apply the 80^{th} percentile value
Any comment:	Only the values determined using national test standard or IEC 62552 or equivalent is eligible for use. The volume of project and baseline refrigerators shall belong to the same volume class. The volume class is determined at the time of determination of baseline electricity intensity factor ($EC_{rn,p}$) and are valid for the project activity as well. It is recommended to define the volume class covering possible refrigerator sizes sold in the host country

Data / Parameter table 2.

Data / Parameter:	$SEC_{90/80,q}$
Data unit:	kWh/litre/year
Description:	90^{th} or 80^{th} per centile of specific annual electricity consumption per unit volume of baseline refrigerator models of volume class *q* sorted from highest to the lowest specific annual electricity consumption in the reference period (kWh/litre/year)

Source of data:	1. (a) Standard & Labelling database; (b) commercial marketing data; (c) manufacturers (industry) data. 2. Refrigerator nameplate has information on annual electricity consumption (kWh/year) and volume in litres, ratio of these may also be used to calculate SEC. 3. Apply stepwise procedures of Appendix 1 for each volume class *q*. Data used shall not be older than three years. Use the most recent data vintage that is at least one-year long. 4. Volume class *q* of refrigerators: (a) Refrigerator models <100 L and >400 L are grouped in separate volume classes; (b) Between 100-400 L, create a separate volume class for every 50 L difference (e.g. 100 -150 L, 150- 200 L)
Measurement procedures (if any):	Step 1: Sort the refrigerator models in the reference period from the highest to the lowest specific annual electricity consumption for each volume class *q*. Where sales data of refrigerator models is available, refrigerator units of volume class *q* sold in year y are sorted from highest to the lowest specific annual electricity consumption; Step 2: Identify the 90th and 80th percentile. Refer to Appendix 2. Data quality requirements apply as per Appendix 2 to apply the 80th percentile value
Any comment:	Only the values determined using national test standard or IEC 62552 or equivalent is eligible for use. The volume of project and baseline refrigerators shall belong to the same volume class. The volume class is determined at the time of determination of baseline electricity intensity factor ($SEC_{rn,q}$) and are valid for the project activity as well. It is recommended to define the volume class covering possible refrigerator sizes sold in the host country

Data / Parameter table 3.

Data / Parameter:	$EEI_{90/80,r}$
Data unit:	Number
Description:	90th or 80th per centile of Energy Efficiency Index of the baseline refrigerator models of volume class *r* in the reference period sorted from highest to the lowest Energy Efficiency Index

Source of data:	1. (a) Standard & Labelling database; (b) commercial marketing data; (c) manufacturers (industry) data (d) the refrigerator efficiency label 2. Apply stepwise procedures in Appendix 1 for each volume class *r*. Data used shall not be older than three years. Use the most recent data vintage that is at least one-year long. Volume class *r* of refrigerators: (a) Refrigerator models <200 L are grouped in separate volume classes for every 50 L difference (e.g. 100-150 L, 150-200L) (b) Models between 200-600 L may be grouped in one volume class (c) Models above 600 L may be grouped under one volume class
Measurement procedures (if any):	Step1: Sort the refrigerator models in year y from the highest to the lowest energy efficiency index. Where sales data of refrigerator models is available, refrigerator units of volume class *r* sold in the reference period are sorted from highest to the lowest energy efficiency index; Step2: Identify the 90^{th} and 80th percentile. Refer to Appendix 2. Data quality requirements apply as per Appendix 2 to apply the 80^{th} percentile value
Any comment:	When the exact EEI numbers of models are not known, the values at mid-points of efficiency classes shall be used for all models in an efficiency class as described in paragraph 18. A national test standard or IEC 62552 or equivalent shall be applied. The volume of project and baseline refrigerators shall belong to the same volume class. The volume class is determined at the time of determination of baseline Energy Efficiency Index ($EEI_{rn,r}$) and are valid for the project activity as well. It is recommended to define the volume class covering possible refrigerator sizes sold in the host country

Data / Parameter table 4.

Data / Parameter:	EC_r
Data unit:	kWh/yr
Description:	Electricity consumption of Refrigerator models for volume class *r* not included in the S&L database (kWhr/year)
Source of data:	Manufacturers data
Measurement procedures (if any):	
Any comment:	-

Data / Parameter table 5.

