MONTREAL PROTOCOL

ON SUBSTANCES THAT DEPLETE

THE OZONE LAYER

UNEP

REPORT OF THE
TECHNOLOGY AND ECONOMIC ASSESSMENT PANEL

MAY 2009

VOLUME 1

PROGRESS REPORT

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Montreal Protocol
On Substances that Deplete the Ozone Layer

Report of the UNEP Technology and Economic Assessment Panel

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The opinions expressed are those of the Panel and its TOCs and do not necessarily reflect the reviews of any sponsoring or supporting organisation.

The TEAP thanks in particular its member Mohamed Besri, MBTOC co-chair, for hosting a great TEAP meeting in Agadir, Morocco, 26-30 April 2008, where this report was discussed, adopted and finalised for last reviews by email circulation to all members.

Foreword

The 2009 TEAP Report

The 2009 TEAP Report consists of three volumes:

Volume 1: May 2009 TEAP Progress Report

Volume 2: May 2009 TEAP Task Force Report on Decision XX/8

Volume 3: June 2009 TEAP Task Force Interim Report on Decision XX/7

A more extensive description can be found in chapter 1, "Introduction".

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MAY 2009 TEAP PROGRESS REPORT

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1 Introduction

The spring 2009 Report of the TEAP consists of three separate volumes:

1. The TEAP 2009 Progress Report (this report);
2. The TEAP Task Force XX/7 report, published the beginning of June 2009;
3. The TEAP Task Force XX/8 report, published the end of May 2009.

The latter two volumes will have separate conclusions chapters and Executive Summaries.

It its 2009 Progress Report TEAP has largely maintained the sequence of chapters as in earlier Progress reports, however, now with a first short general chapter on the status of the ODS Phase-out, status 2009, from a TEAP point of view (chapter 2).

This chapter is followed by the chapter composed by the MTOC, which gives recommendations for essential use requests for CFC quantities for MDIs. It is for the first time that, from a total of 10 nominations, (8) requests for essential uses from Article 5 Parties were analysed and recommendations could be given.

Following the recommendations for CFCs for essential uses for MDIs, the TEAP gives recommendations for an essential use request received from Iraq for the use of CFCs in foam, refrigeration and AC for the years 2010 and 2011, in the light of the criteria given in Decision IV/25.

Thereafter the report contains a chapter on Campaign Production by the MTOC, in response to Decision XX/4. A short chapter follows it, which contains recommendations for changes in the Handbook how to deal with essential use requests and procedures in future. This chapter was drafted in response to decision XX/3(4).

These chapters are followed by progress reports by the CTOC, FTOC and HTOC.

The CTOC briefly reports on the progress in reduction of emissions from process agent applications, following XVII/6; since no essential new information has come forward from the Parties this report has been kept brief. The CTOC recalls the uses listed in Tables A and B in Decision X/14; it elaborates especially on the possible updating of Table B with new uses. Following Decision XVII/10, the TEAP and its CTOC should report bi-annually on the procedures for laboratory and analytical uses that do not use ODS. This CTOC progress report contains extensive information on these uses in a long information table, as well as case studies and regional reports.

The CTOC presents the essential use nomination for CFC-113 by the Russian Federation, and, in an appendix to its progress report, elaborates in nine sub-chapters on the expert meeting on this issue held in Moscow, in the year 2008.

The FTOC, in its progress report, specifically deals with the transition status in non-Article 5 and Article 5 countries.

The HTOC progress report deals with halon 2401 uses and supplies, an update on ICAO procedures and regional emissions of halons as measured in the atmosphere.

For the RTOC, no progress report has been inserted in the 2009 TEAP Progress Report since most of the developments in this sector will be reported in the Task Force Report on Decision XX/8.

After these progress reports, the 2009 TEAP Progress Report presents

- a report by the HTOC on Decision XIX/16, which asked for a follow-up to the HTOC 2006 assessment report. The Decision specifically asked to undertake a further study on projected regional imbalances in the availability of halon 1211, halon 1301 and halon

2402 and to investigate and propose mechanisms to better predict and mitigate such imbalances in the future;

- a report by the RTOC on Decision XIX/8, "Alternatives for HCFCs at high ambient temperatures". This report was delayed in the year 2008. In the current version of the report the deep mines issue is briefly dealt with, but a full report on this deep mines issue will be available for MOP-21;

- an interim report by the QPS Task Force, following Decision XX/6, in which the TEAP is requested to review all relevant, currently available information on the use of methyl bromide for quarantine and pre-shipment applications and related emissions, to assess trends in the major uses, available alternatives and other mitigation options, and barriers to the adoption of alternatives. The relevant Decision also mentioned that, in the interim report, areas should be indicated where the information is not sufficient, explaining, where appropriate, why the data were inadequate and presenting a practical proposal for how best to gather the information required for a satisfactory analysis (in this Decision the TEAP was also requested to present the final report to MOP-21).

Following these three "independent" reports, the 2009 TEAP Progress Report contains two chapters, which were composed by the MBTOC:

- the 2009 MBTOC progress report for both soils and QSC;
- the interim report on the evaluation of critical use applications for MB and subsequent recommendations.

As last chapters, the 2009 TEAP Progress Report contains a chapter on TEAP and TOC organisation issues, a chapter with the biographies of all TEAP members, as well as a number of lists with the current compositions of the membership for TEAP and its TOCs.

2 Ozone Layer Protection in 2009, a TEAP overview

Since the phase-out of several groups of ODS is nearing completion, the Montreal Protocol generally, and the TEAP specifically, face a number of challenging issues. The following summarises developments and processes that will likely affect the focus of the TEAP´s work in the short term:

- The phase-out by Article 5 Parties of CFCs, halons and CTC (Annex A Group I and Group II, and Annex B Group II substances) by January 1, 2010.
- The 2010 65% consumption reduction in HCFCs (Annex C Group I substances) for non-Article 5 Parties.
- The 2013 freeze and the 2015 10% consumption reduction in HCFCs (Annex C Group I substances) for Article 5 Parties.
- Continuing Essential Use Nominations and their submission by Article 5 Parties.
- Continuing methyl bromide (Annex E Group I) Critical Use Nominations for non-Article 5 Parties.

In the short term, TEAP also believes the following issues will require more focused efforts to improve the quality of its technical advice to Parties:

- Discrepancies between the observed and the calculated atmospheric concentration of CTC.
- The need for more detailed information about quarantine and pre-shipment (QPS) uses of methyl bromide (Annex E Group I).
- The need to integrate assessments of both ozone and climate effects of ODS projects, including ongoing ODS phase-out activities and bank management.
- Looking further ahead to the medium term, TEAP anticipates that the following issues may need to be observed and addressed:
- Potential Essential Use Nominations from Article 5 and non-Article 5 Parties, if needed.
- The phase-out of 1,1,1-trichloroethane and methyl bromide (Annex B Group III and Annex E Group I substances) by Article 5 Parties by January 1, 2015.
- The possible need for Article 5 Parties to begin using the Critical Use Nomination process for methyl bromide.
- Further reductions in consumption of HCFCs (Annex C Group I substances) by Article 5 and non-Article 5 Parties.
- The need for a more complete understanding of emissions resulting from use of ODS as feedstock.

The continuing adoption of new technologies and the need to evaluate their interrelated environmental effects, make it likely that TEAP will be asked to conduct increasingly complex assessments, and to respond to additional decisions taken by Parties.

Details of the Short Term Issues:

Article 5 phase-out of CFCs, Halons and CTC (Annex A Group I and Group II, and Annex B Group II substances) by January 1, 2010

With some stockpiles of CFCs, halons and CTC beginning to run short and important uses remaining, there is potential for some Parties to look to Essential Use Nominations to avoid the choice between non-compliance and unacceptable risk for some important societal needs. While the phase-out date is January 1, 2010, the reporting data necessary to identify instances of non-compliance will not be available for analysis until perhaps 2 years later. Although no major problems are expected, because suitable alternatives to these substances exist, local issues concerning availability of recycled and stockpiled materials may present difficult commercial, technical and policy challenges.

Consumption reduction of 65% for HCFCs (Annex C Group I substances) by non-Article 5 Parties

The 65% consumption reduction in HCFCs has already been achieved in most non-Article 5 Parties. Local regulations, which often go beyond the Montreal Protocol, have helped accelerate the reduction. However, there remains a high potential for alternatives to be selected that result in increased greenhouse gas emissions. Alternatives to HCFCs are discussed in detail in the TEAP Task Force Report on Decision XX/8.

The 2013 freeze and the 2015 consumption reduction in HCFCs (Annex C Group I substances) for Article 5 Parties.

Decision XIX/6 requires a freeze in HCFC consumption in 2013 for Article 5 Parties based on an average of reported 2009/2010 consumption. If projects are going to be implemented before 2013, they will need to be identified in 2010. Review of the outcomes of current pilot projects may be a key role for TEAP in the next 12-18 months.

Decision XIX/6, paragraph 9 also emphasises the need to integrate ozone layer and climate protection. While it is technically and economically feasible to phase out HCFCs in Article 5 Parties, the selection of technologies that will minimise environmental impacts, in particular impacts on climate, requires a complex analysis. This will be discussed in the TEAP Task Force Report on Decision XX/8 as well as in other studies.

Continuing Essential Use Nominations and their submission by Article 5 Parties

The Essential Use procedures are well established. Non-Article 5 Parties have more than ten year's experience in collecting essential data and preparing nomination packages that provide the information to the TEAP and its TOCs in order to respond to the criteria established by the Parties. This process has allowed Parties to successfully satisfy their essential needs for ODS for more than a decade. The TEAP 2009 Progress Report presents the TEAP recommendations for Essential Use Nominations from non-Article 5 Parties for 2010 and 2011.

It is now important to help Article 5 Parties develop similar expertise and reporting infrastructure to enable them to use the Essential Use process as a tool that can help manage ODS production and consumption towards a successful phase-out. Availability of pharmaceutical-grade CFCs after 2010 remains uncertain. The 2009 TEAP Progress Report presents the TEAP recommendations for Essential Use Nominations from Article 5 Parties for asthma and COPD for 2010 and discusses the supply challenges for pharmaceutical-grade CFCs.

It might be expected that the earlier a phase-out date occurred, the less likely that new Essential Use Nominations would be required. However, this may not always be the case. For example, halon production ceased in 1994 for non-Article 5 Parties, but important uses remain, including equipment servicing through recycling and reuse of halons produced before the phase-out. Evidence suggests these stocks may be running short. Unless barriers to the global movement of halons (produced before the phase-out) from places where they are in excess to where they are needed are removed, new production may be needed to satisfy important public safety and national security uses.

The need to effectively use banked ODS to avoid Essential Use Nominations is directly connected to the need to resolve challenges related to sound bank management. TEAP has received reports that some ODS are being emitted from banks for a variety of commercial, technical and policy reasons. The HTOC sub-committee report on Decision XIX/16 discusses the regional availability of halons and the ability of existing stocks to meet future needs. The 2009 MTOC report discusses the management of existing stocks of pharmaceutical-grade CFCs for MDIs to minimise or avoid the need for further production.

Discrepancies between measured and expected atmospheric concentration of CTC

The discrepancies between the observed and the calculated atmospheric concentration of CTC are of concern because of their sizeable magnitude. According to the figures observed from atmospheric abundance, CTC emissions would need to be of the order of 70,000 ODP tonnes per year, compared to the 20,000 ODP tonnes calculated using a bottom-up methodology. As instructed by the Parties at MOP-20 in Doha concerning Decision XVIII/10, TEAP will be working with the MLF to better explain this discrepancy. This work is in its early stages, and findings will not be part of the 2009 TEAP Progress Report.

Continuing methyl bromide Critical Use Nominations from non-Article 5 Parties and the need for improved information about quarantine and pre-shipment uses (Annex E Group I)

While Critical Use Nominations for methyl bromide by non-Article 5 Parties continue to decrease, the global production of this substance for quarantine and pre-shipment (QPS) applications was about 8,000 ODP tones in 2007 and is not declining. Methyl bromide is treated differently from other ODS in that its uses have been put into two distinct categories: one containing controlled uses with a phase-out schedule; and one for which a global exemption applies. In 2009, TEAP has established the Quarantine and Pre-shipment Task Force (QPSTF) to respond to Decision XX/6 and provide a more detailed understanding and meaningful assessment of trends in methyl bromide uses for QPS applications and alternatives in those applications. MBTOC and the QPSTF have indicated a need for more detailed information from the Parties on the uses, quantities and applications of methyl bromide for QPS.

The need to integrate assessments of both ozone and climate effects of ODS projects, including ongoing ODS phase-out activities and bank management.

The tasks of assessing potential HCFC alternatives and managing ODS banks present new challenges and opportunities to continue protecting the ozone layer while also contributing to climate protection. The need to develop and apply life cycle analyses to identify options that protect the ozone layer while minimising the climate consequences over the life time of the product adds new complexities to the work of the TEAP. The Task Force report on Decision XX/7 seeks to address some of these issues in respect to the management of ODS banks. Furthermore, in case other alternatives to ODS that are not HFCs or HCFCs, have a significant GWP they will likely require similar analyses to integrate ozone and climate protection. For example, sulfuryl fluoride, one of the important alternatives to methyl bromide, has recently been reported to have a high GWP. A preliminary review can be found in the 2009 MBTOC Progress Report.

Details of the Medium Term Issues:

Potential Essential Use Nominations from Article 5 and non-Article 5 Parties, if needed

Some Article 5 Parties have indicated that they expect continued Essential Use of CFCs for the treatment of asthma and COPD until as late as 2015. Although Article 5 Parties have just begun to use the Essential Use process in 2009, it seems unlikely that CFCs for MDIs will be needed for the same number of years for Article 5 Parties as they were for non-Article 5 Parties, given the global progress with transition to CFC-free alternatives.

The phase-out of 1,1,1-trichloroethane and methyl bromide (Annex B Group III and Annex E Group I substances) in Article 5 Parties by January 1, 2015

TEAP expects little difficulty in the phase-out of 1,1,1-trichloroethane being completed in Article 5 Parties by January 1, 2015 as production and use of 1,1,1-trichloroethane are currently small and appear on track to achieve phase-out.

The vast majority of Article 5 countries have complied with the phase-out schedule for methyl bromide and a large number have achieved early phase-out through MLF funded projects. The provision for Critical Use Exemptions for Article 5 countries does however exist, and it is possible that some could arise, but it is still too early in the process to predict with certainty.

Further reductions in consumption of HCFCs (Annex C Group I substances) by Article 5 and non-Article 5 Parties

The best alternatives for some HCFC uses in Article 5 Parties are often hydrocarbons, but because HCFC projects were funded to phase-out CFCs, there may be issues related to the funding of second conversions that could delay the adoption of hydrocarbon alternatives; particularly in the case of foams. Similarly, if HFCs were used as alternatives in new HCFC phase-out projects, the implementation of these projects might create a future need to fund further conversions, increasing costs and delaying the adoption of more climate protective solutions.

Newer technologies nearing commercial availability have the potential to protect better both ozone and climate; therefore it may be desirable in some cases for Article 5 Parties to wait until these alternatives emerge. This is a significant departure from current convention, which emphasises adoption of alternatives as soon as possible. TEAP and its Task Force analyse these issues in the Report sections dealing with Decision XX/8.

The need for a more complete understanding of emissions resulting from use of ODS as feedstock

In parallel with the reduction in ODS consumption for dispersive or emissive uses under the Montreal Protocol, consumption for some feedstock uses of ODS are growing rapidly; particularly those using HCFC-22. As a result of this growth, the emissions arising from feedstock uses are taking on greater importance. It will be necessary to understand the magnitude of these emissions over time, and to identify options for avoiding them if these uses are to continue without harming the ozone layer.

3 Essential Uses

3.1 Executive Summary of Essential Use Nominations for Metered Dose Inhalers

MTOC received 10 essential use nominations:
8 from Article 5 Parties (Argentina, Bangladesh, China, Egypt, India, Iran, Pakistan, and Syria); and 2 from non-Article 5 Parties (Russian Federation and United States).
Table 3-1 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 metered dose inhalers (MDIs).

Table 3-1: Recommendations for essential use nominations

Party	2010	2011	2012
Argentina	178	-	-
Bangladesh	156.7	-	-
China	972.2	-	-
Egypt	227.4	-	-
India	343.6	-	-
Iran	105	-	-
Pakistan	34.9	Unable to recommend	Unable to recommend
Russian Federation	212	-	-
Syria	44.68	Unable to recommend	-
United States	-	Unable to recommend	-

MTOC found it difficult to assess adequately the nominations from Article 5 Parties in accordance with the criteria set out in Decision IV/25. In particular, there was a shortage of data on the availability and affordability of alternatives to CFC MDIs for the MDI manufacturing/ nominating Party and especially for the Article 5 Parties importing their products. This has become the most critical information in determining essentiality since Parties already have a range of alternatives available.

There is now a wide range of technically satisfactory alternatives to CFC MDIs in most Article 5 Parties. MTOC attempted to minimise the requested quantities for each nomination based on information that Parties provided or that MTOC was otherwise able to collect on the availability of alternatives. However, MTOC was unable to make reductions in quantities confidently, without concern that there might not be adequate supplies to meet patient needs.

Parties have previously taken Decisions intended to provide Parties and MTOC with information on CFC MDIs and their alternatives. Decision XIV/5 requested each Party to submit available information on CFC and CFC-free MDIs and dry powder inhalers (DPIs) in their markets to the Ozone Secretariat by 28 February 2003 with annual updates thereafter, and requires TEAP to review this information in making its annual assessments. Some Parties have submitted data pursuant to Decision XIV/5, but in many cases data are not provided or have not been updated annually. Parties may wish to consider reminding Parties, including Article 5 Parties, to collect data on CFC and CFC-free inhalers and provide it annually to the Secretariat to be posted on its website, in accordance with Decision XIV/5.

Several of the nominations included significant quantities of CFCs to manufacture MDIs for export, mainly to other Article 5 Parties. None of the nominations demonstrated that these CFC MDIs were essential in the designated export markets where in most cases it appeared that an adequate range of technically feasible alternatives was available. In future years, MTOC is unlikely to recommend quantities of CFCs for MDIs intended for export that exceed those recommended for 2010, in the absence of compelling evidence. In subsequent years MTOC would expect to see reductions annually.

Decision XII/2(3) requests Parties, including Article 5 Parties, to notify the Ozone Secretariat of any MDI products determined to be non-essential, and for nominating Parties to take this information into consideration. The Ozone Secretariat website has information pursuant to Decision XII/2(3) only from the European Community. Parties may wish to consider reminding all Parties to notify the Ozone Secretariat of any MDI products determined to be non-essential. Information posted on the Ozone Secretariat website can then be used by nominating Parties and MTOC in the essential use process.

Decisions XV/5, par. 2, and XX/3 par. 1(a) request nominating Parties to provide information on the intended market(s) for sale or distribution for the use, the active ingredient(s) for the use in each market and the quantity of CFCs required for each active ingredient in each market. Decision XVI/12, par. 2 further states that when more specific data are not available, data aggregated by region and product group may be submitted for CFC MDIs intended for sale in Parties operating under paragraph 1 of Article 5. MTOC found it difficult to assess accurately the essentiality of quantities of CFCs intended for export when country-specific information was not provided in the nominations on the quantity of CFCs required for each active ingredient in each market. In future years, in the absence of country-specific information on CFC quantities intended for export, MTOC will consider the alternatives available in intended export markets and make recommendations for a quantity of essential use CFCs for the manufacture of MDIs which specifically excludes any countries considered to have an adequate range of alternatives. For the year 2010, Parties may wish to consider qualifying any approval of essential use exemptions with the condition that any Party exporting CFC MDIs will get prior informed consent of the Government of the importing country for such exports to that country.

Some importing Article 5 Parties have already introduced import controls or bans on CFC MDIs (e.g. Thailand and Fiji). Other importing countries listed in the essential use nominations as intended export markets already have a complete range of CFC-free alternatives (e.g. Costa Rica). Parties may wish to consider the advantages of encouraging Parties to establish controls on the import of CFC MDIs, and to introduce import bans at a certain date when adequate alternatives to CFC MDIs are available. Parties may also wish to consider the advantages of informing the Ozone Secretariat of any controls, and in turn the Ozone Secretariat informing Parties. For example, the Ozone Secretariat's website list of used ODS products not wanted by Parties could include any CFC MDI products not wanted by Parties. In addition, given the complexity and fluidity of export markets, Parties may wish to consider the advantages of all importing Parties, including Article 5 Parties, making annual declarations stating the reasons why the imported CFC MDI products are considered necessary and requiring that these declarations accompany nominations from Parties manufacturing and exporting CFC MDIs.

MTOC has suggested changes to the information requirements of the *Handbook on Essential Use Nominations* 2005 (the Handbook) for consideration by Parties this year (see Chapter 6), to seek more and better quality information on the availability and affordability of CFC-free alternatives in intended markets and to enable a more accurate assessment of nominations in 2010.

If approved by Parties, it is estimated that up to about 2,000 tonnes of essential use CFCs for MDIs may be needed for 2010. The European Commission has regulated to stop production of pharmaceutical-grade CFCs from the 1st January 2010, which would otherwise have supplied many Article 5 Party producers of CFC MDIs. With this development, it is impossible to predict where essential use CFCs might be sourced for 2010. Some MDI manufacturing companies will have to find new sources of pharmaceutical-grade CFCs to supply any essential use exemptions approved by Parties for 2010. CFCs could be sourced from existing plants in China, India or the United States although this would require changes to CFC production phase-out agreements or to regulations. Remaining stockpiles in non-Article 5 Parties could be another potential source. A change in CFC supply would have a number of implications, including the need to validate the suitability of newly sourced CFCs with relevant health authorities, possible disruptions to the normal flow of MDI production, risks to patient health, and delays in the transition from CFC MDIs (see Chapter 4).

3.2 Essential Use Nominations for Metered Dose Inhalers

3.2.1 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 and XX/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 essential use decisions relevant to these Parties are Decisions XVII/5, XVIII/7 and XIX/13.

3.2.2 Review of Nominations

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

Three members of the MTOC independently reviewed each nomination, each preparing an assessment. Further information was requested of nominating Parties where necessary. The MTOC considered the assessments, made recommendation decisions and prepared a consensus report at its meeting in Montreal, Canada, 22-25 March 2009. 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.

Nominations were assessed according to the guidelines for essential use contained within the *Handbook on Essential Use Nominations* (TEAP, 2005) and subsequent Decisions of the Parties listed in section 3.2.1.

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.

3.2.3 *Observations*

MTOC received 10 essential use nominations: 8 from Article 5 Parties (Argentina, Bangladesh, China, Egypt, India, Iran, Pakistan, and Syria); and 2 from non-Article 5 Parties (Russian Federation and United States).

MTOC found it difficult to adequately assess the nominations from Article 5 Parties in accordance with the criteria set out in Decision IV/25. In particular, there was a shortage of data on the availability and affordability of alternatives to CFC MDIs for the MDI manufacturing/ nominating Party and especially for the Article 5 Parties importing their products. This has become the most critical information in determining essentiality since Parties already have a range of alternatives available.

