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# Draft Approved baseline methodology AM0001 – rev. 1

## "Incineration of HFC 23 Waste Streams"

### Source

This methodology is based on a proposal from the HFC Decomposition Project in Ulsan, Republic of Korea whose Baseline study, Monitoring and Verification Plan and Project Design Document were prepared by INEOS Fluor Japan Limited (Japan), Foosung Tech Corporation Co., Ltd. (Korea) and UPC Corporation Ltd. (Korea) (version 2.4, July 8, 2003). For more information regarding the proposal and its consideration by the Executive Board please refer to case "NM007: HFC Decomposition Project in Ulsan" on http://cdm.unfccc.int/methodologies/approved.

### Selected approach from paragraph 48 of the CDM modalities and procedures

"Existing actual or historical emissions, as applicable"

### Applicability

This methodology is applicable to HFC 23 ($CHF_3$) waste streams from a HCFC production facility where the project activity occurs and where regulations do not restrict HFC 23 emissions.

### Project Activity

Production of HCFC 22 generates the HFC 23. Some of the HFC 23 may be captured and sold, but the HFC 23 may also be released to the atmosphere. The project activity captures and decomposes the HFC 23 that would otherwise be released to the atmosphere (and any HCFC 22 present in this waste stream)[1].

### Emission Reduction

Waste HFC 23 is typically released into the atmosphere. Thus, absent regulations to restrict HFC 23 emissions, any HFC 23 not recovered for sale is assumed to be released to the atmosphere.

The greenhouse gas emission reduction achieved by the project activity is the quantity of waste HFC 23 actually destroyed less the greenhouse gas emissions generated by the

[1] In the example of the Ulsan project activity proposal the destruction process will decompose the HFC 23 by heating it to more than 1,200°C in a thermal oxidation chamber with air and steam using LNG as a supplemental fuel. This yields CO2, HCl and HF as by-products in a hot stream of offgas that also contains nitrogen, oxygen, carbon dioxide and moisture. This gas stream is cooled, the acids and moisture are absorbed in an aqueous solution and the acids in the solution are then neutralized with slaked lime to yield calcium chloride (CaCl2) and calcium fluoride (CaF2). The CaCl2 and CaF2 are disposed in a landfill. The remaining cooled and neutralised gas (now nitrogen/oxygen/carbon dioxide with low levels of moisture) is vented to atmosphere.

destruction process less leakage due to the destruction process. Specifically, the greenhouse gas emission reduction ($ER_y$) achieved by the project activity during a given year (y) is equal to the quantity of HFC 23 waste from HCFC production facility ($Q\_HFC23_y$) destroyed by the project activity less the baseline HFC 23 destruction ($B\_HFC23_y$) during that year multiplied by the approved Global Warming Potential[2] value for HFC23 (GWP_HFC23) less the greenhouse gas emissions generated by the destruction process ($E\_DP_y$) less greenhouse gas leakage ($L_y$) due to the destruction process.

$$ER_y = (Q\_HFC23_y - B\_HFC23_y) * GWP\_HFC23 - E\_DP_y - L_y$$

Where $ER_y$ is the greenhouse gas emission reduction measured in tonnes of $CO_2$ equivalents (tonnes $CO_2e$), $Q\_HFC23_y$ is the quantity of waste HFC 23 destroyed during the year measured metric tonnes, and $B\_HFC23_y$ is the baseline quantity of HFC 23 destroyed during the year measured in metric tonnes. The Global Warming Potential converts 1 tonne of HFC 23 to tonnes of $CO_2$ equivalents (tonnes $CO_2e$/tonnes HFC 23). The approved Global Warming Potential value for HFC 23 is 11,700 tonnes $CO_2e$/tonne HFC 23. The emissions due to the destruction process ($E\_DP_y$) and leakage ($L_y$) are both measured in tonnes of $CO_2$ equivalent. The quantity of waste HFC 23 destroyed ($Q\_HFC23_y$) is calculated as the product of the quantity of waste HFC 23 supplied to the destruction process ($q\_HFC23_y$) measured in metric tonnes and the purity of the waste HFC 23 ($P\_HFC23_y$) supplied to the destruction process expressed as the fraction of HFC 23 in the waste [$Q\_HFC23_y = q\_HFC23_y * P\_HFC23_y$].

