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FORMAT FOR PREPARATION OF THE SURVEYS OF ODS ALTERNATIVES AND PRESENTATION OF THE RESULTING DATA (DECISION 74/53(g))

Background

1. At their Twenty-sixth meeting, the Parties to the Montreal Protocol requested the Executive Committee to consider providing additional funding to conduct inventories or surveys on alternatives to ozone depleting substances (ODS) in interested parties operating under Article 5 upon their request (paragraph 4 of decision XXVI/9).

2. In response to this decision, at its 74th meeting the Executive Committee agreed to consider requests for funding surveys of ODS alternatives submitted by bilateral and implementing agencies; defined the objective and scope of the surveys; and limited the funding for preparation of surveys based on the countries' HCFC baseline consumption. The Secretariat was also requested to consult intersessionally with bilateral and implementing agencies and interested Executive Committee members and prepare a format for preparation of the surveys and presentation of the resulting data for the consideration of the Executive Committee at its 75th meeting (decision 74/53).

3. At its 74th meeting, the Executive Committee also approved funding for the preparation of surveys of ODS alternatives for 85 Article 5 countries[1]. Requests for preparation of surveys of ODS alternatives in 44 Article 5 countries have been submitted to the 75th meeting.

4. This draft guide, which contains the format for the preparation of surveys of ODS alternatives, has been developed by the Secretariat in response to decision 74/53. It has taken into account the extensive experience of bilateral and implementing agencies in undertaking ODS surveys and analyzing their results while preparing national plans to phase out CFCs and HCFCs, as well as information on approaches that bilateral and implementing agencies have taken in implementing HFC inventories funded outside the Multilateral Fund.

5. A preliminary draft guide was presented to bilateral and implementing agencies at the Inter-agency coordination meeting held in Montreal on 31 August-2 September 2015. Discussions took

[1] Annex IV of document UNEP/OzL.Pro/ExCom/74/56.

place where bilateral and implementing agencies noted that the data gathering activities and analysis of the data captured in the draft guide was feasible within the level of funding approved and the time frame (i.e., one year from the approval by the Executive Committee). The document was subsequently revised based on the observations and comments from this meeting.

6. The draft guide was also submitted for the intersessional review of interested members of the Executive Committee in line with decision 74/53. Comments that were received from some members[2] were incorporated in the final draft contained in the present document.

Scope of the draft guide for preparation of surveys of ODS alternatives

7. The draft guide is divided into the following sections and annexes:

Part I: Preparation of surveys on ODS alternatives
Describes the objectives, implementation modalities, timeframe, and activities to be undertaken by Article 5 countries with the assistance from bilateral and implementing agencies, for guidance purposes only.

Part II: Presentation of the resulting data from the surveys
Presents a proposed format for the final report, and describes how the results of the surveys will be analysed and presented to the first meeting of the Executive Committee in 2017.

Annex I: Use of ODS alternatives per sector
Summarizes information on most commonly used ODS alternatives in all manufacturing sectors, as contained in decision XXV/5 Task Force Report of the Technology and Economic Assessment Panel (TEAP). It also includes tables that could be used in collecting data and information on the use of alternatives in sectors and sub-sectors during the survey. This Annex is provided for guidance purposes only.

Annex II: Data tables
Includes the required tables to be submitted to the Secretariat as part of the survey report for summarizing and presenting data collected through the surveys.

Annex III: Glossary of terms
Provides definitions of terms used in the present document, for reference purposes only.

Part I: Preparation of surveys on ODS alternatives

Objectives

8. The objective of surveys on ODS alternatives is to assist Article 5 countries to better understand their historical and predicted consumption trends for ODS alternatives, including medium, low- and high-global warming potential (GWP) alternatives, and their distribution by sector and subsector. The surveys will provide the countries with a comprehensive overview of their national markets where ODS alternatives have been and will be phased in, while taking into consideration other existing technologies. It is expected that both consumption and production data will be collected, where available.

[2] Comments were received from the Governments of Sweden and the United States of America.

9. To better define the scope of the ODS alternatives surveys and facilitate the work of collecting data, Annex I to the present document presents a summary of the most commonly used ODS alternatives in all manufacturing sectors.

10. The methodologies developed for collecting and analysing use of ODS alternatives and other relevant data (e.g., names of enterprises using ODS alternatives) should be kept by the national ozone units (NOUs) to enable data collection after the surveys have been completed. In this regard, bilateral and implementing agencies are encouraged to assist NOUs to put in place a system that would facilitate future data collection of ODS alternatives and its incorporation in country programme (CP) data reports.

Activities to be undertaken

11. The main activities to be undertaken by the NOUs and the bilateral and implementing agencies are data collection, and data analysis and assessment, as described below.