The substantive criteria for essential use exemptions are detailed in Decision IV/25 of the Parties. Paragraph 1 (a) of Decision IV/25 states that:

"Use of a controlled substance should qualify as essential only if:

(i) it is necessary for health, safety or is critical for the functioning of society (encompassing cultural and intellectual aspects); and

(ii) there are no available technically and economically feasible alternatives or substitutes that are acceptable from the standpoint of environment and health."

MTOC tried to assess availability and affordability in accordance with Decision IV/25. MTOC attempted to minimise the requested quantities for each nomination, based on information on the availability of alternatives that Parties provided or that MTOC was otherwise able to collect.

However, MTOC was unable to make reductions in quantities confidently, without concern that there might not be adequate supplies to meet patient needs. Furthermore, nominating Article 5 Parties are not required to complete an Accounting Framework this year, so complete data on usage and stockpiles were not available to MTOC. Accordingly, the consensus reached for most nominations from Article 5 Parties was to recommend them as proposed, with the exceptions of the nominations from China, India, and Pakistan, which were recommended with reductions in quantities.

MTOC has suggested changes to the information requirements of the *Handbook on Essential Use Nominations* 2005 (the Handbook) for consideration by Parties this year, to seek more and better quality information on availability and affordability of CFC-free alternatives in intended markets to enable a more accurate assessment of nominations in 2010. It should be recognised that a recommendation this year does not guarantee that MTOC would reach a similar conclusion when reviewing future nominations.

The increasing prevalence of asthma and chronic obstructive pulmonary disease (COPD), the morbidity of these conditions, and the high costs they impose on patients and health systems around the world are some of the reasons why MDIs are the last application where CFCs are being phased-out. Other reasons include the slow rate of transition in Article 5 Parties due to barriers in technology transfer, the high cost of investment and complexity associated with conversion projects, proprietary interests, government pricing policies, and physician and patient preferences.

Economic aspects, in particular those related to affordability, are important criteria for essential uses in Decision IV/25. In their nominations, most Article 5 Parties report price differences between locally produced and imported MDIs. A similar situation was reported several years ago in non-Article 5 Parties where the price difference between generic CFC MDIs and branded hyydrofluorocarbon (HFC) MDIs was identified as a reason to continue the use of CFC MDIs, although CFC-free alternatives were available.

These price differences vary over time and depend strongly on the scale of production. Currently, MDIs produced locally in Article 5 Parties are usually cheaper than imported products because of a combination of some of the following factors:

- Tariffs, subsidies or policies that protect local industry;
- Government price controls;
- Lower regulatory costs;
- Lower manufacturing costs such as labour, energy, etc;
- Use of equipment that is already depreciated;
- Lower costs of locally produced packaging and raw materials;
- Availability of canisters with higher numbers of doses, which reduce price per dose;
- Availability of refills where the actuator can be reused;
- Lower transportation and distribution costs.

The relative importance of these factors varies depending on the specific circumstances for each Party. Some of these factors may affect the costs of locally produced HFC MDIs. The intervention of the MLF through phase-out projects has given a unique opportunity to avoid the need to recover high investment costs. As a result, local producers that transition to HFC MDIs should be able to provide affordable medication at prices similar to those of CFC MDIs.

Due to the high prevalence of asthma and COPD, many countries consider local production of MDIs strategically important. Production in some Parties is carried out by several MDI manufacturers, some with varying degrees of foreign ownership. Imported products provide additional technically satisfactory alternatives, although in many cases at higher prices.

CFC MDIs will cease to be essential either when local production of CFC-free alternatives increases to meet demand or when the price of imported CFC-free products decreases. In summary, CFC MDIs in a given Article 5 Party will not be essential when both of the following conditions are met:

- There are several CFC-free therapeutically equivalent therapies.
- The price difference between CFC and CFC-free therapeutic equivalent alternatives is narrow.

In those countries where the MLF is funding phase-out projects for different companies, it is likely that these conditions could be met before all the projects have been completed. Therefore essentiality should not be linked necessarily to the completion of all phase-out projects, but rather to the satisfaction of the essential use criteria.

Furthermore, it is worthwhile to remember that the concept of therapeutic equivalence (such as within the group of inhaled corticosteroids where one corticosteroid has similar therapeutic benefits to another) implies that not all moieties that were formulated as CFC MDIs need to be reformulated as HFC MDIs to complete the CFC phase-out process. The experience with phase-out in non-Article 5 Parties shows that in some cases reformulation may not be possible at all, while in other cases it was possible to reformulate a moiety as a DPI, but not as an MDI.

3.2.4 Technically and economically feasible alternatives

There is now a wide range of technically satisfactory alternatives to CFC MDIs in most Article 5 Parties.

3.2.4.1 Dry Powder Inhalers

DPIs are a suitable alternative for almost all patients, except for children under the age of 4 years. There are 3 different types of DPIs:

Single dose capsules are made by local manufacturers, are inexpensive and comparable in price to CFC MDIs dose-for-dose. They have the advantage that poorer patients can buy a small number at one time, with a smaller package cost than a 200 dose MDI.

Multi-dose reservoir DPIs: the drug is metered from the reservoir at the time of dosing. Although the manufacturing cost is similar to that of MDIs, reservoir DPIs produced by multinationals are generally more costly to the patient than MDIs locally-produced in an Article 5 Party.

Multi-dose individually-metered DPIs: the multiple individual doses are foil wrapped within the device, and sequentially accessed by the patient as required.

Both types of multi-dose DPIs are predominantly made by multinationals, and, except for salbutamol (which is more expensive in multi-dose DPIs), generally have a similar price to the equivalent dose of drug in an MDI produced by multinationals.

In some cases DPIs are the preferred alternative, depending on local circumstances. For example, Japan has phased out CFC MDIs and switched to a predominantly multi-dose DPI market. In India, single-dose capsule DPIs have overtaken MDIs as the predominant dosage form. In contrast, some countries, such as China, have no tradition for DPI use; this seems to be based mainly on physician or patient preference.

Studies [1]have shown that for many patients single and multi-dose DPIs are easier to use correctly than MDIs. In some studies as many as 50 per cent of patients cannot use an MDI

[1] Atkins, P.J., Dry powder inhalers: an overview, Respir. Care. 2005; 50; 1304-12.

Timsina MP, Martin SP et al., Drug delivery to the respiratory tract using dry powder inhalers. Int J of Pharmaceutics. 1994, Vol 101, pp 1-13.

Singh M and Kumar L., Randomized Comparison of a Dry Powder Inhaler and Metered Dose Inhaler with Spacer in Management of Children with Asthma, Indian Paediatrics. 2001; 38: 24-28.

Zeng X Macritchie H B Marriott C Martin G P., Humidity-induced changes of the aerodynamic properties of dry powder aerosol formulations containing different carriers. International Journal of Pharmaceutics. 2007; 333: 45-55.

efficiently. DPIs are activated by inspiration, and do not require as much patient co-ordination.

Humidity is often cited as a reason for DPIs not being suitable for use in hot and humid developing countries. Older reservoir multi-dose DPIs did have significant loss of pharmaceutical performance, but there are no studies to show loss of clinical performance with multi-dose DPIs in humid and hot climates. Efficiency of patient inhalation has a much greater impact on the efficacy of a drug than humidity. Some HFC MDIs also have water ingress problems, and need to be foil-wrapped for prolonged storage. Small differences caused by water ingress in inhalers are likely to make little difference to efficacy because inhalers provide supra-maximal doses of active ingredients.

Market data show that DPI use is increasing world-wide, reflecting the suitability of DPIs as a satisfactory alternative to MDIs. Transition strategies could include patient and physician education to encourage the use of DPIs as an alternative to CFC MDIs.

3.2.4.2 HFC MDIs

Conversion projects in Article 5 Parties are mainly aimed at reformulating CFC MDIs to HFC MDIs. In non-Article 5 Parties, it proved economically or technically impossible to reformulate many CFC MDI products, and similarly many CFC MDI products in Article 5 Parties may also fail to be reformulated, even if funding is received for conversion projects. CFCs will not be recommended *ad infinitum* for MDIs that show signs they cannot be reformulated.

Pricing policies, tariffs, import taxes and restrictions have been implemented by some Article 5 Parties to protect local industry. These policies favour locally made pharmaceuticals, including CFC MDIs, and discourage use of imported pharmaceuticals, including CFC-free alternatives. Based on an MTOC review of data provided by Article 5 Parties, the price of locally manufactured HFC MDIs is generally lower than imported HFC MDIs. This means there are fewer economically feasible alternatives available in Article 5 Parties.

Locally made HFC MDIs are marginally more expensive (~10 per cent) than locally made CFC MDIs. However, this is determined by commercial and/or government policies, since the cost of manufacture (of propellant, valves etc) is very similar, once the capital and product development costs have been taken into account.

Regulatory approvals have been cited as one reason that there have been delays in the introduction of CFC-free alternatives. Given the phase-out of CFCs, Parties are encouraged now to fast-track approvals of CFC-free alternatives.

The question of essentiality needs to be considered separately from MLF projects for phase-out. There may be an adequate range of suitable CFC-free alternatives in a Party in which an MLF project is underway. A funded project does not in itself demonstrate that CFCs are essential.

MTOC notes that some companies have been successful in transition. Other companies continue to manufacture CFC MDIs, undermining the progress in transition. Market leaders in HFC MDIs ought not be penalised for fast transition by competing against lower priced CFC MDIs in the same markets. These circumstances also arose in non-Article 5 Parties, and this was an important factor in delaying salbutamol CFC MDI transition in some countries.

3.2.5 Exported products

Several of the nominations included significant CFC volumes to manufacture MDIs for export, mainly to other Article 5 Parties. For example, about three quarters of the nomination for India was intended for export of CFC MDIs. None of the nominations demonstrated that these CFC MDIs were essential in the designated export markets (i.e. there was inadequate evidence that satisfactory alternatives were not available) where in most cases it appeared that an adequate range of technically feasible alternatives was available.

MTOC reviewed the available data about alternatives from the nomination and other sources. The only comprehensive dataset has been supplied by IPAC. Decision XIV/5 requested each Party to submit available information on CFC and CFC-free MDIs and DPIs in their markets to the Ozone Secretariat by 28 February 2003 with annual updates thereafter, and requires TEAP to review this information in making its annual assessments. Some Parties have submitted data pursuant to Decision XIV/5 since its inception, but in many cases, data are not provided or have not been updated annually. It is important that Article 5 Parties collect their own data on CFC and CFC-free inhalers and provide it annually to the Secretariat by February each year to be posted on its website, in accordance with Decision XIV/5.

The availability of comprehensive export data would greatly facilitate future essential use assessments. MTOC has suggested changes to the Handbook that would request this data to be provided by nominating Parties.

Decision XII/2(3) also requests Parties, including Article 5 Parties, to notify the Ozone Secretariat of any MDI products determined to be non-essential, and for nominating Parties to take this information into consideration. The Ozone Secretariat website only has information pursuant to Decision XII/2(3) from the European Community. In the future, MTOC would like to receive information in the nominations about both exporting and importing countries, including the data required under Decision XIV/5.

Some importing countries listed in the nominations have already declared CFC MDIs to be non-essential or have banned their import (e.g. Thailand and Fiji), although these are not listed on the Ozone Secretariat's website. Other importing countries listed in the essential use nominations as intended export markets already have a complete range of CFC-free alternatives (e.g. Costa Rica). Parties may wish to consider the advantages of encouraging Parties to establish controls on the import of CFC MDIs, and to introduce import bans at a certain date when adequate alternatives to CFC MDIs are available. Parties may also wish to consider the advantages of informing the Ozone Secretariat of any controls, and in turn the Ozone Secretariat could inform Parties.

Given the complexity and fluidity of export markets, Parties may wish to consider the advantages of all importing Parties, including Article 5 Parties, making annual declarations stating the reasons why the imported CFC MDI products are considered necessary and requiring that these declarations accompany nominations from Parties manufacturing and exporting CFC MDIs.

Decisions XV/5, par. 2 and XX/3 par. 1(a) request nominating Parties to provide information on the intended market(s) for sale or distribution for the use, the active ingredient(s) for the use in each market and the quantity of CFCs required for each active ingredient in each market. Decision XVI/12, par. 2 further states that when more specific data are not available, data aggregated by region and product group may be submitted for CFC MDIs intended for sale in Parties operating under paragraph 1 of Article 5. MTOC found it difficult to assess accurately the essentiality of quantities of CFCs intended for export when country-specific information was not provided in the nominations on the quantity of CFCs required for each active ingredient in each market. In future years, in the absence of country-specific information on CFC quantities intended for export, MTOC will consider the alternatives available in intended export markets and make recommendations for a quantity of essential use CFCs for the manufacture of MDIs which specifically excludes any countries considered to have an adequate range of alternatives. For the year 2010, Parties may wish to consider qualifying any approval of essential use exemptions with the condition that any Party exporting CFC MDIs will get prior informed consent of the Government of the importing country for such exports to that country.

Furthermore, MTOC has maintained that companies engaging in dual marketing of CFC and CFC-free MDIs should discontinue this practice after an adequate period of post-marketing for the CFC-free MDI of not more than 12 months. Exporting countries with significant domestic HFC MDI manufacturing capacity would be expected to justify continued export of CFC MDIs for companies that are marketing both types of inhalers.

In future years, MTOC is unlikely to recommend CFC volumes for MDIs intended for export that exceed those recommended for 2010, in the absence of compelling evidence. In subsequent years MTOC would expect to see reductions annually.

3.2.6 Other Issues

Salbutamol (~65 per cent) and beclomethasone (~15 per cent) CFC MDIs constitute more than 80 per cent of the nominated essential uses for 2010. Decision XX/3 requests Parties to prepare preliminary plans of action by mid-2009 for the phase-out of salbutamol CFC MDIs. These will be critical to facilitate priority phase-out of this product. Of the commonly used active ingredients, salbutamol MDIs generally have the greatest price differential between locally made and imported inhalers, so transition to inexpensive locally made HFC MDIs or single dose DPIs will expedite phase-out of a substantial quantity of CFC.

There are increasing numbers of combination products becoming available in Article 5 Party markets. In previous years, MTOC has indicated that it does not consider combination products to be essential where there are the same active ingredients available in the separate CFC-free inhalers. However, recent evidence has suggested that the combination of active ingredients in a single inhaler is beneficial, with improved compliance and clinical benefit, sometimes combined with a decrease in cost for patients compared to the drugs delivered in separate inhalers. As a result of this evidence, MTOC considers the CFCs requested for combination products to be essential for the nominations received from Article 5 Parties for 2010. However, MTOC is aware that it has proved difficult in non-Article 5 Parties to reformulate and gain regulatory approval for some combination products despite a decade of effort. MTOC will continue to review the essentiality of combination products against the availability of alternatives, including the relevant moieties in separate inhalers, and in future may not recommend as essential combination CFC MDIs just because they are difficult to reformulate.

MTOC is also very unlikely to recommend as essential any new CFC MDIs not in the marketplace in 2009. A ciclesonide CFC MDI (an inhaled steroid) is proceeding through regulatory approval processes in China during 2009, for which CFCs are requested in China's essential use nomination for 2010. All inhaled steroids have very similar characteristics. MTOC does not believe that ciclesonide provides substantial additional health benefits. A new product in the approval process in 2009, without significant additional health benefits, cannot be considered essential in 2010 under Decision IV/25.

A number of countries (e.g. China and India) have a very wide array of active ingredients, often using only small volumes of CFC. It may not be economically viable to reformulate all of these, and some may never be reformulated. This year, MTOC has recommended CFCs requested for these products as essential, but questions the essentiality of a long list of products with similar therapeutic value that may never be reformulated successfully. The essentiality of these moieties will be reviewed again in 2010, taking into consideration transition plans and reasonable efforts to demonstrate research and development towards conversion.

3.2.7 Lessons learned from the phase-out in non-Article 5 Parties

There are some key lessons from the phase-out of CFC MDIs in non-Article 5 Parties:

- Phase-out does not occur without a plan;
- There is no incentive to transition while there are lower priced CFC MDIs; and
- The pace of transition is largely determined by the commercial strategies of companies to phase out CFC MDIs.

In the later stages of phase-out, transition can be driven by importing countries having policies to remove barriers, such as import duties for CFC-free inhalers, to favour the introduction of HFC MDIs, including government procurement, and to restrict the import of CFC MDIs. Exporting companies can implement commercial policies that favour transition and discourage reliance on CFC MDIs.

It should be emphasised that CFCs approved by the Parties under essential exemptions do not necessarily need to be produced if they are not required. For example, under domestic processes the United States allocated 27 tonnes in 2008 from an essential use exemption approved by Parties of 385 tonnes of CFCs, based on a review of domestic needs and available stockpile. Similarly, Article 5 Parties could manage carefully and minimise any allocation of CFCs approved by Parties under an essential use exemption and further protect the ozone layer.

3.2.8 Committee Evaluation and Recommendations

Quantities are expressed in metric tonnes.

Argentina

Year	Quantity nominated
2010	178 tonnes

Specific Use: MDIs for asthma and COPD

Active ingredients and intended markets for which the nomination applies:

Active Ingredients	Intended market
Beclomethasone	Argentina and Latin America
Budesonide	Argentina and Latin America
Fenoterol	Argentina
Fluticasone	Argentina and Latin America
Ipratropium	Argentina and Latin America
Salbutamol	Argentina and Latin America
Salbutamol and Beclomethasone	Argentina and Latin America
Salbutamol and Ipratropium	Argentina and Latin America
Salmeterol	Argentina
Salmeterol and Fluticasone	Argentina and Latin America

Recommendation: Recommend 178 tonnes (125.5 tonnes for Argentina and 52.5 tonnes for export to Latin America).

Comments

The nomination from Argentina requests 125.5 tonnes for domestic market use (split between seven active ingredients and some combinations) and 52.5 tonnes for export to a number of Latin American markets. The nomination states that of the 178 tonnes requested, 120 tonnes are for two active ingredients, salbutamol (108.5 tonnes) and beclomethasone, alone or in combination with salbutamol. The volumes of CFCs requested appear to be consistent with historical trends for CFC MDI production in Argentina. MTOC notes that Argentina has received funding to support the reformulation efforts of a number of companies. The leading producer of salbutamol (Laboratory Pablo Cassara) is exploring the use of *iso*-butane as an alternative propellant for MDIs. Although this may be technically feasible, research and development efforts in both Germany and China over the past 12 years did not successfully develop a clinically acceptable *iso*-butane MDI for salbutamol. It may be challenging to successfully complete this project and MTOC would like to see further documentation on the progress of this development effort in support of any future essential use nomination.

It appears that exports of salbutamol CFC MDIs to some Latin American markets may be occurring even when there is a wide range of CFC-free alternatives in those markets. In addition, there is a range of locally made and imported salbutamol and other active ingredient CFC-free inhalers in the Argentina market. MTOC recommends the nominated quantity of CFCs for 2010 since it lacked information to make reductions to account for these alternatives. MTOC wanted to avoid the risk of harming patients, and will carefully review essentiality in future years.

Bangladesh

Year	Quantity nominated
2010	156.7 tonnes

Specific Use: MDIs for asthma and COPD

Active ingredients and intended markets for which the nomination applies:

Active Ingredients	Intended market
Salbutamol	Bangladesh
Budesonide	Bangladesh
Salmeterol, Fluticasone	Bangladesh
Ipratropium Bromide	Bangladesh
Salbutamol, Ipratropium Bromide	Bangladesh
Tiotropium Bromide	Bangladesh
Levosalbutamol	Bangladesh
Ciclesonide	Bangladesh
Beclomethasone	Bangladesh

Recommendation: Recommend 156.7 tonnes for use in Bangladesh.

Comments

The nomination from Bangladesh requests 156.7 tonnes for domestic market use (split between nine active ingredients and one combination). Of the 156.7 tonnes requested, 125.8 tonnes are for two active ingredients, salbutamol (119 tonnes) and beclomethasone, alone or in combination with salbutamol.

The nomination explains that around 9 million people suffer from asthma and COPD. Hospital sources indicate that asthma morbidity and mortality have sharply increased in recent years, both in urban and rural areas of Bangladesh. Historically, asthma treatment had been primarily dependent on orally administered drugs. Before 1997, the inhaler market was totally dependent on import and very few patients could afford them due to the high price of imported inhalers. Since that date, local companies commenced manufacturing MDIs at a lower price, with consequent increase in use. However, it is estimated that there is still less than 10 per cent of patients who are treated with MDIs.

There are three domestic companies that have manufacturing plants, although one company dominates with around 70 per cent of production. Currently, this is the only manufacturer that supplies any HFC MDIs (salbutamol and beclomethasone).

Data for 2004-2008 show an annual growth for inhaled therapy of around 13 per cent including HFC usage. HFC MDIs containing salbutamol and beclomethasone will have achieved less than 10 per cent share of the market by 2009, despite these two moieties representing over 80 per cent of the total market. While there is considerable detail in the nomination concerning transition activities, this is a disappointing rate of progress, which appears strongly linked to cheaper pricing of the CFC MDIs.

Through the MLF, there are funded projects to convert most of the remaining CFC products to HFC, with a planned completion date of July 2011. However, against this background, the nomination for 2010 for a total of 156.7 ODP tonnes implies a growth that is much higher than the historical values. The 60 per cent increase in CFC consumption over 2008 (27 per cent annually) compared to the historic growth of 13 per cent is surprising, especially in view of the imminent replacement of some CFC products. This increase is largely a result of the quantities requested by the two companies that still do not have HFC alternatives. MTOC does not consider that there is sufficient justification in the nomination for this growth. Indeed, increased availability of CFC MDIs might inhibit transition to the CFC-free alternatives that are already available at only marginally higher cost.

A more reasonable request would have been if the nominations for these two companies for salbutamol had reflected the underlying growth of 13 per cent. This would have reduced the total quantity of CFCs for salbutamol from the requested 119 tonnes to 71.2 tonnes. However MTOC did not have adequate evidence to be certain that this reduction would not adversely affect patient health.

The project funded by the MLF to convert CFC MDIs to HFC MDIs does not include conversion of budesonide, salmeterol, tiotropium and levosalbutamol. The nomination indicates that these four moieties may not transition until 2016. MTOC notes that it will carefully review the essentiality of these moieties in future nominations because there are already equally effective therapeutic CFC-free alternatives in Bangladesh.

The People's Republic of China

Year	Quantity nominated
2010	977.2 tonnes

Specific Use: MDIs for asthma, COPD, and acute pulmonary oedema

Active ingredients and intended markets for which the nomination applies:

Active Ingredients	Intended market
Salbutamol	China, Brazil, Cambodia, Chile, Colombia, Costa Rica, Dominica, El Salvador, Ghana, Honduras, Jordan, Mali, Mexico, Moldova, Myanmar, Nigeria, Pakistan, Peru, Philippines Sri Lanka, Sudan, Venezuela
Terbutaline	China
Clorprenaline	China
Clenbuterol	China
Beclomethasone	China, Brazil, Cambodia, Chile, Colombia, Costa Rica, Dominica, El Salvador, Ghana, Honduras, Jordan, Mali, Mexico, Moldova, Myanmar, Nigeria, Pakistan, Peru, Philippines Sri Lanka, Sudan, Venezuela
Ciclesonide	China
Budesonide	China
Sodium Cromoglycate	China, Cuba
Salmeterol	China
Isoprenaline	China
Ipratropium	China
Isoprenaline+ Guaifenesin	China
Ipratropium+ Salbutamol	China
Beclomethasone + Clenbuterol+ Ipratropium	China
Datura flower extract+ Clenbuterol	China
Radix Salviae Miltiorrhiae extract	China
Radix Physochlainae extract	China
Dimethicone	China

Recommendation: Recommend 972.2 tonnes (847.8 tonnes for China and 124.4 for export markets).

