Proposed VCS Methodology or Methodology Revision

DESTRUCTION OF FLUOROFORM (HFC-23) WASTE GAS STREAMS

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Relationship to Approved or Pending Methodologies

There is no approved VCS methodology covering destruction of HFC-23. The approved baseline and monitoring methodology AM0001 Version 6.0.0 "Decomposition of fluoroform (HFC-23) waste streams" under the CDM program (hereinafter "CDM Methodology AM0001") has repeatedly been criticized for lack of environmental integrity, which has led to the exclusion of CERs from HFC-23 destruction projects in certain emission trading schemes. The exclusion of these projects from emission trading schemes will lead to less HFC-23 destruction and increased, lawful venting of this powerful greenhouse gas. The following methodology has been developed to directly address the criticisms leveled at CDM Methodology AM0001 and is designed as a methodology under which only environmentally and economically-sound HFC-23 destruction projects can qualify.

CDM Methodology AM0001 is limited in its application and does not cover capacity of HCFC-22 production that has not had at least three years of operation before the end of 2004 (called "new" facilities below). Therefore, a new methodology with high environmental integrity is required in order to incentivize destruction of HFC-23 generated from HCFC-22 production facilities excluded under the CDM Methodology AM0001 (e.g. productions facilities that started operation after 2004) and reduce the lawful venting of HFC-23 to the atmosphere.

This proposed methodology implements a standardized approach to the design of an HFC-23 destruction project under the VCS Program. By including stringent eligibility requirements and introducing performance benchmarks, this methodology not only streamlines the determination of additionality and the crediting baseline, but also increases the transparency of how these HFC-23 destruction projects are designed, operated and credited.

Specifically, this methodology:

- Avoids incentives to produce more HCFC-22 than would be produced in the absence of crediting emission reductions, as it caps the amount of HCFC-22 eligible for crediting on an annual basis at the level deemed commercially viable without the generation of emissions credits.
- Establishes an additionality threshold that requires HFC-23 destruction projects to operate with a destruction efficiency of more than 99.99%. This equals a performance benchmark of emissions of 0.0001 tonnes of HFC-23 per produced tonne of HCFC-22 and will ensure that (1) projects use state-of-the-art-destruction technology including storage capacity for HFC-23 for periods where the destruction facility is out of service and (2) virtually all of the potent greenhouse gas is destroyed rather than vented to the atmosphere.
- Rather than rely on CDM Methodology AM0001's controversial use of the waste generation rate on a project-by-project basis, this methodology establishes a crediting baseline defined as the global average emissions of HFC-23 per produced tonne of HCFC-22. The use of the global average emissions factor eliminates any incentive to operate HCFC-22 production plants with a higher waste generation rate than possible under optimal operating conditions because operating with a higher waste generation rate under this methodology would reduce the amount of produced HCFC-22 but would not increase the crediting baseline.

Despite the limitations of CDM Methodology AM0001 this methodology incorporates certain components of CDM Methodology AM0001 where appropriate. The following elements have been adopted and adjusted accordingly from CDM Methodology AM0001:

- Definitions
- Equations (particularly in regard to project emissions)

- Parameters
- Monitoring procedures

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1 SOURCES

- *Midgley P.; Fisher, D. (1993): The production and release to the atmosphere of chlorodifluoromethane (HCFC-22), in:* Atmospheric Environment, 27A*, 14, p. 2215-2223.*
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- *UNFCCC (2012): Approved CDM baseline and monitoring methodology AM0001 - "Decomposition of fluoroform (HFC-23) waste streams", version 6.0.0*
- *UNFCCC (2008): Tool to calculate baseline, project and/or leakage emissions from electricity consumption, version 1*
- *UNFCCC (2008): Tool to calculate project or leakage CO2 emissions from fossil fuel combustion, version 2*
- *UNFCCC/CDM Methodologies Panel (2008): Guidance on addressing uncertainty in the estimation of emissions reductions for CDM project activities, 32nd meeting, Annex 14*

2 SUMMARY DESCRIPTION OF THE METHODOLOGY

Trifluoromethane or fluoroform (HFC-23, CHF_3) is an unavoidable by-product of the production of HCFC-22 (chlorodifluoromethane, $CHClF_2$). HFC-23 is a powerful greenhouse gas with a global warming potential (GWP) of 14,800 for a 100 year period as per the 4th Assessment Report of the IPCC, and is formed at the reactor process of the manufacture of HCFC-22. HCFC-22 is produced in developed and developing countries. The methodology relates to the destruction of HFC-23.

Under the new methodology, the baseline scenario is defined by the global average emission factor of HFC-23 from HCFC-22 production consisting of all HCFC-22 production plants in the world. The project's baseline emissions are calculated using a standardized approach, which uses the global average emission factor as a performance benchmark for the crediting baseline.

The new methodology also uses a performance method to determine additionality by introducing an additionality performance benchmark that establishes a stringent performance level in order to ensure the use of state-of-the-art-destruction technology and achieve almost 100% destruction of HFC-23.

Project emissions include HFC-23 emissions, CO_2 emissions from fossil fuel or electricity consumption for the operation of the HFC-23 decomposition facility and CO_2 emissions from the decomposition of HFC-23 to CO_2. Emission reductions are calculated following the standard procedure as the difference of baseline and project emissions.