The destruction process uses fuel (e.g., natural gas), steam and/or electricity. The steam and electricity are assumed to be purchased, so the emissions associated with these energy sources are included in the leakage calculation.[3] The emissions due to the destruction process ($E\_DP_y$) are the emissions due to the natural gas use, the emissions of HFC 23 not destroyed and the greenhouse gas emissions of the destruction process. Thus:

$$E\_DP_y = ~~F\_ND_y * Q\_HFC23_y~~ ND\_HFC23_y * GWP\_HFC23 + Q\_NG_y * E\_NG_y + Q\_HFC23_y * EF$$

Where ~~F_ND_y_HFC23_y~~ $ND\_HFC23_y$ is the ~~fraction~~ quantity of HFC 23 not destroyed during the year, $Q\_NG_y$ is the quantity of natural gas used by the destruction process during the year measured in cubic-metres ($m^3$), and $E\_NG_y$ is the emissions coefficient for natural gas combustion measured in tonnes $CO_2$ equivalent per cubic metre of natural gas (t $CO_2e/m^3$). The value of $E\_NG_y$ will vary by region and over time[4], but is of the order of 0.00188 $tCO_2e/m^3$. If a different fuel, such as liquid petroleum gas (LPG), is used for the incineration

[2] Global Warming Potential values used shall be those provided by the Intergovernmental Panel on Climate Change in its Second Assessment Report ("1995 IPCC GWP values").
[3] If the steam and/or electricity was generated within the project boundary, the associated emissions would be included in the equation for the emissions due to the destruction process.
[4] In the example of the proposed Ulsan project activity it is of the order of 0.00188 $tCO_2e/m^3$.

process, the variables $Q\_NG_y$ and $E\_NG_y$ are replaced with variables for the quantity of fuel used and emissions coefficient for that fuel.

The ~~fraction~~ quantity of HFC 23 not destroyed (~~$F\_ND_y\_HFC23_y$~~ $ND\_HFC23_y$) is typically small[5]; the monitoring plan provides for its periodic on site measurement. Theoretically HFC 23 can also leak to the water effluent and then escape to the atmosphere. This possibility is ignored because it is infinitesimally small; the solubility of HFC 23 is 0.1% wt at 25$^o$C water.

The thermal destruction process converts the carbon in the HFC 23 into $CO_2$, which is released to the atmosphere. The quantity of $CO_2$ produced by the destruction process is the product of the quantity of waste HFC 23 ($Q\_HFC23_y$) destroyed and the emission factor (EF). The emission factor is calculated as follows:

EF = 44/[(molecular weight of HFC 23)/(number of C in a molecule of HFC 23)] = 44/[70/1] = 0.62857

The thermal destruction process also produces a small quantity of $N_2O$ emissions. The $N_2O$ emissions, on a $CO_2$ equivalent basis, are a small fraction of the $CO_2$e emissions and so are ignored.

**Baseline**

The baseline quantity of HFC 23 destroyed is the quantity of the HFC 23 waste stream required to be destroyed by the applicable regulations. If the entire waste stream is destroyed, $Q\_HFC23_y$ is the total amount of HFC 23 waste generated and the quantity required to be destroyed by the applicable regulations is:

$$B\_HFC23_y = Q\_HFC23_y * r_y$$

Where $r_y$ is the fraction of the waste stream required to be destroyed by the regulations that apply during year y. In the absence of regulations requiring the destruction of HFC 23 waste, the typical situation in non-Annex B Parties, $r_y = 0$. Absent regulations on HFC 23 emissions, the HFC 23 waste is typically released to the atmosphere so the baseline is zero destruction.