Comments

The nomination from People's Republic of China requests 847.8 tonnes for domestic market use (split between fifteen active ingredients and some combinations) and 124.4 tonnes for export to a number of countries. The nomination states that of the 972.2 tonnes requested, 832.6 tonnes are for two active ingredients, salbutamol (626 tonnes) and beclomethasone.

The transition strategy is in the process of being formulated and is planned to be submitted to the Ozone Secretariat by 31 January 2010. There is an approved MLF project for CFC phase-out in China's MDI sector, which is due for completion in 2015. The first product planned for phase-out is salbutamol CFC MDI by the end of 2011, representing about 64 per cent of the total CFC quantity requested. The second largest quantity requested (accounting for another 21 per cent) is for beclomethasone, which will be phased out in the year 2014. The remainder of active ingredients will be phased out in 2015. About 12 per cent of the requested quantity is for export, mainly for salbutamol, beclomethasone and sodium cromoglycate.

There are imported HFC MDIs available (e.g. salbutamol). The current prices of locally produced CFC MDIs are generally 10 to 20 per cent of the prices of imported CFC-free inhalers. Therefore pricing is an important reason for the lack of market penetration of CFC-free inhalers in China.

The CFC consumption between 2004 and 2008 had an annual growth rate of up to 21 per cent. The nomination for 2010 reflects a predicted growth rate of 49 per cent per year from 2008, which is justified by China because of increased treatment of patients with CFC MDI therapy. It reflects the reform and enlargement of medical insurance, basic medicine and the special support of chronic diseases including asthma and COPD.

There are no data on stocks currently available, and these will be required in future nominations. According to the nomination from China, there will be a licence management process in place.

MTOC was unable to recommend the quantities requested for ciclesonide. This is an inhaled steroid, which is undergoing regulatory review in 2009 and not yet in the market. There is no evidence that this product will have any additional clinical advantages compared to other locally produced available steroids such as beclomethasone, fluticasone or budesonide. For the small amount needed for dimethicone and traditional Chinese medicine, MTOC requests published scientific evidence (translated into English) as well as a reformulation schedule for any future nomination.

It appears that exports of CFC MDIs to some markets may be occurring even when there is a wide range of CFC-free alternatives in those markets (e.g. Costa Rica, Cuba, Philippines). MTOC is concerned that the continued export of CFC MDIs to Parties that have a number of suitable CFC-free alternatives will slow transition in those countries. However, MTOC recommends the nomination for 2010 since it lacked information to make specific reductions in volumes with the certainty that these reductions might not harm patients. MTOC will carefully review essentiality of export volumes in future years.

Egypt

Year	Quantity nominated
2010	227.4 tonnes

Specific Use: MDIs for asthma and COPD

Active ingredients and intended markets for which the nomination applies:

Active Ingredients	Intended market
Salbutamol	Egypt, Africa, and Middle East
Beclomethasone	Egypt, Africa, and Middle East
Salmeterol	Egypt, Africa, and Middle East
Beclomethasone/Salbutamol	Egypt, Africa, and Middle East

Recommendation: Recommend 227.4 tonnes (200 tonnes for Egypt and 27.4 tonnes for export markets).

Comments

The nomination from Egypt requests 150 tonnes for domestic market use (split between three active ingredients and one combination), 50 tonnes for stockpile, and 27.4 tonnes for export to a number of African and Middle East markets. The nomination states that of the 227.4 tonnes requested, 214.4 tonnes are for two active ingredients, salbutamol (188.4 tonnes) and beclomethasone, alone or in combination with salbutamol. The Government of Egypt voluntarily reduced an initial nomination of 264 tonnes and deferred an amount to a possible 2011 nomination. The nominated volume for use in 2010 seems in line with historical consumption.

MLF-funded reformulation project activities have recently started. They involve the two local producers and cover all five locally produced CFC MDI products. MTOC commends its ambitious, although very challenging, timeline, which is the basis for Egypt's intention to complete its CFC MDI phase-out by the first half of 2011.

India

Year	Quantity nominated
2010	350.60 tonnes

Specific Use: MDIs for asthma and COPD

Active ingredients and intended markets for which the nomination applies:

Active ingredients	Intended market		
	Domestic Market	**Non-A5 Parties**	**Article 5 Parties**
Salbutamol	India	None	Algeria, Benin, Bolivia, Brazil, Burkina Faso, Burundi, Cameroon, Chile, Colombia, Republic of Congo, Costa Rica, Ethiopia, Guatemala, Guyana, Jamaica, Jordan, Kenya, Liberia, Libya, Macau, Madagascar, Malaysia, Malawi, Mali, Mauritius, Mexico, Mozambique, Myanmar, Nigeria, Oman, Peru, Puerto Rico, Singapore, Sri Lanka, Thailand, U.A.E., Venezuela, West Indies[2], Yemen, Zambia
Beclomethasone	India	United Kingdom	Algeria, Bahrain, Bolivia, Brunei, Brazil, Colombia, Ethiopia, Guatemala, Guyana, Hong Kong, Iran, Iraq, Jamaica, Kenya, Libya, Maldives, Madagascar, Malaysia, Mexico, Oman, Palestine, Peru, Puerto Rico, Saudi Arabia, Sri Lanka, Suriname, U.A.E., Uganda, Venezuela, West Indies, Yemen, Zaire (DRC)
Beclomethasone + Salbutamol	India	None	Benin, Brazil, Bolivia, Chile, Colombia, Jamaica, Libya, Peru, Singapore,Somaliland, Venezuela, West Indies, Yemen, Zambia,
Budesonide	India	None	Algeria, Benin, Chile, Colombia, Kenya, Mauritius, Peru, Sri Lanka, Tanzania, Thailand, U.A.E., Yemen
Budesonide + Formoterol	India	None	Bolivia, Kenya, Libya, Mauritius, Sri Lanka, U.A.E,
Formoterol	India	None	Guatemala, Jordan, Puerto Rico, U.A.E., Venezuela

[2] As stated in the nomination, although not a Party.

Active ingredients	Intended market		
Fluticasone	India	None	Chile, Colombia, Guatemala, Iran,Libya, Oman, Peru, Sri Lanka U.A.E.,
Ipratropium Bromide	India	None	Colombia, U.A.E., Jamaica, Suriname, Singapore, Uganda, Peru, Iran, Panama, South Africa, Sri Lanka
Ipratropium + Salbutamol	India	None	Colombia, Iran, Peru, Philippines, U.A.E., Venezuela,
Levasalbutamol	India	None	Peru
Salmeterol	India	None	Oman, Sri Lanka, U.A.E., Yemen
Salmeterol + Fluticasone	India	None	Chile, Guatemala, Kenya, Mauritius, Morocco, Peru, Sri Lanka, U.A.E.
Tiotropium Bromide	India	None	Colombia, Panama, Peru, Puerto Rico, Sri Lanka
Tiotropium + Formoterol	India	None	Colombia, Panama, Peru, Puerto Rico, Sri Lanka
Beclomethasone + Formoterol	India	None	None
Formoterol Fumarate + Fluticasone	India	None	None

Recommendation: Recommend 343.6 tonnes (87 tonnes for India, and 256.6 tonnes for export markets).

Comments

The Indian nomination requests 350.6 tonnes of CFCs for MDIs. Of this, 87 tonnes are for domestic use and 263.6 tonnes are for CFC MDI products intended for export to mostly Article 5 Parties (except one product intended for the United Kingdom). The total nominated amount was for nine active ingredients for a total of seventeen entities (alone or in combination). The nomination states that for 8 entities (either alone or in combination) an equivalent HFC MDI had already been developed, some dating back to 2006.

Furthermore, MTOC noted that a single company (Cipla) produces a wide range of HFC and CFC MDIs (in approximately equal quantities) and DPIs, and had provided MTOC with information that it intended to transition its CFC MDI manufacture to existing reformulated HFC products during 2009. There are at least two other manufacturers of HFC MDIs in India.

As transition is progressing well and MLF-funded projects are expected to deliver reformulated products in 2010 and 2011, MTOC believes that the CFC amount recommended should be sufficient in 2010 to support CFC MDI manufacturers that have not yet launched reformulated products. The range of reformulated MDIs plus the existing single dose dry powder inhalers provide an adequate range of alternatives. Despite the range of alternatives available, MTOC recommends the nomination for 2010 because it lacked sufficient information to make specific reductions to account for these alternatives without potentially risking harm to patients. MTOC will carefully review essentiality in future years. The nominated volume for export is substantial and the nomination contains no information on the essentiality of the products designated for export to those markets. Indeed, there is a single product (beclomethasone) for the United Kingdom for which MTOC understands there is a new regulation that will ban the import of CFC MDIs into the European Union from 1 January 2010. Therefore the recommended CFC quantity has been reduced to reflect this.

The nomination contained information that was not consistent with information available to the MTOC. For example, Saudi Arabia and Thailand prohibit the import of CFC MDIs but they are included in the intended export markets for India. Furthermore, MTOC is concerned that the continued export of CFC MDIs to Parties that have a number of suitable CFC-free alternatives will slow transition in those countries. It is also concerned that some companies with HFC MDIs and DPIs launched on the local market are simultaneously exporting the equivalent CFC MDI to importing countries. However, MTOC recommends the nominated quantities intended for export for 2010 since it lacked information to make specific reductions in quantities with the certainty that these reductions might not harm patients. MTOC will carefully review essentiality of export volumes in future years.

Islamic Republic of Iran

Year	Quantity nominated
2010	105 tonnes

Specific Use: MDIs for asthma and COPD.

Active ingredients and intended markets for which the nomination applies:

Active Ingredients	Intended market
Salbutamol	Islamic Republic of Iran
Beclomethasone	Islamic Republic of Iran
Salmeterol	Islamic Republic of Iran
Sodium Cromoglycate	Islamic Republic of Iran

Recommendation: Recommend 105 tonnes for use in Iran.

Comments

The nomination from Iran requests 105 tonnes for domestic market use (split between four active ingredients). Of the 105 tonnes requested, 89.5 tonnes are for two active ingredients, salbutamol (75.5 tonnes) and beclomethasone.

In recent years Iran has had approved financial assistance from the MLF to achieve conversion to produce CFC-free alternatives by the end of 2010. Due to complexities with the provision of technology and product formulations, a delay

of several months may occur. Therefore Iran has stated a need for CFCs at least until the end of 2010. The project includes the first three active ingredients listed in the nomination (more than 95 per cent of the total volume). No CFCs will be required after completion of the conversion project.
Consumption was about 100-105 tonnes of CFCs per year for the last 3 years. In 2009 consumption of 110 tonnes is anticipated. The stockpile is about 25 tonnes for CFC 11, CFC 12, which provides a 3-month buffer.

A national transition strategy was introduced in April 2007 and revised in 2009.

Pakistan

Year	**Quantity nominated**
2010	134.9 tonnes
2011	158.2 tonnes
2012	169.7 tonnes

Specific Use: MDIs for asthma and COPD

Active ingredients and intended markets for which the nomination applies:

Active Ingredients	**Intended market**
Salbutamol	Pakistan
Beclomethasone	Pakistan
Salmeterol	Pakistan
Ipratropium Bromide	Pakistan
Triamcinolone	Pakistan
Fluticasone	Pakistan

Recommendation: Recommend 34.9 tonnes for 2010 for use in Pakistan. Unable to recommend for 2011 and 2012.

Comments

The nomination for 2010 from Pakistan requests 134.9 tonnes for domestic market use (split between six active ingredients). Of the 134.9 tonnes requested for 2010, 128.4 tonnes are for two active ingredients, salbutamol (125.5 tonnes) and beclomethasone, alone or in combination with salbutamol. Pakistan nominated essential uses for the years 2010, 2011 and 2012. MTOC only recommends part of the 2010 nomination, and noted a lack of consistency within the nomination regarding the quantities nominated for the three years.

The nomination does not forecast any increase in projected volumes for 2009 and 2010, but it anticipates a 26 per cent increase in CFC MDI use from 2010 to 2012.

Currently, there are three domestic producers of CFC MDIs, the largest of which is a multinational with 22 per cent local ownership. Salbutamol production accounts for 91 per cent of the CFC use for MDI products in Pakistan. Ventolin™, the GSK Pakistan salbutamol CFC brand, holds approximately 90 per cent of the market share. MTOC has learned from the Ministry of Environment that GSK Pakistan will stop all CFC MDI production in December 2009 while it transitions to a CFC- free replacement. In view of this, MTOC is unable to recommend the 100 tonnes of CFC requested for this part of the nomination.

The absence of the GSK Pakistan product in the market place may result in a temporary shortfall in salbutamol availability in Pakistan. GSK advises that it will hold stock of finished product to cover a substantial part of the demand in 2010. The availability of alternatives may also depend on imports of CFC-free MDIs, which have higher prices than locally manufactured CFC MDIs. This makes them less affordable to patients. In 2007, GSK Pakistan launched an imported CFC-free salbutamol inhaler with the brand name of Aerolin™. A temporary reduction or elimination of the import tax on this product would make the product more affordable to patients until domestic products are available. However the Government of Pakistan states that it does not wish to depend on imports.

The 56th Executive Committee meeting approved the plan for phase-out of CFCs in manufacture of pharmaceutical MDIs in Pakistan and the national strategy for transition to CFC-free MDIs, which involved education and information dissemination. The two relevant Pakistan enterprises are expected to complete this project by June 2012.

Russian Federation

Year	**Quantity nominated**
2010	212 tonnes

Specific Use: MDIs for asthma and COPD

Active ingredients and intended markets for which the nomination applies:

Active Ingredients	**Intended market**
Salbutamol	Russian Federation

*Recommendation: R*ecommend 212 tonnes for use in the Russian Federation.

Comments

The nomination from the Russian Federation requests 212 tonnes for domestic use only (for two state-owned enterprises) for the manufacture of salbutamol CFC MDIs. MTOC is concerned that even this quantity of CFCs may not be sufficient to supply patient needs. The recommendation takes into consideration patients' right to have access to affordable inhaled therapy.

Unfortunately, the time line and feasibility of the Russian Federation transition has been repeatedly delayed. The Russian Federation is strongly urged to define a new phase-out strategy, either with MDI or DPI industrial conversion, which require less initial investment on machinery and reformulation; or taking into account the on-going delays in developing domestic capacity, the Russian Federation may need to consider low priced imported CFC-free products as an alternative to local manufacture.

Syria

Year	Quantity nominated
2010	44.68 tonnes
2011	49.22 tonnes

Specific Use: MDIs for asthma and COPD.

Active ingredients and intended markets for which the nomination applies:

Active Ingredients	Intended market
Salbutamol	Syria, Iraq, Yemen, Armenia, Georgia, Mauritania, Sudan
Beclomethasone	Syria, Iraq, Yemen, Sudan
Salbutamol + Beclomethasone	Syria, Iraq, Yemen, Sudan
Salmeterol	Syria
Salmeterol +Fluticasone	Syria
Fluticasone	Syria

Recommendation: Recommend for 2010. Unable to recommend for 2011.

Comments

The nomination from Syria for 44.68 tonnes in 2010 does not provide the split between domestic and export market uses, but it mentions exports to a number of African and Middle East markets. The manufacture of four active ingredients and two combinations is also indicated. Production figures, in numbers of cans filled, rather than CFC consumption per brand are given, but as happens in most markets before transition, these numbers show that about 70 per cent of CFC consumption is for the manufacture of salbutamol MDIs.

The demand for MDIs in Syria in 2007 was reported to be about 2 million units. Continued growth in demand is anticipated. The size of the export market is less than 10 per cent of total consumption, and may contract due to changes in regulations in some markets that now stipulate the import CFC-free products.

The historical growth of the sole domestic manufacturer shows an annual increase of 10 per cent since 2005-2006. The quantities nominated are consistent with that trend.

There are no CFC MDI imports in Syria. The two DPIs (salbutamol and salmeterol/fluticasone) that are approved by Government for import can be considered as alternatives. However, since the prices of these DPIs are much higher than locally produced CFC MDIs, they cannot be considered as affordable alternatives.

Syria proposed a conversion project that was not approved by the ExCom. The local manufacturer has consequently decided to execute the conversion project by itself. A timetable for conversion to HFC technology has been provided in the nomination. Salbutamol HFC MDIs are expected to be produced by the beginning of 2011, other products will be converted later, with final conversion expected to be completed by 2013. Available storage facilities are not adequate to increase stockpiles.

MTOC will carefully review essentiality of export volumes in future years.

United States

Year	Quantity nominated
2011	67 tonnes

Specific Use: MDIs for asthma.

Active ingredients and intended markets for which the nomination applies:

Active Ingredients	Intended market
Epinephrine	United States

Recommendation: Unable to recommend.

Comments

The nomination by the United States requests 67 tonnes of CFC to be used in 2011 for the manufacture of epinephrine MDIs for domestic use only. This is 25 tonnes or 37 per cent less than the amount authorised for 2010.

In general, the nomination adequately addresses and responds to the questions of the Handbook. Details of the management of the stockpile and any surplus (Section III.3.) were provided.

MTOC is pleased to note that during 2008 the US FDA issued a final rulemaking removing the essentiality for CFC MDIs whose active ingredient is epinephrine with an effective date for removal from sale of 31st December 2011.

In its updated 2008 Progress Report MTOC expressed concerns about the slow completion of development efforts for epinephrine. However there was reluctant consensus agreement that the nomination for 2010 should be recommended on the basis of anticipated progress made with reformulation, the claimed inaccessibility of available stockpile, and given that 2010 would be the final year for CFCs to be allocated to epinephrine MDIs.

The United States is the only non-Article 5 Party that holds a significant stockpile of pharmaceutical-grade CFCs. This stockpile amounted to 830 tonnes at the end of 2008 despite the destruction of 234 tonnes of CFCs reported in the Accounting Framework.

MTOC does not consider that the 2011 nomination meets the requirement of Decision IV/25(b) (ii) regarding the availability of sufficient quantity of controlled substances from existing stocks. Although not totally clear, the nomination indicates that a strategic reserve of CFC equal to one year's need would be available for the product at the beginning of 2011. Since the United States' essential use designation for epinephrine will be removed after 31 December 2011, any production during 2011 should be based on remaining stock and not on new CFC production.

Furthermore MTOC does not consider that CFC MDIs for epinephrine are an essential use under Decision IV/25(a). As stated in the nomination four HFC salbutamol (and levalbuterol) alternatives are available and, although available on prescription only, MTOC considers these products to be suitable alternatives to epinephrine.

3.3 Essential Use Nomination for Foam, Refrigeration and Air Conditioning Uses from Iraq

Year	Quantity nominated
2010	690 tonnes
2011	690 tonnes

Specific Use: Foam manufacturing, domestic refrigeration manufacturing, and refrigeration and air conditioning servicing.

Recommendation: Unable to recommend.

Comment

Iraq nominated an essential use exemption for 290 tonnes of CFC-11 for foam manufacturing and 400 tonnes of CFC-12 for the manufacture of domestic refrigerators/freezers and small commercial stand-alone equipment for each of the years 2010 and 2011. The nomination also requests CFC-12 for servicing refrigeration and air-conditioning equipment. Iraq reports historical annual consumption for these applications of more than 300 tonnes of CFC-11 and 1,200 tonnes of CFC-12.

TEAP considered the essential use nomination of Iraq carefully. It is aware of the Iraq's security situation and the factors that delayed its ratification of the Protocol and thus the potential assistance from the MLF. However TEAP is also aware that recycled CFC-11 and CFC-12 are readily available from foreign sources, and could be imported by Iraq to supply its applications for 2010 and 2011, making it unnecessary to produce new CFCs under an essential use exemption.

The Fourth Meeting of the Parties decided in Decision IV/25 to apply the following criteria for assessing an essential use, that:

(a) Use of a controlled substance should qualify as essential only if:

(i) it is necessary for health, safety or is critical for the functioning of society (encompassing cultural and intellectual aspects); and

(ii) there are no available technically and economically feasible alternatives or substitutes that are acceptable from the standpoint of environment and health;

(b) That production and consumption, if any, of a controlled substance for essential uses should be permitted only if,

(i) all economically feasible steps have been taken to minimize the essential use and any associated emission of the controlled substance; and

(ii) the controlled substance is not available in sufficient quantity and quality from existing stocks of banked or recycled controlled substances, also bearing in mind the developing countries' need for controlled substances;

(c) That production, if any, for essential use, will be in addition to production to supply the basic domestic needs of the Parties operating under paragraph 1 of Article 5 of the Protocol prior to the phase-out of the controlled substances in those countries."

TEAP finds that the essential use criteria that "there are no available technically and economically feasible alternatives or substitutes that are acceptable from the standpoint of environment and health" and "the controlled substance is not available in sufficient quantity and quality from existing stocks of banked or recycled controlled substances" are not satisfied in the case of the Iraq nomination. There are alternatives for the foam and refrigeration and air conditioning manufacturing industries that have been proven for the past 13 years. There are also adequate global stocks of recycled material that can be imported by Iraq for its applications. There are techniques for refrigerant management, such as the use of recycled CFCs, and for replacing CFCs with non-CFC blends in existing equipment that avoid continued consumption of CFCs. These techniques have been successful world-wide, and no country has ever had the need to nominate for an essential use exemption for these uses.

Therefore TEAP is unable to recommend the nomination of Iraq. There is extensive global expertise in CFC recovery and recycling, and sufficiently large stocks of recycled CFCs that could be used quickly to help Iraq meet its requirements. Parties may wish to consider Iraq's situation as a new Party to the Protocol and its recent domestic circumstances that make assistance a priority. A bilateral project with another Party may help to solve quickly any problems with recycled CFC supply until the technology transfer projects are completed.

Furthermore, there are two priority measures that TEAP believes could quickly reduce CFC demand for servicing requirements and minimise the volume of imports of recycled CFC-11 and CFC-12; programs to retire installed leaking equipment with new CFC-free equipment, and adoption of recovery and recycling. Both of these actions would liberate recycled CFCs for servicing equipment that has not yet reached its end-of-life and remains in good working order. Equipment replacement can provide additional benefits, including higher energy efficiency and better performance.

According to the nomination, no steps have yet been taken to implement substitutes due to the long period of instability faced by Iraq and because Iraq has just recently (2008) joined the Montreal Protocol and has not yet started to benefit from its technology transfer mechanisms.

Iraq, in co-operation with UNEP and UNIDO, is currently preparing a Country Programme and National Phase-out Management Plan (CP/NPP), including investment and non-investment projects to phase out CFC in foam and refrigeration manufacturing as well as in the servicing sector. At its 57th Meeting, the Executive Committee approved two investment projects in the foam and refrigeration manufacturing sectors: conversion from CFC-11 to methylene chloride in the production of flexible slabstock foam; and replacement of CFC-12 refrigerant and CFC-11 foam-blowing agent with iso-butane and cyclopentane respectively in the manufacture of domestic refrigerators/freezers.

