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Workshop on hydrofluorocarbon management: technical issues
Bangkok, 20 and 21 April 2015

Concept note and provisional programme

(Final version in English only – changes are highlighted)

A workshop on the management of hydrofluorocarbons (HFCs) is being convened in accordance with decision XXVI/9, adopted by the Twenty-Sixth Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer in November 2014. In paragraph 2 of that decision, the Meeting of the Parties decided “to convene a two-day workshop, back to back with an additional three-day meeting of the Open-ended Working Group in 2015, to continue discussions on all issues in relation to hydrofluorocarbon management, including a focus on high-ambient temperature and safety requirements, as well as energy efficiency, taking into account the information requested in the present decision and other relevant information”.

In accordance with decision XXVI/9 issues related to HFC management will be discussed at the workshop and at the thirty-fifth meeting of the Open-ended Working Group. The workshop will take place on 20 and 21 April 2015 at the United Nations Conference Centre in Bangkok. The thirty-fifth meeting of the Open-ended Working Group will take place at the same venue from 22 to 24 April 2015.

The Secretariat has designed the agendas for the two meetings in such a way that the workshop will provide the opportunity for informed and in-depth discussions on all technical aspects of the management of HFCs and the meeting of the Open-ended Working Group will enable further discussions on all issues related to the management of HFCs. The workshop will feature extensive participation by technical experts and industry representatives as overview speakers, panellists and participants with a view to providing clarification of technical issues and allowing for in-depth discussion at a practical level. The conclusions of the workshop will be presented for further consideration and discussion by the Parties during the meeting of the Open-ended Working Group.

I. Objectives and format of the workshop

A. Objectives

1. The workshop on hydrofluorocarbon (HFC) management will focus on technical issues related to the management of HFCs, with the aim of clarifying the status of equipment, products and related technologies in industry sectors that use HFCs as alternatives to ozone-depleting substances as well as on what is needed to improve HFC management practices. Issues covered will include, among others, cost, safety and energy efficiency, with a focus on alternative substances and technologies that are commercially available or expected to be commercially available in the near future. All relevant market and industry sectors and sub-sectors and regions will be covered, with a specific focus on high-ambient temperature conditions where relevant. The specific challenges of small and medium-sized enterprises will also be addressed.

B. Format

2. To enable in-depth discussion of key industry sectors, the issues will be discussed in six separate sessions. Each of the first four sessions will focus on a sector; session 5 will look at overarching and cross-cutting issues; and session six will provide a forum for the discussion of key conclusions. There will also be a side-event on the use of HFCs in the aerosols sector.

3. Sessions 1, 2, 3 and 4 will each feature overview speakers, panellists, a facilitator and a rapporteur. Session 5 will feature panellists, a facilitator and a rapporteur.

4. The overview speakers for each session will present the key facts, based largely on fact sheets developed for the relevant markets or industry sectors (see below), and will act as resource experts for the discussion that will take place during the session. The panellists have been drawn from “technology providers” and “implementers of technologies” from both parties operating under paragraph 1 of Article 5 (Article 5 parties) and parties not operating under that paragraph (non-Article 5 parties). Following the presentations by the overview speakers, the facilitator will invite each of the panellists to make comments or short presentations (3 minutes) and will then invite the audience, the panellists and the overview speakers to engage in an open discussion.

5. Parties are encouraged to invite representatives of all relevant industries, enterprises (for example, installation and servicing companies) and associations in their countries to participate in the workshop and to contribute actively to the discussions.

6. There will be two facilitators who will alternate for the six sessions, and each session will have a rapporteur. Brief biographies for the two facilitators are set out in the annex to the present document. As was the case at the workshop on HFC management convened in July 2014, professional facilitators will be engaged, and the Secretariat will establish a meeting portal enabling participants to submit comments and questions electronically from their laptops or other electronic devices during the workshop. An overhead projector will display any such questions or comments during each session.

7. Each of the rapporteurs for sessions 1–5 will summarize the key issues addressed during his or her session, as well as any unanswered questions, and present them during session 6 for general discussion. Session 6 is expected to distil any additional key conclusions over and above the conclusions reached during sessions 1–5. The conclusions reached during session 6 are expected to address issues such as:

- (a) Specific challenges and opportunities with regard to limiting high-GWP HFC use while phasing out HCFCs in industries and enterprises in Article 5 parties, including the challenges caused by high-ambient temperatures;
- (b) Applications for which high-GWP HFCs are difficult to replace;
- (c) Applications for which high-GWP HFCs are easy to replace;
- (d) Timelines for the availability of alternative technologies.

