UNITED NATIONS

EP

UNEP/OzL.Pro.WG.1/40/2/Add.1

Distr.: General
29 May 2018

Original: English

United Nations Environment Programme

Open-ended Working Group of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer
Fortieth meeting
Vienna, 11–14 July 2018
Items 3, 4, 6 and 7 of the provisional agenda*

Issues for discussion by and information for the attention of the Open-ended Working Group of the Parties to the Montreal Protocol at its fortieth meeting

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 Open-ended Working Group of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer at its fortieth meeting (UNEP/OzL.Pro.WG.1/40/2) contains information that has become available since the preparation of that note. The additional information is set out in sections II and III of the addendum. Section II contains a summary of issues for discussion by the Open-ended Working Group at its fortieth meeting including information provided by the Technology and Economic Assessment Panel in its May 2018 report and on two proposed adjustments to the Montreal Protocol submitted by parties. Section III contains information on progress made in the implementation of decision XXVI/8 of the Twenty-Sixth Meeting of the Parties on measures to facilitate the monitoring of trade in hydrochlorofluorocarbons and substituting substances.

2. As indicated in the note by the Secretariat, the May 2018 report of the Technology and Economic Assessment Panel consists of five volumes:[1]

(a) Volume 1 contains the report of the working group established by the Panel in response to decision XXIX/9 on hydrochlorofluorocarbons and decision XXVII/5;

(b) Volume 2 contains the report of the task force established by the Panel in response to decision XXIX/4 on destruction technologies for controlled substances;

(c) Volume 3 contains the Panel's May 2018 progress report, including the following:

(i) Progress reports by each of the Panel's technical options committees;[2]

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* UNEP/OzL.Pro.WG.1/40/1/Rev.1.

[1] Available on the Ozone Secretariat meeting portal at: http://conf.montreal-protocol.org/meeting/oewg/oewg-40/presession/SitePages/Home.aspx.

[2] Flexible and Rigid Foams Technical Options Committee (chapter 2); Halons Technical Options Committee (chapter 3); Methyl Bromide Technical Options Committee (chapter 4); Medical and Chemicals Technical

(ii) Organizational and other matters;

(d) Volume 4 contains the Panel's May 2018 interim report on the evaluation of 2018 critical-use nominations for methyl bromide and related matters;

(e) Volume 5 contains the report of the task force established by the Panel in response to decision XXIX/10 on issues related to energy efficiency while phasing down hydrofluorocarbons.

II. Summary of issues for discussion by the Open-ended Working Group at its fortieth meeting

3. The issues for discussion by the Open-ended Working Group at its fortieth meeting are presented in the present section in the order in which the respective agenda items are listed in the provisional agenda of the meeting.

Agenda item 3
Kigali Amendment to the Montreal protocol to phase down hydrofluorocarbons

Destruction technologies for controlled substances (decision XXIX/4)

4. The note by the Secretariat presents information on destruction technologies for controlled substances in response to decision XXIX/4, including a summary of the initial findings of the Technology and Economic Assessment Panel task force that was established to deal with this matter (UNEP/OzL.Pro.WG.1/40/2, paras. 8–15 and annexes I and II). The note also indicates that 10 parties, namely Armenia, Australia, Canada, China, the European Union, Japan, Luxembourg, Mexico, the United States of America and Venezuela (Bolivarian Republic of), had submitted information in accordance with the decision. The information submitted by those 10 parties that was confirmed as non-confidential was summarized in appendix 1 to the task force report issued in April 2018 (volume 2 of the Technology and Economic Assessment Panel 2018 report),[3] and the substantive submissions were compiled in a separate document as explained in the report. That document, entitled "Annex to the report of the Technology and Economic Assessment Panel, April 2018, volume 2", is available on the meeting portal for the fortieth meeting of the Open-ended Working Group.[4]

5. Following the issuance of the April 2018 task force report, the Panel received additional information from some of the parties mentioned above, which is presented, along with the revised recommendations for the approved destruction technologies, in its supplemental report[5] as requested in decision XXIX/4. In addition to considering the relevant new information provided, the task force continued to conduct literature research, reviewed other publicly available information, held discussions with technology suppliers and owners, and sought clarification where necessary. As a result, the supplemental report provides updates on:

(a) The assessment of destruction technologies as specified in the annex to decision XXIII/12[6] with a view to confirming their applicability to hydrofluorocarbons (HFCs) (decision XXIX/4, para. 1 (a)) (chapter 3 of the supplemental report);

(b) The assessment of any other technology for possible inclusion in the list of approved destruction technologies in relation to controlled substances (decision XXIX/4, para. 1 (b)) (chapter 4 of the supplemental report).

6. In the supplemental report the task force outlines a number of general additional observations and considerations it has taken into account in finalizing its assessments and clarifies, in chapter 2, changes made in some of the assessment criteria used in its initial April 2018 report. It also indicates where insufficient data were available to assess adequately the destruction technologies against the performance criteria and for technical capability.

Options Committee (chapter 5); Refrigeration, Air-conditioning and Heat Pumps Technical Options Committee (chapter 6).

[3] http://conf.montreal-protocol.org/meeting/oewg/oewg-40/presession/Background-Documents/TEAP-DecXXIX4-TF-Report-April2018.pdf.

[4] http://conf.montreal-protocol.org/meeting/oewg/oewg-40/presession/Background-Documents/TEAP-DecXXIX4-TF-Report-April2018-annex.pdf.

[5] http://conf.montreal-protocol.org/meeting/oewg/oewg-40/presession/Background-Documents/TEAP-DecXXIX4-TF-Supplemental-Report-May2018.pdf.

[6] http://ozone.unep.org/en/handbook-montreal-protocol-substances-deplete-ozone-layer/25548.

7. A summary table of the task force's revised recommendations, presented in chapter 5 of the supplemental report, is reproduced in annex I to the present addendum. Extracts of the task force assessment in chapters 3 and 4 of the supplemental report are reproduced in annex II to the present addendum. The format of the information set out in annexes I and II has been altered from the original format in the supplemental task force report and the annexes have not been formally edited by the Secretariat.

Agenda item 4
Technology and Economic Assessment Panel 2018 report

8. The Technology and Economic Assessment Panel will present its findings and recommendations as contained in volumes 3 and 4 of its May 2018 report under item 4 of the provisional agenda. Volume 3 contains the Panel's annual progress report, the key messages of which are reproduced in annex III to the present addendum without formal editing by the Secretariat.[7] Volume 4 contains the interim report of the Methyl Bromide Technical Options Committee on the evaluation of 2018 critical-use nominations for methyl bromide and related matters.[8]

(a) Nominations for critical-use exemptions for methyl bromide for 2019 and 2020

9. As indicated in the note by the Secretariat (UNEP/OzL.Pro.WG.1/40/2, paras. 20 and 21), the Methyl Bromide Technical Options Committee evaluated a total of six nominations for critical-use exemptions submitted by two parties operating under paragraph 1 of Article 5 (Argentina and South Africa) and two parties not so operating (Australia and Canada). The evaluation of nominations and the initial recommendations of the Committee are discussed in volume 4 of the Technology and Economic Assessment Panel's 2018 report. Table 1 summarizes the nominations of the parties and the interim recommendations of the Committee, with brief comments in the footnotes to the table when the recommendations differ from the amounts nominated.

Table 1
Summary of the nominations for 2019 and 2020 critical-use exemptions for methyl bromide submitted in 2018 and the interim recommendations of the Methyl Bromide Technical Options Committee
(Metric tonnes)*

Party	*Nomination for 2019*	*Interim recommendation for 2019*	*Nomination for 2020*	*Interim recommendation for 2020*
Parties not operating under paragraph 1 of Article 5 and sector				
1. Australia				
Strawberry runners			28.98	[26.08][a]
2. Canada				
Strawberry runners	5.261	[4.735][b]		
Subtotal	**5.261**	**[4.735]**	**28.98**	**[26.08]**
Parties operating under paragraph 1 of Article 5 and sector				
3. Argentina				
Tomato	44.4	[25.60][c]		
Strawberry fruit	27.1	[15.71][d]		
4. South Africa				
Mills	2.0	[0.30][e]		
Structures	45.0	[29.93][f]		
Subtotal	**118.5**	**[71.54]**		
Total	**123.761**	**[76.275]**	**28.98**	**[26.08]**

* Tonne = metric ton.

[a] The nominated amount has been reduced by 10 per cent based on the recognition that the critical-use nomination is for 2020 and that non-chemical alternatives (soilless culture) for runner production are in widespread use in many countries for the production of high plant health status runners. Chemical alternatives continue to be trialled but results that are sufficient to allow acceptance by the certification authorities will probably not be available until after 2020.

[b] The nominated amount has been reduced by 10 per cent to account for the adoption of substrate production for foundation stock and the adoption of suitable varieties that will have a positive impact on subsequent generations.

[7] http://conf.montreal-protocol.org/meeting/oewg/oewg-40/presession/Background-Documents/TEAP-Progress-Report-May2018.pdf.

[8] http://conf.montreal-protocol.org/meeting/oewg/oewg-40/presession/Background-Documents/MBTOC-CUN-Interim-report-May2018.pdf.