Data / Parameter:	SAE_r
Data unit:	kWh/yr
Description:	Standard annual electricity consumption of the refrigerator models for volume class *r* in the reference period that are not included in S & L database
Source of data:	Manufacturers data for compartment volumes (V_i) and compartment temperatures (TF)
Measurement procedures (if any):	When EC and compartment volumes of refrigerators from different exporting countries are used, then the same V_{eq} factors from one metric shall be applied to calculate the respective SAE of all refrigerator models. When only EEI values are available and there are data on EC and no data on compartment volumes, then EEI values from different metrics may be combined
Any comment:	-

4.2. Air conditioners new sales

23. The baseline electricity intensity factor EC_{an} [12] is calculated with one of two options:

(a) Approach 1 is based on EER of baseline air conditioners in a market or market segment;

(b) Approach 2 is based on SEER of baseline air conditioners in a market or market segment.

24. **Approach 1** Baseline electricity intensity factor is calculated as

$$EC_{an} = \frac{hrs_y \times \beta_L}{EER_{90/80,s}}$$ Equation (7)

Where:

EC_{an}	=	Baseline electricity intensity factor (kWh/air conditioner/cooling capacity/year)
$EER_{90/80,y}$	=	90th or 80th per centile of EER of baseline air conditioner models sorted from highest to lowest EER in the reference period (as determined under Data/Parameter Table 8, Data quality requirements apply as per Appendix 2 to apply the 80th percentile value)
hrs_y		
β_L		
hrs_y	=	Annual average operating hours or usage (number, see data/parameter table 6)
β_L	=	Load factor (proportion, see data parameter table 7)

[12] This is a dimensionless factor, when applied in conjunction with "AM XXXAM0XX Methodology for energy efficient refrigerators and air-conditioners', facilitates calculation of baseline emissions.

25. **Approach 2** Baseline factor is calculated as

$$EC_{an} = \frac{(hrs_y \times \beta_L)}{SEER_{90/80,s}}$$ Equation (8)

Where:

$SEER_{90/80,s}$	=	90th or 80th per centile of SEER of baseline air conditioner models sorted from highest to the lowest SEER in the reference period (as determined under Data/Parameter Table 8, Data quality requirements apply as per Appendix 2 to apply the 80th percentile value,)

26. The tables 1 and 2 in the Appendix 3 include conversion factors for all versions of SEERs[13] separately for fixed speed and inverter air conditioners.

27. Air conditioner models have a wide range of sizes and efficiency classes, however typically a small number of manufacturers (less than 15) account for more than three fourths of the market share and in many countries one or two manufacturers command a high market share. Therefore, average EER or SEER from these manufacturers is sufficient as it is representative.

28. If the efficiency of all main models in a country is available, the actual efficiency distribution of those models shall be used. When efficiency data coverage is partial, a baseline factor shall comprise of the most common capacities and sales data for these capacities shall be known[14]. An air conditioner market inventory shall comprise the following variables:

(a) P – cooling capacity (kW) of a model;

(b) EER – energy efficiency ratio, cooling capacity/effective power input (W/W);

(c) SEER – seasonal energy efficiency rating (W/W)[15];

(d) COP – coefficient of performance; (optional);

(e) FS/V – fixed-speed, inverter (variable speed drive); (optional);

(f) Split – split system with internal and external unit ducted, Window-type unit (optional).

29. The limited number of air conditioner brands, often between 20 to 40, allows a higher market coverage than for other appliances.

[13] US: ARI 210/240, Japan: JRA-4046, Korea: KSC 9306-2010, China: GB 21455-2008, EU: regulation 626/2011. Japanese and Korean versions of SEER are referred to as CSPF, HSPF and APF. Differences among these standards reflect consumer habits and also industry interests.

[14] For example, 25% of all air conditioners in China have 3.4 kW, 16% 2.5 kW and 12% 7.2 kW, all other capacities have <5% market share.

[15] Different part load conditions and temperature bins in US, China, Japan, Korean and EU standards.

4.2.1. Data and parameters

Data / Parameter table 6.

Data / Parameter:	hrs_y
Data unit:	Hours
Description:	Annual average operating hours or usage (in a country or a climatic zone)
Source of data:	Published data (national or regional default), survey or grid load curve analysis. **Option 1.** In a country where operating data is published, these shall be assessed for representativeness. Whether they account for annual cooling degree day differences shall be assessed. Published survey results related to census data or from utilities' household surveys shall be compared to calculated averages in energy models[16]. **Option 2.** The operating hours of the baseline air conditioners shall be determined using surveys by continuous measurement of usage hours for a minimum of 90 days representative of the year. For a large population of baseline air conditioners: (a) use a representative sample (sampling determined by a minimum 90% confidence interval and 10% maximum error margin); (b) ensure that sampling is statistically robust and relevant. **Option 3.** Load analysis by utility companies is used to determine an accurate range of average operating hours across the year
Measurement procedures (if any):	Where a survey is applied, sampling should be as per Guidelines for sampling and surveys for CDM project activities and programme of activities
Any comment:	-

Data / Parameter table 7.

