

Calculation of control levels for production, consumption and baseline values of hydrofluorocarbons



Introduction

This briefing note outlines the steps that will be used by the Secretariat in calculating the control levels for production, consumption and baseline values of hydrofluorocarbons (HFCs). The calculations will be based on the relevant definitions and provisions of the Montreal Protocol as adjusted and amended, including by the Kigali Amendment and taking into account the various decisions related to data reporting.

The steps in calculating the control levels for production and consumption of HFCs are similar with those used for the calculation of the control levels for ozone depleting substances (ODSs)¹. The only difference is the use of global warming potential (GWP) of HFCs, instead of the ozone depleting potential (ODP) values.

The briefing note has three sections:

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- Section I provides information on the calculation of annual production and consumption of HFCs in CO₂ equivalents;
 - Section II provides information on the calculation of HFC baselines for production and consumption for both nonArticle 5 and Article 5 Parties;
 - Section III provides information on the calculation of HFC consumption from blends.
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This note is circulated for information purposes only. It will allow parties to understand how the information that they report in tonnes² on production, imports, exports and destruction will be processed by the Secretariat to derive production and consumption expressed in CO₂ equivalents.

Calculation of annual production and consumption of HFCs

Step 1: Submission to the Secretariat of Article 7 data for HFCs in tonnes

The parties report amounts of imports, exports, production and destruction in tonnes as is the case with reporting of ODSs under Article 7. Any sub-components³ of the reported production, imports or exports are also included in

¹ The steps used to calculate control levels for ODSs are usually included as an annex to the data report that is presented to the Meeting of the Parties annually.

² Tonnes represent metric tons.

³ Paragraph 3 of Article 7 of the Protocol lists the components that need to be reported.

the data reporting, such as the amounts intended for feedstock uses or process agent uses⁴. Box 1 provides an example of a hypothetical submission.

Step 2: Conversion of reported HFCs to CO₂ equivalents

The reported amounts of production, import, export and destruction in tonnes for each reported HFC (step 1) are multiplied by the GWP of that substance. The GWP values for HFCs are specified in Annex F of the amended Montreal Protocol. This process is also carried out for the other sub-components³ of the reported amounts, e.g. production for feedstock uses, production for process agent uses⁴, imports for feedstock uses, exports for feedstock uses and exports to non-parties.

The resulting calculation gives all reported amounts in CO₂ equivalents for each individual substance. Box 1 provides an example of a conversion from tonnes to CO₂ equivalents.

BOX 1: EXAMPLE OF CALCULATING HFC CONSUMPTION FOR AN IMPORTING PARTY

A party imports 70 tonnes of HFC-xxx and 30 tonnes of HFC-yyy, some of which are for feedstock uses. The party does not produce or export or destroy any HFCs.

Step 1: Submission to the Secretariat of Article 7 data for HFCs in tonnes

Substances	Total quantity imported for all uses		Quantity imported for feedstock uses	Quantity imported for exempted uses	
	New	Recovered		Quantity	Decision/type of use
HFC-xxx (CxHxFx)	70	-	30	-	-
HFC-yyy (CyHyFy)	30	-	10	-	-

Step 2: Conversion of reported HFCs to CO₂ equivalents (each reported amount is multiplied with the GWP value of the corresponding substance)

Substances	GWP	New imports	Recovered reclaimed	Feedstock imports	Exempted use imports	Decision/type of use
HFC-xxx (CxHxFx)	1,380	96,600	-	41,400	-	-
HFC-yyy (CyHyFy)	480	14,400	-	4,800	-	-

Step 3: Aggregation of all HFCs in CO₂ equivalents

Substances	New imports	Recovered reclaimed	Feedstock imports	Exempted use
HFCs	111,000	-	46,200	-

Steps 4, 5 and 6: Calculation of annual production and consumption of HFCs

Apply the following formulae using figures from step 3 above:

Production = Total amount produced – amount destroyed – production for internal feedstock uses – exports for feedstock
= 0 – 0 – 0 – 0 = 0 tonnes CO₂-equivalent

Consumption = Production + (total imports – imports for feedstock) – (total exports – exports for feedstock – exports to non-parties)
= 0 + (111,000 – 46,200) – (0 – 0 – 0) = 64,800 tonnes CO₂-equivalent

4 Decision X/14 provides that process agent uses are those controlled substances used in the applications listed in table A of that decision and subject to the emission limits in table B of the same decision, and should be treated in a manner similar to feedstock uses, and therefore should not be taken into account in the calculation of production and consumption. To date, all process agent uses have been reported separately by those parties that have such uses, and the amounts produced, imported or exported for such uses have not been taken into account in the calculations in the same way as for feedstock uses. Any process agent uses for HFC would be similarly treated unless the parties decide otherwise.

Step 3: Aggregation of all HFCs in CO₂ equivalents

The CO₂ equivalents of each HFC (step 2) are added together to derive the total reported production, import, export and destruction for all HFCs. This process is also carried out for the other sub-components³ e.g. feedstock uses, process agent uses⁴ and exports to non-parties.

The resulting calculation gives the total amount of reported production, imports, exports and destruction (if any) of HFCs in CO₂ equivalents. Box 1 includes an example of this calculation.

Step 4: Calculation of annual production and consumption of HFCs in CO₂ equivalents

The following formulae are used to calculate the annual production⁵ and consumption⁶, using the aggregated CO₂ equivalents from step 3 above to get the annual production and consumption in CO₂ equivalents:

Production = Amount produced – amount destroyed⁷ – amount used for feedstock

Consumption = Production + imports⁸ – exports⁸

For those parties that do not have destruction of HFCs (Annex F) and that do not have feedstock or process agent uses, the above formulae for the calculation of their annual production and consumption can be simplified as shown below:

Production = Amount produced

Consumption = Production + imports – exports⁸

Step 5: Adjustment for feedstock uses, if any

The data reporting forms adopted under decision IX/28 provide for the required reporting of feedstock uses as follows:

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- amounts “produced for feedstock uses within the producing party”;
 - amounts “imported for feedstock uses within the importing party”; and
 - amounts “exported for feedstock uses”.
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In decision VII/30, the following clarifications are provided in connection with feedstock uses:

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- controlled substances used as feedstock should not be included in the calculation of “consumption” in importing countries (paragraph 2 of the decision); and
 - controlled substances produced and exported for feedstock uses should not be included in the calculation of “production” or “consumption” in exporting countries (paragraph 1 of the decision).
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5 Paragraph 5 of Article 1 of the Protocol.

6 Paragraph 6 of Article 1 of the Protocol.

7 The full expression is “amount destroyed by technologies approved by the parties”.

8 The imports and exports of recycled and used controlled substances are not to be taken into account when calculating consumption, although parties are required to annually report such imports and exports under Article 7 (see paragraph 2 of decision IV/24).

Adjusting the formulae in step 4 above for calculating annual production and consumption to accommodate the aspects of reporting feedstock uses yields the following:

$$\begin{aligned} \text{Production} &= \text{Total amount produced} - \text{amount destroyed}^7 \\ &\quad - \text{production for internal feedstock uses}^9 - \text{exports for feedstock}^{10} \end{aligned}$$

$$\begin{aligned} \text{Consumption}^{11} &= \text{Production} + (\text{total imports} - \text{imports for feedstock}) \\ &\quad - (\text{total exports} - \text{exports for feedstock}^{10}) \end{aligned}$$

Box 2 provides an example of a producing country which exports HFCs for feedstock uses.

BOX 2: EXAMPLE OF A PRODUCING PARTY THAT EXPORTS FOR FEEDSTOCK USES

A party produces 100 tonnes of a substance, and out of that amount 80 tonnes are exported for feedstock uses. There are no other exports and no imports or destruction of that substance.