8. The rapporteurs for session 6 will briefly summarize the discussions at the end of the workshop. They will also report on the key conclusions reached during the workshop to the Open-ended Working Group at its thirty-fifth meeting.

9. As a basis for the overview presentations and for the ensuing discussions, fact sheets will be made available prior to the workshop on the use of HFCs and their alternatives in the various industry sectors. The fact sheets have been prepared by the Secretariat with the help of experts and widely peer

reviewed by experts from the Technology and Economic Assessment Panel and its relevant technical option committees. The purpose of the fact sheets is to summarize factual technical information in a neutral manner, providing a description of the market sector and sub-sectors, information on low-GWP alternatives to HFCs and a discussion of key issues, including commercial availability, cost, safety and standards, energy efficiency, technical training and others.

10. It should be noted that the fact sheets are not exhaustive.

Provisional programme

Day 1: Monday, 20 April

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| 10–11 a.m. | Opening of the workshop |
| 10–10.10 a.m. | Welcome and introduction to the workshop objectives and format by the Executive Secretary, Ozone Secretariat |
| 10.10–10.30 a.m. | Short overview of (i) current atmospheric HFC abundances in the atmosphere and projected concentrations and (ii) current and extrapolated future HFC demand by sectors and potential impacts of mitigation measures
Mr. A.R. Ravishankara, Co-Chair, Scientific Assessment Panel, and Ms. Bella Maranion, Co-Chair, Technology and Economic Assessment Panel |
| 10.30–11 a.m. | Introductory session and overview of the sectors and sub-sectors to be discussed
Mr. Sukumar Devotta, Mr. Ray Gluckman and Mr. Lambert Kuijpers |

11 a.m.–2 p.m. Session 1: Challenges and opportunities in addressing high-GWP HFCs in the refrigeration sector

<p>Facilitator: Mr. Peter Adler</p> <p>Rapporteur: Mr. Ullrich Hesse</p>	
<p>Subsectors/systems</p> <ul style="list-style-type: none"> • Domestic refrigeration (refrigerators and freezers) • Commercial refrigeration (small stand-alone equipment, condensing units, large central pack systems) • Industrial refrigeration (small/medium-sized and large systems) • Transport refrigeration (road vehicle, intermodal containers, ships) 	<p>Presentation on the sector's status</p> <p><i>Overview speakers (resource experts)</i></p> <ul style="list-style-type: none"> • Mr. Reinhard Radermacher • Mr. Paulo Vodianitskaia
<p>Issues to be addressed</p> <ul style="list-style-type: none"> • Availability of components and the implications thereof for system design when using low-GWP chemicals and blends in the refrigeration sector • Low-GWP technology options for medium-sized and larger industrial systems under various ambient conditions • Low-GWP technology options for industrial and large commercial and community applications • Alternative options for plug-in cabinets, including for high-ambient temperature regions, vending machines • Low-GWP options for small commercial equipment • Low-GWP alternatives for on-site-built commercial refrigeration equipment (including condensing unit systems); cost implications and performance in high ambient temperatures • Options (drop-in, retrofit, etc.) for existing commercial systems/equipment (including condensing units); servicing issues • Low-GWP options for cascade systems for medium-sized and larger commercial refrigeration equipment • Technological transition and barriers in Article 5 parties for commercial refrigeration: end users' perspective • Performance of low-GWP supermarket systems in various climate zones, including in high-ambient temperatures • Low-GWP alternatives and standards for transport refrigeration, including intermodal reefer containers, road transport and refrigeration on board vessels 	<p><i>Panellists: Technology providers/implementers</i></p> <ul style="list-style-type: none"> • Mr. Torben Funder-Kristensen (Danfoss) • Mr. Jonathan Ayotte (Carnot, Canada) • Mr. Eric Delforge (Mayekawa) • Mr. Roy Singh (Arctic King Appliances, South Africa) • Mr. Bruno Pussoli (Metalfrio, Brazil) • Mr. Christian Heerup (Danish Technological Institute, Denmark) • Mr. Zhang Zhaohui (CRAA, China) • Mr. Paul de Larminat (Johnson Controls) • Mr. Fernando Galante (EPTA, Argentina) • Mr. Juergen Goeller (Carrier) • Mr. Holger Koenig (consultant, Germany)