Data / Parameter:	β_L
Data unit:	Load factor
Description:	Proportion of hours per year during the cooling periods of the year when air conditioners operate at full capacity.
Source of data:	Fixed speed air conditioner with EER data β_L= 0.75 Fixed speed air conditioner with SEER data β_L = 0.85 Inverter air conditioner with EER data β_L = 0.88 Inverter air conditioner with SEER data β_L = 1.00
Measurement procedures (if any):	

[16] For example, the BUENAS model used in the Int. Energy Studies Group of Lawrence Berkeley Nat. Laboratory uses national Cooling Degree Days to determine annual operating hours, see Shah N, Wei M, Letschert V and Phadke A, 2015, Benefits of Leapfrogging to Superefficiency and Low Global Warming Potential Refrigerants in Room Air Conditioning, LBNL-1003671, p. 19-20.

Any comment:	The default load factors provided are simplifications.[17] The load factor reflects how often households switch air conditioners off/on. For fixed-speed air conditioners, 0.75 is the value generally used to account for the average time when the air conditioner runs at full capacity, versus the time it runs at part capacity (McNeil and Iyer, 2007). With inverter air conditioners, households fix a temperature target and air conditioners regulate the speed so that the target is kept and consequently, households do not switch air conditioners off or switch them off much less frequently than fixed speed ones. Also, the load factor reflects whether it is used with EER and SEER data because EER tests are at full capacity while SEER uses test efficiencies in 15 or 24 “bins” of a number of hours per year at an outdoor temperature. An inverter air conditioner generally follows the temperature profile for the SEER testing. Thus, β_L is assumed as 1 for SEER and inverters and 0.75 for EER (tested only at full speed) data and fixed speed air conditioners where households switch off/on more frequently. For data consistency, the SEER to EER relation used is based on the largest compilation of global air conditioner standards (SEAD 2013, p.41). Based on data from manufacturers the average SEER/EER is 1.13 in the US and in Australia. The other load factors β_L are thus, 1 / 1.13 = 0.88 and 0.75 x 1.13 = 0.85. References: [1] CLASP, 2011, Cooling Benchmark Study Part 2: Benchmarking Component Report. [2] McNeil MA and Letschert V, “Future air conditioning energy consumption in developing countries and what can be done about it: the potential of efficiency in the residential sector”, ECEEE Summer Study Proceedings pp.1311-1322. [3] McNeil MA and Iyer M, 2007, “Techno-economic Analysis of Indian Draft Standard Levels for Room Air Conditioners”, Lawrence Berkeley Laboratory Report 64204

Data / Parameter table 8.

Data / Parameter:	$EER_{90/80,s}$ or $SEER_{90/80,s}$
Data unit:	decimal (Wth/Welec)
Description:	90th or 80th per centile of EER or SEER of baseline air conditioner models sorted from highest to lowest EER or SEER in the reference period

[17] If all SEER temperature bins and their operation hours per year are accurate the load factor is 1.00, however the SEER standards are simplifications with 8, 12 and 15 temperature bins and the EER is measured only at 2 or 4 load points and extrapolated in between (see McNeil et al, 2008, Potential benefits from improved energy efficiency of key electrical products: The case of India, *Energy Policy*, 36: 3467-3476, or, Sachs et at. 2007, Improving Central Air Conditioner Performance Ratings: a Review of SEER, ACEEE Report A071).

Source of data:	(a) Standard & Labelling database; (b) Commercial marketing data; (c) Manufacturers (industry) data (d) efficiency labels on the equipment; (b) Apply stepwise procedures in Appendix 1. Data used shall not be older than three years. Use the most recent data vintage that is at least one-year long
Measurement procedures (if any):	Step1: Sort the air conditioner models in year y from the highest to the lowest EER or SEER. Where sales data of air conditioner mode is available, air conditioner units sold in the reference period are sorted from highest to the lowest EER or SEER; Step2: Identify the 90th and 80th percentile. Refer to Data/Parameter Table 2 and Appendix 2. Data quality requirements apply as per Appendix 2 to apply the 80th percentile value. Only efficiency metrics determined by applying ISO5151(any version) are eligible to use. All national standards are based on ISO5151. For using SEER data, the conversions in Appendix 3 shall be used. To convert EER and SEER from US data in Btu/Wh to SI-units in W/W multiply by 0.2931. Following conversion factors are applicable, where relevant: (1) $EER_{ISO}= EER_{NAFTA} / 1.0096$; (2) $EER_{ISO}= EER_{Korea} / 1.012$; *Source*: Waide P, Rivère P and Watson R, 2011, Cooling Benchmark Study Part 2: Benchmarking Component Report, CLASP, p. 36
Any comment:	-