However, due to the very recent joining of Iraq to the Montreal Protocol, the completion of these projects may not be feasible until 2011. Recovery and recycling are not yet introduced in Iraq because newly produced CFCs have been widely available and projects under the NPP have not yet been started. Iraq stated it would shortly establish regulations and controls on the import, export and use of ozone-depleting substances as a part of the project.

4 Response to Decision XX/4: Campaign Production for Some Article 5 Parties Manufacturing Metered-dose Inhalers Using Chlorofluorocarbons

4.1 Background

At their 17th Meeting, the Parties to the Montreal Protocol discussed the difficulties faced by some Article 5 Parties with respect to the phase-out of chlorofluorocarbons (CFCs) used in the manufacture of metered dose inhalers (MDIs). In Decision XVII/14 the Parties expressed their concern that Article 5 Parties that manufacture CFC MDIs might find it difficult to phase out these substances without incurring economic losses to their countries. There was the further risk that, for some Article 5 Parties, consumption levels in 2007 of CFCs for MDIs might exceed the amounts allowed for all CFC uses under the Protocol.

The Parties considered the issue again at their 18th Meeting and took Decision XVIII/16. Paragraph 12 of this Decision requested:

> "*TEAP to assess and report on progress at the 27OEWG and to report to the MOP19 on the need for, feasibility of, optimal timing of, and recommended quantities for a limited campaign production of chlorofluorocarbons exclusively for metered-dose inhalers in both Parties operating under paragraph 1 of Article 5 and Parties not operating under paragraph 1 of Article 5.*"

The TEAP and its MTOC included its response to Decision XVIII/16 in the April 2007 *Progress Report of the Technology and Economic Assessment Panel* to the 27th Open-ended Working Group Meeting. The Open-ended Working Group discussed the possibility of maintaining the current system of "just-in-time production". However, the Working Group did not achieve consensus and nor was consensus achieved at the 19th Meeting of the Parties.

In its 2008 Progress Report, in an updated response to Decision XVIII/16, MTOC reviewed new information available from the Multilateral Fund Secretariat, implementing agencies, countries, and industry sources and considered not only those Parties manufacturing CFC MDIs but also issues surrounding CFC MDI transition in importing Article 5 Parties.

The Parties considered the issue at the 20th Meeting of the Parties and, in taking Decision XX/4, requested TEAP to present a report to the Twenty-First Meeting of the Parties, preceded by a preliminary report to the Open-ended Working Group at its twenty-ninth meeting, concerning:

(a) The potential timing for final campaign production, taking into account, among other things, the information submitted in the nominations for 2010 and that some Parties operating under paragraph 1 of Article 5 may prepare essential use nominations for the first time for the Twenty-First Meeting of the Parties;

(b) Options for long-term storage, distribution, and management of produced quantities of pharmaceutical-grade chlorofluorocarbons before they are needed by Parties, including existing methods used by Parties not operating under paragraph 1 of Article 5;

(c) Options for minimizing the potential for too much or too little chlorofluorocarbons production as part of a final campaign;

(d) Contractual arrangements that may be necessary, considering the models currently used by Parties not operating under paragraph 1 of Article 5 that submit essential-use nominations consistent with decision IV/25;

(e) Options for reducing production of non-pharmaceutical-grade chlorofluorocarbons, together with options for final disposal of such chlorofluorocarbons.

4.2 Developments relating to campaign production

Progress has been made towards phase-out of the use of CFC in MDIs in Article 5 Parties for certain key moieties, with a range of technically feasible alternatives now available. However, for many Article 5 Parties, the conversion of locally owned CFC MDI manufacturing is only just commencing (e.g. China, Egypt, Iran).

The use of CFC MDIs after technical CFC-free alternatives became available has been justified over the last several years because they continue to provide affordable medication to many patients. This situation could now change as the cost of pharmaceutical-grade CFCs becomes higher than that of pharmaceutical-grade hydrofluorocarbons (HFCs). Therefore the price differences between CFC and HFC MDIs are not currently a consequence of propellant cost, but rather other factors such as MDI component cost differences (canisters, valves etc), development costs, marketing, return on investment of capital costs and, in some cases, due to tariffs imposed to protect CFC MDIs that are manufactured locally against imported HFC MDIs. The price differential between CFC and HFC MDIs has become progressively smaller.

The mandated phase-out date under the Montreal Protocol for the global production of CFCs is less than one year away. The Montreal Protocol's Decision IV/25 allows for the production of CFCs for essential uses, if approved by Parties, after the mandated phase-out date. The pace of implementation of projects to convert CFC MDI manufacturing in Article 5 Parties will largely determine the quantities of CFCs that will be required for CFC MDI manufacturing after 2009. However, continued production of pharmaceutical-grade CFCs will only be economically viable for production runs of at least several hundred tonnes.

MTOC are of the opinion that the decision to fund phase-out projects in Article 5 Parties is not necessarily indicative of an essential use. For instance, a country that did not receive funding by the MLF might still be granted an essential use exemption by the Parties if its requirement for CFCs meets the criteria of Decision IV/25. Conversely, a Party that received funding for a phase-out project might not meet, at a certain point in time, the essential use criteria even when the project funded by the MLF has not been completed.

Given the uncertainties and risks associated with the long-term supply of suitable quality CFCs after 2009, MTOC emphasises that the highest priority for continued supply of inhalers is to complete transition as quickly as possible and ensure the expeditious introduction of CFC-free alternatives.

In its 2007 report, MTOC proposed a final campaign in 2009. However, in 2007 Parties did not adopt a decision on a final campaign, deferring consideration until a later date. In its 2008 Progress Report, the MTOC considered a number of options for the production of pharmaceutical-grade CFCs after 2009 and recommended a preferred option that could best facilitate the final phase-out of CFCs MDIs in countries that were still manufacturing CFC MDIs. The options considered by MTOC were as follows.

- Open-ended annual CFC production after 2009 (under essential use exemptions): This option was not recommended. It does not provide a clear target or timetable for ending CFC production, predictability for CFC producers, or incentive for those companies manufacturing CFC MDIs to switch to CFC-free alternatives. At a certain point, the economics of CFC production would not be favourable and would make impractical and too uncertain the continued production of relatively small amounts of pharmaceutical-grade CFCs. Overall destruction costs for out-of-specification CFCs would be relatively high with this option.

- A final campaign production of pharmaceutical-grade CFCs: This was the preferred option. MTOC believed that, with appropriate planning and co-ordination, this could be feasible in 2011 to provide for CFC MDI manufacturing countries that do not have domestic CFC production. This option assumed that project implementation was not delayed further, and that China maintained domestic production of pharmaceutical-grade CFCs for its own use under an essential use exemption, if approved by Parties, until a stage of its CFC MDI phase-out where it would have its own final campaign. Anticipating a final campaign production at an agreed date provided a clear target for ending CFC production, predictability for CFC producers, and an incentive for those companies currently manufacturing CFC MDIs to switch to CFC-free alternatives. In 2008, MTOC expected that the production of essential use CFCs in 2010 would be around 1,700 tonnes, and that in 2011 it would be possible to run a final campaign of around 2,000 tonnes to cover MDI production requirements in several countries for multiple years. This approach took into consideration the fact that the majority of Article 5 Parties obtained their pharmaceutical-grade CFCs from a plant located in the European Union, and that China would produce its own pharmaceutical-grade CFCs according to its specifications.

During its meeting in 2009 MTOC became aware that the European Commission has regulated to stop production of pharmaceutical-grade CFCs from the 1st January 2010, which would otherwise have supplied many remaining Article 5 Party producers of CFC MDIs. With this decision, these MDI manufacturing companies will have to find new sources of pharmaceutical-grade CFCs to supply any essential use CFCs approved by Parties for 2010. A change of CFC supplier will require that CFC MDI producers validate the suitability of the new propellant. Validation takes time to be completed, and in some cases will require the approval of the relevant health authorities and could disrupt the normal flow of the MDIs that are locally produced in Article 5 Parties, and could risk patient health. Validation efforts could also consume valuable technical resources in MDI manufacturing companies that would otherwise be devoted to the conversion to CFC-free technologies. These factors could further delay the transition from CFC MDIs.

As a consequence of the European Commission regulation, there are two scenarios to describe the possible supply situation of pharmaceutical-grade CFCs once the plant located in the European Union is closed:

- *Single Source Supply*: Under this scenario the only producer of CFCs would be located in China. It is believed that the plant set aside by China to cover its needs of pharmaceutical-grade CFCs has sufficient capacity to satisfy the demand of all Article 5 Parties that are requesting essential use nominations, but MTOC understands that the phase-out agreement for China does not allow exports of CFCs after 2009. Furthermore, it is possible that the CFC produced in China might not meet the registered specifications of all those companies that continue to manufacture in Article 5 Parties. Also, the supplier would hold a monopoly, creating a potential risk to supply if the plant is forced to shut, a lack of competition that could increase the cost, and less storage capacity for inventory.

- *Multiple Source Supply*: Under this scenario additional producers of CFCs would be identified. These producers could include Honeywell in the United States or producers in Article 5 Parties, like India, that have swing plants which are currently producing

HCFC-22. The need to validate quality and the risk of delays in approval remain. Legal aspects, such as their ability to supply for essential use nominations to other Parties, may need to be clarified as swing plants in Article 5 Parties have received funding from the MLF to stop production of CFCs as part of their production phase-out agreements.

Remaining stockpiles in non-Article 5 Parties could also be considered as a potential source of pharmaceutical-grade CFCs. The significant stockpile in the Unites States may still be used domestically to supply CFC MDIs for its essential use exemptions for 2009 and 2010, but some could potentially remain at the end of the CFC MDI phase-out. The stockpile that remains in the European Community is uncertain, since the accounting framework was not reported by the Montreal Protocol deadline of 31st January, or in time for the MTOC meeting, but is likely to be of the order of about 100 tonnes.

The essential use nominations received this year allow a global picture of possible pharmaceutical-grade CFC needs to be developed for 2010. If approved by Parties, it is estimated that up to about 2,000 tonnes of essential use CFCs for MDIs may be needed. However with the current uncertainty of CFC supply, it is impossible to predict where essential use CFCs, if approved by Parties, might be sourced for 2010. China, which is the Party with the biggest consumption of CFCs for MDIs and the one that will most likely take longest to complete its transition from CFC to HFC MDIs, may have a more significant role as a supplier of pharmaceutical-grade CFCs as a consequence of the European Commission's decision. However, this will depend on whether Parties allow such a role. If this were the case, pharmaceutical-grade CFC supply via China alone could encourage open-ended annual CFC production for Parties with essential use exemptions, until a time when China's demand has reduced to a level when a final campaign becomes necessary. As reported in 2008, open-ended annual CFC production does not provide a clear target for ending CFC production or incentive for CFC MDI manufacturers to switch to CFC-free alternatives. Overall destruction costs for out-of-specification CFCs could also be relatively high compared with a final campaign production.

MTOC will continue to follow the developments concerning supply of pharmaceutical-grade CFCs, but is unable to provide Parties with a response to Decision XX/4 until the supply situation becomes clearer.

5 Medical Technical Options Committee Progress Report

5.1 Executive Summary

The Medical Technical Options Committee (MTOC) thanks the Multilateral Fund Secretariat for providing meeting venue and other assistance for the MTOC meeting held in Montreal, Canada, 22-25th March 2009. As part of its hospitality, the MLF provided meeting rooms and other in-kind support, such as telecommunications and copying, and also beverages. Incurred costs were covered under the Montreal Protocol Trust Fund.

The global use of chlorofluorocarbons (CFCs) to manufacture metered dose inhalers (MDIs) continues to decline against a background of steadily increasing global use of inhalation therapy. The total use of CFCs in 2008 was estimated to be about 2,700 tonnes. Three-quarters of this were used to treat patients in Article 5 Parties, with the majority used by local CFC MDI manufacturers.

Stockpiles of pharmaceutical-grade CFCs outside the United States are minimal. Following the decision by the European Commission to ban exports of bulk CFC from 1st January 2010, there is now uncertainty over the security of supply of CFC MDIs for some Article 5 Parties.

Technically satisfactory alternatives to CFC MDIs are available for all therapeutic categories for asthma and chronic obstructive pulmonary disease (COPD). In non-Article 5 Parties, complete transition will have occurred by the end of 2009, with the exception of the Russian Federation, where there has been no reported progress, and some small volumes of CFC associated with moieties of minor use in the United States. In Article 5 Parties, there are many acceptable alternatives to salbutamol and beclomethasone CFC MDIs. However, the presence of CFC-free products cannot alone lead to phase-out without regulatory action, appropriate pricing and a clear national transition strategy.

5.2 Global use of CFCs

The global use of CFCs to manufacture MDIs in 2008 is estimated to be about 2,700 tonnes, a reduction of 700 tonnes from consumption of 3,400 tonnes in 2007. Of this, the Russian Federation and the United States used 250 tonnes and 450 tonnes respectively; Article 5 Parties used the remainder. The total use of CFCs by all Article 5 Parties remained about the same between 2007 and 2008, with some countries increasing and others decreasing consumption.

Stockpiles in the European Community member states are now close to 100 tonnes. The reported stockpile at the end of 2008 in the United States was 830 tonnes, compared to an estimated future annual consumption of less than 100 tonnes. This material may not be available for export in its entirety and therefore might be destroyed in part. Without accounting frameworks, which are not required to be reported until 31st January 2011, it was not possible to accurately assess the stockpile in Article 5 Parties, although many nominations indicated that stockpiles were small and substantially less than that required for 12 months supply of MDIs.

Many CFC MDI manufacturers in Article 5 Parties have used CFC supplied from a European manufacturer, while others have used CFC supplied from China or India. During the MTOC meeting, the European Community declared that from 31st December 2009 all imports of CFC MDIs into the member states of the European Community would be banned. The regulation also bans the export of bulk CFCs from the European Union from the same date. For a CFC MDI manufacturer to source bulk CFC from a new supplier, validation studies and possibly also regulatory approval would almost certainly be required before being able to use it in a marketed product. Taken together with small stockpiles, this makes the future continued supply of CFC MDIs in Article 5 Parties very uncertain. One immediate option would be to expedite the phase-out of CFC MDIs by rapid transition to CFC-free alternatives.

5.3 Transition away from the use of CFC MDIs

Technically satisfactory alternatives to CFC MDIs to treat asthma and COPD are available in almost all countries world-wide.

The International Pharmaceutical Aerosol Consortium (IPAC)[1] has analysed the progress in the transition to CFC-free alternatives based on available market data. Using the IMS[2] definition of standard units (SU) of dosing[3], global data showing trends in inhaler use are shown in Figure 5-1. It should be noted that for dry powder inhalers (DPIs), 1 puff (SU) represents 1 dose, whereas in general for MDIs, 2 puffs (2 SU) equals 1 dose.

Figure 5-1: Trends in global inhaler usage 2002-2007

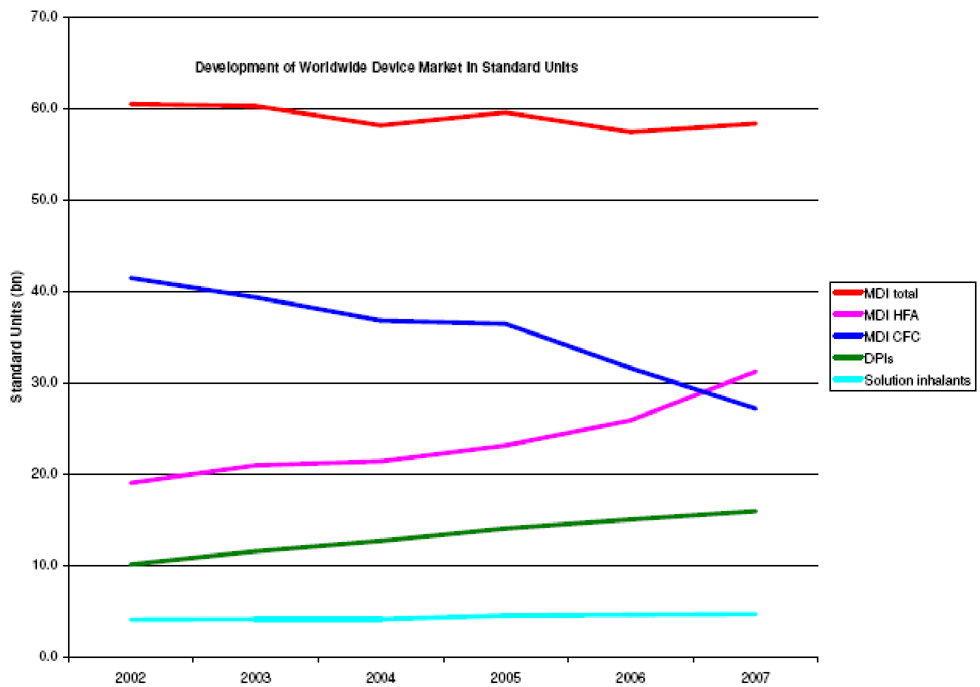

Figure 5-1 shows a slight decrease in the total consumption of MDIs, but this decrease is smaller than the increased use of DPIs. Therefore, it can be concluded that there has been an increased overall use of inhalers, mainly due to the increased use of DPIs, for which growth is larger than the decline in use of total MDIs. DPIs now account for around one-third of all inhaled medication, based on the assumption that all MDI SUs should be divided by 2 to get the equivalent number of doses from a DPI. Worldwide use of CFC MDIs has been declining

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[1] The International Pharmaceutical Aerosol Consortium is a group of companies (Abbott, Astrazeneca, Boehringer Ingelheim, Chiesi Farmaceutici, Glaxosmithkline, Teva. and Sepracor.) that manufacture medicines for the treatment of respiratory illnesses, such as asthma and COPD.

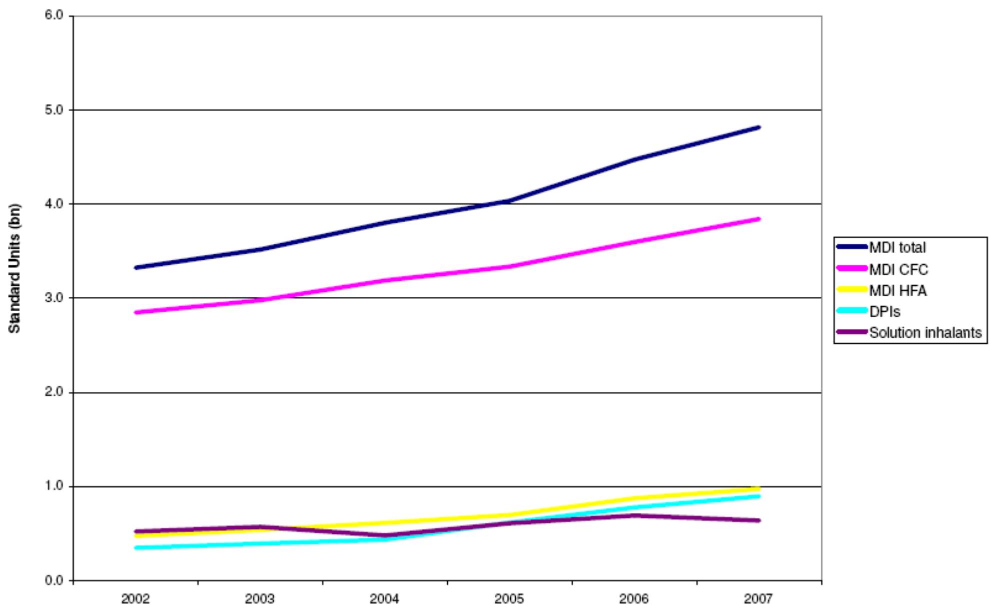
[2] IMS Health is a company that gathers and analyses pharmaceutical market data. IMS Health granted IPAC permission to submit this data to MTOC/TEAP.

[3] IMS definition of SUs: “These are the number of dose units, such as the number of inhalations/puffs, tablets, the number of 5ml doses, or the number of vials, sold for a particular product”.

to a point where it is less than either DPI or hydrofluorocarbon (HFC) MDI usage, on the basis of equivalent number of doses.

This global picture can be contrasted with the data shown in Figure 5-2, specific to Asia and Africa, which are made up mostly of Article 5 Parties. It is encouraging to note that, at around 6 per cent annual growth, the use of inhaled therapy is increasing much faster in Asia and Africa than the global average. However, up to 2007, this increase has been predominantly driven by the increased use of CFC MDIs. Data from nominations and MLF project proposals indicate that around two-thirds of CFC MDI use is for salbutamol and much of the remainder is for beclomethasone.

Figure 5-2: Trends in inhaler usage in Africa and Asia 2002-2007



Data specific to the nominating Article 5 Parties are shown in Table 5-1. With the exception of China, there was an overall flattening of CFC consumption after 2007. In China, there are no locally manufactured alternatives to CFC MDIs. The substantial increase in consumption in China is attributed to improvements in the healthcare and health insurance system.

There are several projects funded by the MLF for the conversion of salbutamol CFC MDI to HFC MDI in Article 5 Parties that are due to be completed by the end of 2010. Given that salbutamol accounts for the majority of CFC usage, MTOC expects that CFC usage in Article 5 Parties will decline significantly in 2011 and beyond.

Table 5-1: Estimated CFC usage for nominating Article 5 Parties

	2006	2007	2008	2009	2010
Argentina	173.10	195.60	179.95	186.80	178.00
Bangladesh	76.30	71.88	102.83	119.91	156.69
Egypt	148.70	164.00	200.00	230.00	264.00
India	746.70	590.27	507.13	317.87	350.60
Iran	96.40	86.00	105.00	110.00	105.00
Pakistan	84.74	99.57	118.30	134.80	124.20
Syria	30.52	33.57	36.92	40.62	44.68
Sub-total excl. China	1,356.46	1,240.89	1,250.13	1,140.00	1,223.17
China	280.90	341.00	508.10	736.10	977.20
Total	1,637.36	1,581.89	1,758.23	1,876.10	2,200.37

MTOC has noted previously the wide availability in Article 5 Parties of technically suitable alternatives to CFC MDIs from multinational companies. However, as noted elsewhere, this has not prompted transition, largely due to affordability of the alternatives. Inhaler products sourced from manufacturers in Article 5 Parties are now substantially increasing the range of alternatives and may help reduce the price difference. For example, Cipla, an Indian pharmaceutical company, now markets 30 different CFC-free inhalers and is committed to largely phasing out domestic supply of CFC MDIs by the end of 2009. However, it is clear from the essential use nomination from India that there will be an ongoing and substantial export of CFC MDIs to Article 5 Parties in 2010. MTOC does not have the information to determine whether the continued export of CFC MDIs is driven by commercial considerations or whether it is the result of the pace of regulatory approval of the alternatives in importing countries.

There are a number of Article 5 Parties that significantly restrict the import of foreign pharmaceutical products, which, in this context, severely limit the availability of alternatives to CFC MDIs. Transition is therefore highly dependent on the progress of projects to convert domestic manufacture to HFC MDIs. The declining availability of bulk CFC propellant may place patient lives in jeopardy if conversion project progress is not closely monitored and managed.

5.4 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[4].