Additionality	Performance Method
Crediting Baseline	Performance Method

3 DEFINITIONS

HCFC-22 production plant. A chemical plant which produces chlorodifluoromethane (HCFC-22) either as an independent facility or as a part of an integrated complex. An HCFC-22 production plant may consist of one or several HCFC-22 production lines. The HCFC-22 production plant shall include all HCFC-22 production lines located at the project activity site.

HCFC-22 production line. An HCFC-22 production line includes one or several HCFC-22 reaction units, the subsequent distillation process and storage tank. It is characterized by the feature that HCFC-22 produced in one production line can be distinguished from HCFC-22 produced in other HCFC-22 production lines.

HCFC-22 reaction unit. The HCFC-22 reaction unit comprises the reactor, column and condenser where HCFC-22 is produced through chemical reaction and fluoroform (HFC-23) is formed through over-fluorination of HCFC-22.

Swing plant. A chemical plant which can produce either (a) HCFC-22 or (b) Chlorofluorocarbon-11 (CFC-11) and/or Chlorofluorocarbon-12 (CFC-12).

HFC-23 decomposition facility. A facility, such as an incinerator, which decomposes HFC-23 into CO_2, hydrogen fluoride (HF) and other gases that are neither greenhouse gases nor ozone depleting substances.

Project activity site. The project activity site includes the entire chemical complex where HCFC-22 is produced, including all HCFC-22 production lines located at the complex.

Global average emission factor. Average emissions of HFC-23 from production of HCFC-22 from all HCFC-22 production plants (emitted tonnes of HFC-23 per tonne of produced HCFC-22), regardless their handling of HFC-23. HFC-23 may be therefore (partially) disposed of into an incineration or destruction facility and thereby destroyed (due to a regulation, voluntary action or due to a project activity aiming to achieve emission reductions, etc.) or (partially) released to the atmosphere or (partially) captured and reused in products.

Waste generation rate. The ratio of mass of HFC-23 formed per unit mass of HCFC-22 produced in a HCFC-22 production line or plant.

Emissive application. The use of HCFC-22 for the purpose where HCFC-22 is not transformed in a chemical reaction into another compound. This includes, inter alia, the use of HCFC-22 as refrigerant, propellant or foam blowing agent.

Non-emissive application. The use of HCFC-22 for purposes where HCFC-22 is transformed in a chemical reaction into another compound. This includes, inter alia, the production of polytetrafluoroethylene (PTFE).

Monitoring period m. The period for which a monitoring report is submitted, the verification is performed and for which issuance of VCUs is requested. A monitoring period can be of shorter duration than one year, but all the monitoring periods within a year y of the crediting period should add up to the duration of the year. For example, if a year includes four monitoring periods, the starting date of the first monitoring period should be the same as the starting date of the year y of the crediting period and the end date of the last monitoring period (fourth in this case) should be the end date of the year y of the crediting period. Under this methodology, emission reductions are calculated for each monitoring period m.

Year y of the crediting period. A year y of the crediting period shall be defined on the basis of the calendar year, starting 1st of January and ending 31st of December.

4 APPLICABILITY CONDITIONS

This methodology is applicable to project activities which capture and decompose HFC-23 formed as a by-product in the production of HCFC-22. The HCFC-22 produced may be used for emissive and/or non-emissive applications. The HFC-23 is decomposed in one or several HFC-23 decomposition facilities which are installed at the project activity site. A single HFC-23 decomposition facility may be used for decomposition of HFC-23 from one or several HCFC-22 reaction units or HCFC-22 production lines. All HFC-23, which is formed as a by-product of the HCFC-22 production process, shall be treated in the HFC-23 decomposition facility. In case of malfunction or temporary capacity constraints of the HFC-23 decomposition facility, storage at the production site is allowed.

This methodology is applicable under the following conditions:

- The host country where the project is located, has ratified the Montreal Protocol and complies with the phase-out of HCFC-22 production for emissive uses as agreed under the latest amendments and adjustments of the Montreal Protocol;
- No destruction of HFC-23 was conducted before the start of the project activity, except if such destruction of HFC-23 was carried out as a registered project under the Clean Development Mechanism (CDM) or the Joint Implementation (JI);
- Each HCFC-22 production line included in the project activity has started operation before 01 January 2009[1];
- The HFC-23 decomposition and, if applicable, any temporary storage of HFC-23, occurs only at the project activity site (i.e. no off-site transport occurs);
- No regulation requires the decomposition of the total amount of HFC-23 generated. No VCUs shall be claimed from decomposition that is required anyway by regulations;

[1] The default emission factor under this methodology has been derived based on data including the year 2008. Therefore, the default emission factor can only be deemed appropriate for plants that started operation before 01January2009.

- The average HFC-23 emissions from the project facility in each monitoring period *m* of the crediting period shall be less than 0.0001 tonnes of HFC-23 per tonne of produced HCFC-22[2]. Otherwise no VCUs shall be issued for such a monitoring period.
- In case the capacity of the HFC-23 decomposition facility is not fully used by destruction of HFC-23, the HFC-23 decomposition facility may also be temporarily used for destruction of other compounds such as ozone depleting substances (ODS) as long as such activities can be clearly differentiated from the destruction of HFC-23 and monitored accordingly. Destruction of HFC-23 and other compounds such as ODS shall not happen at the same time.

