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**Review of the terms of reference, composition, balance,
fields of expertise and workload of the Technology and
Economic Assessment Panel (decision XXX/15)**

Review of the terms of reference, composition, balance, fields of expertise and workload of the Technology and Economic Assessment Panel

I. Introduction

1. The parties to the Montreal Protocol on Substances that Deplete the Ozone Layer, at their Thirtieth Meeting, held in Quito from 5 to 9 November 2018, adopted decision XXX/15, on the review of the terms of reference, composition, balance, fields of expertise and workload of the Technology and Economic Assessment Panel. In paragraph 1 of that decision, the parties requested the Ozone Secretariat “to prepare a document, in consultation with the Technology and Economic Assessment Panel, for the Open-ended Working Group at its forty-first meeting, taking into account the ongoing efforts by the Technology and Economic Panel to respond to changing circumstances, including the Kigali Amendment, in relation to the following:

(a) Terms of reference, composition, and balance with regard to geography, representation of parties operating under paragraph 1 of Article 5 and parties not so operating, and gender;

(b) The fields of expertise required for the upcoming challenges related to the implementation of the Kigali Amendment, such as energy efficiency, climate benefits and safety.”

2. In the same decision (paras. 2–6), the parties addressed the workload of the Panel and decided on a new periodicity for its reports. The Secretariat has prepared an information document to provide an update on the workload of the Panel (UNEP/OzL.Pro.WG.1/41/INF/6).

3. The present document has been prepared in consultation with the Panel and assesses the current situation of the Panel, its technical options committees and temporary subsidiary bodies in terms of their mandates, terms of reference and emerging challenges. Specifically:

(a) Section II comprises two subsections that offer the following background information: (i) a brief overview of the evolution of the Panel’s terms of reference and (ii) a summary of the issues raised by the parties during discussions on the review of the terms of reference;

(b) Section III contains an analysis of the current status of implementation of the relevant provisions of the terms of reference, focusing on: (i) size, balance and composition; (ii) nominations

* UNEP/OzL.Pro.WG.1/41/1.

and the matrix of needed expertise; (iii) appointments and terms of office; and (iv) other procedural matters;

(c) Section IV describes the new challenges arising from the Kigali Amendment and how the Panel has addressed some of them thus far. The section has two parts: (i) upcoming periodic assessments and reviews; and (ii) new issues related to the Kigali Amendment;

(d) Section V provides a summary of the analysis of the terms of reference, composition and balance of the Panel, technical options committees and temporary subsidiary bodies, and highlights areas that the parties may wish to consider and address further;

(e) Section VI provides a summary of the expertise needed under the Kigali Amendment.

4. In sections III, IV, V and VI, the word “Panel” is used to mean the Technology and Economic Assessment Panel itself, and does not include its technical options committees or temporary subsidiary bodies.

II. Background

A. Overview of the evolution of the Panel’s terms of reference

5. **1987:** In Article 6 of the Montreal Protocol, the following provision for periodic assessment and review of control measures of the Protocol was included:

Beginning in 1990, and at least every four years thereafter, the Parties shall assess the control measures provided for in Article 2 on the basis of available scientific, environmental, technical and economic information. At least one year before each assessment, the Parties shall convene appropriate panels of experts qualified in the fields mentioned and determine the composition and terms of reference of any such panels.

6. **1989:** At the First Meeting of the Parties, the establishment of the four original Montreal Protocol review panels, namely the Panel for Scientific Assessment, the Panel for Environmental Assessment, the Panel for Technical Assessment, and Panel for Economic Assessment, was formalized. At the same meeting, the first set of terms of reference was adopted together with the composition of the Panels.¹ The terms of reference addressed the structure of the Panels and the main issues to be included in the first assessment reports. By 1991, the Panel for Technical Assessment and the Panel for Economic Assessment had been merged to form the Technology and Economic Assessment Panel, and six technical options committees had been formed to address the major categories of use of ozone-depleting substances, which had been previously addressed in chapters of the technology assessment reports. From the outset, a balance among developed and developing countries in terms of representation and expertise was of specific concern to the parties.

7. **1992:** At the Fourth Meeting of the Parties, the parties adopted decision IV/13, on assessment panels, in which they noted with appreciation the 1991 quadrennial assessment that had been carried out by the panels and requested that the next quadrennial assessment be completed by late 1994. In the same decision, the parties requested the Technology and Economic Assessment Panel and its committees to report annually to the Open-ended Working Group on technical progress made in reducing the use and emissions of controlled substances and assess the use of alternatives.

8. **1995:** At the Seventh Meeting of the Parties, the parties adopted decision VII/34, on assessment panels, in paragraph 5 (e) (i) of which they requested the Technology and Economic Assessment Panel to proceed with efforts to increase the participation of experts from parties operating under paragraph 1 of Article 5 (Article 5 parties) in order to improve geographical expertise and balance. In that decision, the parties also addressed other issues related to organization and functioning and requested the Panel to present procedures and criteria for the nomination and selection of experts and to report on existing expertise, methods of operation and options for restructuring.

9. **1996:** At the Eighth Meeting of the Parties, decision VIII/19, on the organization and functioning of the Panel, was adopted, in which the parties approved the initial comprehensive terms of reference specifically for the Technology and Economic Assessment Panel.

10. **2003:** At the Eighteenth Meeting of the Parties, decision XVIII/19 was adopted, by which the parties revised the guidelines for disclosure of interest for the Technology and Economic Assessment Panel and its technical options committees, clarifying the terms of reference with regard to potential

¹ The composition and terms of reference were set out in annexes V and VI, respectively, to the report of the First Meeting of the Parties (UNEP/OzL.Pro.1/5). See <https://undocs.org/UNEP/OzL.Pro.1/5>.

conflicts of interest in order to guarantee the independence of the Panel and the objectivity of the policy-relevant technical information that it produced.

11. **2010:** At the Twenty-Second Meeting of the Parties, decision XXII/22, on the assessment panel membership changes, was adopted. In the decision the parties requested the Panel and its technical options committees to draw up guidelines for the nomination of experts by the parties, in accordance with section 2.9 of the terms of reference of the Panel, and to “consider the need for balance and appropriate expertise when appointing members of the technical options committees, task forces and other subsidiary groups in accordance with sections 2.1, 2.5 and 2.8 of the terms of reference of the Panel”.

12. **2011:** At the Twenty-Third Meeting of the Parties, the parties agreed in decision XXIII/10 to update the nomination and operational processes for the Panel and its subsidiary bodies and requested the Panel to provide information that could inform decisions by the parties, including updated terms of reference, revised draft guidelines on recusal and guidelines for the appointment of the co-chairs of the Panel. A task force was set up to that end and presented its report in May 2012.

13. **2012:** On the basis of the May 2012 report by the task force pursuant to decision XXIII/10, the Twenty-Fourth Meeting of the Parties adopted decision XXIV/8, on the revised terms of reference, code of conduct and disclosure, and conflict of interest guidelines for the Panel and its technical options committees and temporary subsidiary bodies. One of the changes made to the terms of reference was to limit the period of appointment of members to no more than four years, with the possibility of reappointment for additional periods of up to four years each. In the same decision, the parties requested the Panel to make recommendations on the future configuration of its technical options committees and to make its standard operating procedures available.

14. **2013:** At the Twenty-Fifth Meeting of the Parties, the parties adopted decision XXV/6, on the operation and organization of the Panel, in which they requested the Panel to provide in its 2014 progress report an update on its processes for the nomination of members to its technical options committees, a proposal for the configuration of the technical options committee and options for streamlining the Panel’s technology updates. The report of the Panel was presented in 2014 and was discussed at the meeting of the Open-ended Working Group and between the Panel and interested parties on a bilateral basis. There were no objections to the proposed configuration of the committees and the Panel implemented the new configuration, taking into consideration advice and comments that had been provided by the parties.

15. **2018:** At the Thirtieth Meeting of the Parties, the parties adopted decision XXX/15, in which they requested the Ozone Secretariat to prepare a document in consultation with the Panel, on the terms of reference, composition of the Panel and the fields of expertise needed by the Panel to address the upcoming challenges in the implementation of the Kigali Amendment as explained in paragraphs 1 and 2 above.