To exclude the possibility of manipulating the production process to increase the quantity of waste, the quantity of HFC 23 waste ($Q\_HFC23_y$) is limited to a fraction (w) of the actual HCFC production during the year at the originating plant ($Q\_HCFC_y$).

$$Q\_HFC23_y \leq Q\_HCFC_y * w$$

Where $Q\_HCFC_y$ is the actual production of HCFCs during the year at the plant where the HFC 23 waste originates measured in metric tonnes. The coefficient w is the waste

[5] In the example of the proposed Ulsan project activity the quantity of HFC 23 not destroyed is estimated at 0.001% of the quantity of HFC 23 supplied to the destruction process.

generation rate (HFC 23[6])/(HCFC 22) for the originating plant. The value of w is set at the lowest actual value during the three years prior to the start of HFC 23 destruction to a maximum of the IPCC default value of 4% (0.04 tonnes of HFC 23 produced per tonne of HCFC 22 manufactured). If the waste originates at a new plant or no historical data are available, the lowest IPCC default value of HFC 23 produced per tonne of HCFC 22 manufactured shall be used.

**Additionality**

In the absence of regulations requiring HFC 23 destruction it is typically released to the atmosphere because a destruction facility entails significant capital and operating costs and the host entity has no direct economic incentive to incur these costs. If the quantity of HFC 23 destroyed is greater than the baseline quantity destroyed, the project activity is additional. The baseline quantity of HFC 23 destroyed is the quantity, if any, required to be destroyed by the host country's regulations governing the plant.

**Leakage**

Leakage is emissions of greenhouse gases due to the project activity that occur outside the project boundary. The sources of leakage due to the destruction process are:

- Greenhouse gas ($CO_2$ and $N_2O$) emissions associated with the production of purchased energy (steam and/or electricity)
- $CO_2$ emissions due to transport of sludge to the landfill

$$L_y = \sum_i (Q\_F_{i,y} * E\_F_{i,y}) + ET_y$$

Where $Q\_F_{i,y}$ is the quantity of energy type $F_i$ purchased for the destruction process during year y, $E\_F_{i,y}$ is the greenhouse gas emissions factor for energy type $F_i$ during year y, and $ET_y$ and the greenhouse gas emissions associated with sludge transport during year y.

[6] The quantity of HFC 23 used to calculate this coefficient is the sum of HFC 23 recovered for sale plus the waste HFC 23.

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**Draft Approved monitoring methodology AM0001 - rev. 1**

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## Applicability

This monitoring methodology can be used for project activities that incinerate HFC 23 wastes in excess of any regulatory requirements from sources of a HCFC production facility in a non-Annex I Party.

## Monitoring Methodology

Monitoring methodology is based on direct measurement of the amount of HFC 23 waste destroyed and of the energy used by the destruction process as shown in Figure 1.

This monitoring methodology provides for direct and continuous measurement of the actual quantity HFC 23 destroyed, as well as the quantities of electricity, steam and fossil fuel used by the destruction process.