2–3 p.m. Lunch

3–6 p.m. Session 2: Challenges and opportunities in addressing high-GWP HFCs in the stationary air-conditioning and heat pump sector

<p>Facilitator: Mr. Saleem Ali</p> <p>Rapporteur: Mr. Richard Abrokwa-Ampadu</p>	
<p>Subsectors/systems</p> <ul style="list-style-type: none"> • Small self-contained air-conditioning (portable systems, window units, through the wall, packaged terminal) • Small split air-conditioning systems (single split systems) • Larger split and other types of air-to-air systems (larger single splits and multi-splits, VRF/VRF systems, ducted systems and packaged rooftop systems) • Chiller systems (chillers with positive displacement compressors, chillers with centrifugal compressors) • Heating-only heat pumps (space heating, water heating, domestic tumble driers, large space heating systems, industrial process heating) 	<p>Presentation on the sector’s status</p> <p><i>Overview speakers (resource experts)</i></p> <ul style="list-style-type: none"> • Mr. Daniel Colbourne • Mr. Roberto Peixoto • Mr. Saurabh Kumar (the energy efficiency perspective)
<p>Issues to be addressed</p> <ul style="list-style-type: none"> • Availability and implications for system design and characteristics of low-GWP chemicals and blends in the air-conditioning (AC) sector • Alternatives to high-GWP HFCs for air-conditioning • Possibilities for applying various low-GWP options in single split air-conditioning units (including under high-ambient temperature conditions) • Current and near future availability of low-GWP refrigerants and barriers to their large-scale application in air-conditioning • Technical consideration of feasibility of low-GWP alternatives: performance, cost • Suitable alternatives at high ambient temperatures for medium-sized air-conditioning equipment • Alternatives for air-conditioning units in high ambient temperatures, with emphasis on energy efficiency • Use of non-HFC refrigerants in small and medium-sized air-conditioning and heat pump units • Large air-conditioning units using a variety of low-GWP options • District cooling and heating systems using low-GWP refrigerants and other sources as drivers 	<p><i>Panellists: Technology providers/implementers</i></p> <ul style="list-style-type: none"> • Mr. Mike Thompson (Ingersoll Rand/Trane, United States) • Mr. Jitendra Bhambure (Blue Star, India) • Mr. Ting Xun Li (Midea and Sun Yat-sen University, China) • Ms. Wang Lei (China Household Electric Appliances Association, China) • Mr. Kazuhiro Sato (Mitsubishi Heavy Industries, Japan) • Mr. Bassam Elassaad (consultant, Lebanon) • Mr. Maher H. Mousa (Saudi Arabia HVAC industry consultant, UTC BIS and Juffali JV, Saudi Arabia) • Mr. Petter Neksa (SINTEF, Norway) • Mr. Alaa Olama (consultant, Egypt) • Mr. Par Dalin (DEVCO-ISO committee on developing country matters)

6–6.30 p.m. Coffee break

6.30–7.30 p.m. Session 3: Challenges and opportunities in addressing high-GWP HFCs in mobile air-conditioning

<p><i>Facilitator:</i> Mr. Saleem Ali</p> <p><i>Rapporteur:</i> Mr. Gursaran Mathur</p>	
<p>Subsectors</p> <ul style="list-style-type: none"> • Mobile air conditioning (MAC) (cars and larger vehicles) 	<p>Presentation on the sector's status</p> <p><i>Overview speaker (resource expert)</i></p> <ul style="list-style-type: none"> • Mr. Predrag Pega Hrnjak
<p>Issues to be addressed</p> <ul style="list-style-type: none"> • Environmental impacts of MAC in high ambient temperatures • Low-GWP systems, including HFO and CO₂ systems, perceived barriers, costs, safety issues and performance in high ambient temperatures • Introduction of low-GWP alternatives to HFC-134a in Article 5 MAC production: cost and safety issues • Options for existing systems/equipment (drop-in, retrofit) 	<p><i>Panellists</i></p> <ul style="list-style-type: none"> • Mr. Pradit Mahasaksiri (Denso) • Mr. Enrique Peral-Antunez (Renault, France) • Mr. Jianping Chen (Shanghai Jiao Tong University, China) • Mr. Sangeet Kapoor (Tata Motors, India)