[c] The nominated amount has been reduced by 42 per cent, based on a lower dosage rate (reduced from 26.0 to 15.0 g/m^2) for the adoption of barrier films (e.g., totally impermeable film (TIF)) for the nominated area of 258 ha, in accordance with the Methyl Bromide Technical Options Committee's standard presumptions.

[d] The nominated amount has been reduced by 42 per cent, based on the adoption of barrier films (e.g., TIF), which will decrease dosage rates from 26 to 15.0 g/m^2 for a final year of a three-year adoption period.

[e] The recommendation represents a reduction of 90 per cent from the approved amount of the critical-use exemption for 2018 for pest control in the three specific nominated mills. It is based on an amount of methyl bromide sufficient for a single fumigation per year per mill at 20 g/m^3 (Methyl Bromide Technical Options Committee standard presumption) as a further transitional measure to allow time for adoption and optimization of alternatives in an integrated pest management system, with phase-in of sulfuryl fluoride if desired.

[f] The recommendation represents a 33.49 per cent reduction of the amount requested, and a reduction of 30 per cent of the approved amount in 2018 for this sector, for the party to begin the implementation of control with sulfuryl fluoride in 2019 since the registration has been approved in 2018.

10. The nominating parties and the Methyl Bromide Technical Options Committee are expected to discuss further bilaterally, including during the fortieth meeting of the Open-ended Working Group, the interim recommendations and additional information that may be provided to the Committee for its final evaluation and recommendations. The final report of the Committee will be available prior to the Thirtieth Meeting of the Parties to the Montreal Protocol to be held in November 2018.

(b) Progress in the implementation of decision XXIX/8 on future availability of halons and their alternatives

11. In response to decision XXIX/8 on future availability of halons and their alternatives, outlined in the note by the Secretariat (UNEP/OzL.Pro.WG.1/40/2, paras. 22 and 23), the Halons Technical Options Committee notes in its progress report (section 3.4 of the Panel's May 2018 progress report) that it has continued to liaise with the International Civil Aviation Organization (ICAO) on the development and implementation of alternatives to halons, and their rate of adoption by civil aviation. As a result, ICAO has established an informal working group, including one of the co-chairs of the Halons Technical Options Committee and one of the co-chairs of the Technology and Economic Assessment Panel, to determine the uses and emissions of halon 1301 within civil aviation fire protection systems. The working group has prepared a survey that ICAO has agreed to send officially to all States with civil aviation halon 1301 service providers. The results of the survey are expected to provide a more accurate estimate of the amount of halon 1301 emitted annually by civil aviation worldwide. The timetable agreed by ICAO and the Halons Technical Options Committee has been set with a view to finalizing the working group's report prior to the Thirtieth Meeting of the Parties and the fortieth session of the ICAO Assembly in 2020, as requested in decision XXIX/8.

12. The Halons Technical Options Committee also notes in its progress report that civil aviation appears to be on schedule to meet the ICAO requirement to use only alternative agents to halon for all handheld extinguishers on aircraft manufactured after 31 December 2018. The agent, which is replacing halon 1211, is 2-bromo-3,3,3-trifluoro-prop-1-ene (2-BTP).

13. Furthermore, the Halons Technical Options Committee has reengaged with the International Maritime Organization (IMO) in an effort to update the decision XXVI/7 report on future availability of halons by assessing the quantity of halons installed on merchant ships, and the quantity and quality of halons being recovered from ship-breaking activities. The Committee suggests that the parties may wish to consider whether it might be worth pursuing a more formal relationship with IMO, such as through the development of a memorandum of understanding, in order to formalize this and other ozone-related activities.

14. The Halons Technical Options Committee is of the opinion that although research to identify potential new fire protection agents is continuing, it could take 5 to 10 years before a viable agent would have a significant impact on the fire protection sector.

(c) Development and availability of laboratory and analytical procedures that can be performed without using controlled substances under the Protocol (decision XXVI/5)

15. As set out in the note by the Secretariat (UNEP/OzL.Pro.WG.1/40/2, para. 24), by decision XXVI/5 the Twenty-Sixth Meeting of the Parties requested the Technology and Economic Assessment Panel to report no later than 2018 on the development and availability of laboratory and analytical procedures that could be performed without using controlled substances. In the Panel's May 2018 progress report (chapters 5 and 8), the Medical and Chemicals Technical Options Committee notes its intention to focus its resources and activities towards completing its report in time for the Thirtieth Meeting of the Parties.

16. Article 7 data related to laboratory and analytical uses have been analysed to determine the quantities of ozone-depleting substances produced and consumed. Small quantities of a wide range of about 40 different such substances are used in these applications, with an overall trend of decreasing global production over time.

17. While information is currently being collected about ozone-depleting substance uses in laboratory and analytical applications and possible alternatives, investigations into analytical procedures are proving to be challenging for the following reasons:

(a) Documented international and national standards are multitudinous and vary from country to country, covering a wide range of different applications;

(b) It is difficult to identify and access a complete range of relevant published standards set by organizations such as the International Organization for Standardization, ASTM International, and the European Committee for Standardization;

(c) Redundant standards that have been replaced by newer methods are still available from standard-setting organizations. It is sometimes difficult to characterize and identify whether a standard is new or has been replaced, and how it might relate to possible alternative procedures. This can hinder the identification of available alternative procedures.

18. The Medical and Chemicals Technical Options Committee notes that it would welcome available information from parties on this topic. As it continues to seek new members who are experts in laboratory and analytical uses, it also suggests that parties may wish to consider nominating such experts.

(d) Process agents (decision XVII/6)

19. As set out in the note by the Secretariat (UNEP/OzL.Pro.WG.1/40/2, paras. 25–28), in paragraph 7 of its decision XVII/6 on process agents, the Seventeenth Meeting of the Parties requested the Technology and Economic Assessment Panel to review the information submitted in accordance with the decision and to report and make recommendations to the parties at their Twentieth Meeting, in 2008, and every other year thereafter, on process-agent use exemptions, on insignificant emission associated with a use, and process-agent uses that could be added to or deleted from table A of decision X/14. Subsequent recommendations by the Panel led to table A of decision X/14 being revised a number of times over the years. The latest version of table A is included in the annex to decision XXIX/7.

20. In paragraph 8 of its decision XVII/6, the Meeting of the Parties also requested parties with process-agent uses to submit data to the Technology and Economic Assessment Panel by 31 December 2007 and 31 December of each subsequent year on opportunities to reduce emissions listed in table B of decision X/14. The Panel was requested to review in 2008, and every other year thereafter, emissions in table B of that decision, taking into account information and data reported by the parties in accordance with that decision, and to recommend any reductions to the make-up and maximum emissions with respect to table B on the basis of that review. As in the case of table A of decision X/14, subsequent recommendations by the Panel led to table B being revised a few times. The latest version of table B is set out in the annex to decision XXIII/7.

21. By 31 December 2017, three out of the four parties using ozone-depleting substances as process agents, China, the European Union and the United States of America, had submitted information on the implementation and development of emission reduction techniques in their process-agent uses, as requested in decision XXIX/7.

22. The Medical and Chemicals Technical Options Committee reviewed the information submitted on quantities produced or imported for process-agent applications, on make-up, levels of emissions, and containment technologies to minimize emissions for those uses. Based on that review, the Committee has found that:

(a) One party no longer requires ozone-depleting substances for two process agent applications;

(b) The reported emissions from the reported processes are considerably lower than the maximum emission limits that are given in table B of decision XXIII/7, suggesting that this may result either from the ceasing of use of controlled substances as process agents in certain processes or from a reduction in emissions through improvements in the processes or a combination of the two.

23. In the light of its findings, the Committee recommends that parties may wish to consider:

(a) Removing the following process-agent use from table A of decision XXIX/7:

Use of CFC-113 in the preparation of perfluoropolyether diols with high functionality;

(b) Updating and removing previously permitted uses of controlled substances as process agents in certain parties from table A of decision XXIX/7, in particular:

Recovery of chlorine by tail gas absorption in chlor-alkali production for the European Union.

(c) Reducing the quantities of make-up or consumption and maximum emission levels contained in table B of decision XXIII/7 to take into account the currently reported process-agent uses and emissions.

24. The proposed changes to table A of decision XXIX/7 are indicated in table 2 below, while table 3 reproduces table B of decision XXIII/7 on limits for process-agent uses, along with the make-up or consumption and emissions reported by parties for 2016.

Table 2
Changes to table A of decision XXIX/7 proposed by the Medical and Chemicals Technical Options Committee

List of uses of controlled substances as process agents

No.	*Process agent application*	*Substance*	*Permitted parties*
1	Elimination of NCl3 in chlor-alkali production	CTC	European Union, Israel, United States
2	Recovery of chlorine by tail gas absorption from chlor-alkali production	CTC	~~European Union,~~ United States
3	Production of chlorinated rubber	CTC	European Union
4	Production of chlorosulfonated polyolefin	CTC	China
5	Production of aramid polymer	CTC	European Union
6	Production of synthetic fibre sheet	CFC-11	United States
7	Photochemical synthesis of perfluoropolyetherpolyperoxide precursors of Z-perfluoropolyethers and difunctional derivatives	CFC-12	European Union
~~8~~	~~Preparation of perfluoropolyether diols with high functionality~~	~~CFC-113~~	~~European Union~~
9	Production of cyclodime	CTC	European Union
10	Bromination of a styrenic polymer	BCM	United States
11	Production of high modulus polyethylene fibre	CFC-113	United States of

Abbreviations: CTC, carbon tetrachloride; CFC, chlorofluorocarbon; BCM, bromochloromethane.