4.3. Replacement SB (Refrigerator)

4.3.1. Calculation of the replaced refrigerators electricity consumption baseline

30. One of the following approaches shall be applied:

(a) **Approach 1.** When the replaced refrigerators are brought to a recycling facility, sample refrigerators shall be selected and tested following the standard for ‘Sampling and surveys for CDM project activities and programme of activities’ and the ‘Guidelines for sampling and surveys for CDM project activities and programme of activities’ such that a 90/10 precision is achieved for the survey results. IEC standard ‘IEC 62552-1:2015 Household refrigerating appliances - Characteristics and test methods’ or a comparable national standard or the procedures in Appendix 5 shall be applied to test the refrigerators to determine the electricity consumption. The baseline factor for refrigerator replacement is calculated as follows:

$$EC_{rr} = SEC_{Bl,m} \quad \text{Equation (9)}$$

Where:

$SEC_{Bl,m}$ = Average specific electricity consumption of the tested refrigerators in kWh/l/y (as determined under Data/Parameter Table 9)

(b) **Approach 2.** This approach may be applied when the information on brand, model and electricity consumption can be inferred from the nameplate of the replaced refrigerators. When only information on the brand and model is available but not electricity consumption, brands making up for at least 50 percent of the collected refrigerators shall be chosen to determine the design annual electricity consumption. Information on the respective models shall be based on information available from the manufacturers or S&L databases for refrigerators. When nameplate data on electricity consumption is also available for at least 25 percent of the refrigerators, the average specific electricity consumption of these refrigerators shall be used to determine the average specific electricity consumption of all replaced units. When the design electricity consumption of a model is known but refrigerator compartment volumes are not known, an estimated overall volume may be used to establish the specific consumption (kWh/l). See Appendix 4 for steps for collecting/determining data parameters required to establish baseline emissions.

$$EC_{rr} = SEC_{Bl} \quad \text{Equation (10)}$$

Where:

SEC_{Bl} = Average specific electricity consumption of replaced refrigerators in kWh/l/y (as determined under Data/Parameter Table 10)

4.3.2. Data and parameters monitored

Data / Parameter table 9.

Data / Parameter:	$SEC_{Bl,m}$
Data unit:	kWh/l/y
Description:	Annual electricity consumption of the tested replaced refrigerator sample in year *y*
Source of data:	'IEC 62552-1:2015 Household refrigerating appliances - Characteristics and test methods' or a comparable national standard or the procedures in Appendix 5 shall be applied to test the refrigerators to determine the electricity consumption.
Measurement procedures (if any):	See Appendix 5 for test protocol
Any comment:	-

Data / Parameter table 10.

Data / Parameter:	SEC_{Bl}
Data unit:	kWh/l/y
Description:	Average specific annual electricity consumption of the replaced refrigerators

Source of data:	S&L database, commercial marketing data or manufacturers specifications obtained with the model code or from the nameplate.
Measurement procedures (if any):	Only when efficiency metrics are reported according to national test standard or IEC 62552 or equivalent they are eligible to apply. Conversion factors in Appendix 1 Table 2 apply
Any comment:	When the annual electricity consumption can be found on the nameplate or in an S&L database the respective refrigerator volume information is also available so that the ratio between the two can be calculated.

4.4. Refrigerant SB (air-conditioners)

31. Only HFC refrigerants or blends of HFC refrigerants used in the baseline air-conditioners are eligible for considering in the baseline emissions under the refrigerant SB. Refrigerant SB establishes the share of HFC refrigerants or blends in the total share of refrigerants used for baseline air-conditioners. Data on cooling capacity of air-conditioners and respective charge rates of specific refrigerants and their GWP values are then used to arrive at standardised emission factor in terms of tCO_2e/kW.

32. Step 1: Using the (a) Standard & Labelling database; or (b) Commercial marketing data; or (c) Manufacturers (industry) data, determine the quantity of different type of refrigerants and blends used in the reference period (e.g. HCFC-22, HFC-134a, R-410A) and the corresponding total cooling capacity (kW) of the air-conditioners in a market or market segment.

33. Step 2: Calculate the refrigerant charge per kW cooling capacity per air conditioner model i.e. specific refrigerant charge (kg/kW) for each of the refrigerant used.