B. Issues raised by parties

16. At the Twenty-Ninth Meeting of the Parties,² held in Montreal in November 2017, the parties considered four nominations or renominations of experts to serve as senior experts in the Technology and Economic Assessment Panel, in addition to the two existing senior experts. The parties appointed them for a term of one year and encouraged parties to consult one another on potential nominations and to refer to the matrix of needed expertise prior to making nominations for appointments of senior experts. During the discussion, a number of parties also suggested that there was a need to further consider the future work and membership of the Refrigeration, Air-Conditioning and Heat Pumps Technical Options Committee (RTOC) in view of the phase-out of hydrochlorofluorocarbons (HCFCs) and the new commitments under the Kigali Amendment (UNEP/OzL.Conv.11/7–UNEP/OzL.Pro.29/8, paras. 122–124).³

17. In July 2018, at the fortieth meeting of the Open-ended Working Group, the parties considered the senior expert nominations received that year, along with the issue of the review of the composition and organization of the assessment panels, that had been included in the agenda of the meeting under other matters. During the discussion some parties noted that the implementation of the Kigali Amendment would introduce a range of important issues to the deliberations of the parties; that the

² Held in conjunction with the eleventh meeting of the Conference of the Parties to the Vienna Convention for the Protection of the Ozone Layer.

³ Report of the combined eleventh meeting of the Conference of the Parties to the Vienna Convention and the Twenty-Ninth Meeting of the Parties to the Montreal Protocol, Montreal, 20–24 November 2017, <http://conf.montreal-protocol.org/meeting/mop/cop11-mop29/report/SitePages/Home.aspx>.

assessment panels needed to have access to appropriate expertise, while not duplicating the work of other entities; that the panels should contain a balance of members from different regions and backgrounds so that the situations faced by all countries were considered; and that concerns could possibly be addressed through a less lengthy process, such as revising the matrix of the expertise needed by the Panel, recalling that a comprehensive and time-consuming review of the terms of reference had been undertaken six years earlier. The importance of having appropriate expertise on issues such as climate change, hydrofluorocarbons (HFCs), energy efficiency and high-ambient-temperature conditions, the balance of members from different regions and backgrounds, and the lack of experts from Article 5 parties, were mentioned by some parties (UNEP/OzL.Pro.WG.1/40/7, paras. 185–187).⁴

18. In November 2018, at the Thirtieth Meeting of the Parties, many parties reiterated their recognition of the invaluable contribution made by the Panel to the work of the Montreal Protocol in phasing out ozone-depleting substances and noted the major challenge ahead given that the work of the parties required new expertise in such fields as energy efficiency, safety standards and climate benefits. Many parties supported the goal of ensuring balanced geographical coverage, gender balance and appropriate representation of Article 5 parties, and the goal of having the right expertise in areas of particular relevance to Article 5 parties, including energy efficiency, HFC phase-down and high-ambient-temperature conditions. It was noted that the Panel had taken steps to address geographical and gender balance, that several new, younger members had brought fresh expertise to the Panel, and that the Panel continued to adjust and augment its composition in the light of the expertise required. Nevertheless, it was worth exploring additional ideas to bring more clarity to the process, bearing in mind that constant rebalancing would be required as new issues came to the fore (UNEP/OzL.Pro.30/11, paras. 154–159).⁵

III. Implementation of the terms of reference

A. Size, balance and composition

1. Key provisions under the terms of reference

19. According to the terms of reference (TOR) of the Technology and Economic Assessment Panel and its technical options committees and temporary subsidiary bodies (UNEP/OzL.Pro.24/10, decision XXIV/24, annex),⁶ the overall goal with respect to balance is to achieve approximately 50 per cent representation of Article 5 parties in the Panel and the committees and appropriate representation of expertise in the different alternatives (TOR 2.1.0).

20. Under the terms of reference, there are different requirements for the Panel, the technical options committees and the temporary subsidiary bodies. The Panel should comprise between 18 and 22 members, including 2 or 3 co-chairs, the co-chairs of the technical options committees, and 2 to 4 senior experts who possess specific expertise not covered by the Panel co-chairs or the committee co-chairs, taking into account gender and geographical balance (TOR 2.1.1).

21. Each technical options committee should have 2 co-chairs. The positions of those co-chairs must be filled to promote balance in respect of geography, gender and expertise. The Panel, through its committee co-chairs, should compose the committees to reflect a balance of appropriate and anticipated expertise so that their reports and information are comprehensive, objective and policy neutral (TOR 2.1.2). Each committee should have approximately 20 members, who are to be appointed by the committee co-chairs in consultation with the Panel (TOR 2.5).

22. Temporary subsidiary bodies can be appointed by the Panel to report on specific issues of limited duration (TOR 2.6). It is stipulated that the Panel, in consultation with the co-chairs of the temporary subsidiary bodies, should compose the membership of those bodies to reflect a balance of appropriate expertise so that their reports and information are comprehensive, objective and policy neutral. The Panel, acting through the co-chairs of the temporary subsidiary bodies, should provide a description in the reports of those bodies on how their composition had been determined. Members of the temporary subsidiary bodies, including their co-chairs, who are not already members of the Panel,

⁴ Report of the fortieth meeting of the Open-ended Working Group, Vienna, 11–14 July 2018, <http://conf.montreal-protocol.org/meeting/oewg/oewg-40/report/SitePages/Home.aspx>.

⁵ Report of the Thirtieth Meeting of the Parties to the Montreal Protocol, Quito, 5–9 November 2018, <http://conf.montreal-protocol.org/meeting/mop/mop30/report/SitePages/Home.aspx>.

⁶ Terms of reference of the Technology and Economic Assessment Panel and its technical options committees and temporary subsidiary bodies, <https://ozone.unep.org/en/handbook-montreal-protocol-substances-deplete-ozone-layer/102>.

do not become members of the Panel by virtue of their service in the temporary subsidiary bodies (TOR 2.1.3).

23. Temporary subsidiary bodies have been established by the Panel to respond to specific decisions of the parties. Those subsidiary bodies have been mostly Panel task forces that consisted of both internal and outside experts. Sometimes they have been Panel working groups that consisted only of Panel members. In recent years, the Panel has established both working groups and task forces on issues related to the implementation of the Kigali Amendment. Although the terms of reference do not specify the size or any balance requirements for the temporary subsidiary bodies, an analysis of the temporary subsidiary bodies constituted for new issues related to the Kigali Amendment has been provided in section IV of the present document.

2. Size

24. The Panel currently has 19 members, 10 from Article 5 parties and 9 from non-Article 5 parties. Following the implementation of decision XXX/16, on membership of the Panel, the Panel now consists of 3 co-chairs, 11 committee co-chairs and 5 senior expert members. There are 5 technical options committees and the size of the committees currently ranges from 16 to 40 members (see table 1 below).

25. In the past, the co-chairs of the Panel and the committees have remained in their posts for long periods. In the past four years, however, one-third of the Panel membership has changed (see para. 45 below). The production of high-quality outputs, upon which the parties depend, requires that the Panel members, and the co-chairs in particular, possess specific qualities and skills, such as leadership experience, the ability to make a major time commitment, the ability to manage consensus, an understanding of party sensitivities and good English writing skills.

26. The terms of reference indicate that the Panel should have 2 to 4 senior experts who provide expertise not covered by either the Panel co-chairs or the committee co-chairs constituting the Panel. In 2018, there were 6 senior experts, all from Article 5 parties. In 2019, there are 5 senior experts, all from Article 5 parties. The senior experts have expertise in economics, the rules, regulations and processes of the Montreal Protocol and the Multilateral Fund for the Implementation of the Montreal Protocol, implementation of the Montreal Protocol in Article 5 parties, and climate change.