Table 3
Limits for process-agent uses (table B of decision XXIII/7) and reported make-up or consumption and emissions for 2016

(Metric tonnes per year*)

Party	*Make-up or consumption Decision XXIII/7*	*Maximum emissions Decision XXIII/7*	*Reported make-up or consumption | for 2016*	*Reported emissions for 2016*
China	1,103	313	177.42	105.05
European Union	1,083	17	365.28	3.808
Israel	3.5	0	0	0.0143
United States	2,300	181	Not reported	[31.2 ODP-tonnes]
Total	4,489.5	511	*[542.70][a]*	*[108.8723][a]*

*Nominal totals for 2016, which exclude data not reported or data reported in ODP-weighted metric tonnes.
[a] Except for the United States which is given in ODP-weighted metric tonnes.

25. Parties may wish to consider the recommendations of the Medical and Chemicals Technical Options Committee and recommend appropriate action to be taken.

(e) Organizational and other matters

26. The present section contains information on organizational matters related to the Technology and Economic Assessment Panel and other key messages arising from the Panel's progress report. The Secretariat would like to thank the European Union for its financial contribution to assist the travel of experts from parties not operating under paragraph 1 of Article 5 (non-Article 5 parties) that participate in the meetings of the technical options committees and the Technology and Economic Assessment Panel as well as to provide administrative support for the work of the technical options committees co-chairs. Such expenses are not covered by the Trust Fund for the Montreal Protocol.

1. Organizational matters

27. Information on the status of the membership of the Technology and Economic Assessment Panel and its technical options committees as at May 2018 is included in annex 1 of the 2018 progress report (volume 3).

28. Table 4 lists the co-chairs and members of the Technology and Economic Assessment Panel whose membership expires at the end of 2018 and whose reappointment requires a decision by the Meeting of the Parties. The members of the technical options committees whose membership expires at the end of 2018 and whose reappointment does not require a decision by the Meeting of the Parties are listed in annex IV to the present addendum.

29. Nominations or renominations to technical options committees and temporary subsidiary bodies, and appointments or reappointments can be made at any time. The Panel has clarified that new appointments to technical options committees are to start from the date of appointment by the committee's co-chairs and are to end on 31 December of the fourth year of membership.

Table 4
Co-chairs and members of the Technology and Economic Assessment Panel whose membership expires at the end of 2018 and whose reappointment requires a decision by the Meeting of the Parties

Name	*Position*	*Country*
Members of the Technology and Economic Assessment Panel		
Marta Pizano	TEAP and MBTOC Co-Chair [a]	Colombia
Ashley Woodcock	TEAP Co-Chair	United Kingdom of Great Britain and Northern Ireland
Fabio Polonara	RTOC Co-Chair	Italy
Mohamed Besri	TEAP Senior Expert	Morocco
Marco Gonzalez	TEAP Senior Expert	Costa Rica
Sidi Menad Si-Ahmed	TEAP Senior Expert	Algeria
Shiqiu Zhang	TEAP Senior Expert	China

Abbreviations: MBTOC, Methyl Bromide Technical Options Committee; RTOC, Refrigeration, Air-conditioning and Heat Pumps Technical Options Committee; TEAP, Technology and Economic Assessment Panel.

[a] Ms. Marta Pizano is both Co-Chair of the Technology and Economic Assessment Panel and of the Methyl Bromide Technical Options Committee; the expiration of her appointment at the end of 2018 refers to her role as Co-Chair of the Panel only.

30. The parties may wish to consider nominating or renominating and appointing or reappointing co-chairs and members, as appropriate, taking into account the Panel's terms of reference as set out in the annex to decision XXIV/8,[9] relevant extracts of which are reproduced in the following paragraphs for ease of reference. In doing so, the parties may wish to consider the expertise currently needed by the Panel and its technical options committees, as set out in the "matrix of needed expertise" contained in annex 2 to the progress report and posted on the Ozone Secretariat website.[10] The appointment of senior experts is being considered separately, under item 8 of the provisional agenda (UNEP/OzL.Pro.WG.1/40/2, paras. 45–47).

[9] http://ozone.unep.org/en/handbook-montreal-protocol-substances-deplete-ozone-layer/25513.

[10] See http://ozone.unep.org/en/teap-experts-required.

Extracts from the terms of reference for the Technology and Economic Assessment Panel (decision XXIV/8)

(a) Nominations to the Technology and Economic Assessment Panel, technical options committees and temporary subsidiary bodies

31. Paragraph 2.2.1 of the terms of reference, on nominations to the Technology and Economic Assessment Panel (TEAP), states that:

> Nominations of members to the TEAP, including co-chairs of the TEAP and TOCs, must be made by individual Parties to the Secretariat through their respective national focal points. Such nominations will be forwarded to the Meeting of the Parties for consideration.

32. Paragraph 2.2.2 of the terms of reference, on nominations to technical options committees (TOCs) and temporary subsidiary bodies (TSBs), states that:

> All nominations to TOCs and TSBs shall be made in full consultation with the national focal point of the relevant party.
>
> Nominations of members to a TOC (other than TOC co-chairs) may be made by individual parties or TEAP and TOC co-chairs may suggest to individual parties experts to consider nominating. Nominations to a TSB (including TSB co-chairs) can be made by the TEAP Co-chairs.

(b) Appointment of members of the Technology and Economic Assessment Panel and the technical options committees

33. Paragraph 2.3 of the terms of reference, on the appointment of members of TEAP, states that:

> The Meeting of the Parties shall appoint the members of TEAP for a period of no more than four years. The Meeting of the Parties may re-appoint members of the Panel upon nomination by the relevant party for additional periods of up to four years each.

34. Paragraph 2.5 of the terms of reference, on the appointment of members of TOCs, states that:

> Each TOC should have about 20 members. The TOC members are appointed by the TOC co-chairs, in consultation with TEAP, for a period of no more than four years. TOC members may be re-appointed following the procedure for nominations for additional periods of up to four years each.

(c) Size and balance of membership

35. Paragraph 2.1.1 of the terms of reference, on TEAP, states that:

> The membership size of the TEAP should be about 18–22 members, including 2 or 3 co-chairs to allow it to function effectively. It should include the co-chairs of the TOCs; there should be two co-chairs per TOC and 2–4 Senior Experts for specific expertise not covered by the TEAP co-chairs or TOC co-chairs, taking into account gender and geographical balance.
>
> At least one and preferably all of the TEAP co-chairs should not simultaneously serve as a TOC co-chair.

36. Paragraph 2.1.2 of the terms of reference, on TOCs, states that:

> Each TOC should have two co-chairs. The positions of TOC co-chairs must be filled to promote a geographical, gender and expertise balance. TEAP, through its TOC co-chairs, shall compose its TOCs to reflect a balance of appropriate and anticipated expertise so that their reports and information are comprehensive, objective and policy-neutral.

2. Other key messages arising from the progress report

37. Volume 3 of the Panel's progress report highlights a number of other issues for the attention of the parties, including updated information on the following matters:

(a) Status of global markets and drivers for foams, relevant regulations and codes (such as building codes for fire protection and for improving energy efficiency as well as safety codes and standards) and status of currently used hydrochlorofluorocarbon (HCFC), HFC and alternative substance blowing agents in the foam sector, progress made thereon to transition to low global warming potential (GWP) alternatives and associated needs (section 2);

(b) Global production and consumption of methyl bromide; update on alternatives for remaining critical uses; the continued concern raised by the Methyl Bromide Technical Options

Committee about the reporting of methyl bromide stocks and emissions of methyl bromide from quarantine and pre-shipment uses; and update on the revision of the International Standard for Phytosanitary Measure (ISPM) 15 on the use of methyl bromide for the treatment of wood packaging materials (section 4);

(c) Feedstock uses of ozone-depleting substances along with global use trends, estimated emissions and minimization emission techniques (section 5.3.5);

(d) Update on solvent uses of ozone-depleting substances (section 5.3.6);

(e) Report on the use and emissions of n-propyl bromide, a substance not controlled under the Montreal Protocol, as requested by decision XIII/7 of the Thirteenth Meeting of the Parties (section 5.3.7);

(f) Update on emissions of carbon tetrachloride (section 5.3.8);

(g) Update on the status of refrigerants and technology in the refrigeration, air-conditioning and heat pumps sector and emerging trends (section 6).

3. Challenges in the operation of the Technology and Economic Assessment Panel

38. Once again, in its progress report the Technology and Economic Assessment Panel addresses a number of ongoing challenges it faces in discharging its functions with a view to bringing those challenges to the attention of the parties. Major issues continue to include the identification and involvement of members with appropriate history, experience, technical expertise and time availability; attrition through retirement of members of the technical options committees; the substantially increased workload in recent years which, if unaddressed, will increasingly affect the delivery and timeline of the Panel's outputs; and the absence of funding for co-chairs of technical options committees and temporary subsidiary bodies given the substantial administrative responsibility associated with bringing their respective groups to consensus, generating draft reports and delivering final products within strict deadlines.