NB: Values for the formulae: Total amount produced = 100 tonnes; Amount destroyed = 0; Production for internal feedstock uses = 0; Exports for feedstock uses = 80 tonnes; Total imports = 0; Imports for feedstock uses = 0; Total exports = 80 tonnes.

$$\text{Production} = 100 - 0 - 0 - 80 = 20 \text{ tonnes}$$

$$\text{Consumption} = 20 + (0 - 0) - (80 - 80 - 0) = 20 \text{ tonnes}$$

Step 6: Adjustment for exports to non-parties

Controlled substances exported to non-parties should not be subtracted¹² when calculating the consumption level of the exporting party. Adjusting the formulae to take into account these exports yields the following:

$$\begin{aligned} \text{Production} &= \text{Total amount produced} - \text{amount destroyed}^7 \\ &\quad - \text{production for internal feedstock uses}^9 - \text{exports for feedstock}^{10} \end{aligned}$$

$$\begin{aligned} \text{Consumption}^{11} &= \text{Production} + (\text{total imports} - \text{imports for feedstock}) - (\text{total exports} \\ &\quad - \text{exports for feedstock}^{10} - \text{exports to non-parties}) \end{aligned}$$

9 This "production for internal feedstock uses" component is the amount of production for feedstock uses within the producing party.

10 "Exports for feedstock uses" are deducted only for parties that report production and export of the given substances within the same year.

11 In the formula for consumption, it might seem that "exports for feedstock uses" are included twice (a) with the inclusion of "production" in the formula for "consumption", since the formula for "production" subtracts "exports for feedstock uses" and (b) when "exports for feedstock uses" are subtracted from "total exports" in the last set of brackets in the formula for "consumption". However, keeping in mind that "total exports" include exports for all uses, including those for feedstock uses, the subtraction of "exports for feedstock uses" from "total exports" in the formula for "consumption" serves to exclude the feedstock sub-component from the "total exports" to avoid double subtraction (NB: the formula for "production" already deducts "exports for feedstock uses").

12 Paragraph 1(c) of Article 3 of the Protocol.

Calculating HFC baselines for production and consumption

A. Non-Article 5 parties: HFC baselines for production and consumption

Table 1 below shows the formulae for calculating HFC production and consumption baselines¹³ for non-Article 5 parties based on the Kigali Amendment to the Montreal Protocol. The formulae for calculating HCFC production and consumption baselines¹⁴ are also provided in the same table, since HCFC baseline values are used in the calculation of the HFC baseline values.

TABLE 1: FORMULAE FOR BASELINE VALUES FOR BOTH HFCS AND HCFCs FOR NON-ARTICLE 5 PARTIES

BASELINES FOR CONSUMPTION	
HFCs	HCFCs
(average of annual HFC consumption for 2011-2013) + (15% ¹³ of consumption baseline of HCFC)	(1989 HCFC consumption) + (2.8% of 1989 CFC consumption)
BASELINES FOR PRODUCTION	
HFCs	HCFCs
(average of annual HFC production for 2011-2013) + (15% ¹³ of production baseline of HCFC)	Average of (1989 HCFC production + 2.8% of 1989 CFC production) and (1989 HCFC consumption + 2.8% of 1989 CFC consumption)

The reported data for CFCs and HCFCs for 1989 are known for every non-Article 5 party. The Secretariat will calculate the CFC and HCFC production and consumption in CO₂ equivalents for non-Article 5 parties for 1989 based on the steps described in section I above. The HCFC component of the baseline, in CO₂ equivalents, for non-Article 5 parties will be made available in the data centre on the Secretariat's website in due course.

Table 2 shows the formulae for getting the baselines for HFC production and consumption after including the formulae for calculating the HCFC production and consumption baselines.

