MONTREAL PROTOCOL

ON SUBSTANCES THAT DEPLETE

THE OZONE LAYER

UNEP

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PROGRESS REPORT

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Montreal Protocol
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Co-ordination:	**Technology and Economic Assessment Panel**
Composition of the report:	Lambert Kuijpers and Meg Seki (UNEP)
Layout and formatting:	Ozone Secretariat (UNEP) Lambert Kuijpers (UNEP TEAP)
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Foreword

The May 2013 TEAP Report

The May 2013 TEAP Report consists of three volumes:

Volume 1: May 2013 TEAP Progress Report

Volume 2: May 2013 TEAP XXIV/7 Task Force Report

Volume 3: May 2013 TEAP XXIV/8 Task Force Report

Volume 1
Volume 1 contains the MTOC essential use report, progress reports, the MB CUN report etc.

Volume 2
Volume 2 is the Assessment Report of the TEAP XXIV/7 Task Force on additional information on alternatives to ozone-depleting substances.

Volume 3
The separate Volume 3 of the TEAP Progress Report contains the report of the Task Force responding to Decision XXIV/8.

The UNEP Technology and Economic Assessment Panel:

Lambert Kuijpers, co-chair	*NL*	*Kei-ichi Ohnishi*	*J*
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Michelle Marcotte	*CDN*	*Masaaki Yamabe*	*J*
		Shiqiu Zhang	*PRC*

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1 Essential Uses

1.1 Executive Summary of Essential Use Nominations for Metered Dose Inhalers

MTOC received two essential use nominations requesting a total of 448.6 tonnes of CFCs for the manufacture of metered dose inhalers (MDIs) in 2014, and one essential use nomination requesting 221.59 tonnes for 2015: one nomination was from an Article 5 country (China, 2014 and 2015); and one was from a non-Article 5 country (Russian Federation, 2014).

Table 1-1 summarises the recommendations of the Technology and Economic Assessment Panel (TEAP) and its Medical Technical Options Committee (MTOC) on nominations for essential use production exemptions for chlorofluorocarbons (CFCs) for MDIs. Recommendations are made in accordance with Decision XV/5(3), which requests TEAP and its MTOC to make recommendations on nominations for essential use exemptions for CFCs for MDIs with reference to the active ingredient of the metered-dose inhalers in which the CFCs will be used and the intended market for sale or distribution. Recommendations are for a total of 341.05 tonnes of CFCs for the manufacture of MDIs in 2014. At this time, MTOC is unable to recommend CFC quantities nominated for 2015.

Table 1-1: Recommendations for essential use nominations

Party	2014	2015	Active Ingredients	Intended Markets
China	235.05 tonnes	Unable to recommend	Beclomethasone, budesonide, dimethicone, ipratropium/salbutamol, isoprenaline, salbutamol, sodium cromoglycate, datura metel extract/clenbuterol	China
Russian Federation	106 tonnes	-	Salbutamol	Russian Federation

MTOC thanks the Ozone Secretariat for providing meeting venue sponsorship for the MTOC meeting held in Beijing, China, 13-15 March 2013. MTOC member, Mr. Wang Ping, Chinese Pharmacopoeia Commission, and the Government of the People’s Republic of China (the State Food and Drug Administration, the China Center for Pharmaceutical International Exchange, and the Ministry of Environmental Protection) provided a range of organisational assistance and hospitality, for which MTOC sincerely thanks those organisations. MTOC is also greatly appreciative for the information given and presentations made by: UNIDO; Compliance Assistance Programme, OzonAction Programme, UNEP Regional Office for Asia and Pacific; and the State Food and Drug Administration and the Ministry of Environmental Protection, Foreign Economic Cooperation Office of the People’s Republic of China.

In 2009, the first year of the essential use process for Article 5 Parties, MTOC reviewed nominations from eight Article 5 Parties. It is very encouraging to note that three years on, Argentina, Bangladesh, Egypt, Iran, India, Pakistan and Syria did not nominate for essential uses of CFCs for MDIs for 2014. There have been significant reductions from about 2,400 tonnes of authorised essential use CFCs in 2010 to about 449 tonnes of CFCs nominated for

2014. Nevertheless, MTOC continues to receive nominations from one non-Article 5 country, Russia, for CFC quantities that are little different from those in previous years.

1.2 Essential Use Nominations for Metered Dose Inhalers

1.2.1 Criteria for Review of Essential Use Nominations for MDIs

Decision IV/25 of the 4th Meeting and subsequent Decisions V/18, VII/28, VIII/9, VIII/10, XII/2, XIV/5, XV/5, XVI/12, XVIII/16, XX/3, XXI/4, XXII/4, XXIII/2 and XXIV/3 have set the criteria and the process for the assessment of essential use nominations for MDIs for Parties not operating under paragraph 1 of Article 5 and Parties operating under paragraph 1 of Article 5 of the Protocol. Other relevant essential use decisions are Decisions XVII/5, XVIII/7 and XIX/13.

1.2.2 Review of Nominations

The review of essential use nominations by the MTOC was conducted as follows.

Four members of MTOC independently reviewed the nomination from China, preparing an initial assessment. Further information was requested of China during February. MTOC considered the assessment and additional information received, made recommendations and prepared this consensus report at its meeting in Beijing, China 13-15th March 2013.

The nomination from Russia was received on 6th March, exactly one week prior to MTOC's Beijing meeting. All members were sent the nomination for consideration. A technical assessment and recommendations were made during the meeting.

Members disclosed any potential conflict of interests ahead of the discussion. Where necessary, members were recused from the decision-making process of the nomination relevant to any potential conflict of interest. Annually listed disclosures of members indicate specific interests and any relevant actions taken such as recusal.

Nominations were assessed according to the guidelines for essential use contained within the *Handbook on Essential Use Nominations* (TEAP, 2009) and subsequent Decisions of the Parties. Recommendations are made in accordance with Decision XV/5(3), which requests TEAP and its TOC to make recommendations on nominations for essential use exemptions for CFCs for MDIs with reference to the active ingredient of the metered-dose inhalers in which the CFCs will be used and the intended market for sale or distribution.

Concurrent with the evaluation undertaken by the MTOC, copies of all nominations are provided to the Technology and Economic Assessment Panel (TEAP). The TEAP and its TOCs can consult with other individuals or organisations to assist in the review and to prepare TEAP recommendations for the Parties.

1.2.3 Observations

MTOC received two essential use nominations requesting a total of 448.6 tonnes of CFCs for the manufacture of metered dose inhalers (MDIs) in 2014, and one essential use nomination requesting 221.59 tonnes for 2015: one nomination was from an Article 5 country (China, 2014 and 2015); and one was from a non-Article 5 country (Russian Federation, 2014). MTOC recommendations are for a total of 339.05 tonnes of CFCs for the manufacture of MDIs in 2014. At this time, MTOC is unable to recommend CFC quantities nominated for 2015.

In 2009, the first year of the essential use process for Article 5 Parties, MTOC reviewed nominations from eight Article 5 Parties. It is very encouraging to note that three years on, Argentina, Bangladesh, Egypt, Iran, India, Pakistan and Syria did not nominate for essential uses of CFCs for MDIs for 2014. There have been significant reductions from about 2,400 tonnes of authorised essential use CFCs in 2010 to about 449 tonnes of CFCs nominated for 2014. Parties are to be commended for their efforts to phase-out CFCs from the manufacture of MDIs.

Also encouraging is the progress in China, with an almost 50 per cent reduction in the nominated CFC quantities for 2014 compared with those nominated for 2013. For 2014, China's nomination is only for CFC MDIs for domestic use, and CFCs for MDIs for two combination products are no longer nominated (ephedra/ginkgo/sophora flavescens/radix scutellariae and beclomethasone/clenbuterol/ipratropium), bringing to ten the total number of active ingredients or products for which CFCs are no longer nominated. Progress is also being made in China with two salbutamol HFC MDIs approved, with one local product already marketed and another soon to be, and others in the pipeline for likely approval within the next year or so. China is commended for these efforts. A number of challenges remain, which are elaborated under the assessment of China's nomination.

In its 2012 assessment, MTOC suggested that China might wish to consider a future campaign production of CFCs to satisfy its total essential use requirements until final phase-out, with a possible nomination in 2013 to cover multiple years. This year, China submitted nominations for 2014 and 2015, for 236.60 and 221.59 tonnes respectively, as a prediction of its likely total future CFC requirements for MDIs. MTOC found this two-year prediction valuable in its deliberations. It is possible that China may be able to manage its phase-out completely from CFC stockpiles, although this is not yet clear. Despite reported stockpiles, MTOC is recommending an essential use exemption for CFC production and consumption for 2014 in the expectation that China would supply its requirements from accumulated stockpile, with new CFCs produced only if absolutely necessary. However, the situation becomes less certain for 2015, with China's CFC requirements potentially significantly less than the current nomination for that year, due to rapid progress currently being made in the development of CFC-free alternatives. Consequently, MTOC is unable to recommend CFCs for 2015 this year, preferring instead to consider a revised nomination next year in order to make a more accurate assessment.

The Russian Federation nomination is for 212 tonnes CFCs for the manufacture of salbutamol CFC MDIs for domestic use only, the same quantity authorised by Parties for 2010, 2011, 2012 and 2013. The GEF co-funded project has been delayed and is now reportedly due for completion at the end of 2014. However, a number of major uncertainties remain, which are elaborated under the assessment of Russia's nomination.

1.2.4 Stockpiles

Stockpiles of pharmaceutical-grade CFCs exist around the world. It is difficult to be accurate about quantity in the absence of accounting frameworks and other information on stockpiles from some Parties. Total stockpile is estimated to be about 1,300 tonnes. The majority of these CFCs are committed to the manufacture of CFC MDIs, and some CFCs are surplus and may need to be destroyed. Judicious management of these stockpiles may avoid the need for new CFC manufacture.

Of the Parties that provided accounting frameworks for CFC use for the year 2012 under authorised essential use exemptions (Argentina, Bangladesh, China, the European Union, Pakistan, Russia), pharmaceutical-grade CFCs stocks were reported to be about 875 tonnes at the end of 2012. At 855 tonnes, China possesses the majority of remaining stockpiles that have been reported in accounting frameworks this year.

Accounting frameworks were not received from India and the United States, which previously reported 371 tonnes of CFCs stockpiles held by MDI manufacturers at the end of 2010, although the United States has advised that remaining CFC MDI manufacturers plan to deplete their own stocks. Accounting frameworks have not been received from Egypt and Syria for 2010 onwards. The United States has also reported under Decision XXIII/2(4) that stockpiles of 429.931 tonnes of pharmaceutical-grade CFCs were potentially available for export to Parties with approved essential use exemptions in 2012. The United States advised that this stockpile quantity, held by Honeywell, is separate to the stockpile reported in its accounting framework held by individual MDI manufacturing companies.

No Parties have reported information invited under Decision XXIV/3(4) as yet in 2013. Having information on stockpiles would allow Parties to track the management and deployment of stockpile until depleted. Information on stockpiles is particularly important in the last stages of global CFC MDI phase-out, and could be valuable in avoiding new CFC production and destruction costs. Further discussion on stockpiles is included in sections 1.3 and 2.3.

1.2.5 China

Year	**Quantity nominated**
2014	236.60 tonnes
2015	221.59 tonnes

Specific Use: MDIs for asthma and COPD

Active ingredients and intended markets for which the nomination applies:

Active Ingredient	**Intended market**	**2014 Quantity (Tonnes)**	**2015 Quantity (Tonnes)**
Beclomethasone	China	9.796	9.473
Budesonide	China	11.9813	11.8875
Datura metel extract/clenbuterol	China	2.0	2.0
Dimethicone	China	0.2	0.2
Ipratropium/Salbutamol	China	0.745	0.745
Isoprenaline	China	30.7	29.4
Salbutamol	China	177.52	164.955
Sodium cromoglycate	China	3.656	2.924
Total		**236.60**	**221.59**

Recommendation:

Recommend 235.05 metric tonnes of CFCs for the manufacture of MDIs for the active ingredients beclomethasone, budesonide, datura metel extract/clenbuterol, dimethicone, ipratropium/salbutamol, isoprenaline, salbutamol, and sodium cromoglycate for 2014.

Unable to recommend 1.55 tonnes CFCs for the manufacture of MDIs for the active ingredients isoprenaline and salbutamol for 2014.

Unable to recommend CFCs for the manufacture of MDIs for 2015.

Comments:

In its 2012 assessment, MTOC suggested that China might wish to consider a future campaign production of CFCs to satisfy its total essential use requirements until final phase-out, with a possible nomination in 2013 to cover multiple years. This year, China submitted nominations for 2014 and 2015 for 236.60 and 221.59 tonnes respectively. Assuming continued smooth progress, China intended these nominations for 2014 and 2015 as its last, for a final production campaign on the basis of China's CFC requirements and national inventory for 2014 and 2015. China is commended for the detailed analysis undertaken in its essential use nominations for 2014 and 2015, and for its estimation of CFC requirements until final phase-out, indicating its concerted efforts to manage transition.

The nomination for 2014 shows an almost 50 per cent reduction from China's 2013 nominated quantity of CFCs, and is an almost 40 per cent reduction from China's 2013 authorised quantity. The nominated quantities for 2015 show a much smaller 6 per cent reduction from 2014.

Compared with 2013, CFCs for two combination products are no longer nominated for essential use exemption in 2014 and 2015 (ephedra/ginkgo/sophora flavescens/radix scutellariae and beclomethasone/clenbuterol/ipratropium). China is commended for these efforts.

The nomination is only for CFC MDIs for domestic use. The Chinese nomination clearly states that CFCs will not be used to manufacture MDIs for export in 2014. MTOC received market information that shows significant quantities of imported CFC MDIs from China remained on sale in Pakistan during 2012, making up more than 70 per cent of Pakistan's total inhaler market. It appears that the Chinese Government was not aware of this because the accounting framework did not include any CFC quantities in exported MDIs.

CFCs for the manufacture of salbutamol MDIs account for about 75 per cent of the nominated quantities for both 2014 (177.52 tonnes) and 2015 (164.955 tonnes). The CFC quantities nominated for 2014 for the manufacture of salbutamol MDIs are a 47 per cent reduction of those nominated for 2013 (332.947 tonnes). This reflects the major progress in conversion of salbutamol CFC MDIs to CFC-free alternatives in China, with two companies, Shandong Jewim Pharmaceutical Co., Ltd. and Yanghzou Sanyao Pharmaceutical Co., Ltd., gaining salbutamol HFC MDI manufacturing licenses (one product already marketed). There is also one approved imported salbutamol HFC MDI, marketed at a similar price to the local products. There are currently 11 salbutamol products undergoing reformulation. Of these, five companies have already submitted applications to manufacture salbutamol HFC MDI products. So it appears that China is well on track to meet its proposed salbutamol CFC MDI phase-out date by the end of 2015.

MTOC notes that four companies appear to have an increase in their CFC requirements in 2014 and 2015 compared with 2013. Of these, three companies have submitted for registration of salbutamol HFC MDIs and should soon be in a position to supply increased market demands with these CFC-free products rather than increase CFC MDI production, assuming timely approval.

Some MDI manufacturing companies in China appear to be building excess CFC stockpile. As an example, one of the companies that submitted for registration had a stockpile of 25 tonnes at the end of 2012, and reported consumption of 22 tonnes in 2012. This company requested 57 tonnes for 2014. A second company, with reported consumption of 7 tonnes in 2012 had the equivalent of 9 years CFC stocks at the end of 2012. This company requested 31 tonnes for 2014. A third company appears to have the equivalent of 5 years of CFCs stocks at the end of 2012. MTOC has previously recommended that prudent strategic reserves (stockpiles) should be limited to no more than 12 months of use, and less as phase-out nears completion.

China has advised that the authorised essential use exemption for 2013 (388.82 tonnes) will be supplied from existing CFC stockpiles (total 854.52 tonnes at the end of 2012). MTOC has observed that some countries had significant surplus CFCs remaining at the end of phase-out of CFC MDIs, which can result in destruction costs to industry or unnecessary use of CFCs to manufacture MDIs that are no longer essential to patients. Uniquely, China will be both the last manufacturer of CFCs and consumer of CFC MDIs. Therefore it will need to ensure stockpiles are effectively managed to avoid surplus at the end of transition, including the evaluation of company stockpiles as part of the allocation of CFC quotas to MDI manufacturing companies.

<u>Final phase-out</u>

MTOC has reported previously the possible benefits of a final campaign production of CFCs in the last stages of transition. China has responded by submitting a multi-year nomination request for 2014 and 2015, stating that these could be its last nominations.

The China transition strategy states that the phase-out of all CFC MDIs will be completed by the end of 2016. However, if four salbutamol alternatives become available on the market during 2013 or 2014, then accelerated transition for salbutamol CFC MDIs may be feasible. Since salbutamol is a major proportion of China’s use, it is likely that total CFC usage to manufacture MDIs will diminish significantly during 2014 and 2015.

At the end of 2012, China would appear to have more than adequate stockpiles to supply its CFC requirements for 2013 and 2014. Decision IV/25 implies that when a Party applies for an essential use exemption, it qualifies only for the amount that cannot be supplied from available stockpiles. Despite reported stockpiles, MTOC is recommending an essential use exemption for CFC production and consumption for 2014 in the expectation that China would supply its requirements from accumulated stockpile, with new CFCs produced only if absolutely necessary. A similar approach was applied to nominations from the United States when it was unclear to MTOC to what extent stockpiles might have been available to meet future requirements.

China’s situation is complicated by Russia’s need for CFCs in 2013, and possibly also in 2014, which Russia has obtained from China in the past. China has stated that CFCs exported to Russia will be met from new CFCs production in 2013, and that China’s inventory of surplus CFCs is intended mainly for domestic markets. Nevertheless, if Parties authorise an essential use exemption for Russia for 2014, it needs to be clarified if this would be supplied from stockpiles of pharmaceutical-grade CFCs in China or elsewhere, or whether this would come from new CFC manufacture.

The situation becomes less clear for 2015, with China’s CFC requirements potentially significantly less than the current nomination for that year. It is possible that China may be able to manage its phase-out completely from CFC stockpiles, although this is not yet clear. Consequently, MTOC is unable to recommend CFCs for 2015 this year, preferring instead to consider a revised nomination next year in order to make a more accurate assessment.

Companies undertaking active research and development

In 2008 the 56th ExCom meeting approved a project for China for the phase-out of 323 ODP tonnes (for a baseline in 2007) for MDI conversion. At the time, the project was established to phase out ODS consumption in 38 enterprises, including license cancellations, for conversion of a total of 25 MDI product types. The Ministry of Environmental Protection and the State Food and Drug Administration, in conjunction with the China Center of Pharmaceutical International Exchange, have been working in cooperation with UNIDO to implement the project. The project has seen some rationalisation of the number of enterprises manufacturing MDIs, with fewer than the original 38 enterprises entering contracts. This is reflected in the decreasing number of enterprises requesting CFCs under China's essential use nominations each year.

In 2013, a total of 13 companies have stated they are undertaking research to re-formulate at least one of the entities they are already marketing. Good progress has been made, with a number of companies applying for licences to manufacture and market HFC MDIs.

However, one company indicated it is not conducting research into the reformulation of HFC MDIs for both isoprenaline and salbutamol. Therefore, MTOC is unable to recommend 1.55 tonnes CFCs for the active ingredients isoprenaline (1.25 tonnes) and salbutamol (0.3 tonnes) requested for 2014.

There is also a lack of progress with HFC reformulation for a number of other companies' products. These may not have reached the market by the time of the China phase-out date for CFC MDI manufacture at the end of 2015. Accordingly, in future years, MTOC is unlikely to recommend CFC quantities for MDIs for which the replacements had not received authorisation for clinical trials by the end of 2013.

Salbutamol

Two local companies have made good progress, having received manufacturing licences for salbutamol HFC MDIs. One company has been manufacturing and selling HFC MDIs since 2012, and the other is expected to be manufacturing and selling salbutamol HFC MDIs in 2013. Five other companies have submitted licence applications to manufacture and sell salbutamol HFC MDIs. China's salbutamol phase-out plan is predicated on the marketing of four locally produced salbutamol HFC MDIs for CFCs to be considered non-essential for salbutamol MDIs. The plan also states that salbutamol CFC MDI manufacturing should conclude by the end of 2015. Based on current progress, it is possible that salbutamol CFC MDIs could be considered non-essential under China's national transition strategy in 2014 and a nomination for 2015 for salbutamol CFC MDIs becomes unnecessary.

The nominated CFC quantities, to manufacture salbutamol MDIs for 2015, account for about 75 per cent of the total requested. Since there are significant uncertainties regarding the CFC quantities required, if any, to manufacture salbutamol MDIs in 2015, MTOC is deferring an assessment of the 2015 nomination until a more accurate picture emerges.

MTOC recommends 177.22 tonnes for the manufacture of salbutamol CFC MDIs for 2014 (177.52 tonnes less 0.3 tonnes).

Isoprenaline

The nomination includes 30.7 and 29.4 tonnes of CFCs for the non-selective[1] beta-agonist isoprenaline for 2014 and 2015 respectively. China notes the low cost of isoprenaline MDIs and its availability in remote regions as justifications for the nomination. The low-cost aerosol isoprenaline hydrochloride is dispensed from a plastic covered glass bottle, which is

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[1] Non-selective refers to beta-agonists that affect the lungs and heart. Selective beta-agonists have much fewer, if any, cardiac effects.

easily produced as a solution without the need for sophisticated dispersing equipment. It is priced at RMB 6.50 compared with the salbutamol CFC or HFC MDIs priced at RMB 22.80 (official maximum price RMB 23.60).

However, MTOC has concerns about this drug for two reasons. First, isoprenaline has been withdrawn elsewhere in the world because of two epidemics of asthma mortality associated with its use[2,3]. Conversion to a selective beta-agonist, such as salbutamol, would be preferable. Second, reformulation of isoprenaline is only just beginning and this drug will probably require a full clinical trials package, which MTOC believes is unlikely to be completed before 2016.

The largest producer of isoprenaline CFC MDIs has applied for regulatory approval for its salbutamol HFC MDI, and has not indicated it is planning to reformulate isoprenaline CFC MDIs. Isoprenaline CFC MDIs will likely be phased out through the uptake of salbutamol HFC MDIs by the end of 2014. China has indicated that conversion of isoprenaline CFC MDIs would not delay the phase-out of the beta-agonist category under its national transition strategy.

MTOC has recommended 29.45 tonnes CFCs for isoprenaline MDIs for 2014 (30.7 tonnes less 1.25 tonnes). Due to the low likelihood of timely reformulation and the emerging availability of suitable salbutamol CFC-free alternatives, MTOC is unlikely to recommend CFCs for isoprenaline MDIs in any future nomination.

Inhaled corticosteroids

For the inhaled corticosteroid category, one beclomethasone HFC MDI has been approved. In addition, licence applications will be made for two ciclesonide HFC MDIs during 2013. Progress is also being made with budesonide. Under China's transition strategy, CFCs become non-essential for this category when there are two locally produced beclomethasone HFC MDI products, and two other corticosteroid products. Therefore, China requires one more locally produced beclomethasone HFC MDI to complete transition of the inhaled corticosteroid category under its transition strategy. For 2014, MTOC recommends 9.8 tonnes of CFCs to manufacture beclomethasone MDIs and 12 tonnes of CFCs to manufacture budesonide MDIs.

Sodium cromoglycate

The nomination includes 3.66 tonnes of CFCs to manufacture sodium cromoglycate MDIs for 2014, to be used by one company, and 2.92 tonnes for 2015. This company has made a registration application for sodium cromoglycate HFC MDIs. Another company has indicated that it has developed a DPI formulation that will be submitted for regulatory review in the first quarter of 2013. Under China's transition strategy, CFCs become non-essential for this category when there is one CFC-free product available. MTOC recommends the requested CFCs to manufacture sodium cromoglycate MDIs for 2014 to allow transition to be completed. MTOC is unlikely to recommend any future CFC quantities.

Combination products

MTOC restates its position from last year that, at this stage of the phase-out, a combination product is not essential when the separate drugs are available in CFC-free formulations. The nomination requests 0.745 tonnes of CFCs to manufacture the combination inhaler containing salbutamol and ipratropium for 2014 and 2015. Ipratropium is already non-essential under China's transition strategy, and the shift to salbutamol HFC MDIs is underway. To ease

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[2] Inman, W.H.W., Adelstein, A.M., *Rise and fall of asthma mortality in relation to use of pressurized aerosols*, Lancet 1969; 2:279-83.

[3] Anderson, R.A. *et al*, *Bronchodilator treatment and deaths from asthma: case-control study*, British Medical Journal 2005; 330:117.

market transition, MTOC recommends the requested CFC quantities for the manufacture of ipratropium/salbutamol combination inhalers for 2014. For 2015, ipratropium/salbutamol combination CFC MDIs are unlikely to be essential under China's transition strategy due to the wide availability of salbutamol HFC MDIs.

Dimethicone for pulmonary oedema

Dimethicone in CFC MDIs is used in China to treat acute toxic pulmonary oedema. This use is supported by anecdotal rather than scientific evidence in the nomination. The nomination requests 0.2 tonnes of CFCs for both 2014 and 2015. Reformulation has been difficult and iso-butane propellant is being investigated. The company is currently undertaking safety assessments of the new formulation. Due to the progress in reformulation, MTOC recommends 0.2 tonnes of CFCs for dimethicone MDIs for 2014.

Traditional Chinese Medicines

The nomination includes 2 tonnes CFCs used to manufacture MDIs containing clenbuterol, a short-acting beta-agonist, and "datura metel extract", a herbal form of an anticholinergic medicine (such as ipratropium), from GuiYang DeChangXiang Pharmaceutical Co.

Decision XXIV/3(9) requested "*...China, if it should nominate again in 2013 the use of CFC to be used in traditional Chinese medicine in remote areas, to provide more information about the absence of alternatives in the region, the phase out efforts undertaken for this use and other relevant information necessary to allow the Medical Technical Options Committee to evaluate the case fully.*" China has stated that this CFC MDI is supplied to remote areas of south-west China where other inhaler products are less freely available.

Traditional Chinese medicine has its own rationale that is completely different from modern western medicine. However, no information has been provided to say whether this TCM inhaler is more effective than available oral or injectable alternative forms of TCMs. No evidence has been presented to differentiate the effectiveness of the different ingredients, or to suggest that the inhaled herbal component is of any additional value over and above the known bronchodilator, clenbuterol. Moreover, no evidence has been presented that shows the combination product to be superior or even equivalent to more common asthma treatments, such as the bronchodilator salbutamol.

Nevertheless, the manufacturer is currently making efforts to convert its manufacture to HFC MDIs and has submitted its registration application. In reviewing this application, the State Food and Drug Administration of the People's Republic of China has stated it will review the safety and effectiveness of this product. Since there has been reformulation progress, and due to the current lack of alternatives in the remote region where the product is used, MTOC recommends 2 tonnes CFCs to manufacture MDIs containing clenbuterol/datura metel extract for 2014.

Recommended quantities in accordance with Decision XV/5(3):

Active Ingredient	Intended market	2014 Quantity (Tonnes)	2015
Beclomethasone	China	9.796	Unable to recommend
Budesonide	China	11.9813	
Datura metel extract/clenbuterol	China	2.0	
Dimethicone	China	0.2	
Ipratropium/Salbutamol	China	0.745	
Isoprenaline	China	29.45	
Salbutamol	China	177.22	
Sodium cromoglycate	China	3.656	
Total		**235.05**	

1.2.6 Russian Federation

Year	Quantity nominated
2014	212 tonnes

Specific Use: MDIs for asthma and COPD

Nominated quantities, active ingredients and intended markets for which the nomination applies:

Year	Active Ingredient	Intended market	Quantity (Tonnes)
2014	Salbutamol	Russian Federation	212.0

Recommendation:

Recommend 106 tonnes CFCs for MDIs for intended use in the Russian Federation for the active ingredient salbutamol for 2014.

Comments:

The Russian Federation indicated that it would not submit a nomination for 2014. However a nomination was received, long after the submission deadline of the 31st January, and only one week before MTOC was due to meet. MTOC was unable to submit any requests for clarification to the Russian Federation prior to its meeting. A UNIDO representative attended the MTOC meeting to give a presentation on progress in the phase-out of CFCs in the manufacture of MDIs in China and Russia. Based on the information available, MTOC believes it was able to assess adequately the nomination from the Russian Federation in the time available.

The nomination requested 212 tonnes of CFCs for the manufacture of salbutamol CFC MDIs for domestic use only, which is the same as the annual authorised quantities for 2010-2013. Russia reports that annual demand of CFCs in 2007-2011 was 241-246 tonnes per year to satisfy fully the needs of patients, and that CFCs were consumed well before the end of the year in both 2011 and 2012. Accordingly, there were no stockpiles at the end of 2011 and 2012. Total CFC consumption was 212.0 tonnes in 2012. There has been no stockpile available since 2011. In recent years, CFCs have been sourced from new production in China.

Two local pharmaceutical companies, CJSC "Altaivitaminy" (Altaivitaminy) and JSC "Moschimpharmpreparaty" named after N.A. Semashko" (Moschimpharmpreparaty), manufacture CFC MDIs and have informal agreements to supply to the eastern and western regions of the Russian Federation respectively. Locally produced CFC MDIs are in 90-dose packs, rather than the more usual 200-dose pack. The domestic HFC MDIs that are under development will be in 200-dose packs.

In the nomination submitted in 2012, the two Russian companies were reportedly engaged in clinical trials, with one company anticipating market approval at the end of 2012. In the current nomination, this approval is now not expected until the second half of 2013. No explanation for the delay has been provided in the nomination.

The first National Action Plan to phase-out CFCs in MDIs was developed in 2004 to phase-out CFCs for MDI production in 2005-2007. The Action Plan was revised several times due to economic and technical reasons before being put on hold in 2007, pending clarity on the schedule for the domestic manufacturers to convert to CFC-free MDI production. In 2009-2010, the Russian Federation, together with the two domestic pharmaceutical companies, worked with UNIDO to initiate a GEF co-funded project to phase-out CFCs in MDIs. Although the project received in principle approval in March 2011, approval for the full project to commence was not made until December that year. The project funding was based on the premise that GEF would provide \$2.5M of funding and the manufacturers would provide \$5.5M.

During early 2012, UNIDO negotiated the terms of reference with both manufacturers for a tendering exercise for conversions that took place between July and September 2012. The submissions to this tender by equipment providers matched the requirements in terms of specification and cost. However, having reviewed the tender submissions, the MDI manufacturers requested modifications to the terms of reference to reduce the manufacturing capacity and thus the cost of the equipment, so that the overall cost of the project (and their contribution) could be reduced. As a consequence, a new bidding process for a revised tender was required, which commenced in March 2013, with a final contract expected in May 2013. The completion of installation is predicted by UNIDO to be 10-12 months after the contracts are signed (mid-2014). MTOC anticipates that a further 12-24 months will be required to validate and launch HFC MDIs at full capacity (up to mid-2016). Based on these developments, MTOC predicts on-going requirements for CFCs until the end of 2016, even assuming that there are no further delays.

In both 2011 and 2012, MTOC reported that if conversion was not achieved within a reasonable timeframe, the Russian Federation would need to consider broadening the importation and distribution of affordable, imported salbutamol CFC-free inhalers to meet the demand of Russian patients with asthma and COPD. For some years, there has been a wide range of affordable CFC-free inhalers available in the Russian Federation, as elsewhere in the world. For at least two years there have been six, imported salbutamol HFC MDIs on sale, and also two breath-actuated salbutamol MDIs, together with one locally produced DPI.

MTOC considered the question of affordability of salbutamol inhalers for Russian patients. In 2012, about 80 per cent of salbutamol inhalers bought by Russian patients are locally made CFC MDIs. The weighted mean price of all salbutamol MDIs (local and imported) sold in Russia was 68 Roubles. The two Russian-made products sold for 35 (Altaivitaminy) and 75 (Moschim-pharmpreparaty) Roubles respectively, imported HFC MDIs sold for 41-214 Roubles. The prices for imported 200-dose HFC MDIs are mostly higher than the locally produced 90-dose CFC MDIs because the pack sizes are more than double. One imported HFC MDI (Astalin, Cipla 41 Roubles) is cheaper than one of the two Russian-made CFC MDIs (Moschim-pharmpreparaty, 75 Roubles), and similarly priced to the other

(Altaivitaminy, 35 Roubles). A low-income patient might find it easier to afford a salbutamol inhaler at a lower unit price within a limited monthly budget. This could include the imported 200-dose HFC MDI that is competitively priced with the locally made products[4]. However, on a dose-for-dose basis, four of the six imported HFC MDIs are cheaper than the more expensive of the two locally produced CFC MDIs, and, per dose, one imported HFC MDI is the cheapest of all. For a Russian patient needing to take 200 doses of salbutamol per month, the annual cost of the cheapest imported salbutamol HFC MDI (492 Roubles) is just over half of the annual cost of the cheapest locally produced salbutamol CFC MDI (933 Roubles)[5]. However, at present, this inexpensive Astalin (Cipla) salbutamol HFC MDI has only 0.1 per cent of the market share (by inhaler quantities).

Last year, the Russian Federation indicated that its nomination for 2013 would be its last. At that time, MTOC indicated that in the event that conversion project timings were delayed, imported products provided technical and economically acceptable alternatives. MTOC identified that such products were already available and priced comparably to locally produced salbutamol CFC MDIs when evaluated on a cost per dose basis. MTOC remains concerned about the lack of progress in CFC MDI phase-out over the past decade and more recent delays. This raises additional concerns that this project may not meet its latest revised timelines. Global supplies of pharmaceutical-grade CFCs may be exhausted or destroyed before conversion in the Russian Federation is completed.

The Russian Federation may wish to assure adequate supplies of medicines to meet patient needs through measures to increase the availability of imported CFC-free inhalers within the Russian Federation. This could include the option of local companies acting as distributors for imported HFC MDIs, even as an interim solution. China’s emerging production of inexpensive salbutamol HFC MDIs, in addition to those already available from Bangladesh and India, provide an additional low-cost imported alternative for Russian patients.

A process to increase imported CFC-free inhalers (for approved or any new salbutamol HFC MDI) may need some time to address any of the following issues:

- Identification of suitable suppliers;
- Commercial agreements to secure volumes;
- Transportation and customs approvals;
- Design of new labels in the case that new distributors step in;
- Time to fill up distribution channels; and
- Advertising and patient instruction.

Therefore, MTOC recommends 106 tonnes CFCs for 2014 to allow for some domestic production of CFC MDIs while any such processes are completed. MTOC believes that it may take until mid-2014 to increase and distribute adequate amounts of imported HFC MDIs. This coincides with the revised completion date for equipment installation of mid-2014 under the conversion project, based on current UNIDO predictions. One further month of CFC requirements could be obtained through an emergency essential use exemption of up to 20 tonnes, if necessary.

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4 Altaivitaminy salbutamol CFC MDI 90 doses: 35 Roubles, with 40 per cent market share by inhaler quantities. Moschim-pharmpreparaty CFC MDI 90 doses: 75 Roubles, with 43 per cent market chare by inhaler quantities. Astalin (Cipla) HFC MDI 200 doses: 41 Roubles, with 0.1 per cent market share by inhaler quantities.

5 Altaivitaminy salbutamol CFC MDI 90 doses; 35 Roubles/inhaler; 0.39 Roubles/dose. Astalin (Cipla) salbutamol HFC MDI 200 doses; 41 Roubles/inhaler; 0.2 Roubles/dose.

In summary, the Russian Federation submitted a late nomination of 212 tonnes CFCs for MDI manufacture immediately prior to the MTOC meeting. The final date for completion of the conversion project and market transition has been delayed and remains uncertain. However, transition may be as late as 2016 based on current MTOC estimations. During this period, pharmaceutical-grade CFCs to manufacture MDIs may cease to be available. Technically and economically feasible alternatives to salbutamol CFC MDIs are available in Russia, and more can be made available by increasing imported salbutamol CFC-free inhalers. Therefore, it is essential for patient safety that, rather than continue production of CFC MDIs, other technically and economically feasible options are considered.

The Russian Federation may wish to consider:

1. Measures to increase the availability of imported salbutamol CFC-free inhalers to guarantee the short-term supply; and
2. Accelerating transition of local manufacturers for the longer-term supply.

MTOC recommends the approval of 106 tonnes of CFC for salbutamol for domestic use to provide time for transition to imported CFC-free inhaler products to occur.

If Parties choose to authorise a nomination for essential use, Parties may wish to consider utilising existing available global pharmaceutical-grade CFC stockpiles of suitable quality rather than new CFC production.

1.3 Reporting Accounting Frameworks for essential use exemptions

The following section describes information provided in reporting accounting frameworks by Parties with authorised essential use exemptions for 2012 that are not nominating essential uses for 2014 or 2015. It also provides updates on Parties with authorised essential use exemptions in previous years that have not reported accounting frameworks with relevant new information. The reporting accounting frameworks of Parties nominating essential uses for 2014 and 2015 are included in the preceding sections.

1.3.1 Argentina

Parties authorised an essential use exemption of 107.2 tonnes of CFCs for the manufacture of MDIs in Argentina for 2011. Argentina did not make an essential use nomination for 2012 or 2013. Argentina's accounting framework for 2012 shows that it used about 15 tonnes from CFC stockpiles to manufacture MDIs. CFC stocks on hand at the end of 2012 decreased to about 5 tonnes.

There are still some remaining CFC MDIs on sale in Argentina, some of which were produced in 2012. There are no regulations to prohibit sales of CFC MDIs.

Regarding progress with research and development of isobutane as an alternative propellant in MDIs by Laboratorio Pablo Cassará, MTOC understands that:

1. Long-term stability studies were initiated in the second semester of 2011, with one year of data collected. The formulation showed no consistent deterioration over time even in conditions of high humidity;
2. Isobutane, which complies with regulatory requirements and within limits for 1,3-isobutadiene, has been selected as an appropriate inhalation propellant.
3. Evaluation of the uniformity of contents and fine particle aerodynamics has been performed with satisfactory results.

1.3.2 Bangladesh

Parties authorised an essential use exemption of 40.35 tonnes of CFCs for the manufacture of MDIs in Bangladesh for 2012. Bangladesh's accounting framework for 2012 shows that it did not acquire any CFCs by production and used the remaining 23 tonnes of CFC stocks to manufacture MDIs in 2012. CFC stocks on hand at the end of 2012 were depleted to zero. Bangladesh used 30 per cent less CFCs to manufacture MDIs in 2012 compared with 2011, reflecting progress in the phase-out of CFC MDI manufacturing. Bangladesh did not apply for any essential use nomination for 2013, and has informed companies that they are not permitted to manufacture CFC MDIs in 2013.

Three companies (Beximco, Acme and Square) received MLF funding for conversion projects to HFC MDIs: Beximco and Acme have already completed the conversion. Square completed its conversion within 2012 and is marketing remaining inventory until depleted. Bangladesh is to be commended for its achievements in CFC MDI transition to alternatives.

1.3.3 Egypt

Parties authorised an essential use exemption of 227.4 tonnes of CFCs for the manufacture of MDIs in Egypt for 2010. However, no accounting framework has been reported for authorised essential uses in 2010. Egypt has not made any essential use nomination since 2010. MTOC understands that Egypt has been manufacturing from stockpile for the last few years, and is now nearing completion of CFC MDI manufacturing conversion to CFC-free alternatives.

1.3.4 European Union

The European Union has not had any authorised essential use exemptions since 2009. A stockpile of about 46.4 tonnes remained at the end of 2009. An accounting framework for 2012 was received from the European Union. The European Union reported destruction of about 12 tonnes of CFCs, which took place in 2011. At the end of 2012, the European Union held about 3 tonnes of CFC stockpile. In 2013, about 2.8 tonnes will be used in Italy to manufacture a CFC-based combination inhaler containing salbutamol sulphate and ipratropium bromide to be sold in that market. It is understood that production of this product may cease this year. Until 2012, this company also produced a salbutamol/flunisolide CFC MDI but this product has been discontinued.

The remaining 360 kg CFCs will be used in the manufacture of CFC MDI valves to be exported to Russia until the stocks are depleted. In 2012, MTOC reported CFC stockpiles being used to manufacture valves for CFC MDIs produced in other countries (Egypt, Pakistan, Russia and Syria). The valve is the metering device for an MDI, and a key component. CFCs are used to wash and clean elastomers to remove leachable contaminants, such as nitrosamines, for all of the valves manufactured. The elastomers in the valve for a CFC MDI must be washed with CFCs (and not other solvents) because these are the substances that the valve will be in contact with during the CFC MDI's operational life. This is probably a relatively small CFC use in volume terms, where fugitive emissions are minimal. Additionally some CFCs are also used to test batch samples of valves for proper functioning.

As the CFCs are used in the manufacturing process for valves supplied to CFC MDI manufacturers, and as this process is essential in ensuring regulatory standards for CFC MDI products made with these valves, MTOC considers the uses of CFCs for this purpose meet the essential use criteria of Decision IV/25. In the past, MTOC recommended CFC essential use nominations from the European Union that included a specific volume of CFCs nominated for use in the manufacture of valves. Any future essential use nominations may wish to specify and elaborate this use and its associated CFC consumption. TEAP does not consider the testing of valves with CFCs to be a laboratory or analytical use.

1.3.5 India

India's final essential use exemption of 343.6 tonnes CFCs for the manufacture of MDIs was authorised for 2010. In 2011, India reported CFC stocks of 226.295 tonnes, including 24.402 tonnes of non-pharmaceutical grade CFCs manufactured during start-up of CFC manufacturing. Accounting frameworks on available stockpiles under Decision XXIII/2 for subsequent years have not been received from India. It is understood through other sources that India has almost completely converted its MDI manufacturing to be CFC-free and that there is some remaining CFC stockpile, for which destruction or deployment is yet to be decided. Further discussion on CFC stockpiles and the deployment of surplus is presented in section 2.3.

1.3.6 Mexico

Parties authorised an emergency essential use of 6 tonnes CFCs for the manufacture of MDIs in Mexico in 2011 under an arrangement where Mexico agreed to destroy an equivalent ODP weighted amount of ODS. Mexico originally planned to destroy CFC-11 to compensate the emergency essential use acquired by import. MTOC understands that Mexico has completed conversion of CFC MDI manufacturing to CFC-free MDIs. Most of the CFCs that remained in Mexico were used by Boehringer Ingelheim to manufacture a CFC MDI product. This product has since been discontinued, and remaining stocks of mixed CFC-11, -12, and -114 will have to be destroyed or deployed for essential use by another Party. A local producer, Laboratorios Salus, has about 15 tonnes of CFC stockpile remaining, which is likely to be out of specification and intended for destruction.

1.3.7 Pakistan

Parties authorised an essential use exemption of 24.1 tonnes of CFCs for the manufacture of MDIs in Pakistan for 2012. Pakistan's accounting framework for 2012 shows that it did not acquire CFCs, and used 6.5 tonnes to manufacture CFC MDIs from CFC stockpile. As a result, CFC stocks on hand at the end of 2012 decreased to 12 tonnes from 18.5 tonnes at the start of the year. Pakistan used 68 per cent less CFCs to manufacture MDIs in 2012 compared with 2011. In 2013 there was no essential use nomination received from Pakistan for 2014.

One company, Macter, has a stockpile of 5-6 tonnes purchased from Honeywell. This company stopped manufacturing CFC MDIs in December 2012, and so, will likely need to dispose of this stockpile. Zafa, despite having successfully applied to receive funding for plant conversion, is not proceeding with this process, and appears to be quitting MDI manufacturing. GSK Pakistan currently imports salbutamol HFC MDIs but is in the process of installing a new plant to manufacture salbutamol HFC MDIs, which is likely to start production towards the end of 2013 and replace the more expensive imported products.

It is a matter of concern that 70 per cent of unit sales in 2012 were CFC MDIs, mainly imported by Getz Pharma (60 per cent of total unit sales) from Jewim Pharmaceuticals in China. Macter also manufactured CFC MDIs before the end of 2012, which will continue to be sold for the next two years. The Chinese imported CFC MDIs continue to be popular, as do Macter's, because of their affordability. Macter is planning to convert its manufacturing lines to HFC MDIs but it is not clear when production will commence.

The regulatory authorities and the pharmaceutical industry will need to ensure that locally manufactured and imported HFC MDIs are affordable for patients in anticipation of the cessation of price favourable Chinese CFC MDI imports, as China transitions steadily towards CFC-free MDIs and as some local manufacture starts. The regulatory authorities have banned the import of CFC MDIs, as of December 2012. However it is likely that a stockpile of Chinese CFC MDIs was purchased in advance to cover supply needs for a couple of years after this.

In order to meet local requirements, GSK is importing HFC MDIs (salbutamol and inhaled corticosteroid) from Europe, which cost more than double the locally produced CFC MDIs. Chiesi also imports HFC MDIs from Europe, which are also priced higher than locally manufactured or Chinese imported CFC MDI brands.

Imported DPIs are used by about 9 per cent of asthma and COPD patients and use is steadily increasing. DPIs are imported by Highnoon Laboratories from Cipla India and are more affordable than equivalent HFC MDIs. It should be noted that these single-dose DPIs are more immediately affordable for patients because they contain fewer doses than pressurised MDIs.

MTOC notes again with concern the slowness of Pakistan's transition to HFC MDIs. It does not yet have one locally produced HFC MDI on the market. The affordable and most commonly used Chinese MDI imports are currently all CFC MDIs.

1.3.8 United States

To date, accounting frameworks or information invited under Decision XXIV/3(4) have not been reported by the United States in 2013. Parties authorised 92 tonnes of essential use CFCs for the manufacture of MDIs in the United States for 2010, which was its last year with an essential use exemption. The United States reported previously that 358 tonnes of CFCs were used for the manufacture of MDIs in 2010 and 28 tonnes were destroyed, with remaining stockpile of 169 tonnes at the end of 2010. Some of the surplus reported was manufactured pre-1996. Under a US FDA rulemaking, two MDIs remain essential under the Clean Air Act until December 31, 2013. The companies manufacturing these MDIs have plans to deplete their CFC stocks by that date. The United States has reported that in the unlikely event that stocks of CFCs remain in 2014, they will be destroyed or exported to Parties with approved essential use exemptions.

In addition, the United States reported under Decision XXIII/2(4) that stockpiles of 429.931 tonnes of pharmaceutical-grade CFCs were potentially available for export to Parties with approved essential-use exemptions in 2012. The United States advised that this stockpile quantity, held by Honeywell, is separate to the stockpile reported in its accounting framework held by individual MDI manufacturing companies. Further discussion on CFC stockpiles and the deployment of surplus is presented in section 2.3.

2 2013 Medical TOC (MTOC) Progress Report

2.1 Executive Summary

MTOC thanks the Ozone Secretariat for providing meeting venue sponsorship for the MTOC meeting held in Beijing, China, 13-15 March 2013. MTOC member, Mr. Wang Ping, Chinese Pharmacopoeia Commission, and the Government of the People's Republic of China (the State Food and Drug Administration, the China Center for Pharmaceutical International Exchange, and the Ministry of Environmental Protection) provided a range of organisational assistance and hospitality, for which MTOC sincerely thanks those organisations.

The global use of CFCs to manufacture MDIs in 2012 is estimated to be about 700 tonnes, a reduction of about 25 per cent from 2011. Article 5 Parties that reported accounting frameworks used about 400 tonnes of CFCs to manufacture MDIs in 2012, a reduction of 30 per cent from 2011.

Of the Parties that provided accounting frameworks for 2012 (Argentina, Bangladesh, China, the European Union, Pakistan and Russia), pharmaceutical-grade CFC stocks were reported to be about 875 tonnes at the end of 2012. Accounting frameworks were not received from India and the United States, which previously reported 371 tonnes of CFCs stockpiles held by MDI manufacturers at the end of 2010, although the United States has advised that remaining CFC MDI manufacturers plan to deplete their stocks. The United States has also reported separate available pharmaceutical-grade CFC stockpile, which is held by Honeywell and totals about 430 tonnes in June 2012. Accounting frameworks have not been received from Egypt and Syria for 2010 onwards.

Having information on stockpiles, that were accumulated under CFC essential use exemptions granted by Parties for previous years, would allow Parties to continue tracking management and deployment of stockpile until depleted. Information on stockpiles is particularly important in the last stages of global CFC MDI phase-out, and could be valuable in avoiding new production and destruction costs.