39. The Panel has expressed its determination to reinvigorate its membership and leadership, while maintaining the involvement of the technical options committee members and senior expert members with substantial experience in order to ensure the continuity of its work. In view of the adoption of the Kigali Amendment, the main focus of the Panel and its technical options committees in terms of membership is the identification of experts in new technical areas, such as safety and energy efficiency, for possible nomination to the technical options committees or the Panel, should the parties request further studies in such areas.

40. With regard to the expiration of the membership of several of its members in 2018, the Panel notes that although this carries the risk of loss of expertise and continuity, it also provides an opportunity for reinvigoration and refocusing.

41. The Panel suggests that there may be a need for it and the parties to consider the overall annual workload, the deadlines for delivery and the support for the Panel at the time of making decisions requesting specific work. Welcoming the opportunity to further engage with parties to address its challenges, the Panel reaffirms its commitment to continue serving the needs of the parties.

Agenda item 6
Issues related to energy efficiency while phasing down hydrofluorocarbons (decision XXIX/10)

(a) Report by the Technology and Economic Assessment Panel on energy efficiency in the refrigeration, air-conditioning and heat pump sectors

42. In response to decision XXIX/10 on issues related to energy efficiency while phasing down hydrofluorocarbons, outlined in the note by the Secretariat (UNEP/OzL.Pro.WG.1/40/2, paras. 34–37), the Technology and Economic Assessment Panel established a task force comprising Panel and technical options committee members as well as outside experts. The task force prepared the report requested in the decision and addressed the issues raised (volume 5 of the Technology and Economic Assessment Panel 2018 report).[11] The executive summary of that report is reproduced in annex V to the present addendum, without formal editing by the Secretariat. The task force response to the parties' requests included in the decision is summarized in the following paragraphs.

[11] http://conf.montreal-protocol.org/meeting/oewg/oewg-40/presession/Background-Documents/TEAP_DecisionXXIX-10_Task_Force_EE_May2018.pdf.

(i) Technology opportunities and challenges to maintain and/or enhance energy efficiency of new refrigeration, air conditioning and heat pump equipment

43. Opportunities to maximize energy efficiency improvement or reduction in energy consumption in refrigeration, air-conditioning and heat pump equipment include: ensuring the minimization of cooling and heating loads; selection of appropriate refrigerant; use of high-efficiency components and system design; ensuring proper installation and optimized control and operation under all common operating conditions; and designing features to support servicing and maintenance.

44. There continue to be many persistent barriers to the uptake of more efficient equipment, which can be classified in the following categories: financial, market, information, institutional and regulatory, technical, service competency and others.

45. Improvements in total system design can yield the largest energy efficiency improvements (compared to a baseline design) ranging from 10 to 70 per cent, while the impact of refrigerant choice on the energy efficiency of the units is usually relatively small, typically ranging from +/-5 to 10 per cent.

(ii) Long-term sustainable performance and viability

46. In line with previous assessments, the task force interprets the term “long-term” for refrigeration, air-conditioning and heat pump technologies to mean “for a period of up to 15 years”. Regarding the term “sustainable performance and viability” (over the 15-year “long-term” time frame), the task force looks to assess whether or not the options and requirements for technology that are commercially available today, and are being commercially developed for the nearer term, would be anticipated to at least meet energy efficiency needs and whether or not they would remain viable over the next 15 years, including with respect to servicing.

47. In the light of the above, the task force finds that the relevant aspects that will impact the long-term sustainment of performance are expected to be technology choices and minimum energy performance standards. In some cases, it may be particularly important to ensure engagement with the customer and the industry and consider issues related to the whole supply chain in order to ensure that the process of putting those technologies to practical use is not jeopardized.

(iii) High-ambient-temperature considerations

48. High-ambient-temperature conditions impose additional challenges on the selection of refrigerants, system design and potential energy efficiency enhancement opportunities. Additional requirements include ensuring that the refrigerant can continue to deliver and sustain acceptable efficiency at elevated ambient temperatures, and that the refrigerant does not break down or react with system components at high temperatures.

(iv) Environmental benefits in terms of carbon dioxide equivalent

49. Over 80 per cent of the global warming impact of refrigeration, air-conditioning and heat pump systems is associated with the indirect emissions generated during the production of the electricity used to operate the equipment (indirect), with a lower proportion coming from the use and release (direct emissions) of greenhouse gas refrigerants. The environmental impact of improving system efficiency is a factor of the type of equipment, how many hours and when it is used (influenced by ambient temperature and humidity conditions), and the emissions associated with power generation, which vary by country.

50. Reducing cooling and heating loads presents the best opportunity to reduce both indirect emissions, through lower consumption of electricity, and direct emissions, through the reduction of the refrigerant charge associated with the load.

(v) Servicing sector requirements

51. While some energy efficiency degradation over the lifetime of equipment is inevitable, there are ways to limit such degradation through improved design and servicing. The impact of proper installation, maintenance and servicing on the efficiency of equipment and systems over its lifetime is considerable, while the impact on additional cost is minimal.

(vi) Capacity-building requirements

52. A number of enabling activities such as capacity-building, institutional-strengthening, demonstration projects and national strategies and plans help to bridge Montreal Protocol activities under the Kigali Amendment and energy efficiency. In addition to support provided by the Multilateral Fund for the Implementation of the Montreal Protocol, such activities are supported by other sources of funding such as the Kigali Cooling Efficiency Programme and the Global Environment Facility.

(vii) Costs related to technology options for energy efficiency

53. The prices of higher efficiency equipment have been found to decline over time in various markets as higher efficiency equipment begins to be produced at scale. This applies especially to small mass-produced equipment where manufacturers quickly absorb the initial development costs and try to get to certain “price points” that help them to sell their equipment.

54. Rigorous cost analyses may be needed to fully understand the impact of energy efficiency improvements and can take more than a year to finalize for a single product category. Simplified examples of corresponding methodologies developed by various countries with established market transformation programmes for promoting energy efficiency, including minimum energy performance standards programmes and labelling programmes, is presented in section 2.7 of the task force report.

(viii) Funding institutions

55. There are numerous financing opportunities available for the implementation of projects on energy efficiency. In addition to funding institutions that provide resources in the form of directed grants (such as the Kigali Cooling Efficiency Programme and the Global Environment Facility), some financing institutions provide project funding support through mechanisms such as loans, green bonds or other instruments (such as the Green Climate Fund, the World Bank Group, international development banks, the German Agency for International Cooperation and specific European Union funds and programmes). Moreover, private capital represents an additional source of funding through companies that might be interested in financing project implementation against investment payback.

56. The relevant criteria, methodologies, financial modalities and other aspects of such institutions are also described in chapter 3 of the task force report.

Agenda item 7
Requirements for hydrochlorofluorocarbons for the period from 2020 to 2030 for parties not operating under paragraph 1 of Article 5 of the Protocol (decision XXIX/9)

(a) Report by the Technology and Economic Assessment Panel on hydrochlorofluorocarbons and decision XXVII/5

57. The key conclusions set out in the report by the working group established by the Technology and Economic Assessment Panel in response to decision XXIX/9[12] are summarized in the note by the Secretariat (UNEP/OzL.Pro.WG.1/40/2, paras. 41–44). As indicated in the note, nine parties, namely Armenia, Azerbaijan, Canada, Costa Rica, Japan, Kazakhstan, Mexico, Palau and Venezuela (Bolivarian Republic of), as well as an interested entity in the United States of America, submitted information in accordance with the decision. Following the issuance of the working group’s report, the substantive parts of those submissions were compiled in a separate document as explained in annex 1 to the report.The report is available on the meeting portal for the fortieth meeting of the Open-ended Working Group.[13]

(b) Proposed adjustments to the Montreal Protocol

58. Under item 7 (b) of the revised provisional agenda, the Working Group is expected to consider two proposals for adjustment of the Montreal Protocol submitted pursuant to paragraph 9 of Article 2 of the Protocol. In accordance with the procedure specified in the Protocol, any proposals for adjustments must be submitted six months prior to the meeting at which they are to be considered. The deadline for the submission of adjustment proposals to be considered at the Thirtieth Meeting of the Parties, which is scheduled to begin on 5 November 2018, was therefore 5 May 2018. As at 5 May 2018, two proposals for adjustments had been received by the Secretariat. One is a proposal by the United States (UNEP/OzL.Pro.WG.1/40/4, annexes I and II) and the other is a joint proposal by Australia and Canada (UNEP/OzL.Pro.WG.1/40/5, annexes I and II).

59. The proposal by the United States seeks to adjust the 0.5 per cent servicing tail for HCFCs from 1 January 2020 to 1 January 2030 to add coverage of the servicing of fire suppression equipment existing before 2020. The proposal would amend paragraph 6 (a) and (b) of Article 2F to expand the scope of the servicing tail which currently covers only existing refrigeration and air-conditioning

[12] http://conf.montreal-protocol.org/meeting/oewg/oewg-40/presession/Background-Documents/ TEAP-DecXXIX9-WG-Report-March2018.pdf.