¹³ Paragraphs 1 and 3 of Article 2J of the Protocol. For Belarus, Kazakhstan, the Russian Federation, Tajikistan and Uzbekistan, the applicable references are paragraphs 2 and 4 of Article 2J respectively, and the applicable percentage is 25% (or a factor of 0.25 in the formulae).

¹⁴ Paragraphs 1 and 2 of Article 2F of the Protocol.

TABLE 2: HFC PRODUCTION AND CONSUMPTION BASELINES FOR NON-ARTICLE 5 PARTIES
HFC CONSUMPTION BASELINE FOR NON-ARTICLE 5 PARTIES

$$[(\text{sum of annual HFC consumption for 2011-2013}) \div 3] + 0.15^{13} \times [(\text{1989 HCFC consumption}) + 0.028 \times (\text{1989 CFC consumption})]$$

HFC PRODUCTION BASELINE FOR NON-ARTICLE 5 PARTIES

$$[(\text{sum of annual HFC production for 2011-2013}) \div 3] + 0.15^{13} \times \{[(\text{1989 HCFC production}) + 0.028 \times (\text{1989 CFC production})] + [(\text{1989 HCFC consumption}) + 0.028 \times (\text{1989 CFC consumption})]\} \div 2$$

The calculations for HFC production and consumption for the applicable years will also be done by using the process outlined in section I above. Box 3 shows an illustrative example of calculating the consumption baseline of a non-Article 5 party.

BOX 3: EXAMPLE OF CALCULATING HFC CONSUMPTION BASELINE FOR A NON-ARTICLE 5 PARTY THAT DOES NOT HAVE PRODUCTION, DESTRUCTION OR FEEDSTOCK USES

Baseline data: A non-Article 5 party with the following imports for the relevant baseline years:

Substance	GWP	CFC and HCFC baseline year: Imports in tonnes	HFC baseline years: Imports in tonnes		
		1989	2011	2012	2013
CFC-11	4,750	200			
CFC-12	10,900	150			
HCFC-22	1,810	100			
HCFC-142b	2,310	12			
HFC-xxx	1,380		80	70	50
HFC-yyy	480		30	20	15

NB:

$$\begin{aligned} \text{HFC consumption baseline} &= [(\text{sum of annual HFC consumption for 2011-2013}) \div 3] \\ &\quad + 0.15 \times [(\text{1989 HCFC consumption}) + 0.028 \times (\text{1989 CFC consumption})] \\ \text{CFC consumption in 1989} &= 200 \times 4,750 + 150 \times 10,900 = 2,585,000 \text{ tonnes CO}_2\text{-equivalent} \\ \text{HCFC consumption in 1989} &= 100 \times 1,810 + 12 \times 2,310 = 208,720 \text{ tonnes CO}_2\text{-equivalent} \\ \text{HFC consumption in 2011} &= 80 \times 1,380 + 30 \times 480 = 124,800 \text{ tonnes CO}_2\text{-equivalent} \\ \text{HFC consumption in 2012} &= 70 \times 1,380 + 20 \times 480 = 106,200 \text{ tonnes CO}_2\text{-equivalent} \\ \text{HFC consumption in 2013} &= 50 \times 1,380 + 15 \times 480 = 76,200 \text{ tonnes CO}_2\text{-equivalent} \\ \text{HFC consumption baseline} &= [(124,800 + 106,200 + 76,200) \div 3] + 0.15 \times [(208,720) + 0.028 \times (2,585,000)] \\ &= 144,565 \text{ tonnes CO}_2\text{-equivalent} \end{aligned}$$

B. Article 5 parties: HFC baselines for production and consumption

Table 3 below shows the formulae for calculating HFC production and consumption baselines¹⁵ for both group 1 Article 5 parties and group 2 Article 5 parties based on the Kigali Amendment to the Montreal Protocol. The formulae for calculating HCFC production and consumption baselines¹⁶ that are used in the calculation of the HFC baselines are also provided in the same table.