34. Step 3: Use the equation below to determine the specific refrigerant charge factor (SRCF) in tCO_2e/kW cooling capacity. It is calculated based on the share of HFC refrigerants or blends and applying GWP corresponding to each refrigerant type and applying zero as values for refrigerants other than HCF or blends of HFC refrigerants.

$$SRCF = \frac{\sum_{i,j,} REFi,j \times n_{i,j} \times GWP_{i,EL}}{\sum_j n_j \times P_{cap,j}} \quad \text{Equation (11)}$$

Where:

$SRCF$	=	Specific refrigerant emission of refrigerant *i* per unit cooling capacity of air conditioner model *j* (*tCO_2e/kW*)
$REF_{i,j}$	=	The initial charge of refrigerant *i* in the air conditioner model *j* (kg)
$n_{i,j}$	=	Number of air conditioner models *j* using refrigerant *i*
$P_{cap,j}$	=	Cooling capacity of the air conditioner *j* (kW)
$GWP_{i,EL}$	=	Global warming potential of the refrigerant *i*, eligible refrigerants are HFC and HFC blends, use 0 for HCFC and other non-HFC refrigerants
j	=	All air conditioner models in a market or market segment

Appendix 1. Steps for collecting data and determining parameters for new sales refrigerators

1. A refrigerator market inventory comprises collection of the following parameters (variables) for all refrigerator models sold in a year:

   (a) V - volume of refrigerator;

   (b) Vc - volume per compartment;

   (c) AE - annual electricity consumption;

   (d) REF - chemical used as refrigerant;

   (e) REFc - refrigerant charge volume;

   (f) BA - chemical used as Polyurethane Foam blowing agent;

   (g) Sales (optional) - total number of a refrigerator model sold through all marketing channels.

2. The inventory shall compare and/or combine data obtained from Standards and Labelling (S&L) data, marketing data from commercial provider and industry data from the manufacturers, importers or retailers to comply with the requirements of the approved “Guidelines on quality assurance and quality control of data used in the establishment of standardized baselines” (QA/QC guidelines). While it is not mandatory to apply all the four steps below, compliance with QA/QC guidelines shall be established irrespective of the number of steps applied.

1. Step 1. Extract data from S&L database and/or commercial marketing data

3. Databases of national agencies responsible for S&L include the information on model and energy consumption or energy efficiency class of appliances. Where available mandatory S&L data shall be used. Voluntary S&L data may be used only if mandatory S&L data is not available and where it can be demonstrated that there are systematic efforts to maintain and update the database, i.e. adequate QA/QC procedures are in place for the voluntary database. Parameters to extract from S&L refrigerator databases are:

   (a) MN - number of models in volume classes;

   (b) AEavr,vc - average annual electricity consumption in volume class (kWh/yr);

   (c) SECavr,vc - average specific electricity consumption in volume class (kWh/l);

   (d) Cov - percentage of models without electricity consumption data;

   (e) EEI - energy efficiency class of model (for example A+++ - F, classes 1 – 5, or class K – N).

4. When marketing data from commercial providers (such as The Nielsen Company, IMS Health, TNS, GfK, The Kantar Group, BSRIA or IPSOS[18]) is used, the parameters extracted are:

   (a) MN - number of models offered in the market in year *y*;

   (b) SNvc - number of models sold in volume class;

   (c) Vvc - average volume of models offered in volume class;

   (d) AEavr,vc - average annual electricity consumption in volume class (kWh/yr);

   (e) SECavr,vc - average specific electricity consumption in volume class (kWh/l);

   (f) AESWavr,vc - average sales weighted annual electricity consumption in volume class;

   (g) Cov - percentage of models without electricity consumption data;

   (h) EEI - energy efficiency class of model (A+++ - F, classes 1 – 5, or class 1 - 3);

   (i) SNeei - number of models sold in energy efficiency class.

2. Step 2. Determine the coverage of S&L and commercial marketing data

5. When data is sourced from two sources referred under step 1, variations between the two data sources may arise from the underlying survey methods used in these sources. Extent and type of variation can provide further market insights, for example:

   (a) AEavr,vc - difference are / are not similar in each volume class;

   (b) AESWavr,vc - biases in sales channels covered.

6. Most relevant are differences between AEavr,vc and AESWavr,vc. When these differences are less than 10% they are considered of similar reliability, when these have more than 10% variation, indicators for discarding one of the data sources will be necessary to proceed.

7. When a S&L database contains annual electricity consumption data while commercial marketing database includes energy efficiency class data (EEI), or vice versa, these should be converted with the respective energy efficiency metric and compared.

3. Step 3. Combining S&L and/or commercial marketing data with industry data

8. Information extracted from a S&L database and commercial marketing data shall be verified/confirmed/completed with data requested from manufacturers, importers, wholesalers and retailers (the latter is termed as industry data in this document). High quality and Internet-accessible public databases such as CNIS (China) and high quality (but expensive) commercial marketing data yield statistically equivalent results. The objective for combining these sources is to ascertain the representativeness of either the average specific annual electricity consumption for a volume class and/or the average energy efficiency class for a market segment.

[18] Acronyms are company names; the list is only an illustration.