[13] http://conf.montreal-protocol.org/meeting/oewg/oewg-40/presession/Background-Documents/TEAP-DecXXIX9-WG-Report-March2018-Annex1.pdf.

equipment, to include fire suppression equipment. The proposal would not increase the amount of the servicing tail.

60. The joint proposal by Australia and Canada seeks to permit essential-use exemptions of HCFCs to be considered and authorized by the Parties as is the case for other ozone-depleting substances and particularly to ensure that HCFCs continue to be available for laboratory and analytical uses after 2020. The proposal also seeks to extend the use of the existing 0.5 per cent servicing tail from 2020 to 2030 to service fire protection equipment installed before 2020 in addition to refrigeration and air-conditioning. The proposal would amend paragraph 6 of Article 2F to permit possible HCFC essential uses by Parties and paragraph 6 (a) and (b) of Article 2F to add fire protection equipment to the equipment permitted to be serviced with HCFCs after 2020.

III. Information for the attention of the Open-ended Working Group at its fortieth meeting

Provisional approval of Harmonized System codes for HFCs by the Harmonized System Committee of the World Customs Organization

61. On 9 March 2018, the Secretariat participated in the meeting of the Harmonized System Committee of World Customs Organization, which provisionally agreed on the adoption of Harmonized System (HS) codes under chapter 29 of the nomenclature for the 18 HFCs listed under the Kigali Amendment to the Montreal Protocol. The Committee adopted the HS codes by taking into account the environmental impact of HFCs in terms of their global warming potential levels and relative importance in international trade.

62. The Committee was, however, unable to conclude discussion on the classification of HFC mixtures (blends) due to concerns that the structure of the new HS codes that had been presented to the Committee did not properly harmonize the products proposed in the subheadings under chapter 38 of the nomenclature. The Committee referred the matter to the Harmonized System Review Subcommittee to sort out the inconsistencies in the proposed subheadings. The Harmonized System Review Subcommittee will meet in June 2018 to discuss the issue.

63. In addition to HFCs, the Committee also agreed to approve HS codes for methyl bromide and the four hydrofluoroolefins (HFOs), which had been dropped from the proposal for the Kigali Amendment in 2016. The decision to assign HS codes for HFOs was made for the purpose of monitoring their international trade in the future.

Annex I

Recommendations for list of approved destruction technologies

The existing list of approved destruction technologies is shown in the table below in green. Recommendations relevant to this assessment are shown in red (for the assessment of the applicability of approved destruction technologies to HFCs and any other technologies for possible inclusion on the list of approved destruction technologies). This table replaces the recommendations presented in the April 2018 task force report.

Technology	Applicability										
	Concentrated sources									Dilute sources	
	Annex A		Annex B			Annex C	Annex E	Annex F			Annex F
	Group 1	Group 2	Group 1	Group 2	Group 3	Group 1	Group 1	Group 1	Group 2		Group 1
	Primary CFCs	Halons	Other CFCs	Carbon tetrachloride	Methyl chloroform	HCFCs	Methyl bromide	HFCs	HFC-23	ODS	HFCs
DRE	99.99%	99.99%	99.99%	99.99%	99.99%	99.99%	99.99%	99.99%	99.99%	95%	95%
Cement kilns	Approved	Not approved	Approved	Approved	Approved	Approved	Not determined	High potential	High potential		
Gaseous/fume oxidation	Approved	Not determined	Approved	Approved	Approved	Approved	Not determined	Recommend for approval	Recommend for approval		
Liquid injection incineration	Approved	Approved	Approved	Approved	Approved	Approved	Not determined	Recommend for approval	High potential		
Municipal solid waste incineration										Approved	High potential
Porous thermal reactor	Approved	Not determined	Approved	Approved	Approved	Approved	Not determined	Recommend for approval	High potential		
Reactor cracking	Approved	Not approved	Approved	Approved	Approved	Approved	Not determined	High potential	High potential		
Rotary kiln incineration	Approved	Approved	Approved	Approved	Approved	Approved	Not determined	High potential	High potential	Approved	
Argon plasma arc	Approved	Approved	Approved	Approved	Approved	Approved	Not determined	Recommend for approval	High potential		
Inductively coupled radio frequency plasma	Approved	Approved	Approved	Approved	Approved	Approved	Not determined	Unable to assess	Unable to assess		
Microwave plasma	Approved	Not determined	Approved	Approved	Approved	Approved	Not determined	Unable to assess	Unable to assess		
Nitrogen plasma arc	Approved	Not determined	Approved	Approved	Approved	Approved	Not determined	Recommend for approval	High potential		
Portable plasma arc	Approved	Not determined	Approved	Approved	Approved	Approved	Not determined	High potential	Unable to assess		
Chemical reaction with H_2 and CO_2	Approved	Approved	Approved	Approved	Approved	Approved	Not determined	Recommend for approval	Recommend for approval		

Technology	**Applicability**										
	Concentrated sources									**Dilute sources**	
	Annex A		**Annex B**			**Annex C**	**Annex E**	**Annex F**			**Annex F**
	Group 1	**Group 2**	**Group 1**	**Group 2**	**Group 3**	**Group 1**	**Group 1**	**Group 1**	**Group 2**		**Group 1**
	Primary CFCs	**Halons**	**Other CFCs**	**Carbon tetrachloride**	**Methyl chloroform**	**HCFCs**	**Methyl bromide**	**HFCs**	**HFC-23**	**ODS**	**HFCs**
Gas phase catalytic dehalogenation	Approved	Not determined	Approved	Approved	Approved	Approved	Not determined	High potential	High potential		
Superheated steam reactor	Approved	Not determined	Approved	Approved	Approved	Approved	Not determined	High potential	High potential		
Thermal reaction with methane	Approved	Approved	Approved	Approved	Approved	Approved	Not determined	Unable to assess	Unable to assess		
Electric heater	Not determined	Not determined	Not determined	Not determined	Not determined	Not determined	Not determined	High potential	High potential		
Fixed hearth incinerator	Unable to assess										
Furnaces	Unable to assess										
Thermal decay of methyl bromide	Not determined	Not determined	Not determined	Not determined	Not determined	Not determined	High potential	Not determined	Not determined		
Air plasma arc	Unable to assess										
Alternating current plasma	Unable to assess										
CO_2 plasma	Unable to assess										
Steam plasma	Unable to assess										
Catalytic destruction											Unable to assess
Chlorination/de-chlorination to vinylidene fluoride	Not a destruction technology										
Solid alkali reaction	Unable to access										

Abbreviations: DRE, destruction and removal efficiency; ODS, ozone-depleting substances.

Annex II

Summary of recommendations for each technology listed in annex I*

The following sections present extracts of chapters 3 and 4 of the supplemental report to the 2018 April task force report on decision XXIX/4, including a summary of the recommendations provided therein for each destruction technology under consideration. The recommendations are based on the task force's assessment of existing approved technologies and other technologies for possible inclusion in the list of approved technologies in relation to controlled substances. The information is presented without formal editing by the Secretariat.

1. Assessment of approved destruction technologies to confirm their applicability to HFCs

Cement kilns: DRE (99.998%) and dioxin/furans data meet the performance criteria for the destruction of HFC-134a. Other emissions data were either unavailable or did not meet performance criteria. **Cement Kilns are recommended as *high potential* for applicability to HFCs destruction, including HFC-23**.

Gaseous/Fume Oxidation: Gaseous/Fume Oxidation is recommended for *approval* for applicability to HFCs destruction, including HFC-23, using HFC-23 data as a proxy for other HFCs.

Liquid Injection Incineration: DRE (99.995%) and emissions data are available that meet all of the performance criteria for HFC-134a destruction. No data were available for HFC-23 performance or destruction; therefore, **Liquid Injection Incineration is recommended for *approval* for applicability to HFCs destruction except for HFC-23, and as *high potential for* HFC-23 destruction.**

Municipal Solid Waste Incineration: No data from HFC destruction were available to the 2018 TFDT, and dioxins/furans emissions were higher than the performance criteria for ODS destruction, as noted in the 2002 TFDT report. **Municipal Solid Waste Incineration is recommended *as high potential* for applicability to destruction of dilute HFC sources (except for HFC-23), specifically for the destruction of HFC blowing agents in foam**.

Porous Thermal Reactor: Data for HFC-23 destruction were not available for this assessment. **Porous Thermal Reactor is recommended for *approval* for applicability to HFCs destruction except for HFC-23. Porous Thermal Reactor is recommended as *high potential* for applicability to HFC-23 destruction.**

Reactor Cracking: No emission data for particulates were available for assessment against the performance criteria. **Reactor Cracking is recommended as *high potential* for applicability to HFCs destruction, including HFC-23**.

Rotary Kiln Incineration: No HFC destruction data were available to undertake a performance criteria assessment for rotary kiln incineration; therefore, **Rotary Kiln Incineration is recommended as *high potential* for applicability to HFCs destruction, including HFC-23**.