Data collection

12. Data would need to be collected from various sources in order to estimate the current use of ODS alternatives by substance and sector. As the first step, data could be gathered through a desk study using information available from institutional sources *inter alia*, NOUs, importers, exporters, producers, customs departments, other sources (e.g., national registry databases, statistic departments), as well as from enterprises that are/were using ODS and/or alternatives to ODS in their manufacturing processes, and end-users. Data collected from surveys funded outside the Multilateral Fund, should be reported in the format proposed in the present document to ensure consistency with all the surveys undertaken.

13. Based on this desk study, the methodology for data collection could be designed to focus only on the specific ODS alternatives commonly used in the country and the key sectors/subsectors where they are used, i.e., domestic, commercial or industrial refrigeration (manufacturing and/or servicing); stationary and mobile air-conditioning (manufacturing and/or servicing); aerosol (technical products and/or metered dose inhalers); foam; solvents; and/or firefighting). The methodology should be developed to allow for comprehensive surveys that could follow the ODS alternatives supply chain from the time the substance is ordered, imported, and passed to distributors, manufactures and/or consumers. It should also allow the identification of how an ODS alternative came to be used in each specific sector, and the reasons why one alternative was chosen over another. Data on the use of these ODS alternatives should be collected, if possible, from 2012 onwards.

14. The data collection methodologies should also be transferred to the NOUs so that they can continue the data collection process after the initial surveys have been completed.

15. The following activities may be undertaken to facilitate data collection:

(a) Develop a detailed questionnaire for distribution to identified key stakeholders including, *inter alia*:

(i) Importers;

(ii) Distributors of chemicals (including systems houses) and ODS- and ODS alternative-based equipment;

(iii) Industry and trade associations;

(iv) Manufacturers of refrigeration and/or air-conditioning equipment;

(v) Refrigeration and (mobile and stationary) air-conditioning service companies;

(vi) Producers of ODS alternatives (where applicable); and

(vii) Others (e.g., end-users).

(b) Identify existing and planned policy, legislative and/or regulatory frameworks supporting the use of ODS alternatives, including those related to energy efficiency of ODS- and ODS alternative-based refrigeration and air-conditioning equipment;

(c) Estimate current use of ODS alternatives by substance through:

(i) Interacting with chemical and equipment suppliers/importers and/or their local representatives, relevant industry and/or trade associations and Government departments as needed;

(ii) Collecting import and export data as applicable, preferably from 2012;

(iii) Estimating the use of ODS alternatives by sector and subsector, taking into account increased demand, particularly in the refrigeration and air-conditioning sector;

(iv) Collecting information on prices and availability of the commonly used ODS alternatives in the country;

(v) For uses of ODS alternatives specifically in the refrigeration and air-conditioning sector, data on estimated equipment population that requires servicing;

(vi) Comparing information obtained from institutional sources against that obtained from field sources to ensure consistency and reliability of the data;

(d) Collect information on prices of electricity and other relevant energy information, to the extent possible; and

(e) Estimate annual production of relevant ODS alternatives, where applicable.

Data analysis and assessment

16. Based on the data gathered through the questionnaires and field surveys, the following analysis will be undertaken:

(a) Growth patterns in consumption of ODS alternatives by substance:

(i) Develop a methodology for forecasting growth of ODS alternatives used in each sector/subsector;

(ii) Review the historical (from 2012) data for the use of each ODS alternatives and forecast their growth (up to 2030[3]);

(iii) Estimate growth patterns of sector and subsector where ODS alternatives are used (up to 2030);

[3] 2030 was selected to be consistent with forecasts done by TEAP.

(b) Analysis of the data on the production of ODS alternatives to determine trends, where applicable;

(c) Describe opportunities and challenges for introducing low-GWP alternatives for the applications where these substances are used: review national regulations and standards related to the import and use of ODS alternatives and identify barriers that limit the introduction of low-GWP technologies and how these could be addressed, (e.g., safety concerns related to flammable alternatives, lack of domestic standards); and

(d) Describe linkages to the HCFC phase-out management plan (HPMP), giving due consideration to how the phase-out of HCFCs has influenced the introduction of ODS alternatives and the difficulties encountered.

Implementation modalities

17. The activities associated with the surveys of ODS alternatives could be carried out through national and/or international industry experts, who are selected by the NOU in close coordination with bilateral and implementing agencies. Other implementation modalities could be used depending on the circumstances prevailing in the countries. The infrastructure established for the preparation and implementation of HPMPs could be used to conduct the surveys.

Implementation time frame

18. The time frame for the completion of the surveys should be up to 12 months from the time of approval by the Executive Committee. Bilateral and implementing agencies are encouraged to submit final survey reports as soon as these are completed[4], to enable the Secretariat's overall analysis of all results for the consideration of the Executive Committee by its first meeting in 2017.

Part II: Presentation of the resulting data from the surveys

19. The final report should present the results of the survey briefly describing the activities undertaken, the analysis of the data gathered, and conclusions. The summary tables provided in Annex II of this guide are mandatory and should be used to present the data collected. These tables and the final reports of each of these countries will be consolidated and aggregated by the Fund Secretariat into a final document that will provide an overall analysis of all the surveys undertaken, for presentation to the Executive Committee at its first meeting in 2017.