Decision XV/5(6) requests non-Article 5 Parties to submit to the Ozone Secretariat specific dates by which time they will cease making nominations for essential use nominations for CFCs for MDIs where the active ingredient is not solely salbutamol. In 2009 the United States submitted advice of the FDA's final rule regarding the removal of essential-use designation for epinephrine as of 31 December 2011. The FDA concluded that there were no

[4] http://ozone.unep.org/Exemption_Information/Essential_Use_Nominations/index.shtml

technical barriers to formulating epinephrine without the use of CFCs. In the United States, epinephrine CFC MDIs cannot be marketed after this date.

For Article 5 Parties, according to Executive Committee Decision 45/54, Low Volume Countries (LVCs) submitting Terminal Phase-Out Management Plans (TPMPs) can obtain up to US$30,000 to develop and implement a transition strategy. Some transition strategies have been approved under national ODS/CFC phase-out plans, others have been approved as part of MLF-funded MDI investment projects; and yet others as stand alone projects.

5.4.1 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 2009, no reports were received other than those contained within a few essential use nominations, such as the United States.

It is now critical that all Article 5 Parties develop their own national transition strategy and provide it to the Secretariat, to be posted on its website, and then to report each year on progress in transition, in accordance with Decisions XX/3 and XII/2. This provides the background information against which TEAP and MTOC can prepare technical assessments of future CFC essential use nominations. For example, Thailand is an importing country whose transition strategy states that it has phased out CFC MDIs. However it remains on the list of countries to which India in its 2010 CFC nomination states that it exports CFC MDIs. As there was no information in the Indian nomination on the volume of export to Thailand, MTOC were unable to adjust the recommended volumes for this apparent inconsistency.

5.5 Global database in response to Decision XIV/5

Under Decision XIV/5, all Parties are requested to submit information on CFC and CFC-free alternatives to the Secretariat by 28 February each year. In 2009, a report was received from Canada[5]. MTOC also requested and/or received this type of information within some essential use nominations. Twenty-two Article 5 Parties have submitted data pursuant to Decision XIV/5 since its inception, but in many cases the data have not been updated annually. These Parties are Argentina, Belize, Bosnia and Herzegovina, Brazil, China, Costa Rica, Croatia, Cuba, Eritrea, Georgia, Guyana, India, Indonesia, Jamaica, Malaysia, Mauritius, Namibia, Oman, Singapore, South Africa, Sri Lanka, and Uruguay.

It is important that Article 5 Parties collect their own data on CFC and CFC-free inhaler use annually and provide it to the Secretariat by 28 February each year, to be posted on its website, in accordance with Decision XIV/5. Decision XII/2(3) also requests Parties, including Article 5 Parties, to notify the Ozone Secretariat of any MDI products determined to be non-essential, and for nominating Parties to take this information into consideration. The Ozone Secretariat website only has information for the European Community. Collection of such data would aid in the development of effective transition plans within each country and in the determination of any essential use nominations for Article 5 Parties beyond 2010.

Given the complexity and fluidity of export markets, Parties may wish to consider the advantages of all importing Parties, including Article 5 Parties, making annual declarations

[5] http://ozone.unep.org/Exemption_Information/Essential_Use_Nominations/index.shtml

stating the reasons why the imported CFC MDI products are considered necessary and requiring that these declarations accompany nominations from Parties manufacturing and exporting CFC MDIs

6 Response to Decision XX/3(4): Suggestions for Appropriate Changes to the Handbook on Essential Use Nominations

In Decision XX/3 paragraphs 1-3, Parties took decisions to make the essential use exemption process and related previous Decisions fully applicable to both non-Article 5 and Article 5 Parties.

Decision XX/3 paragraph 4 requested the Technology and Economic Assessment Panel to reflect paragraphs 1-3 of Decision XX/3 "*in a revised version of the handbook on essential-use nominations and to submit, for consideration by Parties, suggestions for any appropriate changes to the handbook and the timing to make such changes.*"

A revised Handbook on Essential Use Nominations (the Handbook) will be completed and sent to Parties at least two months prior to the MOP-21 reflecting only the changes brought about by paragraphs 1-3 of Decision XX/3.

In this report, the Medical Technical Options Committee (MTOC) presents other appropriate changes to the Handbook for consideration by Parties at the OEWG-29, as requested in Decision XX/3(4). In light of experience obtained during the first year of assessments of essential use nominations from Article 5 Parties, changes to the Handbook are suggested to clarify the information requirements arising from existing Decisions, including new Decision XX/3. Additional changes are suggested that would be necessary for MTOC to assess the nominations properly. A few changes are also suggested to allow flexibility for any possible future campaign production, if needed. Any Decisions by Parties in relation to these suggestions at MOP-21 could be reflected in a subsequent revision to the Handbook in 2010, but, regarding the timing, are recommended to take effect immediately for Parties submitting their nominations in 2011.

MTOC has used the existing information requirements for essential use nominations included in the Handbook (Section 2.5, page 6) to indicate where changes to the Handbook could be made. Changes resulting from Decision XX/3, and suggestions for additional changes, are shown in strikeout and underlined text. Explanations relating to the suggested additional changes are shown in italicised parentheses.

> The following information is requested for each nomination (see nomination forms in Appendix C and, for MDIs only, Appendix D).

1. Provide a detailed description of the use that is the subject of the nomination. (Decision IV/25, pars. 2 and 3)

2. Provide details of the type, quantity and quality of the controlled substances that is requested to satisfy the use. (Decision IV/25, pars. 2 and 3). Specify whether the quantity is requested for production or for use from existing stockpile. *(This information would be needed for a final campaign production, if necessary.)*

3. Indicate the period of time and the annual quantities of the controlled substances that are requested. (Decision IV/25, pars. 2 and 3). For CFC MDIs, indicate the expected annual future requirements until CFC MDI transition is completed and historic 3-year consumption data to satisfy the use. *(This information would be required to estimate needs for a final campaign production, if necessary).*

4. For CFC MDIs, specify the intended market(s) for sale or distribution for the use, the active ingredient(s) for the use in each market and the quantity of CFCs required for each active ingredient in each market. If necessary, provide the best estimate for

quantities for intended markets, using available data from requesting companies. When more specific data are not available, data aggregated by region and product group may be submitted for CFC MDIs intended for sale in Parties operating under paragraph 1 of Article 5. (Decisions XV/5, par. 2, ~~and~~ XVI/12, par. 2, <u>and XX/3 par.1(a)</u>).

5. For CFC MDIs, state whether each intended market for sale or distribution is subject to a transition strategy adopted and submitted to the Secretariat and posted by the Secretariat on its website pursuant to Decision XII/2 or Decision IX/19. (Decision XV/5, par. 3 <u>and XX/3 par. 1(a)</u>).

6. Explain why the nominated volumes and the intended use of these quantities are necessary for health and/or safety, or why it is critical for the functioning of society. (Decision IV/25, pars. 1(a)(i), 2 and 3)

7. Explain what other alternatives and substitutes have been employed to reduce the dependency on the controlled substance for this ~~application~~ <u>use in the intended markets subject to the nomination</u>. (Decision IV/25, pars. 1(a)(ii), 1(b)(i), 2 and 3(d)). *(This change clarifies the information requirements to help ensure adequate information about alternatives, including in export markets, is provided.)*

8. Explain what alternatives ~~were investigated~~ <u>are available in the intended markets</u> and why they ~~were~~ <u>are</u> not considered adequate. <u>Describe the availability and affordability of alternatives in the intended markets subject to the nomination, including examples of comparative data on CFC MDI versus CFC-free product prices. Where a manufacturer's CFC MDI is available in a market at the same time as its equivalent HFC MDI, please explain why the HFC MDI is not a suitable alternative. Describe any barriers to the introduction or uptake of alternatives, including information on regulatory approval processes, and on pricing policies applicable to imported products.</u> (Decision IV/25, pars. 1(a)(ii), 1(b)(i), 2 and 3(d)). *(This change clarifies the information requirements to help ensure adequate information about alternatives, including in export markets, is provided.)* <u>Confirm that the global database of CFC MDIs and their alternatives under Decision XIV/5 has been consulted and taken into account in the nomination.</u> *(This additional change may help nominating Parties assess whether exported products are essential uses in importing countries.)* <u>For each intended import market subject to the nomination, attach a declaration by the importing country stating the reasons why the imported CFC MDI products are considered necessary.</u> <u>*(This additional change would provide an adequate level of assurance that the products being exported are essential to the importing country, and ensure the importing country is actively managing its CFC MDI import.)*</u>

9. For CFC MDIs, confirm that each company requesting essential use allocations has fully complied with Decision VIII/10.1 to respond to the request to demonstrate ongoing research and development of alternatives to CFC MDIs with all due diligence and/or collaborate with other companies in such efforts. (Decision VIII/10, par. 1<u> and Decision XX/3, par. 1(a)(i) and (ii)</u>). <u>Describe the status of the development of alternatives to CFC MDIs, plans for their approval and expected launch dates.</u> *(This change clarifies the information requirements to help ensure adequate information is provided to demonstrate ongoing research and development.)*

10. If the use is for a CFC MDI product approved <u>in non-Article 5 Parties</u> after 31 December 2000<u>, or approved in Article 5 Parties after 31 December 2008, excluding any product in the process of registration and approved by 31 December 2009 for the treatment of asthma and/or chronic obstructive pulmonary disease</u>, provide

documentation to demonstrate that this product is necessary for health or safety and that there are no technically and economically feasible alternatives available. (Decision XII/2, par. 2 and Decision XX/3, par. 1(f)).

11. Describe the measures that are proposed to eliminate all unnecessary emissions. At a minimum, this explanation should include design considerations and maintenance procedures. (Decision IV/25, pars. 1(b)(i), 2 and 3(b); Decision VI/9, par. 4; ~~and~~ Decision VIII/10, pars. 6 and 7; and Decision XX/3, par. 1(a)(i) and (ii)).

12. Explain what efforts are being undertaken to employ other measures for this application in the future, including, in the case of MDIs, efforts to foster approval of alternatives in the domestic and export markets. (Decision IV/25, pars. 1(a)(ii), 3(d) and 4; Decision VIII/10, par. 1; Decision VIII/11; ~~and~~ Decision XII/2, par. 4; and Decision XX/3 par. 1(a)(i) and (ii)).

13. Explain whether the nomination is being made because national or international regulations require use of the controlled substance to achieve compliance. Provide full documentation including the name, address, phone and fax number of the regulatory authority requiring use of the controlled substance and provide a full copy or summary of the regulation. Explain what efforts are being made to change such regulations or to achieve acceptance on the basis of alternative measures that would satisfy the intent of the requirement.

14. For CFC MDIs, confirm that the Secretariat's list of CFC MDI active ingredients and/or category of products determined to be non-essential by a Party has been consulted and that none of the volumes requested shall be used for items posted on that list. (Decision XII/2, par. 3).

15. For CFC MDIs, beginning with the nomination following the submission of a national or regional MDI transition strategy to the Secretariat, briefly summarise the nominating Party's national transition strategy, including phase-out dates and CFC MDI manufacturing plant conversion timelines, and describe progress made on the transition to CFC-free alternatives under that strategy. (Decision IX/19, pars. 5 and 5 *bis*, and Decision XII/2, pars. 5(c) and 6). *(This change clarifies the information requirements.)*

15.*bis* For CFC MDIs, describe the Party's plan of action regarding the phase-out of the domestic use of CFC MDIs where the sole active ingredient is salbutamol, and describe progress towards implementing that plan. (Decision XV/5 pars. 4, 4 *bis* and 5, and Decision XX/3 par. 1(a)(iii)).

16. For CFC MDIs, describe progress made towards determining and submitting a specific date by which time the Party will cease making nominations for essential use exemptions for CFCs for metered-dose inhalers where the active ingredient(s) is not solely salbutamol and the metered-dose inhalers are expected to be sold or distributed on the market of any Party not operating under paragraph 1 of Article 5. (Decision XV/5, par. 6)

16.*bis* For CFC MDIs, for Parties operating under paragraph 1, describe progress made towards submitting a specific date by which time a regulation or regulations to determine the non-essentiality of the vast majority of CFCs for MDIs where the active ingredient is not solely salbutamol will have been proposed. (Decision XVII/5 par. 3 *bis*).

17. Describe the efforts that have been made to acquire stockpiled or recycled controlled substance for this application both domestically and internationally. Explain what efforts have been made to establish banks for the controlled substance. (Decision IV/25, par. 1(b)(ii)).

18. For CFC MDIs, indicate the existing stock of pharmaceutical-grade CFCs (pre- and post-~~1996~~-phase-out) held by the Party requesting an essential use exemption, describing the quantity (metric tonnes), the quality and the availability for the year prior to the nomination. Describe how this stockpile will be utilised in coming years. (Decision IV/25, par. 1(b)(ii) and Decision XVI/12, par. 3)

19. For CFC MDIs, confirm that the nominating Party has given due consideration to the following. That:

   (a) Each company's existing stock of pharmaceutical-grade CFCs (including CFCs the company possesses or has title to, pre- and post- ~~1996~~ phase-out) aims not to exceed one year's operational supply (the amount used by the company to produce CFC MDIs in the preceding year);

   (b) The Party's aggregate stocks of pharmaceutical-grade CFCs (pre- and post-~~1996~~ phase-out) aims not to exceed one year's operational supply for that Party;

   (c) The Party's nomination has been reduced, if necessary, with the objective of the Party's aggregate stocks of available pre- and post-~~1996~~ phase-out pharmaceutical-grade CFCs not exceeding one year's operational supply; and

   (d) All available pre-~~1996~~ phase-out stockpiles have been or will be depleted by companies before drawing on essential use quantities and thereby assure that pre-~~1996~~ phase-out stockpiles are taken into account in making essential use requests.

(Decision IV/25, par. 1(b)(ii), ~~and~~ Decision XVI/12, par. 3, Decision XVII/5 par. 2, Decision XIX/13 par. 2 and Decision XX/3 par 1(c)).

20. Briefly state any other barriers encountered in attempts to eliminate the use of the controlled substance for this application.

7 Chemicals Technical Options Committee (CTOC) Progress Report

7.1 Executive Summary

The CTOC met on March 11-13, 2009 in Sydney, Australia. The agenda of the meeting covered issues requested by the Parties, including process agents, laboratory and analytical uses, and the essential use nomination of CFC-113 in 2010 for the Russian space and rocket industries. All the output on these issues is included in this report.

Process Agents

The new Table A in Decision XIX/15 approved 42 uses of controlled substances as process agents. In the 2008 CTOC Progress Report, a revision of the Table A and the Table B of Decision X/14 was reported according to Decisions XVII/6 (7) and XVII/6 (8), respectively. However, at the MOP-20 in Doha, the Parties decided to defer these issues to their next meeting in 2009.

The recommendation by the CTOC is to add three new applications of the ten candidates requested by China in Table A of Decision XIX/15, and to delete the process agent use of CTC in production of Dicofol (No.6 in Table A of Decision XIX/15), according to a report that India no longer uses CTC in the production of Dicofol.

The CTOC assessed the following three applications to be added in Table A as process agent uses.

(i) CTC as a dispersant or diluting agent in the production of polyvinylidene fluoride (PVdF)

(ii) CTC as a solvent for esterification in the production of tetrafluorobenzoylethyl acetate

(iii) CTC as a solvent for bromination and purification in the production of 4-boromophenol

Regarding Table B of Decision X/14, the CTOC cannot make a recommendation on reductions to the make-up and maximum emissions in Table B because not all the necessary data are available, except for Japan. The CTOC was informed that there are no more process agent uses in Japan and therefore recommends reducing both 300 metric tonnes of the make-up or consumption and 5 metric tonnes of maximum emissions in Japan to zero in Table B.

Laboratory and Analytical Uses

Decision XIX/18 requested the TEAP and its Chemicals Technical Options Committee provide, by the Twenty-first Meeting of the Parties, a list of laboratory and analytical uses of ozone-depleting substances, indicating those for which alternatives exist and which are therefore no longer necessary, and describing those alternatives.

The updated findings by the CTOC are listed in Table 7-3 in the laboratory and analytical uses section below. The table shows how ODS, mainly CTC, are used in standard methods of analysis and where available lists non-ODS alternatives that can be (in many cases have been) used in these methods. The preferred alternatives to ODS include hydrocarbon, aromatics, chlorinated chemicals, ketones and alcohols.

Furthermore, the CTOC developed some case studies to explore how the restrictions on the use of CTC for laboratory and analytical purposes were implemented in some countries/regions, including Australia, European Community, Japan, USA and some countries in Africa.

Essential Use Exemptions of CFC-113 in the Russian Federation

At the MOP-20 in Doha, the TEAP/CTOC confirmed the essentiality of the request for 140 metric tonnes of CFC-113 in 2008 and for 130 metric tonnes in 2009 for use in the Russian rocket and space industry. The recommendation was based upon an appraisal of the progress to phase-out CFC-113 and of the work still needed to commercialise appropriate alternatives in Russia during the expert meeting held in Moscow on October 6-10, 2008. The full report of the expert meeting is attached in the Appendix of this report.

On December 25, 2008, The Ministry of National Resources and Environment of the Russian Federation sent the Ozone Secretariat a request for Essential Use Exemption (EUE) of 120 metric tonnes of CFC-113 in the rocket and space technology production in the Russian Federation in 2010.

The TEAP/CTOC assessed this nomination and found it justifiable since the Russian Federation was making efforts to find economically and technologically feasible alternatives under an authorised time schedule (see Exhibit-C of the Appendix). Thus, the TEAP/CTOC recommends an EUE of 120 metric tonnes of CFC-113 in 2010 for the Russian Federation. The TEAP/CTOC also recommends that the Russian Federation continues to work with the CTOC experts to share successful experiences from other countries.

Other Issues

The CTOC has been mandated to report updates on laboratory and analytical uses of methyl bromide, on CTC emissions and on n-propyl bromide in 2009 according to the Decisions XVII/10 (8), XVIII/10 (1) and XVIII/11 (2), respectively. However, no new information on those issues was obtained in the course of CTOC activities during 2008 or the first part of 2009, so efforts will be made to include any new information in the 2010 CTOC Assessment Report.

7.2 Introduction

The CTOC met on March 11-13, 2009 in Sydney, Australia, where the meeting was hosted by the co-chair, Professor Ian D Rae. The extraordinary courtesy of the Government of New South Wales was highly appreciated for providing CTOC with a conference facility in the building of Department of Environment and Climate Change. Eleven out of twenty CTOC members participated in the meeting. Attending members were six from Article 5 Parties (Chile, China, India, Kuwait, Mauritius and Tanzania) and five from non-Article 5 Parties (Australia, Japan, Russia and USA).

The agenda of the meeting covered issues requested by the Parties, including process agents, laboratory and analytical uses, and essential use nomination of CFC-113 in 2010 by the Russian Federation. In addition, the CTOC discussed the importance of Decisions XX/7 and XX/8 in terms of management including recovery and destruction of ODSs, and the availability of alternatives to HCFCs and HFCs. They also discussed the possible inclusion of new gases in the Kyoto Protocol proposed in the website of UNFCCC.

7.3 Process Agents

Decision XVII/6(6) asked the TEAP and the ExCom to report to the OEWG on progress made in reducing emissions of controlled substances from process-agent uses; the associated make-up quantity of controlled substances; on the implementation of and development of emissions-reduction techniques and alternatives and products. The CTOC was unable to work with the Executive Committee because Parties provided insufficient information on emissions and make-up quantities. If such information is not forthcoming, CTOC will nonetheless attempt (for a future report) to provide information about emission reduction techniques and alternatives. Some information about alternatives was provided by the Process Agents Task Force in 2001.

The CTOC reported in the May 2008 TEAP Progress Report Volume 1 (pp. 49-52), a revision of Table A of Decision X/14, which is revised in the Annex to Decision XIX/15 and Table B of Decision X/14 according to Decisions XVII/6 (7) and XVII/6 (8), respectively.

However, at MOP-20 in Doha, the Parties commented that the list of process agents had been updated in 2007 and was normally only updated every two years. Thus the Parties agreed to defer further consideration and to take it up at their next meeting in 2009.

Therefore the CTOC is reporting again the revision of Table A and Table B for consideration at the MOP-21 in 2009.

The new Table A in Decision XIX/15 approved 42 uses of controlled substances as process agents.

At the time of the 2008 CTOC meeting, the Ozone Secretariat in Nairobi and the TEAP/CTOC had received new information from Israel and Netherlands, and after the meeting also from China. All of the above information had been reviewed by the CTOC, as shown in section 7.1. Regarding the emissions listed in Table B, the Ozone Secretariat received information only from Brazil, EC, and USA in 2008. The data from Brazil is 'in confidence' due to the fact that only one plant was reporting in each case. The review by the CTOC is described in section 7.2.

7.3.1 Reviews of information from Israel, Netherlands and China

The CTOC reviewed the information from Israel. There are two identical installations, which use carbon tetrachloride (CTC) for elimination of NCl3 in the production of chlorine with the capacities of 7.2 metric tonnes of CTC. The CTC quantities used were 3.5 metric tonnes but there were no direct emissions to the atmosphere with some losses of CTC due to an entrainment by chlorine gas. This application is already included as No.1 in the list of Table A in Decision XIX/15.

The Netherlands reported the process agent use of CTC in the manufacturing process of poly-phenylene-terephthal-amide during 2006. The usage of CTC was 6.9 metric tonnes and its emission was reported as 2.86 metric tonnes with destruction of 4.0 metric tonnes of CTC. The Party expects to reduce the emissions of CTC below 1.0 metric tonne over 2007 and the subsequent years. This application is already included as No.8 in the list of Table A in Decision XIX/15.

Further, India had indicated the process agent use in production of Dicofol (No.6 in Table A of Decision XIX/15) would cease by 31 December 2007. In response to a request for confirmation by the CTOC, India reported that the process agent use (CTC) in production of Dicofol has ceased in India. Therefore the application No.6 could be deleted from Table A of Decision XIX/15. Also, information was obtained from UNIDO that the process agent use for production of Sultamicillin (No.31 in Table A of Decision XIX/15) in Turkey has ceased but the process is still operated in South Africa, so this process agent use needs to remain in Table A.

The CTOC investigated a potential list of process agent applications from China in 2007 (see pp27-42 in the April 2007 TEAP Progress Report). The CTOC commented that more information was needed to assess the listed applications, No. 8, 10, 12, 13, 15, 16, 17, 19, 20 and 22 in the Table 4-3 on pages 36-37 in the April 2007 TEAP Progress Report. China submitted information on those 10 applications to the Ozone Secretariat on March 4, 2008. The CTOC examined this information and its findings are summarised in Table 7-1.

Table 7-1: Findin gs by CTOC for the additional information submitted by China

Nos. in Table 4-3	**Applications**	**Information from China**	**CTOC Findings**
No.8	Chlorofluazuron	No production	*Not a Process Agent*
No.10	Dope (water proofing formulation)	No information available	*Not a Process Agent*
No.12	Ethyl-4-chloroacetoacetate (one of the two facilities)	No production	*Not a Process Agent*
No.13	GCLE	No production	*Not a Process Agent*
No.15	Ozagrel	No production	*Not a Process Agent*
No.16	PVdF	CTC as a dispersant or diluting agent	*Meets Process Agent Technical Criteria*
No.17	Tetrafluorobenzoylethyl acetate	CTC as a solvent for esterification	*Meets Process Agent Technical Criteria*
No.19	Using as G.I	No information available	*Not a Process Agent*
No.20	Beta-Bromopropionic acid	No production	*Not a Process Agent*
No.22	4-Bromophenol	CTC as a solvent for bromination and purification	*Meets Process Aagent Technical Criteria*

The CTOC assessed the following three applications, No.16 (PVdF), No.17 (Tetrafluorobenzoylethyl acetate) and No.22 (4-Bromophenol) as process agent uses and these could be added in Table A of Decision XIX/15.