2.2 Global use of CFCs for MDIs

Based on the accounting frameworks received from Argentina, Bangladesh, China, the European Union, Pakistan and Russia, the global use of CFCs to manufacture MDIs in 2012 was about 600 tonnes. This excludes countries that may or may not be using CFCs for MDI manufacture that did not report accounting frameworks, such as Egypt, India, Syria or the United States. Taking potential CFC MDI manufacturing from stockpile in these countries into account, global use in 2012 is estimated to be about 700 tonnes, a reduction of about 25 per cent from 2011.

Article 5 Parties that reported accounting frameworks used about 400 tonnes of CFCs to manufacture MDIs in 2012, which is 65 per cent of the *reported* total global use of CFCs for MDIs. This is a reduction of 30 percent of the CFC use for MDI manufacture in Article 5 Parties in 2011.

Figure 2-1 and Table 2-1 show the use of chlorofluorocarbons (CFCs) for the manufacture of MDIs for asthma and COPD in Article 5 and non-Article 5 Parties for essential uses that was reported through accounting frameworks. This may not represent actual global use this year, due to reports not received and stockpile that may be depleted through on-going MDI manufacture.

Figure 2-1: Quantities of CFCs for MDI manufacture in Article 5 and non-Article 5 Parties reported through accounting frameworks (metric tonnes)

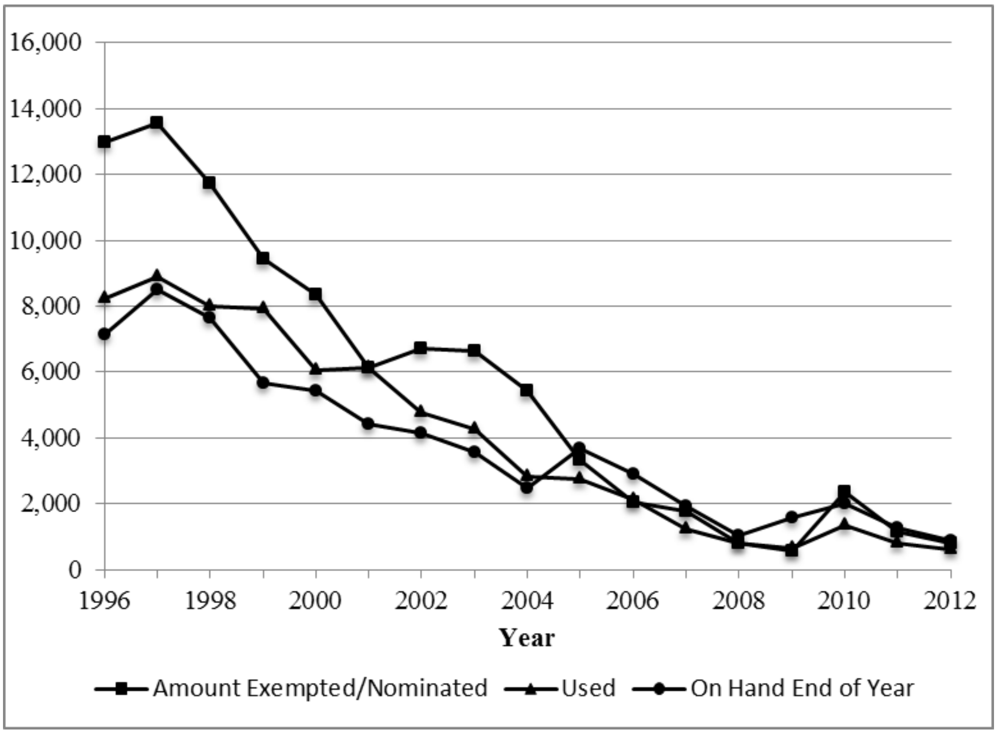

Table 2-1: Quantities (in tonnes) of CFCs for MDI manufacture in Article 5 and non-Article 5 Parties

Year of Essential Use	Amount Exempted/ Nominated for year of Essential Use	Used for Essential Use	On Hand End of Year
1996	12,987.20	8,241.13	7,129.59
1997	13,548.00	8,904.99	8,515.24
1998	11,720.18	8,013.60	7,656.63
1999	9,442.13	7,906.35	5,653.95
2000	8,364.95	6,062.75	5,433.32
2001	6,126.53	6,121.62	4,402.59
2002	6,714.75	4,751.92	4,133.71
2003	6,641.55	4,261.91	3,570.27
2004	5,443.12	2,840.82	2,460.10
2005	3,321.10	2,735.40	3,671.01
2006	2,039.00	2,107.10	2,916.08
2007	1,778.00	1,220.90	1,946.68
2008	797.00	796.10	1,022.18
2009	552.00	659.54	1,590.16
2010	2,366.47	1,338.74	2,011.55
2011	1,162.95	783.87	1250.66
2012	808.49	611.90	874.52
2013	600.82		

Table Footnote:

In the year 2010, Article 5 Parties with essential use authorisations are newly included, which explains in part the sudden jump in quantities for all three categories, amount exempted, used and stockpiled.

For 2011, information includes accounting frameworks received from Argentina, Bangladesh, China, EU, Pakistan and Russia. Information include 6 tonnes of CFCs authorised for emergency essential use by Mexico, but does not include information from Mexico on quantities used or on hand at the end of the year, which is not available in entirety.

For 2012, information includes accounting frameworks received from Bangladesh, China, EU, Pakistan and Russia. Information from Mexico is not available in entirety on quantities used and on hand at the end of the year. One local producer has about 15 tonnes of stockpile remaining that is likely to be destroyed.

Accounting frameworks were not received from India and the United States for 2011 and 2012, which reported 1,020 tonnes of CFCs stockpiles at the end of 2010, therefore use and stockpile do not include India, and only partially include stockpiles for the United States. For the years 2009 and 2010, separately reported stockpile (1,017.148, and 624.637 tonnes respectively) held by Honeywell in the United States is included, in addition to stocks held by individual MDI companies reported in the accounting frameworks. In June 2012, the United States reported 430 tonnes of CFC stocks held by Honeywell, separate to stockpiles held and reported under accounting frameworks and available for export, which appear in the year end stockpile for 2011. Similar data is not included for the end of year stockpile for 2012.

Accounting frameworks have not been received from Egypt and Syria for essential use exemptions authorised for 2010, therefore use and stockpile do not include Egypt or Syria.

2.3 CFC stockpiles

Table 2-1 presents historical stockpile reported by Parties with essential use exemptions through accounting frameworks. Of the Parties that provided accounting frameworks for 2012 (Argentina, Bangladesh, China, the European Union, Pakistan and Russia), pharmaceutical-grade CFC stocks were about 875 tonnes at the end of 2012. Stockpiles reported by China increased from 2011 to 2012, reinforcing the need to manage CFCs carefully in the final stages of phase-out.

Accounting frameworks were not received from India and the United States, which previously reported 371 tonnes of CFCs stockpiles held by MDI manufacturers at the end of 2010. For India and the United States, CFC MDI manufacturing may still be occurring from stockpile. Under a US FDA rulemaking, two MDIs remain essential under the Clean Air Act until December 31, 2013. The companies manufacturing these MDIs have plans to deplete their CFC stocks by that date. The United States has reported that in the unlikely event that stocks of CFCs remain in 2014, they will be destroyed or exported to Parties with approved essential use exemptions.

Decision XXI/4, XXII/4, XXIII/2 and XXIV/3 encouraged Parties with stockpiles of pharmaceutical-grade CFCs potentially available for export to notify the Ozone Secretariat by 31st December of that year. As a result, at the end of 2009 Parties reported that there were about 1,017 tonnes of pharmaceutical-grade CFCs (about 225 tonnes CFC-11, 425 tonnes CFC-12, 367 tonnes CFC-114) available in stockpiles in the United States and 301 tonnes of pharmaceutical-grade CFC-12 available in Venezuela. At the end of 2010, no further information was available on stockpiles in Venezuela, but the United States reported stockpiles of 624.637 tonnes (about 155 tonnes CFC-11, 349 tonnes CFC-12, 121 tonnes CFC-114). In June 2012, the United States reported pharmaceutical-grade CFC stockpiles of 429.931 tonnes. These stockpiles were available for export under commercial agreement with the holders of those stocks for export to Parties with approved essential-use exemptions in 2012. Regulatory processes for exporting CFCs from the United States' stockpiles for essential uses are not complicated. The United States advised that stockpile quantity, held by Honeywell, is separate to the stockpile of 169 tonnes reported in its accounting framework held by individual MDI manufacturing companies at the end of 2010.

The European Union has reported that it has not yet completed MDI manufacturing transition. At the end of 2012, the European Union held about 3 tonnes of CFC stockpile. In 2013, about 2.8 tonnes will be used in Italy to manufacture a CFC-based combination inhaler containing salbutamol sulphate and ipratropium bromide to be sold in that market. It is understood that production of this product may cease this year. Until 2012, this company also produced a salbutamol/flunisolide CFC MDI but this product has been discontinued. The remaining 360 kg CFCs will be used in the manufacture of CFC MDI valves to be exported to Russia until the stocks are depleted. CFC stockpiles in the European Union are not available for export due to regulations prohibiting the production and export of CFCs from 1st January 2010.

In its previous accounting framework, India reported stockpile of about 202 tonnes of pharmaceutical-grade CFCs, and 24 tonnes of non-pharmaceutical grade CFCs, available at the end of 2010.

MTOC understands that Egypt and Syria, which had essential use exemptions for 2010, had been manufacturing CFC MDIs until recently. MTOC understands that Egypt has been manufacturing from stockpile for the last few years, and is now nearing completion of CFC MDI manufacturing conversion to CFC-free alternatives.

Due to incomplete information, MTOC is unable to report fully to Parties on the use or depletion of surplus CFCs that were accumulated under essential use exemptions authorised by Parties to manufacture MDIs, and on exactly how much might be available for acquisition by Parties with authorised essential uses. Total stockpile is estimated to be about 1,300 tonnes. The majority of these CFCs are committed to the manufacture of CFC MDIs, and some CFCs are surplus and may need to be destroyed.

Decision VIII/9(9) states, *"...to request each of the Parties that have had essential-use exemptions granted for previous years, to submit their report in the approved format by 31 January of each year*".

Decision VII/28, paragraph 2(c) states that for the years 1996, 1997, 1998, 1999, 2000 and 2001, "*The Parties granted essential use exemptions will reallocate, as decided by the Parties, to other uses the exemptions granted or destroy any surplus ozone depleting substances authorised for essential use but subsequently rendered unnecessary as a result of technical progress and market adjustments*".

Having information on stockpiles, that were accumulated under CFC essential use exemptions granted by Parties for previous years, would allow Parties to continue tracking management and deployment of stockpile until depleted. Information on stockpiles is particularly important in the last stages of global CFC MDI phase-out, and could be valuable in avoiding new production and destruction costs.

Under Decision IV/25, Parties are required to consider stockpiles when making essential use nominations. Decision IV/25 implies that when a Party applies for an essential use exemption, it qualifies only for the amount that cannot be supplied from available stockpiles. Despite incomplete global information, MTOC tries to take into account national and global stockpiles of pharmaceutical-grade CFCs in assessing essential use nominations. However, in a practical sense, it has always been difficult to relate the CFC stockpiles reported in previous years to nominations made for future years with any degree of accuracy. Potential global transfers and stockpile use in the intervening years further complicates efforts to account for available stockpiles in the assessment of nominations for future years.   Consequently, MTOC has generally made its recommendations conservatively and according to predicted overall CFC requirements, with caveats about potentially available stockpile and its use in preference to new CFC production. In theory, authorised exemptions under this conservative approach should have allowed Parties the flexibility to manage stockpiles at the national and international level while minimising new CFC production. From MTOC's technical perspective, this approach has been in the best interests of patient safety. A less conservative approach, that relied on stockpile being available in the same quantity as reported at least one year before when it might be required, could leave Parties without the ability to manufacture essential use CFCs in the quantities required to meet patient demand for MDIs.

In recent Decisions, Parties have encouraged those Parties with essential use exemptions to consider sourcing required pharmaceutical-grade CFCs initially from stockpiles where they are available and accessible. Decision XXIV/3(6) also states that "*That the Parties listed in the annex to the present decision shall have full flexibility in sourcing the quantity of pharmaceutical-grade CFCs to the extent* *required for manufacturing metered dose inhalers, as authorized in paragraph 1 of the present decision, from imports, from domestic producers or from existing stockpiles*".

Whether a country, or a company, that is manufacturing MDIs acquires its CFCs from global stockpile depends on a range of commercial, economic, regulatory, legal, technical, and practical considerations. CFC MDI manufacturers in Bangladesh, among others, have successfully acquired CFCs from global stockpiles to supply pharmaceutical-grade CFCs of suitable quality, quantity and cost to meet their MDI manufacturing requirements under authorised essential use exemptions.

Some other efforts have been less successful. MTOC is aware of a failed attempt by Boehringer Ingelheim Pharmaceuticals Inc. (BI) and Honeywell International (Honeywell) to make available 280 tonnes of excess pharmaceutical-grade CFCs, meeting drug regulatory standards in Europe and the United States, for the Russian Federation's authorised essential use exemption for 2013. BI and Honeywell made good faith efforts to engage with the Russian Federation's sole authorised CFC importer, which imports and resells to Russia's two CFC MDI manufacturers. However, engagement failed without the opportunity for a formal commercial offer or negotiation, and the Russian CFC importer has now signed a contract with its usual Chinese supplier. With the administrative and cost burdens associated with maintaining excess stockpile, BI and Honeywell now wish to determine whether this stockpile remains an important strategic reserve that may be deployed in future, or, alternatively, proceed with its destruction.

2.4 Transition away from the use of CFC MDIs

Technically satisfactory alternatives to CFC MDIs to treat asthma and COPD are now available in all countries worldwide. More than 75 per cent of global MDIs now contain HFCs. The significant uptake of DPIs and the increased use of MDIs are also indicated. MTOC notes the importance of awareness programmes to facilitate the uptake of CFC-free inhalers among patients. China has initiated a remarkable public awareness programme in 2012.

2.5 Transition strategies

In response to Decision XII/2, transition strategies developed by seven Parties are listed on the Ozone Secretariat's web site. Pursuant to Decision XV/5(4), plans of action regarding the phase-out of the domestic use of salbutamol CFC MDIs from the European Community, the Russian Federation and the United States are also listed on the Ozone Secretariat's web site.

For Article 5 Parties, Decisions IX/19(5*bis*) and XV/5(4*bis*) set out requirements for the development of national transition strategies and preliminary plans of action for the phase-out of salbutamol CFC MDIs respectively. Furthermore, Decision XVII/5(3*bis*) requests nominating Article 5 Parties to submit a date to the Ozone Secretariat prior to the Twenty-Second Meeting of the Parties, by which time a regulation or regulations to determine the non-essentiality of the vast majority of chlorofluorocarbons for metered-dose inhalers where the active ingredient is not solely salbutamol will have been proposed. Decision XV/5(6) requests Parties to submit to the Ozone Secretariat specific dates by which time they will cease making nominations for essential use nominations for CFCs for MDI where the active ingredient is not solely salbutamol.

All Article 5 Parties nominating for essential use exemptions to produce or import CFCs for the manufacture of MDIs (China only for 2014 and 2015) have submitted initial transition strategies and preliminary plans of action, and plans in accordance with Decisions XVII/5(3*bis*) and XV/5(6).

2.5.1 Progress reports on transition strategies under Decision XII/2

Under Decision XII/2, Parties are required to report to the Secretariat by 31 January each year on progress made in transition to CFC-free MDIs. In 2013, reports about progress made with implementation of national transition strategies were received within essential use nominations for China and the Russian Federation.

3 2013 Chemicals TOC (CTOC) Progress Report

3.1 Executive Summary

The CTOC met on 26 - 28 February in Mauritius, with eleven out of fifteen members attending.

Process Agents

Data have been tabulated for process agent uses in 2011 and limited review of existing processes has been undertaken. Three process agent uses have been discontinued and they may be removed from Table A. One European facility has been identified as the source of excessive emissions of CTC and corrective action is being taken.

Feedstocks

Feedstock data for 2011 are presented, with comments on the processes and the nature of the products. Production of ODS for feedstock use is approximately 1.09 million MT (414,000 ODP MT), with emissions estimated to be 5470 Mt (2071 ODP MT).

n-Propyl bromide

Very few quantitative data on production and use of nPB are available. Occupational exposure standards in the US are still under consideration.

CTC in vinyl chloride monomer (VCM) production

The production of VCM in the US, although it involves pyrolysis of ethylene dichloride (EDC), does not involve the use of CTC as feedstock, as is the case with the Indian process reviewed in 2012.

EUN for aerospace use of CFC-113 in Russian Federation

The Russian Federation has nominated 85 metric tonnes of CFC-113 for critical use in the domestic space programme in 2014. CTOC recommends approval of the request.

Laboratory and analytical and uses of ODS

The research literature contains information about alternatives to the use of CTC as solvent in reactions involving N-bromosuccinimide. In many cases, α,α,α-trifluorotoluene is a suitable alternative. Alternative methods for the measurement of surface area of activated carbon, not involving CTC, as recommended by CTOC, have been adopted in producer-countries. The need remains to see that technical information provided by CTOC is made available to practitioners, and that work is done to introduce new standard methods to replace those using ODS.

CTC emissions and stratospheric concentrations

Reassessment of the atmospheric lifetime of CTC has done much to reduced the discrepancy between top down and bottom up estimates of emissions.

Solvents

Unsaturated HFCs (and HCFCs) have been developed for refrigeration, air conditioning and foam blowing, and substances of this type are now being produced for solvent use.

3.2 Introduction

The CTOC met on 26-28 February in Mauritius. Eleven out of fifteen CTOC members participated in the meeting. Attending members were from Australia, Chile, China (2), India, Japan, Kuwait, Mauritius, Netherlands, Russian Federation, and United States of America.

The meeting covered issues requested by the Parties including process agents, laboratory and analytical uses, n-PB, CTC issues, and feedstocks. Attention was also given to considering TEAP/TOC operating procedures and the requirement of Decision XXIII/10 that the present terms of office of members would end in 2013 or 2014, although renomination was possible. The CTOC also reviewed an essential use nomination from the Russian Federation on solvent use of CFC-113 for aerospace industries.

3.3 Process Agents

3.3.1 Introduction

To be accepted as a process agent use, the ODS in the specified process must meet two of the following criteria:

- (i) Chemical inertness during the process.
- (ii) Physical properties.
- (iii) Action as a chain-transfer reagent in free radical reactions.
- (iv) Control of product physical properties such as molecular weight or viscosity.
- (v) Ability to increase yield.
- (vi) Non-flammable/non-explosive.
- (vii) Minimisation of by-product formation.

Most of the process agent uses are of long standing, and the ODS are used as solvents to create unique yields, selectivity and/or resistance to harsh chemical environments, with the result that production is achieved with high efficiency. Legacy processes built around these properties make it difficult or impossible to convert in a cost effective and timely manner, and only a few examples are known. In this regard, the process agent uses have much in common with feedstock uses that are covered in a separate section of this report. Almost all of the removals of process agents from Table X/14, which at one stage included over 40 examples, have resulted from plant closures rather than substitution of other substances for the ODS process agent.

In considering the need to continue process agent use, CTOC members were mindful that the lifetime of a chemical production plant could be as long as 50 years. If the product is important enough to warrant continued production, and the plant is maintained in good condition and not in need of renewal, then the investment required to put into operation a new process that does not use ODS is unlikely to be justified. That said, the use of CTC in the chloralkali industry (uses #1 and #2 in Table A (see Table 7.2.2, below) is declining. Several undertakings in the EU have stopped these processes.

While each of the process agent applications is unique, there exists a suite of measures that can be applied to minimize make-up and emissions and each one needs to be considered by an operator. These measures include limiting make-up to the essential minimum, ensuring tight systems (no leaking valves and joints); evacuation and purging with recovery prior to opening equipment; closed loop transfer systems; proximity of production and use of the ODS; monitoring sensors at potential leak locations to provide alerts for prompt repair; use of absorbents such as activated charcoal on vents; and destruction of vent gases.

The EU advises that uses #4 - #7 are not expected to cease in the near future since no feasible alternatives are available. Nonetheless, consultations have begun with facilities employing these processes to identify further potential for future emissions reductions, and it is hoped that in future the limits for the EU in Decision XXIII/7 to be reduced.

Insufficient data are available to update Table B of Decision X/14.

3.3.2 Response to Decision XXIII/7(6)

At MOP-23 in 2011, Parties were requested to submit information to the Secretariat on make-up quantities and emissions from applications for which process agent exemptions exist. Parties were also requested by Decision XXIII/7 to report under a number of headings on existing process agent uses and to provide information to the thirty-second meeting of the Open-ended Working Group in mid-2012. Given the limited time available for these re-examinations, the CTOC reported on five of the fourteen process agent uses listed in Table A of Decision X/14 as amended in that 2011 decision (#1,2,6,9 and 14). In 2013 it was planned to review the remaining process agent uses, as shown in Table 7.2 but at the time of preparing the report only a little information had been received.

Table 3-1: Process agent uses still requiring review

No.	Process agent application	Substance (ODS)	Permitted parties
3	Production of chlorinated rubber	CTC	European Union
4	Production of chlorosulfonylated polyolefin (CSM)	CTC	China, United States of America
5	Production of aramid polymer (PPTA)	CTC	European Union
7	Photochemical synthesis of perfluoropolyetherpolyperoxide precursors of Z-perfluoropolyethers and difunctional derivatives	CFC-12	European Union
8	Preparation of perfluoropolyether diols with high functionality	CFC-113	European Union
10	Production of chlorinated polypropene	CTC	China
11	Production of chlorinated ethylene vinyl acetate (CEVA)	CTC	China
12	Production of methyl isocyanate derivatives	CTC	China
13	Bromination of a styrenic polymer	BCM	United States of America

Some research notes on four of these process agent uses are provided below.

3.3.3 Preparation of aramid polymer (#5)

For the production of Aramid Polymer (Polyphenylene terephthalamide; PPTA) terephthaloyl dichloride (TDC) is used as one of the monomers. In the production of TDC from terephthalic acid and bis(trichloromethyl)benzene – the chlorination product of p-xylene – carbon tetrachloride (CTC) is used as an auxiliary component. There are many requirements for the use of an auxiliary component in this process. Despite the extensive research over a number of years, no alternative component has been found that satisfactorily fulfills these requirements and can replace CTC. Furthermore, even if such a component might be found, the process will still not be CTC-free because CTC is generated in small amounts during the process that produces TDC. CTC used as auxiliary component and generated CTC is recycled in the process. For example, in the last process step CTC is removed from the final product and recycled. Despite all research no substitute meets the requirements on inertness in the first chemical reaction, the physical properties in the separation section, flammability, minimization of by-products in first and second chemical step and separation. As a process agent, CTC satisfies criteria (i), (ii), (vi) and (vii).

Besides extensive research on finding a substitute for CTC, an alternative process has been studied. This process involves treating terephthalic acid with phosgene, with a catalyst, to convert it directly into TDC. There are several disadvantages of the process. For instance: extreme safety measures have to be taken for using phosgene, and the use of DMF as catalyst causes the formation of a carcinogenic substance. A further disadvantage is that CTC is formed in the production of phosgene from chlorine and carbon monoxide, and carried through into the production of TDC.

3.3.4 Photochemical synthesis of polymer precursors (#7)

The process involves the reaction of tetrafluoroethylene (CF_2=CF_2) with oxygen under ultraviolet irradiation at low temperature, as described in US Patent #4,451,646 (1984). A solvent is required that can resist the extreme conditions and reactive chemical species involved. Fluorocarbon and chlorofluorocarbon solvents meet this criterion and CFC-12 is used in the particular case listed in Table X/14. The product of the reaction is polymeric, with –CF_2-CF_2-O- and -CF_2-O- units, some of which are linked by peroxide –O-O- units. The polymer chains have highly reactive –CO-F (carbonyl fluoride) end groups. This use of ODS as process agent meets criteria (i), (vi) and (vii).

3.3.5 Preparation of polyfluoroether diols with high functionality (#8)

The products of the previous reaction are modified by (a) reducing the in-chain peroxide groups and (b) reducing the end groups to –CH_2OH and attaching to them short- and medium-chain polyethers. Such products are used as high-performance lubricants for magnetic disk drives, as described in data sheets made available by the manufacturer at www.solvaysolexis.com. This process agent use meets criteria (i) and (iv) and (vi).

3.3.6 Bromination of a styrenic polymer (#13)

The US advises that bromochloromethane (BCM) is still used in this process agent application, and that emissions in 2011 were 2 ODP-MT. Emissions are minimized by measures such as the use of a pump instead of pressure transfer when placing BCM in storage tanks and by use of equalization lines between feed and receiver tanks to reduce emissions by vapour displacement. Because BCM is classified as a volatile organic compound (VOC) it is subject to regulation under the US Clean Air Act and control technologies such as activated carbon beds are used to control emissions.

3.3.7 Data tables

Data reported by Parties to UNEP are shown in the following tables, to which explanatory comments are appended.

Table 3-2: Process agent emissions and make-up 2011 (MT)

No.	ODS	Process	Country	Makeup	Emission	Note
1	CTC	Elimination of NCl_3 in chlor-alkali production	Colombia			1
			EU (France, Portugal)	27.75	0.174	
			USA			2
			Israel			
2	CTC	Chlorine recovery by tail gas absorption in chlor-alkali production	EU (France)	125.185	5.175	
			Mexico			
			USA			2
3	CTC	Production of chlorinated rubber	EU (Germany)	12.04	0.293	
4	CTC	Production of chloro-sulfonated polyolefin (CSM)	China	179.92	(179.2)	
			USA			3
5	CTC	Production of aramid polymer (PPTA)	EU (Netherlands)	0	0.148	
6	CFC-11	Production of synthetic fibre sheet	USA			2
7	CFC-12	Photochemical synthesis of perfluoropolyetherperoxide precursors of *Z*-perfluoropolyethers and difunctional derivatives	EU (Italy)	136.198	0.095	
8	CFC-113	Preparation of perfluoropolyether diols with high functionality	EU (Italy)	4.9	0	
9	CTC	Production of cyclodime	EU	648.347	110.543	4
10	CTC	Production of chlorinated polypropene	China			5
11	CTC	Production of chlorinated ethylene vinyl acetate (CEVA)	China			5
12	CTC	Production of methyl isocyanate derivatives	China			5
13	BCM	Bromination of a styrenic polymer	USA			2
14	CFC-113	Production of high modulus polyethylene fibre	USA			2

Note 1: There are no new data because Colombia had previously reported process agent use by Quimpac SA (formerly Prodisal SA) but this will cease when a conversion process (MLF project CUL/PAG/48/INU/66) is completed.

Note 2: Total emissions for all process agent uses in the US are 44.35 ODP weighted MT, well below the maximum emission limit of 181 MT.

Note 3: Chlorosulfonylated polyolefin is no longer produced in the US.

Note 4: The emissions from CTC use in the production of cyclodime are very high and exceed the applicable limit under EU legislation. Unreported emissions by chimney and fugitive emission, taking place over several years, have only recently been identified, and steps are being taken to remedy the situation. However, new abatement measures are unlikely to be fully effective before the end of 2013.

Note 5: These process agent uses have been discontinued, thus they may be removed from Table A.

Table 3-3: Table B of Decision X/14 as amended by Decision XXIII/7 (2011 data)

Party	Make up		Emissions	
	2011 total	Maximum	2011 total	Maximum
EU (MT)	952.42	1085.00	116.427	17.50
US (ODP-MT)			44.35	181

3.4 Feedstocks

3.4.1 Introduction

Carbon tetrachloride (CTC), 1,1,1-trichloroethane (TCA) (also referred to as methyl chloroform), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) and several other examples, all ozone depleting substances, serve as chemical building blocks to other chemicals. They allow incorporation of fluorine atoms into molecule structures and they have been carefully selected as feedstocks in these uses so there are no other technologically and economically viable alternative routes at this time. Such choices involve large investments of capital with plant lifetimes as long as 50 years when properly maintained and upgraded. Their use in chemical reactions provides cost-effective manufacture of materials such as refrigerants, blowing agents, solvents, polymers, pharmaceuticals and agricultural chemicals, to benefit society. As raw materials, they are converted to other products except for *de minimus* residues and emissions. Emissions in feedstock use consist of residual levels in the ultimate products and fugitive leaks in the production, storage and/or transport processes. Significant investments and efforts are spent to handle these feedstocks in a responsible, environmentally sensitive manner.

3.4.2 Montreal Protocol definitions

The Montreal Protocol in Article 1, clause 5, defines Production as follows: “Production means the amount of controlled substances produced, minus the amount destroyed by technologies to be approved by the Parties and minus the amount entirely used as feedstock in the manufacture of other chemicals. The amount recycled and reused is not to be considered as Production.” The nature of feedstock was amplified in Decision VII/30 and although concern was later expressed about emissions of ODS from feedstock uses (Decision X/12) it is usually argued that feedstocks are not controlled by the Montreal Protocol.

3.4.3 How the ODS feedstocks are used

These ODSs can be feedstocks by being fed directly into the process as a raw material stream, as production as an intermediate in the synthesis of another product or as a by-product during manufacture of other desired products. Losses can occur during production, storage, transport, if necessary, and transfers. Intermediates are normally stored and used at the same site and so fugitive leaks are somewhat lower in this case. Extraordinary efforts are made to minimize such losses.

Table 3-3 shows common feedstock applications but is not necessarily exhaustive.

Table 3-3: Common feedstock applications of ozone-depleting substances

Feedstock ODS	Product	Further conversion	Comments
HCFC-21	HCFC-225		Product used as solvent.
CFC-113	Chlorotrifluoro-ethylene	Polymerized to poly-chlorotrifluoroethylene	Barrier film in moisture-resistant packaging.
CFC-114a	HFC-134a		The sequence for production of this refrigerant gas may begin with CFC-113, which is converted to CFC-113a and thence to CFC-114a.
CFC-113 and -113a	HFC-134a and HFC-125		Very high-volume use.
HCFC-22	Tetrafluoroethylene	Polymerized to homopolymer (PTFE) and also co-polymers	Very high-volume use. Work has been done for decades to find an alternative commercial route, but without success.
1,1,1-trichloroethane	HCFC-141b and -142b		Continues until 2030, with phaseout of HCFC-141b preceding HCFC-142b. Note alternative feedstock 1,1,-dichloroethylene (vinylidene chloride) that is not an ODS.
HCFC-142b	Vinylidene fluoride	Polymerized to poly-vinylidene fluoride or co-polymers.	Products are specialty elastomers, likely to have continuing uses and thus continuing feedstock use of 142b.
CTC	CFC-11 and CFC-12		Production and consumption of these CFCs, and thus this feedstock use, have fallen to very low levels.
CTC	Chlorocarbons	Feedstock for production of HFC-245fa and new HFOs.	HFOs have zero ODP and ultra-low GWP.
CTC with 2-chloropropene	Intermediates	Production of HFC-365mfc	
CTC with vinylidene fluoride	HFC-236fa		Production of close to 1 million pounds annually.
HCFC-123, HFC-123a, HFC-133a and Halon-1301	Production of pharmaceuticals		
HCFC-123	HFC-125		This is a possible route but CTOC does not know of current application.
HFC-124	HFC-125		
CTC	Intermediates Production of vinyl chloride monomer (VCM)	Pyrethroid pesticides.	CCl_3 groups in molecules of intermediates become $=CCl_2$ groups in pyrethroids.

The CTOC has received a listing of more than 50 examples of feedstock uses just in the EU. Many are small in nature for very specific niche manufacture in addition to the major uses cited above. Based on this list, the EU estimates annual use of between 100,000 and 200,000 tonnes of ODSs as feedstocks in that region. The estimated annual use in China is about 200,000 tonnes, with quantities HCFC-22>CTC>other ODS.

3.4.4 Estimated emissions of ODS

Data have been received from the Ozone Secretariat reporting production, import and export of ODS used as feedstocks for the year 2011. These also include volumes used as process agents as Parties are directed to report such consumption in a manner consistent to what is done for feedstocks. Detailed information can be found in the spreadsheet provided by UNEP as an attachment. Total production for feedstock uses was 1,093,935 tonnes and represents a total of 414,291 ODP tonnes.

Estimation of emissions is an inexact science. Sophistication of the operating entity can heavily influence emission amounts. Highly automated, tight and well instrumented facilities with proper procedures closely observed can have emission levels as low as 0.1% of the amount used as feedstock. On the other extreme would be batch processes of limited scale with less tight and less concern for operational excellence can have emission levels up to 5%. The largest volumes of feedstock use are at the lower end of the scale as large capacity plants have the most investment and are able to control emission levels well. The IPCC guideline for HFC plants of 0.5% of feedstock is used to generate guidance levels of feedstock emissions. Based on using this guidance figure, the total emissions associated with feedstock and process agent use was approximately 5470 tonnes or 2071 ODP tonnes.

3.4.5 Industry effort to minimize emissions

Major producers in both developed and developing countries have shown respect and responsible treatment of hazardous materials routinely used in chemical manufacture. This can be to manage safety concerns such as highly toxic substances or flammable/explosive materials or highly corrosive materials. Some of this occurs in preparation of fluorochemicals. The additional concern with fluorochemicals is that leakage can adversely impact the ozone layer and/or contribute to global warming due to frequently high GWP of fluorochemicals. As such, efforts are made to keep equipment tight and practices put in place to keep these to the lowest levels possible.

Organized efforts to minimize emissions have been shared by members of the Global Fluorochemicals Producers' Forum (GFPF), an organization of major fluorochemicals manufacturers worldwide. These measures are outlined in their brochure, Fluorochemical Producers' Responsible Use Guide, cosponsored by the GFPF, The Alliance for Responsible Atmospheric Policy, the European Fluorochemical Technology Committee (EFCTC) and the US EPA. Process emissions are limited through use of welded pipe whenever possible to limit potential leak points, use seal-less pumps when possible, recover all process samples, minimize waste during startups and shutdowns, empty all lines and equipment before maintenance by use of vacuum recovery systems and routinely calibrate instrumentation.

In storage and handling, fluorochemicals are stored in appropriately designed pressure vessels, relief valves and rupture discs are used with equalization lines for closed loop transfers (no atmospheric emissions). In discussions the author has had with leading major fluorochemical producers, it is common practice for sequential use of both a rupture disk and relief valve to protect the long term integrity of the valve seats in relief valves from corrosion. All vent gases from bulk containers are recovered.

'Producers are also subject to regulations that apply in their areas of operation. In the US this includes OSHA, RCRA, Clean Air Regulations, TSCA, and FIFRA; in the EU, REACH, IPCC and the F-gas regulation; in Japan, Fluorochemical Recovery and Destruction, recycling of end-of-life vehicles and home appliances with respect to the fluorochemicals they may contain, and the Chemical Substances Control law (CSCL). In short, this industry is held to high standards on many fronts, and accordingly acts to avoid incidents and minimize adverse environmental impacts.

Emissions can be minimized by having tight equipment, monitoring equipment allowing for detection of leaking material, strict procedures that call for rapid repair when leaks are detected, and procedures to evacuate, recover and reuse chemical from all lines prior to opening for servicing. Further, all transfers should be done on a closed loop basis with no venting of tanks or lines to the environment. All process vents should go to scrubbing/destruction devices to avoid leakage to the atmosphere. These are usually thermal oxidizers, plasma arc destruction units or activated carbon beds which capture would be fluorochemicals emissions. The CTOC notes that in China, steps are taken to minimize emissions by generating the ODS in close proximity to the facility where it is used as feedstock (line-to-line arrangement) so that transportation emissions are minimized.

Table 3-4: Data on Feedstocks for the Year 2011

			Feedstock by Compound					
Annex			Production for Feedstock Uses	Imports for Feedstock Uses	Exports for Feedstock Uses	Production for Feedstock Uses	Imports for Feedstock Uses	Exports for Feedstock Uses
Group	Substance	ODP	(MT)	(MT)	(MT)	(ODP Tonnes)	(ODP Tonnes)	(ODP Tonnes)
AI	CFC-12	1	0	0	12	0	0	12
AI	CFC-113	0.8	123310	1964	589	98648	1571	471
AI	CFC-114	1	61885	0	0	61885	0	0
AII	HALON-1301	10	483	0	0	4830	0	0
AII	HALON-2402	6	0	0	0	0	0	0
BI	CFC-112	1	0	0	0	0	0	0
BI	CFC-217	1	0	0	0	0	0	0
BII	CTC	1.1	182625	616	496	200888	678	546
BIII	Methyl Chloroform	0.1	110927	0	0	11093	0	0
CI	HCFC-22	0.055	449616	33482	28222	24729	1842	1552
CI	HCFC-122	0.08	0	0	0	0	0	0
CI	HCFC-123	0.02	1982	3681	3616	40	74	72
CI	HCFC-124	0.022	35638	0	21	784	0	0
CI	HCFC-133	0.06	0	0	0	0	0	0
CI	HCFC-141b	0.11	17834	0	1	1962	0	0
CI	HCFC-142b	0.065	105342	2798	2868	6847	182	186
CI	HCFC-235	0.52	0	0	0	0	0	0
CII	HBFC-22 B1	0.74	72	0	0	53	0	0
CII	HBFC-31 B1	0.73	0.3	0.1	0	0	0	0
CIII	HALON-1011	0.12	0	0	0	0	0	0
EI	Methyl Bromide	0.6	4221	444	478	2533	266	287
Totals			**1093935.3**	**42985.1**	**36303**	**414291**	**4612**	**3127**
Mismatch between Imports and Exports				**84%**	**118%**		**68%**	**147%**

3.5 n-Propyl bromide update

For some years the CTOC has been reporting, on the one hand, the lack of data on production and consumption of nPB and, on the other hand, the growing concern over workplace toxicity of this substance. The American Conference of Governmental Industrial Hygienists (ACGIH®) has under consideration a reduction of the TLV® for n-propyl bromide from 10 ppm to 0.1 ppm. The U.S. EPA SNAP office has proposed to make n-propyl bromide "unacceptable" for the aerosol solvent sector and for the adhesive carrier solvent sector (August 2010). As reported earlier, a European distributor has indicated that n-propyl bromide was pre-registered for REACH and will be registered in the future, at which time usage data for Europe should become available. Production in the EU 2009-2011 was between 1000 and 10,000 tonnes/year; imports 250-750 tonnes/year; and exports 500-2000 tonnes/year. About 2/3 of consumption in the EU was for solvent use and the remainder for feedstock.

One reason for the growth in the use of nPB as a solvent was the phase-out of 1,1,1-trichloroethane (methyl chloroform, TCA) under the Montreal Protocol. If exposure of workers to nPB is restricted on OHS grounds, then specialized containment systems will be needed or other solvents must be found

3.6 CTC involvement in production of vinyl chloride monomer (VCM)

3.6.1 Introduction

The CTOC reported in 2012 on its appraisal of the use of carbon tetrachloride (CTC) in production of vinyl chloride monomer from ethylene dichloride (1,2-dichloroethane, EDC) by pyrolysis. Two examples of this processes were examined, one in India and one in Europe, and in both cases it was established that this was a feedstock use. This assessment was endorsed by the parties in Decision XXIV/6(3).

After the 2012 CTOC report had become public, information was received from the United States about the role played by CTC in production of VCM in that country. CTC is not added at any stage in the process, but some CTC is formed during production of ethylene dichloride (EDC) from ethylene by the oxychlorination route. While traces of CTC in the EDC can be helpful in the formation if VCM by pyrolysis, the presence of CTC accelerates deterioration of the pyrolysis reaction vessel, and so the CTC is removed prior to this step, being either destroyed or (on account of its chlorine content) used as feedstock for production of HCl or other chemical substances.

3.7 Essential Use Nomination of CFC-113 for Aerospace Industries by the Russian Federation

3.7.1 Introduction

For several years the Russian Federation has been granted an Essential Use Exemption for the use of CFC-113 in their domestic space program while research was conducted to identify suitable solvents that would not damage some components of the rocket guidance systems that were not resistant to common solvents. After the Russian Federation explained the delay in its phase down schedule, Decision XXIV/4 approved an essential use exemption of 95 metric tonnes of CFC-113 in 2013 for applications in the missile and aerospace industries in the Russian Federation. This resulted from the TEAP/CTOC findings that no appropriate alternatives to CFC-113 currently exists for its use in the aerospace industries in the Russian Federation and that the search for its alternatives continues, as confirmed in the TEAP May 2012 Progress Report Vol.1 (p36-37). The 2012 decision also requested the Russian Federation to provide as part of its next essential-use exemption nomination a final phase-out plan with an expected end-date, and the gradual reduction steps.

On 27 December 2012, The Ministry of National Resources and Environment of the Russian Federation sent a new request for an Essential Use Exemption for 85 metric tonnes of CFC-113 for manufacturing the missile and space equipments in the year 2014 to the Ozone Secretariat.

3.7.2 CTOC Comments on EUN for CFC-113 in 2014 by the Russian Federation

The Russian Federation had been successful in reducing the annual consumption of CFC-113 in the missile and space industry from 241 metric tonnes in 2001 to 95 metric tonnes in 2013. The new request by the Russian Federation for an Essential Use Exemption for 85 metric tonnes of CFC-113 in the year 2014, which is 10 metric tonnes lower than the approved volume for 2013, describes and explains in detail why this application is urgent for health and safety or vital for society; what efforts have been made to investigate currently available alternatives, and why they are insufficient or unsuitable for the purpose. Efforts to minimize the emissions of CFC-113 are also described.

The Russian Federation’s new nomination satisfies, in principle, the following criteria to qualify as “Essential” under the decision IV/25.

1. It is necessary for the health, safety or critical for the functioning of the society.
2. There are no available technically and economically feasible alternatives or substitutes that are acceptable from the standpoint of environment and health.
3. An action has been attempted to minimize emission of CFC-113.

The Russian Federation still needs CFC-113 for solvent application in this aerospace sector, and quality the imported product would not meet their strict requirements. Efforts have been made to accelerate the ODS phase out process, and the expected end-date (2016) is mentioned in the EUN. This relies, however, on the alternative solvents being available in the international market and not prohibited by Montreal Protocol documents.

The Russian Federation EUN describes that RC-316c earlier considered as a possible alternative to CFC-113 has been discarded because its ODP had been estimated by experts to be about 0.5. A number of other non-ODS are being tested currently. The main CFC- 113 replacement now being introduced is HCFC-141b, which it is intended to be a transitional substance to be used before HCFC phaseout deadline. New products are being developed all the time, and it is possible that other solvents will be found suitable as investigations continue. The Russian federation is aware that good quality CFC-113 could be available for export from stocks held in other countries.

3.7.3 Conclusion

The CTOC acknowledged the research and development work by Russian Federation to reduce essential use of CFC-113. However, it must be underlined that all HCFCs with their non-zero ODPs should be considered as temporary ODS alternatives only, and CTOC recommends further investigation in this area.

After careful review and detailed discussion, the CTOC recommends the Essential Use Exemptions for 85 metric tonnes of CFC-113 in 2014 for the Russian Federation.

3.8 Alternatives to the use of CTC in laboratory and analytical applications

3.8.1 Introduction

No new standard methods using alternatives to CTC in analytical procedures have been reported in the last year.

3.8.2 Alternatives to carbon tetrachloride in a significant laboratory use

CTOC has reported, for almost a decade, that carbon tetrachloride (CTC) is the only solvent suitable for use in certain reactions of organic chemicals, notably bromination reactions involving N-bromosuccinimide (NBS). However, recently published data shows that an alternative solvent, α,α,α-trifluorotoluene (trifluorotoluene, benzotrifluoride) is a suitable replacement for CTC, and an extensive search of the research literature has revealed that although conventional wisdom among organic chemists holds that CTC is the only suitable solvent, a number of other solvents than have been used with success in NBS reactions.

The use of trifluorotoluene a solvent was first described by Ogawa and Curran ('Benzotrifluoride: a useful alternative solvent for organic reactions currently conducted in dichloromethane and related solvents', *Journal of Organic Chemistry*, 1997, **62**, 450-451) but this was not applied to NBS reactions for over a decade. Staples *et al*. (*Organic & Biomolecular Chemistry*, 2011, **9**, 473-479) showed that trifluorotoluene could be used as an alternative to CTC in bromination reactions, and such use is also mentioned by other authors (C. Easton, *et al.*, *Organic & Biomolecular Chemistry*, 2003, **1**, 2492-2498; Crich and Banerjee, *Journal of Organic Chemistry*, 2006, **71**, 7106-7109) and described in US Patents #6573379 (2003) and #6492517 (2002).

Further investigation of the research literature showed that there was an extensive history of searching for alternative solvents for use in bromination reactions by NBS. The bromination reagent N-bromosuccinimide was introduced to organic chemistry only in 1942, with reactions being conducted in CTC as solvent. A few years later a major review (Carl Djerassi, 'Brominations with N-bromosuccinimide and related compounds', *Chemical Reviews*, 1948, **43**, 470-474) explored the suitability of various solvents in which the reaction could be carried out, and found that satisfactory results had been achieved with benzene or chloroform as solvent. A later investigation (W. Offermann and F. Vögtle, 'Brominations with N-bromosuccinimide: solvent selectivity', *Angewandte Chemie International Edition in English*, 1980, **19**, 464-465) compared CTC with other solvents and reported that the best results were obtained with methyl formate or dichloromethane, with some other solvents also giving satisfactory results. Some later researchers used methyl formate (D.M. Tal and S.J.D. Karlish, *Tetrahedron*, 1995, 51, 3823-3830) while others used the related substances (R. Mestres and J. Palensuela, *Green Chemistry*, 2002, **4**, 314) including methyl acetate (Amijs *et al*. *Green Chemistry*, 2003, **5**, 470-474), all with success.

Consulted by CTOC, one researcher who is active in this field (Easton, private communication) indicated that isolation of products from reaction mixtures was easier when CTC was the solvent than when trifluorotoluene was used, but that the alternative solvent was in other respects quite satisfactory. According to catalogue information, the cost of trifluorotoluene and carbon tetrachloride in laboratory quantities of comparable purity is similar.

In view of the alternatives to CTC that could be used in all or most brominations reactions involving NBS, CTOC wishes to bring this information to the attention of Parties with a view to organic chemists using CTC in their jurisdictions being advised that suitable alternatives are generally available. Prices for the two substances, of suitable quality for solvent use, are comparable and the trifluorotoluene is not subject to restrictions that caused the removal of CTC from a number of chemical supplier's catalogues.

3.8.3 Surface area determination of activated carbon

The use of a hydrocarbon such as butane, as replacement for CTC in measurement of the surface area of activated carbon – in particular that derived from coconut husks – was brought to the attention of ozone officers in the South Asia and Asia pacific regions in 2010 and details were included in the CTOC report of 2011. An alternative ASTM method had been developed (ASTM D5228 – 92(2005), together with a correlation table that enabled the analyst to relate values from the butane method to those of the CTC method (ASTM D5742 – 95(2005). This alternative standard method has been adopted by chemists in Sri Lanka, and developed further so that inexpensive liquefied petroleum gas (LPG) – a mixture of low-boiling hydrocarbons, mainly propane and butane - can be used in place of the more expensive laboratory-grade butane. Information on this adaptation has been provided by Sri Lanka to producers in other countries of the South Asian and Asia-Pacific regions, and it will be adopted there, also.

3.8.4 Alternatives to the use of CTC and TCA in laboratory and analytical applications

It is possible that many A(5) countries have incomplete knowledge of the use of CTC and TCA in their laboratories and that as a consequence reporting of solvent uses of small quantities of these ozone-depleting substances is incomplete. At the level of laboratory practice, information is needed about the use of available alternatives, and new norms need to be adopted in many countries so that ODS are no longer employed in this way. CTOC is aware that this will be the subject of discussion with Ozone officers from the Asia and Pacific regions at a workshop to be held in Australia in May. Awareness-raising workshops and demonstration projects might also assist in achieving transition away from ODS in analytical applications.

3.9 Carbon tetrachloride in the atmosphere

TOC has reported for a number of years on the discrepancy between emissions of CTC to the atmosphere based on 'bottom up' estimates based on production and consumption and typical emission rates, and 'top down' estimates based on stratospheric concentrations of CTC and estimates of its atmospheric lifetime.