20. The main components of the report are described below:

(a) *Executive summary:* Presents an overview of the key information contained in the report, a summary of the data collected highlighting the most commonly used ODS alternatives for each sector and subsector.

(b) *General information:* Provides a brief description of country information relevant to the use of ODS alternatives, including the institutional set up, the existing policy regulatory frameworks and controls (i.e., controls on import and export of ODS and ODS alternatives); and planned legislation, policy or regulation to be implemented.

[4] For countries where funding for surveys of ODS was approved at the 74th meeting, the reports should be submitted preferably no later than June 2016, while those approved at the 75th meeting should be submitted no later than November 2016.

(c) *Methodology for data collection:* Describes the methodology developed for data collection, validation, and analysis, including the institutions involved and the sources from which data was obtained.

(d) *Sectors using ODS and ODS alternatives, and analysis of data collected:* Describes the data gathered on the use of ODS alternative in the country, the distribution and supply chain, the sectors and subsectors where ODS alternatives are used, and production of ODS alternatives (where applicable). This information should be provided, to the extent possible, in tables (including, but not limited to those included in Annex II to the present document). It should also contain an analysis of the data collected, including consumption information (2012-2015); forecasts of future use (2016-2030); availability and prices of the identified alternatives; a comparison of the use of these alternatives with the ODS being replaced (i.e., HCFC); challenges faced in the use and further uptake of these alternatives, and proposed solutions, if any; and describe the impact of these ODS alternatives on the environment.

(e) *Conclusions and recommendations:* Presents the main issues encountered during the process, the findings where action may be needed and the recommendations.

Annex I

USE OF ODS ALTERNATIVES PER SECTOR

Introduction

1. This section provides a detailed overview of ODS alternatives that are in use or currently being developed in various sectors. Summaries of the foam and refrigeration and air-conditioning sectors, the two largest ODS and non-ODS using sectors are presented below as a reference. The summaries contain tables on the current and forecast (until 2030) demand for ODS and their alternatives. After the description of each sector, tables listing ODS alternatives for sectors/subsectors are also provided and could be used for data collection purposes.

2. The information in this section is taken from reports of the Technology and Economic Assessment Panel (TEAP) and its Technical Options Committees (TOCs); the report on decision XXV/5 on additional information to alternatives to ODS[1]; and decision XXVI/9 which provides an update to the report prepared under decision XXV/5. Information is also taken from investment projects approved by the Multilateral Fund and the fact sheets developed by the Ozone Secretariat for the HFC workshop held in April 2015 in Bangkok[2].

Commonly used ODS alternatives

3. The most commonly used ODS alternatives at present are contained in Table 1, as reported on the TEAP decision XXV/5 Task Force Report on additional information on alternatives to ODS.

Table 1. Commonly used ODS alternatives at present

Chemical*	GWP[3]	Sectors				
		RAC	Foam	Aerosols	Solvent	Fire suppression
HC-refrigerant	5	X				
HC-blowing agent			X			
Methyl formate			X			
Methylal			X			
CO_2			X			
HFC-23	14,800	X				X
HFC-32	675	X				
HFC-125	3,500	X				X
HFC-134a	1,430	X	X	X		X
HFC-143a	4,470	X				
HFC-152a	124	X	X	X		
HFC-227ea	3,220	X	X	X		X
HFC-245fa	1,030		X	X		
HFC-365mfc	794		X	X	X	
R-407C	1,774	X				
R-407F	1,824	X				
R-410A	2,088	X				

[1] The Parties to the Montreal Protocol requested TEAP to *inter alia*, estimate current and future demand for alternatives to ODS, taking into account increased demand, in particular in the refrigeration and air-conditioning sectors and in Article 5 countries. The present document contains the TEAP forecast (up to 2030) on the consumption of ODS and ODS alternatives in the foam and refrigeration and air-conditioning sectors.

[2] The fact sheets could be found at:
http://conf.montreal-protocol.org/meeting/workshops/hfc_management-02/presession/SitePages/Home.aspx

[3] Global warming potential (GWP) values used are based on the 4th Assessment of the Intergovernmental Panel on Climate Change.