3. Composition and balance

27. In addition to the expertise they bring, the current senior experts are all from Article 5 parties, thereby improving the representation of Article 5 parties on the Panel. Given that there are 10 Article 5 members and 9 non-Article 5 members on the Panel, the goal of achieving representation of Article 5 parties at or near 50 per cent has been fulfilled. Over the past decade, the representation of Article 5 parties in the Panel has averaged 44 per cent and is currently 53 per cent. However, the representation of Article 5 parties in the technical options committees has averaged 35 per cent over the past decade and stands at 36 per cent in 2019. The size, composition and balance of the Panel and its technical options committees are presented in table 1 below. More detailed information can be found in the annex to the present document.

28. Geographical balance among Panel members has also been an important issue for parties. Regional representation is uneven both on the Panel and on its committees. One Panel member is from Africa, six members are from Asia and the Pacific, five members are from Latin America and the Caribbean, four members are from Europe and three members are from North America. The current regional representation in each committee is presented in table 2 below.

29. Currently, 30 per cent of Panel members are women. Recently, the Panel and its committees have increased their efforts to find women experts and an increasing numbers of new expert appointees have been women. The overall proportion of women in the committees has been increasing, from an average of 10 per cent over the past decade, to 20 per cent in 2019 (see table 1).

Table 1
Composition of the Technology and Economic Assessment Panel and its technical options committees in March 2019

	<i>Article 5</i>	<i>Non-Article 5</i>	<i>Male</i>	<i>Female</i>	<i>Total</i>
TEAP ^a	10 (53%)	9 (47%)	13 (68%)	6 (32%)	19
FTOC ^b	9 (36%)	16 (64%)	19 (76%)	6 (24%)	25
HTOC ^c	6 (35%)	11 (65%)	13 (76%)	4 (24%)	17
MCTOC ^d	11 (33%)	22 (67%)	26 (79%)	7 (21%)	33
MBTOC ^e	7 (44%)	9 (56%)	14 (87%)	2 (13%)	16
RTOC ^f	14 (35%)	26 (65%)	37 (93%)	3 (7%)	40

^a Technology and Economic Assessment Panel.

^b Flexible and Rigid Foams Technical Options Committee.

^c Halons Technical Options Committee.

^d Medical and Chemicals Technical Options Committee.

^e Methyl Bromide Technical Options Committee.

^f Refrigeration, Air-Conditioning and Heat Pumps Technical Options Committee.

Table 2
Geographical representation in the Technology and Economic Assessment Panel and its technical options committees in 2019

	<i>Africa</i>	<i>Asia and the Pacific</i>	<i>Latin America and the Caribbean</i>	<i>Europe^a</i>	<i>North America^b</i>	<i>Total</i>
TEAP	1	6	5	4	3	19
FTOC	1	8	2	5	9	25
HTOC	1	5	1	6	4	17
MCTOC	2	10	1	12	8	33
MBTOC	2	8	2	3	1	16
RTOC	1	11	4	17	7	40

^a "Europe" includes the Russian Federation.

^b "North America" comprises the United States of America and Canada.

B. Nominations and the matrix of needed expertise

1. Matrix of needed expertise

30. To facilitate the submission of appropriate nominations by the parties, the terms of reference require the Panel and the technical options committees to draw up guidelines for the nomination of experts by the parties. It is stipulated that "[t]he TEAP/TOCs will publicize a matrix of expertise available and the expertise needed in the TEAP/TOCs so as to facilitate submission of appropriate nominations by the parties. The matrix must include the need for geographic and expertise balance and provide consistent information on expertise that is available and required. The matrix would include the name and affiliation and the specific expertise required including on different alternatives. The TEAP/TOCs, acting through their respective co-chairs, shall ensure that the matrix is updated at least once a year and shall publish the matrix on the Secretariat website and in the Panel's annual progress reports. The TEAP/TOCs shall also ensure that the information in the matrix is clear, sufficient and consistent as far as is appropriate between the TEAP and TOCs and balanced to allow a full understanding of needed expertise" (TOR 2.9).

31. Currently, the Panel publishes the matrix of required expertise⁷ in its annual progress reports, which are issued in May of each year.⁸ It updates the matrix every year. In 2018, the matrix was updated twice, with the second update occurring at the Thirtieth Meeting of the Parties. The Secretariat immediately posts the updated matrix on its website for easy access. Ensuring the immediate posting of the matrix may assist the parties in making timely nominations consistent with the needed expertise.

32. The names and affiliation of the experts serving on the Panel and the technical options committees are also published in the Panel's annual progress reports. Information on the existing or

⁷ See https://ozone.unep.org/teap_experts_required.

⁸ All reports (including progress reports) of the Technology and Economic Assessment Panel, its technical options committees and subsidiary bodies are available at <https://ozone.unep.org/science/assessment/teap>.

available expertise has not been published in every report. Although the Panel publishes the names and affiliations of all members, it is not always easy to understand the available or existing expertise from those lists.

33. The temporary subsidiary bodies need to be constituted quickly to respond to specific requests by parties. When establishing temporary subsidiary bodies, the Panel aims to ensure balance in needed expertise while taking into account Article 5/non-Article 5, geographical and gender balance. The expertise needed by temporary subsidiary bodies is not included in the matrix. Inclusion of the expertise needed is not required by the terms of reference. In recent years, as the importance of refrigeration and air-conditioning in countries with high-ambient-temperature conditions has increased since the adoption of the Kigali Amendment, the number of relevant experts has also increased in the energy efficiency task forces and in RTOC. Experts who perform well in temporary subsidiary bodies may be considered for recommendation to join the technical options committees.

2. Nominations

34. The terms of reference specify that “[n]ominations 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. The TEAP co-chairs shall ensure that any potential nominee identified by TEAP for appointment to the Panel, including co-chairs of TEAP and the TOCs, is agreed to by the national focal points of the relevant party. A member of TEAP, the TOCs or the TSBs shall not be a current representative of a party to the Montreal Protocol” (TOR 2.2.1).

35. For technical options committees or temporary subsidiary bodies, the terms of reference require all nominations to be made in full consultation with the national focal point of the relevant party. The terms of reference further state that “[a]ll nominations to the 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” (TOR 2.2.2).

36. Nominations are currently made through a simple communication accompanied by the curriculum vitae of the nominee so as to better understand the nominee’s expertise. In annex C to its report issued in May 2012 pursuant to decision XXIII/10, the Panel had proposed a draft standardized nomination form for consideration by the parties.⁹ The form was comprehensive, requesting detailed information about the nominee, such as education and other qualifications, employment history, publications, awards, memberships, language knowledge and references, along with the signature of the nominee as confirmation of the accuracy of the information provided in the form.

37. In accordance with the requirements set out in the terms of reference, there is consultation among the parties and the co-chairs of the Panel and/or the relevant committee on potential nominations to the positions of co-chairs of the Panel or the committees. In the case of nominations or renominations for membership of a committee, the committee co-chairs consult with the Panel co-chairs and the relevant national focal points.

38. The technical options committees also receive nominations directly from parties. In determining whether to accept or reject a nomination, the committee co-chairs, in consultation with the Panel as appropriate, consider the expertise of the nominee against the expertise needed by the relevant committee, taking into consideration Article 5/non-Article 5, geographical and gender balance. The gaps in the expertise of the committees are reflected in the matrix of needed expertise. It has been the practice that nominations for committee membership and appointments to the committee can be made at any time.

39. Ensuring appropriate and sufficient technical expertise is the priority consideration for the Panel and its committees. The need to maintain a reasonable size and balance, to avoid the duplication of expertise and to ensure that particular gaps in expertise are filled, means that experts nominated by parties are sometimes rejected or that their consideration is postponed by the committee co-chairs in consultation with the Panel co-chairs. Although the committee co-chairs take into account Article 5/non-Article 5, gender and geographical balance, appropriate technical expertise can outweigh those other factors.

40. For temporary subsidiary bodies such as task forces, the Panel co-chairs first select the co-chairs, with whom they jointly determine the membership. The Panel co-chairs circulate the proposed membership to all Panel members for review and comment. The Panel then requests the

⁹ Available at <https://ozone.unep.org/science/assessment/teap>.

