Draft revision of the approved baseline and monitoring methodology AM0071

"Manufacturing and servicing of domestic and/or small commercial refrigeration appliances using a low GWP refrigerant"

I. SOURCE, DEFINITIONS AND APPLICABILITY

Sources

This baseline and monitoring methodology is based on the proposed new methodology:

- NM0247 "Manufacturing and servicing of refrigerators using low GWP refrigerant by M/s Videocon Appliances Ltd." prepared by Winrock International, India, INFRAS - Consulting, Policy Analysis & Research, Switzerland and South Pole Carbon Asset Management Ltd., Switzerland.

This methodology also refers to the latest approved version of the following tool:

- "Combined tool to identify the baseline scenario and demonstrate additionality".

For more information regarding the proposed new methodology and the tool as well as their consideration by the CDM Executive Board (the Board) please refer to <http://cdm.unfccc.int/goto/MPappmeth>.

Selected approach from paragraph 48 of the CDM modalities and procedures

"Existing actual or historical emissions, as applicable"

Definitions

For the purpose of this methodology, the following definitions apply:

Domestic refrigeration appliance. Refers to refrigerators, freezers and combinations thereof, which are typically used by households for food storage. Domestic refrigeration appliances have a size of up to 600 litres of storage volume.

Small commercial refrigeration appliance. Refers to stand-alone refrigerators, freezers and combinations thereof, which are typically used in commercial applications, e.g. in shops or restaurants, for food or beverage storage. Small commercial refrigeration appliances have a size of up to 600 litres of storage volume. Small commercial refrigeration appliances are restricted to appliances that are fully manufactured at the production facility and delivered in the form of a finished product as a stand-alone appliance. Filling with refrigerant takes only place in the production facility. Small commercial refrigeration appliances are further restricted to hermetic systems; semi-hermetic or open type compressors are excluded.

Other commercial refrigeration appliance. Refers to refrigerators, freezers and combinations thereof, which are used in commercial applications (e.g. supermarkets), which are larger than 600 litres or do not meet one of the other criteria laid out above for small commercial refrigeration appliances.

Refrigerator. Is a cooling device for food storage. It comprises a thermally insulated compartment and a mechanism to transfer heat from it to the external environment, cooling the contents to a temperature a few degrees above the freezing point of water.

Freezer. Is a cooling device for food storage. It comprises a thermally insulated compartment and a mechanism to transfer heat from it to the external environment, cooling the contents to a temperature below the freezing point of water.

~~**Commercial refrigeration appliance.** Refers to refrigerators, freezers and combinations thereof, which are used in commercial applications (e.g. supermarkets) but typically not by households.~~

Low GWP refrigerant. Is a refrigerant, which (a) has a Global Warming Potential (GWP) < 50 according to the latest available assessment reports by the IPCC, and (b) is not an ozone depleting substance as classified under the Montreal Protocol on Substances that Deplete the Ozone Layer.

The term **year** within this methodology may correspond to calendar year, fiscal year or business year whichever is more relevant for the data collection by the project participants. Throughout the methodology the same delineation for **year** has to be applied, including any historical reference periods.

Manufacturing. Refers to those activities in the production process of domestic and/or small commercial refrigeration appliances that involve the charge of a refrigerant into an appliance refrigeration system and the handling of a refrigerant (storage, distribution, etc). For example, the final assembly of semi-finished domestic and/or small commercial refrigeration appliances, which includes charging of the refrigerant, is considered as manufacturing for the purpose of this methodology, while the production of components of refrigeration appliances or the import of finished refrigeration appliances are excluded.

Servicing. Refers to the repair of domestic and/or small commercial refrigeration appliances after they have been sold to end-users. It includes only those repair activities that require refilling of the refrigerant in the refrigeration system of the appliance.

Applicability

This methodology is applicable to project activities undertaken by a manufacturer of domestic~~[1]~~ refrigeration appliances or small commercial refrigeration appliances or both domestic and small commercial refrigeration appliances[2] (hereinafter referred to as refrigeration appliances) aiming at reducing GHG emissions by switching from a refrigerant with a higher GWP to a low GWP refrigerant.

The methodology is applicable under the following conditions:

- The manufacturer, involved in the project activity, has been producing refrigeration appliances charged with HFC-134a or another refrigerant with a high GWP for at least three years and has not been using refrigerants with a low GWP prior to the start of the project activity;

~~[1] Project participants wishing to implement project activities involving manufacturing and servicing of commercial refrigeration appliances may request a revision to this approved methodology or propose a new methodology.~~

[2] Project participants wishing to implement project activities involving manufacturing and servicing of commercial refrigeration appliances that do not meet the criteria for small commercial appliances may request a revision to this approved methodology or propose a new methodology.

- Only one low GWP refrigerant is used in manufacturing and servicing of refrigeration appliances during any year of the crediting period of the project activity. This refrigerant allows for the same or a better energy efficiency of a refrigeration appliance than the continued use of the refrigerant that was used prior to the start of the project activity;[3]

- In case of *domestic* refrigeration appliances: The market share of domestic refrigeration appliances, which are produced and sold in the ~~Host~~ host country and charged with low GWP refrigerants, is below 50 per cent at the time of validation of the project activity;

- In case of *small commercial* refrigeration appliances: The market share of small commercial refrigeration appliances, which are produced and sold in the host country and charged with low GWP refrigerants, is below 50 per cent at the time of validation of the project activity;

- The project activity covers only refrigeration appliances that are manufactured (as defined above) by the manufacturer, involved in the project activity, in the ~~Host~~host country. Imported refrigeration appliances shall not be included in the project activity;

- For any refrigeration appliance vintage, the project participants can monitor the servicing records of refrigeration appliances for the first 3 years of their operation. These include the servicing records by the manufacturer and/or service workshops as applicable. The refrigeration appliances covered under the project activity are labelled in such a manner that the vintage, to which the appliance belongs, can be identified during its servicing (e.g. by a special code in serial number of an appliance). If the project participants have no access to the servicing records of refrigeration appliances, no credits can be claimed for reducing emissions from servicing activities;

- The conversion from the baseline to the project refrigerant causes incremental costs for the manufacturer. Incremental costs may relate *inter alia* to the following:
    - Higher purchase cost of the refrigerant and/or appliance components such as compressor, electrical fittings, etc;
    - Safety measures required in the production and servicing setup on the account of different properties of the project refrigerant (e.g. flammability of the refrigerant);
    - Upgrading of the servicing setup, including training needs related to the introduction of the project refrigerant.

- To avoid potential double counting of emission reductions, the DOE performing validation of the project activity shall confirm in the validation report that no other project activity, involving the same refrigerator models as the proposed project activity, has been registered as a CDM project activity, submitted for registration or uploaded for public comments.

In addition, the applicability conditions included in the tool referred to above apply.

[3] This should be demonstrated by showing that the thermodynamic properties of the low GWP refrigerant allow for a higher efficiency of refrigeration appliances compared to the refrigerant that was used prior to the start of the project activity. This should be documented through relevant, preferably peer-reviewed literature.

Finally, this methodology is only applicable if for both domestic as well as for small commercial refrigeration appliances (as applicable) the identified baseline scenario is the continuation of manufacturing of respective refrigeration appliances charged with HFC-134a.

II. BASELINE METHODOLOGY PROCEDURE

Identification of the baseline scenario and demonstration of additionality

Project participants shall apply the latest version of the "Combined tool to identify the baseline scenario and demonstrate additionality" agreed by the Board.

In applying Step 1a, possible alternative baseline scenarios can include, *inter alia*:

- The proposed project activity undertaken without being registered as a CDM project activity;
- Continued manufacturing of refrigeration appliances charged with HFC-134a;
- Switch to a refrigerant different from that used in the project activity;
- Implementation of the project activity at a later point in time (e.g. due to change in relevant regulations, availability of new technologies, financing aspects, etc).

