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**Montreal Protocol
on Substances that
Deplete the Ozone Layer**

**Thirteenth meeting of the Conference of
the Parties to the Vienna Convention
for the Protection of the Ozone Layer**
Bangkok, 28 October–1 November 2024**Thirty-Sixth Meeting of the Parties to
the Montreal Protocol on Substances
that Deplete the Ozone Layer**
Bangkok, 28 October–1 November 2024**Issues for discussion by and information for the attention of the
Conference of the Parties to the Vienna Convention at its
thirteenth meeting and the Thirty-Sixth Meeting of the Parties
to the Montreal Protocol****Note by the Secretariat****Addendum****I. Introduction**

1. The present addendum to the note by the Secretariat on issues for discussion by and information for the attention of the Conference of the Parties to the Vienna Convention for the Protection of the Ozone Layer at its thirteenth meeting and the Thirty-Sixth Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer presents new and updated information that has become available since the preparation of that note.¹ Section II sets out brief summaries of additional information provided by the Scientific Assessment Panel and the Technology and Economic Assessment Panel on hydrofluorocarbon-23 (HFC-23) issues in relation to agenda item 4 (b) of the provisional agenda for the preparatory segment, a summary of the final recommendations and relevant information by the Technology and Economic Assessment Panel on nominations for critical-use exemptions for methyl bromide for 2025 in relation to item 4 (1), and also information related to nominations by parties of experts to the Technology and Economic Assessment Panel and the classification of the State of Palestine as a party operating under paragraph 1 of Article 5 to the Montreal Protocol in relation to items 4 (m) and 4 (o), respectively.

2. The additional information provided by the Scientific Assessment Panel and the Technology and Economic Assessment Panel is set out in the following reports:²

(a) *Report of the Science Assessment Panel Decision XXXV/7: in Response to Emissions of HFC-23;*

(b) *Report of the Technology and Economic Assessment Panel, August 2024, Volume 4: Evaluation of 2024 Critical-Use Nominations for Methyl Bromide and Related Issues – Final Report;*

¹ UNEP/OzL.Conv.13/2–UNEP/OzL.Pro.36/2.

² Available on the portal for the meeting at <https://ozone.unep.org/meetings/thirty-fifth-meeting-parties/pre-session-documents>.

(c) *Report of the Technology and Economic Assessment Panel, September 2024, Volume 5: Response to Decision XXXV/7: Emissions of HFC-23.*

II. Overview of items on the provisional agenda for the preparatory segment (28–30 October 2024)

3. The issues covered in the present addendum are provided below in the order in which the respective items are listed on the provisional agenda for the meeting.

A. Montreal Protocol issues (item 4 of the provisional agenda for the preparatory segment)

1. HFC-23 issues (sub-item 4 (b) of the provisional agenda for the preparatory segment)

Emissions of HFC-23: reports by the Scientific Assessment Panel and the Technology and Economic Assessment Panel (decision XXXV/7, paras. 1 and 2) (sub-item 4 (b) (i) of the provisional agenda for the preparatory segment)

4. As is mentioned in the note by the Secretariat (UNEP/OzL.Conv.13/2–UNEP/OzL.Pro.36/2, paras. 33–35), in decision XXXV/7, on emissions of HFC-23, the Scientific Assessment Panel and the Technology and Economic Assessment Panel were requested to prepare reports on the matter for consideration by the Thirty-Sixth Meeting of the Parties, as described below.

5. The Scientific Assessment Panel was requested to provide an update on emissions of HFC-23 into the atmosphere and atmospheric concentrations to supplement the information in the 2022 quadrennial assessment report, including by reflecting any new information regarding atmospheric monitoring and atmospheric modelling, with its underlying methodology, including in quantifiable terms, with regard to such emissions, and taking into account information reported under paragraph 3 ter of Article 7 by all parties that manufactured Annex C, Group I (hydrochlorofluorocarbons (HCFCs)) or Annex F substances (HFCs).

6. The Technology and Economic Assessment Panel was requested to include in its report information regarding:

(a) The quantity of HFC-23 being consumed, by country and by sector; and

(b) Updated estimates of the amounts of HFC-23 generated at and of emissions from HCFC-22 production facilities, including the methodology with regard to such emissions, taking into account information reported under paragraph 3 ter of Article 7 by all parties that manufactured HCFCs or HFCs, as well as information from other sources.

7. Furthermore, in paragraph 5 of decision XXXV/7, parties with available relevant scientific or technical information that might help inform the reports of the Panels were invited to provide that information to the Secretariat by 1 March 2024. The Secretariat received no such information from parties.

8. The full reports of the Panels are posted on the portal of the combined thirteenth meeting of the Conference of the Parties to the Vienna Convention and Thirty-Sixth Meeting of the Parties to the Montreal Protocol.³ The executive summaries of these reports are set out in annexes I and II to the present addendum, respectively, reproduced as received from the Panels without formal editing by the Secretariat. A summary of some salient points is provided in the following paragraphs.

9. Both reports define as “generation” the total HFC-23 produced as a by-product, without taking into account any emissions abated. They also define as “emissions” the total HFC-23 emitted from a facility that generates HFC-23 as a by-product after any abatement, noting that the dominant emission pathway is direct emissions to the atmosphere.

10. As background information, the report of the Scientific Assessment Panel summarizes relevant findings of the Panel’s 2022 quadrennial assessment on observations and analyses of HFCs in the atmosphere. According to that assessment, global mean concentrations of HFC-23 increased during 2018–2019 at the highest rate recorded throughout the measurement record, 1.3 parts per trillion per year. Global total HFC-23 emissions peaked during 2019 (17.3 ± 0.8 kilotonnes) and averaged at 16.5 ± 0.9 kilotonnes per year during 2018–2020, making HFC-23 the third-largest contributor to global-warming-potential-weighted emissions from HFCs with 20 per cent, owing to its long lifetime (228 years) and large 100-year global-warming potential (14,700) compared to other HFCs.