Ozone Secretariat to inform the relevant national focal points. A temporary subsidiary body is normally established within approximately 2 months of a decision regarding its membership being taken at a Meeting of the Parties, and has approximately 3 months to provide its report for review by the Panel prior to submission to the Ozone Secretariat no later than six weeks prior to the meeting of the Open-ended Working Group. In recent years, parties have requested preliminary reports from task forces for consideration by the Open-ended Working Group mid-year, followed by final reports to the Meeting of the Parties later in the year (for example, the energy efficiency and trichlorofluoromethane (CFC-11) reports in 2019). This practice adds substantively to the workload of the Panel and increases the number of reports that the parties request the Panel to produce. The task force that conducts the replenishment study on a triennial basis has usually provided an interim report mid-year, and then modified it into a final report for the Meeting of the Parties after taking into consideration comments and further guidance from the parties.

41. The Panel, committees and temporary subsidiary bodies have large workloads and tight schedules. Each annual progress report of the Panel contains a section on organizational matters and challenges faced by the Panel and the committees, including in terms of the workload, expertise needed for new tasks and challenges due to loss of expertise, for example through retirement.

C. Appointments and terms of office

42. Members of the Panel are appointed at a Meeting of the Parties for a period of up to four years. As is indicated in section 2.3 of the terms of reference, members may be reappointed for additional periods of up to four years each. In keeping with the intent of a periodic review of the composition of the Panel, it is stipulated that “[i]n appointing or reappointing members of TEAP, the parties should ensure continuity, balance as well as a reasonable turnover”. In accordance with section 2.5, technical options committee members are appointed by the committee co-chairs, in consultation with the Panel, also for a period of no more than four years and may be reappointed for additional periods of up to four years each.

43. The terms of reference provide that temporary subsidiary bodies can be appointed by the Panel to report on specific issues of limited duration. The terms of reference further stipulate that “TEAP may appoint and dissolve, subject to review by the parties, such subsidiary bodies of technical experts when they are no longer necessary. For issues that cannot be handled by the existing TOCs and are of substantial and continuing nature, TEAP should request the establishment by the parties of a new TOC. A decision of the Meeting of the Parties is required to confirm any TSB that exists for a period of more than one year” (TOR 2.6).

44. Accordingly, over the years, the Panel has constituted task forces and working groups as temporary subsidiary bodies to address specific issues, and the duration of the appointment of members has been for one year. The requirement that the Panel provide a description of how their composition was determined in each report of a given temporary subsidiary body has not always been met.

45. The Panel has maintained continuity in an evolving membership. As is mentioned in paragraph 25 above, in the four-year cycle from 2014 to 2018, there was turnover in approximately one-third of member positions; seven members left the Panel and six new members joined it. While the four-year cycle for appointments may bring about increased turnover in future years, there is no limit to the number of times the members of the Panel and the committees may be reappointed. At the same time, the roles of the Panel co-chairs and members can change for relatively short, temporary periods in response to interim needs. For example, one Panel co-chair stepped into the position of co-chair of FTOC to stabilize that committee when its co-chairs left. With changes to and amalgamations of committees, their co-chairs can be reassigned to manage new committees, as was the case of MCTOC.

D. Other procedural matters

46. The Panel has a number of standard operating procedures, including for meetings, reports and achieving consensus. A description of those procedures was included in the May 2013 report of the task force on decision XXIV/8.

47. The reports of the Panel, technical options committees and temporary subsidiary bodies are developed through a consensus process. The reports of the temporary subsidiary bodies and the annual progress reports are reviewed by the Panel before being finalized and forwarded by the Panel to the Ozone Secretariat for consideration by the Open-ended Working Group, and, subsequently, at the Meeting of the Parties. The quadrennial assessment reports of the technical options committees are forwarded to the Ozone Secretariat directly by the committees. Until publication of the final report, the drafts are treated as confidential. Expert review processes for the reports of the Panel and the committees are limited, being confined to a few technical options committees and some task forces,

for example, on replenishment studies. Such reviews generally result in additional information and views being brought to light.

48. The terms of reference stipulate that the reports of the Panel, committees and temporary subsidiary bodies will be developed through a consensus process (TOR 4.1). In the past, there have been a few cases in which the Panel or committees could not reach consensus on their conclusions and recommendations to the parties, necessitating the establishment of a minority report procedure. In recent years, consensus has been reached on all reports. Through the addition of new and supplemental experts to the Panel, committees and the temporary subsidiary bodies, the Panel is broadening its base of information and expertise, which will improve the recommendations and conclusions. That process will not preclude the issuance of minority reports in the future, however.

IV. Tasks and challenges arising from the Kigali Amendment and related decisions

49. The role of the Panel and its technical options committees continues to evolve to meet the current and future needs of parties. The Panel, its committees and its temporary subsidiary bodies have continued to shift their focus as the Montreal Protocol has moved from introducing and strengthening control schedules (based on assessment reports) to managing the use of controlled chemicals and compliance with the Protocol. The role of the Panel is again evolving with the adoption of the Kigali Amendment and the phase-down of HFCs. The Panel continues to work so that its committees are structured in terms of size and expertise to support the future efforts of the parties.

50. In the course of the phase-out of ozone-depleting substances, beginning in the early 1990s, HFCs were introduced as alternatives. With the adoption of the Kigali Amendment at the Twenty-Eighth Meeting of the Parties, held in Kigali in 2016, the parties agreed to control HFCs under the Montreal Protocol in order to avoid unchecked growth in their use. The Kigali Amendment entered into force on 1 January 2019.

51. In decision XXVIII/2, the Panel was requested to carry out periodic reviews of alternatives and to provide technological and economic assessments of the latest available and emerging alternatives to HFCs. Under the high-ambient-temperature exemption mechanism, the Panel has been further requested to carry out periodic assessment of the suitability of HFC alternatives for use where suitable alternatives do not exist in high-ambient-temperature conditions (see section IV.A below).

52. The Panel was also requested to assess opportunities for energy efficiency, focusing on the refrigeration, air-conditioning and heat-pump sectors (decision XXVIII/3), and to liaise and coordinate with standards organizations and report on safety standards relevant to low-global-warming-potential alternatives (decision XXVIII/4). Parties continue to advance the work being done on energy efficiency through their follow-up requests to the Panel (see section IV.B below).

A. Periodic assessments and technology reviews

53. In decision XXVIII/2, the parties requested the Panel to conduct “periodic reviews of alternatives, using the criteria set out in paragraph 1 (a) of decision XXVI/9, in 2022 and every five years thereafter, and to provide technological and economic assessments of the latest available and emerging alternatives to hydrofluorocarbons” (para. 4) and to conduct “a technology review four or five years before 2028 to consider a compliance deferral of two years from the freeze date of 2028 for Article 5, group 2, parties to address growth above a certain threshold in relevant sectors” (para. 5).

54. In decision XXVIII/2, in the context of exemption for parties with high-ambient-temperature conditions, the parties also decided “[t]hat the Technology and Economic Assessment Panel and a subsidiary body of the Panel that includes outside experts on high ambient temperatures will assess the suitability of hydrofluorocarbon alternatives for use where suitable alternatives do not exist based on criteria agreed by the parties that will include, but not be limited to, the criteria listed in paragraph 1 (a) of decision XXVI/9, and recommend sub-sectors to be added to or removed from appendix I to the present decision and report this information to the Meeting of the Parties” (para. 32) and to conduct the assessment starting four years from the hydrofluorocarbon freeze date and every four years thereafter (para. 33).

55. Parties also envisaged that exemptions other than high-ambient-temperature exemptions might be allowed in the future and that the Panel might carry out periodic reviews of sectors where exemptions might be required. Decision XXVIII/2 provides for consideration of mechanisms for such exemptions in 2029 (para. 39) and stipulates that parties “provide information and guidance to the Technology and Economic Assessment Panel for its periodic review of sectors where exemptions may be required” (para. 40).

56. The upcoming technology reviews and assessments specifically related to the Kigali Amendment are summarized in table 3 below.