5 PROJECT BOUNDARY

Source		Gas	Included?	Justification/Explanation
Baseline Scenario	HFC-23 emissions from HCFC-22 production	HFC-23	Yes	Main emission source
Project Activity	Any remaining HFC-23 emissions from HCFC-22 production lines included in the project activity	HFC-23	Yes	May be an important emissions source
	Fossil fuel and electricity consumption for the operation of the HFC-23 decomposition facility(ies)	CO_2	Yes	Small emission source but included as a conservative approach
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small
	Emissions from the decomposition of HFC-23	CO_2	Yes	Minor emission source but included as a conservative approach and as determination of this source does not require monitoring of additional parameters

[2] Emissions of 0.0001 tonnes of HFC-23 per tonne of produced HCFC-22 equals a destruction efficiency of 99.99%.

6 PROCEDURE FOR DETERMINING THE BASELINE SCENARIO

The baseline scenario is defined by the global average emission factor of HFC-23 from HCFC-22 production (emitted tonnes of HFC-23 per tonne of produced HCFC-22) and includes therefore the following scenarios:

S1 HFC-23 is disposed of into an incineration or destruction facility and thereby destroyed (due to a regulation, voluntary action or due to a project activity aiming to achieve emission reductions, etc.)
S2 Atmospheric release of HFC-23 and partial capture and destruction
S3 Atmospheric release of HFC-23 and partial capture and reuse in products
S4 Atmospheric release of HFC-23 without partial capture and destruction

7 PROCEDURE FOR DEMONSTRATING ADDITIONALITY

The project shall follow the Performance Method as described below.

7.1 Performance Method

Step 1: Regulatory Surplus

The project shall not be mandated by any systematically enforced law, statute or other regulatory framework.

Step 2: Performance Benchmark

The additionality performance benchmark in this methodology is defined as follows:
Projects shall be deemed additional if they can demonstrate that the HFC-23 decomposition facility used for the project activity will result in average emissions of less than 0.0001 tonnes of HFC-23 per tonne of produced HCFC-22 on a yearly basis, *i.e*. the resulting HFC-23 emissions are below 0.01%.

8 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

8.1 Baseline Emissions

Baseline emissions include only HFC-23 emissions. Baseline emissions are calculated for all HCFC-22 production which is eligible for crediting, as the minimum between:

(a) The quantity of HFC-23 that is formed in HCFC-22 production line / production plant and can be emitted to the atmosphere in monitoring period *m* according to applicable regulations ($Q_{HFC23,REG,m}$); and
(b) The quantity of HCFC-22 production that is eligible for crediting in monitoring period *m* ($Q_{HCFC22,el,m}$), multiplied by the crediting benchmark for HCFC-22 production ($EF_{BL,HFC23/HCFC22}$).

Accordingly, baseline emissions are calculated as follows

$$BE_m = \sum GWP_{HFC23} \times MIN\left[Q_{HFC23,REG,m}; Q_{HCFC22,el,m} \times EF_{BL,\frac{HFC23}{HCFC22}}\right] \quad \textbf{(1)}$$

Where:

BE_m	=	Baseline emissions in monitoring period *m* (tCO_2e)
GWP_{HFC23}	=	Global Warming Potential of HFC-23 valid for the commitment period ($t\ CO_2e$ / tHFC-23)
$Q_{HFC23,REG,m}$	=	Quantity of HFC-23 that is formed in HCFC-22 production line / plant and that can be emitted to the atmosphere in monitoring period *m* according to applicable regulations (t HFC-23)
$Q_{HCFC22,el,m}$	=	Quantity of HCFC-22 that is produced in HCFC-22 production line / plant and that is eligible for crediting in monitoring period *m* (t HCFC-22)
$EF_{BL,HFC23/HCFC22}$	=	Crediting benchmark for HFC-23 emissions from HCFC-22 production t HFC-23 / t HCFC-22)
m	=	Monitoring period *m*

The quantity of HCFC-22 production that is eligible for crediting ($Q_{HCFC22,el,m}$) as well as the crediting benchmark ($EF_{BL,HFC23/HCFC22}$), are determined in a conservative manner in order to avoid incentives that:

(a) More HCFC-22 is produced under the project activity than would be produced in the absence of the project activity; and/or

(b) The plant is operated under the project activity at a higher HFC-23/HCFC-22 ratio than in the absence of the project activity.

In the following steps, the required parameters are determined. Step 1 determines the quantity of HCFC-22 that is eligible in monitoring period *m* ($Q_{HCFC22,el,m}$). Step 2 specifies the crediting benchmark ($EF_{BL,HFC23/HCFC22}$).

Step 1: Determination of $Q_{HCFC22,el,m}$

The quantity of HCFC-22 production that is eligible for crediting in monitoring period *m* ($Q_{HCFC22,el,m}$) is determined for the production plant as follows:

In order to avoid incentives to produce more HCFC-22 than would be produced in the absence of crediting emission reductions, the amount of HCFC-22 eligible for crediting is capped on an annual basis at the level deemed commercially viable without the generation of emissions credits ($Q_{HCFC22,comm,y}$).