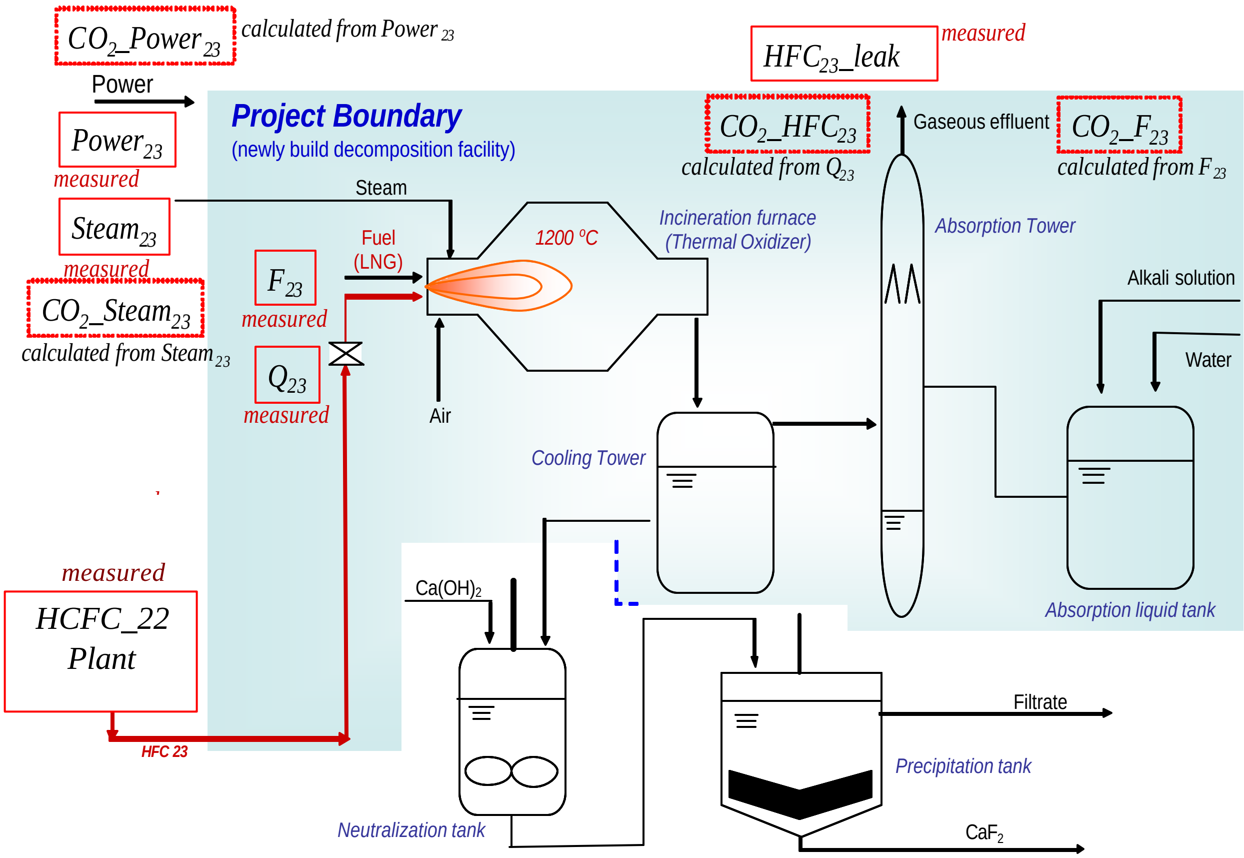
The emission reductions are dominated by the quantity of HFC 23 destroyed. To measure this quantity accurately two flow meters, each of which is recalibrated weekly, are used.

Other factors in the monitoring process for quality control are:

- Purity of HFC 23 is checked monthly by sampling using gas chromatography. Combinations of continuous flow measurement and calculation will be used to estimate quantities of other materials, e.g., air that may be in the HFCs if this is appropriate.
- Amount of HFC 23 waste generated. The output of HFC 23 from the HCFC 22 plant will be checked yearly by comparing the amount of HCFC 22 produced ~~sold~~ to the sum of the HFC 23 recovered for sale and HFC 23 decomposed.

The quantities of gaseous effluents (CO, HCl, HF, Cl2, dioxin and NOX) 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.