³ <https://ozone.unep.org/system/files/documents/TEAP-reponse-to-decision-XXXV-7-report-september-2024.pdf>.
https://ozone.unep.org/system/files/documents/SAP_Report_on_HFC23_September2024.pdf.

11. A main conclusion of the 2022 assessment was the substantial divergence found between estimates of global HFC-23 emissions derived from atmospheric measurements in remote areas and emissions based on reporting to the United Nations Framework Convention on Climate Change⁴ and to the Multilateral Fund for the Implementation of the Montreal Protocol. That divergence emerged in 2015 and remained substantial in the following years reaching 15 ± 0.7 kilotonnes in 2019. The report recognized that there was a large gap in the Panel's understanding of most HFC-23 emissions reaching the atmosphere, suggesting that other sources could contribute HFC-23 emissions independently of direct generation as by-product during the production of HCFC-22, but their magnitudes were not thoroughly assessed.

12. In its current report, the Scientific Assessment Panel presents trends in HFC-23 emissions from the 1990s up to and including 2022, both derived from atmospheric measurements and based on a reassessment of available emission and abatement data reported to the Framework Convention on Climate Change, the Ozone Secretariat and the Multilateral Fund secretariat. It also discusses briefly other known industrial sources of HFC-23, based on the analysis by the Technology and Economic Assessment Panel in its response to decision XXXV/7, and considers a number of recently published studies describing atmospheric measurements at sites that provide new information for HFC-23 emissions from countries in eastern Asia and Europe. Lastly, the report also explores the potential for fluorine-containing gases to provide a source of HFC-23 via their atmospheric oxidation by the hydroxyl radical and ozone, estimating the magnitude of this source to be less than 0.43 kilotonnes per year.

13. The updated results show that in recent years the atmosphere-derived global emissions of HFC-23 decreased steadily from 17.3 ± 0.8 kilotonnes in 2019 to 13.9 ± 0.7 kilotonnes in 2022. In terms of the agreement between atmosphere-derived and reporting-based emissions, the Panel finds it to be within some 2 kilotonnes per year for the two decades preceding 2014. Starting in 2015, however, a difference between the two sets of emission estimates is found, emerging at 3 kilotonnes in 2015, growing to 9 kilotonnes in 2016, reaching a peak of 15 kilotonnes in 2019 and decreasing in the subsequent three years to approximately 10.5–12.5 kilotonnes in 2022.

14. According to the Scientific Assessment Panel, the development of that difference may potentially be related to the development of HFC-23 abatement by key producing parties initially through the Clean Development Mechanism and later on the Montreal Protocol, as amended by the Kigali Amendment, recognizing that other as yet unknown factors may have been involved.

15. As provided in decision XXXV/7, the report of the Technology and Economic Assessment Panel, prepared by its Medical and Chemicals Technical Options Committee, assesses the industrial processes that are likely to contribute to HFC-23 emissions to the atmosphere, including feedstock use, use as a fire suppressant, use in very cold temperature refrigeration, use as an etchant and cleaning agent in semi-conductor and electronics manufacturing, and by-production associated with the production of HCFC-22, some HFCs, and chemicals created in the polymerization of HCFC-22 to produce plastics (for example, trifluoroethylene and hexafluoropropene).

16. Information about HFC-23 consumption per sector and per country is presented in sections 2.1–2.5 of the Panel's report, based on available data reported to the Ozone Secretariat and other sources including the Framework Convention on Climate Change for 2020, 2021 and/or 2022. With regard to HFC-23 by-product generation from HCFC-22 production, the Panel provides estimates for the years 2019–2022, with values being in the range of about 18–36 kilotonnes in 2022. It further presents HFC-23 emissions from HCFC-22 production reported by parties under Article 7 amounting to about 836 tons in 2022.

17. Upon further analysis, the Technology and Economic Assessment Panel finds total reported and estimated HFC-23 emissions from known sources to be 1.47–3.54 kilotonnes in 2022, excluding the potential additional source of HFC-23 from atmospheric oxidation of less than 0.43 kilotonnes per year in recent years reported by the Scientific Assessment Panel.

18. The global HFC-23 emissions estimated by the Technology and Economic Assessment Panel are substantially lower than those estimated by the Scientific Assessment Panel (13.9 ± 0.7 kilotonnes) for 2022 based on atmospheric observations. While the two Panels note the uncertainties involved in their estimates, they acknowledge that there are differences between their global HFC-23 emission estimates that cannot currently be explained.

⁴ Comprising data and information reported by Annex I parties and under the Clean Development Mechanism of the Kyoto Protocol.

2. Nominations for critical-use exemptions for methyl bromide for 2025 (sub-item 4 (I) of the provisional agenda for the preparatory segment)

19. As is mentioned in the note by the Secretariat (UNEP/OzL.Conv.13/2–UNEP/OzL.Pro.36/2, paras. 89–92), the Methyl Bromide Technical Options Committee of the Technology and Economic Assessment Panel evaluated one critical-use exemption for methyl bromide for 2025 submitted in 2024 by Canada, a party not operating under paragraph 1 of Article 5 (non-Article 5 party).

20. According to the Committee, the submitted nomination was attributed to environmental conditions, regulatory restrictions that did not allow for partial or full use of alternatives that had been used successfully for this sector in other countries, and difficulties in the scale-up of substrate technologies and associated economic costs.

21. In accordance with customary practice, the Committee evaluated the nomination and made an interim recommendation for approval of the full amount nominated by Canada for 2025, as set out in volume 2 of the 2024 report of the Technology and Economic Assessment Panel,⁵ which was considered by the Open-ended Working Group at its forty-sixth meeting in July 2024. In making its recommendation, the Committee took into consideration that the nomination represented a significant (26 per cent) decrease in the amount that had been approved for 2024, noting that the party had also indicated that it did not intend to submit a nomination for 2026 and subsequent years.