¹⁵ Paragraphs 8 qua (c) and 8 qua (e) of Article 5 of the Protocol for Article 5, group 1 parties and paragraphs 8 qua (d) and 8 qua (f) of Article 5 of the Protocol for Article 5, group 2 parties.

¹⁶ Paragraphs 8 ter (a) to 8 ter (d) of Article 5 of the Protocol.

TABLE 3: FORMULAE FOR BASELINES FOR BOTH HFCs AND HCFCs FOR ARTICLE 5 PARTIES

BASELINES FOR CONSUMPTION		
HFCs		HCFCs
Group 1	Group 2	
(average of annual HFC consumption for 2020–2022) + (65% of HCFC consumption baseline)	(average of annual HFC consumption for 2024–2026) + (65% of HCFC consumption baseline)	average of annual HCFC consumption in 2009 and 2010
BASELINES FOR PRODUCTION		
HFCs		HCFCs
Group 1	Group 2	
(average of annual HFC production for 2020–2022) + (65% of HCFC production baseline)	(average of annual HFC production for 2024–2026) + (65% of HCFC production baseline)	average of annual HCFC production in 2009 and 2010

The HCFC reported data for the years 2009 and 2010 are known for every Article 5 party. The Secretariat will calculate the HCFC production and consumption in CO₂ equivalents for Article 5 parties for those years based on the steps described in section I above. The HCFC component of the baseline, in CO₂ equivalents, for Article 5 parties will be made available in the data centre on the Secretariat's website in due course.

Table 4 shows the formulae for getting the baselines for HFC production and consumption after including the formulae for calculating the HCFC production and consumption baselines.

TABLE 4: HFC PRODUCTION AND CONSUMPTION BASELINES FOR ARTICLE 5 PARTIES

HFC CONSUMPTION BASELINE FOR ARTICLE 5 PARTIES	
Group 1	Group 2
$[(\text{sum of annual HFC consumption for 2020-2022}) \div 3] + 0.65 \times [(\text{sum of annual HCFC consumption in 2009 and 2010}) \div 2]$	$[(\text{sum of annual HFC consumption for 2024-2026}) \div 3] + 0.65 \times [(\text{sum of annual HCFC consumption in 2009 and 2010}) \div 2]$
HFC PRODUCTION BASELINE FOR ARTICLE 5 PARTIES	
Group 1	Group 2
$[(\text{sum of annual HFC production for 2020-2022}) \div 3] + 0.65 \times [(\text{sum of annual HCFC production in 2009 and 2010}) \div 2]$	$[(\text{sum of annual HFC production for 2024-2026}) \div 3] + 0.65 \times [(\text{sum of annual HCFC production in 2009 and 2010}) \div 2]$

The calculations for HFC production and consumption for the applicable years will also be done by using the process outlined in section I above. Box 4 shows an illustrative example of calculating the consumption baseline of an Article 5 party belonging to group 1.

BOX 4: EXAMPLE OF CALCULATING CONSUMPTION BASELINE FOR AN ARTICLE 5, GROUP 1 PARTY THAT DOES NOT HAVE PRODUCTION, DESTRUCTION OR FEEDSTOCK USES

Baseline data: An Article 5, group 1 party with the following imports for the relevant baseline years:

Substance	GWP	HCFC baseline years: Imports in tonnes			HFC baseline years: Imports in tonnes		
		2009	2010		2020	2021	2022
HCFC-22	1,810	100	90				
HCFC-142b	2,310	12	10				
HFC-xxx	1,380				80	70	50
HFC-yyy	480				30	20	15

NB:

HFC consumption baseline = $[(\text{sum of annual HFC consumption for 2020–2022}) \div 3]$
+ $0.65 \times [(\text{sum of annual HCFC consumption in 2009 and 2010}) \div 2]$

HCFC consumption in 2009 = $100 \times 1,810 + 12 \times 2,310 = 208,720 \text{ tonnes CO}_2\text{-equivalent}$