The status of these estimates and continuing discrepancy of approximately 40 ggram/year was detailed in the 2012 Progress Report, during which attention was drawn to the possibly contribution to 'bottom up' estimates of diffused emissions, often from legacy contaminated sites. The Scientific Assessment Panel, during 2012, took note of this advice from CTOC and agreed to investigate more fully.

The Scientific Assessment Panel also advised the parties that they had revised the atmospheric lifetime for CTC, increasing the value substantially. 'Top down' estimates thus give lower emission rates, by 10-20 ggram/year, to maintain the observed stratospheric concentration of CTC. Diffuse emissions could contribute 8-12 ggram/year, and together these figures significantly reduce the discrepancy between the two types of estimate by as much as 18-32 ggram/year. Refined values for both figures are expected to be reported by the SAP in the first half of 2013.

The gap between the two estimates of emissions has thus been reduced but not entirely closed.

CTOC has become aware that historically there may have been previously unreported or under-estimated emissions of CTC connected with the use of phosgene, for example in the production of methylene diphenyl di-isocyanate (MDI), a reactive substance that is used to make polyurethanes. As mentioned in Section 7.2.3 (above), phosgene produced from chlorine and carbon monoxide is usually contaminated with CTC, the presence of which may not be taken into account when emissions are taken into account. One European facility experiencing high CTC emissions (see Table 7.2.2, footnote 4) is known to have commenced incineration of tail gases so as to prevent emissions of CTC to the environment.

3.10 Solvents

The development of new solvents is discussed in detail in the report of the Task Force responding to Decision XXIV/7, but the major trend is the introduction of substances with unsaturated molecules and thus short atmospheric lifetimes, zero ODP and low GWP. Such substances are expected to replace HCFCs in a number of uses and also to compete with hydrofluoro-ethers (HFEs) in the solvent sector. The main groups of new substancesare unsaturated HFCs (HFOs) and unsaturated HCFCs (HCFOs). In the former category are the by now well know HFC-1234yf and HFC-1234ze.

A recent development is the production of HCFC-1233zd (CF_3-CH=CH-Cl, *trans* isomer). This substance has boiling point 19^{o}C and useful solvency properties.

4 2013 Foams TOC Progress Report

This chapter provides a short summary of the main highlights in the foam sector arising since the 2012 Progress Report. The response to Decision XXIV/7 covers a more detailed update on available alternatives, the barriers to their introduction and the environmental consequences of their selection. The key messages are as follows:

4.1 Emerging blowing agent technologies and market penetration

- New product development continues to be focused on unsaturated HCFCs and HFCs. Extended commercial trials have continued to reinforce earlier observations related to improved energy efficiency – a matter of particular importance in the refrigeration sector, especially in appliances.
- At least one gaseous unsaturated HCFC/HFC is already commercially available. Most others, including several liquid blowing agents, are becoming commercially available in the period from late 2013 through to the end of 2015.
- Methyl formate and, to a lesser extent, methylal have been taken up for a select number of integral skin, flexible moulded and rigid foam applications in Article 5 countries.
- Hydrocarbons continue to be the dominant technology and the main choice for replacing HCFC-141b where safety issues can be managed and cost-effectiveness criteria met. Enterprises in Article 5 countries are choosing to co-fund transitions in some instances in order to overcome investment thresholds.
- Other blowing agent options include hydrocarbon/unsaturated HCFC/HFC blends, reduced unsaturated HCFC/HFC systems and water improved formulations.

4.2 Transitional progress, market pressures and the effect of regulation

- The on-going use of saturated HFCs in non-Article 5 countries continues to attract attention and there are increasing risks of product de-selection.
- The pending re-cast of the F-Gas Regulation in Europe also has the potential to increase pressure on the use of saturated HFCs in foams with the main challenges being faced by the extruded polystyrene and PU Spray sectors
- Article 5 countries are fully concentrating their efforts on the first-phase implementation of their respective HPMPs, which focus particularly on the phase-out of HCFC-141b. Although the adoption of saturated HFCs is discouraged, there are some situations where short-term uptake can provide a bridge to more sustainable longer-term options.
- Although the use of hydrocarbons in non-Article 5 countries has been widely encouraged in the past, there are now some jurisdictions where manufacturing plants are coming under increasing pressure from local regulations on Volatile Organic Compound regulations.
- Additionally, in China, the future use of hydrocarbon blowing agents is coming under pressure, particularly for extruded polystyrene technologies as a result of the more stringent application of fire codes.
- Work continues on the evaluation of regulatory options for the management of ODS banks with fledgling carbon markets emerging in California and elsewhere. In other regions, waste classification approaches are having some limited success, but there are very few jurisdictions where any form of mandatory approach has been adopted outside of the domestic appliance sector.

5 2013 Halons TOC (HTOC) Progress Report

The Halons Technical Options Committee (HTOC) met from the 18th -20th February, 2013 in Pisa, Italy. Attending members were from Canada, India, Italy, Kuwait, Japan, Romania, Russia, United Kingdom, United States of America, and Venezuela. Owing to visa problems, our member from Jordan was unable to attend.

The following is the HTOC update for 2013.

5.1 Alternative Agents

Testing of the new alternative agents and technologies mentioned in the 2010 HTOC Assessment Report continues.

Toxicology testing of the unsaturated hydrobromofluorocarbon (HBFC) 3,3,3-trifluoro-2-bromo-prop-1-ene for use as a halon 1211 replacement in the aviation industry is at an advanced stage. It is anticipated that an application for an acceptability listing under the United States Environmental Protection Agency Significant New Alternatives Policy (SNAP) program will be made before the end of 2013. With values for ODP of 0.005 and 100-year GWP of 0.003, expectations are high that this agent will meet the requirements of the aviation industry as well as other industries requiring a clean agent portable extinguisher.

Another alternative for halon 1211, FK–6–1–14, C7 fluoro-ketone blend, is currently under review for use as a streaming agent in non-residential applications. This substitute is a blend of two C7 isomers:

3-Pentanone, 1,1,1,2,4,5,5,5-octafluoro-2,4-bis(trifluoromethyl)- 813-44-5 (55-65%)

3-Hexanone, 1,1,1,2,4,4,5,5,6,6,6-undecafluoro-2-(trifluoromethyl)- 813-45-6 (35-45%)

A product approval program is yet to be completed.

A chemical producer reports that significant progress has been made on a new, but as yet undisclosed, chemical agent for total flooding applications. Physical, toxicological, and fire extinguishing properties are not yet published, but laboratory testing has confirmed agent minimum design concentrations for typical applications well below the typical human exposure limit parameters currently in use. The chemical producer is pursuing additional fire suppression testing and agent property evaluations in order to establish the efficacy and approval of the agent under national and international standards.

5.2 Halon 1301 Use as a Feedstock

Halon 1301 (CF_3Br) continues to be produced in China and France for use as a feedstock in the manufacture of the pesticide Fipronil. Current production data in France and in China have not been made available to the HTOC.

5.3 Halon Recovery and Recycling in Article 5 Countries

The 2010 HTOC Assessment Report stated that halon recycling and banking in the Middle East was problematic, and that continues to be the case. It has been reported that in the region, decommissioned halons are stored rather than recycled and their condition is unknown. There is a reluctance to sell the halon because recycling costs are high - owing to low throughput. Recycling equipment exists in the region, but at two companies they are not in use. The export of halons from some Parties is prohibited by law, thus unwanted halons cannot be transferred out of the country even for destruction. Recycling companies believe that some regulatory assistance is needed to resolve the situation.
In South Africa (SA), towards the end of 2012, difficulties were encountered with the recycling equipment provided in 2003 by Proklima, in that equipment failures were occurring with some

replacement parts not readily available. It appears that the equipment is reaching a life-cycle stage where maintenance costs are high and parts replacement feasibility is doubtful.

There has been a reduction in the quantity of halons being returned to the SA Bank - less than 1 tonne in 2012 - and the Bank's equipment operator reports that most halon 1301 stock on hand or received fails the initial purity meter test. The operator suspects the contamination of halon 1301 is due mainly to halon 1211, but simple attempts to remove the contamination by distillation have not been successful.

A review of the halon 1301 stock inventory in the SA Bank indicates that the amount of stock suitable for refilling has become insufficient for critical uses such as the refilling of aircraft protection systems.

5.4 Progress in Replacing Halon 2402

Halon 2402 is no longer used in a “fire suppressive” paint product in Russia with the halon being replaced by C3F7I or a mixture of HFCs.

Despite expectations that the demand for halon 2402 would increase in the Russian military sector, information for 2011-2012 shows no increase in demand. This suggests that alternative agents are now being used instead of halon 2402 in some military applications.

In the Indian civil sector, neither halon 2402 nor its blends have been used in fire protection systems or portable fire extinguishers for the past 5 years. Floating roof tank systems have been replaced by AFFF flooding systems.

In the Indian military sector, halon 2402 or its blends with CO_2 and ethyl bromide have been used by all three services, Army, Navy and Air Force, for various applications. However, the military is gradually shifting to alternatives where technically feasible. In some critical applications where a halon is still required, the military is switching to halon 1211 or halon 1301 to maintain the systems.

In both sectors, portable extinguishers have switched to ABC powder, CO_2 or halon 1211. Alternatives such as HFC-236fa are under evaluation.

Some halon 2402 is being recovered from ship breaking (about 2/3 MT/annum) and is available for users or export, but no recycling or reclamation is taking place in India. No demand has been reported for at least a year.

5.5 Update on the Response to Decision XXI/7

The HTOC continues to work with the International Civil Aviation Organization (ICAO) regarding the phase-out of the use of halons on new aircraft. An HTOC representative attended the latest stakeholders meeting held in November 2012, where it was reported that the engine nacelle tests of two different halon alternatives failed. At this time, no commercial airline manufacturer has an acceptable alternative to halons for engine nacelles. Some militaries have used HFC-125 successfully, but the commercial aircraft manufacturers are concerned about a transition to a high GWP alternative. The HTOC is continuing to follow the matter to determine if the failures of these no/low-GWP alternatives are deemed permanent and to determine how the industry plans to meet the 2014 phase-out of halons in engine nacelles on new aircraft designs. The HTOC continues to work with ICAO to place before their General Assembly meeting in September 2013, a requirement for them to report back to their General Assembly in 2016 on the timeframe for the replacement of halon in cargo compartments on new aircraft designs. The anticipated date would likely be in the 2020 timeframe. In addition, the HTOC continues to work with ICAO to determine the stocks of halon held by the aviation sector.

5.6 Portable Extinguishers In Article 5 Countries

There is growing concern regarding the introduction of some clean agent portable extinguishers in South America and Asia that appear not to be rated by internationally recognized testing laboratories. In particular, extinguishers using HFC-125 have been reported to be in wide use in Colombia, and those using HCFC-123 in the Philippines. Of major concern is that at least one manufacturer in the Philippines is offering to convert extinguishers by removing the dry chemical from the extinguisher and replacing it with HCFC-123. It is this kind of activity that has the potential to result in extinguishers that give a false sense of security as they will likely not perform to internationally accepted fire ratings (e.g., may not put out some fires). Also, this practice can lead to contaminated agents.

5.7 HTOC Membership

In accordance with Decision XXIII/10, in 2012 two HTOC co-chairs and a member from Jordan were re-nominated for 4-year periods, and two new non Article 5 members with expertise in various aspects of aviation fire protection were added. A member from Venezuela has indicated that he plans to retire and not seek re-nomination. However, he is looking for a suitable replacement from his region. During 2013, the HTOC plans to seek the re-nomination of seven members and a co-chair. The re-nomination of the remaining members will be sought in 2014.

The HTOC is currently seeking experts with military fire protection experience in the European and Article 5 sectors, and also Article 5 experts with experience in various aspects of aviation fire protection. Recently, Brazil has nominated, and the HTOC co-chairs have appointed an aviation fire protection expert from a Brazilian aircraft manufacturer.

6 2013 Refrigeration, AC and Heat Pumps TOC (RTOC) Progress Report

The Refrigeration TOC met in Gaitherdsburg, MD, USA in October 2012 (back to back with the ASHRAE / NIST Conference) to continue discussions on membership and on outline and drafts for the RTOC 2014 Assessment report. The meeting draw conclusions on membership and meeting schedules; the TOC will meet again in May 2013 to discuss first order drafts of the chapters for the RTOC 2014 Assessment.

6.1 Sector technology updates

The RTOC Progress Report is presented following the chapter subdivision of the RTOC 2010 Assessment report in the subchapters 6.2-6.10. The different subchapters below were drafted by the RTOC Chapter Lead Authors (see TEAP and TOC membership lists), reviewed, re-drafted and once more reviewed for consistency. In the sections below, one will find an update on progress per sub-sector the way they are addressed in the RTOC assessment reports.

6.2 Refrigerants

More than 14 new refrigerants (most of them blends) were commercialized for use either in new equipment or as service fluids (to maintain or convert existing equipment) since the 2010 assessment report. Eight refrigerants (including some of those newly commercialized) obtained and an additional four are undergoing public review for standardized designations and safety classifications through a consensus process. More than 20 previously classified refrigerants have received revised classifications predicated on new data and/or changes in classification criteria.

As manifested by the new refrigerant (including blends) compositions, focus continues on both HFCs and non halogenated candidates, with emphasis on those having practically no ozone depletion potential (ODP) and low or very low global warming potential (GWP). Additional refrigerants, including blend components, still are being developed to enable completion of scheduled phase-outs of ozone-depleting substances (ODSs). As for the 2010 assessment, the shift in development efforts forces more attention than in the past on flammable – primarily low-flammability – candidates. The industry and governments are formulating recommended measures to facilitate such use with particular emphasis on refrigerants classified as A2L (lower degree of toxicity, lower flammability and heat of combustion, and the low burning velocity – all predicated on prescribed criteria), a new safety classification. One such refrigerant, R-32, previously widely used almost exclusively as a blend component, is undergoing further scrutiny as a single-compound refrigerant to replace widely-used R-410A, as the primary replacement for HCFC-22 and of which R-32 it is a component with 50% share by mass.

Considerable effort continues for examination of broader use of ammonia (NH_3, R-717), carbon dioxide (CO_2, R-744), and hydrocarbons (HCs) as well as of blends of them or them with low-GWP HFCs.

A cooperative industry program to evaluate new refrigerants has disclosed the 40 refrigerants included in testing, 32 of them not yet having standardized designations and safety classifications. The primary components are saturated and unsaturated HFCs, though some also included non-halogenated blend components.

Additional research seeks to increase and improve the physical, safety, and environmental data for refrigerants, to enable screening, and to optimize equipment performance. Likewise, research continues to expand the heat transfer, thermophysical, stability, compatibility, and additional engineering data to enable design of efficient, durable, and reliable equipment using them. Recent patent applications suggest heightened attention to inclusion of additives, in both refrigerants and associated lubricants, to stabilize them chemically when in contact both with common materials of construction for internal refrigerant circuits and with contaminants, especially air and moisture. Findings of compatibility studies for both unsaturated HFCs and blends containing them are beginning to emerge, though significant studies are still underway and/or needed

The chapter-update summaries that follow elaborate on progress in evaluation, selection, and introduction of substitute refrigerants for specific applications.

6.3 Domestic Refrigeration

The conversion of new equipment production to the use of non-ODS refrigerants is essentially complete. About half of newly produced units globally now use the refrigerant HC-600a; a more or less similar amount uses HFC-134a. A small percentage of global production uses other regionally available refrigerants such as HC-290/HC-600a mixtures, LPG, HFC-152a etc. New product development focuses on improved energy efficiency with extended usage of upgraded components such as variable speed compressors via frequency control and vacuum insulation panel insulation. Progress slowly continues on product redesign to facilitate transition from HFC-134a to HC-600a in certain countries. Initial developments to assess the HFC-134a replacement by HFC-1234yf have also begun in developed countries.

Regulatory changes continue to facilitate the application of flammable refrigerants in some developed countries. An example of this is the approval of a field service process for recovery of flammable refrigerants by the U.S. EPA. Recovery of all refrigerants during service or disposal of domestic refrigerators is required by the U.S. law. This approval removes a deterrent to the application of flammable refrigerants in the U.S. Similarly, the regulatory consideration of HFC-1234yf has been initiated in the U.S.

CFC emissions from the 150,000 tonnes domestic refrigerant bank are dominated by end-of-life disposal due to the high equipment reliability. Approximately 70% of the current, residual CFCs reside in Article 5 countries.

6.4 Commercial refrigeration

Commercial refrigeration covers a wide variety of equipment, over a wide range of refrigeration capacities, designs and refrigerant choices. According to the type of system, the refrigerant charge varies from some hundreds grams to hundreds of kilograms.

Since the 2012 progress report the available refrigerant options have not really changed. They depend on the equipment size and the levels of evaporation temperature. HFC-134a with a relatively low volumetric capacity is still the preferred choice in small equipment (stand-alone equipment and some condensing units) whereas HCFC-22 or R-404A, with larger refrigeration capacities, are used in large commercial systems but also in smaller systems for freezing applications at present (evaporation at -35°C or lower).

It should be noted, however that HCFC-22 is being phased down in the Article 5 countries and that regulations such as proposed in the European Union might make the R-404A choice as a high GWP candidate not feasible anymore. Especially in Europe, the phase-out of HCFC-22 has been and is associated with an increase in available refrigerant options. Refrigerants as diverse as hydrocarbons (HC-600a and HC-290), R-744, intermediate blends (R-422D or R-427A for drop-in or nearly drop-in replacement of HCFC-22), the usual HFC-134a and R-404A are still, to a certain extent, in competition. Choices very much depend on the emphasis set on GWP, safety and energy efficiency as a HCFC-22 replacement. With more emphasis than before, various new refrigerant options are proposed using HFC-1234yf either as a pure refrigerant or as a component of new blends. It is difficult to actually give any reliable forecast which type of blends would have the best chance on the near future market in commercial refrigeration. The use of indirect systems with significantly lower refrigerant charges (-50 to -75%) is increasing in case of large supermarkets.

Hot climates with high ambient temperatures lead to high condensing temperatures and thus high condensing pressures. Those high pressures and temperatures have several consequences:

- Performances of medium and low temperature commercial systems are 20 to 25% lower in hot climates compared to moderate climates (i.e., lower ambient temperatures) when a conventional system design is used.
- For low-temperature applications (frozen food), the discharge temperatures of compressors are so high that, for HCFC-22, liquid injection has to be used either at a suction port or at an intermediate stage.
- In terms of energy efficiency and reliability the two-stage system (involving carbon dioxide) is the preferred option for low temperature commercial applications as it is in the food industry.

Discharge temperature and pressure constraints in hot climates lead to the choice of "medium pressure" refrigerants such as HFC-134a or HFC-1234yf for single stage systems. Except for HC-290 (where there are charge limitations for large systems due to safety concerns), there is still a lack of low-GWP refrigerants (or blends) with a large enough refrigeration capacity in order to replace R-404A or HCFC-22 in single stage refrigeration systems.

6.5 Large systems

Within the group of large systems there are three distinct segments, i.e., industrial refrigeration, industrial air-conditioning and large heat pumps. The majority of systems in the refrigeration and air-conditioning sectors use R-717 or HCFC-22 (where its use is still permitted). The large heat pump market is divided between R-717 systems, generally using screw or reciprocating compressors, and HFC-134a systems, using centrifugal compressors. R-744 is used in some systems as a cascade or secondary fluid, but is not used in large systems because suitable compressors are not yet available in large sizes.

The acceptance of R-717 as the refrigerant is strongly influenced by national regulations which may restrict where it can be used, limit the amount that can be used in any system, and prescribe the documentation that must be held on the installation and maintenance of the facility. However, it does not imply that a country with complex or strict regulations will necessarily avoid the use of R-717. There are some indications that R-717 is becoming more widely accepted in countries where previously it was difficult to use, for example France and Italy.

Where regulations inhibit the charge of R-717, or where there are other reasons for reducing the quantity on site, cascade systems with R-744 have been implemented, or secondary heat transfer fluids have been used. HFC refrigerants of all types have not been widely adopted, with the exception of HFC-134a in large heat pumps. The cost of the refrigerant is cited as a major impediment. An increase of HFC use in large systems in Europe is unlikely because of concerns about phase-down regulations. In large heat pumps the unsaturated HFC-1234ze(E) has been successfully tested and may replace HFC-134a in the medium term despite the higher cost of the refrigerant.

For Article 5 countries, HCFC-22 was historically the most common refrigerant in places where R-717 was not acceptable. R-717 was frequently seen to be too dangerous or too complicated, and HCFC-22 or R-502 systems were cheaper to construct and safer to maintain. There is therefore a large bank of ODS refrigerants in existing large systems in Article 5 countries and other places where the phase-out of HCFCs for service is not yet complete. Cascade R-744 systems offer a good alternative to HCFCs where a large R-717 system would not be suitable. This could be achieved with a small R-717 charge or an HFC if appropriate. There is a growing realisation that none of the HFCs are a good match for HCFC-22 in large systems because they are less efficient, more expensive, or require larger compressors or higher pressures. Nevertheless, R-717 systems are not universally accepted.

Development over the last twenty years of simple, automatic, low charge systems will help ease the adoption of R-717 systems in Article 5 countries and in places with stricter or more costly regulations. However, in some countries it is likely that a change of the laws will also be required if the cost burden of moving away from ODS refrigerants is to be eased.

6.6 Transport refrigeration

Throughout 2012, the transport refrigeration sector continued to search for and implement steps to reduce the greenhouse gas emissions.

In September 2012, two large manufacturers of transport refrigeration equipment presented concepts of trailer refrigeration units with R-744 at a trade show. One manufacturer continues field testing of refrigerated ISO container units with R-744 for more than a year, and it announced that the solution is feasible. While investigations of various R-744 systems proceeded elsewhere, commercial availability of high pressure components remains limited. In parallel, König and Enkemann are conducting a study to review and overcome barriers to the use of flammable refrigerants. So far they concluded that the use of flammable refrigerants in transport refrigeration is possible, provided that the estimated risks and consequences are acceptable and as safe as with non-flammable refrigerants (König, 2013).

Refrigerant manufacturers are developing low-GWP HFC solutions that are both non-flammable and 2L flammable. An AHRI AREP participant conducted side-by-side “drop in” comparisons of three state-of-the-art low-GWP 2L flammable fluids (GWP’s 200 to 400) presented in January 2013. The evaluation showed that while these 2L flammable fluids did show potential for increased efficiency and capacity to R-404A, they were not suitable for R-404A changeover in service (Kopecka, 2013). The data suggests, however, that existing R-404A hardware and technology could be employed through redesign to accept these refrigerants in new equipment.

A study conducted by the Lloyd’s Register and presented by IMO in July 2012 provided previously missing actual data on the refrigerant charge used aboard various types of vessels (Sillars, 2012). The quantified ozone depleting refrigerants inventory has been in line with our previous estimate.

While discussions are ongoing, the latest drafts of revisions to the EU F-Gas Regulation call for a progressive reduction of HFC supply and a ban of high-GWP refrigerants in transport refrigeration. The only low-GWP options today (cryogenic systems, eutectic panels, indirect R-717 systems) have inherently a limited field of use.

6.7 Air-to-air air conditioners and heat pumps

On a global basis, air conditioners for cooling and heating (including air-to-air heat pumps) ranging in size primarily from 2.0 kW to 35 kW (although in some cases up to 420 kW) comprise a significant segment of the air conditioning market. Nearly all air conditioners and heat pumps manufactured prior to 2000 used HCFC-22 as their working fluid.

Compared to data in the 2010 Assessment, new information is that the installed base of units in 2012 represents an estimated HCFC-22 bank exceeding 1.5 million tonnes. Approximately 75% of the installed population uses HCFC-22. In 2012, the global HFC demand represents approximately 20% of the total refrigerant demand for these categories of products.

Most Article 5 countries are continuing to utilise HCFC-22 as the predominant refrigerant in air conditioning applications, although several major producing countries within Asia, Middle East and South America are now initiating actions to introduce non-ODS alternatives.

The HFC based refrigerant blend R-410A is the dominant alternative used to replace HCFC-22 in air-conditioners. Whilst the use of R-407C in new product designs was common, it is currently decreasing rapidly. HC-290 is also being used to replace HCFC-22 in products having low refrigerant charges. At least one country has introduced HFC-32 and others may follow. R-744 air conditioning is available in some regions. It is possible that HFC-161 may also be used in the future. There are a number of HFC blends (currently without R-number designations) which comprise saturated and unsaturated HFCs; a number of these are currently under evaluation.

Air conditioners using R-410A (and to a lesser extent R-407C) are widely available in most non-Article 5 countries. Moreover, equipment using R-410A is being manufactured in several Article 5 countries. This in particular in China, where a large export market has created demand for these products. However, these R-410A units are not widely sold in the domestic market because of their higher cost.

In addition to the high GWP HFCs (R-410A and R-407C), there are several low and medium GWP alternatives being considered as replacements for HCFC-22 in Article 5 countries. These include HC-290, HC-1270, R-744 as well as HFC-161 (low GWP) and HFC-32 (medium GWP). Current standards restrict the permitted charge of R-744 due to physiological effects. Apart from R-744, these are flammable and should be applied in accordance with appropriate safety standard such as IEC-60335-2-40 or safety codes, which establishes maximum charge amounts and other special construction requirements. In general, most standards limit the system charge quantity of any refrigerant within occupied spaces; however, in most countries the application of such guidelines is voluntary. In some countries, national regulations place controls on flammable refrigerants. Some countries are introducing bans on imports of HFC-containing air conditioners.

HC-290 and HC-1270 have a GWP of 6 and 5, respectively, and are currently considered mainly for systems with smaller charge sizes due to the higher flammability (class 3). The operating pressures and capacities are similar to HCFC-22 and the efficiency is at least as high as HCFC-22. Several manufacturers in China and India are now introducing HC-290 charged split air conditioners.

R-744 has a GWP of 1 but is considered to have limited applicability for air conditioners in Article 5 countries. Whilst R-744 offers a number of desirable properties as a refrigerant, it has a low critical temperature which results in reduced efficiency when the ambient (heat rejection) temperature exceeds the level of about 30°C. There is continuing research on cycle enhancements and components which can help improve the efficiency under such conditions, although they can be detrimental to system cost.

HFC-161 has a GWP of 12 and is currently under evaluation for systems with smaller charge sizes due to its higher flammability (class 3). The operating pressure and capacity is similar to HCFC-22 and the efficiency is at least as high as HCFC-22. HFC-32 has a GWP of 717 and is currently being considered for various types of air conditioners and is recently applied in split units. It has lower flammable refrigerant (class 2/2L). The operating pressure and capacity are similar to R-410A and its efficiency is similar or better than that of R-410A.

Other low GWP single component HFCs, such as HFC-1234yf (GWP=4) and HFC-152a (GWP=133), are unlikely to be used as a replacement for HCFC-22 in air conditioners principally because of their low volumetric refrigerating capacity.

There are various mixtures currently under development specifically for air conditioning applications, which comprise, amongst others, HFC-32, HFC-152a, HFC-161, HFC-1234yf and HFC-1234ze. These mixtures will tend to have operating pressures and capacities similar to HCFC-22 or R-410A, with GWPs ranging from 150 to around 1000 and classes as non-flammable (class 1) for the higher – GWP mixtures and lower flammability (class 2/2L) for the lower- GWP blends. Currently, the above mentioned mixtures are not commercially available and technical data is not in the public domain, however, it is anticipated that they may become available within the next two or three years.

6.8 Water heating heat pumps

Heat pumps are classified by heat source (air, water, or ground) and heat sink (air, water), resulting in designations such as “air to water” (air source, water sink) heat pumps. This section covers only systems where water is the sink. Heat pump water heaters are designed especially for heating service hot water (including domestic water) to a temperature between 50 and 90 ºC. Air-to-water heat pumps have experienced significant growth.

Efficient heat pumps can reduce global warming impact significantly compared with fossil fuel burning systems. The reduction depends on the efficiency level of the heat pump and the carbon emission per kWh of the electricity generation. The tendency of decarbonisation of electricity and the increase of the efficiency levels of the heat pumps strengthens this positive effect. In 2013 Europe launched the energy label and minimum requirements for heat generators for space heating systems and hot water heating systems. This will be favourable for the heat pump promotion on one side but the severe minimum requirements for space heating heat pump systems may limit the choice of refrigerants.

Compared to the report of 2012 there is no substantive evolution in the technical options. On the other hand the choice of refrigerant will be most influenced by the specific energy efficiency regulations and standards as well as the cost of the equipment. Even within the economic unfavorable condition the heat pumps have still the significant growth on global level, mainly in China with air to water heat pumps.

6.9 Chillers

Chillers are used in air conditioning systems to provide cold water that is circulated by pumping systems to heat exchangers cooling air or, in some cases, process fluids. Chillers commonly employ either a vapour compression cycle or an absorption cycle. Vapour compression refrigerants that contributed to ozone depletion have been phased out for new chillers in developed countries and are scheduled for phase-out in developing countries by 2015.

The global warming effects associated with chillers are dominated by the indirect warming component associated with the generation of power to supply the energy they require. The direct global warming effect from refrigerant emissions is very small because chillers have very low leakage rates. Nevertheless, the refrigerants that replaced ozone-depleting refrigerants with high GWPs still have GWPs in the range from 1400 to 2100 so there is strong interest in finding a new generation of chiller refrigerants with significantly lower GWPs. If such refrigerants are to be acceptable they must provide energy efficiencies that are equal or better than the ones they would replace.

A number of new lower-GWP hydrofluorocarbon refrigerants are under consideration for chillers. Testing programs such as the Low-GWP Alternative Refrigerants Evaluation Program being conducted by AHRI from the U.S.A. with international participation and programs in other countries such as Japan are exploring the performance of new refrigerants for a range of applications including chillers. Refrigerants being tested include HFC-1234yf, HFC-1234ze(E), HFC-32, and blends containing these refrigerants and, in some cases, HFC-152a, and HFC-134a. The new refrigerants for chillers either are to replace HFC-134a or R-410A. Factors affecting whether a new refrigerant can be successful include operating pressure levels, cooling capacities, energy efficiency, whether they will be widely available in the future, ability to replace currently-used refrigerants without major equipment redesigns, retrofit capabilities, temperature glide, and costs. A number of the refrigerants and blends have A2L ratings under ASHRAE safety standards, indicating they have lower flammability than A2 or A3 refrigerants, lower flame speeds, and are more difficult to ignite. However, such A2L refrigerants may have different application requirements, standards, and regulations for use than the A2 refrigerants that have been employed widely up to now. Risk analyses are being conducted in parallel with the testing programs for the new refrigerants.

Chillers that employ non-fluorinated refrigerants R-717, R-718, R-744, HC-290 and HC-1270 continue to be available. Their use is increasing both in sales and with number of companies producing them, though in much smaller quantities than chillers with HFC refrigerants. Absorption chillers also are available as “not-in-kind” alternatives to vapour compression chillers. Absorption chillers can be important alternatives when electrical power is expensive or unreliable, and particularly when surplus heat is available as an energy source.

A continuing trend in chiller development is to improve both full-load and seasonal energy efficiency to address energy-related global warming impacts, building energy regulations and incentives, and operating costs. Chillers adapted for heat pump service are increasing in market share.

6.10 Vehicle Air Conditioning

The dramatic increase of new vehicle fuel economy is reducing fossil CO2 emissions and progressively helping to achieve road transport de-carbonization implying the diffusion of hybrid and electric vehicles. This scenario influences the mobile air conditioning design and sizing, requiring more efficient systems, additional functions (e.g., heat pump function) and a deep integration with the rest of the vehicle.

In the European Union a regulation is in force for passenger cars that only allows adoption of a refrigerant with a GWP equal or lower to 150; in US the adoption of a low GWP refrigerant is promoted granting it with off-cycle CO2 credits. Worldwide the use of non-zero ODP refrigerant is practically forbidden and the regulations on refrigerant recovery are becoming more severe (e.g., in China).

In 2012, the unsaturated HFC-1234yf refrigerant was the preferred choice to replace HFC-134a in the European Union and in the United States. In 2012, there were more than 10 car models on the market worldwide, which used HFC-1234yf as a refrigerant.

However, despite multiple confirmations of non-critical results, a German car manufacturer carried out a series of additional real-life tests on HFC-1234yf, demonstrating that HFC-1234yf, which is otherwise difficult to ignite under laboratory conditions, if mixed with lubricant, indeed proves to be flammable in a hot engine compartment. Similar tests of the current HFC-134a refrigerant and lubricant did not yield any ignition. Based on these new findings, the German car manufacturer concluded that HFC-1234yf should and will not be used in its products (Daimler, 2012). As a reaction to the safety concerns of the German car manufacturer, the SAE CRP has again reviewed the use of HFC-1234yf and concluded that the refrigerant is highly unlikely to ignite and also that ignition requires extremely idealized conditions, even when mixed with the lubricant as normally would happen in real world conditions (SAE, 2013).

As a consequence of the safety concerns of one German OEM regarding HFC-1234yf, four additional German car manufacturers proclaimed in March 2013 that they will also develop R-744 (see for example (Volkswagen, 2013)).

In addition to HFC-1234yf, some zeotropic blends are still being considered as possible candidates in vehicle air conditioning systems by many research institutes. Two mildly flammable blends were introduced by a large chemical company. These blends were registered at the January 2013 ASHRAE meeting, and have provisionally been designated as R-444A and R-445A. (see e.g., (Peral-Antunez, 2012)).

Systems enabling the safe use of flammable natural refrigerants are also under evaluation, based on a double loop architecture (liquid cooled condenser and evaporator) leading to a compact refrigeration unit.

The adoption of a thermodynamic cycle (e.g., Rankine) to recover part of the waste heat to produce mechanic or electric energy is also being considered in demonstration equipment. These systems use natural (e.g. ethanol) or organic working fluids (e.g., R-245fa, having a GWP of 1050); furthermore, the chemical companies are currently studying low GWP alternatives such as HCFC-1233zd.

6.11 References

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7 Information on the use of controlled substances on ships

7.1 Introduction

Decision XXIV/9, taken by the Parties at their 24rd Meeting mentions the following:

1. To request the Technology and Economic Assessment Panel to provide together with its 2013 progress report an updated version of the information provided in its previous progress reports on transport refrigeration in the maritime sector;

2. To invite Parties to encourage relevant stakeholders to minimize the use of controlled substances in newly built ships and to consider environmentally benign and energy-efficient alternatives wherever they are available;

3. To revisit the issue at the thirty-third meeting of the Open-ended Working Group.

7.2 Overview

The limited information provided so far has been based on open-access databases. The 2012 TEAP (and TOC) Progress Report stated that shipyards, large fleet operators, or alike must be consulter to obtain more detailed information of the type, size and quantity of ODS on ships. The situation in terms of access to data sources has principally not changed.

In 2012, Lloyd's Register was commissioned by the IMO Secretariat to undertake a study about ODS used to service ships (Lloyds, 2012). In addition to other excellent analyses, the authors determined the previously missing actual amount of refrigerant used in each type of refrigeration system. They used information submitted to Lloyd's Register ClassDirect Live system for class approval in the case larger dedicated systems, and a refrigerant charge calculator and personal experience for systems in the case of air-conditioning and provision room plants.

As reported previously, all vessels have a refrigeration system for food storage; they also all have air-conditioning for engine room control room and sometimes various workshop areas. In small vessels, the refrigerant charge and leakage rates of the self-contained and hermetic systems used is minimal. Many ships have also an air-conditioning system for occupied cabin space. In addition, the 2012 Lloyd's report identifies several vessel types, where refrigeration is used for process or cargo cooling. These types are

- Cruise ships
- Ferries
- Refrigerated cargo ships, incl. reefers, LPG carriers, porthole container ships, nuclear fuel and juice carriers.
- Fish factory ships and fishing trawlers.

The 2012 Lloyd's report further provides details of the typical charge size for these different types of vessels in Appendix 2. Although refrigerant charge of cruise ships and refrigerated cargo ships can be as high as 4,000 kg, they make up only a small percentage of the total fleet.

To be specific, the total passenger and passenger/roll-on roll-off cargo fleet for ships of 300 GT and over was composed of 4,131 ships in 2011. This number included both smaller ferries and large cruise ships and liners, while the latter were 426 and 35, respectively (Shipping, 2011). It is worth noting that the IHS Fairplay claims to registered over 180,000 ships of 100 GT and above today (HIS, 2013).

The ODS inventory is difficult to estimate. The 2012 Lloyd's report quantified the inventory of ozone depleting refrigerant for 41 flag administrations, which estimated stock was greater than 100 t, at 17,696 t. Provided that these 41 countries made up over 82% of the estimated ozone depleting potential refrigerants used in the marine sector, the total inventory is 21,580 t. Using a much less sophisticated approach, the 2012 Progress Report (TEAP, 2012) arrived at the total inventory of 27,650 t (that is 28% higher).

The 2012 Lloyd's report provided also a type-specific estimate of refrigerant leakage rates. The percentages were lower (5 to 15%) for cruise and refrigerated cargo ships, and higher (on average 50%) for the fish factory and trawlers. Regardless of type, the 2012 Progress Report provided an estimated leakage rate of 30% for HCFC-22, which was considered used aboard 80% of ships. Based on these numbers, the refrigerant charge size (already different) and the fleet size, the annual usage quantity (leakage) was estimated at 4.858 t in the Lloyd's report and 8,420 t in the last Progress Report (73% higher).

The pieces of information collected so far on the estimated refrigerant charges, leakage rates and fleet sizes suggest that the fishing sector shall be consulted for more details.

Given the specifics and extreme environment, in which marine refrigeration systems operate, the industry is likely to adopt solutions proven in stationary applications, including many low-GWP solutions. For example, ammonia-CO2 cascade systems are being introduced aboard fishing vessels.

While the ODS survey books required by MARPOL and the Lloyd's databases remain confidential, experts involved in the various types of vessels are being consulted for more information about the system specifications and prevalence. Accordingly, a review of refrigerant options for existing and new equipment is being updated with a target for completion being April 2014.

7.3 References

(Lloyds, 2012) Lloyd's Register, 2012, Study on the treatment of Ozone Depleting Substances used to service ships commissioned, report number LDSO/ENG/Q12-02RMS/07/02 – REV 4

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(Shipping, 2011) Shipping Statistics and Market Review, Volume 55, No 8 – 2011, Institute of Shipping Economics and Logistics

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8 2013 Methyl Bromide TOC (MBTOC) Progress Report and Response to Decision XXIII/5

This chapter updates trends in methyl bromide (MB) production and consumption for controlled uses, and gives progress in the development and adoption of alternatives in the preplant soil, structures, commodities and quarantine and preshipment (QPS) sectors. Special sections deal with recent and relevant developments, key issues and remaining challenges relating to MB phase-out, in A5 and non-Article 5 countries.

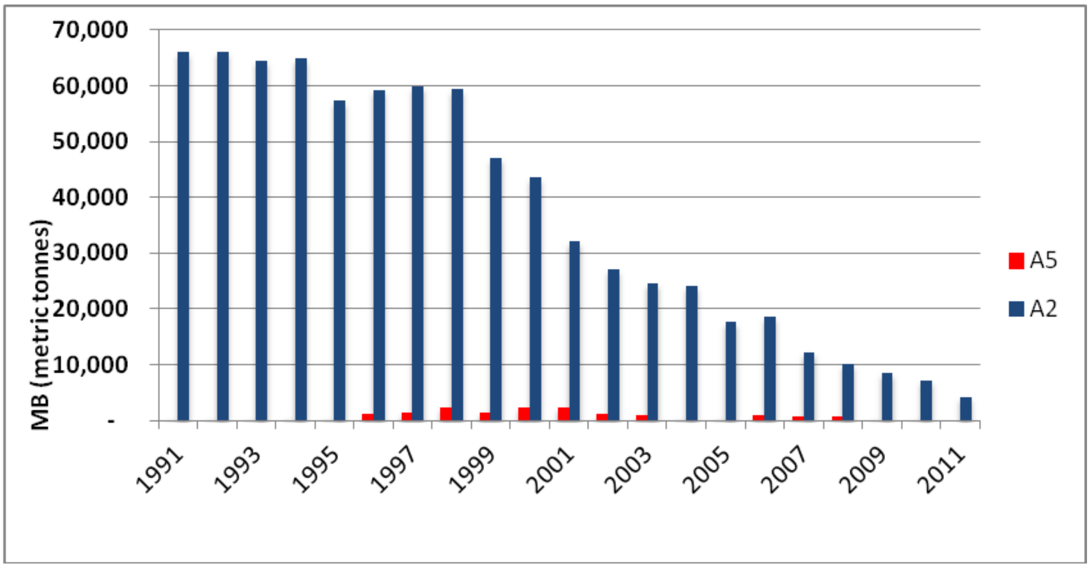
8.1 Trends in Methyl Bromide production and consumption for controlled uses

An update on MB production and consumption for controlled uses was compiled primarily from the database on ODS consumption and production of the Ozone Secretariat available as at 31 March 2013. Under the Protocol, consumption at the national level is defined as '*MB production plus MB imports minus exports, minus QPS, minus feedstock*'; it thus represents the national supply of MB for uses subject to phaseout under the control measures of the Protocol (i.e. non-QPS). Some countries have revised or corrected their historical consumption data, and as a consequence official figures and baselines have changed since official reporting of methyl bromide commenced in 1993. At the time of writing this report, all Parties had submitted data for 2011.

8.1.1 Production trends

Trends in the reported production of MB for all controlled uses (uses subjected to phase-out, or excluding QPS and feedstock) in non A5 and A5 countries are shown in Figure 8-1. Such uses have been falling consistently from 1998 to 2011. Production in 2011 continued the downward trend, totalling 4,555 tonnes or about 11% of the aggregate global baseline.

Fig 8-1: Historical trends in reported global MB production for controlled uses 1991-2011



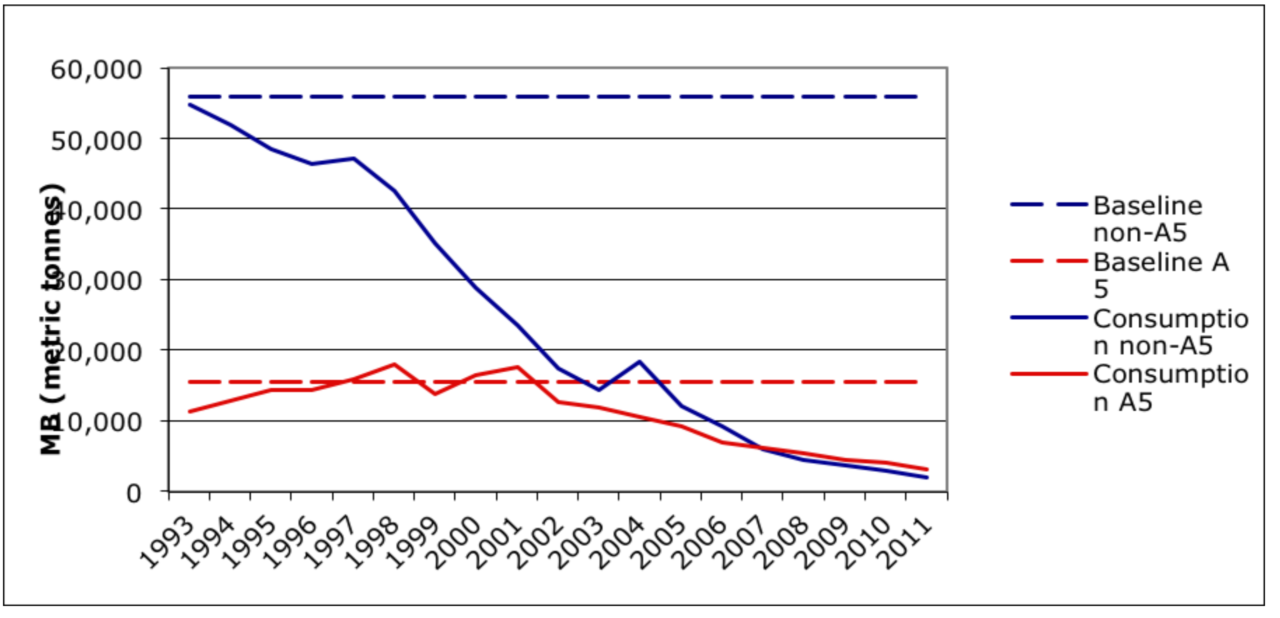
Sources: Data for 1991 and 1995-2011 were taken from the Ozone Secretariat dataset of March 2013. Data for 1992-94 were estimated from Table 3.1 of MBTOC's Assessment Report (2002) and Table 3.1 of MBTOC's Assessment Report (2011).

Non-A5 countries reduced their MB production for controlled uses from about 66,000 metric tonnes in 1991 (non-A5 baseline) to 4,264 tonnes in 2011. A5 countries reduced their production for controlled uses from a peak of 2,397 tonnes in 2000 to about 292tonnes in 2011, which represents 22% of the A5 baseline. At present, reported production of MB for controlled (non-QPS and feedstock) uses in A5 countries takes place entirely in China and a MLF project to phase-out this activity is approved and ongoing. In 2011, MB was also produced for controlled (non-QPS and feedstock) uses in three non-A5 countries (Israel, Japan and USA).

8.1.2 Global consumption for controlled (non-QPS and feedstock) uses

On the basis of Ozone Secretariat data, global consumption of MB for controlled uses was estimated to be about 64,420 metric tonnes in 1991 and remained above 60,000 tonnes until 1998. Global consumption was reported as 45,527 tonnes in 2000, falling to 26,336 tonnes in 2003 and to 5,187 tonnes in 2011 as illustrated by Fig 8-2 below.

Fig. 8-2: Baselines and trends in MB consumption in Non-A5 and A5 regions, 1991 – 2011

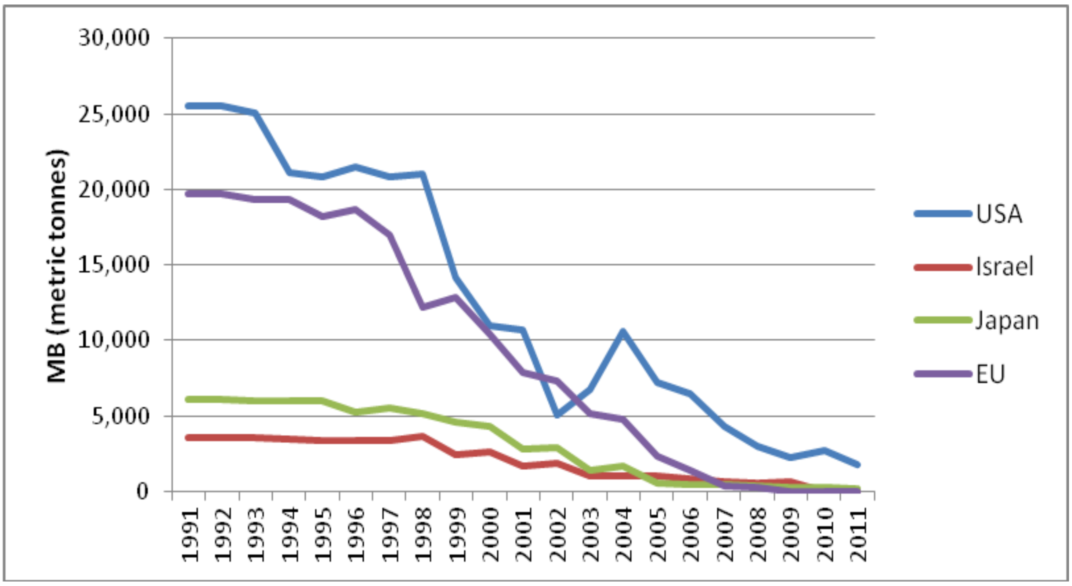


Source: MBTOC estimates and Ozone Secretariat Data Access Centre March 2013.

8.1.3 Consumption trends in Non-A5 countries

Figure 8-3 shows the trends in MB consumption in Non-A5 countries for the period between 1991 and 2011. The official baseline for non-A5 countries was 56,050 tonnes in 1991 and since then the consumption has declined steadily. In 2008 the estimated consumption based on quantities approved or licensed amounted to 6,996 tonnes or about 12% of the non-A5 baseline. For 2011 about 2,143 tonnes were approved or licensed which is a further reduction to about 4% of the baseline. For 2014, 483 tonnes have been exempted by the Parties for CUE use (0.86% of non-A5 baseline).