Figure 1
**Monitoring Plan**




$CO_2\_Power_{23} = E\_F_{1,y}$
$Power_{23} = Q\_F_{1,y}$
$Steam_{23} = Q\_F_{2,y}$
$CO_2\_Steam_{23} = E\_F_{2,y}$
$HCFC\_22\ Plant = Q\_HCFC_y$
$F_{23} = Q\_NG_y$
$CO_2\_F_{23} = Q\_NG_y * E\_NG_y$
$Q_{23} = Q\_HFC23_y$
$HFC_{23}\_leak = ND\_HFC23_y$
$CO_2\_HFC_{23} = Q\_HFC23_y * EF$

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**Data to be collected or used to monitor emissions from the project activity, and how this data will be archived**

**Monitored data for project emissions in the boundary (GHG)**

| ID number *(Please use numbers to ease cross-referencing to table D.6)* | Data type | Data variable | Data unit | Measured (m), calculated (c) or estimated (e) | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | For how long is archived data kept? | Comment |
|---|---|---|---|---|---|---|---|---|---|
| *1. ~~Q~~q_HFC23y* | *mass* | *Quantity of HFC 23 supplied to the destruction process* | *kg-HFC* | *(m) measured by flow meters in parallel that are calibrated weekly* | *monthly* | *100%* | *electronic* | *Project lifetime* | |
| ~~*2. F_ND<sub></sub>y*~~ | ~~*mass*~~ | ~~*HFC 23 in gaseous effluent (fraction of HFC 23 not destroyed)*~~ | ~~*kg-HFC*~~ | ~~*(m) measured*~~ | ~~*monthly*~~ | ~~*100%*~~ | ~~*electronic*~~ | ~~*Project lifetime*~~ | |
| *2. ~~Purity of Q~~_HFC23y* | *%* | *Purity of the HFC 23 supplied to the destruction process* | *%* | *(m) measured monthly by sampling* | *monthly* | | *electronic* | *Project lifetime* | *Measured using gas chromatography* |
| *3. Q_NGy* | *mass* | *Quantity of natural gas used by the destruction process* | $m^3$ | *(m) measured* | *monthly* | *100%* | *electronic* | *Project lifetime* | *Measured using a fuel meter* |

In addition the quantities of gaseous effluents (CO, HCl, HF, Cl2, dioxin and NOX) and liquid effluents (PH, COD, BOD, n-H (normal hexane extracts), SS (suspended solid), phenol, and metals (Cu, Zn, Mn and Cr) are measured in a manner and with a frequency that complies with local environmental regulations.

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D.4. Potential sources of emissions which are significant and reasonably attributable to the project activity, but which are not included in the project boundary, and identification if and how data will be collected and archived on these emission sources.

**Monitored data for project emissions outside of the boundary (GHG)**

| ID number *(Please use numbers to ease cross-referencing to table D.6)* | Data type | Data variable | Data unit | Measured (m), calculated (c) or estimated (e) | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | For how long is archived data kept? | Comment |
|---|---|---|---|---|---|---|---|---|---|
| *4. ND_HFC23y* | *mass* | *Quantity of HFC 23 in gaseous effluent* | *kg-HFC* | *(m) measured* | *monthly* | *100%* | *electronic* | *Project lifetime* | *When the thermal oxidizer stops, analysis of the effluent gas is done to check leaked HFC 23 by sampling.* |
| *5. Q_F1,y,y* | *energy* | *Electricity consumption by the destruction process* | *kWh* | *(m) measured* | *monthly* | *100%* | *electronic* | *Project lifetime* | *Metered* |
| *6. Q_F2,y,y* | *energy* | *Steam consumption by the destruction process* | *kg-steam* | *(m) measured* | *monthly* | *100%* | *electronic* | *Project lifetime* | *Metered* |

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D.5. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHG and identification if and how such data will be collected and archived.