Accordingly, $Q_{HCFC22,el,m}$ is determined as follows:

$$Q_{HCFC22,el,m} = MIN\left[\sum_m Q_{HCFC22,k,m}\ ; Q_{HCFC22,comm,m}\right] \quad \textbf{(2)}$$

Where:

$Q_{HCFC22,el,m}$	=	Quantity of HCFC-22 that is produced in HCFC-22 production plant and

		that is eligible for crediting in monitoring period *m* (t HCFC-22)
$Q_{HCFC22,k,m}$	=	Amount of HCFC-22 produced in HCFC-22 production line *k* in monitoring period *m* (t HCFC-22)
$Q_{HCFC22,comm,m}$	=	HCFC-22 production commercially viable without emissions credits in monitoring period *m* (t HCFC-22)
k	=	HCFC-22 production lines at the project activity site that are eligible for crediting in monitoring period *m*
m	=	Monitoring period within year *y* of the crediting period for which issuance is requested

The commercially viable HCFC-22 equivalent production level ($Q_{HCFC22,comm,m}$) includes only HCFC-22 production. Production of CFC-11 and CFC-12 or any other compounds shall not be taken into account under this methodology.

$Q_{HCFC22,comm,m}$ shall be determined based on the yearly value ($Q_{HCFC22,comm,y}$) by converting to the duration of the monitoring period *m* as follows:

$$Q_{HCFC22,comm,m} = \frac{d_m}{365} \times Q_{HCFC22,comm,y} \quad \textbf{(3)}$$

Where:

$Q_{HCFC22,comm,m}$	=	Quantity of HCFC-22 that is produced and eligible for crediting in monitoring period *m* (t HCFC-22)
$Q_{HCFC22,comm,y}$	=	Quantity of HCFC-22 that is produced and eligible for crediting in the year *y* of the crediting period (t HCFC-22)
d_m	=	Days of the monitoring period *m*
y	=	Year of the crediting period

$Q_{HCFC22,comm,y}$ shall be determined as follows:

$$Q_{HCFC22,comm,y} = Q_{HCFC22,BL} \times AF_y + Q_{HCFC22,contracted,BL,y} \quad \textbf{(4)}$$

Where:

$Q_{HCFC22,comm,y}$	=	Annual HCFC-22 production commercially viable without emissions credits(t HCFC-22)
$Q_{HCFC22,BL}$	=	Eligible HCFC-22 production level in the HCFC-22 production plant before the start of the project activity (t HCFC-22)
$Q_{HCFC22,contracted,BL,y}$	=	Eligible future HCFC-22 production in year *y* of the crediting period as per supply contracts available before the start of the project activity (t HCFC-22)[3]
AF_y	=	Adjustment factor applicable to year *y* of the crediting period

With:

[3] Any future production that is not included in the historical production but already confirmed by a supply contract which has been signed at least 6 months before the start of the project activity shall be eligible.

$$AF_y = (1 + GR_{BL})^y \quad \textbf{(5)}$$

Where:

GR_{BL}	=	Annual growth rate of global HCFC-22 production before the start of the project in percent..

$Q_{HCFC22,BL}$ and GR_{BL} shall be determined at validation for each year of the crediting period based on most recent available data taking into account the following principles:

1. The determination shall be based on most recent data available before the start of the project implementation. Preferably data for HCFC-22 production shall be used. Alternatively, data of HCFC-22 consumption can be used if sufficient data on production is not available.
2. The determination of $Q_{HCFC22,BL}$ shall be based on company specific data such as sales records and operations diary.
3. The determination of GR_{BL} shall be based on publicly available data.
4. In order to calculate $Q_{HCFC22,k,BL}$ and GR_{BL}, all available data of the 5 most recent calendar years prior to the start of the project activity shall be used for the calculation.
5. At least data for 3 years of this five-year period shall be available and applied for the calculation.
6. $Q_{HCFC22,BL}$ shall be determined as the average annual HCFC-22 production before the start of the project activity based on all available data as described above. In addition, any future production that is not included in the historical production but already confirmed by a supply contract which has been signed at least 6 months before the start of the project activity shall be eligible for the determination of $Q_{HCFC22,comm,y}$ as per Equation 4 above.[4]
7. GR_{BL} shall be determined as the average annual growth rate of the global HCFC-22 production based on all available data as described above.

Step 3: Determination of $EF_{BL,HFC23/HCFC22}$

The crediting benchmark for HCFC-22 production in year *y* ($EF_{BL,HFC23/HCFC22}$) is determined, as a conservative approach, as the global average emission factor including the scenarios as described in Chapter 6. However, for reasons of conservativeness, for each year of the crediting period, the following default value shall be applied:

$$EF_{BL,HFC23/HCFC22} = 0.01 \text{ t HFC-23 / t HCFC-22} \quad \textbf{(6)}$$

$\boldsymbol{EF_{BL,HFC23/HCFC22}}$ represents the global average emission factor that has been determined based on most recent available data based on Miller et al. (2010) as the lowest of the yearly global emission factors of the years 2004 to 2008 and applying an uncertainty factor of 0.943. This calculation would result in a value of 0.0119 t HFC-23 / t HCFC-22. However, for reasons of conservativeness, the default value as per Equation 6 above shall be applied[5]. This value remains fixed for all years of the crediting period.

[4] Such supply contracts shall be made available to the VVB during validation.
[5] This factor is also consistent with CDM methodology AM 0001, v. 6.0.0.