Table 3

Summary of the reviews related to the Kigali Amendment, stipulated in decision XXVIII/2

<i>Year</i>	<i>Review</i>	<i>Relevant paragraphs</i>
In 2022, then every 5 years	Periodic review of alternatives to HFCs to provide information on the latest available and emerging alternatives	para. 4
2023 or 2024	One-time technology review to enable Article 5, group 2 parties to consider compliance deferral for 2 years from 2028 to address growth in several sectors	para. 5
In 2028, then every 4 years	Assessment of alternatives in high-ambient-temperature conditions to enable the review by parties of the need to extend exemptions	paras. 32 and 33
Between 2029 and 2032	Parties to provide guidance to the Panel for the periodic review of sectors where exemptions (other than for high ambient temperatures) may be required	para. 40

57. It is also expected that future replenishment studies will continue to be carried out by a task force of the Panel. The study carried out for the 2018–2020 replenishment (as well as on indicative funding levels for the 2021–2023 and 2024–2026 replenishments) in accordance with the terms of reference for the study, adopted in decision XXVIII/5, included additional resources needed for Article 5 parties to carry out initial activities related to the phase-down of HFCs and to comply with control measures for HFCs.

B. New issues related to the Kigali Amendment

1. Energy efficiency

58. The parties recognized that a phase-down of HFCs would present additional opportunities to catalyse and secure improvements in the energy efficiency of appliances and equipment. Therefore, in decisions XXVIII/3,¹⁰ XXIX/10¹¹ and XXX/5,¹² the parties requested the Panel to report on those opportunities. In response to those requests, the Panel established temporary subsidiary bodies on energy efficiency, consisting of a working group in 2016, a task force in 2017 and a task force in 2018. The evolution of the composition of those bodies is shown in table 4 below. The participants in those bodies included experts in refrigeration, air conditioning and heat pumps in high-ambient-temperature conditions.

59. The Panel identified new experts from outside the Panel as well as from within the committees who possessed the needed expertise and had served successfully on the committees. Some of those task force members have been invited to become members of relevant technical options committees in 2019 and are expected to strengthen the future outputs of the committees and increase their relevance to the Kigali Amendment.

¹⁰ In decision XXVIII/3, on energy efficiency, the parties requested the Technology and Economic Assessment Panel “to review energy efficiency opportunities in the refrigeration and air-conditioning and heat-pump sectors related to a transition to climate-friendly alternatives, including not-in-kind options” (para. 1).

¹¹ In decision XXIX/10, on issues related to energy while phasing down hydrofluorocarbons, the parties requested the Technology and Economic Assessment Panel to assess, in relation to maintaining and/or enhancing energy efficiency in the refrigeration, air-conditioning and heat-pump sectors, “technology options and requirements, including: (i) challenges to their uptake; (ii) their long-term sustainable performance and viability; and (iii) their environmental benefits in terms of CO₂ equivalents; capacity-building and servicing sector requirements in the refrigeration and air-conditioning and heat-pump sectors; and related costs including capital and operating costs” (para. 1). They also requested the Panel to provide an overview of the activities and funding provided by other relevant institutions (para. 2).

¹² In decision XXX/5, on access of parties operating under paragraph 1 of Article 5 of the Montreal Protocol to energy-efficient technologies in the refrigeration, air-conditioning and heat-pump sectors, the parties requested the Technology and Economic Assessment Panel to “prepare a report on the cost and availability of low-global-warming-potential technologies and equipment that maintain or enhance energy efficiency, inter alia, covering various refrigeration, air-conditioning and heat-pump sectors, in particular domestic air-conditioning and commercial refrigeration, taking into account geographical regions, including countries with high-ambient-temperature conditions” (para. 3).

Table 4

Output and composition of the temporary subsidiary bodies on energy efficiency

<i>Year</i>	<i>Decision</i>	<i>Output</i>	<i>Composition</i>
2017	XXVIII/3 (2016)	Report of the decision XXVIII/3 working group (October 2017)	Panel/committee experts = 8 Outside experts = 0 Total = 8 Article 5 parties = 4 (50%) High-ambient-temperature experts ^a = 1
2018	XXIX/10 (2017)	Final report of the decision XXIX/10 task force (May 2018) Updated final report of the decision XXIX/10 task force (September 2018)	Panel/committee experts = 7 Outside experts = 14 Total = 21 Article 5 parties = 10 (48%) High-ambient-temperature experts = 6
2019	XXX/5 (2018)	In the decision, the parties requested the Panel to prepare a report without specifying the time for submission.	Panel/committee experts = 6 Outside experts = 15 Total = 21 Article 5 parties = 12 (57%) High-ambient-temperature experts = 9

^a The Technology and Economic Assessment Panel describes high-ambient-temperature experts as having specific knowledge and/or experience of designing, operating and testing refrigeration and air-conditioning equipment or implementing related projects under high-ambient-temperature conditions. High-ambient-temperature experts do not necessarily come from countries with high ambient temperatures.

2. Safety standards

60. The parties also recognized the importance of the timely updating of international standards for flammable, low-global-warming-potential refrigerants and adopted decision XXVIII/4 on the establishment of regular consultations on safety standards. In that decision, the parties requested the Panel to liaise and coordinate with standards organizations on relevant standards and to prepare a report on safety standards relevant to low-global-warming-potential alternatives. In response to that decision, the Panel established a task force on safety standards. The task force had 24 members, 7 from Article 5 parties, with 2 experts on high-ambient-temperature conditions.

V. Summary of key points from section III

61. The parties have placed significant importance on the terms of reference of the Panel to ensure the smooth operation of that body of experts, which carries out important work that contributes to the work of parties in achieving the goals of the Montreal Protocol. Parties dedicated over four continuous years (2010–2013) to discussing the terms of reference and took a number of key decisions that culminated in the current terms of reference, which the Panel has been implementing. The Panel successfully implemented the key decisions and the requirements of the terms of reference, including completing a thorough review of the membership and reappointment process for all its committees in 2014; developing and sharing guidelines for nominations to the committees; developing the standard disclosure of interest and conflict of interest forms and guidance; and reviewing the requirements of the terms of reference at the start of every meeting of the Panel, committees and temporary subsidiary bodies.

62. It is important to remember the specific circumstances under which the Panel, committees and temporary subsidiary bodies work and operate, in particular with regard to the rapidly changing requests and the tight timetables they follow to respond to those requests and to produce their reports.

63. In terms of size, the Panel currently has 19 members. Three committees (FTOC, MCTOC and RTOC) are larger than the size specified in the terms of reference. MCTOC is large and has a wide range of topics to cover; approximately half of the committee is composed of medical experts on metered-dose inhalers, who meet in alternate years. Medical experts on sterilants are corresponding members. RTOC is also large, which reflects the broad expertise required to cover that large sector of use.

64. The 50/50 balance between Article 5 and non-Article 5 parties has been achieved within the Panel itself, but not within its technical options committees, where between 56 and 67 percent of their current members come from non-Article 5 parties. No requirements for geographical or gender balance are specified in the terms of reference or in decisions of the parties. The composition of the Panel is currently uneven with respect to geographical balance. Women remain underrepresented,

despite the recent progress made and the persistent efforts of the Panel. Co-chairs and members of the Panel and the committees have increased their efforts to identify appropriate experts, in particular from Article 5 parties and regions that are not represented, as well as women experts, within their professional networks.

65. The basis for nominations is the matrix of needed expertise. A well-structured matrix of the expertise existing in and needed by the Panel and each technical options committee is key to facilitating the nomination by parties of appropriate experts. The matrix is contained in the annual progress reports of the Panel and is also posted on the Ozone Secretariat website as a stand-alone document for easy access. The terms of reference do not require consultation with the Panel or the committees when parties make nominations to the Panel or the committees. However, discussions on potential nominations to the Panel do take place between the nominating parties and the Panel as needed. In some cases, no discussions take place, for example, in the case of the senior expert nominations.

66. Each nomination is accompanied by a brief curriculum vitae, with an indication of the nominee's expertise. Nominations for positions on the Panel tend to occur immediately prior to or at the Meeting of the Parties at which decisions on appointments are taken by the parties. Nominations for and appointments or reappointments to committees occur throughout the year. Nominations that meet the needed expertise indicated in the matrix are more likely to be accepted by the Panel in the period close to the publication of the matrix. The establishment of temporary subsidiary bodies rests with the Panel given the need for the timely establishment of those bodies. It is therefore the Panel that nominates suitable experts for temporary subsidiary bodies and the Secretariat informs the relevant national focal points to enable consultation.