Fig. 8-3: ***MB consumption trends in non-A5 countries for controlled uses 1991-2011***



Source: Ozone Secretariat Data Access Centre, March 2013

8.1.4 Consumption trends in A5 Parties

Figure 8-4 shows the trend in MB consumption in A5 countries in the period between 1991 and 2010. Trends can be illustrated as follows:

- The A5 baseline was 15,703 tonnes (average of 1995-98), rising to a peak consumption of more than 18,125 tonnes in 1998. A5 consumption was reduced to 67% of baseline in 2004 (10,512 tonnes) and 20% in 2011 (3,164 tonnes).

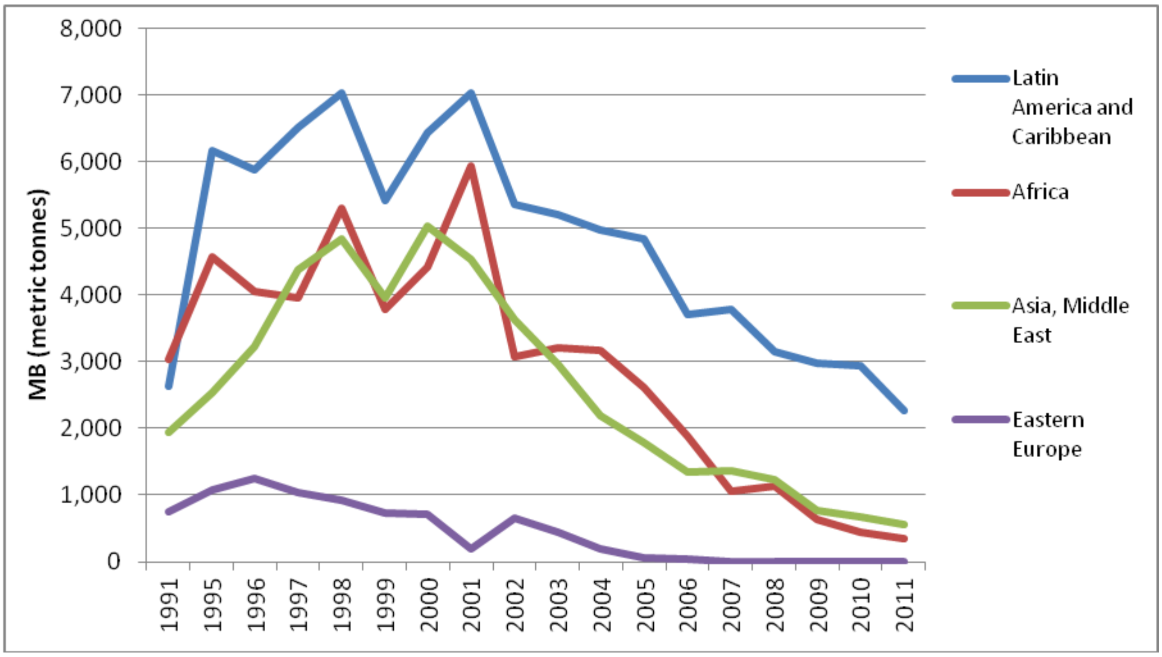
- Most A5 Parties have continued to make substantial progress in achieving reductions in MB consumption at a national level, as illustrated by the following information. Only 25 A5 Parties reported consumption in 2011, and seven of these report less than 5 metric tonnes. Nine countries report consumption larger than 100 metric tonnes and account for 91% of total A5 consumption.

- Latin America continues to be the region showing the smallest relative reduction in MB consumption with respect to its baseline, however it is the region making the largest relative reduction in 2011.

The status of MB phase-out in A5 regions in 2011, compared to the regional baselines (1995-98 average) is as follows:

- ➢ Latin America has phased-out 65% of its regional baseline (increasing from 55% in 2010)
- ➢ Africa has phased-out 92% of its regional baseline (up from 90% in 2010)
- ➢ Asia has phased-out 86% of its regional baseline (from 84% in 2010)
- ➢ CEIT region has phased-out 100% of its regional baseline since 2008

Fig. 8-4. MB Consumption trends in A5 countries 1991 – 2011



Source: Ozone Secretariat database, March 2013

Many Article 5 countries are finishing or have finished implementing MLF projects to reduce or totally phase-out MB. This includes 14 of the 15 largest MB consuming countries (i.e. countries that consumed more than 470 metric tonnes in the past). Several parties previously in this group (e.g. Brazil, Turkey and Lebanon) have phased out completely during the last five years. South Africa reported zero consumption in 2010 and 2011, and is the only country that has not implemented an investment project with funding from the MLF. China has made great strides in reducing MB consumption for controlled uses, which in 2011 amounted to about 16% of its baseline. Only one A5 Party (Mexico) reported consumption above 500 metric tonnes in 2011. As per Montreal Protocol control measures timeline, A5 Parties should phase-out uses of MB entirely by 1 January 2015, with exceptions for approved critical uses, QPS and feedstock.

8.2 Alternatives to MB for Soil Fumigation (pre-plant uses)

In this section of the report, we report on the progress in adoption of alternatives for the most difficult soils sectors, which are still using MB under the CUE process and the progress for controlled uses in A5 countries.

For the CUNs submitted in 2013, methyl bromide is requested by 3 parties (USA, Canada and Australia) only for 2 uses, strawberry fruit (USA) and strawberry runners (Australia and Canada) in 2015 and this amounts to approximately 408 metric tonnes. This is significantly lower than the total 16,000 tonnes applied for all sectors in the first year of CUEs in 2005. Soil fumigation with methyl bromide plus chloropicrin is used as a preplant treatment to control a broad range of strawberries pathogens e.g *Verticillium dahliae*,*Fusarium oxysporum*, *Macrophomina phaseolina*, *Pythium* spp, *Rhizoctonia* spp, weeds and nematodes.

Chemical and non-chemical alternatives are widely used for strawberry and runner production all over the world (Tables 8-1 and 8-2), except in some regions due to specific technical, regulatory or economic circumstances

8.2.1 Chemical alternatives for the remaining critical uses (non A5 Parties).

Adoption of chemical alternatives has been the main means to replace MB in non-A5 countries for strawberry production. The key chemical alternatives adopted include 1,3-D/Pic, Pic alone and some mixtures with metham sodium and chloropicrin. Methyl iodide is no longer considered as an alternative for strawberry production as it has been generally withdrawn from all countries and is not available in the USA nor being considered for registration in Canada or, Australia. Dimethyl disulphide (DMDS) has been recently registered in the US but not yet in California.

Table 8-1 indicates chemical alternatives that are registered or being evaluated for the three remaining CUNs – Australia strawberry runners, Canada strawberry runners and the US strawberry fruit (California).

The US has completed the re-registration process for soil fumigants – including methyl bromide, chloropicrin, metham sodium and metham potassium. Additional mitigation measures such as buffer zones around treated fields have been incorporated onto product labels and must appear on all products used in the field by December 2012. Such measures will impose additional constraints on the use of these fumigants. Similar mitigation measures also apply to DMDS.

Table 8-1: Chemical alternatives to Methyl Bromide for current CUNs

Country	CUN crop	MB Alternatives
USA (California)	Strawberries	1,3-D, Pic, 1,3-D+Pic, MS, 1,3-D+Pic+MS, DMDS+Pic (specialized tarp under development to deal with strong odour problem; registered federally in July 2010, registration in California still pending), MI registration has been cancelled in the U.S. EDN - no federal registration request submitted to date. Pebulate registration cancelled
Australia	Strawberry runners	1,3-D+Pic results in phytotoxicity in heavy soils. 1,3-D+Pic+MS, MS alone or 1,3-D+Pic+dazomet not effective to the degree necessary for certification. No registration request has been submitted for DMDS. EDN registration difficult.
Canada (PEI)	Strawberry runners	1,3-D alone or in any combination prohibited in PEI due to risk of ground water contamination. Pic registered federally but provincial permit has not been issued. No registration request has been submitted for recognised alternative fumigants, MI+Pic, DMDS or EDN.

8.2.2 Non-chemical alternatives for soil fumigation

Many Article 5 and non-Article 5 countries have developed and adopted non-chemical alternatives to MB in many crops including strawberry for both fruit and runner production (Zasada *et al.*, 2010, Medina-Mínguez *et al.*, 2012, Samtani *et al*, 2011). Table 8-2 below summarises the main non-chemical alternatives presently in commercial use, and further analysis is provided in ensuing sections.

Table 8-2: Non-chemical alternatives in strawberry fruit and runner production

Alternatives	Strawberry fruit	Strawberry runners
Non Chemical	Solarisation Steam Resistant varieties Soil-less (substrates) Crop rotation Organic amendments Organic production IPM	Soil-less (substrates)

8.2.2.1 Resistant Cultivars

Plant resistance is more relevant for strawberry fruit production than for nurseries (runners).

Strawberries are attacked by many soil borne pathogens which vary widely in their incidence and in their distribution. *Fusarium* pathogens are particularly problematic in many strawberry producing regions (Fang *et al.,* 2012). With the widespread use of MB as a soil fumigant, soilborne diseases were not generally of high concern in commercial production fields; hence breeding efforts focused on developing cultivars with improved horticultural characteristics and fruit yield (Villanueva *et al.,* 2010), but which unfortunately were often susceptible to soilborne pathogens.

Strawberry cultivars with resistance to crown and root rot diseases are an important element of effective disease management strategies (Shaw *et al*., 2010, Daugovish *et al*., 2011). Some breeding lines and cultivars show differential tolerance to soilborne diseases in different world regions (Weissinger e*t al*., 2011, Fang *et al*., 2012). In the USA, Whitaker *et al*., (2012) reported that a new cultivar, 'Winterstar', was moderately resistant to angular leaf spot, *Colletotrichum* crown rot and charcoal root rot, a disease of increasing importance in Florida since the loss of methyl bromide. However, 'Winterstar' was susceptible to Phytophthora root and crown rots. In California, outbreaks of *Macrophomina phaseolina* and *Fusarium oxysporum* have increased over recent years causing plant collapse and yield reduction. Several strawberry cultivars show moderate tolerance to *F. oxysporum,* however all tested cultivars were susceptible to *M. phaseolina* (Daugovish *et al*., 2011). Some resistant genotypes to *Verticillium dahliae* have been detected in California for commercial cultivar development (Shaw *et al*. 2010, Gordon *et al*., 2011).

In Spain, cv 'Sabrosawas' proved resistant to *P. cactorum, V. dahliae and V. albo-atrum,* and cv. 'Sieger' was resistant to two strains *of X. fragariae* (Pérez-Jiménez *et al*., 2012). In Western Australia, Fang *et al.* (2012) evaluated yields and resistance of strawberry cultivars to crown and root diseases in the field, and cultivar responses to pathogens under controlled conditions. Differential tolerance to various diseases was reported. For example; under controlled conditions, cv. 'Festival' was the most resistant and cv. 'Camarosa' the most susceptible to Fusarium wilt. In Korea, cv. "Gwanha" was reported resistant to Fusarium wilt (Lee *et al*., 2012).

Availability of strawberry cultivars around the world can however be restricted by different factors, like environmental adaptation (mainly latitude), type of bearing (short-day and day-neutral cultivars), and industry strategies (Lopez-Aranda, 2011, Weissinger *et al.,* 2011)

Breeding for resistance is an interesting option for managing soilborne strawberry diseases and work in this respect has increased in many countries. However, incorporating desirable fruit quality characteristics together with multi-gene resistance to two or three important pathogens may prove very difficult. In addition, individual cultivars may perform differently depending on soil type, fertilization and cultural practices (Shaw *et al.,* 2010, Daugovish *et al*., 2011.)

Plant resistance is not reliable as an alternative to MB for producing strawberry runners, which are often subjected to certification requirements, prohibiting presence of pathogens on soil attached to runner roots as these pose a serious biosecurity issue limiting their circulation from one region to another. In addition, runners can act as asymptomatic carriers of pathogens leading to possible re-infestation of fruiting fields (Fang *et al*, 2012).

8.2.2.2 Substrates

Soilless culture is an intensive production system successfully in use in developed and developing for producing various crops including strawberry fruit and runners (Rodriguez-Delfin 2012.)

This system is technically feasible for producing most generations of strawberries in A5 countries such as Brazil (Janisch *et al.*, 2012, Oliveira *et al.*, 2010), Uruguay (Gimenez *et al.*, 2008), Paraguay (Nacimiento and Lopez-Medina 2009), and Non-A5 countries like Japan (Kato and Hayashi 1996), Belgium (Robbe 1997, 1998), Poland (Treder *et al.*, 2007), France (Hennion *et al.*, 1997) and the USA (Bish *et al.*, 1997, Larson *et al.*, 2002). Different factors can affect the plug plant quality including the substrate mixes (Lopez-Galaza *et al.*, 2010) and planting dates (Caracciolo *et al*, 2009).

8.2.2.3 Steam

Steam is a feasible alternative for controlling soil-borne pathogens and weeds, especially in greenhouse systems where high-value crops, such as ornamentals and vegetables are produced (Gelsomino *et al.*, 2010). Steam alone or in combination with other methods provided control of *M. phaseolina*, *F. oxysporum* and weeds in strawberry production, particularly in buffer zones, where fumigants cannot be used (Daugovish 2011, Daugovish *et al.*, 2011; Fennimore *et al.*, 2011a-b). The key disadvantage is the capital cost of the machinery and the relatively slow treatment, which often make this technique suitable for for small areas only.

Steam and steam + solarisation treatments resulted in effective weed control and significantly reduced the number of *Verticillium dahliae* microsclerotia, to levels comparable to MB (Samtani *et al.*, 2012).

8.2.2.4 Solarisation

Soil solarisation has been shown to be effective for controlling soilborne diseases of a variety of crops, particularly strawberries, under various environmental conditions, soil types and agricultural systems, in many countries (Gamliel and Katan, 2012, Besri *et al.*, 2012). Solarisation can increase soil temperatures by 2–15 C in warm climates. Its efficacy is influenced by the combination of soil temperature and treatment duration. Control of some strawberry soil pathogens in solarized soil was improved by combining with other methods such as fumigants at reduced dosages (Gamliel and Katan 2012), biocontrol agents e.g *Trichoderma* (Porras *et al*., 2012), steam (Samtani *et al*., 2012), organic amendments (López-Aranda *et al.*, 2012) and anaerobic soil disinfestation (Butler *et al*., 2012). ***Trichoderma*** populations significantly increased in solarized soil; root colonization, root weight and strawberry yield were also improved (Porras *et al.*, 2007). Samtani *et al.*, (2012) reported that weed seed viability in steam and steam + solarisation treated plots planted with strawberries was equal or lower than in plots treated with a MB standard. Solarisation alone was less effective in controlling weeds. Only some steam treatments reduced the number of *Verticillium dahliae* microsclerotia to levels similar to those achieved with MB-Pic.

López-Aranda *et al*., (2012) reported that biosolarisation plus fresh poultry manure and Brassica pellets significantly reduced the incidence of strawberry soil borne pathogens, particularly *Fusarium oxysporum* and *Macrophomina phaseolina*.

However, failures with this technique have also been reported (Chellemi, 2002, Gamliel and Katan 2012, Katan *et al*, Besri *et al*, 2012) and MBTOC recognizes its limitations to warmer regions where solarisation fits with the rotation system.

8.2.2.5 Biofumigation

Biofumigation is the practice of using volatile chemicals released from decomposing plant materials to suppress soil pests, including nematodes, bacteria and fungi (Oka 2010, Ji *et al.*, 2012). The growth stage of plants has an influence on the biofumigant potential of plant materials against soil borne pathogens (Morales-Rodríguez *et al*., 2012). A variety of organic amendments, such as animal and green manures, compost, nematicidal plants and proteinous wastes, are used for this purpose, but soil borne pathogens are not always satisfactorily controlled (Oka 2010). Nevertheless, Spain has transitioned a significant strawberry area previously fumigated with MB to biofumigation with solarisation (Bello *et al.*, 2007; Diéz-Rojo, 2012).

Soil amendment with manure compost or crop residue has been shown to significantly reduce the severity and impact of strawberry fusarium wilt (Fang *et al*., 2012), however inconsistent results in field trials (Samtani *et al.*, 2011; Yohalem and Passey, 2011) demonstrate the need to further explore biofumigation, alone or in combination with other management practices as an efficient alternative to MB for strawberry production.

8.2.2.6 Anaerobic soil disinfestation

Developed in Japan (Momma, 2008), anaerobic soil disinfestation (ASD), is a non-chemical alternative to MB which has proven efficient for controlling soilborne pathogens, nematodes and weeds in strawberry and vegetable production. ASD involves addition of a carbon source that encourages growth and reproduction of microorganisms in the soil and then irrigating to levels higher than field capacity and covering with a plastic tarp to stimulate anaerobic decomposition. Holes are punched in the tarp 3 weeks later to re-aerate the soil.

In Japan, hundreds of farmers use ASD to control soil-borne pathogens in strawberries and vegetables grown in greenhouses and open fields (Katase and Ushio 2010.) Ebihara *et al* (2010) reported that Verticillium wilt was controlled in strawberry runners when rotating these with paddy rice for 3 years (three times) and green manure for 1 year.

In California, Daugovish *et al.,* (2011) reported that *V. dahliae* and weed populations where significantly reduced in ASD treated plots compared to an untreated control. Marketable fruit yield increased by 95% in ASD treatment. Shennan *et al.,* (2010, 2011, 2012) showed that wheat bran, rice bran, mustard cake, grape pomace and ethanol can reduce *V.dahliae* and weed populations and increase strawberry yields, however, in soils heavily infested with weeds ASD had to be combined with herbicides. Rosskoph *et al.,* (2012) reported that ASD controls *Macrophomina phaseolina*, but MBTOC found no data on the control of nematodes under California conditions. A trial conducted in Ventura County in 2012, ASD did not control *Fusarium oxysporum*; lower temperatures during the growing season in California were cited as possibly impacting the efficacy of ASD (D. Legard, pers comm). Rice bran has been used in California strawberry trials, availability of this material could limit adoption. More work is needed to improve consistency and further elucidate mechanisms of control of soilborne plant pathogens and weeds during ASD treatment (Butler *et al.*, 2012)

In the Netherlands ASD has been applied since 2004 on approximately 70 ha mainly dedicated to asparagus and strawberry runner production. ASD provided good control of *Fusarium oxysporum* for many years in asparagus crops, however ASD is not applied widely in the Netherlands due to the high costs. A new and promising development in ASD is the application of defined C/N ratios, based onset mixtures of carbohydrates and proteins (Lamers, *et al* 2010.)

8.2.2.7 Crop rotation

Strawberry yields often decline over time when continuous production takes place in the same site, as a result of proliferation of weed seeds and pathogenic organisms in the soil. Plots with either continuous tillage or rotated with *Sorghum bicolor*, *Panicum. virgatum*, or *Andropogon gerardii* before planting strawberries showed lower populations of soilborne pathogens, lower weed biomass, strawberry plants that established better and produced higher yield relative to plots continuously grown with strawberries. (Portz and Nonnecke, 2011).

Fang *et al*., (2012) reported that crop rotation could improve disease management in strawberry production. Rotation with tomato reduced severity of Fusarium wilt as compared to plots in continued production. Soil pH, amendments consisting of manure compost or crop residues, and crop rotation, all significantly reduced the severity and impact of Fusarium wilt.

Other important studies include Subbaro *et al*., (2007) who investigated the influence of crop rotation on soilborne diseases and yield of strawberry at a site infested with *Verticillium dahliae*, showing a significant reduction of microsclerotia when rotating with broccoli and Brussels, which led to lower disease severity. Results with lettuce were not as successful and none of the rotation treatments were better than the fumigated control, but they were much cheaper.

Njoroge *et al*., (2009) evaluated the effects of broccoli and lettuce rotations on soil population densities of *Verticillium dahliae* and strawberry yields, in conventional and organic production systems in California for 2 years, compared to a MB standard fumigation.. Plant canopy diameters were not different for the two treatments, and rotation with broccoli has a better effect than lettuce. Crop rotation was deemed as a promising option in particular for organic strawberry production systems.

8.2.3 Strawberry issues in Article 5 countries

A recent review gives an excellent overview of the situation for the strawberry fruit and nursery industries worldwide (Lopez- Aranda, 2012).

8.2.3.1 Strawberry fruit

Several Article 5 countries have adopted alternatives for strawberry production, very often through projects financially supported by the multilateral fund of the Montreal Protocol. In Morocco, drip applied metham sodium (MS) has been used successfully to control soilborne fungi (*Rhizoctonia solani , Verticillium dahliae*, *Phytophthora cactorum)* and weeds (more than 40 species e.g., C*ynodon dactylon, Chenopodium sp , Amaranthus sp*). MS is injected at a dosage of 200 to 250 g/m^2; it is highly effective, economically feasible and does not require modifications of the cropping system. Yields and fruit quality obtained with MS were equivalent to those achieved with MB (Chtaina and Besri, 2006; Chtaina, 2007, 2008).

Soil solarisation and chemical alternatives namely metham sodium and 1,3-D/Pic are used successfully in the Lebanese strawberry fruit sector. (UNEP/MLF/MoE/UNIDO, 2004)

In Turkey, the main strawberry soil borne pathogens are *Fusarium oxysporum*, *Rhizoctonia solani* and *Macrophomina phseolina*. Solarisation + dazomet at a rate of 400 kg/ha was found effective for controlling diseases, nematodes and weeds attacking strawberries. Lower doses of the fumigant still provided effective control, allowing for cost reduction (BATEM, 2008).

In Egypt, large-scale strawberry growers are adopting a combination of metham sodium and solarisation amended with bio-control agents for open field production (UNIDO, 2008a). Alternative fumigants are also being tested for strawberry fruit and runner production including 1,3-D/Pic and DMDS (UNIDO, pers. comm, 2012).

In Chile and Mexico, growers are mainly adopting chemical alternatives, e.g. metham sodium and 1,3-D/Pic. (UNIDO, 2008b; UNIDO, 2010; UNIDO pers. comm, 2010).

8.2.3.2 Strawberry runners

Some Article 5 Parties (Argentina, Chile, China, Egypt, Mexico, Vietnam) are still phasing-out MB used in strawberry nurseries. Alternatives of choice include fumigants, substrates and steam. In Egypt for example, soilless production amended with *Trichoderma* as a bio-control agent has been trialled with success (UNIDO, pers. comm, 2012).

Several Article 5 countries have phased-out in this sector in advance of the 2015 deadline (e.g., Brazil, Lebanon, Turkey.)

8.2.4 Remaining and emerging challenges

8.2.4.1 Non-Article 5 Parties

Adoption of non-chemical alternatives such as substrates, resistant varieties, solarisation and ASD continues to expand as their technical and economical feasibility improves.

Strawberries nurseries are nevertheless the most significant remaining use for MB worldwide and continued research is required to determine the risk imposed by use of alternatives in this sectors and give growers more confidencein using alternatives.

MB continues to be classified differently for nursery applications by several Parties despite the target pests and crops being similar in several countries.

8.2.4.2 Article 5 Parties

MB phase-out over the eighteen months is critical for developing countries as they move towards achieving the 100% phase-out deadline of 1st January 2015.

Complete phase-out has been achieved in many Article 5 countries before the 2015 deadline, most often with support investment projects funded through the MLF but also in some cases through bilateral cooperation between individual Parties and directly by agricultural producers. These projects have identified economically and technically feasible alternatives, which are as efficient as MB; in particular, a combination of alternatives has been encouraged as a sustainable, long term approach for replacing MB, sometimes requiring changes to crop production or pest control systems including investments and training.

Early MB phase-out has proven beneficial to Article 5 Parties in many instances by improving production practices, increasing the competitiveness of agricultural products in international markets and training large numbers of growers, technical staff and other key stakeholders.

MBTOC is nevertheless aware that challenges remain in certain intensive production sectors including strawberries (fruit and runners), ginger, ornamental nurseries and possibly melons.

A recent evaluation conducted by the MLF (MLF, 2012) in response to concerns raised by African Parties on the sustainability of the MB phase-out achieved concluded that, in general, the risk of returning to MB for controlled uses was low, although actions to strengthen such phase-out achieved could still be taken, since it was clear that issues beyond the technical and economic feasibility of alternatives impact their sustainability. Such actions may include further training, measures to improve access and availability of inputs associated with alternatives (e.g. incentives to reduce the price of imported inputs), creating linkages with other initiatives/ funds, promoting information exchange within productive sectors and others. It was also evident that sustaining the MB phase-out through the adoption of environment-friendly production practices provides market headway for many products exported by A5 countries to industrialised countries (MLF, 2012).

8.3 Structures and Commodities (SC)

This section of the TEAP May 2013 Progress Report includes three sections:

- A regulatory news update
- A review of the current status of treatments and processes used to control pests in fresh dates. This section also incorporates science reviews and processing updates on the high moisture dates of North Africa and Middle Eastern countries.
- A review of the current status of treatments and integrated pest management (IPM) processes used to control pests of cured pork during storage.

Parties continue to be interested in finding and assessing alternatives to the use of methyl bromide. Accordingly, MBTOC has prepared several previous reports to assist Parties in their quest for additional information. Additionally, MBTOC SC offers Parties information about potential alternatives for specific current critical uses by referring to recent research in the text boxes relating to Parties critical use nominations. In that way Parties can evaluate the most up to date information to assist in the adoption of appropriate alternatives.

MBTOC's discussion on pest control alternatives for fresh dates is pertinent to Southern California, the origin of the US critical use nominations, but also to the several other Parties that produce dates for domestic and export uses. However, in the instance of the CUN for Southern dry cure pork, methyl bromide is no longer used to control pests of similar pork products in other countries. There are, however, differences in these cured pork products and storage conditions that also affect the potential for the products to become infested, but, there are also similarities. It is thus worth examining the techniques used in other countries for these similar products.

8.3.1 Regulatory News

Since the last Progress Report there have been few changes in registration and other regulatory news of interest to Parties. In fact, as the applicants to Parties for critical use nominations have adopted alternatives or made changes such that CUNs are no longer submitted, MBTOC is not always the first to hear about regulatory improvements. It is noted that methyl bromide registration is under review in the US and currently there is a proposal to reduce the TLV from 5 to 1 ppm (v/v). Other significant changes have been made in the defining of treatment and aeration zones as well as increased requirements for monitoring.

Compared to last year, Australia's rice processors, millers in Canada and the United States, and American dried fruit companies, have either completed their adoption of alternatives or otherwise changed processes and logistics with the result that no CUNs were submitted for these applications for use in 2015. MBTOC believes that this has been accomplished without extensive regulatory changes. For example, we are not aware of changes in regulations pertaining to the use of SF (SF) in Canadian mills or for Australia's rice processing. We have however, been specifically informed in the CUN that all prior registrations and uses of SF in the United States have continued on the same basis and with the same regulations, in spite of legal challenges which are ongoing.

This regulatory situation may have given a sense of certainty which allowed US flour and cereal mills to continue their adoption of SF as an alternative treatment and contributing to the non-submission of CUNs for these uses. By comparison, Canadian millers have tended to use either heat treatments, SF and/or the combination treatment of heat-plus-phosphine-plus- carbon dioxide. MBTOC does not believe the latter combination treatment is currently used by American millers. Canada has also not submitted a CUN for its flour milling for the first time this year. MBTOC has evidence for the need of supplementary heating for ovicidal efficacy of SF when ambient temperatures are below 27^{o}C. To achieve this in practice all mill fumigations in the UK have used supplementary heating with SF to keep temperatures in the mill at about 30^{o}C as a routine since 2005.

In Europe, SF can only be used on empty food processing structures, including mills, and in some countries for certain dried fruit and nuts. The SF treatment is used in combination with supplementary heat and also heat treatments alone are also used. However, as food processing and storage continues in Europe without the use of methyl bromide, it seems that these processes plus integrated pest management approach and heightened sanitation are achieving the necessary level of pest control.

In Germany, registration for sulfuryl fluoride has been significantly changed compared to former years. The authorized dosage schedule for mills no longer include the egg stage, and therefore control of all life stages of pests of mills is no longer included. The registration of SF for control of insects in walnuts still covers all developing stages and the adults.

Since heat treatment has not been shown to be effective and/or practical for pest insect control in large flour mills of more than 50,000 m^3, the loss of sulfuryl fluoride for this purpose may prove problematic. Smaller mills and other food factory structures have access to heat of about 55°C for pest control. Other methods such as contact insecticides, biological control and trapping have not been proven as effective alternative as compared to full-site treatments.

8.3.2 Alternatives for pest control and control of spoilage in fresh dates

Dates, of many different varieties, and for different uses, are grown in several countries. In some countries, dates are a culturally and nutritionally important fruit and also are part of the observance of some religious holidays.

Most commercial date growing regions of the world, typically desert and semiarid regions have low ambient humidity, at least at harvest time. Dates are usually left to dry on the palm to a moisture content safe for storage at ambient temperatures without spoilage from moulding or fermentation. This varies between varieties but is normally less than about 23% moisture content (wet basis). As an exception some dates (c. v. Deglet Noor) in Algeria and Tunisia are harvested at 35-40% moisture content (see below).

Several years ago, MBTOC reported that it did not know of effective MB alternatives for fresh, high moisture, perishable dates. Over the past several years, MBTOC has identified inconsistencies in the definition of "fresh and perishable" in the context of dates, and has focussed on understanding the role of moisture content in date perishability, pest infestation and treatment. Parallel to this, date producing countries have worked to improve date harvesting, logistics, pest control treatments and exporting conditions as a means of reducing spoilage and improving date quality. Additionally, as this report discusses, treatments have been designed and are being used for dates in most date-producing countries.

In the US, the date harvest begins late August and is completed at the beginning of December. The production cycle of dates in California is thus similar to that in North Africa and the Middle East. Dates can become infested before harvest. Although several insects may infest dates, the dried fruit beetle, *Carpophilus hemipterus,* and carob moth, *Ectomyelois ceratoniae,* are the most damaging species.

In the United States dates are grown in the California desert and in 2012 the production was 28,213 metric tonnes (31,100 tonnes) (USDAS, National Agricultural Statistics Service, 2013).

Some MBTOC members and other scientists visited the California date farming region and the date processor (Ciesla *et al.*, 2009). California dates, while fresh in terms of the lack of processing and reasonably fast harvest to market definition, are not the same as the fresh, perishable, high-moisture content dates of North African countries. The reason for this is the difference in moisture content. The totality of the Californian production of dates is made up of dates with a moisture content lower than 23% wet basis, (water activity (a_w) >0.7) contrary to some North African and Middle Eastern dates with high moisture content which can reach 40% of moisture content.

In 2009, in California, when this visit took place, dates were disinfested just after harvest by fumigation with methyl bromide. At that time, the disinfestation was carried out with methyl bromide in two different ways:

- Fumigation under plastic tarp for few days, the fumigation is conducted under tarps and the boxes of dates are placed directly on the hard-packed soil;

- Fumigation in normal atmospheric pressure chambers (~ $100m^3$) for about 36 tonnes of dates for each of the two chambers with an exposure time of approximately 12 hours, plus 4 hours for the degassing.

- Infestation by carob moth mainly occurs during August, September and October. Control of carob moth comprises two techniques since the species can infest dates in the field but also post-harvest:

- Pheromone traps are installed on the trunk of the palm trees for mating disruption. In parallel, insecticidal treatments using an insect growth regulator (IGR) are carried out each year. The presence of the natural hymenopteran parasite of the carob moth was noticed at the time of the visit in 2009.

- As mentioned above, fumigation after harvest was conducted with methyl bromide before storage and/or conditioning, and this would also control any remaining carob moths.

California dates were then stored cold at a temperature of approximately 4.5°C. This is useful in preventing re-infestation, but also spoilage by moulds and yeasts.

In 2009, Ciesla *et al.,* noted that the SF is an alternative available but not used at that time.

Since that time, the California date sector has considerably adopted alternatives to methyl bromide. The California dried fruit industry has already replaced a large portion of methyl bromide, mostly by phosphine treatment, but also by SF to a lesser extent. By contrast the date production industry in Israel has adopted heat treatment and ethyl formate as discussed below.

For dates, assessing the efficacy of phosphine involves an assessment of the harvest-time ambient temperature (as it affects product temperature) as well as the usual time and concentration aspects of the treatment. Excessive storage and handling time prior to disinfestation, is said to increase risk of quality loss from fermentation damage. To avoid this, treatment time must be minimised. The registered label of phosphine from various gas sources will vary by country by domestic regulation. But, reviewing the phosphine label for cylinderised phosphine in CO2 (Eco2fume) as registered in the US, and reviewing the August-to-December harvest temperatures in California, MBTOC has observed that effective treatment times are short enough to be unlikely to cause fermentation of the dates at the moisture level harvested in California. (Note: the label is exactly as in US registration and is therefore not in metric units.)

Table 8-3: Allowable rates of phoshpine

ALLOWABLE PHOSPHINE DOSAGES FOR ECO2FUME®[1,2,3]

Temperature	PH_3 Concentration Maintained/1000 ft^3 of Area	Rate of ECO2FUME®/1,000 cu. Ft.	Minimum Duration
Below 32°F (0° C)	Do not fumigate	Do not fumigate	Do not fumigate
32-39° F (0-4° C)	200-1,000 ppm	0.88 – 4.41 lb	6 days
40-53° F (5-12° C)	200-1,000 ppm	0.88 – 4.41 lb	4 days[4]
54-59° F (12-15° C)	200-1,000 ppm	0.88 – 4.41 lb	3 days
60-79° F (16-25° C)	200-1,000 ppm	0.88 – 4.41 lb	2 days
80° F & Above (≥26° C)	200-1,000 ppm	0.88 – 4.41 lb	36 hours
80° F & Above (≥26° C)	500-1,000 ppm	2.20 – 4.41 lb	24 hours

Williams, reporting on research with sulfuryl fluoride, (2009) reported that chamber fumigation (capacity about 140 m^3) needing a quick overnight turnaround represented about 30% of the date production fumigations. The remaining 70% of the fumigations occur in large stacks of bins under tarps in the open yard, when time is not critical and the fumigation tarps may be kept in place for weeks or even months.

MBTOC has received conflicting reports of the effectiveness of SF to control the target pests of dates, as discussed below.

Williams (2009) presented the results of SF investigations on carob moth (*Ectomyelois ceratoniae*, CM) in freshly harvested dates. Complete mortality of eggs and larvae was achieved with 332 (g-h/m^3 CT dosage of SF (SF), labelled as ProFume, at 21˚C (70˚F) during a 14-h exposure (essentially 24 g m^{-3}). Williams concluded that complete mortality at 21 C could be obtained with 24 g m^{-3} dosage and 16h exposure for chambers with a moderate HLT (half loss time) of 20 h. Furthermore, according to Williams (2009) with the anticipated 50+ h HLT actually measured with tarped stacks in 2007, a fumigation using only 20.8 g m^{-3} of SF would require 16 h to achieve 300 g h m^{-3} necessary for carob moth control. Further gas savings can be made by extending the exposure time. At 50-h HLT and 72h exposure, a 300 g h m^{-3} CT dosage for ProFume can be achieved applying only 6.4 g m^{-3} (Williams, 2009).

Recent studies have shown that under vacuum or atmospheric conditions, SF is effective over the required treatment time against adult, pupal, and larval stages of stored product pests (Walse 2012). Work by Williams and Toms (2008) indicate excellent control of all stages of dried fruit beetle and carob moth with SF at label rates. However, Dr Walse's preliminary results using SF with the maximum label-allowed exposure show less than adequate egg kill at temperatures over the range 15.5-26.6°C (60-80°F) for several species of stored product pests.

As MBTOC has pointed out several times in this and other assessments of the effectiveness of SF, achieving an adequate temperature is key to pest control effectiveness with SF. MBTOC has suggested that supplemental heat should be applied to ensure that temperatures around 30°C are held during a SF fumigation.

The importance of temperature was also shown by Walse (2012), who demonstrated that nearly two-fold the maximum SF exposure allowed on the label is required for 95% control of carob moth eggs at 15.5˚C (60°F), 24 hours, and atmospheric pressure. Studies were conducted to determine the efficacy of SF toward carob moth eggs at 21°C and atmospheric pressure. Eggs of the dried fruit beetle are not controlled at atmospheric pressure, 24 hours exposure, and temperature of 26.6˚C (80˚F), or below, given the current label rates.

Because later in the autumn, ambient temperatures can fall substantially at night, resulting in mean ambient temperatures well below 21˚C. Further research is needed to ensure the ovicidal efficacy of SF (and work needs to be done on the correlation of ambient temperature and product temperature). In addition, further research is needed to determine the efficacy that results from pairing SF with a more potent ovicide, such as propylene oxide. Research on this combination treatment is being conducted by the Dried Fruit Association of California (Muhareb, 2009), and interesting though it is, propylene oxide awaits registration appropriate for control of pests of dried fruit and therefore, even if successful, this combination treatment cannot be considered to be an alternative at this time.

Reichmuth and Klementz (Barakat *et al*., 2009) discussed possible investigations to overcome the inability of SF to control the egg stage of many stored product pest insects. These included combinations of gases such as SF with phosphine or carbon dioxide. They also proposed using heat to increase the efficacy of SF. The authors believed their preliminary data demonstrated that these combinations showed promise for many stored product pests of dried fruits and tree nuts (Barakat *et al*., 2009).

They presented data regarding SF efficacy on the eggs of the rice moth, *Corcyra cephalonica*. He showed that older eggs were more tolerant of SF than were the young eggs. His data showed that by increasing the exposure time the difference in tolerance between the ages of the eggs is reduced and disappears. His results indicated that full control was achieved 4.19, 5.24 and 6.24 g m^{-3} for 5, 4 and 3 days exposure, with CTs corresponding to 502, 503 and 449 g h m-3 respectively. Three days old eggs only required a 3-day exposure at 5.24 g m^{-3} (CT = 377 g h m^{-3}). These CT-products are within the range with corresponding values for lethal CT-products for the other related stored product pest moths *Ephestia kuehniella*, *Plodia interpunctella* and *Ephestia elutella* (Barakat *et al.*, 2009).

Although considerable work has been completed on sulfuryl fluoride, in fact the most commercially adopted method of control of pests of dried fruit is phosphine. It has been widely adopted in all dried fruit producing countries. As temperature is an important parameter, and there are continuing doubts over effectiveness of phosphine at lower temperatures, the following work done in Turkey is helpful. According to Tutuncu and Emekci (2011) phosphine applications at a concentration of 200 ppm (0.28 g m^{-3}) at 15^{O}C gave a complete mortality Table 8-4 gives results of different life stages in detail, with 1-day old eggs requiring longest exposure for full mortality.

By contrast to these chemical-fumigation approaches, Israel has largely adopted heat treatment for disinfestation, control of quality and for ripening of dates. The extensive review paper by Navarro (2006), gives a good understanding of the actions, benefits and practical process of heat treatment. One of the largely overlooked benefits of heat treatment is that during the treatment, the pests exit the fruit trying to escape the heat, a phenomenon also observed during exposure to high CO2 concentrations so that, unlike some chemical treatments, heat treated dates do not contain dead pests. This paper also gives a full explanation of the correlation of moisture factors so key to control of fermentation and that reported by various authors in terms of relative humidity, water activity and/or moisture content. Researchers and growers in Israel have developed and commercialized heat treatment methods even in remote, rural growing areas, with thermal disinfestation now installed in all Israeli date packing houses. This paper also gives a full explanation of the correlation of moisture factors so key to control of fermentation and yet reported by various authors in terms of relative humidity, water activity and/or moisture content.

Table 8-4: Percent mortality of Carpophilus hemipterus after exposure to phosphine.

Table 1. Percent mortality[a] of different development stages of *Carpophilus hemipterus* after exposure to 200 ppm phosphine over differ
exposure times at 15°C

Life stage	Ages of insects[b] (days)	Exposure periods (hours)												
		2	4	6	8	10	12	14	16	20	24	28	32	36
Eggs	1	c	c	c	0.2	c	23.3	c	62.2	67.1	78.9	83.3	95.3	100
	2	c	11.8		34.5	c	78.1	c	83.0	100				
Larvae	12	12.7	56.4	84.1	98.0	98.1	100							
	1	c	c	c	c	21.2	35.4	68.1	85.1	89.4	100			
Pupae	2	c	c	c	29.7	39.2	71.4	90.3	100					
	3	c	c	c	6.5	79.8	92.0	100						
Adults	8	25	56.3	91.1	93.3	94.8	96.8	97.7	100					

[a] Mortalities were corrected by using Abbott's formula.
[b] Age for larval stage from hatching; pupae from pupation; and adults from emergence.
[c] Not tested.

While thermal disinfestation methods have been successfully applied to some dry date varieties (including Medjool), Deglet Noor, Zahidi, and Ameri varieties handled in crates of 200 kg to 400 kg presented some problems. Thermal disinfestation was not successful in these larger crates because of delayed heating due to the resistance of the dates to hot airflow (Finkleman *et al*, 2010). The fumigant formulation of ethyl formate in carbon dioxide (Vapormate™) was tested as an alternative to MB for the disinfestation (proportion of insects found outside the feeding sites) and control of nitidulid beetles from artificial feeding sites at laboratory and for dates in crates at semi-commercial conditions. Vapormate™ contains 16.7% ethyl formate mixed with carbon dioxide. At laboratory conditions the effect of various dosages of Vapormate™ was tested at 30 C and at fixed exposure time of 12 h. Exposure of infested artificial feeding sites by larvae of *Carpophilus* spp. to the concentration of 280 g m^{-3} of Vapormate™ caused 69.3% disinfestation and 79.9% mortality, 350 g m^{-3} resulted in 72.7% disinfestation and 98.8% of mortality and the optimal results were obtained at 420 g m^{-3} that caused 69.6% disinfestations and 100% mortality.

Commercial pilot-plant tests were carried out by applying 420 g m^{-3} Vapormate™ for 12h in a 9 m^3 flexible liner of gas-impervious laminate (polypropylene/aluminum/polyethylene) to cover crates containing infested dates. Disinfestation (removal of larvae from infested dates) was tested on naturally infested dates that resulted in an average 100% disinfestation and 95% mortality, while with the artificially infested dates, disinfestation was 97% and mortality 96%. In a second series of tests, a commercial rigid fumigation chamber of 95.6 m^3 was used. After 12h exposure, 100% mortality was recorded in all date samples. Following the promising results, Vapormate™ was registered in Israel for use by the date industry as an alternative to MB (Finkleman *et al*, 2010).

While not registered for use on dates in the United States (the location of the present CUN), ethyl formate is registered and effective as a pest control additive for dates in some other date-producing countries.

In North Africa, dates are harvested and marketed at three stages of their development. These stages are called: Khalaal, Rutab and Tamr. The most common harvesting stages are the two last ones, being later stages of maturity. The choice for harvesting at one or other stage depends on varietal characteristics, climatological conditions, custom and market demand.

Phosphine fumigation has replaced post harvest methyl bromide fumigation of dates (if it was used) in packing houses in Algeria, Tunisia, Egypt, Jordan, UAE, KSA and in other date-producing countries. Phosphine is either supplied by tablet formulations or a phosphine generator, but mainly now by phosphine generator (P Asher, Mohamed Besri, pers. comm.). The dates treated by this process include typical dry-harvested high-moisture dates, referred to in Decision XV/12. The latter, cv 'Deglet Noor', are harvested at higher moisture contents and then treated and stored in a way that prevents fermentation and moulding while preserving their desirable appearance and marketability. The process includes an initial dipping of the freshly harvested fruit in warm sugar syrup, drying, fumigation, further processing followed by cool storage.

Application has been made for registration of an ethyl formate/CO_2 fumigant formulation for dates in Tunisia for dates (C. Dolman, pers. comm.) and use of controlled atmosphere treatments are under consideration.

8.3.3 Alternatives for control of pests of Southern cured pork

In certain Southern US states, typified by at least one season of cool (but not freezing) weather, and by warm days and cool evenings in another season, and where historically a major salt source was nearby, a natural, cured pork product was developed, utilizing weather changes, salt, sometimes sugar and the most basic of chemical curing agents. According to *Salt: A World History* by Mark Kurlanski (2003), there is a 'pork belt' around the globe where the similar climatic conditions and regional availability of salt resulted in different, but similar, parallel development of natural cured pork products. So, similar, natural regional cured pork products were developed, for example, in China, Italy, Germany, Spain, and parts of the Southern United States. There are differences in the pork products produced in these regions resulting from variances in local weather patterns and resulting from historical differences in processing methods and use of additives.

Although most other cured pork methods have been modernized (with considerable change in the resulting product), this tradition of natural and lengthy pork curing continues today in those regions. The pork products have different names, and in the United States this Southern dry cure pork product is often called Country Ham (even though it might not be just the leg portion). Production of Country Ham while small in the context of total cured pork production in the United States, is not inconsequential. It has been reported to MBTOC that 45 Country Ham facilities produce three to five million hams each year – and these may require fumigation against pests.

All these natural pork products are subject to pest infestation, in part because of the lengthy storage time required for flavour development. The length and situation of the storage rooms and difference in type of curing agents (which by chemical manipulation can encourage or discourage pests) all can impact the extent, types and balance of pest infestation of that region's pork product. However, in a survey of American cured pork producers reported to MBTOC, the most significant factor in the development of pest infestation is length of storage. Hams which are stored for longer than six months were more often infested than those stored less than six months. Resolving this is not simply a matter of shortening storage time, however, since storage times of greater than five months is considered necessary for the product to achieve the correct flavour profile and the longer stored hams are considered better quality.

The pests most commonly reported are beetles (*Necrobiarufipes* (red-legged ham beetles) and mites (*Tyrophagus putrescentiae* (ham mites). The red-legged ham beetle reportedly causes 50-60% of the infestations and the ham mite causes 60-70% of the infestations. Of these, the most difficult to control are mites. Mites are acknowledged to be very difficult to kill with phosphine, and in tests of the effectiveness of SF in 2008, control of the ham mites required three times the US legal limits of SF (Phillips, et al., 2008). (This trial was for research only – commercial application of SF at this level is not a registered use.)

Currently in the United States, there are three fumigants registered to control the pests of Southern cured pork: MB, phosphine and SF.

Research in the US can be summarized as first improving integrated pest management and sanitation approaches. Then, lab scale studies were conducted to determine if the target pests were killed by the approved fumigants, and other known methods of pest control. The approaches successful at lab scale were trialled at larger scale.

Improving IPM and sanitation was difficult to manage in the largely traditional Southern cured pork storage setting. US researchers noted that improved control of pest harbourage in the exterior of the facilities has been conducted. Some companies eliminated grass, trees, and shrubs from their buildings and replacing them with gravel, as suggested by researchers in 2008, to reduced harborage for pests outside their aging houses. These efforts have reduced their use of methyl bromide, but have not eliminated the need to disinfest their dry, cured pork products. Sanitation of storage rooms and equipment in between production runs has reportedly been improved. These aspects are largely meat processing approaches, rather than entomology approaches. This effort has been led by Dr. Wes Schilling of Mississippi State University.

Entomologists, led by Dr Tom Phillips of Kansas State University, have conducted tests to determine if phosphine treatments could be effective against ham pests. Early lab scale tests determined some effectiveness of phosphine against the target pests. Investigators achieved 100% mortality of all life stages of red-legged ham beetles and ham mites with 48 hours exposure at 400 and 1000 ppm of phosphine, respectively (Sekhon, *et al*. 2009b; Phillips, 2009; Sekhon *et al*., 2010c). In addition, residual phosphine concentrations in dry cured hams that were fumigated for 48 hrs at 1000 ppm were below 0.01 ppm, the legal residual limit in stored food products (Sekhon, *et al*. 2009b; Sekhon *et al*., 2010c); and consumer panellists could not detect differences between control and phosphine fumigated samples at 1000 ppm (Sekhon *et al*. 2009b; Sekhon *et al*., 2010c). Therefore, phosphine was considered a potential alternative to methyl bromide for controlling arthropod pests of Southern dry cure hams. Further testing with a greater number of mites indicated that a greater concentration of phosphine (>1000 ppm) is likely necessary to kill substantial mite infestations.