8.2 Project Emissions

Under this methodology, project emissions are calculated for each monitoring period *m*. Project emissions include HFC-23 emissions, CO_2 emissions from fossil fuel consumption for the operation of the HFC-23 decomposition facility and CO_2 emissions from the decomposition of HFC-23 to CO_2. Project emissions in monitoring period *m* (PE_m) are calculated as follows:

$$PE_m = PE_{HFC23,m} + PE_{CO2,FF,m} + PE_{CO2,EL,m} + PE_{CO2/HFC23,m} \quad \textbf{(7)}$$

Where:

PE_m	=	Project emissions in monitoring period *m* (t CO_2e)
$PE_{HFC23,m}$	=	Project emissions of HFC-23 in monitoring period *m* (t CO_2e)
$PE_{CO2,FF,m}$	=	Project emissions of CO_2 from fossil fuel consumption for the operation of the HFC-23 decomposition facility in monitoring period *m* (t CO_2)
$PE_{CO2,EL,m}$	=	Project emissions of CO_2 from electricity consumption for the operation of the HFC-23 decomposition facility in monitoring period *m* (t CO_2)
$PE_{CO2/HFC23,m}$	=	Project emissions of CO_2 from decomposition of HFC-23 in monitoring period *m* (t CO_2)

The four emission sources are determined in the following three steps.

Step 1: Determination of $PE_{HFC23,m}$

Project emissions of HFC-23 in monitoring period *m* ($PE_{HFC23,m}$) include any HFC-23 emissions from all HCFC-22 production lines that are eligible for crediting as per the procedure in step 1 under "Baseline Emissions" above. This includes emissions due to incomplete decomposition of HFC-23 in the HFC-23 decomposition facility, the direct venting of HFC-23 (e.g. through a by-pass to the HFC-23 decomposition facility) and fugitive emissions from storage and other devices connected to the HCFC-22 production lines that are eligible for crediting. Project emissions are not directly measured but are determined based on a HFC-23 mass balance, as the difference between the amount of HFC-23 generated in HCFC-22 production lines that are eligible for crediting ($\sum Q_{HFC23,gen,k,m}$) and the amount of HFC-23 generated as a by-product in these HCFC-22 production lines and decomposed in the HFC-23 decomposition facility(ies) ($Q_{HFC23,dec,m}$), as follows:

$$PE_{HFC23,m} = \left(\sum_k Q_{HFC23gen,k,m} - Q_{HFC23,dec,m} \right) \times GWP_{HFC23} \quad \textbf{(8)}$$

with

$$Q_{HFC23,dec,m} = \sum_d \left(Q_{HFC23,dec,d,inlet,m} - Q_{HFC23,dec,d,outlet,m} \right) \quad \textbf{(9)}$$

Where:

$PE_{HFC23,m}$	=	Project emissions of HFC-23 in monitoring period *m* (t CO_2e)

GWP_{HFC23}	=	Global Warming Potential of HFC-23 valid for the commitment period (t CO_2e / t HFC-23)
$Q_{HFC23,gen,k,m}$	=	Quantity of HFC-23 generated as a by-product in HCFC-22 production line *k* in monitoring period *m* (t HFC-23)
$Q_{HFC23,dec,m}$	=	Quantity of HFC-23 that is generated as a by-product in HCFC-22 production lines that are eligible for crediting and that is decomposed in the HFC-23 decomposition facility(ies) in monitoring period *m* (t HFC-23)
$Q_{HFC23,dec,d,inlet,m}$	=	Quantity of HFC-23 that is generated as a by-product in HCFC-22 production lines that are eligible for crediting and that is supplied to the inlet of the HFC-23 decomposition facility *d* in monitoring period *m* (t HFC-23)
$Q_{HFC23,dec,d,outlet,m}$	=	Quantity of HFC-23 emitted at the outlet of the HFC-23 decomposition facility *d* due to incomplete decomposition of HFC-23 in monitoring period *m* (t HFC-23)
k	=	HCFC-22 production lines at the project activity site that are eligible for crediting in monitoring period *m*
d	=	HFC-23 decomposition facility(ies) operated under the project activity

HFC-23 may be also temporarily stored, e.g. during maintenance of the HFC-23 decomposition facility. However, with the approach applied in equation (2) above, any HFC-23 added to the storage stock in monitoring period *m* is accounted as if it would be released to the atmosphere; when it is subsequently destroyed in monitoring period *m*+1 it is accounted as additional HFC-23 destruction and the project emissions are lowered by this amount. Over the two monitoring periods, the calculated project emissions correspond to the actual amount of HFC-23 released to the atmosphere. Note that this approach for accounting purposes may result in negative project emissions in some monitoring periods.

Project emissions are determined and accounted in this way for two reasons:

(1)The approach avoids that emission reductions could be claimed from long-term storage of HFC-23 and potential release of the stored HFC-23 after the end of the crediting period;

(2)The measurement of the quantity of HFC-23 generated and the quantity of HFC-23 decomposed is simpler and easier to verify than measuring all potential project emission sources which may include fugitive emission sources and different by-passes with varying volume flows and concentrations of HFC-23.

An example of the mass balance approach and the accounting of project emissions is provided in Table 3 below. In the example, 30 tonnes of HFC-23 are stored in the first monitoring period. In the second monitoring period, the stored amount is decomposed in the HFC-23 decomposition facility. For this reason, the amount of HFC-23 decomposed is larger than the amount of HFC-23 generated at the facility. In the first monitoring period, the amount of HFC-23 stored is accounted as project emission and therefore, the calculated project emissions (50 tonnes) are 30 tonnes larger than the actual amount released to the atmosphere. However, the second monitoring period accounts for the fact that the stored HFC-23 was decomposed. For this reason, the calculated project emissions are 30 tonnes less than the actual amount released to the atmosphere.