In case of project activities that involve both domestic refrigeration appliances and small commercial refrigeration appliances, alternative baseline scenarios should be identified separately for domestic refrigeration appliances and small commercial refrigeration appliances. Realistic combinations of baseline alternatives for domestic and small commercial refrigeration appliances should then be considered in subsequent steps (e.g. switch for both types of appliances, switch for only one of the two types of appliances, no switch in any of the two types of appliances, etc).

In applying Step 3 of the tool, the following parameters shall be explicitly stated for each alternative:

- Investment requirements (including break-up into major equipment costs, installation, required R&D activities);
- A discount rate appropriate to the country and sector (use government bond rates, increased by a suitable risk premium to reflect the project type, as substantiated by an independent (financial) expert);
- Current price and expected future price of the refrigerant(s) and other materials used, energy and other products. (As a default, the current prices may be assumed as future prices. Where project participants intend to use future prices that are different from current prices, the future prices have to be substantiated by a public and official publication from a governmental body or an intergovernmental institution);
- Operation and maintenance costs of the manufacturing facility.

The information on all the above factors as well as assumptions made for the investment analysis shall be explicitly stated in the CDM-PDD.

Project participants shall demonstrate that the project activity is not a common practice using Step 4 of the tool. ~~Analyze~~ In the case of projects that involve both domestic refrigeration appliances and small commercial refrigeration appliances the assessment should be conducted separately for domestic refrigeration appliances and small commercial refrigeration appliances.

In case of domestic refrigeration appliances, analyze the market of domestic refrigeration appliances in the host country at the time of validation of the project activity.

In case of small commercial refrigeration appliances, analyze the market of small commercial refrigeration appliances in the host country at the time of validation of the project activity.

Include in the analysis only those refrigeration appliances manufactured within the host country. Refrigeration appliances manufactured under registered CDM project activities shall not be included in the analysis. Provide documented evidence and quantitative information on the above analysis in the CDM-PDD.

Project boundary

The **spatial extent** of the project boundary encompasses the manufacturing facility(s), refrigerant distribution systems, service workshops and the area within the host country of the end-user households, to which the refrigeration appliances are sold.

The greenhouse gases included in or excluded from the project boundary are shown in Table 1.

Table 1: Emissions sources included in or excluded from the project boundary

	Source	Gas	Included?	Justification / Explanation
Baseline	Emissions from manufacturing of refrigeration appliances	HFC-134a	Yes	Major emission source
		CO_2	No	Assumed equal to project emissions from this source
	Emissions from servicing of refrigeration appliances	HFC-134a	Yes	Major emission source
		CO_2	No	Assumed equal to project emissions from this source
	Emissions from refrigerant distribution systems used to supply the manufacturer or used for servicing	HFC-134a	Yes	Major emission source
		CO_2	No	Assumed equal to project emissions from this source
Project Activity	Emissions from manufacturing of refrigeration appliances	Low GWP refrigerant	Yes, if this is a GHG	Major emission source
		CO_2	No	Assumed equal to project emissions from this source
	Emissions from servicing of refrigeration appliances	Low GWP refrigerant	Yes, if this is a GHG	Major emission source
		CO_2	No	Assumed equal to baseline emissions from this source
	Emissions from refrigerant distribution systems used to supply the manufacturer or used for servicing	Low GWP refrigerant	Yes, if this is a GHG	Major emission source
		CO_2	No	Assumed equal to baseline emissions from this source

Baseline emissions

The baseline emissions are the total fugitive emissions of HFC-134a from both manufacturing of refrigeration appliances and servicing during their lifetime, including distribution losses in handling the refrigerant.

The baseline emissions are calculated applying the following steps:

Step 1: Establish the number of refrigeration appliances manufactured and an adjustment factor to account for changes in the market share

Establish for a vintage year *v* the number of refrigeration appliances manufactured by the manufacturer, involved in the project activity. Establish the numbers per refrigerator model *i* on year wise basis. Note that this number refers to units of refrigeration appliances resulting from manufacturing activities as defined above. Document for each refrigerator model *i* whether it is a domestic refrigeration appliance or a small commercial refrigeration appliance.

The value for vintage year *v* in the start year of the project activity ($y = 1$) is $v = 1$.

$$PN_{i,v} = PN_{HOSTCOUNTRY,i,v} + PN_{EXPORT,i,v} \tag{1}$$

Where:

$PN_{i,v}$	=	Number of units of refrigeration appliance model *i* manufactured and sold by the manufacturer, involved in the project activity, in vintage year *v*
$PN_{HOSTCOUNTRY,i,v}$	=	Number of units of refrigeration appliance model *i* manufactured and sold by the manufacturer, involved in the project activity, on the market in the host country in vintage year *v*
$PN_{EXPORT,i,v}$	=	Number of units of refrigeration appliance model *i* manufactured and exported by the manufacturer, involved in the project activity, in vintage year *v*
i	=	All refrigeration appliance models produced by the manufacturer, involved in the project activity, in vintage year *v*

The implementation of the project activity may result in a larger market share of the manufacturer in the host country. In this case, the project activity would not only displace refrigeration appliances produced by the manufacturer but could potentially displace other refrigeration appliances in the market. To address this, the level of emission reductions shall be capped taking into account the historical market share of the manufacturer. An adjustment factor to account for changes in the market share ($AF_{MARKETSHARE,v}$) is defined as follows:

$$AF_{MARKETSHARE,v} = \min\left\{\frac{HMS * MN_v}{\sum_i PN_{HOSTCOUNTRY,i,v}};1\right\} \tag{2}$$

Where:

$AF_{MARKETSHARE,v}$	=	Adjustment factor to account for changes in the market share in the host country of refrigeration appliances sold by the manufacturer involved in the project activity for vintage year v
HMS	=	Historic market share of the manufacturer in the host country's market of refrigeration appliances
MN_v	=	Total number of units of refrigeration appliances manufactured and sold in the host country in vintage year v. This number excludes imported refrigeration appliances
$PN_{HOSTCOUNTRY,i,v}$	=	Number of units of refrigeration appliance model i manufactured and sold by the manufacturer, involved in the project activity, on the market in the host country in vintage year v
i	=	All refrigeration appliance models produced by the manufacturer, involved in the project activity, in vintage year v

The historic market share of the manufacturer in the host country's market of refrigeration appliances is calculated as the average market share during the three years preceding the start of the project activity:

$$HMS = \sum_{v=-2}^{0} \frac{\sum_i PN_{HOSTCOUNTRY,i,v}}{MN_v} * \frac{1}{3} \tag{3}$$

Where:

HMS	=	Historic market share of the manufacturer in the host country market of refrigeration appliances
MN_v	=	Total number of units of refrigeration appliances manufactured and sold in the host country in vintage year v. This number excludes imported refrigeration appliances
$PN_{HOSTCOUNTRY,i,v}$	=	Number of units of refrigeration appliance model i manufactured and sold by the manufacturer, involved in the project activity, on the market in the Host country in vintage year v
i	=	All refrigeration appliance models produced by the manufacturer involved in the project activity in vintage year v

Step 2: Determine the total initial charge of HFC-134a

Determine for each vintage year v the total initial charge of baseline refrigerant HFC-134a contained in the fleet of refrigeration appliances using the following equation:

$$TIC_{BL,v} = \sum_i PN_{i,v} * IC_{BL,i} \tag{4}$$

Where:

$TIC_{BL,v}$	=	Total initial charge of the baseline refrigerant that would be contained in the fleet of refrigeration appliances manufactured and sold in a vintage year *v* (kg)
$PN_{i,v}$	=	Number of units of refrigeration appliance model *i* manufactured and sold by the manufacturer, involved in the project activity, in vintage year *v*
$IC_{BL,i}$	=	Initial charge of the baseline refrigerant that would be used in a refrigeration appliance model that would be sold in the baseline scenario in place of the project refrigeration appliance model *i* (kg/unit)
i	=	All refrigeration appliance models produced by the manufacturer, involved in the project activity, in vintage year *v*