These lab scale tests using phosphine led to fumigation trials conducted in May, October, and November 2011 in 30 m^3 shipping containers intended to simulate dry cure aging ham houses at phosphine concentrations ranging between 1000-2000 ppm and exposure times of 48 or more hours. Temperature was measured in the ham houses during fumigation and twenty *Tyrophagus putrescentiae* (ham mites) bioassay jars and ten *Necrobia rufipes* (red-legged ham beetles) jars were placed in each shipping container for each trial. Ten dry cure hams were hung from racks in shipping containers to simulate dry cure aging conditions. Five of these hams were used for mite inoculation and the other 5 hams were used for sensory analysis and phosphine residue testing. The lean portion of the dry cure hams (that were used for inoculation) was also inoculated with a mixed culture of approximately 1000 mites. Phosphine gas was produced in the shipping containers using magnesium phosphide cells that reached target fumigation doses at between 8 to 12 hours after the fumigation was started. Phosphine concentration was measured in the shipping containers using both Dräger tubes and a calibrated UV-VIS detector.

The post-embryonic mite mortality was 99.8% in the bioassays at two weeks post fumigation when 2000 ppm phosphine was achieved, but the eggs on either the hams or in the bioassays were not controlled, even at concentrations as great as 2000 ppm. If the pest eggs are not controlled the product would be infested again within days.

The US indicated that it next intended to fumigate at 2000 ppm for 72 hours to determine if greater control of ham mite eggs can be reached with a longer exposure time when the temperature is greater than 20^o C. A trial fumigation of 72 hrs in November 2011 had been planned; however, the ambient temperature was already too cold (<15^oC) to achieve successful control of ham mites in this follow up trial. Earlier investigations presented at 2010 MBAO at temperatures of 20ºC or greater, all life stages of red-legged ham beetles were controlled in all fumigation trials. Variations in test conditions indicated that temperatures and exposure time need to be optimized for fumigation since 48 hours was not long enough to control ham mites at 2000 ppm and ambient temperatures below 15ºC decreased the effectiveness of the fumigation against both ham mites and red legged beetles.

For the sensory tests, ham slices were oven baked to an internal temperature of 71ºC and served to trained panellists. A randomized complete block design with three replications was used to determine if trained panellists (n=6-8) could detect a difference between fumigated and non-fumigated hams in sensory difference from Control Tests. Sensory tests indicated that trained panellists could not determine differences (P>0.05) between phosphine treated dry cured hams and non-fumigated hams. In addition, residual phosphine concentration was below the legal limit of 0.01 ppm w/w in ham slices that were taken from phosphine fumigated hams. Further research is underway to determine if phosphine can be used at the plant level to control ham mite infestations.

Following this work, one phosphine fumigation trial (Zhao et al 2012b) was conducted in a 1,000 m^3(36,000 cubic feet) processing facility at 1600 ppm. Ham mite assays with live mites were distributed throughout the aging room. After 48 h of fumigation at 1600 ppm (26ºC, 70-80 % RH), there were no living ham mites in the assays. However, phosphine fumigation corroded the electrical switches to the fans, and these switches had to be replaced. In addition, the research needs to be repeated when many hams are infested with mites to determine if it is effective in real world situations. In addition, if phosphine is going to corrode and incapacitate electrical equipment, it may not be adaptable to the industry.

In spite of the inadequate control of pest eggs achieved, research to try to optimize this approach continued with the hope that some process might be found that was effective. Sensory tests indicated that trained panellists could not determine differences between phosphine treated dry cured hams and non-fumigated hams (P>0.05). In addition, residual phosphine concentrations were below the legal limit of 0.01 ppm in ham slices that were taken from phosphine fumigated hams. Thus maintenance of post-treatment market quality and food safety support continued research on efficacy of phosphine fumigation for hams. (Phillips, et al. 2008)

Previously CUNs from the US had described the failure of SF, carbon dioxide, and ozone to control ham mites and red legged ham beetles (as was expected by MBTOC researchers). Also the US previously reported the results of low pressure and low oxygen concentrations on ham mites under laboratory settings, which took too long to be a viable option at this time.

The results of investigations with carbon dioxide, phosphine, methyl bromide and ozone treatments on *Tyrophagus putrescentiae*, ham mite, and *Necrobia rufipes*, red-legged ham beetle, were presented at the 2009 MBAO Conference, in San Diego, CA (Sekhon *et al*., 2009a, b; Phillips, 2009, Phillips *et al*. 2011, Sekhon *et al*., 2010b, 2010c). The studies included eggs and a mixture of adults and nymphs of mites and eggs, large larvae, pupae and adults of beetles. The experiments were conducted for variable times at 23°C at various concentrations of carbon dioxide, phosphine, methyl bromide and ozone. The investigators achieved mortality of all life stages of mites with a concentration of 60 % carbon dioxide with 144 hr of exposure (Sekhon *et al*., 2009a; Phillips, 2009; Sekhon *et al*., 2010b). However, fumigation with carbon dioxide would likely not be applicable since ham structures are not airtight and 144 hr is too long of a time to fumigate the hams. In addition, a carbon dioxide concentration (> 80 %) with an exposure time of 144 hr was necessary to cause 100 % mortality for all life stages of red-legged ham beetles (Sekhon, *et al*. 2009a; Phillips, 2009; Sekhon *et al*, 2010b). .

MBTOC, in its text boxes responding to critical use nominations for this application, explained that other regions employed hot dips of lard or oil to control pests of similar cured pork products. MBTOC also suggested physical exclusion by means of fine mesh or air blowing out of the curing chamber could help avoid mite infestation. Lehms *et al.* (2012) showed that nets of 30 µm were sufficient to keep out all stages of the mite *Tyrophagus putrescentiae*. This needs to be confirmed in commercial process and to resolve practical questions. For example, the mesh could be used to form a shroud over the hanging shelves of hams to keep mites infesting the aging room from attacking the clean hams. MBTOC suggested that the Party examine these possibilities, and examine increasing the temperature during fumigation to enhance effectiveness; the Party informed MBTOC in 2013 that it is doing this.

Following MBTOC's suggestion to try hot dips, US researchers began a series of laboratory experiments (Zhao et al 2012a) in which 1-cm square cubes of ham were dipped into a test compound of a given concentration for 1.0 minute and then placed in a ventilated glass jar and inoculated with 20 adult mites. Jars were held for 14 days to allow for mite reproduction and population growth, after which the total number of mite adults and nymphs were counted and compared to numbers produced on other treated ham pieces and on control hams dipped in water only. Three groups of experiments were conducted that compared common food oils, synthetic polyols and common legal food preservatives. Among oils tested, 100% lard from pork fat completely prevented mite reproduction on treated ham pieces, while vegetable oils such as olive, corn and soybean had minimal effects on mites. Of the polyols, glycerol had little effect on mites while propylene glycol at 100% or 50% prevented mite reproduction. Other short-chain diols had significant effects on mite reproduction. Of the other food preservatives tested, the various salts of sorbic and propionic acids were effective at preventing mite growth when applied as 10% solutions in water. Research so far suggests that approved food oils and synthetic food preservatives show potential for protecting dry cured hams from mite infestation, and future work will need to address the effects of these additives, if any, on the quality of hams during the aging process and on consumer acceptability.

In additional studies (Zhao *et al*., 2012b), ham slices and 1-cm square cubes were dipped directly into either mineral oil, propylene glycol, 10% potassium sorbate solution or glycerin for 1 minute and dripped on a mesh colander for another minute. Lard was applied directly by rubbing a thin layer to cover the whole piece. Ham cubes (2.5 cm ×2.5 cm × 2.5cm) were used for the mite infestation study. During the study, 20 mites (mostly adult female) were placed on one cube of ham, which was placed in a ventilated, mite proof glass container and incubated for 21 days at 27ºC and 70% relative humidity. Mite populations on ham cubes were counted every week. Coatings on ham slices were washed off before cooking. Ham slices were oven baked to internal temperature of 71°C and served to trained panellists for sensory Difference from Control tests. A randomized complete block design with 3 replications was used to determine if differences ($P<0.05$) existed between treatments with respect to mite number and sensory differences between products.

Results indicated that both lard and propylene glycol were effective ($P<0.05$) at controlling mite reproduction. No difference was detected in sensory characteristics between control ham slices and samples treated with food grade ingredients. In addition, potassium sorbate and mineral oil did not inhibit mite reproduction but slowed mite growth ($P<0.05$) when compared to the control, and glycerin was ineffective at lowering mite counts ($P>0.05$) when compared to the control.

The majority of research that has been conducted on use of food grade ingredients with meat products has been to prevent water loss and reduce rancidity of meat products. However, a finished ham product needs to lose at least 18% of its original weight during aging. At the same time, the unique flavors of dry cured ham are caused by proteolysis and lipolysis with the presence of oxygen. In this case, water vapor permeability of the films and coatings needs to be considered when choosing a proper coating. Current and future research is being conducted to develop a cost-effective food grade coating with high oxygen and water vapor permeability.

Based on the research studies described above (Zhao *et al.,* 2012a), the active ingredients that show the most promise as potential methyl bromide alternatives are propylene glycol, butylate dhydroxytoluene (BHT), and lard. Propylene glycol (PG) is likely the most feasible food-grade ingredient that could be used to control ham mites but is also relatively expensive. BHT is effective at controlling mites on ham pieces at a concentration of 10 %. However, 0.01 % BHT (by fat percentage) is the acceptable level in some meat products. This makes it unlikely that it would be accepted for use, but may have application if it can be washed off the surface and there is less than 0.01% BHT in the finished product. Lard was effective at controlling mites on ham pieces. However, use of lard may prevent moisture loss and transmission of oxygen which would prevent the preservation and flavour development of the ham. However, these 3 ingredients need to be evaluated on whole hams for their ability to control mite infestations. In December of 2012, research was started on whole hams such that the hams are treated with BHT, lard, or propylene glycol. Hams will be infested with a known number of mites and evaluated over 3 weeks for the number of mites on the hams. In addition, propylene glycol will be used in food-grade gel coatings to determine if incorporating PG in a gel will prevent evaporation of the PG and prolong its effectiveness at controlling mites. US researchers indicated they will also work with processors to implement PG and other food grade products that may control mites in their plants to determine their impact in industrial settings.

Part of the problem of conducting research on ham mites is the practical difficulty of assessing their presence and counting them. (Mites are microscopic.)

To help resolve this problem, Dr Phillips' research group (Zhao *et al*., 2012b) developed a mite trap based on the basic design of a trap first developed in England. This trap consists of a 90 mm disposable plastic Petri dish that is painted black on the entire outer surface. Around the sidewall of the dish are eight evenly spaced holes, approximately 0.5 mm in diameter, at 2 mm above the bottom of the dish for entry of responding mites. A food bait was placed inside the middle of the dish and was a 25 mm diameter circular plug of mite diet, approximately 10 mm high. Mite diet was composed primarily of ground dog food with yeast, glycerin, anti-fungal agent and gelled with 2% agar. Mites respond to the baited dishes, enter the holes in the side wall, and feed to the diet plug where they mate and lay eggs. Laboratory studies confirmed that traps baited with diet were highly attractive to mites compared to unbaited traps. A study was initiated to monitor mite populations in which twenty traps were distributed evenly throughout each of three different ham production facilities for consecutive one-week periods. Mite numbers lured to traps varied from zero to several hundred in one week, and seasonal trapping determined that certain areas of facilities had higher mite activity than other areas. Traps confirmed that fumigation in certain circumstances caused severe reduction in mite populations, and showed that mites would slowly increase activity following fumigation.

In summary, to MBTOC's knowledge no other similar traditional cured pork product is disinfested with methyl bromide. Although there had been some promising results of potential alternatives for mite control in dry cure hams at lab scale, currently, no fully effective treatment has been found which controlled the target pests at commercial scale for Southern cured pork production.

8.4 Methyl Bromide for QPS uses and response to Decision XXIII/5

8.4.1 Methyl Bromide production and consumption for QPS (exempted uses)

Data on MB-QPS consumption and production presented in this report were obtained from the Ozone Secretariat's Data Centre, which is based on Article 7 of the Montreal Protocol mandating Parties to report data on ODS consumption and production annually, including the consumption and production of MB for QPS.

Recent Decision XXIV/14 of the 24 MOP seeks to clarify the submitted information by requesting parties that,

> *.... when reporting production, imports, exports or destruction, to enter a number in each cell in the data reporting forms that they submit, including zero, where appropriate rather than leaving the cell blank;"*

and further asks the Secretariat,

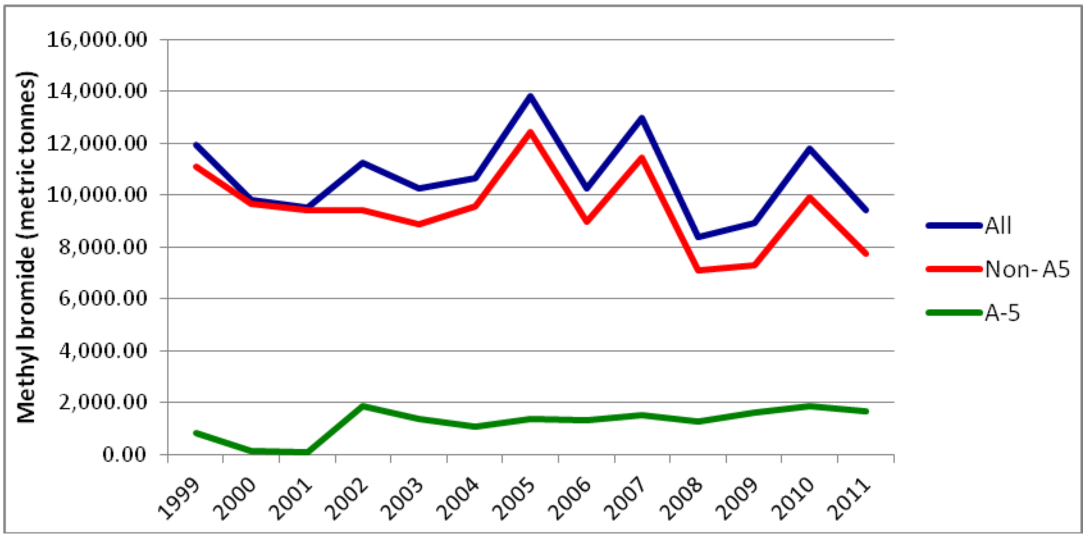
> *".... To request clarification from any party that submits a reporting form containing a blank cell."*

On this basis, (and just as in past reports), MBTOC did not assume that any blanks in the Secretariat's database indicated zero consumption by the Party. The following sections provide a brief update of production and consumption of methyl bromide for QPS purposes up to 2011, the most recent year for which data was available at the time of preparing this report.

8.4.1.1. Production of Methyl Bromide for QPS uses

Global production in 2011 was reported at 9,436 metric tonnes, down from 11,477 metric tonnes in 2010 as shown in Fig.8-5. Average global production over the past 13 years (1999-2011) was 10,692 tonnes.

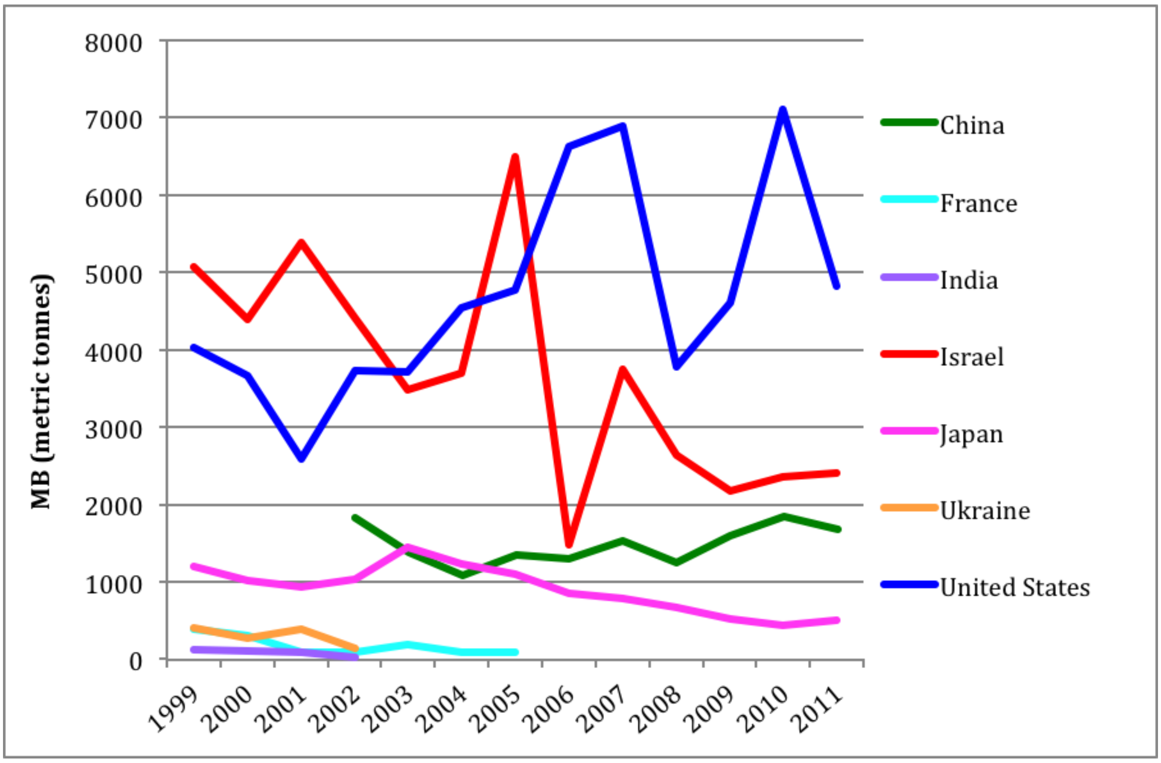
Fig. 8-5: Global production of Methyl Bromide for QPS uses 1999 – 2011



Source: Ozone Secretariat Data Centre, March

Three non-A5 Parties (USA, Israel, Japan) presently produce methyl bromide for QPS purposes. Compared to 2010, the quantity of QPS methyl bromide produced in 2011 decreased in the USA, and increased (about10%) in Israel and Japan. Japan has shown a consistent reduction trend since 2003, whilst the USA and Israel show relatively large fluctuations over several years, as shown in Fig 8-6.

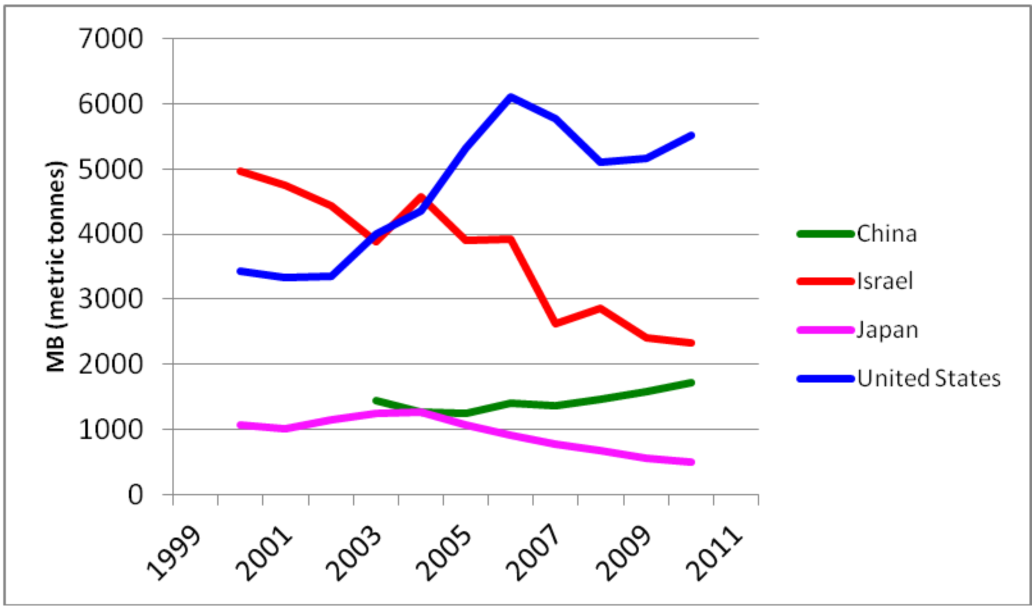
*Figure 8-6: Production of MB for QPS uses per country 1999 -2011**



Source: Ozone Secretariat Database, April 2013

Average trends taken over several years indicate a falling QPS production in Israel but stable or rising production in the USA although lower than in 2006 as illustrated by Figure 8-6a, based on three-year running averages.

Fig 8-6a: Production of MB for QPS uses 1999 -2011 (three-year running averages)



Source: Ozone Secretariat Data Centre, March 2013

Two A5 countries have reported production of methyl bromide for QPS since 1999: India and China. India last reported QPS production in 2002 and has not reported any production since that time. India was believed to have ceased production in 2003 (Ozone Secretariat Data Access Centre; Pak Chun Il, 1999, *pers. comm.*; S.K. Mukerjee, 2006, *pers. comm.*). However, several companies in India indicate on their websites that they manufacture MB (for QPS, non-QPS and/or feedstock uses)[6]. China's production each year has ranged from 700 tonnes in 1999 to 1,680 tonnes in 2011. Overall, China's production of MB for QPS shows a slightly increasing trend since 2004 (Figure 8-6a).

8.4.2 Consumption of Methyl Bromide for QPS uses

8.4.2.1 Global consumption

Fluctuations in consumption of methyl bromide for QPS purposes are also observed from year to year. However, reported consumption in Article 5 Parties shows a consistent upward trend since 2000, and has been higher than that of non A5 Parties since 2007 to varying degrees. The overall trend in QPS consumption is shown in Figure 8-7.

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[6] Websites for Indian companies:

http://www.indianchemicalportal.com/methyl-bromide.html
IntechPharma: http://www.ippl.co.in/company.html

Sarti Chem Ltd: http://sarthichem.com/ **and** http://sarthichem.com/product.html

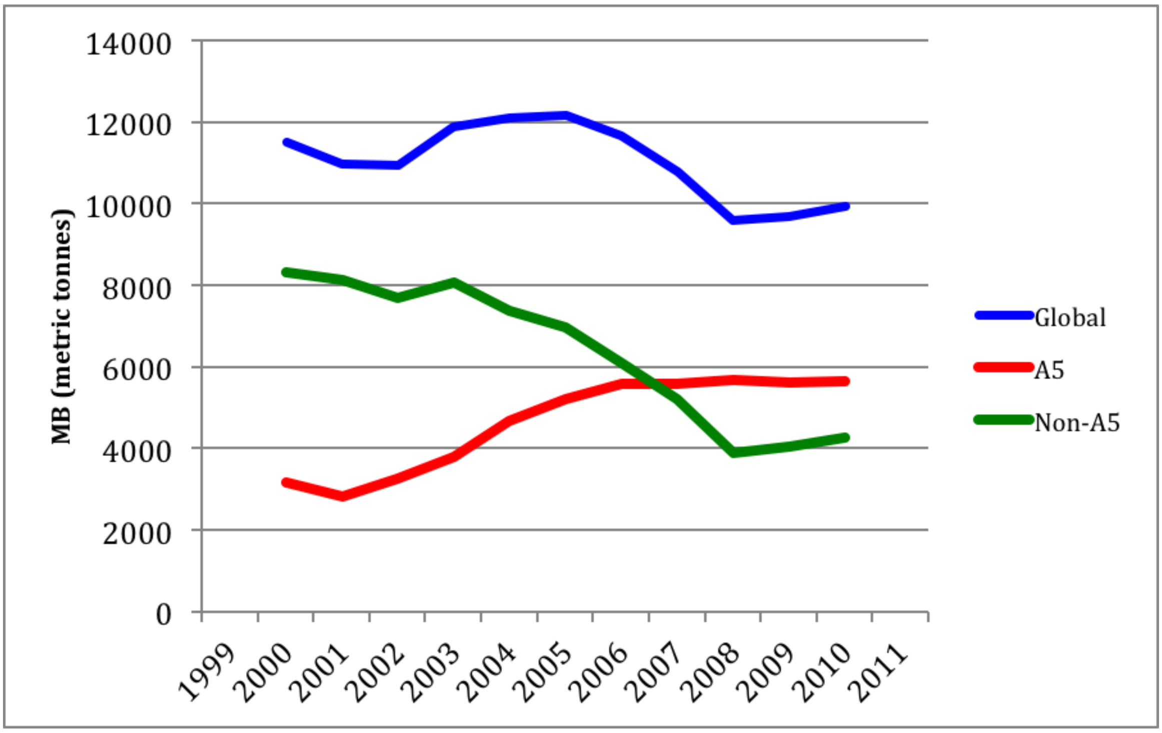
Sang Froid Chemicals**:** http://trade.indiamart.com/search.mp?search=methyl+bromide

Chemtron Science Laboratories: www.chemtronscience.com

Consumption of MB for QPS in 2010 was similar in A5 (5,558 tonnes) and non-Article 5 Parties (5,355 tonnes), but was larger in Article 5 Parties in 2011 (5,880 metric tonnes vs. 3,812 metric tonnes for non-Article 5 Parties). Global consumption was however lower in 2011 as compared to the previous year.

Overall global consumption for the last three years has been relatively stable at about 2,000 tonnes below the high years of 2005 and 2006, most probably, at least in part, as a consequence of the MB ban for QPS uses since 2010.

Fig 8-7: Global consumption of Methyl Bromide for QPS uses 1999 – 2011*

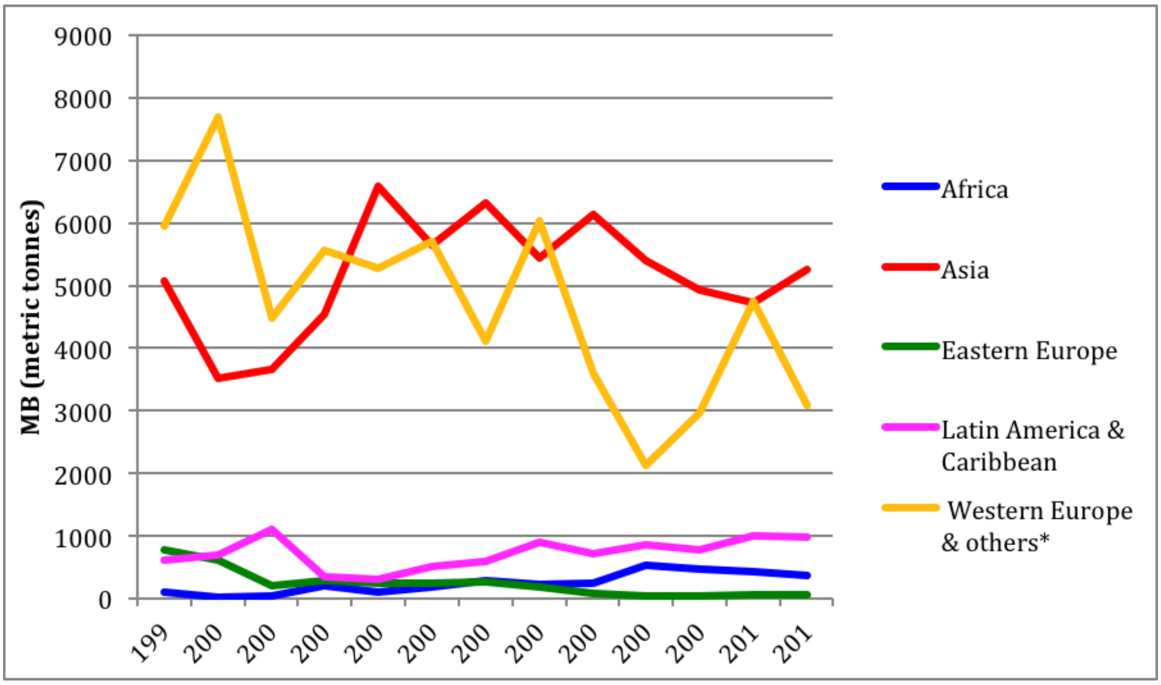


Source: Ozone Secretariat Data Centre, March 2013. * Three-year running averages

8.4.2.2 Regional consumption

Regional consumption of methyl bromide for QPS was examined according to regional groups of countries established by the Ozone Secretariat as shown in Fig 8-8.

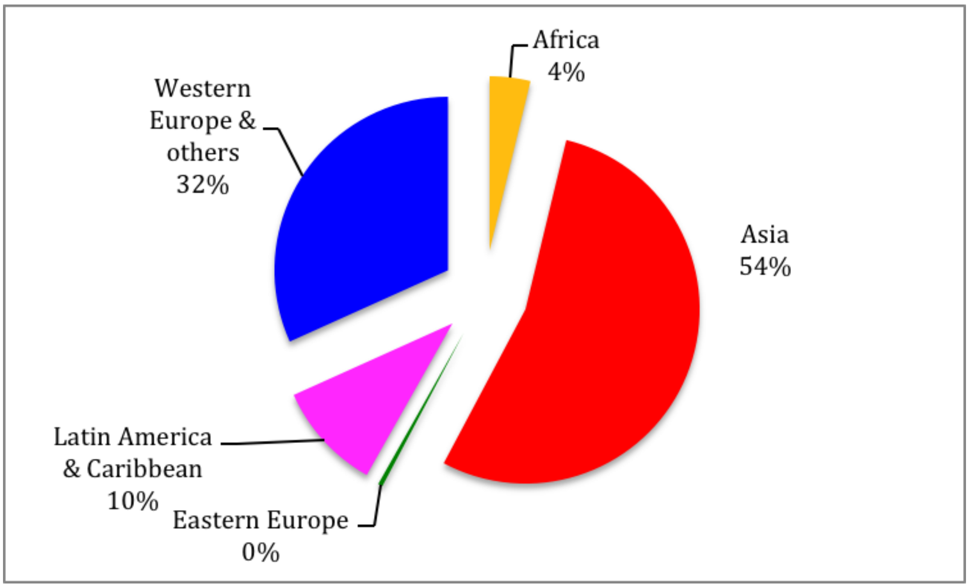
Figure 8-8: Regional Methyl Bromide consumption for QPS uses 1999-2010



Source: Ozone Secretariat Data Centre, March 2013.

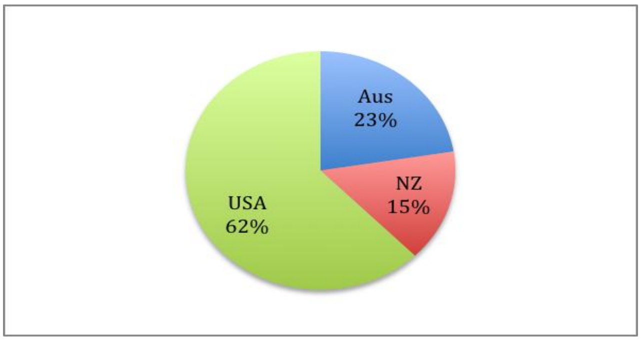
Reported consumption in 2011 is compared on a regional basis in Fig 8-9.

Figure 8-9: Regional consumption of MB for QPS uses in 2011



The "Western Europe and Others" Group comprises includes 16 member states of the European Union plus 9 Parties (Australia, New Zealand, European Union, Holy See, Iceland, Norway, Switzerland, USA). With respect to MB for QPS uses only four Parties reported consumption in 2011, Australia, New Zealand, USA and a relatively small amount by Canada (approx. 1 tonne) as shown in Fig 8-9a.

Fig. 8-9a: Reported MB consumption for QPS purposes in the region "Western Europe & others" in 2011



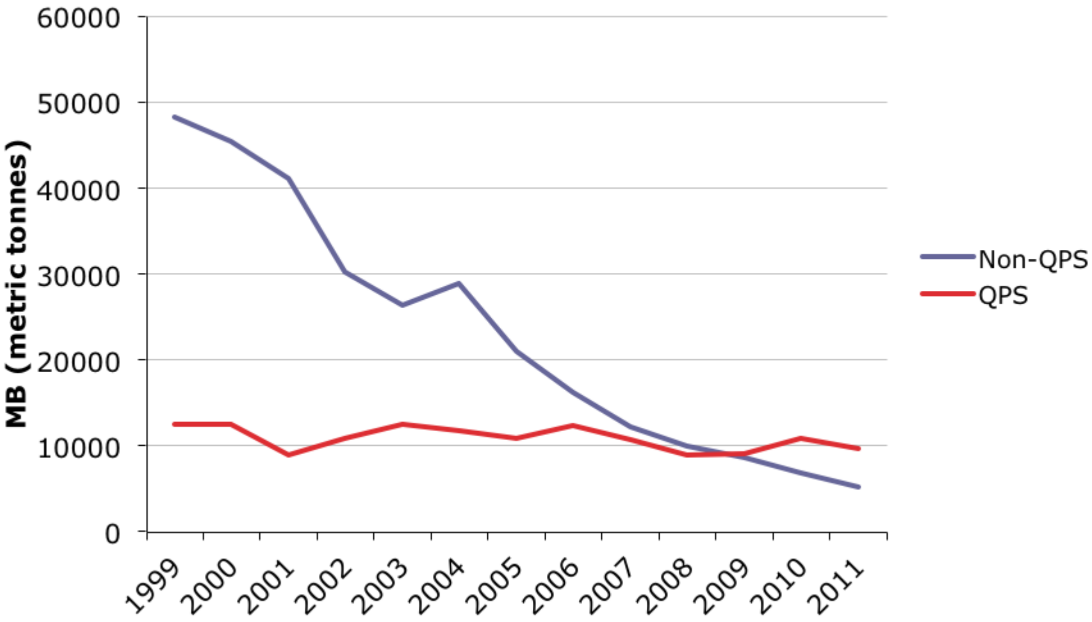
Source: Ozone Secretariat Data Centre, March 2013.

The "Asia" group comprises 56 Parties including China, Republic of Korea and Israel. Non-A5 consumption of methyl bromide for QPS uses is presently concentrated in four countries: Australia, Japan, New Zealand and the United States. These accounted for 97% of non-A5 annual consumption in 2011. There were twelve A5 Parties that reported MB-QPS consumption of more than 100 tonnes in 2011. Aggregated annual consumption for these twelve Parties accounted for 83% of total A5 consumption of MB for QPS purposes in 2011. Aggregate consumption in A5 Parties shows upward trend with respect to non-A5.

8.4.2.3 Non-QPS vs. exempted MB consumption

Reported global consumption of methyl bromide for QPS uses was greater than consumption for non-QPS uses for the first time in 2008. This trend, which is related to progress made in phasing out methyl bromide for controlled uses globally, has continued since that year as seen in Fig 8-10.

Figure 8-10: Comparison of non-QPS and QPS global consumption from 1999 to 2011



Official reports submitted by Parties in accordance with Article 7 of the Montreal Protocol; data in the report stored in the Ozone Secretariat Data Centre, April 2013.

8.4.3 *Update on the registration status of alternative fumigants for QPS*

8.4.3.1 Progress in the registration of alternatives to MB for QPS treatments

There are a number of constraints to the replacement of MB for particular QPS uses. It is necessary in most countries to have registration to use of the chemical for application to the treated commodity and situation, in addition to the need to show efficacy of candidate alternatives to appropriate standards for QPS. Registration of three fumigants, cyanogen ('ethanedinitrile or EDN), an ethyl formate / CO2 (Vapormate) and carbonyl sulphide ('Cosmic') continues to progress in several countries, as reported by the Linde Group, manufacturer of these products (see http://www.linde-gas.com.sg/en/products_and_supply/fumigants/index.html)

Linde Gases, a division of The Linde Group, is opening a EDN manufacturing plant in the Czech Republic in May 2013. This should allow commercially quantities of EDN to be available for use, hitherto an major impediment for trialling and commercial application of this fumigant as an MB replacement.

a. EDN

EDN is likely to be technically suitable for QPS timber fumigation, very possibly including pathogen control, some soil fumigation, grain devitalisation and possibly some other QPS treatments of durable and perishable foodstuffs presently using MB. Penetration in timber (Ren et al 2011) is better than both MB and sulphuryl fluoride, another candidate fumigant for QPS treatment of timber and logs. It can be used on wet timber and is a very good fungicide. Barrier films are likely to be used with EDN for soil fumigation to prevent the fumigant from immediately dissipating or dispersing into air. EDN rapidly degrades soon after application to release mainly innocuous products, but sometimes including hydrogen cyanide.

The manufacturer, Linde Gases is further expecting registration to be completed this year in Australia and New Zealand. The registration process is also progressing in SE Asia, South Africa, Israel and being reviewed in a number of additional countries. Market acceptance tests are currently being run in many of these regions as well (Jessup et al, 2012).

b. Ethyl formate + CO2 (Vapormate)

Ethyl formate mixed with CO2, as Vapormate is being increasingly used for fresh fruit and other perishables in situations where MB could be used, particularly where target pests are on the outside of the treated commodity. Vapormate is a rapid acting, non-residual post-harvest fumigant for the control of insects (adult, juvenile and eggs) in stored grain, oilseeds, dried fruit, nuts, fresh produce (e.g. bananas, blueberries) and cut-flowers, enclosed food containers and food processing equipment. It is also a naturally occurring compound in the environment and present in some plants/food products.

The residues from ethyl formate quickly break down to levels occurring naturally in food and in the environment. Ethyl formate is effective at cool temperatures and therefore does not reduce the shelf life of products. Its activity is strongly synergised by CO2. Vapormate is registered in Australia and New Zealand for a range of postharvest durable commodities as well as cereal grains. It is also registered in South Korea and used for fumigating imported bananas. Registration is also progressing in SE Asia, South Africa and the US and Tunisia. BOC South Pacific Co. is continuing with industry market acceptance tests.

Vapormate use is increasing and has been used successfully controlling surface pests on export blueberries in New Zealand where some 120 consignments have been treated in shelf ready packaging and passed phytosanitary inspection with no live pests found immediately after treatment (Glassey, pers comm.).This contrasts with MB fumigation where some pests can take some days to die at rates suitable for fruit. Apples infested with eucalyptus weevil have been successfully treated in four large field trials with ethyl formate at 50-55g/m3 for 24 hours at 4-8^{o}C with no harm to the apples (Agawal et al 2012). Vapormate also successfully treated overwintering mites, *T. urticae*, on persimmons in 6 hours at 5^{o}C with 147.98mg.h/m3 and scale insects, A.kaki, at 41.12 mg.h/m3 (Cho et al 2012).

Narasimhan et al. (1986) found that ethyl formate has comparable penetration properties through twelve types of plastic and paper/foil packaging. Thalaviassundar am and Royce (CAF 2012) found that ethyl formate penetrated through the commercial cardboard and plastic wrapping of sultanas.

In Japan, mortality tests are being carried out with a mixture of ethyl formate gas and carbon dioxide for controlling leafminers (*Liriomyza sativae*&*L. trifolii*), spider mites (*Tetranychus cinnabarinus, & T. Kanzawai*), scales and mealybugs. All spider mites except for diapause adults of *T. kanzawai* were killed with the gas mixture at a dosage rate of 250 mg/l, and diapause adults were killed at 350 mg/l. Control of pupal stages of both leaf miners was less effective (Yamada et al. 2012). Quality changes in banana, pineapple, strawberry, grapefruits, Satsuma mandarin, squash, string bean, parsley and broccoli are also investigated in Japan; it has been found that the gas mixture of ethyl formate and carbon dioxide is an effective quarantine treatment of fruits that could be adopted in the near future. Some degree of damage has been observed on leafy vegetables, but changes in flavour were observed in parsley (Misumi et al., 2013).

While the price per kilo is comparable to methyl bromide it is more expensive to apply due to the higher application rate but does have the advantage of lower phytotoxicity and immediate death of pests.

c. Carbonyl sulphide (COS)

COS is suitable for fumigation of cereal grains for controlling typical grain pests such as grain weevils, moths and beetles in time-critical applications such as at some export grain ports where methyl bromide is still used. Fumigation with COS offers treatment times that are similar to those used with MB and substantially less than the 5 or more days exposure required for full effectiveness of phosphine, another alternative fumigant. COS aerates (disperses) from treated grain rapidly. It is also a naturally occurring compound in the environment and present in some plants/food products. Registration is under consideration in Australia and being reviewed in additional countries. Market acceptance trials have been conducted in Australia.

d. Other fumigants

HCN is a preferred fumigant for bananas and some other imported fruit in NZ, Japan and other countries where methyl bromide might otherwise be used.

Propylene oxide was recently registered in Australia for treatment of almonds against *Salmonella*, however it is an excellent insecticide, with potential to replace MB in some instances (http://www.infopest.com.au/labels/labels/55000/55095_41543g.pdf). This product is also presently registered in Turkey for dried fruit and in the USA for sterilisation of some nuts.

8.4.3.2 International Cargo Biosecurity Arrangement (ICCBA)

Department of Agriculture, Fisheries and Forestry (DAFF) in Australia is progressing a multilateral agreement, the International Cargo Cooperative Biosecurity Arrangement (ICCBA), with 27 countries at the 2013 Quarantine Regulators Meeting in Manila in June 2013. The aim is to improve the application of treatments including methyl bromide to reduce wastage and retreatments.

ICCBA represents an expansion of the Australian Fumigation Accreditation Scheme (AFAS) that trains and audits methyl bromide QPS fumigation operators in a number of countries with the aim of improving application of fumigants, providing better and more reliable biosecurity outcomes and reducing wastage and multiple treatments. Cox (2008) said that there had been a saving of use of approximately 95 tonnes of methyl bromide in Indonesia and Malaysia alone over the 3 years since implementation of the AFAS scheme there. The scheme (DAFF 2013) is now operating in Indonesia, Malaysia, Thailand, the Philippines, India, Papua New Guinea, Vietnam, and Sri Lanka. Full implementation of the scheme in Peru, Chile, China and the countries of Central America (Belize, Honduras, Nicaragua, Guatemala, El Salvador, Mexico, Costa Rica, Panama and the Dominican Republic) is expected in 2013, with continuing negotiations in New Zealand and Fiji.

DAFF Australia with Singapore and New Zealand collaborators conducted research that identified that shipping containers could successfully be fumigated without the need for pressure testing. For containers on a good surface, leak testing, internal concentration monitoring and the sand bagging of gaps to prevent wind movement under the container was sufficient to ensure good routine retention of fumigant. For containers on skeletal trailers the sealing of the floor joins provides sufficient leak prevention. Application of these methods will reduce the amount of methyl bromide required by reducing the volume to be treated compared to covering the container.

8.4.3.3 Research presently under development

a. Khapra Beetle

Paul Fields (Canada) is working with a number of international collaborators to find alternatives including controlled atmospheres, heat, alternative fumigants and other non-fumigant pesticides for controlling the notorious quarantine pest, Khapra beetle, *Trogoderma granarium*. Some strains of the beetle are totally resistant to phosphine. Both Australia and Canada are undertaking work on temperature (both high and low) required to kill *Trogoderma* spp. Canada is obtaining various strains from around the world to test chemical resistant strains. The USA is undertaking work with crack and crevice sprays for control Trogoderma.

b. Controlled Atmosphere Treatment

Controlled Atmosphere Treatment trials on timber pests such as the lesser Auger beetle have been carried out in Australia. Heat treat of caravans and vehicles under tent have been carried out for quarantine (Kershaw, pers comm).

c. Other

USDA PPQ (Plant protection and Quarantine) now has a dedicated treatments laboratory, which is now operational in Miami and will be carrying out research on alternative treatments and inspection methods.

The USA has been conducting vacuum steam treatment trials on wood veneer with good results (Hennessey, USDA PPQ, pers comm). Phosphine combined with a cold treatment is being tested on grapes for mites in the USA.

8.4.3.4 Cases of de-registration and withdrawal of chemical alternatives

A fumigant for logs, in the form of a gas mixture of sulfuryl fluoride and MITC (trade name Ecotwin) was deregistered in Japan on Sep. 26th, 2012. According to the manufacturer, Sumika Green Co. Ltd. (formally Yashima industry Co.Ltd.), this action was taken due to various problems associated to the use of this fumigant for plant quarantine fumigation under practical circumstances. Economic hurdles for maintaining registration of this fumigant were also cited (FAMIC, 2012).

Methyl iodide was withdrawn from the market by the manufacturer for all uses in Australia, New Zealand and the USA in 2012, including potential QPS uses (registration remains valid but the product is no longer commercially available). MI is still registered in Japan but recent demand for iodine is rapidly increasing for medicinal and industrial purposes and iodine price is expected to remain high over the coming years (Table 8-6), possibly affecting MI supply.

Table 8-6. Iodine price change in Japan

2010	2011	2012
26	32	55

US$ / Kg, Source: Import iodine price report (1 US$= 95 yen)[7]:

The USA obtained approval for use of sulfuryl fluoride (SF) on logs to China (Jeffers et al, Baca 2012), however this approval was recently withdrawn (Vick, pers comm 2013). SF is presently on the Australian label for use on logs.

8.4.4 International Plant Protection Convention – Review of ISPM 15

The IPPC is an international agreement aiming to protect cultivated and wild plants by preventing the introduction and spread of pests. The IPPC develops standards, guidelines and recommendations that are recognized as the basis for phytosanitary measures.

Standards adopted by the CPM may result in a decrease in the use of MB if they include MB-free options and if they are adopted for pest and disease control by countries. The standards are voluntary and can be useful guidance for Parties wishing to establish a phytosanitary agreement for new trade, or for establishing the appropriate protocols for existing trade. National Plant Protection Organisations (NPPOs) are required by the IPPC to take into account a previous Commission on Phytosanitary Measures (CPM) Recommendation "*Replacement or reduction of the use of methyl bromide as a phytosanitary measure (2008)*" (IPPC, 2008).

8.4.4.1 MOU between IPPC and the Ozone Secretariat (UNEP)

On November 14, 2012, during the 24th Meeting of the Parties of the Montreal Protocol, IPPC and UNEP (Ozone Secretariat) signed a Memorandum of Understanding (MOU) by which they agreed to jointly promote a wider implementation of existing recommendations regarding methyl bromide as a quarantine treatment and support efforts to develop alternative phytosanitary treatments to replace it. The MOU aims at strengthening information gathering on how methyl bromide is currently used for quarantine purposes in order to identify opportunities for shifting to alternative measures; improving regional and international coordination regarding MB management; fostering information exchanges and cooperative research aimed at reducing emissions of the gas and developing alternative phytosanitary treatments; and promoting best fumigation practices in order to minimize MB emissions and encourage wider use of methyl bromide recovery and recycling technologies.

8.4.4.2 ISPM-15 Standard for Wood Packaging Material - update

The IPPC's 'Technical Panel on Phytosanitary Treatments' (TPPT) and the 'Technical Panel on Forest Quarantine' (TPFQ) continue to consider additional treatments for inclusion in ISPM-15 standard containing phytosanitary measures for the treatment of Wood Packaging Material (WPM). This standard currently only allows two processes, the use of MB, or two forms of heat treatment.

[7] Trade statistics of Japan, Ministry of Finance (http://www.customs.go.jp/toukei/info/, [Japanese site])

Despite the widespread availability of heat treatment facilities in A5 and non-A5 countries, some of them have not installed heat treatment facilities[8] and they do not have access to non-wood packaging material[9]. Therefore, alternatives to MB for compliance with ISPM-15 are needed. Brazil has recently reported a portable chamber for heat treatment, consisting of a heating module (tailor made to address specific needs of the consumer) coupled to a light truck and portable chamber, that delivers efficient, on-site heat treatment at costs which are significantly lower than MB (Fitolog, 2013).

A recommendation that the revised annex to ISPM 15 (International Standard for wood packaging material) that included a new treatment using dielectric heating (microwave ovens) go for adoption at the Commission for Phytosanitary Measures (CPM) 8 in April 2013. This was successful after some detailed technical discussions were required on aspects of the revised annex.

The proposal for the use of sulfuryl fluoride for ISPM 15 was not approved at the recent CPM. Although there were no concerns about the science, there were concerns that the treatment would be difficult to implement in practice at the temperatures recommended in the schedule that have not yet been resolved[10].

The Standards Committee of the CPM made several recommendations in 2011 that may enhance the prospects for additional ISPM-15 treatments being developed and accepted[11]:

- That the treatment must be shown to be effective against *Bursaphelenchus xylophilis* (pinewood nematode, PWN) and *Anoplophora glabripennis* (Asian longhorned beetle, ALB).

- That the current list of pests should be narrowed further to individual species if possible and should also focus on organisms to be eliminated at the point of treatment i.e., the issue of infestation after treatment should not be considered.