Table 1: Example for a HFC-23 mass balance and accounting of HFC-23 project emissions (metric tonnes of HFC-23)

	A	B	C	D=A-B-C	E=A-B
Monitoring report no	**HFC-23 generated**	**HFC-23 decomposed**	**Addition to HFC-23 storage stock***	**HFC-23 released to the atmosphere**	**Calculated project emissions**
1	200	150	30	20	50
2	200	220	-30	10	-20
Total	**400**	**370**	**0**	**30**	**30**

*Positive values mean that the stock of stored HFC-23 was increased by this amount in monitoring period *m* and negative values mean that the stock of stored HFC-23 was reduced in monitoring period *m* and that the corresponding amount was either decomposed in the HFC-23 decomposition facility or released into the atmosphere.

Step 2: Determination of $PE_{CO2,FF,m}$ and $PE_{CO2,EL,m}$

Project emissions of CO_2 from fossil fuel and electricity consumption for the operation of the HFC-23 decomposition facility(ies) in monitoring period *m* ($PE_{CO2,FF,m}$ and $PE_{CO2,EL,m}$) shall be determined using the latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" and "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".

The parameter $PE_{FC,j,y}$ used in the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" corresponds to the parameter $PE_{CO2,FF,m}$ in this methodology and the element process *j* in the tool corresponds to the consumption of fossil fuels for the operation of the HFC-23 decomposition facility(ies) in monitoring period *m*. The parameter $PE_{EC,y}$ used in the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" corresponds to the parameter $PE_{CO2,EL,m}$ in this methodology and the project electricity consumption source *j* corresponds to the consumption of electricity for the operation of the HFC-23 decomposition facility(ies) in monitoring period *m*.

Step 3: Determination of $PE_{CO2/HFC23,m}$

Project emissions of CO_2 from decomposition of HFC-23 in monitoring period *m* ($PE_{CO2/HFC23,m}$) are determined based on the quantity of HFC-23 decomposed in monitoring period *m* ($Q_{HFC23,dec,m}$) and a conversion factor ($EF_{CO2/HFC23}$) expressing the amount of CO_2 generated per amount of HFC-23 decomposed, as follows:

$$PE_{CO2/HFC23} = Q_{HFC23,dec,m} \times EF_{CO2/HFC23} \quad \textbf{(10)}$$

Where:

$PE_{CO2/HFC23,m}$ = Project emissions of CO_2 from decomposition of HFC-23 in monitoring period *m* (t CO_2)

$Q_{HFC23,dec,m}$ = Quantity of HFC-23 decomposed in the HFC-23 decomposition facility(ies) in monitoring period *m* (t HFC-23)

$EF_{CO2/HFC23}$ = Conversion factor expressing the mass of CO_2 generated per unit mass of HFC-23 decomposed (t CO_2 / t HFC-23)

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8.3 Leakage

No leakage is assumed to occur under this methodology

8.4 Summary of GHG Emission Reduction and/or Removals

The net GHG emissions reductions and/or removals in monitoring period *m* (or in the year *y*) are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \quad \textbf{(11)}$$

Where:

ER_m = Net GHG emissions reductions and/or removals in monitoring period *m*

BE_m = Baseline emissions in monitoring period *m*

PE_m = Project emissions in monitoring period *m*

9 MONITORING

9.1 Data and Parameters Available at Validation

Data / Parameter:	GWP_{HFC23}
Data unit:	t CO_2e / t HFC-23
Description:	Global Warming Potential of HFC-23
Source of data:	IPCC
Justification of choice of data or description of measurement methods and procedures applied:	
Any comment:	A value of 14,800 as been adopted by UNFCCC for periods after the end of 2012 as per the 4th Assessment Report of the IPCC

Data / Parameter:	$EF_{CO2/HFC23}$
Data unit:	t CO_2 / t HFC-23
Description:	Conversion factor expressing the amount of CO_2 generated per amount of HFC-23 decomposed
Source of data:	Molecular weight balance of the chemical process of conversion of HFC-23 into CO_2.
Justification of choice of data or description of measurement methods and procedures applied:	
Any comment:	Value to be applied: 0.62857

Data / parameter:	$EF_{BL,HFC23/HCFC22}$
Data unit:	t HFC-23 / t HCFC-22
Description:	Conservative default value based on the global average emission factor.
Source of data:	Calculated based on Miller et al. (2010) and adjusted as a conservative approach.
Justification of choice of data or description of measurement methods and procedures applied:	
Any comment:	Value to be applied: 0.01 , consistent with CDM methodology AM 0001, v. 6.0.0

Data / parameter:	$Q_{HCFC22,BL}$
Data unit:	t HCFC-22
Description:	Average annual HCFC-22 production before the start of the project activity
Source of data:	Company specific data
Justification of choice of data or description of measurement methods and procedures applied:	
Any comment:	Remains fixed for the crediting period.

Data / parameter:	$Q_{HCFC22,contracted,BL,y}$
Data unit:	t HCFC-22
Description:	Eligible future HCFC-22 production in year *y* of the crediting period as per supply contracts available before the start of the project activity
Source of data:	Company specific data
Justification of choice of data or description of measurement methods and procedures applied:	
Any comment:	Any future production that is not included in the historical production but already confirmed by a supply contract which has been signed at least 6 months before the start of the project activity shall be eligible. Remains fixed for the crediting period.