The baseline refrigerant initial charge for refrigeration appliance model *i* ($IC_{BL,i}$) is calculated on the basis of the monitored initial charge of refrigerant used under the project activity for refrigeration appliance model *i* ($IC_{PJ,i}$) and typical values for the charge weight ratio between the baseline and the project refrigerants. For example, for the conversion from HFC-134a to HC-600a or HC-600a/HC-290 blend, a charge weight ratio of HC: HFC-134a = 0.45 should apply.[4] $IC_{BL,i}$ is calculated as follows:

$$IC_{BL,i} = \frac{IC_{PJ,i}}{r_{ref,i}} \tag{5}$$

Where:

$IC_{BL,i}$	=	Initial charge of the baseline refrigerant that would be used in a refrigeration appliance model that would be sold in the baseline scenario in place of the project refrigeration appliance model *i* (kg/unit)
$IC_{PJ,i}$	=	Project refrigerant initial charge weight per unit of refrigeration appliance model *i* (kg/unit)
$r_{ref,i}$	=	Ratio of refrigerant charge between the project and baseline refrigerants
i	=	All refrigeration appliance models produced by the manufacturer involved in the project activity in vintage year *v*

Step 3: Calculate baseline emissions from manufacturing

Emissions from manufacturing include the following emissions that occur within the factory premises before the refrigeration appliances leave the factory gate:

- Physical leakage of refrigerant from the refrigerant distribution system of the factory;
- Losses at the refrigerant charging head during the charging process;
- Refrigerant emissions from reject units in production and handling processes.

For simplification, only the emissions from refrigeration appliances that are rejected in the production process leading to refrigerant venting are included in the calculation of the baseline emissions from manufacturing, while emissions from physical leakage of refrigerant from the refrigerant distribution system of the factory and charging head losses are considered negligible as a conservative assumption.

[4] NCCoPP 2004.

Emissions resulting from handling of refrigerant containers used for supplying the refrigerant to the factory set-up are not included in the emissions from manufacturing and are covered under distribution losses emissions.

The baseline emission factor for manufacturing $EF_{BL,MANUFACTURE,v}$ is determined using one of the two following options (a) or (b):

(a) A conservative default value is used:

- In case of domestic refrigeration appliances a default value of $EF_{BL,MANUFACTURE,v} = 0.002$ is used;

- In case of small commercial refrigeration appliances a default value of $EF_{BL,MANUFACTURE,v} = 0.005$ is used.

These values for the emission ~~factor~~ factors for manufacturing is in each case the lower range end of IPCC default values for manufacturing emission factor of domestic or small commercial refrigerators, respectively.[5]

(b) A factory specific emission factor $EF_{BL,MANUFACTURE,v}$ is derived from monitoring of reject units during the manufacturing process. Reject units included in the calculation of the emission factor for manufacturing are those units where the cause for rejecting the refrigeration appliance leads to opening of the refrigerant circuit and venting the refrigerant in taking remedial action.

The factory specific baseline emission factor for manufacturing is determined as follows:

$$EF_{BL,MANUFACTURE,v} = \min\left\{\frac{ML_{BL,v}}{TIC_{BL,v}}; EF_{MANUFACTURE,HISTORIC}\right\} \quad \text{with} \qquad (6)$$

$$ML_{BL,v} = \sum_i RN_{i,v} * IC_{BL,i} \quad \text{and} \qquad (7)$$

$$EF_{MANUFACTURE,HISTORIC} = \sum_{v=-2}^{0} \frac{ML_{BL,v}}{TIC_{BL,v}} * \frac{1}{3} \qquad (8)$$

Where:

$EF_{BL,MANUFACTURE,v}$	=	Baseline emission factor for HFC-134a emissions from manufacturing for vintage year *v*
$EF_{BL,MANUFACTURE,HISTORIC}$	=	Historic emission factor for HFC-134a emissions from manufacturing
$ML_{BL,v}$	=	Total loss of HFC-134a from manufacturing of refrigeration appliances belonging to vintage year *v* (kg)
$RN_{i,v}$	=	Number of reject units of refrigeration appliance model *i* causing the refrigerant venting and recharge and belonging to vintage year *v*

[5] 0.2% … 1.0% for domestic and 0.5% … 3% for stand-alone commercial applications, IPCC 2000, p. 3.106.

$IC_{BL,i}$	=	Initial charge of the baseline refrigerant that would be used in a refrigeration appliance model that would be sold in the baseline scenario in place of the project refrigeration appliance model *i* (kg/unit)
$TIC_{BL,v}$	=	Total initial charge of the baseline refrigerant contained in the fleet of appliances belonging to vintage year *v* (kg)
i	=	All refrigeration appliance models produced by the manufacturer involved in the project activity in vintage year *v*

If Option (b) is used and more than one production site is included in the project activity, then individual baseline emission factors for manufacturing have to be established for each production site. In case of insufficient data for establishing a factory specific emission factor at a particular production site, the default value for emission factor for manufacturing as per Option (a) above can be used for this particular site.

The average baseline emission factor for manufacturing $EF_{BL,MANUFACTURE,v}$ is then determined as weighted average from all production site specific baseline emission factors by using the following equation:

$$EF_{BL,MANUFACTURE,v} = \frac{\sum_s EF_{BL,MANUFACTURE,s,v} * TIC_{BL,s,v}}{\sum_s TIC_{BL,s,v}}$$

$$\mathrm{EF_{BL,MANUFACTURE,v}} = \frac{\sum_s \mathrm{EF_{BL,MANUFACTURE,s,v}} * \mathrm{TIC_{BL,s,v}}}{\sum_s \mathrm{TIC_{BL,s,v}}} \quad \text{with} \tag{9}$$

$$TIC_{BL,s,v} = \sum_i PN_{i,s,v} * IC_{BL,i} \tag{10}$$

Where:

$EF_{BL,MANUFACTURE,s,v}$	=	Baseline emission factor for HFC-134a emissions from manufacturing for the production site *s* in vintage year *v,* calculated using option (a) or (b) above
$TIC_{BL,s,v}$	=	Total initial charge of the baseline refrigerant contained in the fleet of refrigeration appliances produced in the production site *s* and belonging to vintage year *v* (kg)
$PN_{i,s,v}$	=	Number of units of refrigeration appliance model *i* manufactured at the production site *s* and sold by the manufacturer, involved in the project activity, in vintage year *v*
$IC_{BL,i}$	=	Initial charge of the baseline refrigerant that would be used in a refrigeration appliance model that would be sold in the baseline scenario in place of the project refrigeration appliance model *i* (kg/unit)
s	=	All production sites included in the project activity

The baseline emissions from manufacturing activities in year *y* are calculated using the following equation:

$$BE_{MANUFACTURE,y} = \frac{TIC_{BL,v} * EF_{BL,MANUFACTURE,v} * GWP_{HFC134a}}{1000} * \frac{(\sum_i PN_{HOSTCOUNTRY,i,v} * AF_{MARKETSHARE,v} + PN_{EXPORT,CAPPED,v})}{\sum_i PN_{i,v}}$$

with v=y **(11)**

Where:

$BE_{MANUFACTURE,y}$	=	Baseline emissions from manufacturing of refrigeration appliances in year *y* (tCO_2e/yr)
$TIC_{BL,v}$	=	Total initial charge of the baseline refrigerant contained in the fleet of appliances belonging to vintage year *v* (kg)
$EF_{BL,MANUFACTURE,v}$	=	Baseline emission factor for HFC-134a emissions from manufacturing for vintage year *v*
$GWP_{HFC134a}$	=	Global warming potential of the baseline refrigerant HFC-134a ($kgCO_2e$/kg of refrigerant)
$PN_{HOSTCOUNTRY,i,v}$	=	Number of units of refrigeration appliance model *i* manufactured and sold by the manufacturer, involved in the project activity, on the market in the host country in vintage year *v*
$AF_{MARKETSHARE,v}$	=	Adjustment factor to account for changes in the market share in the host country of refrigeration appliances sold by the manufacturer involved in the project activity for vintage year *v*
$PN_{EXPORT,CAPPED,v}$	=	Number of units of refrigeration appliances manufactured and exported by the manufacturer, involved in the project activity, in vintage year *v,* capped by the average historic export number
$PN_{i,v}$	=	Number of units of refrigeration appliance model *i* manufactured and sold by the manufacturer, involved in the project activity, in vintage year *v*