- That any new treatment was recommended to be at least as efficacious as heat and methyl bromide that are already approved for ISPM-15. As the efficacy of these two treatments might not be known, the Committee recommended that an expert judgement of their efficacy may be sufficient if exact scientific data were not available, as these data are urgently needed for the approval of new treatments.

The International Forestry Quarantine Research Group at its meeting in September 2011 agreed that Probit-9 was impractical for many wood pests and proposed an alternative approach to treatment that did not prescribe an efficacy target[12]. This three step testing protocol[13] was discussed at length and refinements were made for the consideration of the Technical Panel on Forest Quarantine and the Standards Committee.

8.4.4.3 Cardiff Protocol

The November 2012 meeting of the International Plant Protection Convention (IPPC) Standards Committee in Rome endorsed the use of the so-called 'Cardiff Protocol', a model to estimate the level of treatment efficacy required for treatments for ISPM 15 (wood packaging), to support the development of treatment criteria for ISPM 15. This was also successful and the SC approved a 2013

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8 TEAP. 2009. QPS Task Force Report. A5 facilities Pp 84 ; Non-A5 Pp 52. See also page 99 of TEAP 2010 Progress Report; There are more than 6,000 certified heat treatment facilities deployed globally (Dec XXI/10 2009)

9 TEAP. 2009. QPS Task Force Report. Pp 75-76.

10 CPM 2012/INF/10Rev1, page 2.

11 Standards Committee Working Group Report. 9-13 May 2011. 1314198519_Report_2011_SC7_May_2011-08-24, page 19.

12 CPM 2012/INF/01, page 2.

13 1) Identify the Most Resistant Stage of the pest to the proposed treatment; 2) Determine the treatment conditions to obtain Probit 9 (99.667% mortality) of 30,000 to 100,000 specimens of the Most Recent Stage 3) Semi commercial tests of the treatment.

meeting of the Standards Committee subsidiary group the Technical Panel on Forest Quarantine to compete development of the treatment criteria.

The Technical Panel on Phytosanitary Treatments (TPPT) met in Nagoya, Japan in 2012 to evaluate 27 phytosanitary treatments submitted by contracting parties to the IPPC. Of the 27 treatments evaluated, 6 had been submitted in a new call for phytosanitary treatments earlier in 2012.

The 'Cardiff Protocol', is a model being developed to estimate the level of treatment efficacy required for treatments for ISPM 15 (wood packaging), a standard that includes methyl bromide as a treatment option. It uses a biological systems approach to determine the required level of efficacy for any risk-mitigating measures and considers all factors along the biological pathway, including host or commodity infestation, pest development and survival, and population ecology effects related to invasion and persistence.

Within the biological system there are three particular points defined:

- the **host infestation level**, which is the number of individuals of the pest in question that infest the host or commodity under consideration;
- the **maximum pest limit** (MPL), which is the maximum number of individuals of the pest that can remain after the risk-mitigating measure has been applied. The MPL will apply to the point in the biological system where the measure is applied;
- the **founder population**, which is equivalent to the population size required to establish the pest in the new area.

This information can then be used to calculate the test size required for each of the selected pests. Requirements for a very high mortality of test insects to be demonstrated (e.g. less than 3 survivors out of 100,000) have been a major constraint to approving methyl bromide alternatives for ISPM 15.

8.4.5 Recapture technologies for methyl bromide

8.4.5.1 Background

In theory, recapture provides an attractive means of restricting emissions of the ozone-depleting substance, methyl bromide, to the atmosphere after it has been used in a fumigation. Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer, are urged under Decision VII/5(c) dealing with QPS uses to minimise emissions and use of methyl bromide through containment and recovery and recycling methodologies to the extent possible while XI/13(7) requests Parties to "encourage the use of methyl bromide recovery and recycling technology (where technically and economically feasible)…until alternatives to methyl bromide for QPS uses are available".

Restricting emissions of methyl bromide requires best fumigation practice with good sealing of the fumigation enclosures and optimum dosage rates, as well as a recapture system, excepting where methyl bromide remaining after one fumigation is directly transferred to another fumigation treatment.

In situations where methyl bromide use is permitted and may persist in absence of alternatives, recapture systems appear an attractive option for decreasing emissions to atmosphere, as well as addressing various worker and bystander safety issues associated with methyl bromide fumigations.

Despite these advantages, recapture is little implemented worldwide (estimated <0.1% of total methyl bromide use). All current installations known to MBTOC are for recapture of methyl bromide from QPS fumigations of commodities.

The cost of current systems is a major constraint on the adoption of recapture technologies in both non-A5 and A5 countries. In the absence of regulatory constraints or any incentives, it is difficult for individual fumigation providers to install recapture technologies voluntarily in a competitive situation when other providers in the same area may not do so, thus reducing their comparative costs. Costs of individual recapture systems are very situation dependent, but may add a significant additional cost to fumigations. Furthermore, at this time, there are no approved destruction technologies for methyl bromide in the sense of Decision XV/9 that would allow some ‘credit’ for quantities of methyl bromide destroyed.

Recapture technologies need to be able to remove fumigant concentrations of methyl bromide from the atmosphere remaining in a fumigation chamber or other enclosure. In scrubbing systems where the fumigant-laden atmosphere is blown through the unit and exhausted directly to atmosphere the concentration needs to be reduced to below maximum safe levels in the vented air stream. Typical fumigant concentrations range from a maximum of about 120 g m^{-3} (30,000 ppm v/v) down to about 10 g m^{-3} (2,500 ppm v/v) at the end of treatment, although exit concentrations in some cases may be specified as low as 5 ppm v/v or even less by regulatory agencies consistent with bystander health, environmental or worker safety issues.

At this time, there are no currently operating recapture installations known to MBTOC that operate with the principal purpose of protecting the ozone layer through preventing emissions of fumigant levels of methyl bromide. A system in the port of Rotterdam, Netherlands was installed primarily for ozone layer protection, but no longer is used for recapture of fumigant concentrations. With the total withdrawal of methyl bromide including for QPS in the EU, other recapture facilities for fumigation levels that had been installed there have ceased operation. These were arguably installed for ozone protection as well as for local safety and air quality reasons.

All identified currently operating methyl bromide recapture installations are installed for purposes of ensuring local air quality and bystander and worker safety, usually to meet local regulations and standards.

For example,

- The New Zealand port of Nelson requires methyl bromide recapture on its methyl bromide fumigation of sawn timber from the port, while the Wellington port intend to have similar requirements at the end of 2013. Both installations are to control methyl bromide emissions to meet worker and bystander safety reasons.
- Installations at the inland import terminal at Dallas/Fort Worth Airport, TX, and in Chicago in the USA are operated so that larger numbers of treatments can be carried out while satisfying stringent local total emission rate standards.
- Installations capturing methyl bromide are required for all exports requiring MB fumigation from Laem Chabang, the major port for Bangkok in Thailand (Nordiko Quarantine Systems, personal communication), to meet local air quality standards.
- A large installation at Well-Pict, Watsonville, California, USA operates to scrub methyl bromide emissions from export strawberry fumigations to meet local air quality concerns.

New Zealand EPA has ruled that recapture is required for all methyl bromide fumigations starting 2020.

8.4.5.2 Recycling and reclamation

There appears to be no reclamation and recycling of recaptured methyl bromide at this time. Formerly, an installation in the USA that fumigated cotton at very high rates (see MBTOC 2007) used low temperature condensation to recover some of the added methyl bromide. This was subsequently reused on fresh batches of cotton under fumigation, with appropriate top up. Methyl bromide captured on activated carbon scrubbers could be desorbed by heating and condensed or reused directly. The now discontinued Desclean methyl bromide scrubbing system (see MBTOC 2007) had a facility to do this.

The proportion of the added methyl bromide that reacts with the fumigated commodity to produce bromide ion and other non-volatile constituents sets the upper limit on quantities of methyl bromide that is, in theory, available for recapture. In practice, there are inevitable losses by leakage from a fumigation and removal of all unchanged gas may impractical, because it desorbs too slowly from commodities, often over a period of days or weeks.

As a global approximation, taking these non-volatile products into account, MBTOC (2007) estimated about 82% (range 76 – 88%) of the applied methyl bromide was lost to atmosphere in absence of recapture measures for fumigation of commodities, including timber. With a practical efficiency of recapture of 95%, a value of 77% is best estimate of methyl bromide available for recapture and reclamation. Thus even with recovery, there will be a continuing need for fresh methyl bromide to top up dosages to meet standard QPS fumigation levels.

Overall, development and use of recovery and recycling systems are not favoured commercially and are unlikely to be so while newly produced methyl bromide continues to be freely available at comparatively low cost and costs associated with destruction of recaptured methyl bromide, where required, are manageable. There are also regulatory issues with reuse of recycled material and concerns over possible presence of contaminants in reused methyl bromide.

8.4.5.3 Availability and uptake of recapture technology

QPS methyl bromide fumigations of commodities are all currently carried out in contained systems of some sort. The contained systems must be well sealed to minimise leakage and unintentional loss of fumigant, for both efficiency and safety reasons. Contained systems potentially can be adapted to allow efficient recapture of the added methyl bromide at the end of the treatment.

There are numerous ways that methyl bromide could be recaptured from a fumigation atmosphere. These are catalogued in MBTOC (2010). There is active research on development of ways of recapturing and destroying methyl bromide in several companies and institutions (e.g. Chen and Pignatello 2012, Mitch and Yang 2012, Hall and Walse 2012). Only two systems are commercially available and installed at this time – sorption on activated charcoal, and liquid scrubbing. Both are run so that the captured methyl bromide is destroyed or buried.

Activated carbon systems retain the captured methyl bromide unchanged. Potentially, the sorbed methyl bromide can be released for reuse or reclamation. The methyl bromide can be stripped from the carbon by heating with steam or hot gases or electrothermally. A unit in Poland, possibly no longer in use, not only recaptured the methyl bromide, but the methyl bromide was reclaimed from the carbon absorbent by heating and reused giving a net saving of about 75% in new methyl bromide. No installations using this approach were located by MBTOC at this time.

Table 8-7 summarises current commercial suppliers known to MBTOC of methyl bromide recapture equipment capable of removing fumigant at concentrations applied in QPS fumigations. Activated carbon-based scrubbing systems use various reactivation, decomposition and disposal systems, as appropriate to local waste and hazardous substances regulation. These include thiosulphate washing or landfill disposal (Nordiko), heat regeneration and scrubbing of evolved methyl bromide in thiosulphate solution (Value Recovery) and incineration or thermal destruction offsite with recovery of bromine (TIGG).

The Insects Ltd system (Swords et al. 2012) is said to be able to decompose not only methyl bromide but also sulphuryl fluoride and phosphine. The active constituents of the liquid scrubbing system have not been disclosed.

Table 8-7: Commercial suppliers of methyl bromide recapture systems.

Scrubbing system	Company	Address	Reference or webpage
Activated carbon	Nordiko Quarantine Systems Pty Ltd	403 Pacific Highway Artarmon, Sydney NSW 2064 Australia	http://www.nordiko.com.au/index.php?id=9
Activated carbon	TIGG Corporation	1 Willow Ave, Oakdale, PA 15071, USA	http://www.tigg.com/newsarchives.html
Activated carbon	Value Recovery, Inc.	510 Heron Drive, Bridgeport, NJ 08014, USA	http://www.valuerecovery.net/page/page/6115316.htm
Liquid reactant	Insects Limited	16950 Westfield Park Road,Westfield, IN 46074, USA	http://www.insectslimited.com/files/g3uf/Issue%20103.pdf

8.4.6 Soils QPS uses

The exact amount of MB used for soil uses for QPS at this time is difficult to obtain, but is considered to occur only for one Party, the US, where Federal Register Rulings are interpreted to allow MB for that use. Official figures were last provided by the US in 2006. At that time, the Party reported use of around 1450t, but an additional assessment by MBTOC in 2010 (TEAP, 2010, Table 5) indicated that the amount may be approximately 2800 t and may be continuing to grow.

MBTOC has in the past discussed some QPS uses of methyl bromide that are not consistent with the definitions of QPS under the Montreal Protocol (TEAP 2009, 2010). These refer in particular to MB use as a soil fumigant in different kinds of nurseries (strawberries, forest and fruit trees, ornamentals and others, see Section 5.2.2 in TEAP, 2010). In 2009 this use accounted for approximately 15-20% of the reported global consumption of methyl bromide for QPS (TEAP, 2010). MBTOC estimated that about 50% of the soil uses of methyl bromide that had been so categorised were replaceable and urged Parties to require the uses of methyl bromide to be fully consistent with the definitions of QPS agreed by the Parties, as consistency with the definitions would significantly reduce the amount of methyl bromide used for QPS.

8.5 Response to Decision XXIII/5

8.5.1 Mandate

Paragraph 2, of Decision XXIII/5, invited parties in a position to do so to voluntarily submit information to the Ozone Secretariat on:

> *The amount of methyl bromide used to comply with phytosanitary requirements of destination countries;*
>
> and
>
> *Phytosanitary requirements for imported commodities that must be met through the use of methyl bromide and to request the Secretariat to forward the information to the Technology and Economic Assessment Panel.*

Para 6 of this same Decision requested TEAP to provide, for consideration of the OEWG at its 33rd meeting

> "*a concise report based on the information in accordance with paragraph 2…"*

which is presented in the following sections.

8.5.2 Responses received

Seven Parties responded to this Decision, and responses were forwarded to MBTOC by the Ozone Secretariat. Original responses are included as Annexes at end of this report.

The information submitted is variable in content and scope as shown in Table 8-8. Although Parties sometimes indicated difficulties in sourcing specific information (for example, distinguishing between pre-shipment and export treatments), confusion between uses subjected to phase-out and exempted uses as defined under the Montreal Protocol was also apparent, as well as between 'imports' and 'use' of MB. Import and export quarantine uses were generally not identified.

In recent years, on occasion of preparing its Assessment Report and QPS Reports as mandated by different Decisions of the Parties, MBTOC has had access to wider, and often more complete information on QPS uses of methyl bromide (MBTOC, 2011; TEAP, 2009, 2010; MEP, 2012; Johnson et al, 2012)

It thus appears that guidance on how to collect and record information, such as recently provided by MBTOC in response to Decision XXIV/15 (TEAP, 2012; http://ozone.unep.org/Data_Reporting/Data_Reporting_Tools/dec24-15(4)-example_data_reporting_forms.pdf) is useful. Training efforts on uses of MB which are subjected to phase-put and uses that are exempted under the Montreal Protocol may also be needed in some cases.

Table 8-8: Summaries of responses received from Parties as per Decision XXIII/5

Party	Export phytosanitary requirements			Comments
	2010	2011	2012	
Australia	335	506	512	Major usage categories were identified.as well as phytosanitary requirements for imported commodities that must be met with MB fumigation Distinction between export quarantine and pre-shipment treatments was difficult and accurate data not available, however best efforts were made to distinguish between the two and estimates provided.
Botswana	0	0	0	No MB use in 2012. Party has never reported MB QPS consumption
Costa Rica	Only total MB imports for QPS uses in 2010, (4t), 2011 (5t) and 2012 (5t)			Report refers to total imports of MB for QPS uses, not actual use categories of MB
European Union			0	The EU banned all uses of MB including QPS in 2010
Japan	Only total consumption for period as per paragraph a) of Decision (4.336 t)			Only provides total consumption figures on export. Information refers to categories of use on import and no figures
Mexico	Total MB use for QPS uses in 2012 only. Import/ export			Grain and wooden products are main categories of use. Some uses unspecified. Import/ export nature of fumigations not specified
Romania	0	0	0	Report makes reference to uses subjected to phase-out only, which are banned since 2005. QPS uses have never been reported by Party

8.5.3 MB consumption for QPS purposes in Australia

In response to Decision XXIII/5, Australia provided a comprehensive analysis of methyl bromide uses for QPS purposes for the period 2009 – 2012. Usage categories were identified for both import and export purposes and specific amounts used for each provided. Major uses were as follows:

- **Export -** cereal grains cottonseed, hay, pulses, fresh fruit and vegetables, wood packaging (including ISPM 15) and timber logs and sawn wood.

- **Import -** tyres, wood packaging and timber logs and sawn wood.

The distinction between export quarantine treatments and pre-shipment treatments is problematic and accurate data in this respect is not available. However, best efforts were made to distinguish between the two and estimates provided. A description of such uses is included as shown in Table 8-9.

Table 8-9: Major methyl bromide usage and preshipment requirements of destination countries in Australia in 2012

Methyl bromide application	Class of treatment	Phytosanitary Requirements
Export grains	Pre-shipment	**India** Consignments are to be free from pests, soil, weed seeds and extraneous material. Methyl bromide fumigation required.
Export pulses	Pre-shipment	**India** Consignments are to be free from pests, soil, weed seeds and extraneous material. Methyl bromide fumigation required.
Export hay and straw	Pre-shipment	**Japan and South Korea** Consignments are to be free from pests, soil, weed seeds and extraneous material. Exports are subject to detailed a detail preparation and inspection processes by Australia under the Hay Export Procedure 2000. The procedures recognise methyl bromide along with two other treatments as being effective.
Export wood and timber, including logs	Quarantine	**China** Consignments are to be free from soil and quarantine pests of concern to China or pests specified in bilateral plant quarantine agreement.
Export wood packing, including for ISPM15	Quarantine	Methyl bromide and heat treatment is the only currently approved treatment by the IPPC Commission.
Export cottonseed.	20% Quarantine, 80% Pre-shipment.	**China** Consignments are to be free from pests, soil, weed seeds and extraneous material. However does not specify methyl bromide as the only way of achieving this. **USA** Exports must be fumigated specifically with methyl bromide to eliminate a particular strain of Fusarium fungus.
Export fresh fruit and vegetables	Quarantine	The most common specified quarantine pest is Queensland fruit fly but many others are involved

Best estimates of amounts of MB (in metric tonnes) used to comply with the phytosanitary requirements of destination countries as described above are also provided.

Australian phytosanitary requirements for imported commodities that must be met through the use of methyl bromide are also specified in the report, including a summary of requirements for major imported commodities that must be met through the use of MB, such as dried fruit, equipment, flours and meals, flowers, bulbs and plants, fresh fruit and vegetables and wood and timber, including WPM. The Australian Quarantine and Inspection Service (AQIS) maintains an imports conditions database which provides import conditions for plant, animal, microbial, mineral and human commodities. The database is used to determine if a commodity intended for import to Australia needs a quarantine permit and/or treatment or if there are any other quarantine prerequisites.

A copy of the full Australian report is included in Annex 1 at the end of this chapter.

8.5.4 Activities implemented in Japan to reduce and record MB use for QPS

In response to Decision XXIII/5 Japan has established a system for recording uses of MB for QPS purposes abiding by the terms of the decision. A plant quarantine application and fumigation record sheet is used, including plants fumigated, company, name of pest control operator, chamber category for gas retention capacity or gas tightness, amount of MB applied (kg) and dosage rate (g/m3). Target pests for which fumigation is performed are recorded by the plant quarantine officer.

Efforts to reduce MB use are undertaken to the best extent possible. If quarantine pests are not found on the plant materials inspected no treatment is conducted with MB, nor with hydrogen cyanide or aluminium phosphide. Warehouses, chambers or silos where QPS fumigation is conducted must have high gas retention capability to ensure minimum MB use and emission. Plant quarantine authorities report that 99.7% of such enclosures are in class super A (>85%) or A (>70%) with respect to their gas retention capability. In addition dosage rates for treatment of imported grain are set in consideration of the type of grain treated, grain temperature, exposure time and gas retention capability of the enclosure, to ensure minimum possible use of MB.

Japan further continues to update its lists of quarantine and non-quarantine pest insects; In 1997, a total of 36 non-quarantine insects and diseases were recorded, but this list had increased to 226 in 2012, on the basis of pest risk analysis guidelines set out by IPPC ISPM No.2. In accordance to this, the proportion of imported fresh fruit fumigations resulting from plant quarantine inspections have decreased from 74% in 2002 to 67% in 2012. In the case of vegetables, this rate decreased from 21% in 2002 to only 6% in 2012. Various other factors influence this reduction including improvement of fumigation practices (Japanese plant quarantine association news vol. 101, 2012). Two types of phosphine gas generators have been developed and a new fumigation technique using bagged aluminium phosphide, which may reduce labour costs and no resides of aluminium phosphide left on grain is under evaluation.

8.6 Economic issues related to methyl bromide phase out

Norman (2005) provided the most satisfactory ex ante analysis of the impact of the methyl bromide phase-out on the California strawberry industry. Her main argument was:

- Mexican exports to the USA were less of a threat than perceived by the growers
- US demand for strawberries is increasing rapidly and the income elasticity of demand for strawberries is high;
- Growers were likely to be able to shift some of the cost increases associated with the adoption of alternatives on to consumers, and the extent to which this was possible depended on knowing the share of fumigation costs in production and the own-price elasticity of demand for strawberries.

In a follow-up study, Mayfield and Norman (2012) point out correctly that it is impossible to advise Parties on the economic feasibility or otherwise of methyl bromide and its alternatives because they (the Parties) have yet to arrive at a consensus definition of what standard must be met. At best it could be argued (as MBTOC has proposed) that it cannot mean that users of methyl bromide do not have to change their production practices or that there are no changes in costs (p 93).

Mayfield and Norman (2012: 95) also argue that, given the current rules, it is possible that methyl bromide is being used on new areas under strawberries (i.e. where the industry has expanded), but that it is not possible to establish whether this is actually the case. While the US has adopted a policy of not allowing growth in nominations because of new areas planted, the rule allows such use as long as the total amount requested has declined.

Mayfield and Norman (2012: 99) note that by the CUN of 2012 (for a 2014 CUE) the main motivation by the US for an exemption was the township cap or the need for buffer zones. Importantly, they argue that

> *"…the township caps that limit 1,3-D are being reached in regions where strawberry acreage has grown substantially since the US agreement to phaseout methyl bromide. It is difficult to argue that a substate regulatory decision that limits the amount of acreage in all crops that can be treated with certain pesticides represents a substantial disruption of the California strawberry market due to the elimination of methyl bromide."*

The authors point out that the data on economic feasibility are not plausible given that the adoption of alternatives has increased, that strawberry yields have increased, and that the acreage under strawberries has increased (Mayfield and Norman, 2012: 99). In their view farmers are likely to have modified their production practices (e.g. input substitution, different weeding methods) and to have learned while implementing new procedures. Furthermore, even if costs increase, some of this cost may be shifted to consumers given the particular relative elasticity of demand and of supply, as shown in Norman (2005).

Finally, Mayfield and Norman (2012: 100) conclude:

> *"Alarming numbers in the CUNs sent to the Parties to the Montreal Protocol are not consistent with the success of California strawberry growers in aggregate as use of MeBr has been reduced. Nor are they consistent with basic economics. The 'economic disruption' standard of the CUE process was not intended to require the Parties to permit application of MeBr on new acreage to allow limitless expansion of a given industry using MeBr, and it is difficult to justify ongoing exemptions to support expansion rather than protect existing growers and growing regions. If all the new acres in production since 2005 are being managed profitably without MeBr, and existing acres are using less MeBr less often while overall and per acre yields and revenues rise steadily, it seems we have reached a point where alternatives are demonstrating successes for field strawberries in California".*

The purpose of the article by Samtani, *et al.* (2012) was to test the efficacy of steam in strawberry production in coastal California, to determine if solarisation and steam in combination would achieve better results than singly, and to determine the economic feasibility of these treatments relative to MB/Pic. An economic analysis for 2008/09 showed that net returns from steam or solarisation treatments were less than for MB/Pic treatment.

Herrington, *et al.*, (2012) investigated the contribution of plant characteristics to cost and income under subtropical Queensland (Australia) conditions to expedite the identification of new economically superior strawberry cultivars.

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9. 2013 Evaluations of Critical Use Nominations for Methyl Bromide and Related Matters – Interim Report

9.1 Scope of the Report

This 2013 interim report provides evaluations by MBTOC of Critical Use Nominations (CUNs) submitted for methyl bromide (MB) for 2015 by three Parties (Australia, Canada, and USA). As per provisions set out in Decision IX/6 (Annex I, MOP16), CUNs were submitted to the Ozone Secretariat by the Parties in accordance with the timetable shown in paragraph 1 of Annex I, Decision XVI/4.

This report provides 1) interim recommendations for the CUNs for which the Parties provided information as per the timelines set at the 24th Meeting of the Parties 2) information on the CUNs from Parties on stocks (Decision Ex.1/4 (9f)), 3) partial information on actual MB consumption for critical uses (in accordance with Decision XVII/9) and 4) apparent adoption rates of alternatives, as evidenced by trend lines on reduction of MB CUNs (in accordance with Decisions XIX/9, XX/5). It is noted that trend lines on adoption may not necessarily indicate true adoption rates for alternatives, as the use of stocks of MB that may have been available to the same sector or areas of production may have increased or fallen within the sector due to a range of circumstances. MBTOC notes that stock volumes have significantly decreased in recent years.

Standard presumptions used in the 2013 round were the same as those used in the 2012 evaluations of the CUNs. These standard presumptions are subject to continual review. However, any changes proposed by MBTOC are required to be approved by the Party's in the MOP preceding the year of assessment based on a draft Decision presented to the MOP in accordance with paragraph 2 in Annex 1 to the report of MOP16.

9.2 Critical Use Nominations for Methyl Bromide

9.2.1 Mandate

Under Article 2H of the Montreal Protocol, Parties not operating under Article 5(1) are required to phase-out all production and consumption (defined as production plus imports minus exports) of MB after 1 January 2005. However, the Parties agreed to a provision enabling exemptions for those uses of MB that qualify as critical. Parties established criteria, under Decision IX/6 (see Annex 1 of this report) of the Protocol, which all critical uses need to meet in order to qualify for an exemption. TEAP and its MBTOC provided guidance to the Parties' decisions on critical use exemptions in accordance with Decisions IX/6, Annex I of Decision XVI/2 and a number of subsequent decisions (XVI/2; XVII/9, XVIII/13, XIX/9, XX/5, XXI/11, XXII/6, XXIII/4 and XXIV/5).

The recent decision XXIV/5 differed from past decisions in that it reinforced that Parties 'take all reasonable steps to explore further the possibility of transitioning to technically and economically feasible alternatives… and to ensure that the Methyl Bromide Technical Options Committee is fully aware of these efforts.

9.2.2 Fulfilment of Decision IX/6

Decision XVI/2 and Decision XXI/11 directed MBTOC to indicate whether all CUNs fully met the requirements of Decision IX/6. When the requirements of Decision IX/6 are met, MBTOC can recommend critical uses of MB. Where some of the conditions are not fully met, MBTOC can recommend a decreased amount depending on its technical and economic evaluation, or determine the CUN as "unable to assess" and request further information from the Party. When the information is submitted, MBTOC is required to re-assess the nomination, following the procedures defined in Annex 1 of the Sixteenth Meeting of the Parties.

MBTOC recommended less methyl bromide that requested in a CUN when technically and economically feasible alternatives were considered to be available or, when the Party failed to show that there was no technically and economically feasible alternative. In this round, MBTOC did not recommend one nomination as important information essential to the assessment had not been supplied and the nomination did not meet the requirements of Decision IX/6. Also, in this round of CUNs, as in previous rounds, MBTOC considered all information provided by the Parties, including answers to questions requested by MBTOC up to the date of the evaluation.

Now that technically and economically feasible alternatives have been identified for virtually all applications of methyl bromide, regulations on the use of these alternatives often determine their availability to the end users. In addition, comparative information on the economic feasibility/infeasibility of the use of alternatives compared to MB is critical to the outcomes of present and future CUNs. MBTOC needs annual updates of the economics information evaluating the costs of alternatives. In many cases, MBTOC has proposed that existing commercially and economically feasible alternatives should be used. Where these are not available, MBTOC has suggested research that could lead to commercial alternatives to replace MB. MBTOC has also shown how regulatory issues can hinder or promote the phase out of MB, and has directed Parties attention toward such issues.

9.2.3 Reporting of MB Consumption for Critical Use

A number of decisions (Ex.I/3(5); XVI/2(4); XVII/9(5)), XVIII/13(6), XIX/9(7), XX/5(7), XXI/11(6), XXII/6(5), XXIII/4(4) and XXIV/5 set out provisions which request Parties to submit by 1 February each year information on how criteria in IX/6(1) is met when licensing permitting or authorizing CUEs. Decision XVII/9 of the 17th MOP specifically requests TEAP and its MBTOC to "*report for 2005 and annually thereafter, for each agreed critical use category, the amount of methyl bromide nominated by a Party, the amount of the agreed critical use and either:*

(a) The amount licensed, permitted or authorised; or

(b) The amount used

Since the start of the CUN reviews in 2003, MBTOC has provided the amounts of MB nominated and agreed for each critical use (Annexes III and IV). MBTOC is now able to report more information on amounts of MB permitted and/or used for CUE uses. Parties are required to report the data to UNEP by March 2013 as part of the accounting framework, form 2.

In 2012, the Meeting of the Parties authorised Australia to use 33.413 t, ie 29.760 tonnes of MB for strawberry runners and 3.653 t for the rice growers. The Party exempted 32.593 tonnes and all of this was reportedly used for the critical uses in 2012 (http://www.environment.gov.au/atmosphere/ozone/publications/pubs/exemption-list-non-qps12.pdf).

For Canada, the Meeting of the Parties authorised 16.281 t, ie.11.020 tonnes for flour-mills and a further 5.261 tonnes for strawberry runners. In the accounting framework the party reported that 12.725 t was used for critical uses in 2012.

For the United States, the MOP authorised 1023 tonnes for a wide range of crops and commodities in 2012 (Annex III and IV). In their allocation regulation for 2012 critical uses, the Party reported that 1,022.826 tonnes had been approved for pre-plant soil uses and postharvest uses (Federal Register 77, May 17, 2012).

9.2.4 Trends in Methyl Bromide Use for CUEs since 2005

The nominated amounts and the apparent rate of reduction in MB or adoption of alternatives achieved by Parties are shown in Table 9-5, as well as Figures 9-1 and 9-2. It is noted that for those countries that have pre-2005 stocks of MB that are being drawn down, the reductions in CUEs from year to year cannot be taken directly as evidence of ´ adoption of alternatives since pre-2005 stocks may have been used in the same sectors. Tables 9-9 and 9-11 in particular show the amounts nominated by Parties for soil uses, and structures and commodity uses and the final recommendations for 'Critical Use' in 2015.

Decision XVII/9 requires TEAP to show trends in the phase out of the critical uses of MB by the Parties (Fig 9-1 and Fig 92, Annexes III and IV). Since 2005, there has been a progressive trend in the reduction of methyl bromide for CUNs by all Parties for both soil and post- harvest uses, although this has occurred at different rates. Figs 9-1 and 9-2 show reduction trends in amounts approved/nominated by Parties for 'Critical Use' from 2005 to 2015 for all the remaining soil and structures and commodity uses. The complete trends in phase out of MB by country, as indicated by change in CUE, are shown in Annexes III and IV.

9.2.5 Disclosure of Interest

As in past reports, MBTOC members were requested to update their disclosure of interest forms relating specifically to their level of national, regional or enterprise involvement for the 2013 CUN process. The Disclosure of Interest declarations for 2013, updated in February 2013 can be found on the internet at http://ozone.unep.org/new_site/en/disclosure_of_interest.php?body_id=6&committee_id=6 and a list of members in Annex I, chapter 11 of this TEAP report. As in previous rounds, some member withdrew from a particular CUN assessment or only provided technical advice on request, for those nominations where a potential conflict of interest was declared.

MBTOC co-chairs requested members to complete a Categorisation of Interest Form on the application of declarations of interest as per Decision XXIV/8. Most MBTOC members found it difficult to accurately categorise their conflicts accordingly, however they discussed these during the plenary at the start of the MBTOC meeting in London and members were given the opportunity to declare their conflicts of interest. These were managed appropriately by recusal or self- recusal during the relevant CUN assessment.

MBTOC co-chairs further briefed members of recent updates introduced by the Parties to the Terms of Reference (TOR) of the TEAP/TOC, as per recent Decision XXIV/8.

9.2.6 Article 5 Issues

Methyl bromide is due to be fully phased out in A5 Parties by January 1, 2015, 10 years after full phaseout by non-A5 Parties. In both cases, uses for feedstock and QPS are exempted from phase out under the control measures described in Article 2H. There is also provision for exemption from phase out for uses deemed 'critical' according to Article 2H, as complying with Decision IX/6.

Presently, approximately 80% of the controlled consumption in A5 Parties has been phased out, ahead of the 2015 deadline. This has been achieved largely as a result of investment projects implemented by the Montreal Protocol agencies, with MLF funding, bilateral cooperation and also national funding. Most of the remaining MB consuming A5 Parties have agreements in place with the MLF and other organisations for full phaseout of methyl bromide by 1st January 2015 at the latest, very often earlier. These are usually accompanied with legislation to ban further consumption of MB for controlled uses, and funding to support ongoing implementation of alternatives therefore promoting the sustainability of the phase out.

Article 5 Parties may submit nominations for Critical Use Exemptions (CUEs) for uses they consider appropriate for the year 2015 and possibly subsequently. The first CUNs by non-A5 Parties were made in 2003 for CUEs to be in place in 2005. No A5 Parties submitted CUNs in this round, but may in 2014 for use in 2015 the first year after the scheduled phase out schedule. MBTOC is mindful of the difficult and complex process that occurred during the first round of CUNs in 2003 for non A5

Parties. TEAP urges Parties to consider the requirements for CUNs in due time as set out in the 'Handbook on Critical Use Nominations' which has been revised and updated to meet the needs of the non A5 and A5 Critical Use Process in response to Decision XXIII/14. (http://ozone.unep.org/Assessment_Panels/TEAP/Reports/MBTOC/Handbook%20CUN-version 7)

9.2.7 Consideration of Stocks, Decision Ex.1/4 (9f)

One criterion for granting a critical use is that MB "*is not available in sufficient quantity and quality from existing stocks of banked or recycled methyl bromide*" (paragraph 1 (b) (ii) of Decision IX/6). Parties nominating critical use exemptions are requested under decision Ex.I/4(9f) to submit an accounting framework with the information on stocks. MBTOC has not reduced its recommended amount of methyl bromide in consideration of stocks held by the Party and has instead relied on Parties to take this into consideration when approving the amounts recommended by TEAP for each nomination. To assist the Parties with their consideration of stocks, and in accordance with Decision XVIII/13(7), a summary of the data on stocks as reported by the Parties in the first year for accounting in 2006, and then reports submitted in 2011 and 2012 are summarized in Tables 9-1 to 9-3 below.

Parties may wish to consider this information in the light of Decision IX/6 1(b) (ii) when authorising methyl bromide for critical uses.

Efficient functioning of commerce requires a certain level of available stocks and additional stocks to respond to emergencies. Additionally, stocks may be held on behalf of other Parties or for exempt uses (feedstock and QPS uses). The correct or optimal level of stocks for virtually every input to production is not zero. In addition, stocks are privately owned and may not be readily available for critical uses, or there may be national regulations preventing the transfer of stocks. Despite these restrictions, Parties may wish to ensure that stocks are used wherever possible in order to minimize the quantity of MB that need to be produced each year for critical uses. Tables 9-1 to 9-3 report the quantities of MB 'on hand' at the beginning and end respectively of 2005, 2011 and 2012 as required under Decision XVI/6. The earlier CUN reports identified stocks for the other years.

Table 9-1: Quantities of MB (metric tonnes) 'on hand' at the beginning and end of 2005, as first reported by Parties in 2006/2007 under Decision XVI/6.

Party	**Critical use exemptions authorized by MOP for 2005**	**Quantity of MB as reported by Parties (metric tonnes)**				
		Amount on hand at start of 2005	**Quantity acquired for CUEs in 2005 (production +imports)**	**Amount available for use in 2005**	**Quantity used for CUEs in 2005**	**Amount on hand at the end of 2005**
Australia	146.6	0	114.912	114.912	114.912	0
Canada	61.792	0	48.858	48.858	45.146	3.712
EU	4 392.812	216.198	2 435.319	2 651.517	2 530.099	121.023
Israel	1 089.306	16.358	1 072.35	1 088.708	1 088.708	0
Japan	748	0	594.995	594.995	546.861	48.134
New Zealand	50	6.9	40.5	47.4	44.58	2.81
USA(a)	9 552.879		7 613	not reported	7 170	443

Additional information on stocks was reported on US EPA website, September 2006: MB inventory held by USA companies: 2004 = 12,994 tonnes; 2005 = 9,974 tonnes.

Table 9-2: Quantities of MB 'on hand' at the beginning and end of 2011, as reported by Parties in 2012 under Decision XVI/6.

Party	**Critical use exemption authorized by MOP for 2011**	**Quantity of MB as reported by Parties (metric tonnes)**				
		Amount on hand at start of 2011	**Quantity acquired for CUEs in 2011 (production +imports)**	**Amount available for use in 2011**	**Quantity used for CUEs in 2011**	**Amount on hand at the end of 2011**
Australia	34.66	0	33.333	33.333	33.333	0
Canada	21.451	1.185	15.889	17.074	17.691	-0.617
Israel	Not reported					
Japan	239.746	6.413	225.552	231.965	222.239	9.726
USA	1,500 [2055 approved by MOP for CUEs]	1,803(a)	1,499	3,302	1,499 555(c)	0 1,249(b)

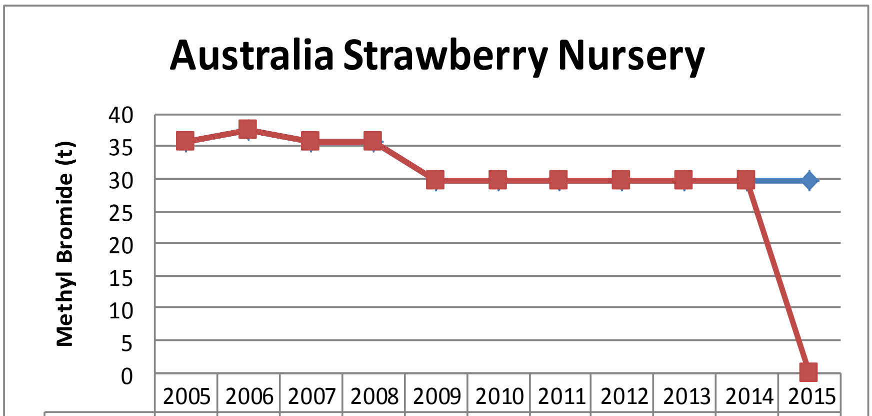
(a) Amount of pre-2005 stocks available at the start of 2011
(b) Amount of pre-2005 stocks available at the end of 2011.
(c) Stocks used for CUE uses in 2011.

Table 9-3: Quantities of MB 'on hand' at the beginning and end of 2012, as reported by Parties in 2013 under Decision XVI/6.

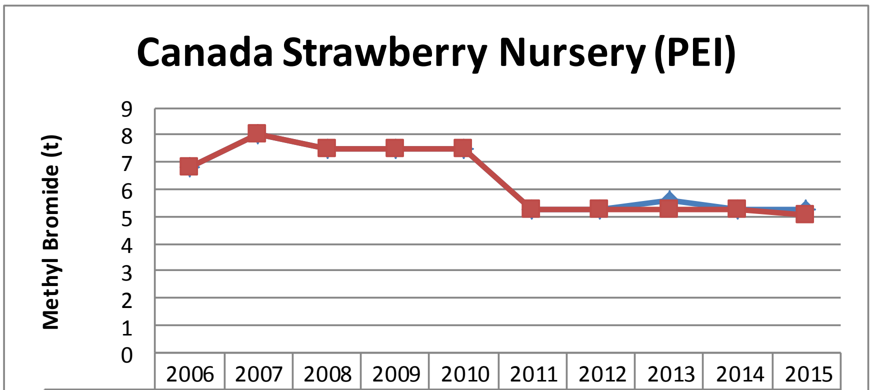
Party	**Critical use exemption authorized by MOP for 2012**	**Quantity of MB as reported by Parties (metric tonnes)**				
		Amount on hand at start of 2012	**Quantity acquired for CUEs in 2012 (production +imports)**	**Amount available for use in 2012**	**Quantity used for CUEs in 2012**	**Amount on hand at the end of 2012**
Australia	33.413	0	32.593	32.593	32.593	0
Canada	16.281	1.455	12.186	13.641	12.725	0.916
Japan	219.609	9.726	155.902	165.628	174.708	2.709
USA	1023 [760 t authorization and 263 t critical stock allowances]	1249(a)	759	2008	759	? 627(b)

(a) Amount of pre-2005 stocks available at the start of 2012
(b) Amount of pre-2005 stocks available at the end of 2012
(c) Stocks used for CUE uses in 2012

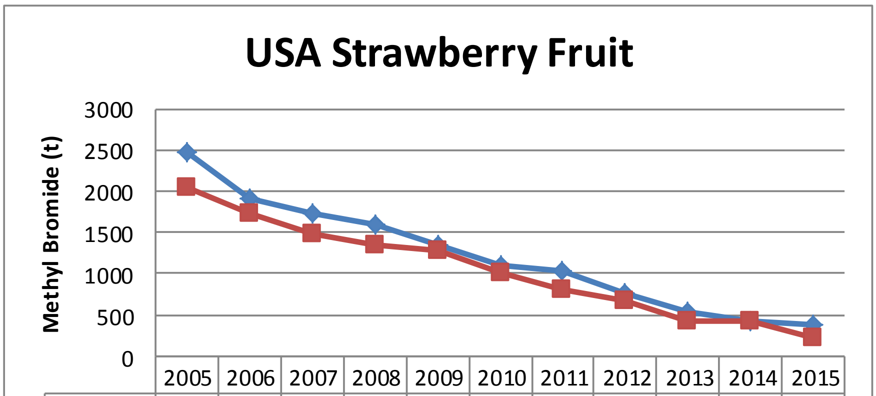
Figure 9-1: *Amounts of MB nominated and exempted for CUE uses in nominated preplant soil sectors from 2005 to 2015. Blue lines indicate the trend of CUN nominated and the red lines the amount CUE methyl bromide approved by the Parties*



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CUN	35.75	37.5	35.75	35.75	29.79	29.79	29.79	29.79	29.76	29.76	29.76
CUE	35.75	37.5	35.75	35.75	29.79	29.79	29.79	29.76	29.76	29.76	0

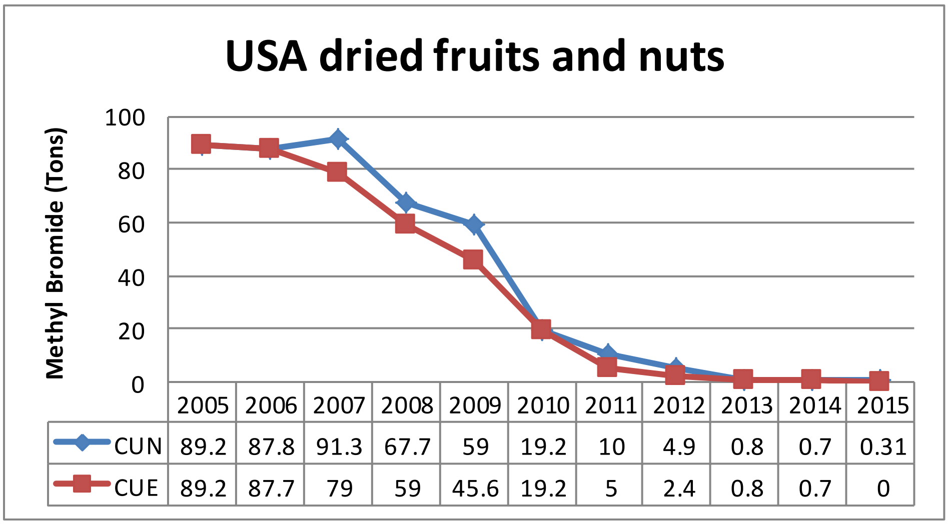


	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CUN	6.84	7.995	7.462	7.462	7.462	5.261	5.261	5.596	5.261	5.261
CUE	6.84	7.995	7.462	7.462	7.462	5.261	5.261	5.261	5.261	5.05



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CUN	2469	1918	1734	1605	1337	1103	1023	754	531.7	415.1	373.7
CUE	2053	1731	1476	1350	1269	1007	812.7	678	415.1	415.1	224.2

Figure 9-2: Amounts of MB nominated and exempted for CUE uses in Dates and cured pork from 2005 to 2015. Blue lines indicate the trend in of CUN nominated and the red lines the amount CUE methyl bromide approved by the Parties



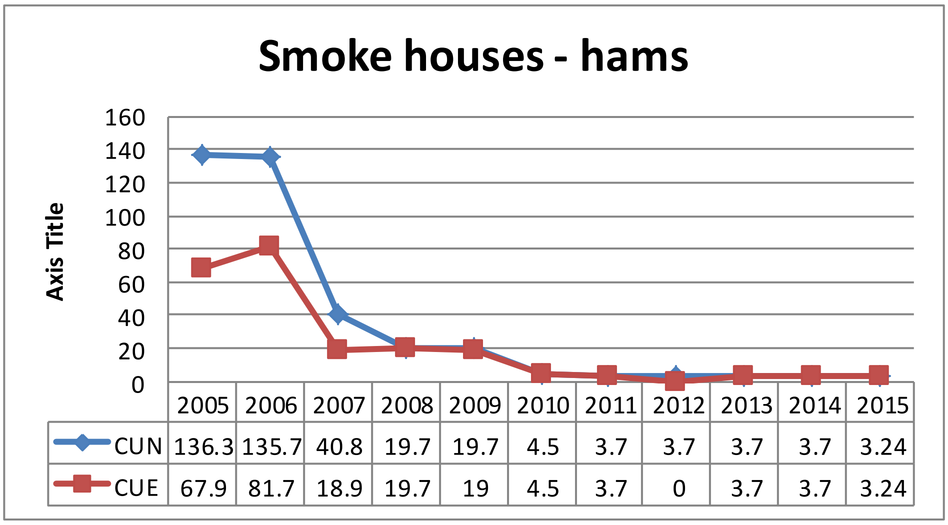


Table 9-4: Summary of Critical Use Nominations and Exemptions of Methyl Bromide (tonnes)

	Quantities Nominated											Quantities Approved										Interim Recommendation
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2005 (1ExMOP and 16MOP)	2006 (16MOP+ 2ExMOP+ 17MOP)	2007 (17MOP + 18MOP)	2008 (18MOP + 19MOP)	2009 (19MOP)	2010 (20MOP + 21MOP)	2011 (21MOP)	2012 (22MOP)	2013 (23MOP)	2014 (24 MOP)	2015
Australia	206.950	81.250	52.145	52.900	38.990	37.610	35.450	34.660	32.164	30.947	29.79	146.600	75.100	48.517	48.450	37.610	36.440	28.710	31.708	32.134	[27.971]	[0]
Canada	61.992	53.897	46.745	42.241	39.115	35.080	19.368 +3.529	16.281	13.444	10.305	5.261	61.792	53.897	52.874	36.112	39.020	30.340 +3.529	19.368	16.281	13.109	[10.094]	[5.050]
EC[14]	5754.361	4213.47	1239.873	245.00	0	0	0	0	0	0	0	4392.812	3536.755	689.142	245.146	0	0	0	0	0	0	0
Israel	1117.156	1081.506	1236.517	952.845	699.448	383.700	232.247	0	0	0	0	1089.306	880.295	966.715	860.580	610.854	290.878	0	0	0	0	0
Japan	748.000	741.400	651.700	589.600	508.900	288.500	249.420	221.104	3.317	0	0	748.000	741.400	636.172	443.775	305.380	267.000	239.746	219.609	3.317	0	0
New Zealand	53.085	53.085	32.573	0	0	0	0	0	0	0	0	50.000	42.000	18.234	0	0	0	0	0	0	0	0
Switzerland	8.700	7.000	0	0	0	0	0	0	0	0	0	8.700	7.000	0	0	0	0	0	0	0	0	0
USA	10753.997	9386.229	7417.999	6415.153	4958.034	3299.490	2388.128	1181.779+ 6.339	691.608	442.337	377.170	9552.879	8081.753	6749.060	5355.976	4261.974	3232.856 +2.018	2055.200	993.706	562.328	442.337	[227.436]
TOTALS	**18704.241**	**15617.837**	**10677.552**	**8297.739**	**6244.487**	**4044.380**	**2928.142**	**1460.163**	**740.533**	**483.589**	**412.191**	**16050.089**	**13418.200**	**9160.714**	**6990.039**	**5,254.838**	**3572.183**	**2343.024**	1261.304	610.888	483.589	[232.486]

* Not yet available.