22. Given that no reassessment of the nomination was required, and no further information or issues were raised by the Working Group, the Committee put its interim recommendation forward as a final recommendation. The nomination submitted by Canada for 2025 and the final recommendation by the Committee are listed in the table below. The report of the Committee, as set out in volume 4 of the 2024 report of the Technology and Economic Assessment Panel, containing detailed information on the final recommendation, is available on the meeting portal for the Thirty-Sixth Meeting of the Parties.⁶

Summary of the nomination for the 2025 critical-use exemption for methyl bromide submitted in 2024 and the final recommendation of the Methyl Bromide Technical Options Committee

(Metric tons)

<i>Party and sector</i>	<i>Nomination for 2025</i>	<i>Final recommendation for 2025</i>
Non-Article 5 party and sector		
Canada		
Strawberry runners	2.850	[2.850]
Total	2.850	[2.850]

23. In addition to the final recommendation on the submitted critical-use nomination, the report of the Methyl Bromide Technical Options Committee includes information on the reporting requirements under relevant decisions; trends in methyl bromide critical-use nominations and exemptions for all parties that have submitted nominations to date; and the reported accounting frameworks for critical uses and stocks of methyl bromide.

24. According to the accounting framework information submitted by the nominating party in 2024, at the end of 2023 Canada had no available stocks.

25. As in its previous reports, the Committee reiterated that the current accounting information presented by relevant parties did not accurately show the total stocks of methyl bromide held globally for controlled uses by Article 5 parties. This is because reports on stocks are required only from parties applying for critical-use exemptions, some parties have no formal mechanism to account accurately either for such stocks or for stocks used in quarantine and pre-shipment applications, and there is no requirement for parties under the Montreal Protocol to report pre-2015 stocks. According to the Committee, such stocks might be substantial (approximately 1,000 tonnes).

26. The Committee was also concerned that not all parties might be aware of the need to report all methyl bromide uses, including for quarantine and pre-shipment, feedstocks and critical uses, whether controlled or not, under Article 7 of the Protocol. and suggested that these parties would benefit from additional guidance or assistance to fulfil their reporting obligations.

⁵ <https://ozone.unep.org/system/files/documents/TEAP-CUN-interim-report-may-2024.pdf>.

⁶ <https://ozone.unep.org/system/files/documents/TEAP-CUN-final-report-aug-2024.pdf>.

27. The parties may wish to consider the final report and recommendations of the Methyl Bromide Technical Options Committee and adopt a decision on critical-use exemption and associated issues as appropriate.

3. Changes in the membership of the Technology and Economic Assessment Panel (sub-item 4 (m) of the provisional agenda for the preparatory segment)

28. Information about the status of membership of the Technology and Economic Assessment Panel and its technical options committees, including an outline of the nomination process, is set out in the note by the Secretariat (UNEP/OzL.Conv.13/2–UNEP/OzL.Pro.36/2, paras. 93–100 and annex I). Pursuant to decision XXXI/8, parties wishing to nominate experts to the Panel are requested to use the Panel’s nomination form, available on the Secretariat website, and are urged to follow the terms of reference of the Panel, consult the co-chairs of the Panel and refer to the matrix of needed expertise prior to making nominations.

29. At the time of preparation of the present addendum, the Secretariat had received submissions from the following parties:

(a) Brazil, nominating Paulo Altoe, currently a co-chair of the Flexible and Rigid Foams Technical Options Committee, to continue serving on the Technology and Economic Assessment Panel in that role for an additional period of four years; and Sueley Machado, currently a senior expert on the Technology and Economic Assessment Panel, to continue serving on the Panel in that role for an additional period of four years;

(b) Lebanon, nominating Bassam Elassaad, currently a member of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee, to serve on the Technology and Economic Assessment Panel as senior expert for a period of three years.

The completed nomination forms and curriculum vitae of the nominees are posted on the portal of the Thirty-Sixth Meeting of the Parties.

30. The parties may wish to consider these nominations, along with any others that the Secretariat may receive prior to and during the Thirty-Sixth Meeting of the Parties.

4. Classification of the State of Palestine as a party operating under paragraph 1 of Article 5 of the Montreal Protocol and access to support from the Multilateral Fund (sub-item 4 (o) of the provisional agenda for the preparatory segment)

31. As indicated in paragraph 103 of the note by the Secretariat on issues for discussion by and information for the attention of the Conference of the Parties to the Vienna Convention at its thirteenth meeting and the Thirty-Sixth Meeting of the Parties to the Montreal Protocol (UNEP/OzL.Conv.13/2–UNEP/OzL.Pro.36/2), on 30 July 2024, the Secretariat received a letter dated 29 July 2024 from the Office of the Chair of the Environmental Quality Authority of the State of Palestine, requesting the inclusion of the matters of the classification of the State of Palestine as an Article 5 party and its access to support from the Multilateral Fund in the provisional agenda of the preparatory segment of the combined thirteenth meeting of the Conference of the Parties to the Vienna Convention and Thirty-Sixth Meeting of the Parties to the Montreal Protocol (Annex III to UNEP/OzL.Conv.13/2–UNEP/OzL.Pro.36/2).

32. Annex III to the present note contains further background information to assist parties in their consideration of the request of the State of Palestine to be classified as an Article 5 party, as described in paragraph 31 above.