DAY 2

10–11.30 a.m. **Session 4: Challenges and opportunities in addressing high-GWP HFCs in the foam sector**

<i>Facilitator:</i> Mr. Saleem Ali	
<i>Rapporteur:</i> Mr. Enshan Sheng	
Subsectors <ul style="list-style-type: none"> Closed-cell rigid foams used for thermal insulation: extruded polystyrene boards, polyurethane and phenolic boards and panels, polyurethane appliance insulation, polyurethane spray foam, polyurethane in situ/block foam 	Presentation on the sector's status <i>Overview speakers (resource experts)</i> <ul style="list-style-type: none"> Mr. Paulo Altoe Mr. Igor Croiset
Issues to be addressed <ul style="list-style-type: none"> Developments in the phase-in of low-GWP chemicals in various polyurethane sectors Alternatives currently offered in the extruded polystyrene industry, compromises on physical properties, cost constraints on process development Safe and commercially viable low-GWP alternatives for micro, small and medium-sized enterprises in Article 5 and non-Article 5 parties System houses and development of low-GWP technologies Use of fourth generation blowing agent to replace high-GWP HFCs 	Panellists: Technology providers/implementers <ul style="list-style-type: none"> Ms. Kultida Charoensawad (Polyurethane Group, Federation of Thai Industries, Thailand) Mr. Ashok Chotani (Isofoam, Kuwait) Mr. Samir Arora (Industrial Foams, India) Mr. Bruno Fierro (Bono, Italy) Ms. Achara Bowornprasitkul (BASF)

**11.30 a.m.–1.30 p.m.
and 3–5 p.m.**

Session 5: Overarching and cross-cutting issues on technical aspects of HFC management (part 1 and part 2)

11.30–11.45 a.m.

Introductory remarks on overarching and cross-cutting issues
Mr. Mack McFarland (Global Fluorochemical Producers' Forum)
Mr. Marc Chasserot (Shecco)

11.45 a.m.–1.30 p.m.

Session 5, part 1: costs of conversion, intellectual property rights, accessibility to low-GWP alternatives and timeline of availability for new technologies

Facilitator: Mr. Peter Adler

Rapporteurs: Mr. Chandra Bhushan

Issues to be addressed	<i>Panellists</i>
<ul style="list-style-type: none"> • How will the EU F-gas legislation (and others) affect the market for HFC-related technologies around the world, including cost and availability of low-GWP options? • Examples of low-GWP alternatives that industries are scheduling to phase in with specific timelines and cost estimates in the refrigeration and air-conditioning sectors • For systems and sectors that currently use high-GWP chemicals, what are the challenges faced by companies in Article 5 parties in converting to low-GWP options? • What are the costs of replacing conventional cooling units with non-conventional low-GWP options, including retrofitting, with reference to projects in high ambient temperatures? • What are the costs of non-HFC technologies for mobile air-conditioning and what are the expected cost depreciation for those technologies? • Can low-GWP fluorocarbons be cost-effective alternative to high-GWP HFCs used in foam blowing? • Impact of intellectual property rights on technology transfer and development 	<ul style="list-style-type: none"> • Ms. Andrea Voigt (EPEE, Europe) • Mr. Rajan Rajendran (Emerson) • Mr. Ravinder Mehta (RAMA, India) • Mr. Hisham Mikhi (Millennium Energy Technologies, Jordan) • Mr. Predrag Pega Hrnjak (University of Urbana Champaign, USA) • Mr. Miquel Quintero (consultant, Colombia) • Mr. Alistair McGlone (consultant, United Kingdom)

1.30–3 p.m.

Lunch

2–3 p.m.