7.3.2 Attempted review of Table B of Decision X/14

Table 7-2 shows an updated Table B of Decision X/14 by adding reported data in 2006. Not all the data have been available, but the reported data by the EC and USA are in agreement with Table B of Decision X/14. For the EC it should be taken into account that not all data of the new member states are included in the reported data. Due to the fact that not all the data are available, the CTOC cannot make any recommendation on reductions to the make-up and maximum emissions regarding to Table B of Decision X/14.

Since the CTOC 2008 Progress Report was completed, new information on Table B was obtained only from Japan. No more process agent uses existed in Japan. Therefore 300 metric tonnes of the make-up or consumption and 5 metric tonnes of maximum emissions in Japan were reduced to zero and the total number was corrected accordingly.

Table 7-2: Updated Table B of Decision X/14
(expressed in metric tonnes per year)

Countries/Regions	*Maximum make-up or consumption*	*Reported make-up or consumption (2006)*	*Maximum emissions*	*Reported emissions (2006)*
European Community	1083***	594*	17.5***	5*
United States of America	2300	No data?	181	47**
Canada	13	No data	0	No data
Japan	0	No data	0	No data
Russian Federation	800	No data	17	No data
Australia	0	No data	0	No data
New Zealand	0	No data	0	No data
Norway	0	No data	0	No data
Iceland	0	No data	0	No data
Switzerland	5	No data	0.4	No data
TOTAL	4201	594	216	52

*Updated Table B in metric tonnes; *European Commission DG Environment and CTOC data ** EPA data ***The total number is corrected by adding those from Hungary and Poland which have been included in EC as new members.*

The CTOC could provide a more complete overview of ODS emissions arising from process agent uses, should all Parties submit required information to the Ozone Secretariat.

7.4 Laboratory and analytical uses

Decision XVII/10 (8) requested the Technology and Economic Assessment Panel (TEAP) to report in 2007 and every other year on the development and availability of laboratory and analytical procedures that can be performed without using the controlled substances in Annex E of the Protocol. The CTOC was unable to obtain new information on the alternative uses of Methyl Bromide in laboratory and analytical uses.

Decision XIX/18 requested the TEAP and its Chemicals Technical Options Committee to provide, by the Twenty-first Meeting of the Parties, a list of laboratory and analytical uses of ozone-depleting substances, indicating those for which alternatives exist and which are therefore no longer necessary and describing those alternatives.

7.4.1 Information table

An interim report was produced in 2008 and included in the CTOC section of the May 2008 TEAP Progress Report (pp. 54-62). The interim report was not discussed at MOP-19 in Doha but will not be reproduced in full here. Instead, the updated findings have been included in the following table.

The table shows how ODS, mainly CTC, are used in standard methods of analysis and, where possible, lists non-ODS alternatives that can be (and in many cases have been) used in these methods. Also listed in the table are some alternative methodologies for performing the analysis.

Table 7-3: Updated findings of feasible alternatives to ODS in analytical procedures

ODS	Methodology		Feasible Substitutes	
ODS Type	General use	Methodology	Substance / Methodology	Methodology
CCl4	Standard method	Analysis of Cyanocobalamin, United States Pharmacopea (USP) Method.	Coulometric electrochemical and ultraviolet detection	Determination of cyanocobalamin, betamethasone, and diclofenac sodium in pharmaceutical formulations, by high performance liquid chromatography. L. González, G. Yuln and M. G. Volonté High-performance liquid chromatography method for the simultaneous determination of thiamine hydrochloride, pyridoxine hydrochloride and cyanocobalamin in pharmaceutical formulations using coulometric electrochemical and ultraviolet detection. Marcin Leszek Marszałł, Anna Lebiedzińska, Wojciech Czarnowski and Piotr Szefer.
CCl4	Standard Method	Analysis of cascarosides	- Dichloro methane, - Chloroform Ttrichloroethylen e	
CCl4	Standard Method	Analysis of simethicone by Infrared spectroscopy / Cleaning of IR cells (Valuation of Simethicone in finished products, using infrared spectroscopy (IR). Method "Simethicone Capsules" of Official Monographs USP XXIV (p. 1519).)	Chloroform Toluene	ICP-AES Determination of Trace Simethicone Levels in Biopharmaceutical Products. J. Qiu, V. Wong, H. Lee, C. Zhou J Pharm Biomed Anal. 2002 Sep 5;30 (2):273-8 12191712. A RP-LC method with evaporative light scattering detection for the assay of simethicone in pharmaceutical formulations. Douglas E Moore, Tina X Liu, William G Miao, Alison Edwards, Russell Elliss. Faculty of Pharmacy, The University of Sydney, Sydney 2006, Australia.
CCl4	Standard Method	Analysis of Trimethoprim. United States Pharmacopea (USP) Method (Also at: S.Z. Qureshi; M.I.H Helaleh; N. Rahman; R.M.A.Q. Jamhour; "Spectrometric determination of trimethoprim by oxidation in drugs formulations; Fresenius J Anal Chem (1997) 357: 1005-1007; Springer-Verlag 1997)	- Acetonitrile and methanol	L. K. Sørensen&, T. H. Elbæk; "Simultaneous Determination of Trimethoprim, Sulfadiazine, Florfenicol and Oxolinic Acid in Surface Water by Liquid Chromatography Tandem Mass Spectrometry"; Chromatographia **2004**, 60, September (No. 5/6); p. 287.
CCl4	General Method	Analysis of conjugated estrogens by gas chromatography		No alternatives found.
CCl4	Standard Method	Analysis of Furazolidone, United States Pharmacopea (USP) Method	- UV detection	S. M. Hassan / F. A. Ibrahim* / M. S. El-Din / M. M. Hefnawy; "A Stability-Indicating High-Performance Liquid Chromatographic Assay for the Determination of Some Pharmaceutically Important Nitrocompounds"; Chromatographia

ODS	Methodology		Feasible Substitutes	
				Vol. 30, No. 3/4, August 1990; p. 176.
CCl4	General method	Analysis of copper gluconate	Dichloromethane, - Chloroform -Trichloro-ethylene	
CCl4	Standard Method	Gravimetric determination of sulfur, Collaborative International Pesticides Analytical Council CIPAC Method [1]	- Gravimetric method	Gravimetric method using nitric acid. Reflux with ethanol and titration with iodine, according to CIPAC (Collaborative International Pesticides Analytical Council Limited)
CCl4	Standard Method	Determination of specific weight in cement samples (National standard NCh 154 Of. 69 / ASTM C 243-95, Standard test)	- Kerosene Benzene	ASTM C 188-44 (Revised in 1967)
CCl4	Standard Method	ASTM D 2821-96[2], Standard Test Method for Measuring the Relative Stiffness of Leather by Means of a Torsional Wire Apparatus	Trichloroethylene	
CCl4	Standard Method	ASTM D 3921-85 (re-approved in 1990), Standard test method for oil and grease and petroleum hydrocarbons in water	- Perchloroethylene	ASTM D7066-04
CCl4	Standard Method	Determination of hydrocarbons in water ASTM D3921-96 / D3921-97	- Perchloroethylene S-316 (dimer/trimer of chlorotrifluoro ethylene)	
CCl4	Standard Method	Determination of the jellification point. Method M SAC 10 14 11 (Own method)		No alternatives found
CCl4	Standard Method	Iodine index by volumetry in oil and greases AOCS CD 1-25 "Iodine Value (Wijs)"	- Hexane Cyclohexane and acetic acid Chloroform Iso-octane	Method CD1D-92
CCl4	Standard method	Iodine[3] index by ASTM D1959-97 Standard Test Method for Iodine Value of Drying Oils and Fatty Acids (Withdrawn 2006) ASTM D5554- 95 (2006) Standard Test Method for Determination of the Iodine Value of Fats and Oils.	Cyclohexane and acetic acid and diluted with iodine monobromide solution.	[4] Hanus ISO 3961:1996

[1] Note: The sulphur is converted by refluxing with sodium sulphite to sodium thiosulphate. The thiosulphate is then titrated with Standard iodine solution. CIPAC Handbook E.

[2] Updated by ASTM D2821-00(2005)e1.

[3] The Iodine value expresses the content of compounds with unsaturated carbon-carbon double bonds. It is determined by adding a halogen, e.g. iodine to the simple.

ODS	Methodology		Feasible Substitutes	
CCl4	General Method	Liquid-liquid partitioning method, for iodide and bromide analysis	- Dichloromethane. Chloroform	
CCl4	Standard Method	Extraction of iodine and its derivatives and thyroid extracts from semi-solid pharmaceutical preparation. United States Pharmacopea (USP) method	- Petroleum ether Hexane Chloroform Dichloromethane Benzene Hexane + ethyl acetate	
TCA	Standard Method	Bromine index ASTM D2710-99 Determination of bromine number ASTM ASTM D1159-07[5]	- Dichloromethane Diethylcarbonate 1-methyl-2-pirrolidone Dichloro-methane	ASTM D 2710[6] ASTM D 1159-07
CCl4	General Method	Determination of copper	- Chloroform Dichloromethane Perchloroethylene Trichloroethylene	Flame Atomic Absorption Spectrometric Methods Research and Development (2) Page 25.
CCl4	General Method	Arsenic extraction	- Chloroform	Atomic Absorption Spectrometry AAE with hydride generation
CCl4	General Method	Analysis of chloride in saline solutions	- Aliphatic hydrocarbon Chloroform Dichloromethane Perchloroethyle	

[4] In the determination of the iodine value according to Hanus the sample is dissolved in cyclohexane and acetic acid and diluted with iodine monobromide solution. Potassium iodide and water are added, and the formed iodine is titrated back with sodium thiosulphate solution. The methods according to Wijs and Kauffmann slightly differ from the Hanus method. Information on the accuracy of the methods is given in the test methods. Only in the case of some oils with a high iodine value can the results deviate from one another. Cyclohexane and acetic acid have generally substituted chloroform (trichloromethane, not an ozone depleting substance) and carbon tetrachloride. Also ISO 3961:1996, which is similar to the Wijs method, uses cyclohexane and acetic acid. The modified Hofmann and Green method allows a shorter reaction time, and is recommended for samples containing hydroxy fatty acids because the substitute reactions occurring in this case using the Wijs method do not take place. (Ref. TemaNord 2003:516)

[5] ASTM D 1159 is generally applicable for gasoline, kerosene and distillates in the gas oil range that fall in specific distillation and bromine number limits. However, the method is not satisfactory for normal alpha-olefins. The method can be used to estimate the percentage of olefins in petroleum distillates boiling up to approximately 315ºC by using a calculation method described in the standard. Dichloromethane is temporarily being allowed as an alternative to 1,1,1-trichloroethane (an ozone depleting substance) until a permanent substitute can be identified and adopted by ASTM. A program to identify and evaluate candidate solvents is currently underway in the Subcommittee D02.04. (Ref. TemaNord 2003:516; "Use of ozone depleting substances in laboratories"; © Nordic Council of Ministers, Copenhagen 2003 ISBN 92-893-0884-2).

[6] This method also mentioned dichloromethane as an alternative to TCA.

ODS	Methodology		Feasible Substitutes	
			ne. In the first cleaning stage: benzene / ether.	
CCl4	Solvent	Washing of NMR (Nuclear Magnetic Resonance) tubes	- Acetone	Washing should be followed by oven-drying of inverted tubes to remove traces of acetone.
CCl4	Solvent	Grease solvent and cleaning of glass materials	- Acetone	A chlorinated solvent such as chloroform, trichloroethylene or dichloromethane may also be used.
CCl4	Solvent	Organic synthesis	- Dichlorometha ne Chloroform	
CCl4	Carrier (inert); analytical equipmet (Infrared)	Reaction of phenol and aromatics. Oxygen containing functional groups - Noncarbonyl Groups, Example: The determination of hydroxyl values of alcohols, page 34.	- Perchloroethyl ene	Welcher 6th Edition, p. 1180.[7]
CCl4	Carrier, analytical use.	Solvent in metals analysis by UV-Vis spectrometry, with ditizone (International method). / "Titration of cadmium: Photometric Method with Ditizone", page 44.	- Chloroform Dichloromethan e Benzene Toluene Cadmium sulfide can be extracted from solution with iodine	Furman Sixth Edtion pp. 254-256[8]
CCl4	Solvent	Solvent of polymers	- Tetrahydrofur ane. Chloroform. Dichloromethan e. Dichloro-ethane	
CCl4	Carrier (inert); analytical equipmet - Infrared analysis for spectral range 4000 to 50 cm-1	Spectrophotometry IR (USP XXIII) "Standard practice for general techniques for qualitative infrared analysis E 1252-94", page 26	- Toluene Carbon disulphide	[9]

[7] Research and Development (ICE Consulting, "Consumption of Ozone Depleting Substances (ODS) by Laboratories in the European Community and ODS-Free Methods to Reduce Further ODS Use - Confidential Report Prepared for the European Commission - April 2005".

[8] Research and Development (ICE Consulting, "Consumption of Ozone Depleting Substances (ODS) by Laboratories in the European Community and ODS-Free Methods to Reduce Further ODS Use - Confidential Report Prepared for the European Commission - April 2005".

[9] Research and Development (ICE Consulting, "Consumption of Ozone Depleting Substances (ODS) by Laboratories in the European Community and ODS-Free Methods to Reduce Further ODS Use - Confidential Report Prepared for the European Commission - April 2005".

ODS	Methodology		Feasible Substitutes	
CFC-113	Standard Method	US EPA Office of Water Method 418.1, extraction of total petroleum hydrocarbons from water samples, for analysis by infrared spectroscopy "Petroleum Hydrocarbons, Total Recoverable - Spectrometric, Infrared"	- S-316 (dimer/trimer of chlorotrifluoroethylene	ASTM D 7066-04 "Test Method for dimer/trimer of Chlorotrifluoroethylene S-316 recoverable oil and grease and non polar material by infrared determination".
CCl4	Carrier (inert), analytical equipment, GC	Adsorption Chromatography (Welcher 6th edition pp 216-219,[10] page 38.	- Petroleum ether Cyclohexane Carbon disulfide Diethyl ether Benzene Esters Chloroform Dichloroethane Alcohols Water Pyridine Organic acid Inorganic acids and bases.	Welcher Sixth Edition pp. 216-219.
CCl4	Vapor producer	Test of breakthrough times of gas mask cartridges and canisters in the National Approval Test of Respirators. Testing of breathing filters (personal safety equipment), 42 CFR part 84	- Cyclohexane	Mitsuya FURUSE1, Seiichiro KANNO, Tsuguo TAKANO and Yoshimi MATSU; "Cyclohexane as an Alternative Vapor of Carbon Tetrachloride for the Assessment of Gas Removing Capacities of Gas Masks"; National Institute of Industrial Health, Kawasaki, Japan; Industrial Health 2001, 39, 1–7.
CCl4	Solvent	*O*- and *N*- difluoromethylations	- Chlorodifluoromethyl phenyl sulfone	Ji Zhenga, Ya Lia, Laijun Zhanga, Jinbo Hu*.a, Gerrit Joost Meuzelaarb, and Hans-Jürgen; "Chlorodifluoromethyl phenyl sulfone: a novel non-ODS based difluorocarbene reagent for *O*- and *N*-difluoromethylations"; Supplementary Material (ESI) for Chemical Communications. This journal is © The Royal Society of Chemistry 2007.

7.4.2 Case studies

Some case studies were also developed to explore how the restrictions on the use of one ODS, carbon tetrachloride (CTC) for laboratory and analytical purposes were implemented in some jurisdictions.

Australia

A bottom-up investigation of the use of carbon tetrachloride (CTC) in research laboratories in Australia was undertaken.

[10] Research and Development (ICE Consulting, "Consumption of Ozone Depleting Substances (ODS) by Laboratories in the European Community and ODS-Free Methods to Reduce Further ODS Use - Confidential Report Prepared for the European Commission - April 2005".

Inquiry at a major research university revealed that, although there were small holdings of CTC in some laboratories, resulting from prior usage, no orders for CTC had been placed in recent years.

Purchasers of chemicals at the university were required to consult a listing of chemical substances for which purchases required special permission. CTC as well as other listed ozone depleting substances were on this list, as were chemicals of security concern (such as explosives and toxins and their precursors) and chemicals that might be involved in substance abuse or the production of illicit drugs.

The inquiry was pursued with the major suppliers in Australia of laboratory chemicals, who confirmed that no orders had been received for CTC in recent years from any Australian laboratory. In fact, none of the major laboratory suppliers in Australia have obtained import licenses to import ODS.

The Ozone and Synthetic Gas Section of the Department of the Environment, Water, Heritage and the Arts confirmed that importers of all controlled ozone depleting substances (including CTC) needed to possess appropriate licenses. The Australian National University was granted a license in 2008 to import laboratory grade ODS in 2008 and 2009, but none was imported in 2008. The National Halon Bank has also previously supplied recovered CTC (removed from fire extinguishers) to Sydney University for domestic use in cancer research.

A license will not be granted unless the applicant can satisfy the essential use criteria under the Montreal Protocol. An essential use license may be obtained subject to an application fee of Australian $3,000. Under the regulations, the Minister has the option to waive the fee.

European Community

Under European Community (EC) legislation imports of ODS are subject to licensing, including those for laboratory uses. Also the production of ODS for laboratory uses is subject to an authorisation, thus enabling the tracking of quantities imported and produced for laboratory use for each substance in the EC.

The actual quantity used may be less than the total imported because (a) not all of the ODS imported in a particular year may be used in that year, (b) part of the total is exported, and (c) the quantities eventually imported and produced may be lower than licensed.

The quantity of CTC licensed to be produced in and imported into the European Community for laboratory and analytical uses is about 50 ODP tonnes annually; there has been a decreasing trend at least since 2002. This CTC accounts for approximately 48% of the total laboratory use of ODS.

EC laboratories need to register with the European Commission, and receive an identification number, which they need to present to their supplier. Currently approximately 5,000 laboratories are registered as users of ODS. A detailed description of the procedure, including the conditions applicable for laboratory uses, is available online on the website (http://ec.europa.eu/environment/ozone/uses.htm) and in the licensing manual for laboratory users (http://ec.europa.eu/environment/ozone/pdf/manual_part_x.pdf). As can be seen from the manual, for the time being the registration does not include information about the actual use, the quantities or the ozone depleting substances involved. However, the corresponding legislation is currently under revision. As of March 2009 the revised legislation is being finalised and the new text proposes to make reporting of this information mandatory as of 1 January 2010.

Although the global exemption for laboratory and analytical uses has been extended to 31 December 2011 (Decision XIX/18), the ODS may be used only if no alternative is available.

Certain uses are excluded from the exemption. These include testing of oil, grease and petroleum hydrocarbons in water; testing of tar in road-paving materials; forensic finger-printing; testing of organic matter in coal; laboratory refrigeration equipment; cleaning etc. of electronic components and assemblies; preservation of publications and archives; and laboratory sterilisation of materials. The size and purity standards described in Annex II of the report of MOP-6 also apply.

Studies of laboratory use of ODS have been prepared in 2003 by ICF and by the Nordic Council (http://www.norden.org/pub/ebook/2003-516.pdf) and summarised in earlier TEAP/CTOC reports.

Japan

The Ozone Section of the Ministry of Economy, Trade and Industry (METI) has oversight of the production and uses of carbon tetrachloride (CTC) in Japan. The quantity of CTC for analytical and laboratory use has declined in the 2000s and remained stable at approximately 26,000 ODP kg (26 ODP tonnes) since 2006.

The major users of CTC are analytical laboratories in universities and industry, and organisations (both government and private) that undertake environmental analyses. The major applications, which are likely to be found in laboratories in most countries, are as follows:

- water and waste water quality testing by liquid chromatography and ion;
- chromatography;
- solvent for chemical reactions in organic synthesis;
- solvent for extracting specific substances from plant and animal;
- organisms and products;
- standard for comparison in CTC analysis.

Analytical chemists and researchers may obtain CTC from chemical suppliers, but they are required to fill in a form "Carbon tetrachloride use confirmation note" in which the user reports the chemical name of the chemical to be used, its quantity, user's affiliation and contact, and purpose of use whether it is for analytical or for others. New users are required to submit the form when they intend to use the chemical and for repeated users, they must submit the form once a year annually in April as a standard. Two suppliers, when contacted, responded that only small quantities were sold and that these were declining.

USA

With over 40,000 laboratories in the United States of America and numerous suppliers of chemicals for laboratory and analytical purposes, the review of individual applications would be costly and burdensome.

The US EPA is responsible for implementation of the Montreal Protocol and has incorporated into domestic regulations the criteria agreed by the Parties regarding the quantity (very small), quality (very pure) and labelling of exempt ODS for laboratory and analytical use, as found in Annex II to Decision VI/9.

In the mid-1990s when the Parties decided on the global laboratory exemption and criteria, EPA conducted educational outreach and training for the companies that supply laboratory chemicals. Since then EPA has maintained regular contact with these suppliers through very detailed and stringent regulatory reporting and record keeping requirements. The regulations make it a violation to use any quantity of exempt laboratory and analytical ODS for any purpose other than for permitted laboratory and analytical uses. Each laboratory supplier reports quarterly the amounts it purchases under the exemption and the amount it supplies. Suppliers are required to receive from each laboratory a certification that the material being purchased will only be used for the exempt laboratory purpose. Through the regulation, the EPA has disallowed the production and sale of ODS for the specific uses the Parties have "taken off the list".

Each kilogram of ODS, if produced, sold, or used improperly is a separate violation under the regulation with a penalty of up to US$32,500 per violation. The active compliance monitoring and enforcement of US regulations acts as a strong deterrent against illegal uses of ODSs under the ozone layer protection program, including the exemption for laboratory and analytical uses. Under the Protocol, the USA reports quantities of ODS under the global laboratory and analytical use exemption, the figure for 2008 being 2 metric tonnes of CTC (a notional average of 50 g for each of 40,000 laboratories).

An inquiry at a research-active university showed that purchase of small quantities of CTC for laboratory and analytical use was routine matter that did not require special paperwork but an industrial laboratory reported that justification needed to be provided before purchase.

Africa

For several years, CTC is no longer being used in university/analytical laboratories of some countries of the continent (e.g. Tanzania and Mauritius) because of its toxicity. Being an ODS, CTC along with other ODSs has also been included in the list of chemicals banned/prohibited in the national legislation of many of the Parties of the region. These chemicals can no longer be imported except for specific and justified purposes where a permit must be obtained from appropriate authorities before importation.

In many countries of the region the management of waste solvents is a problem. As far as possible solvents are recycled, however a significant volume of waste solvents including CTC and other chlorinated solvents (e.g. chloroform, dichloromethane) exist in these countries where there is no proper disposal facility. Presently these waste solvents are stored in large containers awaiting disposal.

7.4.3 Gulf Region and West Asia

The CTOC has begun work to obtain information about laboratory and analytical uses of ODS in these regions. The available data are incomplete and difficulty has been experienced in obtaining responses to inquiries. Therefore the CTOC recommends a workshop for the region for representatives of these countries, to help gather information and alert people to the desirability of replacing ODS with non-ozone depleting substances.