Number of units of refrigeration appliances manufactured and exported by the manufacturer in vintage year *v,* capped by the average historic export number, is determined as follows:

$$PN_{EXPORT,CAPPED,v} = \sum_i PN_{EXPORT,i,v} \quad if \quad \sum_i PN_{EXPORT,i,v} \leq PN_{EXPORT,HISTORIC} \tag{12}$$

$$PN_{EXPORT,CAPPED,v} = PN_{EXPORT,HISTORIC} \quad if \quad \sum_i PN_{EXPORT,i,v} > PN_{EXPORT,HISTORIC} \quad with \tag{13}$$

$$PN_{EXPORT,HISTORIC} = \sum_{v=-2}^{0} \sum_i PN_{EXPORT,i,v} * \frac{1}{3} \tag{14}$$

Where:

$PN_{EXPORT,CAPPED,v}$ = Number of units of refrigeration appliances manufactured and exported by the manufacturer, involved in the project activity, in vintage year *v,* capped by the average historic export number

$PN_{EXPORT,i,v}$ = Number of units of refrigeration appliance model *i* manufactured and exported by the manufacturer, involved in the project activity, in vintage year *v*

$PN_{EXPORT,HISTORIC}$ = Average annual number of units of refrigeration appliance manufactured and exported by the manufacturer, involved in the project activity, during the last three years prior to the start of the project activity

Baseline emissions from manufacturing can only be claimed if the business practice of the manufacturer under the baseline scenario is venting of the refrigerant from reject units, which were rejected on the basis of problems in the refrigeration circuit. Therefore for all production sites included in the project activity the project participants have to submit and make public a written confirmation of the business practice with regard to the refrigerant handling (recovery or venting) in reject units, which was in place for a historic period of three years preceding the start of the project activity implementation. The DOE has to validate the business practice of the manufacturer based on internal process definitions and interviews and, in addition, confirm that the historic business practice of the manufacturer is common practice in the host country on the basis of studies, surveys and/or independent expert judgments.

Step 4: Determine baseline emissions from distribution losses in manufacturing

Potential sources of distribution losses on account of manufacturing activities are:

- Fugitive emissions in unloading activities;
- Fugitive emissions in connecting/disconnecting operations of refrigerant cylinders;
- Fugitive emissions in container cleaning processes at the manufacturing site before returning the containers for refilling;
- Fugitive emissions in the cylinder cleaning and refilling process at the refrigerant filler site.

The emission factor for distribution losses on account of manufacturing activities $EF_{DISTRIBUTION,MANUFACTURE} = 0.02$ is used.

This value for distribution losses on account of manufacturing is the lower end of the range as per IPCC.[6]

The baseline emissions resulting from distribution losses on account of manufacturing activities in year *y* $BE_{DISTRIBUTION, MANUFACTURE, y}$ are calculated as follows:

[6] IPCC 2000, p. 3.106.

$$BE_{DISTRIBUTION,MANUFACTURE,y} = \frac{\left(TIC_{BL,v} + ML_{BL,v}\right) \cdot EF_{DISTRIBUTION,MANUFACTURE} \cdot GWP_{HFC134a}}{1000} \cdot$$

$$\cdot \frac{\left(\sum_i PN_{HOSTCOUNTRY,i,v} \cdot AF_{MARKETSHARE,v} + PN_{EXPORT,CAPPED,v}\right)}{\sum_i PN_{i,v}}$$

with v=y **(15)**

Where:

$BE_{DISTRIBUTION,MANUFACTURE}$	=	Baseline emissions from distribution losses on account of manufacturing activities in year *y* (tCO_2e/yr)
$TIC_{BL,v}$	=	Total initial charge of the baseline refrigerant contained in the fleet of appliances belonging to vintage year *v* (kg)
$ML_{BL,v}$	=	Total loss of the baseline refrigerant in manufacturing of refrigeration appliances belonging to vintage year *v* (kg)
$EF_{DISTRIBUTION,MANUFACTURE}$	=	Emission factor for distribution losses on account of manufacturing activities
$GWP_{HFC134a}$	=	Global warming potential of the baseline refrigerant HFC-134a ($kgCO_2e$/kg of refrigerant)
$PN_{HOSTCOUNTRY,i,v}$	=	Number of units of refrigeration appliance model *i* manufactured and sold by the manufacturer, involved in the project activity, on the market in the host country in vintage year *v*
$AF_{MARKETSHARE,v}$	=	Adjustment factor to account for changes in the market share in the host country of refrigeration appliances sold by the manufacturer involved in the project activity for vintage year *v*
$PN_{EXPORT,CAPPED,v}$	=	Number of units of refrigeration appliances manufactured and exported by the manufacturer, involved in the project activity, in vintage year *v,* capped by the average historic export number
$PN_{i,v}$	=	Number of units of refrigeration appliance model *i* manufactured and sold by the manufacturer, involved in the project activity, in vintage year *v*

The baseline emissions from distribution losses on the account of manufacturing activities shall only be accounted for if the business practice of the manufacturer or his refrigerant supplier was venting of the refrigerant heel during the cleaning and refilling process of the cylinders. The project participants have to submit and make public a written confirmation of the respective business practice, which was applied for a historic period of the three years preceding the start of the project activity. The DOE has to validate the business practice of the manufacturer based on internal process definitions and interviews and, in addition, confirm that the historic business practice of the manufacturer is common practice in the host country on the basis of studies, surveys and/or independent expert judgments.

Step 5: Determine baseline emissions from servicing

The baseline emissions in year *y* from servicing of refrigeration appliances belonging to vintage year *v* are calculated as follows:

$$BE_{SERVICE,v,y} = \frac{\sum_{i} FRR_{i,v,y} * TIC_{BL,v} * EF_{SERVICE} * GWP_{HFC134a} * AF_{MARKETSHARE,v}}{1000} \quad \text{if } v \leq y < (v + \cancel{12}\ t_L) \tag{16}$$

$$BE_{SERVICE,v,y} = 0 \quad \text{if } v > y \text{ or } y \geq (v + \cancel{12}\ t_L) \tag{17}$$

Where:

$BE_{SERVICE,v,y}$	=	Baseline emissions in year *y* from servicing of refrigeration appliances belonging to vintage year *v* (tCO_2e/yr)
$TIC_{BL,v}$	=	Total initial charge of the baseline refrigerant contained in the fleet of appliances belonging to vintage year *v*. Relevant are only finished goods, which are ready for being sold to the market (kg)
$FRR_{i,v,y}$	=	Repair rate, which is the fraction of refrigeration appliances of model *i* belonging to vintage *v* that have been repaired involving a recharge of the refrigerant in year *y*
$EF_{SERVICE}$	=	Emission factor for servicing of refrigeration appliances
$AF_{MARKETSHARE,v}$	=	Adjustment factor to account for changes in the market share in the host country of refrigeration appliances sold by the manufacturer involved in the project activity for vintage year *v*
i	=	All refrigeration appliance models produced by the manufacturer involved in the project activity in vintage year *v*
t_L	=	Lifetime of considered type of refrigeration appliances (years)

~~In equations (16) and (17) it is assumed that the lifetime of domestic refrigeration appliances is 12 years. This value for lifetime is the lower range end of IPCC default values for domestic refrigerators[7] and thus a conservative choice.~~

$FRR_{i,v,y}$ is determined *ex post* on the basis of failure rate of refrigeration appliances produced under the project activity. This approach is appropriate as it can be reasonably assumed that there the type of refrigerant does not significantly influence the rate of failure of the refrigeration appliances.[8]

For the first three years of operation $FRR_{i,v,y}$ is determined from project specific monitored data. For any subsequent year, the minimum annual value of the three year monitoring period is used. $FRR_{i,v,y}$ is determined as follows:

$$FRR_{i,v,y} = \frac{NRA_{i,v,y}}{PN_{i,v}} \quad \text{for } v \leq y \leq v+2 \text{ (i.e. for the first three years of operation)} \tag{18}$$

~~[7] IPCC 2000, p. 3.106.~~

[8] UNEP 2006, p. 51 and McInerney 1999, p. 2.