[14] Members of the European Community which had CUNs/CUEs included:
2005 – Belgium, France, Germany, Greece, Italy, Netherlands, Poland, Portugal, Spain, and the United Kingdom.
2006 – Belgium, France, Germany, Greece, Ireland, Italy, Latvia, Malta, Netherlands, Poland, Portugal, Spain, and the United Kingdom.
2007 – France, Greece, Ireland, Italy, Netherlands, Poland, Spain, and the United Kingdom
2008 – Poland, Spain

9.3 Evaluations of CUNs – 2013 round for 2015 exemptions

Detailed interim assessments of all CUNs were made by MBTOC at a meeting in London (UK) from 2-5 April, 2013, attended by the three MBTOC sub-committees: Soils, SC and QPS.

For the soils CUNs, Australia and Canada submitted similar amounts to the previous rounds highlighting difficulties with phase out of MB for the strawberry runners sector. In the USA the only soil CUN submitted was for strawberry fruit production.

Canada and the US submitted two CUNs in total for the postharvest sector, down from 5 in the previous round. In Structures and Commodities, Parties continued to show progress in reducing the quantity of methyl bromide requested in the CUNs. The reduction was most likely the result of continuing efforts by Parties to resolve the inter-related issues of treatment logistics, costs and effectiveness of alternatives.

The total nominated amount for all countries for 2014 was 412.191 t representing a 14.8% reduction to that nominated in 2012 for 2014. MBTOC recommended 232.486 tonnes and the grounds used for these recommendations are given in detail for the relevant CUNs in Tables 9-9 and 9-11.

Also during the first meeting progress reports were prepared and 'Disclosure of Interest' declarations updated. At the London meeting, MBTOC held bilateral meetings with the US delegation and also conducted a video conference with experts from the USA on alternatives for the ham sector.

MBTOC also updated the Handbook taking into consideration comments from Parties at the 24th MOP in November 2012.

In general the CUNs were submitted due to the following issues: regulatory restrictions that did not allow partial or full use of alternatives, difficulties in the scale-up of alternatives and that all alternatives were considered uneconomical and/or unavailable. Additionally, MBTOC-SC notes that in one case technically effective alternatives have not been found and that Parties continue to struggle with the ability to adapt previously identified alternatives to their circumstances. In paragraph 20 of Annex 1 referred to in Decision XVI/4, Parties specifically requested that MBTOC explicitly state the specific basis for the Party's economic statement relating to CUNs. Tables 9-9 and 9-11 provide this information for each CUN. This information was prepared by the MBTOC economist. MBTOC notes there was an improvement in the economic information supplied by the nominating Parties in this round.

9.3.1 Critical Use Nominations Review

The meetings were held as required in accordance with the time schedule for the consideration of CUNs provided in Annex I referred to in Decision XVI/4. In considering the CUNs submitted in 2013, as in previous rounds, both MBTOC subcommittees applied as much as possible the standards contained in Annex I of the final report of 16 MOP, and, where relevant, the standard presumptions given below. In particular, MBTOC sought to provide consistent treatment of CUNs within and between Parties while at the same time taking local circumstances into consideration. Unless otherwise indicated, the most recent CUE approved by the Parties for a particular CUN was used as baseline for consideration of continuing nominations. In evaluating the CUNs for soil treatments, MBTOC assumed that the presence of a technically feasible alternative to MB would need to provide sufficient pest and/or weed control for continued production of that crop to existing market standards.

For commodity and structural applications, it was assumed that technically and economically feasible alternatives would provide disinfestation to a level that met the objectives of a MB treatment, e.g. meeting infestation standards in finished product from a mill. Costs for alternatives for soil or postharvest uses should be within 20% (MBTOC 2011) of the cost of using methyl bromide for it to be considered economically feasible in the context of that nomination, to the extent that could be determined.

The outcome of evaluations of CUNs for the soil and structural treatments are presented in Table 9.9 and 9.11 below.

9.3.2 Achieving Consensus

In accordance with decision XX/5(9) and similar subsequent decisions (XXI/11(4), XXII/6(4) and XXIII/4(3)) and XXIV/5 and 8 the Parties have indicated that MBTOC '*should ensure that it develops its recommendations in a consensus process that includes full discussion among all available members of the Committee and should ensure that members with relevant expertise are involved in developing its recommendations'*.

In 2013 as described in the TEAP Progress Report, MBTOC's procedures were designed to improve members' contribution and reaching final decisions on nominations at the MBTOC meeting. This procedure ensured all members were sent information and able to discuss issues related to all nominations, but only those members able to participate who were at the meeting formed consensus. In this round, any minority views were discussed fully in plenary and issues debated until a consensus position was reached.

During the interim assessments, MBTOC achieved consensus on all nominations. One member presented a minority view in the text box for the US strawberry fruit nomination commenting that transition rates to effective alternatives would be slower than the decision reached by the majority.

Several members recused from evaluation of nominations as required by MBTOC's working procedures. These included George Lazarovits (US Strawberry fruit and Canadian Strawberry Nurseries), Jim Wells (US Strawberry Fruit) and Ian Porter (Australian Strawberry nurseries). The recusals took place either as a result of a member's disclosure as per MBTOC's guidelines or members may have chosen to self-recuse to avoid any perceived conflict of interest.

9.4 MBTOC Soils: Interim Evaluations of 2013 Critical Use Nominations for Methyl Bromide for 2015

9.4.1 Critical Use Nomination Assessment

Table 9.5 identifies the quantities recommended by MBTOC after consideration of all the information provided by the Parties. In summary, the Australian nomination was not recommended at the time of assessment as important economic information had not been provided; the Canadian and US nominations were reduced because alternatives, which are available and effective, could be used for at least some of the nomination. The detailed descriptions can be found in Table 9-5

Table 9-5: Summary of the interim recommendations by MBTOC-S (in square brackets) for CUE's for preplant uses of MB (tonnes) submitted in 2013 for 2015

Country and Sector	Nomination by the Party for 2015	Interim Recommendation for 2015
1. **Australia**		
Strawberry runners	**29.760**	**[0]**
2. **Canada**		
Strawberry runners	**5.261**	**[5.050]**
3. **USA**		
Strawberry fruit	**373.660**	**[224.196]**
TOTAL	**408.681**	**[229.246]**

9.4.2 Issues Related to CUN Assessment for Preplant Soil Use

Key issues which influenced assessment and the need for MB for preplant soil use of MB in the 2013 round were:

i) An increase in the chloropicrin dosage rate allowed in California was a key issue related to the further reduction made in the US nomination.
ii) Continued adoption of a new formulation of 1,3-D/Pic ('Pic-Clor 60') in the USA, which increases the area that may be treated with 1,3-D in regions affected by township caps.
iii) More effective disease control obtained with shank applied fumigants than drip applied fumigants will influence the practices being adopted for existing and future CUE sectors

Successful use of soilless production systems for strawberry nursery crops . MBTOC has noted more specific issues related to requests for CUNs below and also in the CUN text boxes (Table 9.9).

9.4.3 General Comments on the Assessment for Preplant Soil Use

MBTOC continues to encourage Parties to consider a review of regulations covering the registration, use and adoption of alternatives, particularly those regarding barrier films to reduce dosage rates of MB and its alternatives, and associated emissions. MBTOC also notes that a large proportion of MB has been nominated for uses where regulations or legislation prevent reductions of MB dosage. For several cases, the mandatory use of MB is specified at a high dosage for either treatment of certified propagation material or because regulations prevent use of barrier films which otherwise could have reduced the MB dosage rate. Also regulations on the use of alternatives are preventing their uptake for a substantial proportion of the remaining CUNs for preplant soil use.

9.4.4 Registration of Alternatives for Preplant Uses - Decision Ex I/4 (9i) and (9j)

Decision Ex. I/4 (9i) requires MBTOC, "*To report annually on the status of re-registration and review of methyl bromide uses for the applications reflected in the critical-use exemptions, including any information on health effects and environmental acceptability"*. Further, Decision Ex I/4 (9j) requires MBTOC "*To report annually on the status of registration of alternatives and substitutes for methyl bromide, with particular emphasis on possible regulatory actions that will increase or decrease dependence on methyl bromide".*

Where these have impacted a nomination, the party or MBTOC may have adjusted quantities to allow for effective use of the alternative. A description of any changes has been made available in the CUN text boxes (Tables 9.9 and 9.11).

The EU has further reported that registration for 1,3-D has been cancelled and that other chemical alternatives including chloropicrin, dazomet and metam sodium are under review. Any future nominations submitted by Australia, Canada and the US should include information on expected rates of adoption of alternatives following registration, in accordance with paragraphs 34-35 of Annex 1 of the MOP16, as this information would assist MBTOC in its evaluation of these CUNs.

9.4.5 Sustainable Alternatives for Preplant Uses

MBTOC urges Parties to consider the long term sustainability of treatments adopted as alternatives to MB; whilst chemical treatments have been shown to offer an adequate solution, combining them with environmentally sustainable non-chemical alternatives where possible, within an integrated approach will provide best results in the longer term. Decision IX/6 1(a)(ii) refers to alternatives that are '*acceptable from the standpoint of environment and health'*. MBTOC has visited various regions where successful non-chemical alternatives e.g. soil less culture, solarisation, steam, biodisinfestation and anaerobic soil disinfestation, are used as sustainable alternatives to MB. Several Parties consider these techniques as viable alternatives, particularly when an integrated approach that combines different options is adopted.

MBTOC recognizes the potential benefit of the recent establishment of a California DPR “Strawberry Non Fumigant Workgroup” to evaluate and adopt further chemical and non-chemical technologies such as: anaerobic soil disinfestation; soilless substrate systems and steam (CalDPR, 2013).

9.4.6 Standard Presumptions Used in Assessment of Nominated Quantities.

The tables below (Tables 9-6 and 9-7) provide the standard presumptions applied by MBTOC-S for this round of CUNs for preplant soil uses. These standard presumptions were first proposed in the MBTOC report of October 2005 and were presented to the Parties at 17th MOP. Studies and reports to support them have been provided in previous reports and were revised for some sectors after consideration by the Parties at the 19th MOP. The rates and practices adopted by MBTOC as standard presumptions are based on maximum rates considered acceptable by published literature and actual commercial practice.

As in the evaluations in previous years, MBTOC considered reductions to quantities of MB in particular nominations to a standard rate per treated area where technical evidence supported its use. As a special case, MBTOC continues to accept a maximum rate of 200 kg/ ha (20 g/m^2) in MB/Pic formulations with high Pic-containing mixtures with or without barrier films for certified nursery production, unless regulations prescribe lower or higher rates. However, MBTOC notes that studies have shown that rates of 200 kg/ha (20g/m^2) or less of MB: Pic 50:50 are effective with barrier films for production of ‘certified’ nursery material and urge Parties to consider regulations which permit these lower rates. MBTOC also notes that certified runner production may involve regulations which specify the mandatory use of a fumigant such as MB or an alternative, in order for the runners to be “certified runners”.

The indicative rates used by MBTOC were maximum guideline rates, for the purpose of calculation only. MBTOC recognises that the actual rate appropriate for a specific use may vary with local circumstances, soil conditions and the target pest situation. Some nominations were based on rates lower than these indicative rates.

Table 9-6: Standard Presumptions Used in Assessment of CUNs for Preplant Soil Use of MB

	Comment	**CUN adjustment**	**Exceptions**
1. Dosage rates	Maximum guideline rates for MB:Pic 98:2 are 25 to 35 g/m^2 with barrier films (VIF or equivalent); for mixtures of MB/Pic are 12.5 to 17.5 g MB/m^2 for pathogens and nutsedge respectively, under barrier films depending on the sector. All rates are on a 'per treated hectare' basis.	Amount adjusted to maximum guideline rates. Maximum rates set dependent on formulation and soil type and film availability.	Higher rates accepted if specified under national legislation or where the Party had justified otherwise.
2. Barrier films	All treatments to be carried out under low permeability barrier film (e.g. VIF, TIF)	Nomination reduced proportionately to conform to barrier film use.	Where barrier film prohibited or restricted by legislative or regulatory reasons
3. MB/Pic Formulation: Pathogens control	Unless otherwise specified, MB/Pic 50:50 (or similar) was considered to be the standard effective formulation for pathogen control, as a transitional strategy to replace MB/Pic 98:2.	Nominated amount adjusted for use with MB/Pic 50:50 (or similar).	Where MB/Pic 50:50 is not registered, or Pic (Pic) is not registered
4. MB/Pic Formulation: Weeds/nutsedge ass control	Unless otherwise specified, MB/Pic 67:33 (or similar) was used as the standard effective formulation for control of resistant (tolerant) weeds, as a transitional strategy to replace MB/Pic 98:2.	Nominated amount adjusted for use with MB/Pic 67:33 (or similar).	Where Pic or Pic-containing mixtures are not registered
5. Strip vs. Broadacre	Fumigation with MB and mixtures to be carried out under strip	Where rates were shown in broad acre hectares, the CUN was adjusted to the MB rate relative to strip treatment (i.e. treated area). If not specified, the area under strip treatment was considered to represent 67% of the total area.	Where strip treatment was not feasible e.g. some protected cultivation, emission regulations on MB, or open field production of high health propagative material

Table 9-7: Maximum dosage rates for preplant soil use of MB by sector used since 2009 (standard presumptions).

Film Type	**Maximum MB Dosage Rate (g/m^2) in MB/Pic mixtures (67:33, 50:50) considered effective for:**			
	Strawberries and Vegetables	**Plant Nurseries***	**Orchard Replant**	**Ornamentals**
Barrier films - Pathogens	12.5	15	15	15
Barrier films - Nutsedge	15.0	17.5	17.5	17.5
No Barrier films – Pathogens	20	20	20	20
No Barrier films - Nut sedge	26	26	26	26

* Maximum rate unless certification specifies otherwise

9.4.7 Adjustments for Standard Dosage Rates using MB/Pic Formulations

As in previous assessments, one key transitional strategy to reduce MB dosage has been the adoption of MB/Pic formulations with lower concentrations of MB (e.g. MB/Pic 50:50, 33:67 or less). These formulations are considered to be equally as effective in controlling soilborne pathogens as formulations containing higher quantities of MB (e.g. 98:2, 67:33) (Porter 2006; Santos *et al*., 2007; Hamill *et al.*, 2004; Hanson *et al.*, 2006). MBTOC notes that reported use of MB/Pic formulations in the US shows that formulations with greater amounts of MB (CalDPR, 2012a) are still being used in California and the Party is urged to consider even lower dosage rates of MB for the remaining CUN. This includes rates as low as 75 kg/ha (7.5 g/m^2) with mixtures of 30:70 or 33:67 mixtures (at 250 kg/ha or 25 g/m^2) or 100 kg/ha (10 g/m^2) of MB in 250 kg/ha (25 g/m^2) of 50:50 MB/Pic mixtures in conjunction with barrier films (Table 9-8).

Table 9-8: Actual dosage rates applied during preplant fumigation when different rates and formulations of MB/Pic mixtures are applied with and without barrier films. Rates of application reflect standard commercial applications rates.

Commercial application rates (kg/ha) of MB/Pic formulation	**MB/Pic formulation (dose of MB in g/m^2)**			
	98:2	**67:33**	**50:50**	**30:70**
A. With Standard Polyethylene Films				
400	39.2	26.8	20.0	12.0
350	34.3	23.5	17.5	10.5
300	29.4	20.1	15.0	9.0
B. With Low Permeability Barrier Films (LPBF)				
250	24.5	16.8	12.5	7.5
200	19.6	13.4	**10.0***	6.0
175	17.2	11.8	8.8	5.3

** Note: Trials from 1996 to 2008 (previous CUN reports) show that a dosage of 10g/m^2 (e.g. MB/Pic 50:50 at 200kg/ha with low permeability barrier Films) is technically feasible for many situations and equivalent to the standard dosage of >20g/m^2 using standard PE films*

9.4.8 Use/Emission Reduction Technologies - Low permeability barrier films and dosage reduction

Decision XXI/11 (para 9) requested further reporting on Decision IX/6 to ensure Parties adopted emissions controls where possible. For preplant soil use, this includes the use of barrier films or other mitigation strategies such as high moisture sealing and the lowest effective dose of MB with mixtures of chloropicrin. Other methods include deep shanking and use of ammonium thiosulphate and different irrigation technologies (Yates *et al.,* 2009). These latter technologies have not been reported or adopted widely by Parties.

In southeast USA the reported use of barrier films in vegetable crops, which expanded rapidly to over 20,000 hectares in 2009 has continued to increase. A recent change in the regulations should lead to an increase in the adoption of barrier films is in the State of California. MBTOC notes that barrier films particularly more recently developed totally impermeable (TIF) films can be used with alternatives and this is consistently improving the performance of alternatives at lower dosage rates (Driver et al. 2011; Fennimore and Ajwa, 2011)]. Effectiveness at lower dosages can allow for greater areas to be treated with 1,3-D under township cap regulations.

As of December 1, 2012, EPA issued new set of soil fumigant product label changes, implementing important new protections for workers and bystanders. In the frame of these changes, the State of California now allows the use of VIF films for fumigation with MB, which were formerly prohibited (Cal DPR, 2012b & c; EPA, 2013). MBTOC is at this time unclear on the impact this change could have in terms of potential reduction of dose rates of MB and emission control. Studies continue to show the advantages of barrier films and other technologies for reducing emissions and improving efficacy of alternatives as well as MB (Quin et al 2013; Chellemi et al 2013).

Table 9-9: Final evaluation of CUNs for preplant soil use submitted in 2013 for 2015

Country	Industry	CUE for 2005[1]	CUE for 2006[2]	CUE for 2007[3]	CUE for 2008[4]	CUE for 2009[5]	CUE for 2010[6]	CUE for 2011[7]	CUE for 2012[8]	CUE for 2013[9]	CUE for 2014	CUN for 2015	MBTOC interim rec for 2015
Australia	Strawberry runners	35.750	37.500	35.750	35.750	29.790	29.790	29.790	29.760	29.760	29.760	29.760	**[NR]**

MBTOC Recommendation for 2015:

MBTOC does not recommend this nomination for 2015 until further economic and technical information is provided showing that soilless substrates are unsuitable for the nomination.

Nomination by the Party

The quantity requested for this CUN is 29.760 tonnes, an amount that has essentially remained unchanged for this production region since 2005.

Circumstances of the Nomination by the Party:

The Party states that the key pests affecting strawberry runner production are fungi (*Phytophthora, Pythium, Rhizoctonia* and *Verticillium spp*.) and weeds (*S. arvensis*, *Agrostistenuis sp, Raphanus spp*., *Poa annua, Cyperus spp*). In its answers to MBTOC, the party reported that the fruit industry expansion in Victoria is currently constrained by the amount of MB:Pic available for the production of 'certified' transplants and that runner production in soils treated with MB:Pic is mandatory for meeting certification standards. The Victorian runner industry only produces runners in soils treated with MB:Pic, and is not using any other methods (other than substrates for Foundation stock production). Some non-chemical alternatives are not feasible. Plant resistance is unreliable as an alternative to MB:Pic for delivering certified runners (Fang et al 2012). Integrated soil disinfestation with combinations of existing, registered fumigants is now considered the mostly likely and quickest approach for delivering a viable alternative to MB for the runner industry.

The party reports significant changes since the last nomination including:

- The Victorian Strawberry Industry Certification Authority (VSICA) completed the second year of a 2-year development program for soil-less systems for production of foundation stock strawberry runners, established a commercial facility in 2011 with the capacity to produce 60,000 plants, and completed the first growing season (2011/2012). Results indicated that the productivity of the soil-less system is similar to the current method of production in MB:Pic fumigated soils, and the economics of the soil-less system compares favourably with the current method of production.
- The most promising alternative, MI/Pic, has been withdrawn by the manufacturer.
- Funding for research in support of the registration of ethanedinitrile (EDN) has been discontinued.
- Research to support the use of re-captured MB for soil use has been discontinued.
- In 2007 the State Government of Victoria has withdrawn funding and ceased playing a leadership role in methyl bromide alternatives research.
- A new research and development plan was developed, but not funded, in Sept/Oct 2012 that will focus on 3 areas if funding becomes available:
    - integrated disinfestation systems based on combinations of existing chemistries

Country	Industry	CUE for 2005[1]	CUE for 2006[2]	CUE for 2007[3]	CUE for 2008[4]	CUE for 2009[5]	CUE for 2010[6]	CUE for 2011[7]	CUE for 2012[8]	CUE for 2013[9]	CUE for 2014	CUN for 2015	MBTOC interim rec for 2015

- partial budget analysis of soil-less systems to be available approximately July 2013
- hazard and risk analysis to assess critical control points including a review of pathogen threshold levels for certified runners.

Additionally, a key alternative, 1,3-D:Pic, is considered ineffective due to phytotoxicity and doubling of plant back times in the heavy and wet soil conditions in the high elevation regions. The Party also states that MB:Pic 50:50 at a MB dose of 25 g/m2 is required to meet certification standards. Although this quantity exceeds MBTOC's standard presumption of 20 g/m2, the lower rate is unregistered. Three years of trials with lower MB rates do not support bioequivalency and rates below 25 g/m2 are not registered.

As a consequence of these changes and the circumstances of the nomination, the Party states that the previous transition plans based on the assumption that alternatives under development would be registered in Australia are no longer relevant and cannot be implemented. Development of a new transition plan will commence when a new alternative(s) is identified.

MBTOC Interim Assessment in 2013 for 2015:

Although MBTOC is at this time unclear whether soilless production is technically suitable for all the nomination, MBTOC considers that this non chemical alternative is technically feasible for production of some generations of strawberries in many Non A5 countries e.g Japan (1996), Belgium (Robbe 1997, 1998), Poland (Treder *et al.,* 2007), France (Hennion *et al* .,1997) and A5 countries e.g.Brazil (Janisch *et al* ., 2012, Oliveira *et al*., 2010) ,Uruguay (Gimenez *et al* ., 2008) and Paraguay (Nacimiento and Lopez- Medina 2009) and others ((Lieten (2013), Neocleous and Vasilakakis. (2013), Palha *et al.* (2012), Ramírez-Gómez *et al.* (2012), Roostaand Afsharipoor (2012) Villagra *et al.* (2012), Yoshida (2013).

The nomination reports that industry does not consider further expansion of soil-less systems for the production of mother and certified runners. In the nomination, the party reported also that soil-less substrate production is technically feasible for the foundation generation. MBTOC considers soilless substrates are also technically feasible for successive early generations of nursery runners and can be implemented for a portion of the production in the next 2 years. Screenhouse facilities and soil-less systems were constructed with the aim of producing 50,000 foundation stocks, but at the moment, only 38,000 are produced. MBTOC considers that the party has capacity to increase the production of the foundation stocks. MBTOC also considers that soil-less culture is a technique used widely throughout the world for production of strawberry runners and is technically and economically suitable for some of the certified nursery production system as well as stock plants resulting in healthy nursery material (López-Galarza *et al.,* 2010, Rodríguez-Delfín 2012).

MBTOC recommends that the Party provide the economic analysis that supports their assertion that any expansion of the use of soilless substrates beyond the foundation stock is not economically feasible. MBTOC notes that the first year of commercial production of foundation generation plants was completed in the 2011/2012 growing season. MBTOC also recommends that the Party address technical issues associated with the production of foundation stock using soil-less systems to improve current yields. The nomination indicates that funding for the R&D program at this time has been withdrawn and is uncertain for the future which is not in accordance with Decision IX/6 (b) (i) and (iii). MBTOC recommends that the Party confirm funding and actively pursue a research program that complies with Decision IX/6 as soon as possible.

While MBTOC recognizes the Party's past efforts in research and development of MB alternatives, these efforts have not resulted in significant commercial uptake of them. Furthermore, there have been essentially no significant reductions made for this production region since 2005 and no reduction in use rate as this is regulated by certification rules. MBTOC notes that after more than ten years there is no action plan to phase out MB for this sector.

MBTOC notes the termination of all significant methyl bromide alternatives' research as a result of decisions made by potential alternatives manufacturers and the Victorian State government. Without a funded and active research program, the Party would not be in compliance with Decision IX/6and a complete transition away from methyl bromide may not be possible.

Country	Industry	CUE for 2005[1]	CUE for 2006[2]	CUE for 2007[3]	CUE for 2008[4]	CUE for 2009[5]	CUE for 2010[6]	CUE for 2011[7]	CUE for 2012[8]	CUE for 2013[9]	CUE for 2014	CUN for 2015	MBTOC interim rec for 2015

MBTOC comments on Economics in 2013:

The nomination was not based on economic arguments. The data on the economic feasibility of soilless systems for mother and certified stock will become available by July 2013.

Comments Requested in Dec. XX1/11 (para 9):

- **Dec. IX/6 b(i)** Emission reduction: No, but the Party states that standard films perform the same as VIF for the reduction of emissions in the cold temperatures and heavy wet soils typical for strawberry runner production in Victoria. Party also states that use of VIF did not improve the efficacy of reduced rates of MB to an acceptable level for the strawberry runner industry.
- **Dec. IX/6 b(ii)** Research program: No approved and funded research program is currently in place at the time of this nomination.
- **Dec. IX/6 b(iii)** Appropriate efforts: Research effort is not adequate - no funded research program currently in place at the time of this nomination.

Country	Industry	CUE for 2005[1]	CUE for 2006[2]	CUE for 2007[3]	CUE for 2008[4]	CUE for 2009[5]	CUE for 2010[6]	CUE for 2011[7]	CUE for 2012[8]	CUE for 2013[9]	CUE for 2014	CUN for 2015	CUE for 2015
Canada	Strawberry runners (PEI)	6.840	6.840	7.995	7.462	7.462	7.462	5.261	5.261	5.261	5.261	5.261	[5.050]

MBTOC Final Recommendation for 2015:

MBTOC recommends a reduced CUE of 5.050 tonnes, a 4% reduction of the nominated amount. This assumes adoption of alternatives for 50% of the foundation stock plants.

Nomination by the Party

The Party has nominated 5.261 t of MB which was similar to the CUE granted in 2014. It is for use on (24.3 ha) of field grown runners and (2 ha) of stock plants. The nomination is based on a reduced rate of MB of 20 g/m² under high barrier films for the entire 26.3 ha to be fumigated.

Circumstances of the Nomination by the Party:

The Party has attempted to replace MB with 1,3-D, but 1,3-D was banned for use in Prince Edward Island in January 2003 due to ground water contamination. Chloropicrin (PIC 100) has been registered by PMRA, but the PEI authorities have denied a permit for its use until further groundwater testing has been conducted. Ground water studies have been submitted to PMRA and are awaiting final reviews and regulatory decision. Registration applications for MI, DMDS and EDN have not been submitted to date. The company has tested organic production from 2006 - 2009 with different varieties, but found that significant reductions in yield ranging from 40% to 70% resulted. Only one variety using the organic production system compared favourably to conventional production. While MB:Pic 67:33 at 500 kg/ha is the only use rate registered for strawberry runners, which exceeds MBTOC's standard presumption of 200 kg/ha, the grower petitioned PMRA to use a lower rate under barrier films. PMRA, in the absence of a formal label amendment, granted permission to use a lower rate, but at the grower's own risk and liability. The CUN for 2015 is based entirely on a reduced rate for MB of 200 kg/ha for the entire area to be fumigated (26.3 ha).

Country	Industry	CUE for 2005[1]	CUE for 2006[2]	CUE for 2007[3]	CUE for 2008[4]	CUE for 2009[5]	CUE for 2010[6]	CUE for 2011[7]	CUE for 2012[8]	CUE for 2013[9]	CUE for 2014	CUN for 2015	MBTOC interim rec for 2015
	MBTOC Interim Assessment in 2013 for 2015: MBTOC considers substrate culture is feasible for production of foundation stock for this use in 2015 (in many Non A5 countries e.g Japan (1996), Belgium (Robbe 1997, 1998), Poland (Trader *et al* .,2007), France (Hennion, 1997) and A5 countries e.g.Brazil (Janisch *et al.,* 2012, Oliveira *et al* .,2010) ,Uruguay (Gimenez *et al* .,2008) and Paraguay (Nacimiento and Lopez- Medina, 2009) and has adjusted the amount for uptake of alternatives for 50 % of the foundation stock . MBTOC recommended no further reductions in view of the Party stating the 'objective of an action plan' was that 2016 will be the final year for use of MB for this sector as. MBTOC notes that MB formulations containing Pic (67:33) are used in PEI under permit without groundwater contamination apparently occurring and suggests a similar situation should be possible for Pic alone which is not currently permitted. **MBTOC comments on economics in 2013 for 2015:** The nomination was not based on economic arguments. However the Party is planning analysis of the costs to the grower of transition to soilless culture in greenhouses for the nursery stock **Comments requested in Dec. XX1/11 (para 9)** **Dec. IX/6 b(i)** Emission reduction: Yes, uses barrier films with reduced application rate of MB conforming to MBTOC's presumptions **Dec. IX/6 b(iii)** Research program: No recent research; previous focus has been on organic production testing; registrant for Midas has not submitted any registration application materials at this time. **Dec. IX/6 b(iii)** Appropriate effort: The Party has not demonstrated an active research program on its most critical issue since it has been unable to obtain assistance to do the necessary GW testing required by PEI authorities before approving the use of PIC100 in PEI.												

Country	Industry	CUE for 2005[1]	CUE for 2006[2]	CUE for 2007[3]	CUE for 2008[4]	CUE for 2009[5]	CUE for 2010[6]	CUE for 2011[7]	CUE for 2012[8]	CUE for 2013[9]	CUE for 2014	CUN for 2015	MBTOC interim rec for 2015
United States	Strawberry (field)	2052.846	1730.828	1476.019	1349.575	1269.32	1007.477	812.709	678.004	461.186	415.067	373.660	**[224.196]**

MBTOC interim recommendation for 2015:

MBTOC recommends an amount of 224.196 t for use in this sector for 2016. MBTOC acknowledges that the Party reduced the nomination by 10% from the amount approved for 2014, however MBTOC recommends a further 40% reduction due to a faster transition to effective alternatives. MBTOC considers that alternatives are now available and complete phase out of MB is feasible although accepts that the Party requires time to transition to these alternatives.

Alternatives (1,3-D/Pic and chloropicrin under the new permitted rates of up to 392 kg/ha)with or without barrier films, not restricted by regulations, are considered available to replace MB for specific uses, including *Macrophomina sp.* and *Fusarium spp.* in specific counties. They should also allow for greater use of 1.3-D/Pic formulations on a greater area where township caps are binding.

MBTOC considers that the alternatives suggested to replace MB for this nomination are similar to those already in commercial practice in California, therefore a two year period starting in 2015 will be sufficient time to adapt the production systems for these alternatives in those areas not currently using them or where regulations previously prevented their use.

One member considered that a reduction of 46% from the amount approved in 2014 (ie 40% further than that nominated in 2015) would be too large a reduction to successfully transition 50% by 2016 and that a 33% reduction is more feasible. This is to ensure time for regulatory certainty, to confirm efficacy under regional conditions and to develop and implement training to ensure worker and bystander safety in light of past information from the party on accidental releases of alternatives containing chloropicrin and the potential negative impact on future availability of these alternatives.

Nomination by the Party:

The Party nominated 373.660 t for 2,198 ha at a dosage rate of 170 kg/ha. The proportion of total crop area to be treated with MB was noted by the Party as 13.5%. The CUN amount represented a 10% transition in 2015 from the exempted amount in 2014.

Circumstances of the Nomination by the Party:

The CUN requests MB specifically for areas: 1) where *Macrophomina* and *Fusarium* have not been acceptably controlled with alternative fumigant methods, 2) where a transition period is necessary to implement use of straight chloropicrin, and 3) where township caps adversely impact the use of 1,3-D as an alternative. There was no further breakdown of the rationale for each provided by the Party for the reduction in 2015, nor an action plan for total phase-out of MB.

After the bilateral by MBTOC, the US advised that they are planning further work to test the efficacy of metam-sodium on *Macrophomina* under California conditions. The Party also plans to gather data on efficacy of the high rate of chloropicrin under TIF and its ability to control diseases caused by *Macrophomina, Fusarium* and *Verticillium* in commercial field applications over time on California strawberries and will apprise MBTOC of its findings.

<table>
<tr><th>Country</th><th>Industry</th><th>CUE for 2005[1]</th><th>CUE for 2006[2]</th><th>CUE for 2007[3]</th><th>CUE for 2008[4]</th><th>CUE for 2009[5]</th><th>CUE for 2010[6]</th><th>CUE for 2011[7]</th><th>CUE for 2012[8]</th><th>CUE for 2013[9]</th><th>CUE for 2014</th><th>CUN for 2015</th><th>MBTOC interim rec for 2015</th></tr>
<tr><td></td><td colspan="13">**MBTOC Interim Assessment for 2015**:

After reviewing the references provided by the Party and others, MBTOC considered that either shank applied 1,3-D/Pic and other similar Pic mixtures, Pic alone or Pic in sequential application with MITC generators (KPam, Vapam, dazomet) and disease tolerant varieties of strawberries would be suitable to address a significant proportion of one or more of the 3 issues raised by the Party as a reason for the nomination (Medina-Minguez 2012, Noling and Cody 2012, Porter et al, 2006, Zveibel et al, 2012,etc.).

Macrophomina phaseolina is a widespread fungus all over the world in many crops. MBTOC recognizes *Macrophomina* has increased in importance as a pathogen of strawberry crops in the last decade. Recent studies show effective alternatives to MB to control this pathogen in some countries. In Florida, Noling & Cody (2012) showed that 1,3D; DMDS+Pic; Vapam and KPam are as effective as MB for season long protection of this pathogen. Zveibil *et al.,* in Israel (2012) also reported that metam sodium was as effective as MB. TeloDrip has given inconsistent results which confirm the Parties concerns with drip fumigation (Zviebel, 2012). A number of cultivars are also considered to provide options for tolerance to this disease (Fang *et al.,*, 2012; Daugovish *et al.*, 2011; MBAO). MBTOC reiterates its 2010, 2011 and 2012 suggestion that shank injection of 1,3-D/Pic by strip or broadcast application would result in improved disease control compared to drip applications (Noling and Cody 2012, Medina-Minquez 2012, Zveibil 2012). Also in previous assessments it has been suggested that alternatives (1,3-D/Pic and Pic alone with or without barrier films), if not restricted by regulations, were considered available to replace MB for specific uses, including *Macrophomina* and *Fusarium* in specific counties.

A key change from previous nominations is that regulations in California have recently changed and now permit rates of up to 392 kg/ha of chloropicrin beginning in 2013. MBTOC considers this rate, especially if shank applied, can provide equivalent efficacy with MB (Medina-Minquez 2012). Formulations with chloropicrin are the key chemical alternatives being adopted effectively in other regions of the world.

MBTOC considers that the technical expertise required for application of 100% chloropicrin already exists in California and uptake of this method should be feasible within two years. As the nomination is for 2015, there is an additional period to gain further experience with these high rates of chloropicrin to accommodate both technical and regulatory issues, such as worker and bystander safety and effective pest control. Average annual use of chloropicrin for the last five years in California strawberry industry is of 1,786 t which accounts for 70% of the use of this product in the State (Cal DPR, 2012). There has been an increased use of chloropicrin alone and in formulations with 1,3-D in California. It's use has almost tripled between 2006 and 2010 (Cal DPR, 2012) whilst its use in formulations with MB has been declining.

MBTOC recognizes the potential benefit of the establishment of a new committee (Strawberry Non Fumigant Workgroup) to evaluate and adopt further chemical and non chemical technologies such as: anaerobic soil disinfestation; soilless substrate systems and steam (CalDPR, 2013).

MBTOC notes that as of December 1, 2012, an EPA new set of soil fumigant product label changes went into effect, fully implementing important new protections for workers and bystanders. In the frame of these changes, the State of California allows now the use of VIF films for MB fumigation, which were formerly prohibited (Cal DPR, 2012b & c; EPA, 2013). MBTOC is at this time unclear on the impact this change could have in terms of potential reduction of MB dose rates as well as emission control. Studies continue to show the advantages of barrier films and other technologies for reducing emissions and improving efficacy of alternatives as well as MB (Quin et al 2013; Chellemi et al 2013).

After the bilateral, the Party reiterated concerns about the impact of current reviews on two key alternatives, chloropicrin and 1,3-D, on the nomination of future regulatory requirements by the California Department of Pesticide Regulation (CDPR). MBTOC also acknowledges that approval for the use of the new higher rates of chloropicrin will be controlled by the County Agricultural Commissioners.

In view of the recent progress with alternatives, MBTOC strongly encourages the Party to formally develop a phase out plan for this sector.</td></tr>
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<tr><th>Country</th><th>Industry</th><th>CUE for 2005[1]</th><th>CUE for 2006[2]</th><th>CUE for 2007[3]</th><th>CUE for 2008[4]</th><th>CUE for 2009[5]</th><th>CUE for 2010[6]</th><th>CUE for 2011[7]</th><th>CUE for 2012[8]</th><th>CUE for 2013[9]</th><th>CUE for 2014</th><th>CUN for 2015</th><th>MBTOC interim rec for 2015</th></tr>
<tr><td></td><td colspan="13">
MBTOC comments on economics in 2013 for 2015:

A recent peer reviewed study (Mayfield and Norman, 2012) highlights the strong growth in output in the California strawberry industry since 2004. This publication also questions the accuracy of the economic data (and varying yields) in CUNs and how this makes analysis of the economic information difficult.

The present CUN states that "The economic analyses…indicate fumigant-treated soils can result in gains or losses to net revenues that range from -37% (with drip Pic-Clor 60) to 9% (with 100% broadcast chloropicrin), based on the cost of the individual fumigant and estimated yield loss".

The information provided in the CUN excludes fixed costs from the calculation of changes in net revenue because "... fixed costs are considered to be identical for all alternative scenarios ..." but by convention when fixed costs can be allocated fully to a specific activity they should be included in a partial budget. Because this has not been done, steam appears to be an economically feasible alternative.

Comments Requested in Dec. XX1/11 (para 9):

• Dec. IX/6 b(i) Emission reduction: In California low permeability (high barrier) films are not allowed for use with MB, but are allowed and available for use with alternatives, this regulation is presently under review.

• Dec. IX/6 b(ii) Research program: Yes, there is an on going research program, but specific data justifying CUN requests need to be provided.

• Dec. IX/6 b(iii) Appropriate efforts: California has extensive research programs being conducted and continual regulatory reviews on the use of MB and other fumigant alternatives in the State. MBTOC is unaware from the CUN application what efforts are being made to register some alternatives registered and being used in other areas of the USA (eg. Pic-clor 80, DMDS in combination with Pic).
</td></tr>
</table>

[1]1ExMOP and 16MOP; [2]16MOP+2ExMOP+17MOP; [3]MOP17+MOP18; [4]MOP18+MOP19; [5]MOP19+MOP20; [6]MOP20+MOP21; [7]MOP21+MOP22; [8]MOP22, [9]MOP23, [10]MOP24

d 16MOP; [2]16MOP+2ExMOP+17MOP; [3]MOP17+MOP18; [4]MOP18+MOP19; [5]MOP19+MOP20; [6]MOP20+MOP21; [7]MOP21+MOP22; [8]MOP22, [9]MOP23, [10]MOP24

9.5 Interim evaluation of CUNs: Structures and Commodities

MBTOC, Structures and Commodities (SC), Soils and QPS, met together in London, United Kingdom April 3-5, 2013.

MBTOC SC assessed the two remaining CUNs submitted in 2013 for 2015, prepared the Progress Report and reviewed the Decisions taken by Parties at the MOP in 2012 concerning the organization and operation of TEAP, TOCs and the implications for MBTOC members. The Handbook on Critical Use Nominations for Methyl Bromide, and its readiness for use by Parties, was also discussed. Also during the meeting, a bilateral meeting was held with United States government officials and also electronically by Skype with US research scientists to discuss questions about the CUNs and to improve understanding of recent research, and to understand US regulatory matters.

Plenary discussions were held with the three sub-committees of MBTOC to discuss the critical use nomination recommendations, discuss reports and answer questions from members.

In 2012 there were five CUNs submitted by three Parties.

By contrast, in 2013 there were two postharvest CUNs submitted by Parties. Between 2012 and 2013, applicants from three Parties: Australia, Canada and the US, were able to complete their planned adoption of alternatives. Accordingly, Australia did not submit a CUN for rice processing, Canada did not submit a CUN for flour milling and the US did not submit a CUN for flour milling and also several dried fruit sectors. Completing the adoption of these former methyl bromide applications was no doubt difficult and required effort of the industry and government; MBTOC was happy to hear of these successes.

In 2013, the US submitted two postharvest CUNs for 2015; one CUN was for dry cure pork and for CUN was for fresh dates (formerly included in the dried fruit CUN).

9.5.1 Standard rate presumptions

MBTOC assessed CUNs for appropriate MB dosage rates and deployment of MB emission/use reduction technologies, such as appropriate sealing techniques.

Decision IX/6 requires that critical uses should be permitted only if '*all technically and economically feasible steps have been taken to minimise the critical use and any associated emission of methyl bromide*'. Decision Ex.II/1 also mentions emission minimisation techniques, requesting Parties "…*to ensure, wherever methyl bromide is authorised for critical-use exemptions, the use of emission minimisation techniques that improve gas tightness or the use equipment that captures, destroys and/or reuses the methyl bromide and other techniques that promote environmental protection, whenever technically and economically feasible.*"

With the beginning of the CUN process in 2005, MBTOC published its standard presumptions for structures (20g m^{-3}) and indicated that the European Plant Protection Organization's (EPPO) published dosage rates for commodities should be considered standard best practice for fumigation worldwide. Since that time all Parties submitting CUNs stated their adherence to those practices. The EPPO dosage rates for commodity treatment vary by commodity, sorption rate and environmental conditions. They can be found in annexes to the MBTOC 2006 Assessment Report (MBTOC, 2007). Where possible, reduced dosages, combined with longer exposure periods, can reduce MB consumption, while maintaining efficacy (MBTOC 2007).

9.5.2. Details of evaluations

Parties have submitted two CUNs for the use of MB in structures and commodities in 2013. This year all CUNs were for one year – 2015.

The total MB volume nominated in 2013 for non-QPS post-harvest uses, was 3.550 tonnes. Of the nominations in 2013 for 2015, MBTOC recommended 3.240 tonnes (Table 9.10 and 9.11). Table 9-11 provides the MBTOC-SC interim recommendations for the CUNs submitted.

Table 9-10: Summary of the interim recommendations by MBTOC SC (in square brackets) for CUE's for postharvest uses of MB (tonnes) for 2015 submitted in the 2013 round.

Country and Sector	**Nominated in 2013 (tonnes)**	**Recommended for 2015 (tonnes)**
United States – cured pork	3.240	[3.240]
United States – fresh dates	0.310	[0]
Total	**3.510**	**[3.240]**

Table 9-11: Final evaluations of CUNs for structures and commodities submitted in 2013 for2015

Country	Industry	CUE for 2005[1]	CUE for 2006[2]	CUE for 2007[3]	CUE for 2008[4]	CUE for 2009[5]	CUE for 2010[6]	CUE for 2011[7]	CUE for 2012[8]	CUE for 2013[9]	CUE for 2014[10]	CUN for 2015	MBTOC rec. for 2015
United States	Commodities (Dates only)	89.166	87.719	78.983	58.921	45.623	19.242	5.000	2.419	0.822	0.740	**0.310**	**[NR]**

MBTOC Recommendation for 2015:

MBTOC does not recommend the use of methyl bromide for fresh dates in the United States in 2015.

Nomination by the Party:

The Party nominated 0.310 tonnes of methyl bromide for fresh dates in 2015. The nomination represented a 58.1% reduction in the former US Commodities CUN of which dates was an element in previous years. In 2012, as part of the Commodities CUN, the Party nominated 0.325 tonnes for dates, and therefore the 2013 CUN for dates represents a 4.6% reduction in the amount nominated for dates compared to 2012.

Circumstances of the Nomination:

This nomination is for the portion of fresh dates for which quick shipment (defined as either three or 3-5 days in the CUN and subsequent correspondence) to the fresh market segment. The Party notes that phosphine and sulfuryl fluoride are the primary fumigants for dates, although sulfuryl fluoride has not been found to be effective at killing the eggs of pests at temperatures at or below 26.6˚C (80°F) which often occurs in Riverside County of California, their main date production area.

The Party noted that fumigation with phosphine takes approximately 3-5 days, whereas MB fumigation is less than 24 hrs. As a result, when market demands fast turnaround immediately before shipping, methyl bromide treatment, typically a 20h exposure, is still required, according to the Party.

The Party noted that, currently, methyl bromide is the only treatment available to rapidly disinfest California dates at harvest time, when up to a million pounds per day are harvested within a relatively tight timeframe during the fall. These dates are harvested by hand, and growers need to get them to the marketplace in three, or 3-5 days, to meet the demand of a market segment for fresh dates.

MBTOC Interim Assessment in 2103 for 2015:

MBTOC was unable to recommend this nomination because there are technically effective, commercially available alternatives and because the need for a three-day market window for the approximate 25% of the total harvest volume nominated was not substantiated by the Party. MBTOC was unable to determine a justification, technical, economic, market, regulatory or otherwise for the necessity of marketing within three days, as compared for example, to marketing within five days.

In past, MBTOC's text boxes have reported its concern about the length of time the sector is taking to make the logistical changes to enable the use of phosphine or other alternatives. MBTOC's text boxes for the past few years have indicated a need for the date and dried fruit sector to hasten the expansion of its phosphine fumigation capacity.

Country	Industry	CUE for 2005[1]	CUE for 2006[2]	CUE for 2007[3]	CUE for 2008[4]	CUE for 2009[5]	CUE for 2010[6]	CUE for 2011[7]	CUE for 2012[8]	CUE for 2013[9]	CUE for 2014[10]	CUN for 2015	MBTOC rec. for 2015

The California date sector conducts phosphine fumigation in chambers and also conducts fumigation in crates under tarps in the field -- for which it seems there is more than adequate capacity for expansion. By harvest 2015, MBTOC considers there is time to make logistical changes to expand phosphine treatment facilities which would allow for a staged release of sufficient product to meet a market demand for freshly harvested dates.

For example, the use of phosphine generators or cylinderized phosphine (as opposed to solid forms of phosphine) would, for the warmer harvest months of August to October, result in three days or shorter phosphine treatment being effective. Using the example of other commodity marketing, the strongest consumer demand for fresh fruit often occurs in the beginning of the new harvest period. For dates the harvest period begins mid-August, a time of high temperatures in the California date producing region. This means that in the early harvest months the high ambient temperatures will assist to ensure an adequate phosphine treatment within three days.

In California, date harvest continues until mid-December. In the colder months, phosphine treatment without supplemental heat would require four to five days, but if the chamber or bag stack was to be heated to > 25˚C, the treatment time would be closer to three days. (Readers can refer to table below pertaining to the time, temperature and concentration parameters for treatment of dried fruit by cylinderized phosphine.)

ALLOWABLE PHOSPHINE DOSAGES FOR ECO_2FUME®[1,2,3]

Temperature	PH_3 Concentration Maintained/1000 ft^3 of Area	Rate of ECO_2FUME®/1,000 cu. Ft.	Minimum Duration
Below 32ºF (0º C)	Do not fumigate	Do not fumigate	Do not fumigate
32-39º F (0-4º C)	200-1,000 ppm	0.88 – 4.41 lb	6 days
40-53º F (5-12º C)	200-1,000 ppm	0.88 – 4.41 lb	4 days[4]
54-59º F (12-15º C)	200-1,000 ppm	0.88 – 4.41 lb	3 days
60-79º F (16-25º C)	200-1,000 ppm	0.88 – 4.41 lb	2 days
80º F & Above (≥26º C)	200-1,000 ppm	0.88 – 4.41 lb	36 hours
80º F & Above (≥26º C)	500-1,000 ppm	2.20 – 4.41 lb	24 hours

Changing the current methyl bromide treatments to phosphine treatments would interrupt logistics of market once, and only for a couple of days because as new commodity is harvested frequently (or daily), and treatment by phosphine would be staged frequently (or daily), it stands to reason that each day would see the completion of fumigation and the newly treated dates would be then available to meet the market demand for fresh dates.