Data / parameter:	GR_{BL}
Data unit:	%
Description:	Annual growth rate of global HCFC-22 production before the start of the project
Source of data:	Publicly available data
Justification of choice of data or description of measurement methods and procedures applied:	
Any comment:	Remains fixed for the crediting period.

9.2 Data and Parameters Monitored

Data / Parameter:	$Q_{HFC23,gen,k,m}$
Data unit:	t HFC-23
Description:	Quantity of HFC-23 generated as a by-product in HCFC-22 production line *k* in monitoring period *m*
Source of data:	Measurements by project participants

Description of measurement methods and procedures to be applied:	The quantity of HFC-23 generated is a key parameter for the calculation of overall emission reductions. The quantity shall be measured separately for each HCFC-22 production line *k* that is eligible for crediting as per the procedure in step 1 under "Baseline emissions". To measure this quantity accurately, two flow meters shall be used for each HCFC-22 production line. The flow meters shall be installed in a manner which ensures that no HFC-23 from the production process can by-pass the flow meters. Where the flow meter readings differ by greater than twice their claimed accuracy (for example 10% if the accuracy is claimed to be ±5%) then the reason for the discrepancy shall be investigated and the fault remedied. For the sake of conservativeness, for each meter reading *t*, the higher value of the two readings shall be used to estimate $Q_{HFC23,gen,k,m}$: $Q_{HFC23gen,k,m} = \sum_{t} MAX\left(Q_{HFC23gen,k,meter\ 1,t}; Q_{HFC23gen,k,meter\ 2,t}\right)$ The concentration of HFC-23 in the stream shall be measured by sampling using gas chromatography. The average flow rate should be multiplied with the average HFC-23 concentration in the stream to derive the amount of HFC-23 generated
Frequency of monitoring/recording:	Flow measurements: continuously, meter integrated for at least every hour Concentration measurements: at least weekly in constant measurement intervals
QA/QC procedures:	A quality team should be formed to audit these procedures according to relevant national or international standards
Any comment:	The amount of HFC-23 generated shall be reported in monitoring reports for each HCFC-22 production line separately and for each calendar month as well as for the entire monitoring period *m*

Data / Parameter:	$Q_{HFC23,dec,d,inlet,m}$
Data unit:	t HFC-23
Description:	Quantity of HFC-23 that is generated as a by-product in HCFC-22 production lines that are eligible for crediting and that is supplied to the inlet of the HFC-23 decomposition facility(ies) *d* in monitoring period *m*
Source of data:	Measurements by project participants

Description of measurement methods and procedures to be applied:	The quantity shall be measured separately for each HFC-23 decomposition facility *d* at the project activity site. To measure this quantity accurately, two flow meters shall be installed at the inlet of each HFC-23 decomposition facility. The flow meters shall be installed in a manner that they only measure the quantity of HFC-23 that is generated as a by-product in HCFC-22 production lines that are eligible for crediting. Where the flow meter readings differ by greater than twice their claimed accuracy (for example 10% if the accuracy is claimed to be ±5%) then the reason for the discrepancy shall be investigated and the fault remedied. For the sake of conservativeness, for each meter reading *t*, the lower value of the two readings shall be used to estimate $Q_{HFC23,dec,d,inlet,m}$: $Q_{HFC23,dec,d,inlet,m} = \sum_t MIN\left(Q_{HFC23,dec,d,inlet,meter\ 1,t}; Q_{HFC23,dec,d,inlet,meter\ 2,t}\right)$ The concentration of HFC-23 in the stream shall be measured by sampling using gas chromatography. The average flow rate should be multiplied with the average HFC-23 concentration in the stream to derive the amount of HFC-23 supplied to the inlet of the HFC-23 decomposition facility
Frequency of monitoring/recording:	Flow measurements: continuously, meter integrated for at least every hour Concentration measurements: at least weekly in constant measurement intervals
QA/QC procedures:	A quality team should be formed to audit these procedures according to relevant national or international standards
Any comment:	The amount of HFC-23 supplied to the inlet of the HFC-23 decomposition facility shall be reported in monitoring reports for each HFC-23 decomposition facility separately and for each calendar month as well as for the entire monitoring period *m*

Data / Parameter:	$Q_{HFC23,dec,d,outlet,m}$
Data unit:	t HFC-23
Description:	Quantity of HFC-23 emitted at the outlet of the HFC-23 decomposition facility(ies) *d* due to incomplete decomposition of HFC-23 in monitoring period *m*
Source of data:	Measurements by project participants
Description of measurement methods and procedures to be applied:	The quantity shall be measured separately for each HFC-23 decomposition facility *d* at the project activity site The concentration of HFC-23 in the stream shall be measured by sampling using gas chromatography. The average flow rate should be multiplied with the average HFC-23 concentration in the stream to derive the amount of HFC-23 emitted at the outlet of the HFC-23 decomposition facility

Frequency of monitoring/recording:	Flow measurements: continuously, meter integrated for at least every hour Concentration measurements: at least weekly in constant measurement intervals
QA/QC procedures:	A quality team should be formed to audit these procedures according to relevant national or international standards
Any comment:	The amount of HFC-23 emitted at the outlet of the HFC-23 decomposition facility shall be reported in monitoring reports for each HFC-23 decomposition facility separately and for each calendar month as well as for the entire monitoring period *m*