Chemical*	GWP[3]	Sectors				
		RAC	Foam	Aerosols	Solvent	Fire suppression
R-404A	3,922	X				
R-507A	2,465					
R-717		X				
R-744	1	X				

* Note on chemicals listed in the table:
R-404A: 44% HFC-125; 52% HFC-143a; 4% HFC-134a
R-407C: 25% HFC-125; 52% HFC-134a; 23% HFC-32
R-407F: 30% HFC-125; 40% HFC-134a; 30% HFC-32
R-410A: 50% HFC-125; 50% HFC-32
R-507A: 50% HFC-125; 50% HFC-134a
HC refrigerant: HC-290 (propane); HC-600a (isobutane); HC-1270 (propylene)
HC blowing agent: pentane, cyclopentane, butane

4. HFCs form a large family of fluorocarbon chemicals. Each one consists of different combinations of hydrogen, fluorine and carbon. The most commonly used HFCs include HFC-134a, HFC-125, HFC-143a, HFC-32, HFC-152a, HFC-245fa, and HFC-365mfc/HFC-227ea[4]. Other HFCs are mostly used as components of blends[5] used mainly in the refrigeration and air conditioning, foam and aerosol sectors. The three dominant HFC blends currently used are R-404A, R-410A and R-407C.

5. In the recent past, HFOs, chemical compounds composed of hydrogen, fluorine and carbon, derivatives of alkenes (olefins) rather than alkanes (as HFCs), have been developed and become commercially available. HFOs currently in use include HFO-1234yf[6], HFO-1234ze[7], HFO-1233zd[8], and HFO-1336mzzm[9].

Sectors where ODS alternatives are commonly used

6. The sectors and subsectors where ODS alternatives are currently used is presented in Table 2.

Table 2. Sectors and subsectors where ODS alternatives are currently used

Sector	Subsector
Aerosol	Propellant
Foam: polyurethane	Insulation domestic refrigeration
	Insulation other appliance
	Reefers
	Board stock
	Continuous panel
	Discontinuous panel
	Spray foam
	Pipe-in-pipe
	Block
	PU block
Foam: extruded polystyrene	
Fire suppression	
Refrigeration: domestic	Appliances/freezers

[4] HFC-134a, HFC-32 and HFC-245fa are used as pure substances.
[5] There are numerous refrigerant blends available and the number is growing rapidly as new blends are rapidly being introduced in response to regional controls on the use of high GWP HFCs. There are already over 60 different blends listed in the ASHRAE refrigerant numbering system.
[6] 2,3,3,3 tetrafluoropropene.
[7] 1,3,3,3 tetrafluoropropene.
[8] 1 chloro 3,3,3 trifluoropropene.
[9] 1,1,1,4,4,4-hexafluoro-2-butene.

Sector	Subsector
Refrigeration: commercial	Stand-alone equipment
	Condensing units
	Centralised systems
	Transport
Refrigeration: mobile air-conditioning	Automobiles, public transport
Refrigeration: chillers	Positive displacement
	Centrifugal
Air-conditioning	Small self-contained
	Mini-split (non-ducted)
	Multi-split
	Ducted split commercial and non-split
Heat pumps	Hot water
	Space heating
Solvent	

Foam sector

7. With regard to the foam sector, the report of decision XXV/5 Task Force indicates that under a "business as usual scenario" HCFC-141b used as a blowing agent for polyurethane (PU) foam will be completely phased out by 2020, while HCFC-22/HCFC-142b used in the manufacture of extruded polystyrene (XPS) foam will be phased out by 2025. These HCFCs will be replaced by hydrocarbon-based blowing agents (mainly cyclopentane), HFCs and mixtures of HFCs and HFO as shown in Table 3.

Table 3. Demand for ODS and ODS alternative foam blowing agents in Article 5 countries*

Substance	Consumption (mt)				
	2010	**2015**	**2020**	**2025**	**2030**
HCFC-141b	39,895	29,032	8,295	0	0
HCFC-142b	16,508	22,562	17,895	6,678	0
HCFC-22	17,436	23,345	18,118	6,678	0
HCFC-245a	354	2,171	3,841	4,986	5,504
HFC-365mfc/HFC-227ea	0	1,758	3,428	4,547	5,020
HFC-134a/HFC-152a	955	6,729	11,338	22,560	30,450
HFO/HCFO	0	0	10,996	23,296	31,081
Hydrocarbon	31,665	43,764	54,459	63,939	71,189
Other	0	0	0	0	0
Total	**106,813**	**129,361**	**128,370**	**132,684**	**143,244**

* TEAP decision XXV/5 Task Force Report (Table 4.7)

8. The main uses of foam blowing agents are for PU and XPS foam. PU foam includes insulation board/panel/block, insulation of domestic refrigerators and other appliances, floating foam for marine vessels, spray foam and integral skin foam. XPS is used primarily as a building insulation and often competes with PU boardstock[10]. The current and forecasted use of ODS and alternatives in the foam sector in Article 5 countries is presented in Table 4.

[10] There is another form of XPS known as 'sheet' which is typically used for non-insulating applications such as leisure products (e.g., surf boards) and packaging materials. CFC was used in the manufacture of XPS sheet and replaced with hydrocarbons.