Phosphine has been commercially adopted to control pests of dried fruit. It has been widely adopted in all dried fruit producing countries. As temperature is an important parameter, this work done in Turkey is helpful. According to Tutuncu et al, 2012, phosphine applications at a concentration of 200 ppm at 15oC gave a complete mortality in all life stages of *C. hemipterus* in 36 h of exposure. Results also showed that complete mortality time of eggs, larvae, pupae and adult stages of *C. hemipterus* was found to be 36 h, 12 h, 24 h, and 16 h, respectively. Complete mortality times of 1- and 2-day-old eggs were 36 h and 20 h, respectively. For 1-, 2- and 3-day-old pupae, total mortalities were obtained after 24 h, 16 h, and 14 h of exposure, respectively.

Country	Industry	CUE for 2005[1]	CUE for 2006[2]	CUE for 2007[3]	CUE for 2008[4]	CUE for 2009[5]	CUE for 2010[6]	CUE for 2011[7]	CUE for 2012[8]	CUE for 2013[9]	CUE for 2014[10]	CUN for 2015	MBTOC rec. for 2015

MBTOC also notes that the efficacy of heat treatment is both well-known and commercially established in other countries (Navarro et al, 2006.) Compared to phosphine, heat treatment has the added benefit of actually removing the larvae from the fruit because they exit the fruit to escape. The eggs of insects are highly susceptible to heat treatment, dying within a few minutes. Unlike chemical treatments, heat is consistent with organic certification regulations in most countries and often organically certified product obtains a higher price in the marketplace. Heat treatment also allows the treatment and sale of dates while the dates are still attached to small branches; this is a very good-looking fresh product well appreciated by consumers of fresh dates in other countries.

There is, however, a need for the California date sector to resolve practical adoption issues for heat treatment. As noted by Finkleman et al, (2010) in Israel, heat treatment with Deglet-Noor (one of the two date varieties included in the US CUN), was not successful because the large crates (200 – 400kg) did not allow for fast enough heat transfer. MBTOC notes that the same crate size is used in the United States.

However, as it is clear that heat treatment disinfests dates; it is worth the effort to overcome practicalities by using smaller crates or by using an in-line processing system and doing the needed food quality assessments. As this CUN pertains to MB use in 2015, and having studied the adoption of heat treatment in Israel, MBTOC believes that the logistical and practical issues could be resolved by 2015.

MBTOC Comments on Economics 2012:

Dates: The CUN is largely, but not entirely, based on technical, rather than economic arguments. The Party reports only on the economic comparison of sulfuryl fluoride versus methyl bromide. Sulfuryl fluoride costs less than methyl bromide. The Party did not report on the comparison of methyl bromide versus phosphine. MBTOC believes that phosphine costs considerably less than methyl bromide.

Comments Requested in Dec. XX1/11 (para 9):

- **Dec. IX/6 b(i)** Emission control: Fumigations are conducted in chambers or under tarps of sufficient gas tightness.
- **Dec. IX/6 b(iii)** Research program: Research on dates has been focussed and ongoing. A combination treatment of SF, carbon dioxide and propylene oxide continues to be researched as preliminary results were positive for dried fruits, but the registration approval scenario for this combination treatment indicates it would only be a longer term proposition.
- **Dec. IX/6 b(iii)** Appropriate effort: As with all postharvest registration issues, neither the applicant nor the Party mandated with Montreal Protocol nominations has control over pesticide registration.

Country	Industry	CUE for 2005[1]	CUE for 2006[2]	CUE for 2007[3]	CUE for 2008[4]	CUE for 2009[5]	CUE for 2010[6]	CUE for 2011[7]	CUE for 2012[8]	CUE for 2013[9]	CUE for 2014[10]	CUN for 2015	MBTOC rec. for 2015
United States	Cured pork	67.907	40.854	18.998	19.669	18.998	4.465	3.73	3.730	3.730	3.730	**3.240**	**[3.240]**

MBTOC Recommendation for 2015:

MBTOC recommends 3.240 tonnes, the amount nominated by the Party for use in US dry cure pork in 2015.

Nomination by the Party:

The Party nominated 3.240 tonnes, a reduction of 13.1% from the amount granted by the Parties for this use in 2014. This reduction has been achieved by improvements in methyl bromide fumigation efficacy.

Circumstances of the Nomination:

Currently there are no commercially effective alternatives to methyl bromide for Southern dry cure pork, a regional, traditional product. The pests of this product are the red-legged ham beetle (*Necrobia rufipes*) and the ham mite (*Tyrophagus putrescentiae*). The US dry cure pork research program has identified the incidence of pests in dry cure pork facilities; 50-60% of plants have reported infestations of the red-legged beetle. The incidence of mites is approximately 60-70 %. (Shilling, in USG response to MBTOC Mar 30, 2010).

Of methods already considered and rejected, heat would alter the product unacceptably, and the only effective dosage of sulfuryl fluoride was three times the legal limit of use before mite eggs were controlled (and therefore not registered). (Phillips, et al., 2008).

There is an ongoing multi-university, multi-state research program which is focused on improving meat processing sanitation, IPM and pest control through a variety of possible fumigants. So, for example, the Party reports processors are now trying to steam clean, use approved disinfectants with acaricidal properties, or both, to sanitize their facilities when the hams are not present and before new hams are introduced.

In addition, prior to the phase-out of methyl bromide this industry tended to fumigate on a monthly basis. Plus processors brought in new hams into aging houses that also contained contaminated hams. This is no longer the case. Processors keep new hams away from the older hams and many have subdivided their aging house space to accomplish this. Southern cured pork processors only fumigate when the pests, or signs of the pests, are present.

MBTOC Interim Assessment in 2013 for 2015:

The US has a robust research program which has investigated, and reported to MBTOC, the progress and results of its investigation of every possible mite-control method suggested by MBTOC in its previous text boxes. More research to find an effective treatment (or combination of treatments), followed by commercial trials need to be conducted before any treatment can be considered an alternative to methyl bromide for treatment of ham mites.

<table>
<tr><th>Country</th><th>Industry</th><th>CUE for 2005[1]</th><th>CUE for 2006[2]</th><th>CUE for 2007[3]</th><th>CUE for 2008[4]</th><th>CUE for 2009[5]</th><th>CUE for 2010[6]</th><th>CUE for 2011[7]</th><th>CUE for 2012[8]</th><th>CUE for 2013[9]</th><th>CUE for 2014[10]</th><th>CUN for 2015</th><th>MBTOC rec. for 2015</th></tr>
<tr><td></td><td colspan="13">Research is still ongoing with phosphine. The Party released and discussed results of commercial scale trials conducted in winter 2013. Unfortunately, these phosphine tests did not show adequate efficacy against mites. Additionally, problems were experienced such as significant damage to electronic elements of the facility. Further learning would be needed to determine if phosphine treatment parameters could be achieved which might improve efficacy and while avoid facility damage. MBTOC notes that problems in achieving efficacy in phosphine at commercial scale might be overcome by increasing temperature.

Additionally, the Party has noted that it intends to work on temperature-related control of mites for example, using both heat and cold as control measures.

In the face of continued lack of success with what had been considered to be possible alternatives, and after considering the review of the Party’s ongoing research, MBTOC’s experts suggest a focus on the following aspects. While these steps might not eliminate the pests, it might take longer before hams are infested. These and other IPM steps might allow an increase in the time period between fumigation of the ham storage facilities. To this end, MBTOC agrees with the research being currently conducted by the Party to develop and test methods to quantify if and to what extent sanitation and pest control methods work to reduce mite infestation.

1. *A continued focus on protecting the ham from mite infestation during the aging process. The Party’s research on dips such as with propylene glycol, hot lard (90°C; with curative and preventive effects), and other substances seems to offer a promising method to prevent infestation of these pests. This kind of protection may also lead to improvement of the final quality of the ham by avoiding excess drying.*

Another protective measure is a physical barrier against mites. The suggestion is a fine mesh gauze that is wrapped around the ham pieces (Lehms et al, 2012). Data is available on the effectiveness of the size of the mesh to prevent invasion of all stages of Tyrophagus putrescentiae (<30 µm). Following MBTOC’s release of this information in its 2012 text box, the Party has already begun testing and resolving practical aspects of implementing this method in the aging process.

2. *Encourage measures which reduce pest pressure. Assess if improvements in environmental manipulation would decrease mite population and reduce re-infestation. For example, continue to make improvements outside of the facility to remove pest harborages, and also establish methods to prevent the entrance of mites into the facility by employees and other vectors. It might be possible that doorway shoe sanitization and ensuring employees change from street clothes to sanitized uniforms in the plant might reduce mite invasion.*

Improvements in the building might be necessary to reduce the ability of mites to survive treatment and then re-infest the facility. For example, changes which make the walls and floors easier to clean might decrease the resident mite population. Cement floors and metal storage racks can be more effectively cleaned by power washing with steam and bleach.

3. *Continue to improve gastightness in facilities before fumigation. With improved gastightness, air circulation and temperature can be increased during the fumigation which will improve the effectiveness of the MB at the dosage of 20g/m3.*

4. *Continue to gather up-to-date information on the use of MB in this sector, by, for example, updating its 2008 survey on frequency of fumigation as it relates to length of ham storage. MBTOC notes that the 2012 survey of facilities was quite useful. Also continue to improve understanding of actual use of MB by facility as this might help benchmark the actions of some better performing facilities to assist the ham sector as a whole.*</td></tr>
</table>

Country	Industry	CUE for 2005[1]	CUE for 2006[2]	CUE for 2007[3]	CUE for 2008[4]	CUE for 2009[5]	CUE for 2010[6]	CUE for 2011[7]	CUE for 2012[8]	CUE for 2013[9]	CUE for 2014[10]	CUN for 2015	MBTOC rec. for 2015

MBTOC Comments on Economics 2012:

The CUN is not based on economics.

Comments Requested in Dec. XX1/11 (para 9):

- **Dec. IX/6 b(i)** Emission control: Over the years the applicants have made facility improvements to improve gastighness, but this is a traditional meat curing process and some of the facilities are older and unusual. The research program continues to work with the applicants to improve gastightness, IPM and other process improvements which reduce the need for fumigation and result in decreased use of MB. This work needs to continue. Producers have modified their buildings both to make them more gas-tight and to exclude pests.
- **Dec. IX/6 b(iii)** Research program: Excellent research effort to date and still ongoing. A multi-state, multi-university research program is ongoing and full reports of research have been made available to MBTOC.
- **Dec. IX/6 b(iii)** Appropriate effort: As with all postharvest registration issues, neither the applicant nor the Party mandated with Montreal Protocol nominations has control over pesticide registration. Phosphine is registered for use on processed meats such as cured pork but it has not been shown to be effective against mites.

[1]1ExMOP and 16MOP; [2]16MOP+2ExMOP+17MOP; [3]MOP17+MOP18; [4]MOP18+MOP19; [5]MOP19+MOP20; [6]MOP20+MOP21; [7]MOP21+MOP22; [8]MOP22, [9]MOP23

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Annex I to Chapter 9: Decision IX/6

1. To apply the following criteria and procedure in assessing a critical methyl bromide use for the purposes of control measures in Article 2 of the Protocol:

(a) That a use of methyl bromide should qualify as "critical" only if the nominating Party determines that:

(i) The specific use is critical because the lack of availability of methyl bromide for that use would result in a significant market disruption; and

(ii) There are no technically and economically feasible alternatives or substitutes available to the user that are acceptable from the standpoint of environment and health and are suitable to the crops and circumstances of the nomination;

(b) That production and consumption, if any, of methyl bromide for critical uses should be permitted only if:

(i) All technically and economically feasible steps have been taken to minimise the critical use and any associated emission of methyl bromide;

(ii) Methyl bromide is not available in sufficient quantity and quality from existing stocks of banked or recycled methyl bromide, also bearing in mind the developing countries' need for methyl bromide;

(iii) It is demonstrated that an appropriate effort is being made to evaluate, commercialise and secure national regulatory approval of alternatives and substitutes, taking into consideration the circumstances of the particular nomination and the special needs of Article 5 Parties, including lack of financial and expert resources, institutional capacity, and information. Non-Article 5 Parties must demonstrate that research programmes are in place to develop and deploy alternatives and substitutes. Article 5 Parties must demonstrate that feasible alternatives shall be adopted as soon as they are confirmed as suitable to the Party's specific conditions and/or that they have applied to the Multilateral Fund or other sources for assistance in identifying, evaluating, adapting and demonstrating such options;

2. To request the Technology and Economic Assessment Panel to review nominations and make recommendations based on the criteria established in paragraphs 1 (a) (ii) and 1 (b) of the present decision;

3. That the present decision will apply to Parties operating under Article 5 and Parties not so operating only after the phase-out date applicable to those Parties.

Para. 2 of Decision IX/6 does not assign TEAP the responsibility for determining the existence of "significant market disruption" specified in paragraph 1(a)(i).

TEAP assigned its Methyl Bromide Technical Options Committee (MBTOC) to determine whether there are *no technically and economically feasible alternatives or substitutes available to the user that are acceptable from the standpoint of environment and health and are suitable to the crops and circumstances of the nomination*, and to address the criteria listed in Decision IX/6 1(b).

Annex II to Chapter 9 - Part A: Trend in MB Preplant Soil Nominations and Exemptions

List of nominated (2005 – 2015) and exempted (2005 – 2014) amounts of MB granted by Parties under the CUE process for each crop.

Party	Industry	Total CUN MB Quantities											Total CUE Quantities									
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Australia	Cut Flowers – field	40.000	22.350										18.375	22.350								
Australia	Cut flowers – protected	20.000											10.425									
Australia	Cut flowers, bulbs – protected Vic	7.000	7.000	6.170	6.150								7.000	7.000	3.598	3.500						
Australia	Strawberry Fruit	90.000											67.000									
Australia	Strawberry runners	35.750	37.500	35.750	35.750	29.790	29.790	29.790	29.790	29.760	29.760	**29.760**	35.750	37.500	35.750	35.750	29.790	29.790	23.840+ 5.95	29.760	29.760	**29.760**
Belgium	Asparagus	0.630	0.225										0.630	0.225								
Belgium	Chicory	0.600	0.180										0.180	0.180								
Belgium	Chrysanthemums	1.800	0.720										1.120									
Belgium	Cucumber	0.610	0.545										0.610	0.545								
Belgium	Cut flowers – other	6.110	1.956										4.000	1.956								
Belgium	Cut flowers – roses	1.640																				
Belgium	Endive (sep from lettuce)		1.650											1.650								
Belgium	Leek & onion seeds	1.220	0.155										0.660									

Party	Industry	Total CUN MB Quantities											Total CUE Quantities									
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	Lettuce(& endive)	42.250	22.425										25.190									
Belgium	Nursery	Not Predictable	0.384										0.900	0.384								
Belgium	Orchard pome & berry	1.350	0.621										1.350	0.621								
Belgium	Ornamental plants	5.660											0.000									
Belgium	Pepper & egg plant	5.270	1.350										3.000	1.350								
Belgium	Strawberry runners	3.400	0.900										3.400	0.900								
Belgium	Tomato (protected)	17.170	4.500										5.700	4.500								
Belgium	Tree nursery	0.230	0.155										0.230	0.155								
Canada	Strawberry runners (PEI)	14.792	6.840	7.995	7.462	7.462	7.462	5.261	5.261	5.596	5.261	5.261	(a)14.792	6.840	7.995	7.462	7.462	7.462	5.261	5.261	5.261	**5.261**
Canada	Strawberry runners (Quebec)		1.826	1.826									(a)	1.826	1.826							
Canada	Strawberry runners (Ontario)			6.129											6.129							
France	Carrots	10.000	8.000	5.000									8.000	8.000	1.400							
France	Cucumber	85 revised to 60	60.000	15.000									60.000	60.000	12.500							
France	Cut-flowers	75.000	60.250	12.000									60.000	52.000	9.600							
France	Forest tree nursery	10.000	10.000	1.500									10.000	10.000	1.500							
France	Melon	10.000	10.000										7.500	6.000								

Party	Industry	Total CUN MB Quantities											Total CUE Quantities									
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
France	Nursery: orchard, raspberry	5.000	5.000	2.000									5.000	5.000	2.000							
France	Orchard replant	25.000	25.000	7.500									25.000	25.000	7.000							
France	Pepper	Incl in.tomato cun	27.500	6.000										27.500	6.000							
France	Strawberry fruit	90.000	86.000	34.000									90.000	86.000								
France	Strawberry runners	40.000	4.000	35.000									40.000	40.000	28.000							
France	Tomato (and eggplant for 2005 only)	150(all solanaceous)	60.500	33.250									125.000	48.400								
France	Eggplant		27.500	33.250										48.400								
Greece	Cucurbits	30.000	19.200										30.000	19.200								
Greece	Cut flowers	14.000	6.000										14.000	6.000								
Greece	Tomatoes	180.000	73.600										156.000	73.600								
Israel	Broomrape			250.000	250.000	125.000	12.500	12.500							250.000	250.000	125.000	12.500				
Israel	Cucumber - protected new 2007			25.000	18.750		18.750	12.500							25.000	18.750	-	15.937				
Israel	Cut flowers – open field	77.000	67.000	80.755	53.345	42.777	42.554	23.292					77.000	67.000	74.540	44.750	34.698	28.554				
Israel	Cut flowers – protected	303.000	303.000	321.330	163.400	113.821	72.266	52.955					303.000	240.000	220.185	114.450	85.431	63.464				
Israel	Fruit tree nurseries	50.000	45.000	10.000									50.000	45.000	7.500							

Party	Industry	Total CUN MB Quantities											Total CUE Quantities									
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Israel	Melon – protected & field	148.000	142.000	140.000	87.500	87.500	87.500	35.000					125.650	99.400	105.000	87.500	87.500	70.000				
Israel	Potato	239.000	231.000	137.500	93.750	75.000							239.000	165.000	137.500	93.750	75.000					
Israel	Seed production	56.000	50.000			22.400							56.000	28.000			NR					
Israel	Strawberries – fruit (Sharon)	196.000	196.000	176.200	64.125	52.250	47.500	28.500					196.000	196.000	93.000	105.960	42.750					
Israel	Strawberries – fruit (Sharon & Ghaza)																	57.063				
Israel	Strawberry runners (Sharon)	35.000	35.000		20.000	15.800	13.570	13.500					35.000	35.000	28.000	31.900	15.825					
Israel	Strawberry runners and fruit Ghaza				87.875	67.500	67.500	34.000									47.250					
Israel	Strawberry runners (Sharon & Ghaza)																	22.320				
Israel	Tomatoes			90.000											22.750							
Israel	Sweet potato					95.000	20.000	20.000								111.500	95.000	20.000				
Italy	Cut flowers (protected)	250.000	250.000	30.000									250.000	187.000	30.000							
Italy	Eggplant (protected)	280.000	200.000	15.000									194.000	156.000								
Italy	Melon (protected)	180.000	135.000	10.000									131.000	131.000	10.000							

Party	Industry	Total CUN MB Quantities											Total CUE Quantities									
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Italy	Pepper (protected)	220.000	160.000	67.000									160.000	130.000	67.000							
Italy	Strawberry Fruit (Protected)	510.000	400.000	35.000									407.000	320.000								
Italy	Strawberry Runners	100.000	120.000	35.000									120.000	120.000	35.000							
Italy	Tomato (protected)	1300.000	1030.00	418.000									871.000	697.000	80.000							
Japan	Cucumber	88.300	88.800	72.400	68.600	61.400	34.100	29.120	26.162				88.300	88.800	72.400	51.450	34.300	30.690	27.621			
Japan	Ginger – field	119.400	119.400	112.200	112.100	102.200	53.400	47.450	42.235				119.400	119.400	109.701	84.075	63.056	53.400	47.450			
Japan	Ginger – protected	22.900	22.900	14.800	14.800	12.900	8.300	7.770	6.558				22.900	22.900	14.471	11.100	8.325	8.300	7.036			
Japan	Melon	194.100	203.900	182.200	182.200	168.000	90.800	77.600	67.936				194.100	203.900	182.200	136.650	91.100	81.720	73.548			
Japan	Peppers (green and hot)	189.900	200.700	169.400	162.300	134.400	81.100	68.260	61.101				187.200	200.700	156.700	121.725	81.149	72.990	65.691			
Japan	Watermelon	126.300	96.200	94.200	43.300	23.700	15.400	13.870	12.075				129.000	98.900	94.200	32.475	21.650	14.500	13.050			
Malta	Cucumber		0.096											0.127								
Malta	Eggplant		0.128											0.170								
Malta	Strawberry		0.160											0.212								
Malta	Tomatoes		0.475											0.594								
New Zealand	Nursery material	1.085	1.085											0								
New Zealand	Strawberry fruit	42.000	42.000	24.78									42.000	34.000	12.000							

Party	Industry	Total CUN MB Quantities											Total CUE Quantities									
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
New Zealand	Strawberry runners	10.000	10.000	5.720									8.000	8.000	6.234							
Poland	Strawberry Runners	40.000	40.000	25.000	12.000								40.000	40.000	24.500							
Portugal	Cut flowers	130.000	8.750										50.000	8.750								
Spain	Cut Flowers – Cadiz	53.000	53.000	35.000									53.000	42.000								
Spain	Cut Flowers – Catalonia	20.000	18.600	12.840	17 (+Andalucia)								20.000	15.000	43.490 (+Andalucia)							
Spain	Pepper	200.000	155.000	45.000									200.000	155.000	45.000							
Spain	Strawberry Fruit	556.000	499.290	80.000									556.000	499.290	0.0796							
Spain	Strawberry Runners	230.000	230.000	230.000	215.000								230.000	230.000	230.000							
UK	Cut flowers		7.560											6.050								
UK	Ornamental tree nursery	12.000	6.000										6.000	6.000								
UK	Strawberry (& raspberry in 2005)	80.000	63.600										68.000	54.500								
UK	Raspberry nursery		4.400										4.400	54.500								
USA	Chrys. Cuttings/roses	29.412											29.412	0								
USA	Cucurbits – field	1187.8	747.839	598.927	588.949	411.757	340.405	218.032	59.500	11.899			1187.800	747.839	592.891	486.757	407.091	302.974	195.698	59.500		

Party	Industry	Total CUN MB Quantities											Total CUE Quantities									
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
USA	Eggplant – field	76.761	101.245	96.48	79.546	62.789	34.732	21.561	6.904	1.381			76.721	82.167	85.363	66.018	48.691	32.820	19.725	6.904		
USA	Forest nursery seedlings	192.515	157.694	152.629	133.140	125.758	120.853	106.043					192.515	157.694	122.032	131.208	122.060	117.826	93.547			
USA	Ginger	9.2											9.2	0								
USA	Orchard replant	706.176	827.994	405.415	405.666	314.007	226.021	203.591	18.324	6.230			706.176	527.600	405.400	393.720	292.756	215.800	183.232	18.324		
USA	Ornamentals	210.949	162.817	149.965	138.538	137.776	95.204	70.178	48.164	48.164			154.000	148.483	137.835	138.538	107.136	84.617	64.307	48.164		
USA	Nursery stock - fruit trees, raspberries, roses	45.789	64.528	12.684	51.102	27.663	17.954	7.955	1.591	0.541			45.800	64.528	28.275	51.102	25.326	17.363	7.955	1.591		
USA	Peppers – field	1094.782	1498.53	1151.751	919.006	783.821	463.282	212.775	28.366				1094.782	1243.542	1106.753	756.339	548.984	463.282	206.234			
USA	Strawberry fruit – field	2468.873	1918.40	1733.901	1604.669	1336.754	1103.422	1023.471	753.974	531.737	415.067	**373.660**	2052.846	1730.828	1476.019	1349.575	1269.321	1007.477	812.709	678.004	415.067	**415.067**
USA	Strawberry runners	54.988	56.291	4.483	8.838	8.837	7.381	7.381	3.752	3.752			54.988	56.291	4.483	8.838	7.944	4.690 + 2.018	6.036	3.752		
USA	Tomato – field	2876.046	2844.985	2334.047	1840.1	1406.484	994.582	336.191	54.423	10.741			737.584	2476.365	2065.246	1406.484	1003.876	737.584	292.751	54.423		
USA	Turfgrass	352.194	131.600	78.040	52.189	0								131.600	78.04	0						
USA	Sweet potato	224.528			18.144	18.144	18.144	14.515	8.709							18.144	18.144	14.515	11.612			
USA	Research								2.768	2.768												

Annex III to Chapter 9 - Part B: Trends in MB Structural and Commodity Nominations and Exemptions

List of nominated (2005- 2015) and exempted (2005 - 2014) amounts of MB granted by Parties under the CUE process for each commodity.

Party	Industry	Total CUN MB Quantities											Total CUE Quantities									
		2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Australia	Almonds	1.900	2.100										1.900	2.100								
Australia	Rice consumer packs	12.300	12.300	10.225	9.200 +1.8	9.2	7.82	5.66	3.653	2.374	1.187	**1.187**	6.150	6.150	9.205	9.200	7.820	6.650	4.870	3.653	1.187	**1.187**
Belgium	Artefacts and structures	0.600	0.307										0.590	0.307								
Belgium	Antique structure & furniture	0.750	0.199										0.319	0.199								
Belgium	Churches, monuments and ships' quarters	0.150	0.059										0.150	0.059								
Belgium	Electronic equipment	0.100	0.035										0.100	0.035								
Belgium	Empty silo	0.050	0.043										0.050	0.043								
Belgium	Flour mill see mills below	0.125	0.072										See mills below	0.072								
Belgium	Flour mills	10.000	4.170										9.515	4.170								
Belgium	Mills	0.200	0.200										0.200	0.200								
Belgium	Food processing facilities	0.300	0.300										0.300	0.300								

Party	Industry	Total CUN MB Quantities											Total CUE Quantities									
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	Food Processing premises	0.030	0.030										0.030	0.030								
Belgium	Food storage (dry) structure	0.120	0.120										0.120	0								
Belgium	Old buildings	7.000	0 .306										1.150	0.306								
Belgium	Old buildings and objects	0.450	0.282										0	0.282								
Belgium	Woodworking premises	0.300	0.101										0.300	0.101								
Canada	Flour mills	47.200	34.774	30.167	28.650	26.913	22.878	14.107	11.020	7.848	5.044	**5.044**	(a)47	34.774	30.167	28.65	26.913	22.878	14.107	11.020	5.044	**5.044**
Canada	Pasta manufacturing facilities	(a)	10.457	6.757	6.067	4.740	4.740	2.084					(a)	10.457	6.757	6.067	4.740	3.529				
Canada	Commodities					0.068																
France	Seeds sold by PLAN-SPG company	0.135	0.135	0.100									0.135	0.135	0.096							
France	Mills	55.000	40.000	8.000									40.000	35.000	8.000							
France	Rice consumer packs	2.000	2.000										2.000	2.000								
France	Chestnuts	2.000	2.000	1.800									2.000	2.000	1.800							
Germany	Artefacts	0.250	0.100										0.250	0.100								

Party	Industry	Total CUN MB Quantities											Total CUE Quantities									
		2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Germany	Mills and Processors	45.000	19.350										45.000	19.350								
Greece	Dried fruit	4.280	3.081	0.900									4.280	3.081	0.450							
Greece	Mills and Processors	23.000	16.000	1.340									23.000	15.445	1.340							
Greece	Rice and legumes		2.355											2.355								
Ireland	Mills		0.888	0.611										0.888								
Israel	Artefacts	0.650	0.650	0.600									0.650	0.6500								
Israel	Dates (post harvest)	3.444	3.444	2.200	1.800	2.100							3.444	2.755	2.200	1.800	2.100	1.040				
Israel	Flour mills (machinery & storage)	2.140	1.490	1.490	0.800	0.300							2.140	1.490	1.040	0.312	0.300					
Israel	Furniture–imported	1.4220	1.4220	2.0420									1.4220	0								
Italy	Artefacts	5.500	5.500	5.000									5.225	0	5.000							
Italy	Mills and Processors	160.000	130.000	25.000									160.000	65.000	25.000							
Japan	Chestnuts	7.100	6.500	6.500	6.300	5.800	5.400	5.350	3.489	3.317			7.100	6.800	6.500	6.300	5.800	5.400	5.350	3.489		
Latvia	Grains		2.502											2.502								
Netherlands	Strawberry runners post harvest		0.120	0.120		0.120								0	0.120							
Poland	Medicinal herbs & dried mushrooms as dry commodities	4.000	3.560	1.800	0.500								4.100	3.560	1.800	1.800						

Party	Industry	Total CUN MB Quantities											Total CUE Quantities									
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Poland	Coffee, cocoa beans	(a)	2.160	2.000	0.500									2.160	1.420	1.420						
Spain	Rice		50.000											42.065								
Switzerland	Mills & Processors	8.700	7.000										8.700	7.000								
UK	Aircraft			0.165											0.165							
UK	Mills and Processors	47.130	10.195	4.509									47.130	10.195	4.509							
UK	Cereal processing plants		8.131	3.480					(a)					8.131								
UK	Cheese stores	1.640	1.248	1.248									1.640	1.248	1.248							
UK	Dried commodities (rice, fruits and nuts) Whitworths	2.400	1.256										2.400	1.256								
UK	Herbs and spices	0.035	0.037	0.030									0.035	0.037								
UK	Mills and Processors (biscuits)	2.525	1.787	0.479									2.525	1.787								
UK	Spices structural equip.	1.728											1.728	0	0.479							
UK	Spices stored	0.030											0.030	0								
UK	Structures buildings (herbs and spices)	3.000	1.872	0.908									3.000	1.872	0.908							

Party	Industry	Total CUN MB Quantities											Total CUE Quantities									
		2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
UK	Structures, processors and storage (Whitworths)	1.100	0.880	0.257									1.100	0.880	0.257							
UK	Tobacco equipment	0.523											0.050									
UK	Woven baskets	0.770											0.770									
USA	Dried fruit and nuts (walnuts, pistachios, dried fruit and dates and dried beans)	89.166	87.719	91.299	67.699	58.912	19.242	10.041	2.419	0.822	0.740	**0.310**	89.166	87.719	78.983	58.921	45.623	19.242	5.000	2.419	0.740	**0.740**
USA	Dry commodities/ structures (cocoa beans)	61.519	61.519	64.028	52.256	51.002							61.519	55.367	64.082	53.188						
USA	Dry commodities/ structures (processed foods, herbs and spices, dried milk and cheese processing facilities) NPMA	83.344	83.344	85.801	72.693	66.777	37.778	17.365	0.200				83.344	69.118	82.771	69.208	54.606	37.778	17.365			
USA	Smokehouse hams (Dry cure pork products) (building and product)	136.304	135.742	40.854	19.669	19.699	4.465	3.730	3.730	3.730	3.730	**3.730**	67.907	81.708	18.998	19.699	18.998	4.465	3.730	3.730	3.730	**3.730**
USA	Mills and Processors	536.328	505.982	401.889	362.952	291.418	173.023	135.299	74.51	25.334	22.800		483.000	461.758	401.889	348.237	291.418	173.023	135.299	74.510	22.800	**22.800**
USA	Research								0.159	0.159												

10 TEAP and TOC Organisation Issues

10.1 Current TEAP and TOC membership

Currently TEAP has 21 members, this number includes the TEAP co-chairs, the TOC co- chairs and Senior Expert members. Of the 21 members, 7 are from Article 5 Parties, 1 from a former Country with Economy in Transition (CEIT) and 13 are from non-Article 5 Parties.

The total membership of the TEAP and its six TOCs is about 150 members with a third from Article 5 Parties and two thirds from non-Article 5 Parties (which includes a small number of experts from non-A5 former CEIT countries in Eastern Europe and Central Asia). Full lists of the TEAP and TOC members are contained in the Annex to this report. The latest collection of disclosures of the interests of TEAP, TOC and Task Force members is posted on the Ozone Secretariat website.

10.2 Future TEAP Membership

Paragraph 9 of Decision XXIII/10 of the Twenty-Third Meeting of the Parties to the Montreal Protocol (Updating the nomination and operational processes of the Technology and Economic Assessment Panel and its subsidiary bodies) specifies: "*That the terms of all the members of the Panel and its technical options committees shall otherwise expire at the end of 2013 and 2014, respectively, in the absence of reappointment by the parties prior to that time, except for those experts that have already been nominated for four-year periods in past decisions;" subject to paragraph 10 of Decision XXIII/10: "That parties may revisit the status of the Panel and its technical options committee membership at the Twenty-Fifth and Twenty-Sixth Meetings of the Parties respectively if more time is needed by the parties to submit nominations;*

At the Twenty-fourth MOP in 2012, in Decision XXIV/19, Parties approved the appointment of Bella Maranion as Co-Chair of TEAP for a four year term, Lambert Kuijpers as Co-Chair of TEAP and the RTOC for a two year term and Stephen O. Andersen as a Senior Expert Member for a one year term. They also approved the appointment of Ashley Woodcock as Co-Chair of the MTOC, Dave Catchpole and Dan Verdonik as Co-Chairs of the HTOC, and Paul Ashford as Co-Chair of the FTOC, all for four year terms. Additional re-appointments to TEAP are anticipated in 2013 given the "end-of-2013" deadline as required by Decision XXIII/10.

10.3 TOC and Task Force Membership

The TOCs are still in the process of finalising their memberships for the 2014 Assessment. Overall, the status of TOC memberships as of May 2013 is about the same as in 2012. With the Decision XXIII/10 requirement for re-appointment of TOC members by the end of 2014, TOC co-chairs are currently working to ensure that current and potential members are nominated in full consultation with the national focal point of the relevant Party, prior to appointment by the TOC co-chairs. TOC co-chairs continually review membership and recruit new members to satisfy TOC requirements for expertise and balance to meet anticipated workloads. Recommendations for future TOC configurations, as requested by the Parties in Decision XXIV/8, are provided in the 2013 TEAP XXIV/8 Task Force Report.

10.4 Financial Constraints and Challenges

TEAP is grateful for the continuing support of governmental and non-governmental organizations, industries and academic institutions that finance time and expenses for the participation of experts in the TEAP, TOCs and Task Forces. Each TEAP, TOC and Task Force member annually reports the source of their funding in their individual Disclosure of Interest, posted on the Ozone Secretariat website. Sponsorship funds are paid as reimbursements to employees, as payment for independent contractors (consultants), and in some cases via the Ozone Secretariat from special contributions from industry associations and Parties. In many cases, consultants to industry associations and Parties are paid for their time in addition or expenses or are granted a lump sum payment for both time and expenses, but in others, members (both Article 5 and non-Article 5) contribute their time and expertise on a purely voluntary basis, with no economic retribution. The Montreal Protocol Trust Fund continues to fund the travel of Article 5 members and a limited number of non-Article 5 experts on a case-by-case basis to the relevant meetings of the TEAP and TOCs. It has become increasingly difficult for many non-Article 5 experts to find funding for travel and miscellaneous meeting expenses. As a result, the TEAP and TOC operations are remaining difficult to maintain.

In this way, good attendance at meetings is difficult and it jeopardises the ability of TEAP and its TOCs to maintain the quality and consensus of its many reports. TOCs and Task Forces met again with partial membership, or met back-to-back with other meetings to reduce travel costs (but making deadlines for review and submission of reports unreasonably tight), met by Internet, or scheduled TOC meetings to take advantage of professional meetings that some of the members were attending. As mentioned, TEAP would ask Parties consider allowing further flexibility by the Ozone Secretariat in supporting the work of TEAP and its TOCs to ensure that the needed expertise is available to participate in the work and meetings of the Panel and its TOCs in order to continue to address the needs of the Parties.

10.5 Minority Reports

In 2013, no minority reports emerged from work undertaken by TEAP, TOCs, or Task Forces. During its interim assessment, MBTOC achieved consensus on all nominations. One MBTOC member presented a minority view concerning transition rates to effective alternatives (this member considered such transition should be slower than the decision reached by the majority) but did not block consensus. Several members recused from evaluation of nominations as required by MBTOC’s working procedures, as described in the MBTOC CUN 2013 report.

It is TEAP’s intent to ensure that minority views are appropriately reflected in its reports as required in its Terms of Reference. TEAP has taken the opportunity in its Decision XXIV/8 TEAP Task Force Report to provide the Parties with its standard operating procedures related to, *inter alia*, achieving consensus.

Annex to Chapter 10: TEAP TOC Membership List Status May 2013

The disclosure of interest (DOI) of each member can be found on the Ozone Secretariat website at: http://ozone.unep.org/Assessment_Panels/TEAP/toc-members-disclosures.shtml. The disclosures are normally updated at the time of the publication of the progress report.

Technology and Economic Assessment Panel (TEAP)

Co-chairs	Affiliation	Country
Lambert Kuijpers	Technical University Eindhoven	Netherlands
Bella Maranion	U.S. EPA	USA
Marta Pizano	Consultant	Colombia

Senior Expert Members	Affiliation	Country
Stephen O. Andersen	Institute for Governance and Sustainable Development	USA
Masaaki Yamabe	National Inst. Advanced Industrial Science and Technology	Japan
Shiqiu Zhang	Center of Environmental Sciences, Peking University	China

TOC Chairs	Affiliation	Country
Paul Ashford	Caleb Management Services	UK
Mohamed Besri	Institut Agronomique et Vétérinaire Hassan II	Morocco
Biao Jiang	Shanghai Institute of Organic Chemistry	China
David V. Catchpole	Petrotechnical Resources Alaska	UK
Sergey Kopylov	All Russian Research Institute for Fire Protection	Russian Federation
Michelle Marcotte	Marcotte Consulting LLC and Marcotte Consulting Inc	Canada
Kei-ichi Ohnishi	Asahi Glass	Japan
Roberto de A. Peixoto	Maua Institute (IMT), Sao Paulo	Brazil
Jose Pons-Pons	Spray Quimica	Venezuela
Ian Porter	Department of Primary Industries	Australia
Miguel Quintero	Consultant	Colombia
Ian D. Rae	University of Melbourne	Australia
Helen Tope	Energy International Australia	Australia
Daniel P. Verdonik	Hughes Associates	USA
Ashley Woodcock	University Hospital of South Manchester	UK

TEAP Chemicals Technical Options Committee (CTOC)

Co-chairs	Affiliation	Country
Biao Jiang	Shanghai Institute of Organic Chemistry	China
Kei-ichi Ohnishi	Asahi Glass	Japan
Ian D. Rae	University of Melbourne	Australia

Members	Affiliation	Country
D. D. Arora	The Energy and Research Institute	India
Joan Bartelt	DuPont	USA
Steven Bernhardt	Honeywell	USA
Olga Blinova	Russian Scientific Center for Applied Chemistry	Russia
Jianxin Hu	College of Environmental Sciences & Engineering, Peking University	China
Abid Merchant	Consultant	USA
Koichi Mizuno	National Inst. Advanced Industrial Science and Technology	Japan
Claudia Paratori	Coordinator Ozone Programme -CONAMA	Chile
Hans Porre	Teijin Aramids	Netherlands
John Stemniski	Consultant	USA
Fatemah Al-Shatti	Kuwait Petroleum Corporation	Kuwait
Nee Sun Choong Kwet Yive (Robert)	University of Mauritius	Mauritius

TEAP Flexible and Rigid Foams Technical Options Committee (FTOC)

Co-chairs	Affiliation	Country
Paul Ashford	Caleb Management Services	UK
Miguel Quintero	Consultant	Colombia

Members	Affiliation	Country
Samir Arora	Industrial Foams	India
Terry Arrmitt	Hennecke	UK
Chris Bloom	Dow	USA
Roy Chowdhury	Foam Supplies	Australia
Koichi Wada	Bayer Material Science/JUFA	Japan
Mike Jeffs	Consultant	UK
Ilhan Karaağaç	Izocam	Turkey
Candido Lomba	ABRIPUR	Brazil
Yehia Lotfi	Technocom	Egypt
Joseph Lynch	Arkema	USA
Christoph Meurer	Solvay	Germany
Ulrich Schmidt	Haltermann	Germany
Enshan Sheng	Huntsman Co	China
Helen Walter-Terrinoni	DuPont	USA
Dave Williams	Honeywell	USA
Allen Zhang	Consultant	China

TEAP Halons Technical Options Committee (HTOC)

Co-chairs	Affiliation	Country
David V. Catchpole	Petrotechnical Resources Alaska	UK
Sergey Kopylov	All Russian Research Institute for Fire Protection	Russian Federation
Daniel P. Verdonik	Hughes Associates	USA
Members		
Tarik K. Al-Awad	King Abdullah II Design & Development Bureau	Jordan
Jamal Alfuzaie	Kuwait Fire Department	Kuwait
Seunghwan (Charles) Choi	Hanju Chemical Co., Ltd.	South Korea
Adam Chattaway	Kidde Graviner Ltd.	UK
Michelle M. Collins	Consultant- EECO International	USA
Salomon Gomez	Tecnofuego	Venezuela
Carlos Grandi	Embraer	Brazil
Andrew Greig	Protection Projects Inc	South Africa
Zhou Kaixuan	CAAC-AAD	PR China
H. S. Kaprwan	Consultant – Retired	India
John J. O'Sullivan	Bureau Veriitas	UK
Emma Palumbo	Safety Hi-tech srl	Italy
Erik Pedersen	Consultant – World Bank	Denmark
Donald Thomson	Manitoba Ozone Protection Industry Association	Canada
Filippo Tomasello	European Aviation Safety Agency	Italy
Robert T. Wickham	Consultant-Wickham Associates	USA
Mitsuru Yagi	Nohmi Bosai Ltd & Fire and Environment Prot. Network	Japan
Yong Meng Wah	Singapore Civil Defence Force	Singapore
Consulting Experts		
Thomas Cortina	Halon Alternatives Research Corporation	USA
Matsuo Ishiyama	Nohmi Bosai Ltd & Fire and Environment Prot. Network	Japan
Nikolai Kopylov	All Russian Research Institute for Fire Protection	Russian Federation
David Liddy	United Kingdom Ministry of Defence	UK
Steve McCormick	United States Army	USA
John G. Owens	3M Company	USA
Mark L. Robin	DuPont	USA
Joseph A. Senecal	Kidde-Fenwal	USA
Ronald S. Sheinson	United States Naval Research Laboratory – Retired	USA
Ronald Sibley	Defense Supply Center, Richmond	USA

TEAP Medical Technical Options Committee (MTOC)

Co-chairs	Affiliation	Country
Jose Pons Pons	Spray Quimica	Venezuela
Helen Tope	Energy International Australia	Australia
Ashley Woodcock	University Hospital of South Manchester	UK

Members	Affiliation	Country
Emmanuel Addo-Yobo	Kwame Nkrumah University of Science and Technology	Ghana
Paul Atkins	Oriel Therapeutics Inc.	USA
Sidney Braman	Mount Sinai School of Medicine	USA
Nick Campbell	Arkema SA	France
Hisbello Campos	Instituto Fernandes Figueira, FIOCRUZ, Ministry of Health	Brazil
Jorge Caneva	Favaloro Foundation	Argentina
Christer Carling	Private Consultant	Sweden
Guiliang Chen	Shanghai Institute for Food and Drug Control	China
Davide Dalle Fusine	Chiesi Farmaceutici	Italy
Charles Hancock	Charles O. Hancock Associates	USA
Eamonn Hoxey	Johnson & Johnson	UK
Javaid Khan	The Aga Khan University	Pakistan
Katharine Knobil	GlaxoSmithKline	USA
Suzanne Leung	3M	USA
Nasser Mazhari	Sina Darou Laboratories Company	Iran
Gerald McDonnell	STERIS	UK
Hideo Mori	Private Consultant	Japan
Tunde Otulana	Boehringer Ingelheim Pharmaceuticals Inc.	USA
John Pritchard	Philips Home Healthcare Solutions	UK
Rabbur Reza	Beximco Pharmaceuticals	Bangladesh
Raj Singh	The Chest Centre	India
Roland Stechert	Boehringer Ingelheim	Germany
Ping Wang	Chinese Pharmacopoeia Commission	China
Adam Wanner	University of Miami	USA
Kristine Whorlow	National Asthma Council Australia	Australia
You Yizhong	Journal of Aerosol Communication	China

TEAP Methyl Bromide Technical Options Committee (MBTOC)

Co-chairs	**Affiliation**	**Country**
Mohamed Besri	Institut Agronomique et Vétérinaire Hassan II	Morocco
Michelle Marcotte	Marcotte Consulting	Canada
Marta Pizano	Consultant - Hortitecnia Ltda	Colombia
Ian Porter	Department of Primary Industries, Victoria	Australia

Members	**Affiliation**	**Country**
Jonathan Banks	Consultant	Australia
Chris Bell	Consultant	UK
Fred Bergwerff	Oxylow BV	The Netherlands
Aocheng Cao	Chinese Academy of Agricultural Sciences	China
Peter Caulkins	US Environmental Protection Agency	USA
Ricardo Deang	Consultant	Philippines
Raquel Ghini	EMBRAPA	Brasil
Ken Glassey	MAFF – NZ	New Zealand
Eduardo Gonzalez	Fumigator	Philippines
Darka Hamel	Inst. For Plant Protection in Ag. And Forestry	Croatia
George Lazarovits	A & L Biologicals	Canada
Takashi Misumi	MAFF – Japan	Japan
David Okioga	Ministry of Environment and Natural Resources	Kenya
Christoph Reichmuth	Honorary Professor	Germany
Jordi Riudavets	IRTA – Department of Plant Protection	Spain
John Sansone	SCC Products	USA
Sally Schneider	US Department of Agriculture	USA
JL Staphorst	Consultant	South Africa
Akio Tateya	Technical Adviser, Syngenta	Japan
Robert Taylor	Consultant	UK
Alejandro Valeiro	National Institute for Agriculture Technology	Argentina
Ken Vick	Consultant	USA
Nick Vink	University of Stellenbosch	South Africa
Chris Watson	Consulting fumigator	UK
Jim Wells	Environmental Solutions Group	USA
Eduardo Willink	Ministerio de Agricultura	Argentina
Suat Yilmaz	Ministry of Food, Agriculture and Livestock	Turkey

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

Co-chair	Affiliation	Country
Lambert Kuijpers	Technical University Eindhoven	Netherlands
Roberto de A. Peixoto	Maua Institute, IMT, Sao Paulo	Brazil

Members	Affiliation	Country
Radhey S. Agarwal	IIT New Delhi	India
James M. Calm	Engineering Consultant	USA
Radim Cermak	Ingersoll Rand	Czech Republic
Guangming Chen	Zhejiang University, Hangzhou	China
Jiangpin Chen	Shanghai University	China
Denis Clodic	Ereie Consultancy	France
Daniel Colbourne	Consultant	UK
Richard DeVos	GE	USA
Sukumar Devotta	Consultant	India
Martin Dieryckx	Daikin Europe	Belgium
Dennis Dorman	Trane	USA
Bassam Elassaad	Consultant	Lebanon
Dave Godwin	U.S. EPA	USA
Marino Grozdek	University of Zagreb	Croatia
Samir Hamed	Petra Industries	Jordan
Kenneth E. Hickman	Consultant	USA
Martien Janssen	Re/genT	Netherlands
Makoto Kaibara	Panasonic, Research and Technology	Japan
Michael Kauffeld	Fachhochschule Karlsruhe	Germany
Jürgen Köhler	University of Braunschweig	Germany
Holger König	Consultant	Germany
Richard Lawton	CRT	UK
Tingxun Li	Guangzhou San Yat Sen University	China
Petter Nekså	SINTEF Energy Research	Norway
Horace Nelson	Manufacturer	Jamaica
Carloandrea Malvicino	Fiat	Italy
Alaa A. Olama	Consultant	Egypt
Alexander C. Pachai	Johnson Controls	Denmark
Andy Pearson	Star Refrigeration Glasgow	UK
Per Henrik Pedersen	Danish Technological Institute	Denmark
Rajan Rajendran	Emerson	USA
Giorgio Rusignuolo	Carrier Transicold	USA
Alessandro Silva	Bitzer Industries	Brazil
Paulo Vodianitskaia	Consultant	Brazil
Asbjorn Vonsild	Danfoss	Denmark