Data / Parameter:	$Q_{HCFC22,k,m}$
Data unit:	t HCFC-22
Description:	Amount of HCFC-22 produced in HCFC-22 production line *k* in monitoring period *m*
Source of data:	Measurements by project participants
Description of measurement methods and procedures to be applied:	-
Frequency of monitoring/recording:	Continuously, aggregated monthly and for the duration of the monitoring period *m*
QA/QC procedures:	Cross-check measured data with sales data
Any comment:	If more than one HCFC-22 production line exists at the project activity site, the production in each HCFC-22 production line shall be separately measured and reported

Data / Parameter:	$Q_{HFC23,REG,k,m}$
Data unit:	t HFC-23
Description:	Quantity of HFC-23 that is formed in HCFC-22 production line *k* and that can be emitted to the atmosphere in monitoring period *m* according to applicable regulations
Source of data:	Relevant regulations
Description of measurement methods and procedures to be applied:	-
Frequency of monitoring/recording:	For each monitoring report
QA/QC procedures:	-
Any comment:	-

9.3 Description of the Monitoring Plan

General monitoring provisions

Describe and specify in the PDD all monitoring procedures, including the type of measurement instrumentation used, the responsibilities for monitoring and QA/QC procedures that will be applied. Where the methodology provides different options (e.g. use of default values or on-site measurements), specify which option will be used. Meters should be installed, maintained and calibrated according to equipment manufacturer instructions and be in line with national standards or, if these are not available, international standards (e.g. IEC, ISO).

In the case of measurements of the flow of streams containing HFC-23, the flow meters shall be calibrated every six months by an officially accredited entity. The zero check on the flow meters shall be conducted at a time interval as required and specified by the manufacturer specification but at a minimum time interval of one month. If the zero check indicates that the flow meter is not stable, an immediate calibration of the flow meter shall be undertaken.

The quantities of gaseous effluents (CO, HCl, HF, Cl_2, dioxin and NO_X) and liquid effluents (PH, COD, BOD, n-H (normal hexane extracts), SS (suspended solid), phenol, and metals (Cu, Zn, Mn and Cr) are measured every six months to ensure compliance with environmental regulations.

All data collected as part of the monitoring should be archived electronically and be kept at least for two years after the end of the last crediting period. 100% of the data should be monitored if not indicated differently in the comments in the tables above.

Establishment of a HFC-23 balance

For each monitoring period *m*, a HFC-23 mass balance shall be established. The mass balance should include all HCFC-22 production lines that are eligible for crediting. The HFC-23 mass balance shall include the following information:

- The stock of HFC-23 stored at the beginning of the monitoring period (measured);
- HFC-23 generated in each HCFC-22 production line *k* in the monitoring period (measured);
- HFC-23 sold to third parties in the monitoring period (measured/recorded);
- HFC-23 added to or taken from the stock of HFC-23 stored in the monitoring period (measured);
- HFC-23 sent to the inlet of each HFC-23 decomposition facility in the monitoring period (measured);
- HFC-23 released to the atmosphere through incomplete decomposition of HFC-23 in each HFC-23 decomposition facility in the monitoring period (measured);
- HFC-23 released to the atmosphere through venting or other sources (calculated based on the remainder of the mass balance);

- The stock of HFC-23 stored at the end of the monitoring period (calculated based on the stock of HFC-23 stored at the beginning of the monitoring period and any additions/subtractions to the stock of HFC-23 stored).

The mass balance shall be conducted for each calendar month as well as for the duration of the monitoring period m and shall be documented transparently in a table in the monitoring report.

10 REFERENCES AND OTHER INFORMATION

A separate document is submitted along with this proposed new methodology to explain the determination of benchmarks (the performance levels) applied under this methodology.

References:

Midgley P.; Fisher, D. (1993): The production and release to the atmosphere of chlorodifluoromethane (HCFC-22), in: Atmospheric Environment, 27A*, 14, p. 2215-2223.*

Miller, B. R., Rigby, M., Kuijpers, L. J. M., Krummel, P. B., Steele, L. P., Leist, M., Fraser, P. J., McCulloch, A., Harth, C., Salameh, P., Mühle, J., Weiss, R. F., Prinn, R. G., Wang, R. H. J., O'Doherty, S., Greally, B. R., and Simmonds, P. G (2010): HFC-23 (CHF3) emission trend response to HCFC-22 (CHClF2) production and recent HFC-23 emission abatement measures, Atmos. Chem. Phys., 10, p. 7875-7890

UNFCCC (2012): Approved CDM baseline and monitoring methodology AM0001 - "Decomposition of fluoroform (HFC-23) waste streams", version 6.0.0

UNFCCC (2008): Tool to calculate baseline, project and/or leakage emissions from electricity consumption, version 1

UNFCCC (2008): Tool to calculate project or leakage CO2 emissions from fossil fuel combustion, version 2

UNFCCC/CDM Methodologies Panel (2008): Guidance on addressing uncertainty in the estimation of emissions reductions for CDM project activities, 32nd meeting, Annex 14

APPENDIX 1: SIMILAR PROJECT METHODS

Program	Methodology Reference Number and Title
CDM	AM0001 Decomposition of fluoroform (HFC-23) waste streams, version 06.0.0