Table 4. Foam subsector distribution of ODS and alternatives in Article 5 countries*

Subsector	Consumption (mt)				
	2010	**2015**	**2020**	**2025**	**2030**
Insulation domestic refrigeration	42,004	46,192	45,202	47,548	52,497
Insulation other appliance	2,757	3,055	3,055	3,242	3,579
Reefers	3,100	3,294	3,294	3,496	3,860
Board stock	175	192	192	203	225
Continuous panel	2,689	2,788	2,788	2,959	3,267
Discontinuous panel	7,908	7,583	7,583	8,047	8,885
Spray foam	7,653	7,306	7,306	7,753	8,560
Pipe-in-pipe	4,764	5,039	5,039	5,347	5,904
Block	2,591	2,777	2,777	2,946	3,253
PF block	101	117	117	124	137
Extruded polystyrene foam	33,071	51,017	51,017	51,017	53,078
Total	**106,813**	**129,360**	**128,370**	**132,682**	**143,245**

* TEAP decision XXV/5 Task Force Report (Table 4.8)

9. During the survey, data collection should focus on the PU and XPS foam applications and the ODS alternatives being considered by foam manufacturers. This will help to understand the uptake of alternatives and the barriers to adoption of these alternatives in the country. Table 5 is provided as a data collection tool that could be used during the surveys.

Table 5. Data collection on use of ODS alternatives in the PU and XPS foam sector

Subsector/application	Alternatives	Use in metric tonnes			
		2012	**2013**	**2014**	**2015**
Rigid PU foam	HFC-245fa				
	HFC-365mfc/HFC-227ea				
	Pentane (C,I,N)				
	Methyl formate				
	HFO-1233zd				
	HFO-1336mzz				
	CO_2 (water)				
	Others (specify)				
Spray foam	HFC-245fa				
	HFC-365mfc/HFC-227ea				
	HFO-1233zd				
	HFO-1336mzz				
	CO_2 (water)				
	Supercritical CO_2				
	Others (specify)				
Integral skin and flexible moulded foam	HFC-134a				
	HFC-245fa				
	Methyl formate				
	Methylal				
	CO_2 (water)				
	Others (specify)				
XPS foam	HFC-134a				
	HFC-152a				
	HFO-1234ze				
	CO_2				
	CO_2/ethanol				
	Others (specify)				

Refrigeration and air-conditioning sector

10. With regard to the refrigeration and air-conditioning sector, the Decision XXV/5 Task Force report indicates that under a "business as usual scenario" the demand for HFC-134a will quadruple between 2015 and 2030; the demand for R-404A and R-407C will grow by a factor of four to five; and the demand for low-GWP refrigerants will grow by a factor of three, mainly due to the fact that these refrigerants are only assumed to occur in certain subsectors (e.g., the mobile air-conditioning (MAC) and the stationary air-conditioning subsectors). Between 2015 and 2030, the total demand for refrigerants will increase by about 200 per cent as shown in Table 6.

Table 6. Demand for ODS and ODS alternative refrigerants in Article 5 countries*

Substance**	Consumption (mt)				
	2010	2015	2020	2025	2030
HFC-134a	54,400	110,400	183,500	287,200	209,900
R-404A/R-507	13,100	35,200	55,500	112,600	179,800
R-407C	16,500	58,600	105,600	167,500	246,500
R-410A	41,000	95,800	162,500	247,500	360,300
Low-GWP	22,400	33,700	48,800	68,900	98,500
Total	147,400	333,700	555,900	883,700	1,095,000

* TEAP decision XXV/5 Task Force report (Table 4.2)
** Note on chemicals listed in the table:
R-404A: 44% HFC-125; 52% HFC-143a; 4% HFC-134a
R-507A: 50% HFC-125; 50% HFC-134a
R-407C: 25% HFC-125; 52% HFC-134a; 23% HFC-32
R-410A: 50% HFC-125; 50% HFC-32

11. The refrigeration and air-conditioning sector is the largest user of ODS and alternatives in several Article 5 countries. The main uses of refrigerants are in stationary air-conditioning, followed by commercial refrigeration and MAC, as shown in Table 7.

Table 7. Distribution of ODS and ODS alternatives in the refrigeration and air-conditioning sector in Article 5 countries*

Subsector	Consumption (mt)				
	2010	2015	2020	2025	2030
MAC	36,600	62,300	92,700	131,400	184,200
Domestic	16,000	23,300	31,000	44,100	62,300
Commercial	14,100	57,000	107,300	211,600	326,400
Industrial	20,700	31,300	47,900	68,000	95,500
Transport	1,700	3,200	5,100	7,900	11,500
Stationary air-conditioning	58,600	156,500	271,800	420,500	615,000
Total	147,700	333,600	555,800	883,500	1,294,900

* TEAP decision XXV/5 Task Force Report (Table 4.3)

12. During the survey, the refrigeration and air-conditioning sector needs to be broken down in each sub-application. These are further described in detail below.