9. Any variations between S&L and commercial marketing data discovered under the previous steps is the basis for the need for and extent of industry data to be considered in an inventory. Such industry data shall be requested from all manufacturers, all importers and all wholesalers. Where extrapolation of the data to the entire market is undertaken based on the data collected for a segment, the method used for extrapolation shall be transparently described and justified. In the data request made, it shall be documented how all manufacturers, importers and wholesalers are equally approached. Acknowledging commercial confidentiality, the following data request formats may be applied:

    (a) SNvc and SNEEC - total sales for a volume class or energy efficiency class;

    (b) AESWavr,vc - sales weighted annual electricity consumption in volume class.

10. Total sales numbers and sales per volume class obtained from commercial marketing database and obtained from industry shall be compared. This comparison shall be separated for models with electricity consumption data (e.g. in the nameplate or energy efficiency class) from models sold without this data. Such a comparison is important to verify the coverage of a voluntary S&L database.

4. Step 4. Addressing data gaps

11. Under some instances data gaps may persist when using S&L data or Commercial Marketing data. The measures indicated in the following table1. shall be applied to address any potential data gaps that may have arisen to compensate for and fill data gaps.

Table 1. Cross-verification of Data Sources

S&L database	Commercial marketing data	Industry information
Coverage of models may be limited or uncertain	- Add manufacturers missing in S&L database - Add volume classes missing in S&L database - Estimate models in S&L data that are not offered any more in year *y*	- Verify the extent of coverage - Add manufacturers or brands - Remove models not offered any more
Energy consumption data coverage is limited	- Verify if limited coverage affects the average in a volume class - Select a volume class or efficiency range that is better represented in the S&L	- Complete data by using data on models that manufacturer provided - Use total sales per energy efficiency class and EEI to estimate average AE
Volume data available is limited	Verify energy efficiency class	Verify energy efficiency
Refrigerant data missing	Verify brand market shares	- Total sales per refrigerant - Total number of models with refrigerant in volume class - Average charge of refrigerant per volume class

S&L database	Commercial marketing data	Industry information
Blowing agent data not included	- Verify brand market shares average refrigerator volume	- Total sales per blowing agent - Number of models with each blowing agent - Design blowing agent per kg of insulating foam - Volume of insulating foam per model

12. Table 2 Conversion Factors for Refrigerator Test Standards shall be used to apply conversion factors to compare test results that are undertaken following different applicable international standards i.e. ISO 15502, EN 153, IEC 62552, AS/NZS 4474.

Table 2. Conversion Factors for Refrigerator Test Standards[19]

	AS/NZS	ANSI/AHAM	ISO	JISC
AS/NZS		1.0081	0.9046	0.7520
ANSI/AHAM	0.9919		0.8973	0.7460
ISO	1.1055	1.1144		0.8313
JISC	1.3297	1.3405	1.2029	

13. In table 2, the columns represent the numerator while row represents the denominator of the ratio (e.g. for $E_{ISO}/E_{AS/NZS}$= 0.6787).

14. Where only efficiency class information is available and these refer to different efficiency metrics (for instance some refrigerator class information comes from Indian energy star rating and other refrigerator class information from the Brazilian PBE label), the EEI shall use the conversion factors in Table 3 below. Similar conversion factors shall be established for all efficiency metrics that use linear equations for adjusted volume ($V_{equivalent}$), using mid-points across the volume range. These conversion factors shall be used to combine EEI data where different importers can provide EEI information from the S&L data in the countries where the refrigerators are produced.

Table 3. Conversion factors for EEI values between efficiency classes

China Grade 1: EU class A;
China Grade 2: EU class B * 1.08;
China Grade 3: EU class C * 1.11;
China Grade 4: EU class D * 1.21;
China Grade 5: EU class E * 1.24;
India Grade 1: EU class E / 1.1
India Grade 2: EU class D / 1.07
India Grade 3: EU class C / 1.05
India Grade 4: EU class B / 1.02
India Grade 5: EU class A

[19] *Source*: bigEE, 2012, Test procedures, measurements and standards for refrigerators and freezers, Wuppertal Institute, p.7.

Brazil Grade A: EU class A
Brazil Grade B: EU class B / 1.2
Brazil Grade C: EU class C / 1.4
Brazil Grade D: EU class D / 1.6
Brazil Grade E: EU class E / 1.8
Brazil Grade F: EU class F / 2.0

Appendix 2. Baseline options

1. The benchmark level for the baseline is based on availability and quality of data. Where efficiency parameters and sales data for all models in a market, are known, then baseline thresholds can be less stringent as compared to the case where only the model data is available.