HCFC consumption in 2010 = $90 \times 1,810 + 10 \times 2,310 = 186,000 \text{ tonnes CO}_2\text{-equivalent}$

HFC consumption in 2020 = $80 \times 1,380 + 30 \times 480 = 124,800 \text{ tonnes CO}_2\text{-equivalent}$

HFC consumption in 2021 = $70 \times 1,380 + 20 \times 480 = 106,200 \text{ tonnes CO}_2\text{-equivalent}$

HFC consumption in 2022 = $50 \times 1,380 + 15 \times 480 = 76,200 \text{ tonnes CO}_2\text{-equivalent}$

HFC consumption baseline = $[(124,800 + 106,200 + 76,200) \div 3] + 0.65 \times [(208,720 + 186,000) \div 2]$
= $230,684 \text{ tonnes CO}_2\text{-equivalent}$

4.

Calculation of HFC consumption from trade in blends

In the past, parties that imported or exported mixtures or blends containing controlled substances were required to calculate the quantity of each pure substance contained in mixtures and blends, and to report only the quantities of the pure substances.

With HFCs, a significant portion of trade is expected to take place in the form of mixtures and blends. The Secretariat has proposed to the parties to consider allowing the reporting of quantities of mixtures and blends rather than specific amounts of pure HFCs contained in those mixtures and blends. The Secretariat would then be responsible for carrying out the calculations to derive the different

amounts of pure substances contained in the reported mixtures and blends (see box 5 below for a party that has imports and exports of both pure HFCs and blends containing HFCs).

BOX 5: EXAMPLE OF CALCULATING CONSUMPTION OF HFCs FROM BLENDS

Scenario: A party imports pure HFCs and blends containing HFCs, with some of the imports being for feedstock uses

Step 1: Submission to the Secretariat of Article 7 data for HFCs: Imports and exports only

Substance	New imports (tonnes)	Feedstock imports (tonnes)	Exports (tonnes)
HFC-nnn	150	-	50
HFC-zzz	100	40	-
Blend 1	400	50	-
Blend 2	300	-	100

Step 2: Conversion of reported HFCs to CO₂ equivalents (each reported amount is multiplied with the GWP value of the corresponding substance taking into account the percentage of pure HFCs in the blends)

Substance	Component	%	GWP	New imports	Feedstock imports	Exports
HFC-nnn	HFC-nnn	100%	2,580	387,000	-	129,000
HFC-zzz	HFC-zzz	100%	980	98,000	39,200	-
Blend 1	HFC-aaa	13%	280	14,560	1,820	-
	HFC-bbb	27%	1,800	194,400	24,300	-
	HFC-nnn	60%	2,580	619,200	77,400	-
	Blend 1	100%	2,070.4	828,160	103,520	-
Blend 2	HFC-aaa	80%	280	67,200	-	22,400
	HFC-bbb	20%	1,800	108,000	-	36,000
	Blend 2	100%	584	175,200	-	58,400

Step 3: Aggregation of all HFCs in CO₂ equivalents

Substance	-	-	-	New imports	Feedstock imports	Exports
HFC	-	-	-	1,488,360	142,720	187,400

Steps 4, 5 and 6: Calculation of annual production and consumption of HFCs

Apply the following formulae using figures from step 3 above:

$$\begin{aligned} \text{Production} &= \text{Total amount produced} - \text{amount destroyed} - \text{production for internal feedstock uses} - \text{exports for feedstock} \\ &= 0 - 0 - 0 - 0 = 0 \text{ tonnes CO}_2\text{-equivalent} \end{aligned}$$

$$\begin{aligned} \text{Consumption} &= \text{Production} + (\text{total imports} - \text{imports for feedstock}) - (\text{total exports} - \text{exports for feedstock} - \text{exports to non-parties}) \\ &= 0 + (1,488,360 - 142,720) - (187,400 - 0 - 0) = 1,158,240 \text{ tonnes CO}_2\text{-equivalent} \end{aligned}$$