67. In the case of senior experts on the Panel, the nominating parties submit their nominations directly to the Ozone Secretariat for forwarding to the Meeting of the Parties. Although the terms of reference do not require nominating parties to consult the Panel, prior discussions with the Panel co-chairs on the potential nominations may help to ensure that needed expertise is acquired and that balance is achieved. Senior experts, as is true for all the Panel members, should have the relevant expertise, time and skills to contribute to the work of the Panel, and, consistent with the terms of reference, they should possess specific expertise not covered by the Panel co-chairs or committee co-chairs. Consultations with other parties on potential nominations could also help to ensure that there is coordination and support among the parties for the nominations as well as avoiding multiple nominations from particular regions. Sufficiently detailed information on the needed expertise in the matrix, accurate and timely reflection on the expertise needed, and a clear nomination process may facilitate nominations and appointments.

68. Currently, the term of office of co-chairs and members is a maximum of four years, with the possibility of renomination and reappointment for additional periods of up to four years each. There are no limits on a number of times one can be reappointed. The process of appointment and reappointment of Panel and committee members, as set out in the existing terms of reference, occurs in four-year cycles. One third of the Panel has turned over in the past four years. There is a balance to be struck among continuity, balance, reasonable turnover rates and bringing in new expertise, especially to address new challenges relating to the Kigali Amendment.

69. Ensuring appropriate and sufficient technical expertise has been a priority of the Panel and the committees. That priority can outweigh other factors and sometimes results in Panel and committee co-chairs not accepting nominations made by parties because they are not considered suitable for the specific expertise needed.

70. On other procedural matters, several technical options committees and a number of task forces, for example on replenishment studies, conduct expert reviews for their reports. Such reviews generally result in additional information and views being brought to light. A similar approach has not been employed by the Panel and other technical options committees for their reports, in particular the quadrennial and other periodic assessments, for which the time constraints on producing reports are not so severe.

VI. Summary of the key points from section IV

71. In carrying out the assessments and technology reviews related to the Kigali Amendment, the Panel and its technical options committees will require expertise in HFC-related technologies and their alternatives, in particular in the refrigeration, air-conditioning and heat-pump sectors, as well as expertise in the feasibility and efficacy of those alternatives in high-ambient-temperature conditions. Knowledge of the economics of those technologies and their market situations will also be needed. Expertise in understanding the climatic and environmental benefits to be gained from the adoption of

alternatives in equipment and industry sectors would also be useful. Linkages to and implications for the Sustainable Development Goals could also increase in importance.

72. Furthermore, it is important to ensure that expertise to address the concerns of certain regions or groups of countries is present to an adequate extent on the Panel, committees and temporary subsidiary bodies that will carry out the relevant work. Knowledge of and expertise in the specific technical and economic situations and needs of parties is essential in certain assessments, including in the work of RTOC, which is a key committee that keeps under review the development, availability and adoption of HFC alternatives in the refrigeration, air-conditioning and heat-pump sectors.

73. Measures under the Kigali Amendment are embedded in the overall context of climate change mitigation, including through energy efficiency improvements, which in turn will affect energy demand considerably. The current matrix of needed expertise includes the following areas of expertise relevant to climate change and energy efficiency:

- (a) Ozone and climate benefits modelling related to HFC alternatives and energy efficiency;
- (b) Energy efficiency policy and labelling, standards and testing, and incentives to address market barriers.

74. The needs for expertise will evolve depending on the focus of the requests made by the parties to the Panel and the technical options committees in the future. The Panel is expected to reflect those needs in the matrix, with a view to facilitating the identification and nomination of appropriate experts.

75. Parties may wish to consider that, for some specific tasks and questions related to climate change, it may be beneficial to work with bodies possessing climate change expertise to undertake joint activities, such as workshops and expert meetings, and organize ad hoc groups to produce specific reports.¹³

¹³ For example, to date, two activities have been carried out jointly by the Intergovernmental Panel on Climate Change and the Technology and Economic Assessment Panel: (a) an expert meeting on options for the limitation of emissions of HFCs and perfluorocarbons (PFCs), held in 1999; and (b) an assessment on safeguarding the ozone layer and the global climate system by addressing issues related to HFCs and PFCs, the outcome of which was a special report that was issued in 2005.

Annex

Membership, demographics and expertise of the Technology and Economic Assessment Panel and its technical options committees, as at March 2019

1. Technology and Economic Assessment Panel

The Technology and Economic Assessment Panel is presently composed of three co-chairs, the co-chairs of the technical options committees and five senior experts, as indicated in table 1 below. The senior experts are providing expertise related to Montreal Protocol processes, including replenishment, global financing mechanisms, economics, energy efficiency and climate change.

Needed expertise¹

The latest version of the matrix of needed expertise lists areas of expertise that are relevant to the implementation of the Kigali Amendment, as follows:

- Experience in replenishment and funding mechanisms under the Multilateral Fund
- Economic analysis of options for transition, taking account sector considerations, ozone and climate aspects
- Knowledge of global financing mechanisms relevant to ozone and climate protection

Table 1

Composition of the Technology and Economic Assessment Panel

Panel co-chairs	Gender	Affiliation	Country
Bella Maranion	F	Environmental Protection Agency	United States
Marta Pizano	F	Independent expert, MBTOC	Colombia
Ashley Woodcock	M	Manchester University NHS Foundation Trust	United Kingdom of Great Britain and Northern Ireland
Senior experts		Affiliation	Country
Suely Carvalho	F	Independent expert	Brazil
Marco Gonzalez	M	Independent expert	Costa Rica
Rajendra Shende	M	TERRE Policy Centre	India
Sidi Menad Si-Ahmed	M	Independent expert	Algeria
Shiqiu Zhang	F	College of Environmental Sciences and Engineering, Peking University	China
Technical options committee co-chairs	Gender	Affiliation	Country
Paulo Altoé	M	Dow Chemical, FTOC	Brazil
Adam Chattaway	M	Collins Aerospace, HTOC	United Kingdom
Sergey Kopylov	M	All-Russian Research Institute for Fire Protection, HTOC	Russian Federation
Roberto de A. Peixoto	M	Maua Institute of Technology, RTOC	Brazil
Fabio Polonara	M	Marche Polytechnic University, RTOC	Italy
Kei-ichi Ohnishi	M	AGC Inc., MCTOC	Japan
Ian Porter	M	La Trobe University, MBTOC	Australia
Helen Tope	F	Energy International Australia, MCTOC	Australia
Daniel Verdonik	M	Jensen Hughes Inc., HTOC	United States
Helen Walter-Terrinoni	F	Air-conditioning, Heating and Refrigeration Institute, FTOC	United States

¹ The expertise needed by the Panel and each of the committees is taken from the matrix of needed expertise, most recently updated in November 2018 and available on the Ozone Secretariat website (https://ozone.unep.org/teap_experts_required). A majority of requests for needed expertise are for Article 5 experts.

Jianjun Zhang	M	Zhejiang Chemical Industry Research Institute, MCTOC	China
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Abbreviations: TEAP, Technology and Economic Assessment Panel; FTOC, Flexible and Rigid Foams Technical Options Committee; HTOC, Halons Technical Options Committee; MCTOC, Medical and Chemicals Technical Options Committee; MBTOC, Methyl Bromide Technical Options Committee; RTOC, Refrigeration, Air-Conditioning and Heat Pumps Technical Options Committee.

Distribution

Total members: 19

Article 5 parties: 9 (47%); non-Article 5 parties: 10 (53%)

Male: 13 (68%); female: 6 (32%)

Africa: 1 (5%); Latin America and the Caribbean: 5 (26%); Europe (includes the Russian Federation and the United Kingdom): 4 (21%); North America (Canada and the United States): 3 (16%); Asia and the Pacific: 6 (32%)

2. Flexible and Rigid Foams Technical Options Committee

General expertise

The members of the Flexible and Rigid Foams Technical Options Committee (FTOC) have expertise in producing and handling foam blowing agents; foam formulation; foam production (extruded polystyrene, spray foam and appliances, etc.) and life-cycle analysis; emissions and banks modelling; certification testing for foams; regulations related to foams; global foam markets, including the forecasting of future production; historical knowledge of foams, foam blowing agents, regulations and the Montreal Protocol; the building envelope and reducing energy demand from buildings; and energy efficiency in appliance design and production. The composition of FTOC is provided in table 2 below.