$FRR_{i,v,y} = \min\left\{FRR_{i,v,y=v}; FRR_{i,v,y=v+1}; FRR_{i,v,y=v+2}\right\}$ for $y > v+2$ (i.e. from 4th year of operation onwards) **(19)**

Where:

$FRR_{i,v,y}$	=	Repair rate, which is the fraction of refrigeration appliances of model *i* belonging to vintage *v* that have been repaired involving a recharge of the refrigerant in year *y*
$NRA_{i,v,y}$	=	Number of repaired refrigeration appliances of model *i* belonging to vintage *v* in year *y* (repair involving the refrigerant recharge)
$PN_{i,v}$	=	Number of units of refrigeration appliance model *i* manufactured and sold by the manufacturer involved in the project activity in vintage year *v*
i	=	All refrigeration appliance models produced by the manufacturer involved in the project activity in vintage year *v*

In $NRA_{i,v,y}$ only those service activities should be included, which require refilling of the refrigerant. As ~~domestic~~ the refrigeration appliances under consideration are hermetic systems, and the refilling of the refrigerant involves evacuation or sweep charge before recharging the refrigerant, the full refrigerant charge quantity as per the name plate needs to be charged in each service case. Therefore no topping up of the refrigerant is possible, which could reduce the refrigerant charge to less than the design refrigerant charge.

An emission factor $EF_{SERVICE}$ of 120% of initial charge is used to account for the additional losses from purging of charging hoses, residual amount remaining in charging hoses when disconnecting from the charging tube of the compressor, sweep charge (resulting in losses of 1 to 3 times the system charge quantity),[9] repeat charge under a repair activity, etc. which can be minimised through good practice but can not be avoided during servicing. The value for $EF_{SERVICE}$ of 120% is based on the assumption that on average additional 20% of the refrigerant are lost.

The baseline emissions from servicing can only be claimed, if the common business practice under the baseline is venting of the refrigerant (and no recovery) during repair activities. The DOE has to validate the business practice of the manufacturer and/or the service workshops for refrigerant handling in service activities based on internal process definitions and interviews and confirm that it is the common practice in the host country on the basis of studies, surveys and/or independent expert judgments.

The baseline emissions from servicing activities in year *y* are calculated as the sum over all vintage years *v* as follows:

$$BE_{SERVICE,y} = \sum_{v} BE_{SERVICE,v,y} \qquad \textbf{(20)}$$

Where:

$BE_{SERVICE,y}$	=	Baseline emissions from servicing of refrigeration appliances in year *y* (tCO_2e/year)
$BE_{SERVICE,v,y}$	=	Baseline emissions in year *y* from servicing of refrigeration appliances belonging to vintage year *v* (tCO_2e/year)

[9] McInerney 1999, p. 3.

Step 6: Determine baseline emissions from distribution losses on account of servicing

Distribution losses in servicing result from fugitive emissions during the refrigerant transfer between different cylinders (e.g. losses during decanting from a large to a small cylinder), from residual heel left in disposable cylinders or from cleaning of used refillable cylinders. The distribution loss emission factor for servicing is applied on the total amount of the refrigerant used for servicing activities, i.e. the refrigerant charged to the appliances and the losses during this process. The emissions on account of distribution losses from servicing are directly proportional to the emissions from servicing.

$$BE_{DISTRIBUTION,SERVICE,y} = BE_{SERVICE,y} * EF_{DISTRIBUTION,SERVICE} * AF_{MARKETSHARE,v} \qquad \textbf{(21)}$$

Where:

$BE_{DISTRIBUTION,\ SERVICE,y}$	=	Baseline emissions from distribution losses on account of servicing activities in year *y* (tCO_2e/year)
$BE_{SERVICE,y}$	=	Baseline emissions from servicing of refrigeration appliances in year *y* (tCO_2e/year)
$EF_{DISTRIBUTION,\ SERVICE}$	=	Emission factor for distribution losses on account of servicing activities
$AF_{MARKETSHARE,v}$	=	Adjustment factor to account for changes in the market share in the host country of refrigeration appliances sold by the manufacturer involved in the project activity for vintage year *v*

A default value for the emission factor for distribution losses on account of servicing activities $EF_{DISTRIBUTION,SERVICE}$ is 2%. This value is at the lower end of the range of the IPCC default values.[10]

Step 7: Determine total baseline emissions

The total baseline emissions in year *y* include the emissions resulting from manufacturing and servicing of refrigeration appliances and related distribution losses. Emissions of the refrigerant from disposal at the end of lifetime of a refrigeration appliance are not accounted for as a conservative approach.

$$BE_{CO2e,y} = BE_{MANUFACTURE,y} + BE_{DISTRIBUTION,MANUFACTURE,y} + BE_{SERVICE,y} + BE_{DISTRIBUTION,SERVICE,y} \qquad \textbf{(22)}$$

Where:

$BE_{CO2e,y}$	=	Total baseline emissions in year *y* (tCO_2e/year)
$BE_{MANUFACTURE,y}$	=	Baseline emissions from manufacturing of refrigeration appliances in year *y* (tCO_2e/year)
$BE_{DISTRIBUTION,\ MANUFACTURE,y}$	=	Baseline emissions from distribution losses on account of manufacturing activities in year *y* (tCO_2e/year)
$BE_{DISTRIBUTION,\ SERVICE,y}$	=	Baseline emissions from distribution losses on account of servicing activities in year *y* (tCO_2e/year)
$BE_{SERVICE,y}$	=	Baseline emissions from servicing of refrigeration appliances in year *y* (tCO_2e/year)

Ex ante estimation of baseline emissions

For an illustrative *ex* ante estimation of the baseline emissions the following guidelines may be used:

[10] IPCC 2000, p. 3.106.

- Assume continued use of the refrigerant used in the past;
- Whenever possible use the most recent historic data (e.g. for the number of units produced, number of reject units, etc.) and assume the continued validity of these data in the future;
- When historic data are not available, use IPCC default values.

Project emissions

Project emissions are determined through the same procedure as used for calculating the baseline emissions. The procedures for calculating project and baseline emissions relate largely to the same physical refrigeration appliance units and only account for the difference in the refrigerant properties between the baseline and the project scenario.

Project emissions are calculated applying the following steps:

Step 1: Establish the number of refrigeration appliances manufactured

For calculation of the project emissions the numbers of refrigeration appliances of model *i* manufactured and sold by the manufacturer, involved in the project activity, in vintage year *v* as established under Step 1 for calculation of the baseline emissions are used. The same delineation for year as for calculation of the baseline emissions has to be applied. The same models *i* considered for calculation of the baseline emissions are to be included for calculation of the project emissions.

The value for vintage year *v* in the project activity start year ($y = 1$) is $v = 1$.