7.4.4 Chemical Education

An article that appeared in the widely read *Journal of Chemical Education* in July 2008 (vol. 85, pages 962-964) described the replacement of carbon tetrachloride – a 'well-known carcinogen' - as a solvent in an undergraduate experiment by light petroleum spirit. CTOC Co-chair, Prof. Ian D Rae, wrote to the journal to draw attention to another reason for replacement of carbon tetrachloride and that is its status as a controlled substance under the Montreal Protocol. This letter was intended to bring the Protocol to the attention of the academic community and their students. Prof. Ian Rae's letter was published in the June issue of the *Journal of Chemical Education* (2009, Vol. 86 (6), page 698).

Prof. Rae's letter is entitled as *Banned Solvents* and reads as follows:

"My attention was caught by a detail of some significance in a recent article in this *Journal* (1), and I would like to bring it to the attention of the readers. Alluding to the principles of green chemistry, the authors note that they have replaced the traditional solvent for the iodination reaction – carbon tetrachloride – with light petroleum, justified by the carcinogenicity of carbon tetrachloride.

There is another reason for the removal of carbon tetrachloride from laboratory use: it is a controlled substance under the Montreal Protocol – in the same way that chlorofluorocarbons and some other substances are banned – because their release in to the atmosphere leads to depletion of the stratospheric ozone layer. It is true that there is a general exemption for the use of carbon tetrachloride in laboratories, but this is very limited and the solvent has largely been eliminated from such uses in developed countries.

Most academic chemists are unaware of the restrictions on the use of carbon tetrachloride (which also apply to methyl bromide and to 1,1,1- trichloroethane). I believe it is important that the restrictions be brought to their attention and that academic chemists impart this knowledge to students working in their laboratories. It is a "green message" that takes into account inter-governmental conventions such as the Montreal Protocol (over 190 signatory countries) as well as important local and personal considerations such as health and safety."

Details of the Montreal Protocol controls on chemical use may be found on the Web (2).

(1) Amiet, R. G.; Urban, S. *J. Chem. Educ.* 2008, 85, 962-964.
(2) United Nations Environment Programme: Ozone Secretariat *http://ozone.unep.org*

7.5 Essential Use Nomination of CFC-113 in the Russian Federation

Decision XVIII/8 of MOP-18 approved an essential use exemption of 150 metric tonnes of CFC-113 in 2007 for applications in the aerospace industry in the Russian Federation. Further, Decision XIX/14 of MOP-19 authorised 140 metric tonnes for 2008 and 130 metric tonnes for 2009, provided the TEAP/CTOC experts ratified essentiality through a meeting and consultations with engineers and technicians of the Russian Federation.

At the MOP-20 in Doha, the TEAP/CTOC confirmed the essentiality of the request for 140 metric tonnes of CFC-113 in 2008 and for 130 metric tonnes in 2009 for use. The recommendation was based upon an appraisal of the progress to phase-out CFC-113 and of the work still needed to commercialise appropriate alternatives in Russia during the expert meeting held in Moscow on October 6-10, 2008. The full report of the expert meeting is attached in the Appendix.

Further, the Ministry of National Resources and Environment of the Russian Federation sent the Ozone Secretariat a new nomination by the Russian Federation for an Essential-Use Exemption of 120 metric tonnes of CFC-113 in the rocket and space technology production in the Russian Federation for 2010.

The TEAP/CTOC investigated this nomination and recommends an EUE for 120 metric tonnes of CFC-113 for 2010 for the Russian Federation.

CTOC comments on the Essential Use Nomination of CFC-113 for 2010 by the Russian Federation

The Ministry of National Resources and Environment of the Russian Federation sent the Ozone Secretariat the nomination by the Russian Federation for an Essential Use Exemption of 120 metric tonnes of CFC-113 in the rocket and space technology production in the Russian Federation for 2010.

As seen in Illustration 2 in the Appendix, between 2000 and 2008 the Russian Federation reduced the use of CFC-113 for this application from 300 to 140 metric tonnes. Most of the reduction was achieved through improved recovery and recycling of the spent solvent. Also some 10-15 metric tonnes of CFC-113 were successfully substituted to an aqueous system, mainly in the manufacturing of launch vehicle assemblies and systems.

With this background, the TEAP/CTOC concludes that further reduction and complete phase-out of CFC-113 in these applications will require introduction of appropriate alternatives, adoption of newly designed equipments, and of materials compatible with the alternatives.

The nomination for 2010 describes and explains in detail, currently available alternatives, steps for their introduction, and the factors that affect the time schedule of their introduction including regulatory requirements.

An element that was not discussed in the expert meeting is presented in the request by the Russian Federation. This element is the use of CFC-113 to clean and degrease "printed-circuit-boards of electronic equipments". Difficulties to clean with aqueous technology (Detalan) are described, and further discussion will be necessary on this issue with CTOC experts.

Accordingly, progress after 2010 seems rather slow, but this is something that can be expected when the necessary transition period required to adopt new alternatives is considered. A faster pace is likely afterwards.

In conclusion, the TEAP/CTOC recommends an EUE for 120 metric tonnes of CFC-113 for 2010 for the Russian Federation. The TEAP/CTOC also recommends that the Russian Federation continues to work with the CTOC experts to share successful experiences from other countries.

7.6 Update of n-propyl bromide

No new information on n-propyl bromide was obtained in the course of the CTOC activities during 2008 or the first part of 2009. The update status of n-propyl bromide will be included in the 2010 CTOC Assessment Report.

7.7 Carbon Tetrachloride (CTC) emissions

No new information on CTC emission was obtained in the course of the CTOC activities during 2008 or the first part of 2009. The update status of CTC emissions will be included in the 2010 CTOC Assessment Report.

Appendix to Chapter 7: TEAP/CTOC Report on the 2008 Expert Meeting in Moscow

Review of the Russian Federation Space Agency

CFC-113 Uses and Phase-Out Program

1. Objectives

This report summarises a visit by the TEAP-designated solvents experts to the Russian Federation to review its CFC-113 based cleaning processes, the alternatives test program, and planned phase-out of CFC-113 in the space and rocket industries. It also documents information provided and discussed on the CFC-113 alternatives being tested and their assessments and the substitution schedule. The TEAP assessment and recommendation on the Russian phase-out are also provided.

This report is based on face-to-face discussions and presentation in the conference room setting. Russian hosts did not agree to TEAP's request that experts visit the cleaning facilities, laboratories and manufacturing sites.

2. Background

At the 2007 meeting of the Montreal Protocol in New Delhi, the Russian Federation was granted CFC-113 for the calendar years 2007, 2008 and 2009 for a volume of 150, 140 and 130 metric tonnes, respectively under the essential use exemption (EUE) for the Russian rocket and space industry. The granting of the EUE for the ozone depleting substances (ODS) CFC-113 is based on the TEAP finding that there are no available ODS substitutes which could be implemented in the Russian rocket and space industry during this period. It is also stipulated that there is an active program in place in Russian Federation to find, develop and evaluate all available ozone friendly substitutes and technologies for this application.

3. Meeting of TEAP Experts with Russian Technical Personnel

On October 6-10, 2008, TEAP solvent experts Mr. Abid N. Merchant and Mr. David A. Ferguson met in Moscow with the scientists, engineers and technicians of the Federal Space Agency and associated Research Institutes and some of the manufacturers of the space and rocket hardware. The meeting was to fulfil the requirement of Decision XIX/14 and was aimed to acquaint the experts with the main applications of CFC-113 in the space industry of the Russian Federation and results of research performed to find possible ozone-safe alternatives for CFC-113.

A list of the attendees is given in Exhibit –A.

The following reports and papers were presented and thoroughly discussed:

– Application of CFC-113 in rocket and space industry, development and testing of alternatives and the implementation plan – Mr. V.S. Morozov, Deputy General Director, "NII "GHERMES";
– Applications of CFC-113 in production of high-precision mechanical devices for control systems of the rocket and space products and compatibility issues with the alternatives – Mr. A.S. Kosukhin, Production Manager, "Academicien Pilyugin Center"
– Use of CFC-113 in production of different class of liquid-propellant engines, and about results of alternatives tested. – A.A. Borisov, Deputy Chief Engineer, "NPO Energomash";

– Sucessful substitution of aqueous detergents in processes of cleaning and degreasing for manufacturing of launch vehicle assemblies and systems – Mr. V.V. Nikiforov, DB "Salyut"of FSUE "Khrunichev R&P Space Center
– Supply and allocations of CFC-113 for production of rocket and space products in rocket and space industry of the Russian Federation – Mr. Yu. M. Shchemelyov, FSUE "EKHO".
(See Exhibits-B and -C)

The presentations were discussed in detail and resulting questions were addressed during the meeting and in some cases responses were sent by e-mail after the meeting.

4. CFC-113 Production

The CFC-113 required by the Russian Federation is currently produced in Russia by a chemical manufacturer (Kirovo-Chepetsk) under the essential use exemption granted by the MP to the Russian Federal Space Agency. The Federal Space Agency co-ordinates requests for CFC-113 from various manufacturers of the space hardware and allocates supply to them. The goal of the Russian Federation is to reduce CFC-113 requirement by substituting alternatives where possible and meet the remaining CFC-113 need by a combined domestic CFC-113 production and purchasing the balance from the global inventories of CFC-113 in other countries (such as US and Europe) that is ear marked for an ultimate disposal by destruction (such as incineration or other destruction technology).

5. CFC-113 Applications

In Russia, CFC-113 is currently used in cleaning and testing of fuel, hydraulic, and temperature control, components and for gyro and accelerometer instruments, and other similar control systems.

These applications can be divided conveniently into two groups based on their material contents and the resulting sensitivity of materials to the alternatives.

The first group will be all-metal structural elements made of aluminium and aluminium-magnesium alloys, corrosion- and heat-resistant chromium-nickel alloys, or elements containing non-metallic materials resistant to solvents (polytetrafluoroethylene (PTFE) , polyethylene etc.). They include fuel tanks, pipelines, trunk lines, route fittings and automatic equipment, assembly units of liquid rocket engines.

The second group consists of components with both metals and a large number of non-metallic materials that are not resistant to fluids (rubbers, elastomers, polymers etc.). These are float-type gyro instruments, accelerometers, heat-exchange elements of temperature control systems.

The CFC-113 uses are approximately 45% for the first group (all metallic components and assemblies), 40% for the second group (metallic and non-metallic) and 15% for all other uses. The CFC-113 use has been reduced from 300 to 140 metric tonnes (2000-2008) in this application. Exhibit C- page 16 and 17 represent the CFC-113 uses since 2000 including forecast through 2014. The most of the CFC-113 reduction has been accomplished by reducing emission from the cleaning process, using improved recovery and recycle of the spent solvent. Only 10-15 metric tonnes/yr of the CFC-113 reduction was accomplished by substitution with an alternative such as aqueous system with Detalan in the manufacturing of launch vehicle assemblies and system. It was also mentioned that during this period the production of the space hardware had increased by 40% while reducing the CFC-113.

6. Alternatives Being Evaluated

Based on information provided before and during the meeting it is clear that the Russian Federation has expertise in all globally available alternatives to CFC-113 currently used in various cleaning applications in the aerospace industries. (See Exhibit-B).

The Russian ODS phase-out program has recognised, like other countries, that there does not exist a single alternative that could be substituted for all of the CFC-113 application and is of mindful to use various alternatives for specific applications for a optimum cleaning performance. Based on their own testing as well as international experience in the field, for the group one cleaning application they have focused on replacement chemistries in the groups of chlorocarbons, hydrocarbons, aqueous system with detergents and hydrochlorofluorocarbons. These chemistries do meet or exceed the cleaning effectiveness in most cases but do not meet other considerations or constraint.

For example, the chlorocarbons such as Trichloroethylene and Perchloroethylene have superior cleaning efficiency and are used successfully in other countries but its use is limited and restricted to a small size cleaning equipment due to a very restrictively low Russian exposure limits of 2 ppm (vs. 25 ppm or higher in other countries).

Hydrocarbons, such as benzene and petroleum distillate may also be used only in a small scale application due to their flammability. The existing large cleaning facilities are not rated for flammables and lack the proper explosion rating. Also the new replacement equipment with an appropriate explosion rating is significantly more expensive and could discourage conversion. The results of the cleaning tests with aqueous chemistry with detergents were also similar to the experience of other countries in that it was judged acceptable for the metal components with simple geometry. This chemistry is being substituted for CFC-113 in the manufacturing of the launch vehicle assemblies and systems. However, similar to experience of other countries, in the complex geometry the cleaning performance of the aqueous system was judged unacceptable. Only hydrochlorofluorocarbons such as HCFC-141b, HCFC-122 and HCFC-225 have met most of the criteria such as cleaning efficiency regardless of geometry, solubility of the soils and working fluids, low toxicity, and flammability. It should also be noted that only Russia is developing the alternative, HCFC-122.

Because most of the cleaning applications consist of the complex geometry, the current program for the CFC-113 phase-out is based on HCFC alternatives such as HCFC-122 and HCFC-141b.

The selection of an alternative(s) for cleaning space equipment in the second group presents the most challenge not only to Russia but to other countries. The function of the cleaning agent not only includes degreasing performance and the ability to effectively remove mechanical contaminations, but good solvency for working fluids used in making gyro (fluorinates and silicone fluids), accelerometer, and instruments for control systems. The compatibility of the non metallics and corrosion resistance of some metal materials limit use of aggressive solvents. Of the list of alternatives that have worked for the group one components, only HCFC by itself and with some additives such as HFC, HFE and PFC have been used with some success in the USA and

other countries. Also, the use of polymethylmethacrylate (PMMA) as a material of construction for the cleaning equipment and the fixtures to hold the parts to be cleaned is unique to Russian Federation. Unfortunately, PMMA is also not compatible with HCFC and HFC currently used as substitutes for CFC-113.

Hydrocarbons, such as cyclopentane and propyl alcohol mixture and petroleum distillate with other fluorinated compounds such as HFC, HFE, and PFC may also have to be considered.

Also the new replacement equipment with an appropriate explosion rating should be considered along with retrofitting or upgrading the existing facility. Another approach for non-metallic cleaning may involve a multiple cleaning steps with one or more alternatives and or tailored alternatives blends of the known substitutes. The use of a flammable hydrocarbon/alcohol as suggested earlier has been used in other countries

Although during the meeting the Russian Space Agency did not discuss or present their detailed technical and implementation plan for the phase out of CFC –113, as a follow-up response to one of our after meeting questions, they sent us a copy of the program. See Exhibit E. The review of the program indicates that the Russian Space Agency has a well defined step-by-step implementation plan for the HCFC substitution with well-defined organisational responsibility. Having each step outlined with dates for start and completion, and the responsibilities for the implementation, gives confidence that they can meet their forecasted CFC-113 reduction.

The Russian Federation recognises that HCFCs are transitional substitutes and have to be phased out by 2020.

7. New Cleaning Equipment for Alternatives

The Federal Space Agency of the Russian Federation, its contractors, and OEMs who provide components to the space vehicles have been working cohesively to minimise their requirements for ozone depleting solvents. To this end, the Federal Space agency has evaluated the cleaning equipment utilising CFC-113 to determine what advancements could be made in cleaning improvement and solvent minimisation.

New systems are designed to utilise sealed cleaning chambers, thus minimising fugitive emissions. Carbon adsorption is designed to be used with larger systems to capture and reuse solvent vapours that can be evacuated from tanks, piping, and fixtures. Line flushing equipment has been tooled to accomplish the necessary task without allowing solvent runoff.

Liquid propellant fuel tanks need to be cleaned to remove all contaminants that may result in premature combustion. Fixtures with rotating nozzles have been incorporated into the cleaning matrix so that the task can be accomplished with only a percentage of the solvent that would be consumed using conventional flushing techniques.

At the time of our meeting, it was understood that this equipment had been designed and approved, but not yet installed in the facilities of their contractors or OEMs. Therefore it is not possible to accurately calculate the improved efficiency of these new systems. The timeline for purchase and installation would be affected by contract completion dates, and funding.

In addition, the new equipment may not address all of the material compatibility challenges involved in building, assembling and cleaning the various components. Further, there are applications for leak testing, pressure testing and other tasks where only marginal improvements can be made without jeopardising functionality. Finally, 10-15% of the solvent consumption is used in bench-top manual cleaning. It is unclear if advancements in cleaning equipment could be applied to some of these processes.

8. Conclusions

1. The Russian Federation has the know-how on all available alternatives to CFC-113.

2. The HCFC alternatives (HCFC-122 and HCFC-141b) have been identified and qualified by the laboratories for substitution in cleaning primarily the group one, metallic components and assemblies of the space hardware.

3. The scaling up of the HCFC alternatives from the successful laboratory evaluation to the commercial use still faces significant approval process by various organisations, field trial, and contractual obligation delays.

4. The current forecast for successful substitution by 2010 is possible but will require close co-ordination and co-operation between various organisations.

5. The prototype of the cleaning systems with the HCFC alternatives have been built and tested in the laboratory but not yet installed in the facilities of their contractor or OEM.

6. Approximately 40 % of the cleaning application involves components containing both metal and non metallic material. The compatibility of the HCFC alternatives with non metallic materials (rubbers, elastomers, polymers etc) is an issue and will limit their use in this application.

7. Although tests with mix solvent have been tried, no substitute(s) have been identified for this application. The substitution may involve a multiple cleaning steps with one or more alternatives and or tailored alternatives blends of the known substitutes. Also, a proven flammable hydrocarbon/alcohol blend (in USA) with appropriately designed explosion rated equipment should be tested.

8. For a total CFC-113 phase-out specially in the control and guidance instrument over the next 5 –years will require significant research, testing and bold initiatives by the Russian Space Industry.

9. Future steps to phase-out CFC-113 are depicted in the table of Exhibit-C.

10. The Russian Federation foresees continued use of CFC-113 even beyond 2014. A combination of domestic CFC-113 production and purchases from the global inventories of CFC-113 in other countries will satisfy the requirements for this substance.

(See Illustration 2 in Exhibit-C.)

9. Recommendations

1. Based on progress made to-date and work remain to commercialise HCFC alternatives, (which may take as much as 12 months) the TEAP recommends that 130 metric tonnes of CFC-113 for 2009.

2. Significant quantities of CFC-113 are likely necessary in future years.

3 For components containing the non-metallic may require multiple steps, a mixture of one or more alternatives, and or a flammable hydrocarbon/alcohol blend (in appropriately designed explosion rated equipment).

4 Replacement of the parts made from PMMA with some other compatible material should be considered.

Exibit-A: List of Attendees

Experts of TEAP UNEP

MERCHANT Abid Nazaraly
FERGUSON David Albert

Federal Space Agency

YAKUSHIN Nikolay Ivanovich	Deputy Head of FSA Department
SAMBROS Vitaliy Vasilevich	Head of Division
KOZYREV Valentin Ivanovich	Head of Division
SPOSOBIN Vitaliy Ivanovich	Main specialist

JSC "Research Institute "GHERMES" ("NII "GHERMES")

MOROZOV Vladimir Sergeevich	Deputy General Director
KOZHEVNIKOV Evgeniy Mikhailovich	Head of Section
BULGAKOVA Nadezhda Vladimirovna	Research Engineer

Federal state Unitary Enterprise "Research and Production Center for Automatics and Instrument-Building named after academician N.A.Pilyugin" ("Academician Pilyugin Center")

KOSUKHIN AJexandr Sergeevich	Chief Production Engineer
ZHAGRIN Valeriy Efimovich	Head of Section

JSC «NPO Energomash named after academician V.P.Glushko» (Energomach)

BORISOV Andrey Anatolievich	Deputy Chief Engineer
RUSSKIKH Galina Arsenievna	Head of Bureau
VTOROVA Natalia Evgenievna	Interpreter

Central Research Institute for Machine Building (TsNIIMash)

SHATROV Yakov Timofeevich	Main Research Fellow

Federal State Unitary Enterprise "Cosmic Research and Production Center named after M.V.Khrunichev", Design Bureau "SALYUT" (Khrunichev R&P Space Center, DB "SALYUT")

NIKIFOROV Vladimir Valentinovich	Main specialist
ZAITSEVA Irina Victorovna	Head of Section

Federal State Unitary Enterprise "EKHO" (FSUE "EKHO")

SCHEMELEV Yuriy Mikhailovich	Deputy General Director

Exhibit–B:

Analytical Note -On the Results of Research and Experimental Work to Find Acceptable Alternatives to CFC-113 for Use in Production of Russian Space Technology Products

In space industry, chlorofluorocarbon CFC-113 ($C_2F_3Cl_3$) is used in processes of cleaning, degreasing, washing and testing the fuel system elements of liquid fuel rockets and spacecraft, hydraulic channels of liquid rocket engines, fittings, automatic equipment, thermal loops of temperature control systems, gyro instruments of control systems, and other units. The high effect of process application of this solvent is due to the unique combination of its physical and chemical properties, its processing and application qualities.

Exclusion of CFC-113 from process application would lead to significant deterioration of the quality of products released, and in some cases, to practical suspension of production. With this in view, searching for and exploring alternatives equivalent to CFC-113 and creating new ozone-safe processes based on them becomes a problem of current importance.

Rocket and space industry's leading enterprises and specialised research centres of the Russian Federation have carried out a large amount of work to find and try out ozone-safe solvents and aqueous detergents which are alternative to CFC-113, as well as to use them as a basis to develop and master techniques of finish cleaning of space equipment elements of organic and mechanical contaminations and removing residues of working and process fluids from their surfaces.

In particular, research has been conducted on the following potential ozone-friendly and ozone-safe CFC-113 substitutes:

- high efficiency aqueous detergents;
- organic solvents;
- chlorocarbon solvents;
- hydrochlorofluorocarbon solvents;
- fluorocarbons, perfluorocarbons and other fluorocarbon liquids;
- mixed compositions based on the above solvents.

Space equipment structural elements exposed to finish precision cleaning operations with the use of CFC-113 can be divided into two groups:

The first group: all-metal structural elements made of aluminium and aluminium-magnesium alloys, corrosion- and heat-resistant chromium-nickel alloys, or elements containing non-metallic materials resistant to solvents (polytetrafluoroethylene (PTFE), , polyethylene etc.). They include fuel tanks, pipelines, trunk lines, route fittings and automatic equipment, assembly units of liquid rocket engines etc.;

The second group: structural elements containing a large number of non-metallic materials that are not resistant to fluids (rubbers, elastomers, polymers etc.). These are float-type gyro instruments, accelerometers, heat-exchange elements of temperature control systems etc.

I.

The problem of selecting an alternative solvent for cleaning structural elements of the first group has been addressed by testing and process tryout of organic, chlorocarbon, hydrochlorofluorocarbon solvents, mixed solvents and new high-efficiency aqueous detergents. The physicochemical properties and processing qualities of the analysed alternative solvents are provided in Appendix 1. The physicochemical properties and technical characteristics of aqueous detergents are provided in Appendix 2.

1.1 Results of Tryout of Finish Cleaning Techniques Using High-Efficiency Aqueous Detergents

Techniques with the use aqueous detergents may be employed both for inter-operation product cleaning and during finish cleaning operations to remove grease and mechanical contaminations. The main advantages of water cleaning: the cleaning action versatility in relation to various contaminations, operational safety, high efficiency when ultrasound is used, low cost of cleaning agents.