Needed expertise

- Polyurethane foams from the Middle East
- Appliance production from southern Africa
- Foam production during the conversion to low-global-warming-potential alternatives, and relevant safety issues

Table 2

Composition of the Flexible and Rigid Foams Technical Options Committee

Co-chairs	Gender	Affiliation	Country
Paulo Altoé	M	Dow Chemical	Brazil
Helen A Walter-Terrinoni	F	Air-conditioning, Heating and Refrigeration Institute	United States
Members	Gender	Affiliation	Country
Samir Arora	M	Industrial Foams	India
Paul Ashford	M	Anthesis Group	United Kingdom
Angela Austin	F	Independent expert	United Kingdom
Kultida Charoensawad	F	Covestro	Thailand
Roy Chudhury	M	Foam Supplies	Australia
Joe Costa	M	Arkema	United States
Gwyn Davies	M	Kingspan Group	United Kingdom
Rick Duncan	M	Spray Polyurethane Foam Alliance	United States
Gaby Dreyfuss	F	Kigali Cooling Efficiency Programme	United States
Rajaram Joshi	M	Owens Corning	India
Ilhan Karaağaç	M	Izocam	Turkey
Shpresa Kotaji	F	Huntsman Corporation	Belgium
Simon Lee	M	Independent expert	United States
Yehia Lotfi	M	Technocom	Egypt
Lisa Norton	F	Solvay	United States
Miguel Quintero	M	Independent expert	Colombia
Sally Rand	F	Independent expert	United States
Sascha Rulhoff	M	H-C-S Group	Germany
Enshan Sheng	M	Huntsman Corporation	China
Koichi Wada	M	Japan Urethane Industry Institute	Japan
David J Williams	M	Honeywell	United States

Guolian Wu	M	Samsung	United States
Wentao Allen Zhang	M	Independent expert	China

Distribution

Total members: 25

Article 5 parties: 9 (36%); non-Article 5 parties: 16 (64%)

Male: 18 (72%); female: 7 (28%)

Africa: 1 (4%); Latin America and the Caribbean: 2 (8%); Europe (includes the Russian Federation): 5 (20%); North America (Canada and the United States): 9 (36%); Asia and the Pacific: 8 (32%)

3. Halons Technical Options Committee

General expertise

In line with the Kigali Amendment to the Montreal Protocol, the role of the Halons Technical Options Committee (HTOC) has broadened to cover low-global-warming-potential alternatives to halons, HCFCs and high-global-warming-potential HFCs. However, additional areas of expertise in the fire protection sector are not required under the Kigali Amendment because the use remains unchanged. From a safety standpoint, HTOC remains concerned that the flammability of refrigerants, foam blowing agents and solvents requires fire protection expertise that almost exclusively resides in HTOC. The composition of HTOC is provided in table 3 below.

Needed expertise

- Fire suppression applications in civil aviation in South-East Asia
- Halon, HCFC and HFC alternatives and their market penetration from Africa, South America and South Asia
- Halon banking and supply from Africa and South America
- Halon recovery in ship breaking

Table 3

Composition of the Halons Technical Options Committee

Co-chairs	Gender	Affiliation	Country
Adam Chattaway	M	Collins Aerospace	United Kingdom
Sergey Kopylov	M	All-Russian Research Institute for Fire Protection	Russian Federation
Daniel P. Verdonik	M	Jensen Hughes Inc.	United States
Members	Gender	Affiliation	Country
Jamal Alfuzai	M	Independent expert	Kuwait
Johan Åqvist	M	Swedish Defence Materiel Administration	Sweden
Youri Auroque	M	European Aviation Safety Agency	France
Seunghwan (Charles) Choi	M	Hanchang Corporation	Republic of Korea
Michelle M. Collins	F	EECO International	United States
Khaled Effat	M	Modern Systems Engineering	Egypt
Carlos Grandi	M	Embraer	Brazil
Laura Green	F	Hilcorp	United States
Elvira Nigido	F	A-Gas Australia	Australia
Emma Palumbo	F	Safety Hi-Tech	Italy
Erik Pedersen	M	Independent expert	Denmark
R.P. Singh	M	Centre for Fire, Explosive and Environment Safety, Defence Research and Development Organization	India
Donald Thomson	M	Manitoba Ozone Protection Association	Canada
Mitsuru Yagi	M	Nohmi Bosai Ltd., Fire and Environment Protection Network	Japan

Distribution

Total members: 17

Article 5 parties: 5 (29%); non-Article 5 parties: 12 (71%)

Male: 13 (76%); female: 4 (24%)

Africa: 1 (6%); Latin America and the Caribbean: 1 (6%); Europe (includes the Russian Federation): 6 (35%); North America (Canada and the United States): 4 (24%); Asia and the Pacific: 5 (30%)

4. Methyl Bromide Technical Options Committee

General expertise

The Methyl Bromide Technical Options Committee (MBTOC) brings together expertise on controlled and exempted uses of methyl bromide, such as quarantine and pre-shipment uses, and alternatives that are technically and economically feasible. Members are experts in the control and management of soil-borne pests and pathogens that attack crops on which methyl bromide is or was used; pest control in a variety of stored commodities and structures; and alternatives for controlling quarantine pests and pathogens. Members have research, regulatory and commercial experience. The composition of MBTOC is provided in table 4 below.

Needed expertise

- Validation of alternatives to methyl bromide for certification of nursery plant materials in the context of movement across state and international boundaries and related risk assessment
- Economic assessment of alternatives to methyl bromide
- Quarantine and pre-shipment uses of methyl bromide and alternatives
- Substrate technology

Table 4

Composition of the Methyl Bromide Technical Options Committee

Co-chairs	Gender	Affiliation	Country
Marta Pizano	F	Independent expert	Colombia
Ian Porter	M	La Trobe University	Australia
Members		Affiliation	Country
Cao Aocheng	M	Institute for Plant Protection, Chinese Academy of Agricultural Sciences	China
Jonathan Banks	M	Independent expert	Australia
Fred Bergwerff	M	EcO2	Netherlands
Mohamed Besri	M	Agronomy and Veterinary Institute Hassan II	Morocco
Sait Erturk	M	Directorate of Plant Protection, Central Research Institute	Turkey
Ken Glassey	M	Ministry of Agriculture and Forestry	New Zealand
Alfredo Gonzalez	M	Independent expert	Philippines
Rosalind James	F	Department of Agriculture	United States
Takashi Misumi	M	Ministry of Agriculture, Forestry and Fisheries	Japan
Christoph Reichmuth	M	Humboldt University	Germany
Jordi Riudavets	M	Department of Plant Protection, Institute of Agrifood Research and Technology	Spain
Akio Tateya	M	Japan Fumigation Technology Association	Japan
Alejandro Valeiro	M	Department of Agriculture	Argentina
Nick Vink	M	Stellenbosch University	South Africa

Distribution

Total members: 16

Article 5 parties: 7 (44%); non-Article 5 parties: 9 (56%)

Male: 14 (87%); female: 2 (13%)

Africa: 2 (13%); Latin America and the Caribbean: 2 (13%); Europe (includes the Russian Federation): 3 (19%); North America (Canada and the United States): 1 (5%); Asia and the Pacific: 8 (50%)

5. Medical and Chemicals Technical Options Committee

General expertise

The Medical and Chemicals Technical Options Committee (MCTOC) was formed from the amalgamation of the Chemicals and Medical Committees in 2015 and it brings together expertise on metered dose inhalers and their alternatives; aerosols; sterilants; production of controlled substances for feedstock use; solvent and process agent applications; chemical substances of interest owing to

their ozone depletion potential or global warming potential; laboratory and analytical uses; and destruction of controlled substances. Members are experts in asthma and chronic obstructive pulmonary disease and their treatment; pharmaceutical manufacturing and marketing; aerosol manufacturing and marketing; hospital and industrial sterilization of medical equipment; chemical manufacturing; laboratory and analytical procedures; and destruction technologies. Members have research, academic, clinical, regulatory, laboratory, industrial and commercial experience. Thirteen medical experts in metered-dose inhalers meet in alternate years to review progress made in phasing down HFCs in metered-dose inhalers and 2 medical experts in sterilants are corresponding members. The composition of MCTOC is provided in table 5 below.