2. The baseline thresholds shall be set at least the 80th percentile of units sold in the reference period where the units are sorted from highest to the lowest baseline energy intensity factor ($EC_{90/80,p}$; $SEC_{90/80,q}$; $EEI_{90/80,r}$) under the condition that the data of refrigerator or air conditioner models available is complete including the sales data

   Otherwise, where requirements in paragraph 2 cannot be complied with (e.g. sales data is not available) the baseline threshold shall be set at minimum 90th percentile of models available in the reference period where the units are sorted from the lowest to highest energy efficiency or at the level specified by the mandatory minimum efficiency performance standard (MEPS) whichever is higher.

Appendix 3. Steps for collecting/determining data parameters required to establish baseline emissions (new sales air conditioners)

1. Options to Improve Standardized Baseline Parameters under Data Gaps

1. The necessary Energy Efficiency Ratio (EER) and Seasonal Energy Efficiency Ratio (SEER) coverage shall be ascertained. Different model numbers used in different countries by the same manufacturer (e.g. in a S&L database in China (CNIS) a different model code might exist for a model number that is included with another code in the INMETRO database) shall be addressed with respective information from manufacturers.

2. When one or several of the importers or wholesalers provide average EER for the air conditioners distributed, this average EER in relation to average cooling capacity shall be used to extrapolate for all importers and all wholesalers. In this regard, it is important to consider the market share of importers or wholesalers to check if there are dominant importers or wholesalers with long-term agreement with dominant manufacturers to explore if the manufacturers can provide accurate and representative EER data.

3. The following tables contain conversion factors for the major air conditioner exporter countries so that in all countries, all imported model data can be converted to a common denominator. All SEER data from models sold must be converted to the same SEER standard in order to calculate the average SEER. The highest model share can be the common SEER. While the SEER standards have different temperature profiles, it is not possible to improve the accuracy by using one particular SEER.

Table 1. Conversion of SEER between different SEER standards Fixed Speed AC(1)

To	From	%
Korea	China	99
Japan CSPF	China	104
US SEER non-ducted	China	99
EU SEER non-ducted	China	112
China	Korea	101
Japan CSPF	Korea	105
US SEER non-ducted	Korea	100
EU SEER non-ducted	Korea	113
China	Japan CSPF	96
Korea	Japan CSPF	95
US SEER non-ducted	Japan CSPF	95
EU SEER non-ducted	Japan CSPF	107
Korea	US SEER non-ducted	100
Japan CSPF	US SEER non-ducted	105
China	US SEER non-ducted	101
EU SEER non-ducted	US SEER non-ducted	113

To	From	%
Korea	EU SEER non-ducted	89
Japan CSPF	EU SEER non-ducted	93
US SEER non-ducted	EU SEER non-ducted	89
China	EU SEER non-ducted	90

(1) *Source*: Waide P, Rivière P and Watson R, 2011, Cooling Benchmark Study Part 2: Benchmarking Component Report, CLASP, p.46-47.

Table 2. Conversion of Inverter air conditioner SEER standards(1)

To	From	Slope	
Japan APF	US SEER	0.865	0.733
EU SEER	US SEER	1.080	0.286
China SEER	US SEER	0.998	-0.258
Korea SEER	US SEER	1.014	0.559
US SEER	Japan APF	1.101	-0.521
EU SEER	Japan APF	1.187	-0.265
China SEER	Japan APF	1.102	-0.798
Korea SEER	Japan APF	1.111	0.062
Japan APF	EU SEER	0.799	0.556
US SEER	EU SEER	0.919	-0.216
China SEER	EU SEER	0.910	-0.425
Korea SEER	EU SEER	0.946	0.240
US SEER	China SEER	0.993	0.310
EU SEER	China SEER	1.064	0.668
Japan APF	China SEER	0.861	0.987
Korea SEER	China SEER	0.989	0.969
US SEER	Korea SEER	0.954	-0.338
EU SEER	Korea SEER	1.047	-0.189
Japan APF	Korea SEER	0.822	0.446
China SEER	Korea SEER	0.937	-0.491
Japan CSPF	China SEER	1.032	0.773
China SEER	Japan CSPF	0.926	-0.464
Japan CSPF	US SEER	1.051	0.384
US SEER	Japan CSPF	0.938	-0.273
Japan CSPF	EU SEER	0.975	0.088
EU SEER	Japan CSPF	1.024	-0.081
Japan CSPF	Korea SEER	1.025	-0.119
Korea SEER	Japan CSPF	0.972	0.141

Source: Waide P, Rivière P and Watson R, 2011, Cooling Benchmark Study Part 2: Benchmarking Component Report, CLASP, p.65-66.
(1) 1st column = constant + slope x 2nd column unit.