Annex I*

Report by the Scientific Assessment Panel

Response to decision XXXIV/7: Emissions of HFC-23

Executive Summary

From 2019 to 2022, the global mean atmospheric abundance of hydrofluorocarbon-23 (HFC-23; CHF₃) increased at Earth's surface by 1.13 ppt yr⁻¹. This rate of increase was 6% slower than the 1.20 ppt yr⁻¹ observed during 2016-2020. HFC-23 atmospheric mole fraction reached 35.9 ± 0.9 ppt in 2022, accounting for 6.9 mW m⁻² of radiative forcing. Total radiative forcing from all HFCs amounted to 44.1 mW m⁻² in 2020.

Global emissions of HFC-23 estimated from measured atmospheric abundances have steadily decreased from a high of 17.3 ± 0.8 kt in 2019 (254 MMTCO₂e) to 13.9 ± 0.7 kt in 2022 (204 MMTCO₂e) in 2022. This decrease in emissions was observed despite an increase in total production of hydrochlorofluorocarbon-22 (HCFC-22; CHF₂Cl) reported for all uses from 2019 to 2022, noting that the principal source of HFC-23 is as a by-product from HCFC-22 production. The decline in global HFC-23 emissions while HCFC-22 production was increasing may reflect increased mitigation of HFC-23 emissions as an increasing number of parties ratified the 2016 Kigali Amendment to the Montreal Protocol.

Global emissions of HFC-23 estimated from measured atmospheric abundances can be contrasted with values derived from reporting to the United Nations Framework Convention on Climate Change (UNFCCC), the Multilateral Fund for the Implementation of the Montreal Protocol (MLF), and the Ozone Secretariat. From 1995 to 2014, good consistency was observed between estimated and reporting-based global emissions of HFC-23. This was the case even from 2005 to 2014 when reported HFC-23 destruction, mostly in China and supported by the UNFCCC's Clean Development Mechanism (CDM), peaked near 9 kt yr⁻¹. After 2014, differences (or gaps) emerged between estimated and reporting-based global emissions of HFC-23. The gaps grew to reach a peak of 15 kt in 2019 and have decreased in the three years since 2019 to reach approximately 10.5 - 12.5 kt in 2022.

The increasing emission gaps between 2015 and 2018 are similar in magnitude and coincident in time with the destroyed amounts of HFC-23 reported by China to the MLF, amounts that are consistent with the country's Hydrochlorofluorocarbon Production Phase-out Management Plan (HPPMP) agreement with the MLF Executive Committee.

The emission gaps after 2015 are substantially larger than can be explained by emissions from all known sources and reported abatements. An assessment by the Technology and Economic Assessment Panel (TEAP) estimates HFC-23 emissions from all known sources and reported abatements after 2020 to be in the range of 1.47 - 3.54 kt yr⁻¹, which is substantially smaller than the atmospherically-derived mean of 15 kt yr⁻¹ during 2020 to 2022.

The decrease in the gaps after 2020 is concurrent with a declining ratio of global atmospherically-derived HFC-23 emissions relative to reported total HCFC-22 production (E_{23}/P_{22}), suggesting an increase in the inferred overall abatement of HFC-23 emissions.

HFC-23 is produced in the atmosphere from reactions that oxidize fluorinated gases present in the atmosphere. An upper limit to this source in 2022 is estimated to be 0.43 kt HFC-23 yr⁻¹, which accounts for less than 3.1% of global HFC-23 emissions in that year. This estimate is an upper limit, meaning that the actual value could be substantially smaller. The magnitude of this HFC-23 source is estimated using measured atmospheric abundances of relevant fluorinated gases, where available, and laboratory kinetic studies of the reactions that lead to HFC-23 production.

* The annex has not been formally edited.

New atmospheric measurements have refined the quantification of HFC-23 emissions in some geographic regions. The sum of available regional emission estimates is less than the global total derived from atmospheric abundances in the remote atmosphere, indicating that not all regional sources are included to date. Indeed, atmosphere-based estimates are not available for all parties producing HCFC-22 in recent years. Estimates have become available based on atmospheric abundances measured at stations in and around China, and new estimates or updates are available from the United Kingdom, western Japan, Korea, The Netherlands, and portions of Europe.

From 2015 to 2019, regional HFC-23 emission estimates were derived for eastern China from atmospheric abundances measured at the Gosan, Korea, station. The emissions from eastern China increased during these years from 5.7 ± 0.3 to 9.5 ± 1 kt yr⁻¹ despite reporting provided to the MLF showing that by 2018 more than 95% of the HFC-23 generated in China had been destroyed, stored, or used as feedstock. The derived geographical distribution of regional sources is broadly consistent with known locations of fluorochemical production facilities in China, including those producing HCFC-22. Since 2020, additional HFC-23 measurements made at multiple sites in China suggest continued emissions of HFC-23 during 2020-2023, in amounts from two different regions of 3.2 ± 0.9 and 6.7 ± 3.1 kt yr⁻¹, which are substantially larger than A7 emissions for controlled processes reported for all of China to the Ozone Secretariat (between 0.5 to 1.1 kt yr⁻¹ during 2020-2022). Based on these studies, unreported emissions from China account for approximately 20 to 50% of the global emissions gap during 2015 to 2022.

Estimates of regional emissions of HFC-23 derived from measured atmospheric abundances have also become available during 2008 to 2021 for a number of countries other than China or portions of those countries (Australia, Belgium, Democratic People's Republic of Korea, France, Germany, Ireland, Japan, Luxembourg, Netherlands, Republic of Korea, and the United Kingdom). Summed emissions in recent years from these countries totals 0.75 kt yr⁻¹, which is 0.4 kt yr⁻¹ higher than their reporting and not enough to explain a significant portion of the global emission gap. Together, HCFC-22 production in China and these other regions accounted for about 85% of reported HCFC-22 production in 2022. Atmospherically-derived HFC-23 emission estimates are not available in recent years for the countries that account for nearly all of the remaining HCFC-22 production reported during 2022: India, the United States, and the Russian Federation.