Refrigeration

13. This sector includes refrigeration systems for domestic, commercial and industrial applications (e.g., domestic refrigerators and freezers, food display systems and beverage dispensing units in supermarket, food storage rooms, industrial manufacturing processes, refrigerated trucks/vessels and refer containers). The most commonly used alternative refrigerants are R-404A and HFC-134a and, to a lesser extent, R-407A, R-744, HC-600a and HC-290 as shown in Table 8.

Table 8. Data collection on use of ODS alternatives in refrigeration manufacturing

Applications*	Refrigerant charge (kg)	Alternatives	Use (mt)			
			2012	2013	2014	2015
Domestic refrigerators and freezers	0.1-0.3	HFC-134a				
		HC-600a				
		Others (specify)				
Commercial refrigeration systems (stand alone, condensing units and small/medium sized systems)	0.1-200	R-404A				
		HFC-134a				
		HC-290				
		R-407A				
		R-744				
		Others (specify)				
Large systems	250-5,000	R-717				
		R-507A				
		R-404A				
		R-744				
		HCs				
		Others (specify)				
Industrial chiller system	100-2,000	HFC-134a				
		R-407C				
		R-410A				
		R-717				
		HCs				
		Others (specify)				
Transport refrigeration (containers and ships)	1-1,000	R-404A				
		HFC-134a				
		R-744				
		R-717				
		Others (specify)				

* The priority in this subsector should be commercial and industrial refrigeration equipment

Air-conditioning

14. This sector refers to air-conditioning systems that cool and/or heat enclosed spaces ranging from single rooms to large commercial buildings, and vehicles. These include small self-contained air-conditioning, split air-conditioning, ducted and packaged rooftops, water chillers, heat pumps for heating and mobile air-conditioning systems. The cooling capacity ranges from two kilowatts (kw) to 10,000 kw, and refrigerant charge ranges from 0.2 kg to 13,000 kg.

15. The most commonly used HFC in the air-conditioning sector include: R-404A, HFC-134a, R-410A and R-407C. The medium and low-GWP refrigerants include HFC-32, HFC-161, HC-290, R-717, and R-744, as shown in Table 9.

Table 9. Data collection on use of ODS alternatives in air-conditioning manufacturing

Applications*	Refrigerant charge (kg)	Alternatives	Use (mt)			
			2012	2013	2014	2015
Room air-conditioning (including small split air-conditioning)	0.2-3	R-410A				
		R-407C				
		HFC-161				
		HFC-32				
		HC-290				
		Others (specify)				

Applications*	Refrigerant charge (kg)	Alternatives	Use (mt)			
			2012	2013	2014	2015
Other air-conditioning (including split, multi-split and variable refrigerant flow systems, ducted and package rooftop)	3-100	R-410A				
		R-407C				
		HFC-161				
		HFC-32				
		HC-290				
		CO_2				
		Others (specify)				
Chillers (small/medium sized water chillers, large sized water chillers)	500-13,000	R-407C				
		R-410A				
		HC-290				
		HC-1270				
		HFC-134a				
		HFC-32				
		R-717				
		Others (specify)				
Heat pumps (space heating heat pumps (air-water) and domestic hot water heating heat pump (air source)	3-6	R-410A				
		R-744				
		HFC-134a				
		Others specify				
Large district heating system (waste sewage)	250-7,000	HFC-134a				
		R-717				
		Others (specify)				

* The priority applications are various air-conditioners and chillers; heat pumps may be included in case of significant use at the present or in future planning

Mobile air-conditioning sector (MAC)

16. This sector refers to the MAC systems used to cool land transport systems (e.g., vehicles, vans/trucks, lorries (18-wheel trucks), buses, agricultural vehicles and trains). It excludes air-conditioning used on ships as these systems are large air-conditioning and water chillers, which are described under the air-conditioning sector.

17. The most commonly used refrigerants include HFC-134a, R-410A, and R-407C. The low-GWP refrigerants include CO_2 and HFO-1234yf, as shown in Table 10.

Table 10. Data collection on use of ODS alternatives in MAC

Applications	Refrigerant charge (kg)	Alternatives	Use (mt)			
			2012	2013	2014	2015
Cars and small vans	0.4-0.8	HFC-134a				
		HFO-1234yf				
		Others (specify)				
Large vehicles	2.0-10.0	R-410A				
		R-407C				
		HFC-134a				
		Others (specify)				

Refrigeration and air-conditioning servicing sector

18. This sector includes enterprises dedicated to providing servicing to refrigeration and air-conditioning equipment and installations, as well as assembling, installing, charging and commissioning new refrigeration equipment, in particular when such equipment is custom-made for specific installations (e.g., supermarkets, refrigerated transportation, and cold rooms).

19. During the survey, it would be necessary to collect the data in Table 11 to have the overall description of the servicing sector at the national level.