Step 2: Determine the total initial charge of the project refrigerant

Determine for each vintage year *v* the total initial charge of the project refrigerant contained in the fleet of refrigeration appliances using the following equation:

$$TIC_{PJ,v} = \sum_{i} PN_{i,v} * IC_{PJ,i} \quad \textbf{(23)}$$

Where:

$TIC_{PJ,v}$	=	Total initial charge of the project refrigerant that is contained in the fleet of refrigeration appliances manufactured and sold in vintage year *v* (kg)
$PN_{i,v}$	=	Number of units of refrigeration appliance model *i* manufactured and sold by the manufacturer, involved in the project activity, in vintage year *v*. This includes refrigeration appliances both sold on the market in the host country and exported
$IC_{PJ,i}$	=	Project refrigerant initial charge weight per unit of refrigeration appliance model *i* (kg/unit)
i	=	All refrigeration appliance models produced by the manufacturer involved in the project activity in vintage year *v*

Step 3: Calculate project emissions from manufacturing

The project emissions from manufacturing activities in year *y* are calculated using the following equation:

$$PE_{MANUFACTURE,y} = \frac{TIC_{PJ,v} * EF_{PJ,MANUFACTURE,v} * GWP_{PR}}{1000} \quad \text{with } v=y \quad \textbf{(24)}$$

Where:

$PE_{MANUFACTIRE,y}$	=	Project emissions from manufacturing of refrigeration appliances in year *y* (tCO_2e/year)
$TIC_{PJ,v}$	=	Total initial charge of the project refrigerant that is contained in the fleet of refrigeration appliances manufactured and sold in vintage year *v* (kg)
$EF_{PJ,MANUFACTIRE,v}$	=	Project emission factor for manufacturing of refrigeration appliances in vintage year *v*
GWP_{PR}	=	Global warming potential of the project refrigerant ($kgCO_2e$/kg of refrigerant)

The project emission factor for manufacturing of refrigeration appliances is calculated as follows:

$$EF_{PJ,MANUFACTURE,v} = \frac{ML_{PJ,v}}{TIC_{PJ,v}} \quad \text{with} \tag{25}$$

$$ML_{PJ,v} = \sum_i RN_{i,v} * IC_{PJ,i} \tag{26}$$

Where:

$EF_{PJ,MANUFACTIRE,v}$	=	Project emission factor for manufacturing in vintage year *v*
$ML_{PJ,v}$	=	Total loss of the project refrigerant in manufacturing of refrigeration appliances belonging to vintage year *v* (kg)
$RN_{i,v}$	=	Number of reject units of refrigeration appliance model *i* causing the refrigerant venting and recharge and belonging to vintage year *v*
$IC_{PJ,i}$	=	Project refrigerant initial charge weight per unit of refrigeration appliance model *i* (kg/unit)
$TIC_{PJ,v}$	=	Total initial charge of the project refrigerant that is contained in the fleet of refrigeration appliances manufactured and sold in vintage year *v* (kg)
i	=	All refrigeration appliance models produced by the manufacturer involved in the project activity in vintage year *v*

If more than one production site is included in the project activity, then individual project emission factors for manufacturing have to be established for each production site. The average project emission factor for manufacturing $EF_{PJ,MANUFACTIRE,v}$ is then determined as weighted average from all production site specific project emission factors by using the following equation:

$$EF_{PJ,MANUFACTURE,v} = \frac{\sum_s EF_{PJ,MANUFACTURE,s,v} * TIC_{PJ,s,v}}{\sum_s TIC_{PJ,s,v}} \quad \text{with} \tag{27}$$

$$TIC_{PJ,s,v} = \sum_i PN_{i,s,v} * IC_{PJ,i} \tag{28}$$

Where:

$EF_{PJ,MANUFACTIRE,s,v}$	=	Project emission factor for emissions of the project refrigerant from manufacturing for the production site *s* in vintage year *v*
$TIC_{PJ,s,v}$	=	Total initial charge of the project refrigerant contained in the fleet of refrigeration appliances produced in the production site *s* and belonging to vintage year *v* (kg)
$PN_{i,s,v}$	=	Number of units of refrigeration appliance model *i* manufactured at the production site *s* and sold by the manufacturer, involved in the project activity, in vintage year *v*
$IC_{PJ,i}$	=	Initial charge of the project refrigerant used in a refrigeration appliance model *i* (kg/unit)
S	=	All production sites included in the project activity

Step 4: Determine project emissions from distribution losses in manufacturing

The emission factor for distribution losses on account of manufacturing activities $EF_{DISTRIBUTION,\ MANUFCATURE} = 0.02$ is used.

This value for distribution losses on account of manufacturing is the lower end of the range as per IPCC.[11]

The project emissions resulting from distribution losses on account of manufacturing activities in year *y* $PE_{DISTRIBUTION,\ MANUFACTURE,y}$ are calculated as follows:

$$PE_{DISTRIBUTION,MANUFACTURE,y} = \frac{(TIC_{PJ,v} + ML_{PJ,v}) * EF_{DISTRIBUTION,MANUFACTURE} * GWP_{PR}}{1000} \quad \text{with } v = y \tag{29}$$

Where:

$PE_{DISTRIBUTION,\ MANUFACTURE,y}$	=	Project emissions from distribution losses on account of manufacturing activities in year *y* (tCO_2e/year)
$TIC_{PJ,v}$	=	Total initial charge of the project refrigerant contained in the fleet of refrigeration appliances produced in the production site *s* and belonging to vintage year *v* (kg)
$ML_{PJ,v}$	=	Total loss of the project refrigerant in manufacturing of refrigeration appliances belonging to vintage year *v* (kg)
$EF_{DISTRIBUTION,\ MANUFACTURE}$	=	Emission factor for distribution losses on account of manufacturing activities
GWP_{PR}	=	Global warming potential of the project refrigerant ($kgCO_2e$/kg of refrigerant)

Step 5: Determine project emissions from servicing

The project emissions in year *y* from servicing of refrigeration appliances belonging to vintage year *v* are calculated as follows:

[11] IPCC 2000, p. 3.106.

$$PE_{SERVICE,v,y} = \frac{\sum_{i} FRR_{i,v,y} * TIC_{PJ,v} * EF_{SERVICE} * GWP_{PR}}{1000} \quad \text{if } v \leq y < (v + \cancel{12}\ t_L) \tag{30}$$

$$PE_{SERVICE,v,y} = 0 \quad \text{if } v > y \text{ or } y \geq (v + \cancel{12}\ t_L) \tag{31}$$

Where:

$PE_{SERVICE,v,y}$	=	Project emissions in year y from servicing of refrigeration appliances belonging to vintage year v (tCO_2e/year)
$TIC_{PJ,v}$	=	Total initial charge of the project refrigerant contained in the fleet of refrigeration appliances produced in the production site s and belonging to vintage year v (kg)
$FRR_{i,v,y}$	=	Repair rate, which is the fraction of appliances of model i belonging to vintage v that have been repaired involving a recharge of the refrigerant in year y
$EF_{SERVICE}$	=	Average emission factor for servicing of refrigeration appliances
GWP_{PR}	=	Global warming potential of the project refrigerant ($kgCO_2e$/kg of refrigerant)
i	=	All refrigeration appliance models produced by the manufacturer involved in the project activity in vintage year v
t_L	=	Lifetime of considered type of refrigeration appliances

For calculating project emissions from servicing activities the same values for $EF_{SERVICE}$ and $FRR_{i,v,y}$ shall be applied as used for calculating the baseline emissions (see Step 5 under the section on baseline emissions). This takes into account that the emission factor for servicing activities and the rate of failure involving the refrigerant recharge are independent from the type of refrigerant used.[12]

~~In equations (30) and (31) it is assumed that the lifetime of a domestic refrigeration appliance is 12 years. This value for lifetime is the lower range end of IPCC default values for domestic refrigerators.[13]~~

The project emissions from servicing activities in year y are calculated as sum over all vintage years v as follows:

$$PE_{SERVICE,y} = \sum_{v} PE_{SERVICE,v,y} \tag{32}$$

Where:

$PE_{SERVICE,y}$	=	Project emissions from servicing of refrigeration appliances in year y (tCO_2e/year)
$PE_{SERVICE,v,y}$	=	Project emissions in year y from servicing of refrigeration appliances belonging to vintage year v (tCO_2e/year)

Step 6: Determine project emissions from distribution losses on account of servicing

The project emissions on account of distribution losses from servicing are directly proportional to the project emissions from servicing.

$$PE_{DISTRIBUTION,SERVICE,y} = PE_{SERVICE,y} * EF_{DISTRIBUTION,SERVICE} \tag{33}$$

[12] UNEP 2006, p. 51 and McInerney 1999, p. 2.
~~[13] IPCC 2000, p. 3.106.~~

Where:

$PE_{DISTRIBUTION, SERVICE,y}$	=	Project emissions from distribution losses on account of servicing activities in year y (tCO_2e/year)
$PE_{SERVICE,y}$	=	Project emissions from servicing of refrigeration appliances in year y (tCO_2e/year)
$EF_{DISTRIBUTION, SERVICE}$	=	Emission factor for distribution losses on account of servicing activities

The same value for $EF_{DISTRIBUTION, SERVICE}$ as used for calculation of the baseline emissions is applied as the emission factor is not influenced by the type of refrigerant used.