A substantial shortfall remains in the attribution of global emissions of HFC-23 to known sources or regions despite the new information provided in this Supplemental Report. The gap between reported emissions and those inferred from atmospheric abundances is not reconciled by considering all known sources. The sum of updated estimates of previously unrecognized or unaccounted sources as provided by TEAP (TEAP, 2024) and the estimated production from the atmospheric oxidation of other fluorinated industrial gases could reduce the emissions gap by as much as 3 kt/yr⁻¹. However, regional studies conclude that emissions in recent years from regions of China are substantially larger than expected from China as a whole (by as much as 6 kt), and they account for a substantial fraction of the gap (18-55%). These emissions have not been reported or considered previously in a quantitative assessment of the global gap. In contrast, the total of regional emissions from 11 other countries in recent years are small relative to the gap (less than 4%). A regional-scale accounting of global emissions remains incomplete, as atmosphere-based estimates are not available from some regions of the world that are potentially significant sources of HFC-23 emission.

Annex II***2024 Report by the Technology and Economic Assessment Panel,
Volume 5****Response to decision XXXV/7: emissions of HFC-23****Executive Summary**

Decision XXXV/7, paragraph 2, requests the Technology and Economic Assessment Panel (TEAP) to prepare a report to the Thirty-Sixth Meeting of the Parties containing information regarding:

- (a) The quantity of HFC-23 being consumed, by country and by sector;
- (b) Updated estimates on the amounts of HFC-23 generated at and emissions from HCFC-22 production facilities including methodology with respect to such emissions. In preparing this information, the Technology and Economic Assessment Panel should take into account information reported under paragraph 3 ter of Article 7 by all parties that manufacture Annex C, Group I and/or Annex F substances, as well as information from other sources.

Decision XXXV/7, paragraph 1, requests the Scientific Assessment Panel (SAP) to provide an update on HFC-23 emissions into the atmosphere and atmospheric concentrations to supplement the information in the 2022 quadrennial assessment report; paragraph 4 requests the Ozone Secretariat to make available on the website, aggregated by party, data reported under paragraph 3 ter of Article 7; and, paragraph 5 invites parties with available relevant scientific or technical information that may help inform the reports of the SAP and the TEAP to provide that information by 1 March 2024.

This report responds to paragraph 2 of decision XXXV/7. Among other things, TEAP had access to information made available by the Ozone Secretariat under paragraph 4 of the same decision. No technical information was provided by parties under paragraph 5 of decision XXXV/7 to help inform this report.

To provide additional context, and consistent with TEAP's approach in the 2022 MCTOC Assessment Report and 2023 Response to Decision XXXIV/7: Strengthening Institutional Processes with Respect to Information on HFC-23 By-Product Emissions, updated information has been provided on other HFC-23 emissions from consumptive and emissive uses of HFC-23, including as by-product from the production of other Annex C, Group I, and Annex F substances. For comparison, the report includes estimates of global "top-down" HFC-23 emissions based on atmospheric observations, as reported separately by SAP in its response to decision XXXV/7.¹

Background

There are several chemical mechanisms that can, by their nature, generate HFC-23 as a by-product in chemical production processes, including:

- *Over- or under-reaction of chemicals* present in the reaction vessel en route to the intended product, e.g., HFC-23 is an over-fluorination of HCFC-22.
- *Presence of impurities in the feedstocks that are being reacted*, e.g., the chloroform impurity in dichloromethane feedstock, used to produce HFC-32, is hydro-fluorinated to HFC-23.
- *Unintended side reactions*, where the feedstock follows a different reaction path than the one that is desired to make the product, e.g., cleavage of carbon–carbon bond in the production of HFC-125 from perchloroethylene, with subsequent hydro-fluorination of the resulting mono-carbon molecule to form HFC-23.

The generation of HFC-23 as a by-product during the production of HCFC-22 is far greater than the amount of HFC-23 required for use as feedstock or for consumption. Parties to the Montreal Protocol

* The annex has not been formally edited.

¹ UNEP 2024, September 2024 Report of the Science Assessment Panel, Response to Decision XXXV/7: Emissions of HFC-23.

that have ratified the Kigali Amendment in which HCFC-22 is produced² are required to destroy HFC-23 using a destruction technology, e.g., incineration, approved by the Meetings of the Parties to the Montreal Protocol. Operation and maintenance of incineration facilities to destroy HFC-23 by-product is a cost to the companies responsible for its generation, particularly as HCFC-22 is a low-cost product.

Quantity of HFC-23 being consumed, by country and by sector

Information on consumption is not always readily available to this level of granular detail requested in the decision, i.e., by country and by sector.

HFC-23 consumption and feedstock use data are not available for all parties due to the timing of reporting obligations associated with ratification of the Kigali Amendment. Some data are available from other sources relating to the quantities used for each of the applications.

As has been reported previously,³ HFC-23 is consumed as a feedstock in the manufacture of other chemicals and in very small quantities in emissive uses for fire suppression, very low temperature refrigeration, and for etchant and chamber cleaning in semiconductor and electronics manufacturing.

Several parties that manufacture Annex C, Group I and/or Annex F substances capture the HFC-23 that is generated for feedstock (primarily for the production of fipronil via Halon 1301) and/or emissive uses or divert it for destruction; alternatively, they produce HFC-23 separately for feedstock and/or emissive uses.

HFC-23 uses as fire suppressant and low temperature refrigerant create a bank of installed equipment containing HFC-23. HFC-23 emissions can occur during manufacture (filling), use, and at end-of-life. The use of HFC-23 as an etchant and for chamber cleaning results in emissions of unreacted HFC-23 that can be significantly reduced by implementation of emissions control technologies.

In 2022, total reported HFC-23 consumption (Article 7 and published by US EPA), excluding feedstock use, was 2,614.3 tonnes.