**Monitored data for baseline emissions (GHG)**

| ID number *(Please use numbers to ease cross-referencing to table D.6)* | Data type | Data variable | Data unit | Measured (m), calculated (c) or estimated (e) | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | For how long is archived data kept? | Comment |
|---|---|---|---|---|---|---|---|---|---|
| *7. $Q\_HCFC_y$* | *mass* | *The quantity of HCFC 22 produced in the plant generating the HFC 23 waste* | *tonnes - HCFC 22* | *(m) measured* | *monthly* | *100%* | *electronic* | *Project lifetime* | *Reference data to check cut off condition and rough estimation of $Q\_HFC23_y$* |
| *8. HFC23_sold* | *mass* | *HFC 23 sold by the facility generating the HFC 23 waste* | *tonnes -HFC 23* | *(m) measured* | *annually* | *100%* | *electronic* | *Project lifetime* | *Reference data to check cut off condition and rough estimation of $Q\_HFC23_y$* |

D.6. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored. **(data items in tables contained in section D.3., D.4. and D.5 above, as applicable)**

| Data *(Indicate table and ID number e.g. 3.-1; 3.-2.)* | Uncertainty level of data (High/Medium/ Low) | Are QA/QC procedures planned for these data? | Outline explanation why QA/QC procedures are or are not being planned. |
|---|---|---|---|
| *1. ~~Q~~-q_HFC23y* | *Low* | *Yes. A QA & QC organization will be formed and QA & QC procedures that are equivalent to JIS (Japanese Industrial Standard) in terms of equipment and analytical method will be set.* *Will be measured using two flowmeters in parallel with weekly calibration* | *QA & QC procedures are set and implemented in order to,* *1. Secure a good consistency through planning to implementation of this CDM project and,* *2. Stipulate who has responsibility for what and,* *3. Avoid any misunderstanding between people and organization involved.* |
| ~~*2. $F\_ND_y$*~~ | ~~*Low*~~ | ~~*Will be measured from the gas effluent of the destruction process*~~ | ~~*Ditto*~~ |
| *2.P ~~urity of~~* | *Low* | *Will be measured using gas chromatography* | *Ditto* |

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| | | | |
|---|---|---|---|
| *QHFC23y* | | | |
| *3. Q_NGy* | *Low* | *Will be metered using natural gas meter* | *Ditto* |
| *4. ND_HFC23y* | *Low* | *Will be measured from the gas effluent of the destruction process* | *Ditto* |
| *5. Q_F1 y* | *Low* | *Will be metered using electricity meter* | *Ditto* |
| *6. Q_F2,y* | *Low* | *Will be metered using steam meter* | *Ditto* |
| *7. Q_HCFCy* | | *Will be obtained from production records of the facility where the HFC 23 waste originates* | *Ditto* |
| *8. HFC23_sold* | | *Will be obtained from production records of the facility where the HFC 23 waste originates* | *Ditto* |

All of the measurement instruments are to be recalibrated monthly per internationally accepted procedures except for the HFC 23 flowmeters whose recalibration frequency is weekly to reduce the error level.

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**Miscellaneous parameters** ~~**Baseline Data**~~

Calculation of the emission reductions also requires data for:

$E\_NG_y$ - The emissions coefficient for the natural gas used by the destruction process in tonnes of $CO_2$ equivalent per cubic metre of natural gas (t $CO_2e/m^3$). The value of $E\_NG_y$ will vary by region and over time.

$E\_F_{i,y}$ - The emissions coefficient for the electricity used by the destruction process in tonnes of $CO_2$ equivalent per kWh. The value of $E\_F_{i,y}$ for electricity depends on the source of the electricity and may vary over time.

$E\_F_{i,y}$ - The emissions coefficient for the steam used by the destruction process in tonnes of $CO_2$ equivalent per tonne steam. The value of $E\_F_{i,y}$ for steam depends on the source of the steam and may vary over time.

GWP_HFC23 - The 100 year Global Warming Potential of HFC 23. The Global Warming Potential converts 1 tonne of HFC 23 to tonnes of $CO_2$ equivalents (tonnes $CO_2$e/tonnes HFC 23). The approved Global Warming Potential value for HFC 23 for the first commitment period is 11,700 tonnes $CO_2$e/tonne HFC 23.