Side event: HFCs in aerosols – metered dose inhalers and non-medical aerosols
(Speaker: Ms. Helen Tope, discussion moderated by Mr. Ashley Woodcock)

3–5 p.m. Session 5, part 2: energy efficiency, safety, industry’s response to low-GWP policies

<i>Facilitator:</i> Mr. Peter Adler	
<i>Rapporteur:</i> Mr. Chandra Bhushan	
Issues to be addressed	<i>Panellists</i>
<i>Energy efficiency issue to be still addressed in the discussion.</i>	<i>Mr. Saurabh Kumar moved to session 2 as an overview speaker.</i>
<ul style="list-style-type: none"> • Status of safety standards, current and near future developments • Challenges regarding flammability concerns and related safety standards, possibilities for compact systems limiting charge sizes • Training and certification schemes to ensure the safe and environmentally friendly handling of low-GWP alternative refrigerants • Contribution of Article 5 party servicing organizations to the reduction of high-GWP emissions and low-GWP safety concerns • HFC management through leak reduction and recovery and next actions for stepping forward • Potential of leak reduction and recovery for refrigerant consumption reduction • Overall issues in adequate design for high-ambient temperature operation • Case study examples of using low-GWP substances and industries’ response to policies 	<ul style="list-style-type: none"> • Mr. Henry Ma (UL, China) • Mr. Asbjorn Vonsild (Danfoss) • Mr. Marco Buoni (AREA, ATF, Galileo) • Mr. Manuel Azucena (RACTAP, Philippines) • Mr. Tetsuji Okada (JRAIA, Japan) • Mr. Julio Esteban (Smart Refrigerants, Panama) • Mr. Samir Hamed (Petra Engineering Industries Company, Jordan) • Mr. Kevin Fay (Alliance for Responsible Atmospheric Policy, United States)

5–6.30 p.m. Session 6: Key conclusions relevant to policymaking on technical management of HFCs

<i>Facilitator:</i> Mr. Peter Adler
<i>Rapporteurs:</i> Ms. Karin Shepardson and Mr. Stephan Sicars
Rapporteurs of sessions 1–5 to present the conclusions of the sessions
Sessions 1, 2 and 5 (7 minutes per speaker); sessions 3 and 4 (5 minutes per speaker)
Key issues for drawing up conclusions:
<ul style="list-style-type: none"> - Specific challenges in phasing out HCFCs and phasing down HFCs in Article 5 Parties, including with regard to high ambient temperatures (for specific sectors) - Applications for which high-GWP HFCs are difficult to replace - Applications for which high-GWP HFCs are easy to replace - Timelines for the availability of alternative technologies

6.30 p.m. Closure of the workshop

Annex

Brief biographies of the professional facilitators

Mr. Peter S. Adler, PhD – United States of America

Mr. Peter Adler is a planner, mediator, facilitator and a principal of Accord3.0, a professional network of people specializing in foresight, strategy and cooperative trouble-shooting. Adler has worked in government, business and non-governmental organizations and teaches advanced negotiation courses in the Department of Urban and Regional Planning at the University of Hawaii. Prior executive experience includes nine years as President and Chief Executive Officer of Keystone Policy Center (www.keystone.org), Executive Director of the Hawaii Justice Foundation and founding Director of the Hawaii Supreme Court's Center for Alternative Dispute Resolution. He is the author of three books and numerous academic and popular articles and lives and works in Hawaii.

Website: www.accord3.com

Mr. Saleem H. Ali, PhD – Pakistan

Mr. Saleem H. Ali is Director of the Centre for Social Responsibility in Mining and Professor of Sustainable Science, Politics and International Studies at the University of Queensland in Brisbane, Australia. He is also Adjunct Professor of Environmental Planning at the University of Vermont in the United States. Mr. Ali's research focuses on environmental conflicts in the extractive industries and how ecological cooperation can promote peace in international relations. He is the author of three sole authored books, including "Treasures of the Earth: Need, Greed and a Sustainable Future," published by Yale University Press, and Environmental Diplomacy (with Mr. Lawrence Susskind, published by Oxford University Press). Mr. Ali was chosen as a Young Global Leader by the World Economic Forum in 2011 and received an Emerging Explorer Award from the National Geographic Society in 2010. Since then he has also been a member of the World Commission on Protected Areas of the International Union for Conservation of Nature and Natural Resources. He received his doctorate in Environmental Planning from the Massachusetts Institute of Technology, a Master's degree in Environmental Studies from Yale University and a Bachelor's degree in Chemistry from Tufts University. Professor Ali can be followed on Twitter: [@saleem_ali](https://twitter.com/saleem_ali).