Only limited information on actual amounts of HFC-23 consumed in fire protection is available and indicates that HFC-23 consumption is typically small compared to HFC-227ea consumption. Based on indicative estimates and emission factor assumptions, HFC-23 fire protection emissions would be about 50 tonnes at the end of 2022, with a fire protection bank of about 1,700 tonnes.

There is very small consumption of HFC-23 in RACHP applications. It is only used in ultra-low temperature (ULT) refrigeration equipment (e.g., below -50°C) as the refrigerant in the low temperature stage of cascade refrigeration systems. Some emissions data are available from UNFCCC for 2021 suggesting that emissions are relatively low from this application compared with emissions of HFC-23 as a by-product.

Global consumption of HFCs for etchant and chamber cleaning in semiconductor and electronics manufacturing has increased significantly since 2013. Since 2013, the average annual growth rate of HFC-23 consumption for semiconductor manufacturing (etching and chamber cleaning) has been approximately 15%, from global consumption of 277 tonnes in 2013 to 720 tonnes in 2020. HFC-23 emissions were about 64 tonnes in 2013 and about 92 tonnes in 2020. Consumption and emissions are expected to have increased in 2021.

² The requirement for HFC-23 destruction applies generally to the production of HCFCs and HFCs. Article 2J, paragraph 6, states, “Each Party manufacturing Annex C, Group I, or Annex F substances shall ensure that for the twelve-month period commencing on 1 January 2020, and in each twelve-month period thereafter, its emissions of Annex F, Group II, substances generated in each production facility that manufactures Annex C, Group I, or Annex F substances are destroyed to the extent practicable using technology approved by the Parties in the same twelve-month period.”

³ [UNEP 2023, September 2023 TEAP Report, Volume 6: Response to Decision XXXIV/7: Strengthening Institutional Processes with Respect to Information on HFC-23 By-Product Emissions.](#)

Global HFC-23 consumption for feedstock use reported under Article 7 was 1,070 tonnes for 2022. Assuming an emission factor of 2.1% (the high end of the most likely range), emissions of about 22 tonnes are estimated from 1,070 tonnes of feedstock use.

Updated estimates for the quantities of HFC-23 generated at, and emissions from, HCFC-22 production facilities

Article 7 data on the production of HCFC-22 and emissions of HFC-23, reported by parties under mandatory obligations, are summarised in Tables 3.1 and 3.3, the latter supplemented with data for the United States from UNFCCC. Data is provided on a voluntary basis⁴ by parties on the quantities of HFC-23 generated from HCFC-22 production. HFC-23 generation data are not reported by all parties known to produce HCFC-22. Table 3.2 applies estimated HFC-23 by-product generation rates to Article 7 reported HCFC-22 production quantities to derive estimated HFC-23 by-product generation quantities from 2019 to 2022.

Total production of HCFC-22 reported under Article 7 was 1,196,999.41321 tonnes in 2022 (sub-totals in tonnes: A5 parties, 989,637.75; non-A5 parties, 207,361.66321). Estimated HFC-23 by-product generation from HCFC-22 production is expected to be in the range of about 18,000 to 36,000 tonnes in 2022. The total amount of HFC-23 emissions from HCFC-22 production reported under Article 7 and the UNFCCC (for the United States) was about 836 tonnes in 2022.

Updated contextual information on global HFC-23 emissions

Available best estimates of HFC-23 emissions from known emissions sources

An update is provided of estimates of global HFC-23 emissions, including from facilities that manufacture Annex C, Group I, or Annex F substances, as previously presented in the September 2023 TEAP response to decision XXXIV/7.5 The updated compilation of current best estimates of HFC-23 emissions is based on known sources and updated available information included in this report and from the September 2023 TEAP Report. Some of these are broad estimates where further information is currently not available to improve their accuracy.

The combined reported and best available annual⁶ estimate of HFC-23 emissions from known emissions sources is about 1,470–3,540 tonnes. These estimates exclude the potential additional source of HFC-23 from atmospheric oxidation of less than 430 tonnes per year in recent years, as reported by SAP.⁷ Under the UNFCCC's Category 2 Industrial Processes and Product Use for net HFC-23 emissions and removals, total HFC-23 emissions were reported to be 1,431 tonnes for 2021 for Annex I parties only.

In comparison, in response to decision XXXV/7, SAP reports estimated global HFC-23 emissions of 13,900 ± 700 tonnes for 2022 based on atmospheric observations.⁸

Elaborations of emissions estimation methodologies are included throughout the report and in the September 2023 TEAP Report.⁹

⁴ Section 10 of the instructions and guidelines "*Instruction VI on data on emissions of Annex F, Group II substance – HFC-23 (data form 6)*", paragraph 10.3, states, "*The information in columns 2 to 5 of data form 6 is excluded from the reporting requirements under Article 7 of the Protocol and is provided on a voluntary basis.*" The following text is at the top of data reporting form 6 on emissions: "*Note: Information in columns 2 to 5 is excluded from the reporting requirements under Article 7 of the Protocol and is provided on a voluntary basis.*"

⁵ [UNEP 2023, September 2023 TEAP Report, Volume 6: Response to Decision XXXIV/7: Strengthening Institutional Processes with Respect to Information on HFC-23 By-Product Emissions.](#)

⁶ Contemporaneous annual estimate for the recent years for which data is available or estimated, which is from 2020-2024.

⁷ UNEP 2024, September 2024 Report of the Science Assessment Panel, Response to Decision XXXV/7: Emissions of HFC-23.

⁸ UNEP 2024, September 2024 Report of the Science Assessment Panel, Response to Decision XXXV/7: Emissions of HFC-23.

⁹ [UNEP 2023, September 2023 TEAP Report, Volume 6: Response to Decision XXXIV/7: Strengthening Institutional Processes with Respect to Information on HFC-23 By-Product Emissions.](#)

Summary, uncertainties, and possible inferences from differences in HFC-23 emissions estimates

There are differences between the SAP and TEAP estimates of global HFC-23 emissions that cannot currently be explained.