Needed expertise

- Range of various destruction technologies
- Industrial chemical manufacturing processes
- Analytical procedures for laboratory use

Table 5

Composition of the Medical and Chemicals Technical Options Committee

Co-chairs	Gender	Affiliation	Country
Kei-ichi Ohnishi	M	AGC Inc.	Japan
Helen Tope	F	Independent expert/Energy International Australia	Australia
Jianjun Zhang	M	Zhejiang Chemical Industry Research Institute	China
Members		Affiliation	Country
Emmanuel Addo-Yobo	M	Kwame Nkrumah University of Science and Technology	Ghana
Fatima Al-Shatti	F	Independent expert/International Ozone Committee, Kuwait Environmental Public Authority	Kuwait
Paul Atkins	M	Oriel Therapeutics Inc.	United States
Bill Auriemma	M	Diversified CPC International	United States
Olga Blinova	F	Russian Scientific Centre – Applied Chemistry	Russian Federation
Steve Burns	M	AstraZeneca	United Kingdom
Nick Campbell	M	Arkema	France
Nee Sun (Robert) Choong Kwet Yive	M	University of Mauritius	Mauritius
Rick Cooke	M	Man-West Environmental Group Ltd.	Canada
Maureen George	F	Columbia University School of Nursing	United States
Kathleen Hoffmann	F	Sterigenics International Inc.	United States
Jianxin Hu	M	College of Environmental Sciences and Engineering, Peking University	China
Ryan Hulse	M	Honeywell	United States
Javaid Khan	M	Aga Khan University	Pakistan
Andrew Lindley	M	Independent expert/Mexichem (UK) Ltd., European Fluorocarbon Technical Committee	United Kingdom
Gerald McDonnell	M	DePuy Synthes Companies, Johnson and Johnson	United States
Robert Meyer	M	Independent expert/Greenleaf Health (consultant)	United States
Tim Noakes	M	Mexichem (UK) Ltd.	United Kingdom
John G. Owens	M	3M	United States
Jose Pons Pons	M	Spray Quimica	Venezuela
Hans Porre	M	Teijin Aramid	Netherlands
John Pritchard	M	Independent expert/Inspiring Strategies	United Kingdom
Rabbur Reza	M	Beximco Pharmaceuticals	Bangladesh
Paula Rytälä	F	Orion Corporation	Finland
Rajiev Sharma	M	GlaxoSmithKline	United Kingdom
Jørgen Vestbo	M	University of Manchester	Denmark
Kristine Whorlow	F	Non-Executive Director	Australia

Ashley Woodcock	M	Manchester University NHS Foundation Trust	United Kingdom
Yizhong You	M	Journal of Aerosol Communication	China
Lifei Zhang	M	National Research Centre for Environmental Analysis and Measurement	China

Distribution

Total members: 33

Article 5: 10 (30%); non-Article 5: 23 (70%)

Male: 26 (79%); female: 7 (21%)

Africa: 2 (6%); Latin America and the Caribbean: 1 (3%); Europe (includes the Russian Federation): 11 (34%); North America (Canada and the United States): 9 (27%); Asia and the Pacific: 10 (30%)

6. Refrigeration, Air-Conditioning and Heat Pumps Technical Options Committee

General expertise

The Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee (RTOC) is the largest committee and is focusing on reorganization in 2019. It brings together expertise in the refrigeration, air-conditioning and heat-pump sectors. Members are experts in refrigerants; domestic refrigeration; commercial refrigeration; industrial refrigeration and heat-pump systems; transport refrigeration; air-to-air conditioners and heat pumps; water and space heating heat pumps; chillers; vehicle air conditioning; energy efficiency and sustainability applied to refrigeration systems; not-in-kind technologies; high-ambient-temperature applications; and modelling of refrigeration, air-conditioning and heat-pump systems. Members have research, regulatory and commercial experience. The composition of RTOC is provided in table 6 below.

Needed expertise

- Ozone and climate benefits modelling related to energy efficiency in the refrigeration, air-conditioning and heat-pump sectors
- Ozone-depleting substances and HFC transition modelling of refrigeration, air-conditioning and heat-pump sectors
- Energy efficiency policy and labelling, standards and testing, and incentives to address market barriers
- Ozone-depleting substances and HFC refrigerant banks and/or recovery, recycling and reclamation

Table 6

Composition of the Refrigeration Technical Options Committee²

Co-chairs	Gender	Affiliation	Country
Roberto de A. Peixoto	M	Maua Institute of Technology	Brazil
Fabio Polonara	M	Marche Polytechnic University	Italy
Members		Affiliation	Country
Maria C. Britto Bacellar	F	Johnson Controls	Brazil
James M. Calm	M	Calm Consultancy	United States
Radim Cermák	M	Ingersoll Rand	Czechia
Guangming Chen	M	Zhejiang University	China
Jiangpin Chen	M	Shanghai Jiao Tong University	China
Daniel Colbourne	M	Re-phridge Consultancy	United Kingdom
Richard De Vos	M	GE Appliances	United States
Sukumar Devotta	M	Independent expert	India
Martin Dieryckx	M	Daikin Europe	Belgium
Dennis Dorman	M	Trane	United States
Bassam Elassaad	M	Independent expert	Lebanon
Ray Gluckman	M	Gluckman Consulting	United Kingdom
Dave Godwin	M	Environmental Protection Agency	United States
Marino Grozdek	M	University of Zagreb	Croatia
Samir Hamed	M	Petra Engineering Industries	Jordan

² Three additional members are awaiting confirmation of their appointments: Omar Abdelaziz (Egypt); Jitendra Bambhure (India); and Helene Rochat (Switzerland).

Herliatika Herlin	F	PT AWH	Indonesia
Martien Janssen	M	Re/genT	Netherlands
Holger König	M	Ref-Tech Consultancy	Germany
Michael Kauffeld	M	Karlsruhe University of Applied Sciences	Germany
Mary E. Koban	F	Chemours Company	United States
Jürgen Köhler	M	Technical University of Braunschweig	Germany
Lambert Kuijpers	M	A/genT Consultancy	Netherlands
Richard Lawton	M	Cambridge Refrigeration Technology	United Kingdom
Tingxun Li	M	Sun Yat-Sen University	China
Carloandrea Malvicino	M	Fiat Chrysler Automobiles	Italy
D. Mohan Lal	M	Anna University	India
Maher Mousa	M	MHM Consultancy	Saudi Arabia
Petter Nekså	M	SINTEF Energy Research	Norway
Horace Nelson	M	Independent expert	Jamaica
Tetsuji Okada	M	Japan Refrigeration and Air-Conditioning Industry Association	Japan
Alaa M. Olama	M	Independent expert	Egypt
Alexander C. Pachai	M	Johnson Controls	Denmark
Per Henrik Pedersen	M	Independent expert/Danish Technological Institute	Denmark
Rajan Rajendran	M	Emerson	United States
Giorgio Rusignuolo	M	United Technologies Carrier	United States
Asbjørn Vonsild	M	Vonsild Consulting	Denmark
Samuel Yana Motta	M	Honeywell	Peru
Hiroichi Yamaguchi	M	Toshiba Carrier Co.	Japan

Distribution

Total members: 40

Article 5 parties: 14 (35%); non-Article 5 parties: 26 (65%)

Male: 37 (93%); female: 3 (7%)

Africa: 1 (2%); Latin America and the Caribbean: 4 (10%); Europe (includes the Russian Federation): 17 (43%); North America (Canada and the United States): 7 (18%); Asia and the Pacific: 11 (28%)