Step 7: Determine total project emissions

The total project emissions in year y include the emissions resulting from manufacturing and servicing of refrigeration appliances and related distribution losses. Emissions of the refrigerant from disposal at the end of lifetime of a refrigeration appliance are not accounted for as a conservative approach.

$$PE_{CO2e,y} = PE_{MANUFACTURE,y} + PE_{DISTRIBUTION,MANUFACTURE,y} + PE_{SERVICE,y} + PE_{DISTRIBUTION,SERVICE,y} \quad \textbf{(34)}$$

Where:

$PE_{CO2e,y}$	=	Total project emissions in year y (tCO_2e/year)
$PE_{MANUFACTURE,y}$	=	Project emissions from manufacturing of refrigeration appliances in year y (tCO_2e/year)
$PE_{DISTRIBUTION, MANUFACTURE,y}$	=	Project emissions from distribution losses on account of manufacturing activities in year y (tCO_2e/year)
$PE_{DISTRIBUTION, SERVICE,y}$	=	Project emissions from distribution losses on account of servicing activities in year y (tCO_2e/year)
$PE_{SERVICE,y}$	=	Project emissions from servicing of refrigeration appliances in year y (tCO_2e/year)

Ex ante estimation of project emissions

For an illustrative *ex ante* estimation of the project emissions the following guidelines may be used:

- Assume a realistic conversion schedule to change production from a high to a low GWP refrigerant and define the type of refrigerant that will most likely be used in the future;
- Whenever possible use the most recent historic data (e.g. for number of units produced, number of reject units, etc.) and assume the continued validity of these data in the future;
- When historic data are not available, use IPCC default values.

Leakage

No leakage is considered under this methodology as no significant source of leakage is identified for this type of project activity.

Emission reductions

Emission reductions are calculated as follows:

$$ER_{CO2e,y} = BE_{CO2e,y} - PE_{CO2e,y} \quad (35)$$

Where:

$ER_{CO2e,y}$	=	Emission reductions in year y (t CO_2e/year)
$BE_{CO2e,y}$	=	Baseline emissions in year y (t CO2e/year)
$PE_{CO2e,y}$	=	Project emissions in year y (t CO_2e/year)

Changes required for methodology implementation in 2nd and 3rd crediting periods

It is required to re-assess the continued validity of the baseline scenario and update non-monitored parameters as relevant at the renewal of the crediting period.

The DOE has to verify that the baseline assumptions for technology and systems used for distribution of the refrigerant in manufacture and servicing of refrigeration appliances and for handling of the refrigerant in servicing (e.g. venting) are still the common practice in the host country. If this is not the case, the latest available IPCC values have to be used for respective emission factors ($EF_{DISTRIBUTION,\ MANUFACTURE}$ and $EF_{SERVICE}$). This is to be verified on the basis of historical records, site visits, independent expert statements or other documented evidence.

A common practice test has to be conducted to verify that manufacturing of domestic and/or small commercial refrigeration appliances using a low GWP refrigerant is not wide spread in the host country.

Data and parameters not monitored

Data / Parameter:	$GWP_{HFC134a}$
Data unit:	kg CO2e/kg of refrigerant
Description:	Global warming potential of the baseline refrigerant HFC-134a
Source of data:	IPCC
Measurement procedures (if any):	-
Any comment:	Applicability conditions restrict to HFC-134a as the baseline refrigerant

Data / Parameter:	$RN_{i,v}$
Data unit:	Absolute number
Description:	Number of reject units of refrigeration appliance model i causing refrigerant venting and recharge and belonging to vintage year v; for v = -2, -1, 0
Source of data:	Historic records on the number of rejected units of model i in vintage year v. The data shall be based on the production records
Measurement procedures (if any):	Historic data for reject units as per ISO 9001 records or computerised data recording & monitoring tools (for example SAP Systems and similar tools) or through a typical production monitoring system
Any comment:	Written confirmation by the project participants to the validator that rejects, which occurred during the manufacturing process, required venting of the refrigerant. Only those reject units are included, where the cause for rejecting the refrigeration appliance leads to opening of the refrigerant circuit in taking remedial action and the refrigerant is not recovered as a common business practice. Document for each model i whether it is a domestic refrigeration appliance or a small commercial refrigeration appliance

Data / Parameter:	$EF_{DISTRIBUTION, MANUFACTURE, y}$
Data unit:	%
Description:	Emission factor for distribution losses on account of manufacturing activities for appliances produced in year *y*
Source of data:	IPCC
Measurement procedures (if any):	
Any comment:	Source of default value: IPCC 2000, p. 3. 106

Data / Parameter:	$EF_{SERVICE}$
Data unit:	%
Description:	Average emission factor in servicing activity
Source of data:	Technical literature
Measurement procedures (if any):	Default value is considered. This includes the refrigerant charge and additional losses from purging of charging hoses, residual amount remaining in charging hoses when disconnecting from the charging tube of the compressor, sweep charge (resulting in losses 1 to 3 times the system charge quantity) (McInerney 1999, p. 3), repeat charge under a repair activity, etc. The value for $EF_{SERVICE}$ of 120% is based on the assumption that on top of the initial charge filled into the refrigeration system on average additional 20% are lost on account of residual volumes in charging hoses, purging of hoses, improper handling, etc.
Any comment:	This default value applies for both the baseline and project scenarios

Data / Parameter:	$EF_{DISTRIBUTION, SERVICE}$
Data unit:	%
Description:	Emission factor for distribution losses on account of servicing activities
Source of data:	IPCC 2000, p. 3.106
Measurement procedures (if any):	-
Any comment:	~~IPCC 2000, p. 3.106.~~ This default value applies to both the baseline and project scenarios

Data / Parameter:	GWP_{PR}
Data unit:	$kgCO_2e$/kg of refrigerant
Description:	Global warming potential of the project refrigerant valid for the applicable commitment period
Source of data:	IPCC/CMP decisions
Measurement procedures (if any):	~~Default value, which is provided by IPCC~~
Any comment:	-

Data / Parameter:	$PN_{HOSTCOUNTRY,i,v}$
Data unit:	Absolute number
Description:	Number of units of refrigeration appliance model *i* manufactured and sold by the manufacturer, involved in the project activity, in vintage year *v;* for *v* = -2, -1, 0
Source of data:	The data shall be based on the production records. Production data must account for 100% of the production volume of the manufacturer, i.e. covering all models and refrigeration appliances sold in the host country
Measurement procedures (if any):	The source for the production data is industry data certified by financial auditors or production data monitoring as per ISO 9001 records, computerised data recording & monitoring tools (for example SAP Systems and similar tools)
Any comment:	Historic data for $PN_{HOSTCOUNTRY,i,v}$ is used for establishing the adjustment factor for market share. For $v \geq 1$ the data are monitored (see monitoring section)

Data / Parameter:	MN_v
Data unit:	Absolute number
Description:	Number of units of refrigeration appliances sold in the host country in vintage year *v*; for v = -2, -1, 0
Source of data:	Historic records on the national market of domestic and small commercial refrigeration appliances. The data shall be based on published information from trade journals, industry association or other reliable source
Measurement procedures (if any):	-
Any comment:	Historic data for MN_v are used for establishing the adjustment factor for market share

Data / Parameter:	$PN_{EXPORT,i,v}$
Data unit:	Absolute number
Description:	Number of units of refrigeration appliance model *i* manufactured and exported by the manufacturer, involved in the project activity, in vintage year *v;* for *v* = -2, -1, 0
Source of data:	The data shall be based on the production records. Production data must account for 100% of the production volume of the manufacturer, i.e. covering all models of refrigeration appliances exported in year *v*
Measurement procedures (if any):	The source for the production data is industry data certified by financial auditors or production data monitoring as per ISO 9001 records, computerised data recording & monitoring tools (for example SAP Systems and similar tools)
Any comment:	Historic data for $PN_{EXPORT,i,v}$ is used for establishing the capping factor $PN_{EXPORT,HISTORIC,v}$. For $v \geq 1$ the data are monitored (see monitoring section)