SAP has described in its methodology elsewhere the uncertainties in the derivation of emissions estimates from atmospheric observations. However, these uncertainties do not bridge the differences between the SAP and TEAP estimates.

Data reported under Article 7 and the UNFCCC for HFC-23 emissions predominantly from HCFC-22 production contribute a major portion of TEAP's estimates of total HFC-23 emissions from known sources, noting also that around 95% of the estimated total global HFC-23 by-product generation is from HCFC-22 production.¹⁰

There are unknowns and uncertainties surrounding the Article 7 data for HFC-23 emissions, including how facilities are measuring and reporting HFC-23 emissions. Consideration of the approaches used by parties when measuring and reporting HFC-23 emissions might address some of these current unknowns and uncertainties. Guidance for facilities in measuring, estimating, and reporting emissions is available under the UNFCCC Guidelines and from national governments. The refinements under way for Data Form 6 might help resolve some of these possible data reporting issues.

There are also unknowns and uncertainties surrounding the TEAP estimations for sources other than HFC-23 emissions from HCFC-22 production; however, inaccuracy in estimations of these relatively smaller emissions is unlikely to bridge the difference with atmospheric-derived emissions. TEAP has identified all the major sources that are likely to contribute most of the HFC-23 emissions and these are outlined in the report. Any smaller unknown sources are unlikely to bridge the large difference with SAP estimates.

¹⁰ UNEP 2023, September 2023 TEAP Report, Volume 6: Response to Decision XXXIV/7: Strengthening Institutional Processes with Respect to Information on HFC-23 By-Product Emissions.

Annex III

State of Palestine

A. Introduction

1. Article 13 of the Vienna Convention for the Protection of the Ozone Layer provides that the Convention and any protocol shall be subject to ratification, acceptance or approval by States and by regional economic integration organizations. Instruments of ratification, acceptance or approval shall be deposited with the Depository. Article 14 of the Convention provides that Convention and any protocol shall be open for accession by States and by regional economic integration organizations from the date on which the Convention or the protocol concerned is closed for signature. The instruments of accession shall be deposited with the Depository.
2. The State of Palestine, a non-member observer State in the United Nations, acceded to the Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer on 18 March 2019. These treaties entered into force for Palestine on 16 June 2019.¹
3. As a party to the Vienna Convention and the Montreal Protocol,² the State of Palestine has the obligation to comply with all the provisions of the treaties and also has the right to full participation in the meetings of the parties to the Vienna Convention and the Montreal Protocol.
4. The State of Palestine has not ratified, accepted, or approved any of the amendments to the Protocol.³
5. Pending the classification of the State of Palestine as an Article 5 party, it is considered to have the obligations set out in Article 2 of the Montreal Protocol as adopted on 16 September 1987 (that is, without the amendments).⁴

B. Article 5, paragraph 1, of the Montreal Protocol and related decisions of the Meetings of the Parties

6. Article 5, paragraph 1, of the Montreal Protocol as adopted on 16 September 1987 (namely, without the amendments), provides as follows:

Any Party that is a developing country and whose annual calculated level of consumption of the controlled substances is less than 0.3 kilograms per capita on the date of the entry into force of the Protocol for it, or any time thereafter within ten years of the date of entry into force of the Protocol, shall, in order to meet its basic domestic needs, be entitled to delay its

¹ On 29 November 2012, the State of Palestine was granted to the status of “non-member observer State” by the United Nations General Assembly (see UNGA Resolution 67/19 on the status of Palestine in the United Nations). As an observer State, the State of Palestine does not have the right to vote in the General Assembly or to put forward its candidature to United Nations organs. However, it can become a party to treaties that have adopted the “all States” formula, such as the Vienna Convention for the Protection of the Ozone Layer.

² Two parties sent communications to the Depository in response to the notifications regarding the accession of the State of Palestine to the Vienna Convention and the Montreal Protocol, indicating that they do not recognize the accession of the State of Palestine to these two treaties. Relevant Depository Notifications are: [C.N.162.2019.TREATIES-XXVII.2](#), [C.N.164.2019.TREATIES-XXVII.2](#), [C.N.165.2019.TREATIES-XXVII.2.a](#) and [C.N.167.2019.TREATIES-XXVII.2.a](#). Responses of the State of Palestine are contained in Depository Notifications [C.N.448.2020.TREATIES-XXVII.2](#), [C.N.449.2020.TREATIES-XXVII.2](#), [C.N.451.2020.TREATIES-XXVII.2.a](#) and [C.N.452.2020.TREATIES-XXVII.2.a](#).

³ Following the practice in relation to the Vienna Convention and the Montreal Protocol (the ozone treaties), the State of Palestine is not considered a party to these amendments to the Montreal Protocol until it ratifies them: the [London Amendment](#) (adopted on 29 June 1990 and entered into force on 10 August 1992); the [Copenhagen Amendment](#) (adopted on 25 November 1992 and entered into force on 14 June 1994); the [Montreal Amendment](#) (adopted on 17 September 1997 and entered into force on 10 November 1999); the [Beijing Amendment](#) (adopted on 3 December 1999 and entered into force on 25 February 2002); and the [Kigali Amendment](#) (adopted on 15 October 2016 and entered into force on 1 January 2019).

⁴ The authentic text of the Montreal Protocol is available on this page: https://treaties.un.org/doc/Treaties/1989/01/19890101%2003-25%20AM/Ch_XXVII_02_ap.pdf. Since the State of Palestine has not ratified, accepted, approved or acceded to any of the amendments to the Montreal Protocol, the text of the Montreal Protocol without any of the amendments will be used for the purposes of this annex.

compliance with the control measures set out in paragraphs 1 to 4 of Article 2 by ten years after that specified in those paragraphs. However, such Party shall not exceed its annual calculated level of consumption of 0.3 kilogram per capita. Any such Party shall be entitled to use either the average of its annual calculated level of consumption for the period 1995 to 1997 inclusive or a calculated level of consumption of 0.3 kilograms per capita, whichever is the lower, as the basis for its compliance with its control measures.