Plasma Technologies

Argon Plasma Arc: DRE (99.994%) and emissions data are available that meet all of the performance criteria for HFC destruction except for HFC-23. For HFC-23 destruction, DRE and emissions data meet the performance criteria except for CO, which did not meet the performance criteria. Therefore, **Argon plasma arc is recommended for *approval* for applicability to HFCs destruction except for HFC-23, and as *high potential* for HFC-23 destruction.**

Inductively coupled radio frequency plasma: Due to insufficient data for HFC destruction applicability being available, **the 2018 TFDT is *unable to assess* Inductively Coupled Radio Frequency Plasma for applicability for HFCs destruction.**

Microwave Plasma: Due to insufficient data for Hbeing available, **the 2018 TFDT is *unable to assess* Microwave Plasma for applicability for HFCs destruction**.

* The format has been altered from the original version in the supplemental task force report.

Nitrogen Plasma Arc: DRE (99.99%) and emissions data are available that meet all of the performance criteria for HFC destruction, including for HFC-23. Therefore, **Nitrogen Plasma Arc is recommended for *approval* for applicability to HFCs destruction, including HFC-23.**

Portable Plasma Arc: While DRE, HF, and CO emissions meet the performance criteria for HFCs destruction, data were not available for particulates and dioxins/furans emissions for HFCs destruction. No emissions data were available for HFC-23 destruction. **Portable Plasma Arc is recommended as *high potential* for applicability to HFCs destruction except for HFC-23. The 2018 TFDT is *unable to assess* Portable Plasma Arc for applicability for HFC-23 destruction.**

Conversion (non-incineration) technologies

Chemical Reaction with H_2 and CO_2: Chemical Reaction with H_2 and CO_2 is recommended for *approval* for HFC destruction including HFC-23. Additional substantive information was provided by the technology owner for the 2018 TFDT Supplemental Report. The technology owner noted that refrigerants are first reclaimed to saleable purity of refrigerants before processing. Further, that all gases from the processes are recycled back into the reactor. Pressure relief devices are used on the reactors and other vessels as a means for pressure relief. These process features suggest that only DRE should be relevant for the assessment, and thus meets the performance criterion.

Gas Phase Catalytic De-halogenation: No dioxins/furans emissions data for HFCs destruction were available to the 2018 TFDT. The 2002 TFDT report noted that the TFDT believed that the dioxins/furans emissions would be comparable to those from rotary kilns, although also had no actual emissions data available. **Gas Phase Catalytic De-halogenation is recommended as *high potential* for applicability to HFCs destruction, including HFC-23.**

Superheated steam reactor: In the absence of emissions data demonstrating that it meets the performance criteria for particulates, **Superheated Steam Reactor is recommended for *high potential* for applicability to HFCs destruction, including HFC-23.**

Thermal Reaction with Methane: Due to insufficient data being available at the time of writing, **the 2018 TFDT is *unable to assess* Thermal Reaction with Methane to confirm its applicability to HFCs destruction**.

2. Assessment of any other technology for possible inclusion in the list of approved destruction technologies in relation to controlled substances

Thermal Oxidation

Electric Heater: The available emissions data applies to HFCs destruction. Particulate emissions that meet the performance criteria were unavailable. Additional DRE and more elaboration on the measurement of emission results would be useful, noting the general reporting of nil results. No information was provided to indicate whether other controlled substances (CFCs, etc.) have been destroyed using this technology. **Electric Heater is recommended as *high potential* for HFCs destruction, including HFC-23.**

Fixed Hearth Incinerator: No other data to assess the technology were provided. Due to insufficient data being available, **the 2018 TFDT is *unable to assess* Fixed Hearth Incinerators** for possible inclusion on the list of approved destruction technologies. Also, it is noteworthy that the operating temperatures appear to be lower than recommended in the European Union submission for optimal destruction of HFCs.

Furnaces Dedicated to Manufacturing: Due to insufficient data being available, **the 2018 TFDT is *unable to assess* Furnaces Dedicated to Manufacturing** for possible inclusion on the list of approved destruction technologies.

Thermal Decay of Methyl Bromide: The technical application submitted by one company (Australia) is described as a portable system for the capture and destruction of methyl bromide, at locations where it is used as a fumigant. The technology is based on destruction of methyl bromide by thermal decay in a single pass destruction step, followed by conversion of the by-products through a water-based scrubbing system. This technology is more than a capture system alone and, based on the information provided, falls within the scope of an assessment as a destruction technology.

Further information has been received to enable a more complete assessment of the technology against the performance and technical capability criteria.

DRE, HBr and particulate emissions meet performance criteria. A test to measure for brominated dioxins/furans emissions was not feasible in the circumstances, and CO emissions exceeded the performance criteria. **Thermal Decay of Methyl Bromide is recommended as *high potential* for methyl bromide destruction.**

Plasma technologies

Air Plasma Arc: No other data to assess the technology was provided. Due to insufficient data being available, **the 2018 TFDT is *unable to assess* Air Plasma Arc** for possible inclusion on the list of approved destruction technologies.

Alternating Current Plasma (AC Plasma): Due to insufficient data being available, **the 2018 TFDT is *unable to assess* AC Plasma Arc** for possible inclusion on the list of approved destruction technologies.

CO_2 Plasma: Due to insufficient data being available, and no data that meets the performance criteria, **the 2018 TFDT is *unable to assess* CO_2 Plasma Arc** for possible inclusion on the list of approved destruction technologies. The 2002 TFDT reported emissions data for dioxins/furans for the destruction of ODS that meets the performance criterion, and emissions data for particulates that do not meet the criterion.

Steam Plasma Arc: The 2018 TFDT has been unable to contact the technology owner. Due to insufficient data being available, **the 2018 TFDT is *unable to assess* Steam Plasma Arc** for possible inclusion on the list of approved destruction technologies.

Conversion (or non-incineration) technologies

Catalytic Destruction: Due to insufficient data being available, **the 2018 TFDT is *unable to assess* Catalytic Destruction** for possible inclusion on the list of approved destruction technologies.

Chlorination/De-chlorination to Vinylidene Fluoride: This technology is part of a chemical manufacturing process and is not a destruction n process.

Solid Alkali Reaction: Due to insufficient data being available, **the 2018 TFDT is *unable to assess* Solid Alkali Reaction** for possible inclusion on the list of approved destruction technologies.

Annex III

Technology and Economic Assessment Panel May 2018 Progress Report (Volume 3)

1.1. Key TEAP messages

TEAP presents the main findings contained in each of the TOC progress reports below.

1.1.1. *Flexible and Rigid Foams Technical Options Committee (FTOC)*

- Regulations continue to evolve regarding the use of hydrofluorocarbons (HFCs) as foam blowing agents. Significant transitions to low global warming potential (GWP) alternatives have occurred in many regions and especially in non-Article 5 parties (non- A5 parties) in the last two years.
- There have been significant improvements in the development and availability of additives, co-blowing agents, equipment and formulations and the availability of low GWP blowing agents enabling the successful commercialization of foam systems containing these agents especially for nonA5 parties where regulations related to GWP have been implemented. For some foam-types, conversions to zero ODP/low GWP alternatives are nearing completion (e.g. appliance foams, flexible foams, integral skin etc.).
- Article 5 parties (A5 parties) face common challenges in phasing out hydrochlorofluorocarbons (HCFCs) and phasing down high GWP HFC blowing agents.
    - HCFC Phase-out Management Plans (HPMPs) continue to drive transitions in foams.
    - In general, HCFCs are about one third of the cost of high-GWP HFCs and hydrofluorolefin / hydrochlorofluoro-olefin (HFO/HCFOs). HFO/HCFO blown foams remain more expensive than HFC foams due to the total cost of blowing agent and the required additives.
    - In some A5 parties, import of HCFC-141b itself is controlled or under license, but polyols containing HCFC-141b can be imported without controls. To counter this, some A5 parties are implementing regulations that would ban or restrict import of HCFC-containing polyol systems.
- Decisions on transition for some segments of use (e.g. spray foam and extruded polystyrene (XPS)) may be delayed because the cost of transition is still being optimised for some applications and regions.
- Matching the capacity to produce low-GWP alternatives to HCFCs, to the demand for use in foam blowing, will require continued communication between regulators, producers and users to ensure smooth transitions.
- Total global production of polymeric foams is projected to grow (3.9% per year) at a slightly lower rate than noted last year (4.0%), from 24 million tonnes in 2017, to 29 million tonnes by 2023. Production of foams used for insulation is expected to grow in line with global construction and continued development of refrigerated food processing, transportation and storage (cold chain).

1.1.2 *Halons Technical Options Committee (HTOC)*

- HTOC is of the opinion that although research to identify potential new fire protection agents continues, it could be five to ten years before a viable agent might have significant impact on the fire protection sector.
- In response to Decision XXIX/8, the International Civil Aviation Organization (ICAO) has formed an informal working group, including an HTOC co-chair and a TEAP co-chair, to determine the uses and emissions of halon 1301 within civil aviation fire protection systems.
- The HTOC has re-engaged with the International Maritime Organization (IMO). This will enable HTOC to update the Decision XXVI/7 report on future availability of halons by assessing the quantity of halons installed on merchant ships, and the quantity and quality of halons being recovered from ship-breaking activities. The Parties may wish to consider if a

more formal relationship, such as developing a joint Memorandum of Understanding (MOU) to formalize this and other ozone-related activities is worth pursuing.