Table 11. Data collection on the use of ODS alternatives in servicing refrigeration and air-conditioning equipment

Substance	Unit charge (kg/unit)	Cooling capacity (kw)	Energy efficiency ratio*	No. of units (year)	Use (mt)			
					2012	2013	2014	2015
Air-conditioning								
R-410A								
R-407C								
R-404A								
HFC-134a								
R-717								
Others (specify)								
Refrigeration								
R-410A								
R-407C								
R-404A								
HFC-134a								
R-717								
Others (specify)								

* Optional, where available

Aerosol sector

20. This sector includes a large number of applications such as insecticides, cosmetics, paints, cleaners, pharmaceutical and veterinarian products, glues and lubricant oils.

21. The most commonly used alternatives sector for industrial and cleaning applications with flammability and safety considerations include HFC-245fa, HFC-134a (sometimes mixed with perchloroetylene), HFC-152a, and HFC-227ea. For metered dose inhalers (MDI), HFC-134a is used, as shown in Table 12.

Table 12. Data collection on use of ODS alternatives in the aerosol sector

Application*	Alternatives	Use (mt)			
		2012	2013	2014	2015
Technical/consumer aerosol	HFC-134a				
	HFC-152a				
	HFC-227ea				
	Hydrocarbons				
	DME				
	HFO-1234ze				
	CO_2/N_2/Air				
	N_2O				
	Not-in-kind technology				
	Others specify				
MDI	HFC-134a				
	HFC-227ea				

* Data collection may focus on information on the use of alternatives in the MDI sector and specialized cleaning and industrial applications where the use of flammables is not possible

Solvent sector

22. Solvents are widely used as process agents in a variety of industrial manufacturing processes although they are not contained in the final products to consumers. Their main applications include metal cleaning, electronics cleaning, and precision cleaning. Many alternative solvents and technologies include not-in-kind technology such as aqueous and semi-aqueous cleaning, hydrocarbon and alcohol-based solvents; and in-kind solvents such as chlorinated and fluorinated solvents which include HFCs and HFEs with various levels of acceptance as shown in Table 13.

Table 13. Data collection on use of ODS alternatives in the solvent sector

Application*	Alternatives	Use (mt)			
		2012	2013	2014	2015
Metal cleaning	HFC (please specify)				
	HFE (please specify)				
	Not-in-kind technology				
	Others (specify)				
Electronics cleaning	HFC (please specify)				
	HFE (please specify)				
	Not in kind technology				
	Others (specify)				
Precision cleaning	HFC (please specify)				
	HFE (please specify)				
	Not in kind technology				
	Others (specify)				

* Data collection may focus only on available information on ODS alternatives use in this sector, taking into account that solvents use in a majority of Article 5 countries is small

Annex II

DATA ANALYSIS TABLES BY SECTORS

1. The following data tables must be submitted as part of the final report presenting the results of the survey on ODS alternatives, as these tables will be used by the Secretariat to undertake the overall analysis of the results of all completed surveys as requested by the Executive Committee in decision 74/53. These tables should be provided as Excel sheets for ease of reference and data inputs.

2. When filling in these tables, care should be taken in ensuring that amounts for individual pure HFCs do not include those that are part of HFC blends.

3. The list of ODS alternatives presented in the tables are the most commonly used in the majority of the countries. In case of ODS alternatives not listed in the tables that are being used in the country, these alternatives should be included.

ODS alternatives use scenario (only substances relevant to the country must be filled in)

Table 1. Estimated use by ODS alternative

Alternative	Estimated use (mt)			
	2012	2013	2014	2015
HFC*				
HFC-134a				
HFC-32				
HFC-152a				
HFC-161				
HFC-245fa				
HFC-227ea/HFC-365mfc				
Others (specify)				
HFC blends				
R-404A				
R-407C				
R-410A				
R-507A				
Others (specify)				
HFO				
HFO-1234yf				
HFO-1234ze				
HFO-1233zd				
HFO-1336mzzm				
Other alternative				
Methyl formate				
Methylal				
Ethanol				
DME				
HC-290				
HC-600a				
Pentane(C,N,I)				
R-744				
R-717				
Others (specify)				

* Amounts for pure HFCs only

Table 2. Summary of use in all sectors for each year between 2012 to 2015* (mt)

Alternative	Refrigeration and air-conditioning		PU foam	XPS foam	Aerosol	Fire fighting	Solvent	Others
	Manufacturing	Servicing						
HFC								
HFC-134a								
HFC-32								
HFC-152a								
HFC-161								
HFC-245fa								
HFC-227ea/HFC-365mfc								
Others (specify)								
HFC blends								
R-404A								
R-407C								
R-410A								
R-507A								
Others (specify)								
HFO								
HFO-1234yf								
HFO-1234ze								
HFO-1233zd								
HFO-1336mzzm								
Other alternative								
Methyl formate								
Methylal								
Ethanol								
DME								
HC-290								
HC-600a								
Pentane(C,N,I)								
R-744								
R-717								
Others (specify)								