7. Decision I/12E adopted by the First Meeting of the Parties does not include the State of Palestine in the list of countries that are to be considered as developing countries for purposes of the Protocol. The Third Meeting of the Parties, in decision III/5 on the definition of developing countries, decided, among other things, to consider the requests by States for classification as developing countries on an individual basis as and when they come. The same decision requested the Open-ended Working Group of the Parties to the Montreal Protocol to study and fully define the criteria which will be applied in the future in case of applications for classification as a developing country for the purpose of the Montreal Protocol, and to submit a report for consideration to the Fourth or Fifth Meeting of the Parties.

8. At the seventh meeting of the Open-ended Working Group of the Parties to the Montreal Protocol, under the agenda item on criteria for future classification as a developing country for the purpose of the Montreal Protocol, after a short discussion, it was decided that the Working Group would not make a specific recommendation on the issue.⁵ The Fourth Meeting of the Parties in decision IV/7, on the definition of developing countries, noted that the Open-ended Working Group recommended that no criteria for future classification as a developing country for the purpose of the Montreal Protocol be adopted by the Meeting of the Parties and decided that the parties should consider individually applications by parties for classification as developing countries as and when such applications are made.

9. Decision II/10, on data of developing countries, provides that in accordance with the provisions of Article 5 of the Protocol, no party will be eligible for paragraph 1 of Article 5 treatment until it submits complete data to the Secretariat establishing that its annual calculated level of consumption is below 0.3 kg per capita.

10. In decision VI/5, on the status of certain parties vis-à-vis Article 5 of the Protocol, the Sixth Meeting of the Parties adopted principles regarding treatment of classified and reclassified developing country parties. Among these principles are that the Secretariat should continue to classify, in the absence of complete data, developing countries temporarily as operating or not operating under Article 5 based on the information available to the Secretariat.

C. Information provided by the State of Palestine

11. In its request to be classified as an Article 5 party, the State of Palestine describes itself as “a developing country with limited resources”.

12. Under Article 7 of the Montreal Protocol as adopted initially in 1987 (that is, without any of the amendments), the State of Palestine was required to provide the Secretariat with:

(a) Statistical data on its production, imports and exports of each of the controlled substances for the year 1986, or the best possible estimates of such data where actual data was not available within three months of becoming a party; and

(b) Statistical data on the annual production, imports and exports to parties and non-parties, respectively, of such substances for the year during which it became a party and for each year thereafter, no later than nine months after the end of the year to which the data relate.

13. The State of Palestine has reported its level of consumption of chlorofluorocarbons (CFCs) and halons for 1986 (285 and 110 ODP tonnes, respectively). It has also reported a zero level of consumption of CFCs and halons for 2019, 2020, 2021 and 2022. In addition, it has reported its level of consumption of hydrochlorofluorocarbons of 31.9, 30.8, 0.14 and 0 ODP tonnes for the years 2019, 2020, 2021 and 2022, respectively, and its level of consumption of hydrofluorocarbons for 2020 and 2021 (62,625 and 385,520 CO₂-eq tonnes, respectively).

⁵ See paragraph 134 of the report of the Seventh Meeting of the Open ended Working Group of the Parties to the Montreal Protocol, UNEP/OzL.Pro/WG.I/7/4, <https://ozone.unep.org/system/files/documents/OEWG-7-4E.pdf>.

D. Access to support from the Multilateral Fund for the Implementation of the Montreal Protocol

15. In its request, the State of Palestine seeks access to support from the Multilateral Fund.
16. Article 10 on the financial mechanism was introduced through the London Amendment,⁶ which the State of Palestine has not ratified, accepted, approved or acceded to.
17. Paragraph 1 of Article 10 of the Protocol provides that the parties shall establish a mechanism for the purposes of providing financial and technical co-operation, including the transfer of technologies, to parties operating under paragraph 1 of Article 5 of the Protocol to enable compliance with the control measures set out in Articles 2A to 2E, Article 2I and 2J, and any control measures in Articles 2F to 2H that are decided pursuant to paragraph 1 bis of Article 5 of the Protocol.⁷
18. If the State of Palestine ratifies, accepts, approves or accedes to the London Amendment which established the financial mechanism and the transfer of technology, and once that amendment has entered into force for it, it will become eligible to operate under the financial mechanism. Once the determination is made on its classification as an Article 5 party, it will become eligible for support from the Multilateral Fund. Its eligibility for financial support for the phase-out of hydrochlorofluorocarbons will require its ratification acceptance, approval or accession to the London and Copenhagen amendments, and its eligibility for financial support for the phase-down of hydrofluorocarbons will require ratification, acceptance, approval or accession to the Montreal, Beijing and Kigali amendments.⁸
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⁶ The authentic text of the London Amendment is available on this page:
https://treaties.un.org/doc/Treaties/1992/08/19920810%2003-51%20AM/Ch_XXVII_02_bp.pdf.

⁷ Article 10 of the Protocol on the financial mechanism was introduced through the London Amendment, which referred to control measures set out in Articles 2A to 2E of the Protocol. References to additional articles that were incorporated into the Montreal Protocol through subsequent amendments were inserted into the text of Article 10 through the provisions of the respective amendments.

⁸ Each of the amendments following the London Amendment provides that no State or regional economic integration organization may deposit an instrument of ratification, acceptance, approval or accession to that amendment unless it has previously, or simultaneously, deposited, such an instrument to the previous amendment.