- Civil aviation appears to be on schedule to meet the ICAO requirement to use only alternative agents to halon for all hand-held extinguishers on new production aircraft after 31 December 2018. The agent is 2-bromo-3,3,3-trifluoro-prop-1-ene (2-BTP), and this is. replacing halon 1211.

1.1.3 *Methyl Bromide Technical Options Committee (MBTOC)*

- Methyl Bromide (MB) phase-out for reported controlled uses is almost complete.
- A5 Parties have critical use requests for less than 1% of the A5 baseline for controlled consumption of MB.
- Alternatives to MB (both chemical and non-chemical), including technologies which altogether avoid the need for MB (e.g. heat, soil-less culture, resistant varieties and rootstocks), exist for almost all controlled uses of MB (both for pre-plant, commodities and structures).
- Recapture technologies are continually developing and being adopted in some countries because of human safety concerns
- Phase-out for the remaining methyl bromide critical uses will be greatly influenced by the registration of sulfuryl fluoride and methyl iodide, the use of some non-chemical options like soil-less culture and by consideration of specific Integrated Pest Management schemes.
- Improved reporting of production and trade for controlled uses and quarantine and pre-shipment (QPS) may assist understanding global movements of MB and uses.
- Pre-2015 stocks (an estimated 2000 tonnes) appear to be used for critical uses but are not being reported.
- An estimated 31 to 47% of present QPS uses could be replaced immediately with available alternatives.
- MBTOC is aware of continuing discrepancy (in the thousands of tonnes) between top-down and bottom-up comparisons of emissions and reported production/consumption.

1.1.4 *Medical and Chemical Technical Options Committee (MCTOC)*

- The global transition away from chlorofluorocarbon (CFC) metered-dose inhalers (MDIs) is complete.
- Based on the information reported by parties on the use of controlled substances under exemptions as process agents, parties may wish to consider the recommended changes to Table A of Decision XXIX/7 and Table B of Decision XXII/7.
- Based on Article 7 data reported by parties, total production of controlled substances (ozone-depleting substances (ODS)) for feedstock and process agent uses was 1,189,536 tonnes in 2016. Estimated associated emissions can be calculated as 5,948 tonnes, or 2,194 ozone depletion potential (ODP) tonnes.
- The use of HCFC-141b and HCFC-225 for solvent cleaning in non- 5 parties has been phased out, with the exception of aerospace and military applications. In A 5 parties, HCFC use for solvent cleaning has declined. There is a reported solvent use of HCFC-225 for syringe/needle coating in Japan. Several manufacturing processes use HCFCs as solvents in processes that might be considered similar to process agent uses.
- In 2017, China announced its commitment to phase out the use of carbon tetrachloride for the testing of oil in water by 2019 and, accordingly, no essential use nomination for this laboratory and analytical use was received.
- In response to decision XXVI/5(2) on laboratory and analytical uses, MCTOC plans to report in time for the 30th MOP.

1.1.5 *Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee (RTOC)*

- The development of hydrocarbons (HCs), R-717 (ammonia), and R-744 (carbon dioxide) in relevant sectors has continued. Recently, unsaturated fluorochemicals (especially HFOs), and blends of HFOs with HFCs have become the main option to replace high GWP refrigerants.

Since the publication of the RTOC 2014 Assessment Report, 33 new refrigerants, most of them blends, have received standard designations and safety classifications in ASHRAE Standard 34. Of these 33 new refrigerants, 23 have been previously listed in the 2017 RTOC progress report, and 10 are new since that report. Among the 10 new fluids there are two single-compound refrigerants and eight blends.

- The majority of medium- and low-GWP alternatives are flammable and require the development of new safety standards. There has been significant progress, although it is unclear when the A2/A3 amendment to standards IEC 60335-2-40 and IEC 60335-2-89 will be published.
- The phase down of high-GWP HFC's is underway in all refrigeration, air conditioning and heat pump (RACHP) sectors.
    - Some sectors have identified possible long-term solutions for a majority of applications (e.g., domestic refrigeration with HC-600a and commercial refrigeration with R-744) while some other sectors are investigating different alternatives (e.g., air-to-air air conditioners with HFC-32 and HC-290, and motor vehicle air conditioning (MAC) with HFO-1234yf and R-744).
    - In almost all sectors, testing of lower-GWP blends is under way in order to find a suitable alternative to high-GWP fluids in the near or medium term.
- Energy efficiency is being taken into account in all decisions regarding which low-GWP alternatives are to be introduced. Over 90% of energy efficiency improvements accompanying the transition to low-GWP refrigerants, are due to improvements in equipment efficiency (with 5-10% attributable to the working fluid itself).
- The risk assessment of flammable refrigerants in different applications in different regions is subject to special safety considerations. For example, in high ambient temperature (HAT) conditions, the elevated refrigerant charge and the capability of technicians in the service sector to manage safety risk, are both important factors.

Annex IV

Members of the Technology and Economic Assessment Panel technical options committees[a] whose membership expires at the end of 2018 and whose reappointment does not require a decision by the Meeting of the Parties

Name	*Position*	*Country*
Members of technical options committees		
Roy Chowdhury	FTOC member	Australia
Rick Duncan	FTOC member	United States of America
Koichi Wada	FTOC member	Japan
Shpresa Kotaji	FTOC member	Belgium
Simon Lee	FTOC member	United States
Yehia Lotfi	FTOC member	Egypt
Sascha Rulhoff	FTOC member	Germany
Enshan Sheng	FTOC member	China
Dave Williams	FTOC member	United States
Jamal Alfuzaie	HTOC member	Kuwait
Seunghwan Choi	HTOC member	Republic of Korea
Michelle M. Collins	HTOC member	United States
Emma Palumbo	HTOC member	Italy
Emmanuel Addo-Yobo	MCTOC member	Ghana
Fatima Al-Shatti	MCTOC member	Kuwait
Paul Atkins	MCTOC member	United States
Olga Blinova	MCTOC member	Russian Federation
Nick Campbell	MCTOC member	France
Jorge Caneva	MCTOC member	Argentina
Nee Sun Choong Kwet Yive	MCTOC member	Mauritius
Davide Dalle Fusine	MCTOC member	Italy
Eamonn Hoxey	MCTOC member	United Kingdom
Jianxin Hu	MCTOC member	China
Biao Jiang	MCTOC member	China
Javaid Khan	MCTOC member	Pakistan
Gerald McDonnell	MCTOC member	United States
Robert Meyer	MCTOC member	United States
Hans Porre	MCTOC member	Netherlands
John Pritchard	MCTOC member	United Kingdom
Rabbur Reza	MCTOC member	Bangladesh
Surinder Singh Sambi	MCTOC member	India
Roland Stechert	MCTOC member	Germany
Kristine Whorlow	MCTOC member	Australia
Yizhong You	MCTOC member	China
Jonathan Banks	MBTOC member	Australia
Fred Bergwerff	MBTOC member	Netherlands
Aocheng Cao	MBTOC member	China
Sait Erturk	MBTOC member	Turkey
Ken Glassey	MBTOC member	New Zealand
Eduardo Gonzalez	MBTOC member	Philippines
Takashi Misumi	MBTOC member	Japan
Christoph Reichmuth	MBTOC member	Germany
Akio Tateya	MBTOC member	Japan
Alejandro Valeiro	MBTOC member	Argentina

Name	*Position*	*Country*
Nick Vink	MBTOC member	South Africa
James M. Calm	RTOC member	United States
Radim Cermak	RTOC member	Czechia
Guangming Chen	RTOC member	China
Jiangpin Chen	RTOC member	China
Daniel Colbourne	RTOC member	United Kingdom
Richard DeVos	RTOC member	United States
Sukumar Devotta	RTOC member	India
Martin Dieryckx	RTOC member	Belgium
Dennis Dorman	RTOC member	United States
Bassam Elassaad	RTOC member	Lebanon
Dave Godwin	RTOC member	United States
Marino Grozdek	RTOC member	Croatia
Samir Hamed	RTOC member	Jordan
Martien Janssen	RTOC member	Netherlands
Michael Kauffeld	RTOC member	Germany
Jürgen Köhler	RTOC member	Germany
Holger König	RTOC member	Germany
Richard Lawton	RTOC member	United Kingdom
Tingxun Li	RTOC member	China
Petter Nekså	RTOC member	Norway
Horace Nelson	RTOC member	Jamaica
Carloandrea Malvicino	RTOC member	Italy
Tetsuji Okada	RTOC member	Japan
Alaa A. Olama	RTOC member	Egypt
Alexander C. Pachai	RTOC member	Denmark
Per Henrik Pedersen	RTOC member	Denmark
Rajan Rajendran	RTOC member	United States
Giorgio Rusignuolo	RTOC member	United States
Asbjorn Vonsild	RTOC member	Denmark

[a] The five technical options committees are: Flexible and Rigid Foams Technical Options Committee (FTOC), Halons Technical Options Committee (HTOC), Medical and Chemicals Technical Options Committee (MCTOC), Methyl Bromide Technical Options Committee (MBTOC), and Refrigeration, Air-Conditioning and Heat Pumps Technical Options Committee (RTOC).