*****A separate table has to be provided for each year from 2012-2015

ODS alternatives supply scenario

Table 3. Import amounts of ODS alternatives

Alternative	Imports (mt)			
	2012	2013	2014	2015
HFC				
HFC-134a				
HFC-32				
HFC-152a				
HFC-161				
HFC-245fa				
HFC-227ea/HFC-365mfc				
Others (specify)				
HFC blends				
R-404A				
R-407C				
R-410A				
R-507A				
Others (specify)				
HFO				
HFO-1234yf				
HFO-1234ze				
HFO-1233zd				
HFO-1336mzzm				
Other alternative				
Methyl formate				
Methylal				
Ethanol				
DME				
HC-290				
HC-600a				
Pentane(C,N,I)				
R-744				
R-717				
Others (specify)				

Source:

Table 4. Export amounts of ODS alternatives

Alternative	Exports (mt)			
	2012	2013	2014	2015
HFC				
HFC-134a				
HFC-32				
HFC-152a				
HFC-161				
HFC-245fa				
HFC-227ea/HFC-365mfc				
Others (specify)				
HFC blends				
R-404A				
R-407C				
R-410A				
R-507A				
Others (specify)				
HFO				
HFO-1234yf				
HFO-1234ze				
HFO-1233zd				
HFO-1336mzzm				
Other alternative				
Methyl formate				
Methylal				
Ethanol				
DME				
HC-290				
HC-600a				
Pentane(C,N,I)				
R-744				
R-717				
Others (specify)				

Source:

Table 5. Production of ODS alternatives* (mt)

Alternative	Production mt)			
	2012	2013	2014	2015
HFC				
HFC-134a				
HFC-32				
HFC-152a				
HFC-245fa				
HFC-227ea/HFC-365mfc				
Others (specify)				
HFC blends				
R-404A				
R-407C				
R-410A				
R-507A				
Others (specify)				
HFO				
HFO-1234yf				
HFO-1234ze				
HFO-1233zd				
HFO-1336mzzm				
Other alternative				
Methyl formate				
Methylal				
Ethanol				
DME				
HC-290				
HC-600a				
Pentane(C,N,I)				
R-744				
R-717				
Others (specify)				

* Only relevant to countries that produce ODS alternatives
Source:

Annex III

GLOSSARY OF TERMS

Term/ Acronym	Definition*
CFC	Chlorofluorocarbon: a family of chemicals containing chlorine, fluorine and carbon
Chiller	A refrigerant system designed to chill a liquid
CO_2	Carbon dioxide
Condensing unit	A combination of a condenser and compressor. Used in split systems connected to an evaporator in a separate location
DME	Dimethyl ether: an HFC alternative used in aerosols and foams
GWP	Global Warming Potential. The GWP compares the global warming impact of a gas to CO_2 which is defined as having a GWP of 1.
HC	Hydrocarbon: a family of chemicals containing hydrogen and carbon
HCFC	Hydrochlorofluorocarbon: a family of chemicals containing hydrogen, chlorine, fluorine, and carbon
HFC	Hydrofluorocarbon: a family of chemicals containing hydrogen, fluorine and carbon
HFE	Hydrofluoroether
HFO	Hydrofluroolefin: a family of chemicals containing hydrogen, fluorine and carbon, with a double bond in the molecule
MAC	Mobile air-conditioning. This refers to an air-conditioning system used in a vehicle including MACs in cars, busses and trains.
MDI	Metered dose inhaler. A specialised aerosol used to deliver respiratory drugs. MDIs use HFC aerosol propellants
ODP	Ozone Depleting Potential compares the impact on the ozone layer of a gas compared to CFC-11 which is defined as having an ODP of 1
ODS	Ozone Depleting Substance. A gas that can cause damage to the stratospheric ozone layer
PF foam	Phenolic insulation foam
PU foam	Polyurethane insulation foam
Split system	A type of refrigeration or air-conditioning system with a cooling evaporator in one location and a compressor/condenser in a different location. Usually used with reference to small air-conditioning systems that use an indoor unit and an outdoor unit
Stand-alone	Small factory built refrigeration units that need to be connected to an electricity supply. A domestic refrigerator is a stand-alone system. Various types of stand-alone unit are used in food retail and food service
TEAP	Technology and Economic Assessment Panel
VRF	Variable refrigerant flow. A type of split system air-conditioning system used in medium and large sized air-to-air applications. One or more condensing units are connected to a number of indoor units (up to 64). Each indoor unit can be selected for either cooling or heating. Variable speed compressors provide control flexibility
XPS foam	Extruded polystyrene insulation foam

* Source: (i) Report of the workshop on hydrofluorocarbon management: technical issues (UNEP/OzL.Pro/Workshop/8.2); (ii) Fact sheet 15: Glossary of terms and technical definitions (Ozone Secretariat, Workshop on HFC management: technical issues, April 2015); and (iii) September 2015 TEAP Update XXVI/9 Task Force Report: Additional information on alternatives on ozone-depleting substances