Data / Parameter:	t_L
Data unit:	years
Description:	Lifetime of considered type of refrigeration appliances
Source of data:	The lower range end of IPCC default values for domestic or small commercial refrigerators, as per IPCC 2000, p. 3.106

Measurement procedures (if any):	• In case of *domestic* refrigeration appliances, a default value of t_L = 12 yr is used; • In case of *small commercial* refrigeration appliances a default value of t_L = 8 yr is used
Any comment:	-

Data / Parameter:	$r_{ref,i}$
Data unit:	Fraction
Description:	Ratio of refrigerant charge between the project and baseline refrigerants
Source of data:	
Measurement procedures (if any):	
Any comment:	For example, for the conversion from HFC-134a to HC-600a or HC-600a/HC-290 blend, a charge weight ratio of HC: HFC-134a = 0.45 should apply[14]

III. MONITORING METHODOLOGY

All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period. One hundred per cent of the data should be monitored if not indicated otherwise in the tables below. All measurements should be conducted with calibrated measurement equipment according to relevant industry standards.

The key variables, which need to be monitored, are the number of units produced for each refrigeration appliance model, the refrigerant charge for each model, the number of refrigeration appliances serviced involving the refrigerant refilling, the amount of refrigerant procured for manufacturing and the amount of refrigerant contained in cylinders at time of shipping for refilling. These data are collected throughout the crediting period, except for the failure rate, which for a particular vintage has to be monitored only for three years from the date of manufacturing.

In addition, a database shall be established to keep track of all the data generated for refrigeration appliances. This can be used to generate the reports that would support the CER claims. The data should contain:

- Units manufactured under each model;
- Refrigerant content for each model;
- Receipt of refrigerant for manufacturing, refrigerant cylinder weight (filled and empty ones), tare weight;
- Reject units in production for each model;
- Service records during the first three years from the date of manufacture for each model.

[14] NCCoPP 2004.

In case the CDM project covers both (i) domestic and (ii) small commercial refrigeration appliances, key parameter have to be determined and documented for each of the appliance types (i) and (ii) separately, as shown below. Each refrigeration appliance model *i* should be clearly attributed either to type (i) or (ii) and documented in the PDD.

Data and parameters monitored

Data / Parameter:	$IC_{PJ,i}$
Data unit:	kg/unit
Description:	Project refrigerant initial charge weight per unit of refrigeration appliance model *i*
Source of data:	Technical design value as printed on appliance label and documented in design documents
Measurement procedures (if any):	The refrigerant initial charge content need to be obtained from the design documents
Monitoring frequency:	As and when a new model enters the market
QA/QC procedures:	Technical design value is verified through measuring the amount of refrigerant charged for each new appliance. Refrigerant initial charge weight need to be cross verified for each model *i*, through representative sampling, by taking physical weight of gas charge, even if the charging is done through fully automatic charging machines.
Any comment:	The baseline initial charge weight $IC_{BL,i}$ is estimated on basis of $IC_{PJ,i}$ by applying a default value for charge weight ratio between the baseline refrigerant and the project refrigerant as per recognised technical literature

Data / Parameter:	$PN_{HOSTCOUNTRY,i,v}$
Data unit:	Absolute number
Description:	Number of units of refrigeration appliance model *i* manufactured and sold on the market in the host country by the manufacturer, involved in the project activity, in vintage year *v*; for $v \geq 1$
Source of data:	Production number of model *i* in vintage year *v*. The data shall be based on production records. Production data must account for 100% of the production volume of the manufacturer, i.e. covering all models and all regions of the host country
Measurement procedures (if any):	The source for the production data is industry data certified by financial auditors or production data monitoring as per ISO 9001 records, computerised data recording & monitoring tools (for example SAP Systems and similar tools)
Monitoring frequency:	Annually
QA/QC procedures:	
Any comment:	

Data / Parameter:	$PN_{EXPORT,i,v}$
Data unit:	Absolute number
Description:	Number of units of refrigeration appliance model *i* manufactured and exported by the manufacturer, involved in the project activity, in vintage year *v*; for v≥1
Source of data:	Production number of model *i* in vintage year *v*. The data shall be based on production records
Measurement procedures (if any):	The source for the production data is industry data certified by financial auditors or production data monitoring as per ISO 9001 records, computerised data recording & monitoring tools (for example SAP Systems and similar tools)
Monitoring frequency:	Annually
QA/QC procedures:	
Any comment:	

Data / Parameter:	$PN_{i,s,v}$
Data unit:	Absolute number
Description:	Number of units of refrigeration appliance model *i* manufactured at the production site *s* and sold by the manufacturer, involved in the project activity, in vintage year *v*; for v≥1. This includes refrigeration appliances both sold in the host country and exported
Source of data:	Production number of model *i* in vintage year *v*. The data shall be based on production records. Production data must account for 100% of the production volume of the manufacturer at the production site *s*
Measurement procedures (if any):	The source for the production data is industry data certified by financial auditors or production data monitoring as per ISO 9001 records, computerised data recording & monitoring tools (for example SAP Systems and similar tools)
Monitoring frequency:	Annually
QA/QC procedures:	
Any comment:	

Data / Parameter:	$RN_{i,v}$
Data unit:	Absolute number
Description:	Number of reject units of refrigeration appliance model *i* causing the refrigerant venting and recharge and belonging to vintage year *v*; for v≥1
Source of data:	The data shall be based on production records
Measurement procedures (if any):	Data monitoring as per ISO 9001 records or computerised data recording & monitoring tools (for example SAP Systems and similar tools) or through typical production monitoring system
Monitoring frequency:	Annually

QA/QC procedures:	
Any comment:	Written confirmation by the project participants to the validator that rejects occurred during the manufacturing process required venting of the refrigerant. Only those reject units are included where the cause for rejecting the appliance leads to opening of the refrigerant circuit in taking remedial action and refrigerant is not recovered as a common business practice

Data / Parameter:	$NRA_{i,v,y}$
Data unit:	Absolute number
Description:	Number of repaired refrigeration appliances of model *i* belonging to vintage *v* in year *y* (repair involving the refrigerant recharge)
Source of data:	Monitored
Measurement procedures (if any):	$NRA_{i,v,y}$ includes repairs involving the refrigerant recharge that have been undertaking in year *y* by i) repair centres run by the manufacturer and ii) service workshops. Each repair centre and each service workshop has to produce verifiable monitoring records of the repair activities including detailed data on at least: • Model type; • Vintage of appliance; • Year of repair; • Information whether refrigerant recharge was involved; • Name and address of customer. Imported appliances have to be clearly identifiable and have to be excluded from $NRA_{i,v,y}$
Monitoring frequency:	First three years of refrigeration appliance lifetime from the date of manufacture
QA/QC procedures:	Consolidated service records of service stations by a centralised system
Any comment:	Maintaining of computerised data or data as per ISO or similar systems for each service station is a complex task hence consolidated service records shall be maintained by a centralised system

Data / Parameter:	MN_v
Data unit:	Absolute number
Description:	Number of units of refrigeration appliances sold in the host country in vintage year *v*; for $v \geq 1$
Source of data:	Monitored
Measurement procedures (if any):	Records on the national market for domestic and small commercial refrigeration appliances. The data shall be based on published data from trade journals, industry association or other reliable source
QA/QC procedures	Only reliable data sources to be used such as trade journals and industry association data
Any comment:	

IV. REFERENCES AND ANY OTHER INFORMATION

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History of the document

Version	Date	Nature of revision(s)
02	EB 53, Annex # 26 March 2010	Revision to expand the applicability of the methodology to “small commercial refrigeration appliances” in addition to “domestic refrigeration appliances”.
01	EB 42, Annex 2 26 September 2008	Initial adoption.
Decision Class: Regulatory **Document Type**: Standard **Business Function**: Methodology		