Appendix 4. Steps for collecting/determining data parameters required to establish baseline emissions (replacement of refrigerators)

1. Step 1. Establish the nameplate data of the replaced refrigerators

1. At all recycling sites, the replaced refrigerators are connected to an electricity supply to ascertain that they are functional, irrespective of the cooling they achieve. The brand and volume of the refrigerator, the refrigerant gas type is documented, and the nameplate model number and annual electricity consumption is recorded where these are visible on the nameplate.

    (a) The refrigerant is removed by means of a vacuum pump that achieves a vacuum of 0.3 bar or less and the refrigerants, Isobutane, HFC-134a and CFC-12 are collected separately for subsequent treatment. CFC-12 can be treated according to national regulation (for example destruction in cement kilns).

2. Step 2. Establish the share of refrigerators with nameplate data

2. Calculate the percentage of:

    (a) Replaced refrigerators with brand;

    (b) Replaced refrigerators with brand but not model information;

    (c) Replaced refrigerators with brand, model information but no electricity consumption data;

    (d) Replaced refrigerators with brand, model code, electricity consumption data and age.

3. A typical outcome can be half or up to 80% of all replaced refrigerators have brand data, less than half with model information and less than a quarter with electricity consumption data. The replacement baseline is applicable irrespective of the level of nameplate data.

Appendix 5. Test Protocol for Used Refrigerators

1. The following description is a simplified version of refrigerator test standards which permits to measure the electricity consumption of used refrigerators with sufficient accuracy for a Replacement Standardized Baseline.

1. Background

2. During the recycling process the old refrigerators taken back will go first through a routine of statistical analysis and testing. The specification here is for a typical round of some 100 refrigerators. The definitive specification will be updated based on these preliminary results. The tests should be reproducible.

2. Room for testing

3. At the recycling plant a room (circa 20m^2, 3m height) will be used for the tests. It should be directly accessible from the transport vehicle in order not to load/unload the refrigerators more than necessary.

4. The room has to be equipped with sufficient electrical outlets to test approximately 5 to 10 refrigerators in parallel and to maintain the necessary testing temperature. The line Voltage should be within ±5% of nominal Voltage.

5. For the subtropical climate class SN Zone, the required reference ambient temperature is 32°C. The room temperature should be measured 1.5 m above ground on a shaded place not directly in contact with external partitions and 2 m away from the test refrigerators.

6. The relative humidity should be between 40% and 75%.

3. Sample

7. From all of the refrigerators taken back a statistical report should be kept.

8. Description of refrigerator:

   (a) Measured external size (length/width/height);

   (b) Number of doors;

   (c) Estimated internal volume (liters): total, internal freezer compartment, separate freezer compartment;

   (d) Technical description (if possible): Brand, year of production, size of compressor, type of refrigerant, defrosting;

   (e) General status of refrigerator: door, seals, internal/external intact/defective.

9. From these refrigerators a typical sample of some 100 refrigerators should be chosen for measuring tests. This sample should represent the major types, sizes, brands.

4. Test

10. In order to achieve a stable and reproducible test result, the test should be run in two phases:

    (a) Start phase (2 hours):

        (i) Check of functionality (compressor starts, cooling works), internal temperature depending on thermostat setting;

        (ii) Goal for normal volume: to reach 5 °C internal temperature (if not possible: set thermostat to max.);

        (iii) Goal for freezer volume: to reach -12°C (internal ** compartment) and - 18°C for separate *** freezer compartment) internal temperature (if not possible: set thermostat to max.);

    (b) Run phase (24 hours).

11. Measure and record electronically or manually:

    (a) Electricity consumption (Wh/24h);

    (b) Peak load during 5 minutes (W);

    (c) Average and max/min voltage (V);

    (d) Average and max/min internal temperature of main volume and separately for freezer compartment (° C);

    (e) Average and max/min ambient temperature (°C).

5. Accuracy

12. The test chamber temperature should be kept within ± 1 K of the nominal testing room temperature. The thermometer should be accurate to ± 0.1 K.

13. The internal refrigerator temperature (main volume) should be kept within ± 5 K of the nominal refrigerator temperature. The average refrigerator temperature in 24 hours should be 5° C ±1 K. The thermometer should be accurate to ± 0.1 K.

14. The internal temperature of the freezer volume should be kept within ± 5 K of the nominal freezer temperature. The thermometer should be accurate to ± 0.1 K.

15. The Watt meter should be accurate to within 0.1 W (range 1 W to 200 W).

16. The Voltage meter should be accurate to within 1 V (range nominal line ± 30%).

6. Results

17. Document (1 page A4) with descriptive results:

    (a) Place, date and time of test;

    (b) Name and signature of responsible testing person;

(c) Description of refrigerator;

(d) Test results.

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