Annex V

Report by the Technology and Economic Assessment Panel (May 2018) Volume 5

Technology and Economic Assessment Panel decision XXIX/10 Task Force report on issues related to energy efficiency while phasing down hydrofluorocarbons

Executive Summary

At their 29th Meeting, parties requested the Technology and Economic Assessment Panel (TEAP) to report to the 40th Open-ended Working Group (OEWG-40) on issues related to energy efficiency (EE) while phasing down hydrofluorocarbons (HFCs), as outlined in Decision XXIX/10. Decision XXIX/10 requests, in relation to maintaining and/or enhancing energy efficiency in the refrigeration and air-conditioning and heat-pump (RACHP) sectors, an assessment of:

- Technology options and requirements including
  - Challenges for their uptake;
  - Their long-term sustainable performance and viability; and
  - Their environmental benefits in terms of CO_2 eq;
  - Capacity-building and servicing sector requirements in the refrigeration and air-conditioning and heat-pump sectors;
- Related costs including capital and operating costs;

The decision also requested TEAP to provide an overview of the activities and funding provided by other relevant institutions addressing EE in the RACHP sectors in relation to maintaining and/or enhancing energy efficiency while phasing down HFCs under the Kigali Amendment.

Finally, Decision XXIX/10 requested the Secretariat to organise a workshop on EE opportunities while phasing-down HFCs at hydrofluorocarbons at OEWG-40, and, thereafter, for TEAP to prepare an updated final report for the 30th Meeting of the Parties to the Montreal Protocol, taking into consideration the outcome of the workshop.

In response to Decision XXIX/10, TEAP established the Decision XXIX/10 Task Force, which included TEAP and Technical Options Committees members as well as outside experts. EE is a broad topic of major importance for the environment, economics and health, and there is an enormous amount of published literature and reviews. In preparing its response to the decision, the Task Force referenced information provided in earlier TEAP reports (e.g., Decision XXVIII/3 Working Group Report – October 2017) and examined updated, available research and studies. Outside expert members of the Task Force provided relevant information from their own research and of work done by their colleagues and organisations for consideration in this report.

This report is organised, following the format requested in Decision XXIX/10, into an introduction and two main chapters. Chapter 2 deals with the technology opportunities related to maintaining or enhancing EE during the phasedown of HFCs. Various aspects of the EE opportunities in the RACHP sector were considered. Chapter 2 also considered the other topics requested from the decision including the long-term sustainability and viability of the technology opportunities, consideration of high ambient temperature conditions, climate benefits from adopting the RACHP EE measures, and consideration of related capital and operating costs. Chapter 3 examines other financial institutions where these may intersect with support for realizing EE goals in the RACHP sectors during the phasedown of HFCs. Contained in two annexes are information about the different challenges to the technology uptake in the RACHP sectors and examples of relevant projects funding or financing.

Below are summaries of the various sections of the report.

Technology opportunities and challenges to maintain and/or enhance energy efficiency of new RACHP equipment

By using a rigorous integrated approach to RACHP equipment design and selection, the opportunities to improve energy efficiency (EE) or reduce energy use can be maximised. This approach includes:

1) Ensuring minimisation of cooling/heating loads;

2) Selection of appropriate refrigerant;

3) Use of high efficiency components and system design;

4) Ensuring proper installation, optimised control and operation, under all common operating conditions;

5) Designing features that will support servicing and maintenance.

While the benefits of higher EE, such as savings in energy, operating cost to the consumer, peak load and GHG emissions are widely recognised, many barriers to the uptake of more efficient equipment continue to persist. There are a number of common challenges that apply to all types of RACHP equipment. There also are certain market and sector-specific issues that are presented in further detail. Broadly, these barriers can be classified into the following categories: financial, market, information, institutional and regulatory, technical, service competency and others.

Technologies resulting in efficiency improvement opportunities available for high-GWP refrigerants may be applicable to low-GWP refrigerants as well.

The largest potential for EE improvement comes from improvements in total system design and components, which can yield efficiency improvements (compared to a baseline design) that can range from 10% to 70% (for "best in class" unit). On the other hand, the impact of refrigerant choice on the EE of the units is usually relatively small – typically ranging from +/- 5 to 10%.

Long-term sustainable performance and viability

In assessing consideration of long-term sustainable performance and viability (of technology options and requirements in the context of maintaining or exceeding energy performance), it was necessary for the Task Force to define the terms and timeframes for this assessment. The Task Force interpreted the term "long-term" for RAHCP technologies to mean for a period of up to 15 years, which is consistent with previous assessments of this term used and reported by the TEAP.

For the phrase "sustainable performance and viability" (over the 15-year "long-term" timeframe), the Task Force looked to assess whether or not the options and requirements for technology that are commercially available today and being commercially developed for the nearer term (which include zero or low-GWP refrigerants - single chemicals and blends, and compatible equipment/hardware), would be anticipated to at least meet EE needs (i.e., would be viable) and whether or not they would remain viable over the next 15 years, including considerations for servicing.

Therefore, the relevant aspects that will impact the long-term sustainment of performance are expected to be as follows:

- Technological environment,
- Minimum Energy Performance Standards (MEPS).

While the challenge of researching and finding sound, technical solutions is important, in some cases it may be even more important to ensure engagement with the customer and the industry and consideration of issues of the whole supply chain in order to ensure that the process of putting those technologies to practical use is not jeopardized.

High ambient temperature (HAT) considerations

A HAT environment imposes an additional set of challenges on the selection of refrigerants, system design, and potential EE enhancement opportunities.

HAT conditions impose additional requirements such as ensuring the refrigerant can continue to deliver and sustain acceptable efficiency at elevated ambient temperatures, and that the refrigerant doesn't breakdown or react with system components at high temperature.

Environmental benefits in terms of CO_2 eq

Over 80% of the global warming impact of RACHP systems is associated with the indirect emissions generated during the production of the electricity used to operate the equipment (indirect), with a lower proportion coming from the use/release (direct emissions) of GHG refrigerants where used.

The environmental impact of improving system efficiency is a factor of the type of equipment, how many hours and when it is used (influenced by ambient temperature and humidity conditions), and the emissions associated with generating power, which vary by country.

Climate and development goals are driving governments to adopt policies to improve the EE of equipment. In the RACHP sector, a holistic approach is important for reducing equipment energy consumption.

Servicing sector requirements

The present concern in most Article 5 countries in the HCFC phase-out process is to train technicians on the use of new refrigerants. EE aspects require additional training and further awareness.

Some EE degradation over the life time of equipment is inevitable; however, there are ways to limit the degradation through improved design and improved servicing which include both installation and maintenance.

The impact of proper installation, maintenance, and servicing on the efficiency of equipment and systems is considerable over the life time of these systems while the impact on additional cost is minimal.

The benefits of proper maintenance are considerable. Appropriate maintenance and servicing practices can curtail up to 50% reduction in performance and maintain the rated performance over the lifetime.

Capacity-building requirements

There are enabling activities such as capacity building, institutional strengthening, demonstration projects, and national strategies and plans that help to bridge Montreal Protocol activities under the Kigali Amendment and EE. A number of enabling activities supported by the other funds such as, the Kigali Cooling Efficiency Programme and the Global Environment Facility, have advanced both ozone depletion and EE goals.

Additional enabling activities under the Kigali Amendment can bridge the current Montreal Protocol activities with those destined towards EE and serve as examples of potential synergy between HFC phasedown and EE opportunities.

Costs related to technology options for energy efficiency

A summary is presented of methods developed by various countries with established market transformation programs for promoting EE including MEPS programs and labelling programs.

It should be noted that the presented methodology offers a "snapshot" of the cost of efficiency improvement at any given time and will tend to provide a conservative (i.e. higher) estimate of the cost of efficiency improvement. In actual practice, the prices of higher efficiency equipment have been found to decline over time in various markets as higher efficiency equipment begins to be produced at scale. This applies especially for small mass-produced equipment where manufacturers quickly absorb the initial development costs and try to get to certain "price points" that help them sell their equipment.

Retail price of products is not an adequate indicator for the costs of maintaining or enhancing EE in new equipment due to:

- bundling of various non-energy related features with higher efficiency equipment,
- variation of manufacturer's skills and know-how,
- variation in manufacturer's pricing, marketing and branding strategies, and
- the idea that efficiency can be marketed as a "premium" feature.

Rigorous cost analysis may be needed to fully understand the impact of EE improvements. These types of analyses are relevant when setting MEPS as several EE levels need to be evaluated compared with the baseline. These studies can take more than 1 year to conclude for a single product category. As such, in this report we would like to refer parties to the corresponding methodologies and present simplified examples based on products already introduced on the market.

Funding institutions

There are numerous financial resources for projects implementation in the field of EE. Besides funding institutions that provide resources in the form of directed grants, there are financing institutions that provide project funding support through mechanisms such as loans, green bonds or other instruments. Moreover, private capital is an additional source through companies who might be interested to finance project implementation against investment payback.

Broad consideration of the various potential interested stakeholders, opportunities for partnerships with shared goals, and options for co-financing would be important to planning for potential projects related to EE in the RACHP sector while phasing down HFCs.