The results of the tests conducted on the aqueous detergents Detalan, Detalan AL, Detalan F, VMS-S have shown that the cleaning of components and assembly units with open smooth surfaces produces results that are comparable to those obtained with the use of CFC-113 (the residual content of grease contaminations on the surfaces is 15 to 30 mg/m^2, the grade of mechanical purity as per GOST 17216-2001 is 7…9). On condition that the residues of washing agents are thoroughly removed from the surfaces of the washed items and they are subsequently dried, no considerable corrosion effect of the agents tested is observed.

The Detalan, Detalan AL, Detalan F, VMS-S aqueous detergents are recommended for use in processes of cleaning and degreasing space equipment components and assembly units of unsophisticated design with open smooth surfaces, on which no high tightness requirements are imposed. The regulatory guidance document OST 134-1036-2003 *Rocket and Space Technology Products. General Requirements for Processes of Cleaning and Degreasing Components and Assembly Units Using Detalan Aqueous Detergents* has been developed, which regulates process requirements for methods, conditions and means of removing contaminations from the surfaces of space equipment components and assembly units using aqueous detergents.

Cleaning and degreasing processes using aqueous detergents are now introduced at FGUP M.V. Khrunichev GKNPC, OAO V.P. Glushko NPO Energomash and other enterprises.

1.2 Results of Tryout of Application Techniques for Organic Solvents

Organic solvents: petroleum solvent S2-80/120, ethanol, acetone, white spirit, ethers, ketones are traditionally used in processes of manufacture of components and assembly units for cleaning, degreasing and removing residues of various process fluids. The tests conducted have shown that some organic solvents, specifically petroleum solvent S2-80/120, are comparable to CFC-113 in terms of degreasing and cleaning properties and event more effective. However, such two significant factors as high fire and explosion hazard and insufficient purity of products supplied from manufacturers limit the possibilities for wide use of these solvents. Because of this, they are recommended for process application instead of CFC-113 mainly in processes of cleaning and degreasing of small-size items (not exceeding 300 to 350 mm). Before application, the solvent should be additionally purified to the degree of residual grease contaminations controlled by the luminescent method (1-10 mg/l), and the purity grade as per GOST 1716-2001 of 5…7.

The process application of organic solvents instead of CFC-113 has been introduced at such enterprises as OAO S.P. Korolyov RKK Energiya, FGUP OKB Fakel, FGUP M.V. Khrunichev GKNPC, FGUP GNPRKC-Progress and others.

For more extensive application of organic solvents, special fire- and explosion-proof process equipment is required for additional purification and regeneration of solvents, as well as for performing cleaning, degreasing and washing operations.

1.3 Results of Tryout of Application Techniques for Chlorocarbon Solvents

The potentially high washing and cleaning performance of chlorocarbon solvents: dichloromethane CH_2Cl_2, trichloroethylene C_2HCl_3, perchloroethylene C_2Cl_4 is testified by such physical characteristics as high density (1.34-1.66 g/cm^3), low surface tension coefficient (19.6-28.1 mN/m), low viscosity (0.435-0.88 mPa·s). The parameters that characterise the dissolving performance of these liquids in comparison with CFC-113, the kauri butanol values and the experimentally estimated values of inter-diffusion of molecules of the solvent and the substance being dissolved (a mixture of mineral oils capable of contaminating the surfaces of items in the course of manufacturing) are shown in Table 1 below.

Appendix, Table 1

Dissolving capacity parameter	Solvent			
	Dichloromethane	Trichloroethylene	Perchloroethylene	CFC-113
Kauri butanol value, KB	135	130	90	31
Solvent and contaminant inter-diffusion coefficient value, cm^2/s	$6.2 \cdot 10^{-6}$	$5.8 \cdot 10^{-6}$	$3.9 \cdot 10^{-6}$	$2.7 \cdot 10^{-6}$

It follows from the table that the ability of chlorocarbon alternatives to dissolve mineral oils and fats is much higher than that of CFC-113.

In the course of tests and tryout of chlorocarbon solvents in processes of cleaning space equipment structural elements, is has been found that in terms of the dissolving and cleaning action on organic contaminants and the surface cleaning quality achieved chlorocarbon solvents are comparable to and even surpass CFC-113. However, in terms of the set of such processing qualities as high toxicity, fire and explosion hazards, low chemical stability, high degree of negative effect on structural materials, such solvents are significantly inferior to CFC-113.

Because of the high toxicity of vapours of these solvents (the maximum allowable concentration of vapours in the workplace air must not exceed 5-50 mg/m^3, whereas for CFC-113 the maximum allowable concentration is 5000 mg/m^3) the practical application of these solvents requires radical reconstruction of technological facilities. Specifically, closed hermetically sealed process equipment with a recirculation loop of solvent use, contaminated solvent regeneration, vapour phase recovery and solvent vapour adsorption from ventilation emissions would be required.

The insufficient chemical stability of chlorocarbon solvents requires additional costly stabilisers to be introduced into them.

Because of the stronger (as compared with CFC-113 --or Freon-113--) negative effect of chlorocarbon solvents on structural materials, these solvents may be used mainly for cleaning components and assembly units made of corrosion-resistant metals and alloys that do not contain rubbers, polymers, elastomers, adhesives.

Regulatory guidance documents regulating general requirements for cleaning processes using chlorocarbon solvents have been developed. Cleaning processes using these solvents are introduced at OAO S.P. Korolyov RKK Energiya, FGUP Research Institute of Physical Measurements and other enterprises mostly as applied to small-size components and assembly units that do not exceed 200-300 mm.

1.4 Results of Tryout of Application Techniques for Hydrochlorofluorocarbon Solvents

In terms of their physicochemical properties, hydrochlorofluorocarbon (hydrochlorofluorocarbon) solvents are the closest to CFC-113.

In the world practice, such hydrochlorofluorocarbon solvents as HCFC-141b ($C_2FCl_2H_3$), HCFC-225 ($C_3F_5Cl_2H$), as well as mixed solvents based on them are used most often as an alternative to CFC-113. In addition, Russian chemists have synthesised hydrochlorofluorocarbon solvents HCFC-122, and HCFC-122a ($C_2F_2Cl_3H$).

The parameters that characterise the dissolving performance of hydrochlorofluorocarbon solvents in comparison with CFC-113, the Kauri butanol values and the experimentally estimated values of inter-diffusion of molecules of the solvent and the substance being dissolved (a mixture of mineral oils capable of contaminating the surfaces of items in the course of manufacturing) are shown in Table 2.

Appendix, Table 2

Dissolving capacity parameter	Solvent			
	HCFC-122	HCFC-141b	HCFC-225	CFC-113
Kauri butanol value, KB	66	56	31	31
Solvent and contaminant inter-diffusion coefficient value, cm^2/s	$3.3 \cdot 10^{-6}$	$4.64 \cdot 10^{-6}$	$3.6 \cdot 10^{-6}$	$2.7 \cdot 10^{-6}$

It can be seen from the table that the degreasing performance of hydrochlorofluorocarbon solvents, as well as the dissolving and cleaning action on mineral oils, fats and other organic contaminants is higher than that of CFC-113.

In the course of the research, tests and experimental tryout of hydrochlorofluorocarbon solvents (HCFC solvents) in processes of cleaning and degreasing components and assembly units of space technology products, the following has been found:

- the surface cleaning quality with the use HCFC solvents complies with the requirements established by the design documentation: the residual contents of grease contaminations on the surfaces of items do not exceed 5-20 mg/m^2, the grade of mechanical purity is 5…8 as per GOST 17216-2001;

- metallic materials used in space equipment constructions are resistant enough to HCFC solvents. Their contact with solvents does not significantly reduce their resistance to atmospheric corrosion;

- the degree of the negative effect of HCFC solvents on non-metallic structural materials, specifically rubbers, polymers, plastics, elastomers, adhesives, paint coatings etc., is higher that of CFC-113. Because of this, HCFC solvents can be recommended mainly for processing all-metal components and assembly units, or those made of non-metallic materials resistant to HCFC solvents, such as fluoroplastics, polyethylenes, polyamides, phenolic plastics, compounds, anaerobic sealants;

- HCFC solvents are quite compatible with working fluids, including components of liquid rocket fuels, heat transfer agents, steering gear fluids etc.;

- increased volatility of HCFC-141b requires the use of closed-type hermetically sealed equipment

Taking the results obtained into consideration, hydrochlorofluorocarbon solvents: HCFC-122, HCFC-122a ($C_2F_2Cl_3H$), HCFC-141b ($C_2FCl_2H_3$), HCFC-225 ($C_3F_5Cl_2H$) are recommended as the main alternative to CFC-113 for use in processes of cleaning, degreasing and washing space equipment structural elements of the first group. The industry standard OST 134-1041-2005 *Rocket and Space Technology Products. General Requirements for Processes of Using Ozone-Friendly Freons* has been developed, which sets general requirements for cleaning and degreasing processes using ozone-friendly HCFC solvents. The following foreign-made solvents are currently recommended to space industry enterprises for use as principal HCFC solvents: 141b (HCFC-141b) produced by Zhejiang Sanmei Chem. Industry Co., Ltd (China); Forane 141b DGX produced by Atofina (France, USA); AK-225 (HCFC-225) produced by Asahi Glass (Japan).

OAO V.P. Glushko NPO Energomash, OAO KB Khimavtomatiki, FGUP Krasnoyarsk and other enterprises have been trying out processes and special equipment designed for cleaning and degreasing using HCFC-141b.

II.

The problem of selecting an alternative solvent of CFC-113 for cleaning space equipment structural elements of the second group presents the most complex challenge.

Along with high degreasing performance and the ability to effectively remove mechanical contaminations, an alternative solvent must produce a strong dissolving action on working and process (fluorocarbon, organic and organosilicon) fluids used in making gyro instruments and heat-exchange devices of spacecraft temperature control systems. Besides, the structures of these items use up to 10 metallic materials that are not corrosion-resistant, and up to 30 non-metallic materials with low resistance to solvents, specifically: rubbers, polymers, elastomers, compounds, adhesives, varnishes, paints etc. Accessories used in the production of gyro instruments contain transparent elements made of polymethylmethacrylate, which is exceptionally sensitive to solvents.

The use of HCFC solvents for cleaning space equipment structural elements of the second group appears impossible because of a strong negative effect that these solvents produce on non-metallic structural materials and total lack of dissolving action on fluorocarbon and organosilicon working fluids. Composite solvents based on HCFC-225 (such brands as AK-225, AK-225AES, AK-225ATE, AK-225DH, AK-225FPL supplied by Asahi Glass (Japan)) cannot be used because of a strong negative effect they produce on polymethylmethacrylate (PMMA).

2.1. Research and tests

Research and tests have been conducted on chemically stable and neutral (in terms of their effect on non-metallic materials) solvents belonging to the class of fluorocarbon liquids to find out possibilities for their use as an alternative to CFC-113 in the production of gyro instruments. In particular, the following solvents have been tested:

- perfluorotriethylamine $(C_2F_5)_3N$, brand name MD-3F (Russia);
- perfluorocarbon (perfluoro-4-methyl-pentene) C_6F_{12}, brand name FOL-62 (Russia);
- hydrofluorocarbon $C_5H_2F_{10}$, brand name Vertrel XF, HFC43-10mee (DuPont, USA);
- hydrofluoroether $C_4F_9OCH_3$, brand name Novec HFE-7100 (3M, USA);
- mixed compositions based on these solvents.

In the course of research conducted to assess the effect of the solvents being tested on non-metallic structural materials it has been found out that the practical effect of these solvents with the duration of their contact with the materials being up to one hundred days is comparable, and even weaker in comparison with CFC-113. The exception to this is hydrofluorocarbon $C_5H_2F_{10}$ (Vertrel XF, HFC43-10mee), which produces a strong negative, even destructive effect on polymethylmethacrylate and other non-metallic materials. The research has also demonstrated that all solvents from the class of fluorocarbon liquids in their pure form practically do not dissolve grease contaminations, as well as polymethylsiloxane-based working fluid.

Taking the results obtained into consideration, mixed solvents based on MD-3F, FOL-62 and Novec HFE-7100 solvents have been subjected to further research and tryout. During the tests of the mixed solvent Novec HFE-71DE ($C_4F_9OCH_3$ – 50 % + $C_2H_2Cl_2$ – 50 %), a negative result has been obtained due to a strong negative effect of this mixed solvent on structural materials. That is why neutral additives (in terms of their effect on structural materials) have been used in subsequent tryouts of mixed solvents as additional components: solvent naphtha nefras S2-80/120, which dissolves grease contaminations, and HCFC solvent Freon 141b, which dissolves polymethylsiloxanes. Mixed compositions based on solvents MD-3F, FOL-62 and Novec HFE-7100 have been tried out. The tryout of these mixed solvents has produced generally positive results. At the same time, the non-azeotropic composition of these solvents and associated process-related difficulties of their practical utilisation rule out possibilities for introducing these mixed solvents into space equipment production. Possible use of solvent HFC-365 ($C_4F_5H_5$) as a solvent and component of mixed compositions has not been assessed due to its high fire and explosion hazard.

Despite the significant amount of the research, tests and experimental tryouts performed, no alternative solvent that totally equates to CFC-113 in its physicochemical properties and processing qualities has been found so far for application in the production of gyro instruments and other instruments of precision mechanics. Solvents MD-3F, FOL-62 and Novec HFE-7100 may be used to perform specific process operations, in particular, to wash residues of working and balancing fluorocarbon fluids (fluorinated polyesters, fluorinated hydrocarbons) form gyro instruments. Solvent Vertrel XF, (HFC43-10mee) may only be used for removing these contaminations from the surfaces of all-metal assembly units. These solvents are included in the industry regulatory standardisation document OST 134-1041-2005.

2.2 An experimental try-out

An experimental try-out has been performed of the process application of solvent naphtha nefras S2-80/120 (instead of CFC-113) additionally purified in advance to reduce the content of residual grease contaminations to a level not exceeding 1 $mg/dm,^3$ in cleaning, degreasing and washing processes to remove residues of heat-transfer organic liquids in the heat-transfer loops of spacecraft temperature control systems. Considering the results of the tryout of cleaning processes using solvent naphtha nefras S2-80/120 performed at OAO M.F. Reshetnyov Information Satellite Systems, they are recommended for development and introduction at other enterprises of the industry.

Ш.

For the purpose of the most economical use of volatile ozone-safe solvents in the process application, samples of new special equipment have been created and tried out at space industry enterprises, including:

- equipment for preparation and regeneration of ozone-safe solvents;

- equipment for cleaning, degreasing and washing items using immersion (filling), jet, hydrodynamic, and vapour condensate methods, with solvent recirculation, vapour phase recovery, which equipment is characterised by the following main characteristics:

a) the degree of purity of the solvent being used in the process:

- the allowable content of grease contaminants controlled by the luminescent method: 5-1 mg/dm^3;
- the grade of mechanical purity as per GOST 17216-2001: 8…5;

b) the degree of purity of items after cleaning and degreasing operations:

- the allowable content of grease contaminants on the surfaces of the items being processed: 3-5 mg/m^2;
- the grade of purity as per GOST 17216-2001: 8…5;

c) the allowable losses of the solvent in the process: less than 1 %.

3.1 Conclusion

1. The research, tests and experimental tryouts performed make it possible to recommend the following ozone-safe and ozone-friendly solvents as an alternative to CFC-113 for introduction into processes of cleaning, degreasing and washing components and assembly units of the main space equipment assemblies, including fuel tanks, pipelines, trunk lines, route fittings and automatic equipment, liquid engines: chlorocarbon solvents – dichloromethane, perchloroethylene, trichloroethylene; HCFC solvents – HCFC-141b (Forane 141b DGX), HCFC-122, HCFC-225 (AK-225) and mixed compositions based on them; high-efficiency aqueous detergents – Detalan, Detalan AL, Detalan F, VMS-S and others. The regulatory guidance documents have been developed, which gives general guidance for process using these solvents and detergents. Ozone-friendly processes using these solvents and aqueous detergents are now being introduced at space industry enterprises.

2. Solvent naphtha nefras S2-80/120 has been tried out and recommended for introduction at space industry enterprises to be used, after additional purification, in processes of cleaning, degreasing and washing elements of the heat-transfer loops of spacecraft temperature control systems.

3. New samples of special closed hermetically sealed process equipment have been created and tried out under production conditions, including:

- equipment for preparation and regeneration of ozone-safe solvents;
- equipment with solvent recirculation, solvent vapour recovery to provide possibilities for successive application of various cleaning methods: for cleaning, degreasing and washing components and assembly units of space technology products.

4. Despite the significant amount of the research and tryouts performed, the problem of selecting an ozone-friendly solvent that could fully replace CFC-113 in the production of instruments of precision mechanics, including gyro instruments and float-type accelerometers, has not been resolved so far.

5. The price of the recommended foreign-made solvents HCFC-225, HFE-7100, HFC43-10mee etc. is 4 to 5 times higher than the price of CFC-113 on the average, which significantly limits the possibilities for their extensive use in processes of production of space technology products.

Exhibit-C; **Russian Space Agency-Technical Program for CFC-113 Phase-out (Approved by General Director of OAO «NII «Germes» I. I. Varavin, 2007**

THE PROGRAM of activities for transfer of the space rocket industry companies to technologies that exclude or limit CFC-113 application in technological processes of cleaning, degreasing, flushing, preparation for pressure proof tests and leak checks and conducting of these tests and checks of space rocket industry product parts and assembly units.

(The financial source for activities – state contracts with the Federal Space Agency No. 996-T 413/06 dated March 02, 2006 and No. 996-0709/06 dated March 02, 2006 and also the means of the principal business of the space rocket industry companies)

Description of efforts	**Subcontractor**	**Due Date** **Commencement** **Completion**
Prepare proposals for arrangement of production capacities for industrial production of ozone safe solvents HCFC-122 and HCFC-141b (output of 100 tonnes per year of each product) for introduction into the targeted integrated program "Renovation of scarce, strategic, import replacing materials and small tonnage chemicals production …".	OAO «NII «Germes», FGUP «RNTs «Applied Chemistry», OAO «Kompozit»	Jun.-2007 Oct.-2007
Prepare and submit to FGUP «NPO «Tekhmash» and the proper controlling agencies a draft project for Design and Research Work for verification of performance figures, quality and reliability and life time of the space industry products for the case that ozone safe solvents are applied and ozone safe technologies are introduced into the design documentation with justifications.	OAO «NII «Germes», Companies developing space hardware: FGUP «NPTs AP named after academician N.A.Pilugin», OAO «KB KhA», OAO «NPO Energomash named after academician V.P. Glushko», OAO «ISS» named after academician M.F. Reshetnev, FGUP «GKNPTs named after M.V. Khrunichev»	Jun.-2007 Oct.-2007
Build and enable facilities for industrial production of ozone safe solvents HCFC-122 and HCFC-141b (output of 100 metric tonnes per year of each product)	FGUP «RNTs «Applied Chemistry»	Jan.-2009 Dec.-2010
Provide the space industry companies with normative methodical documents for developed ozone safe technologies and technological means for cleaning, degreasing, flushing, testing of space rocket industry products.		

Description of efforts	Subcontractor	Due Date Commencement Completion
4.1 Prepare and distribute in accordance with companies requests: • industrial standard OST 134-1036-2003 “Space rocket industry products. General requirements to technological processes of cleaning, degreasing of product parts and assembly units with the use of aqueous detergents of the “Detalan” series”; industrial standard OST-134-1041-2005 “Space rocket industry products. General requirements to technological processes of ozone safe HCFC solvent application in production”.	OAO «NII «Germes»	Mar.-2006 Dec.-2006
4.2 Develop and distribute industrial standards in accordance with companies requests: • OST «Space rocket industry products. General requirements to technological processes of finish cleaning of parts and assembly units with the use of organic and organic chloride solvents in replacement of CFC-113»; • OST «Space rocket industry products. Development of technological equipment for cleaning, degreasing, flushing, testing of parts and assembly units with the use of ozone safe solvents. Modification of operating equipment for transfer to ozone safe solvent application».	OAO «NII «Germes»	Jun.-2008 Feb.-2009
• Perform scientific-research and designing -experimental work:		
5.1 Search for and try out ozone safe and ozone saving solvents and new high effective detergents:		
- for application in production of main components of space rocket industry products (the propellant system, pipelines and manifolds, fittings and controls, liquid propellant rocket engines);	OAO «NII «Germes» OAO «NPO Energomash named after academician V.P. Glushko», FGUP «Krasmash», OAO «KB KhA», FGUP «GKNPTs named after M.V. Khrunichev»	Jan.-2007 Dec.-2009
- for application in production of high-precision mechanics devices (gyroscopes and accelerometers of the floating type), thermal loops of the spacecraft thermal control system.	OAO «NII «Germes», FGUP «NPTs AP named after academician N.A. Pilugin», OAO «ISS» named after academician M.F. Reshetnev, FGUP «RNTs «Applied Chemistry», OAO «Astro-Electronics»	Jan.-2008 Dec.-2010

Description of efforts	Subcontractor	Due Date Commencement Completion
5.2 Conduct field tests of space rockets industry product prototypes for verification of performance figures, quality and reliability and life time for the case that ozone safe solvents are applied and ozone safe technologies are introduced into the design documentation with justification.	FGUP «NPTs AP named after academician N.A.Pilugin», OAO «ISS» named after academician M.F. Reshetnev, OAO «NPO Energomash named after academician V.P. Glushko», OAO «KB KhA», FGUP «Krasmash»	Jan.-2010 Dec.-2012
5.3 Develop and try out typical prototypes of technological equipment for cleaning, degreasing, flushing of space rocket industry product parts and assembly units with ozone safe and ozone saving solvents, equipment prototypes, preparation (after purification) and regeneration of contaminated solvents with assurance of economical mode of operations and safety of technological application. Rebuild (reconstruct) technological equipment available at the companies for its adaptation to ozone safe solvent application.	OAO «NII «Germes», FGUP «NPTs AP named after academician N.A.Pilugin», OAO «NPO Energomash named after academician V.P. Glushko», OAO «KB KhA», OAO «ISS» named after academician M.F. Reshetnev, FGUP «GKNPTs named after M.V. Khrunichev» FGUP «Krasmash»	Jun.-2006 Dec.-2009
5.4 Try out technological processes of cleaning, degreasing, flushing, preparation and testing of parts and assembly units of space rocket industry products with the use of ozone safe solvents, effective aqueous detergents in space rocket industry companies. .	OAO «NII «Germes», FGUP «NPTs AP named after academician N.A.Pilugin», OAO «NPO Energomash named after academician V.P. Glushko», OAO «KB KhA», OAO «ISS» named after academician M.F. Reshetnev,	Sep.-2008 Dec.-2009
Establish serial production of developed technological equipment in accordance with requests of space rocket industry companies.	OAO «NII «Germes»	Jan.-2010 Dec.-2011
Introduce in FGUP «NPTs AP named after acad. N.A.Pilugin» measures for decrease of CFC-113 consumption:	OAO «NII «Germes», FGUP «NPTs AP named after academician N.A.Pilugin»	
- develop, try out and implement sealed installation 924.46.050 for after purification, storage and distribution of solvent CFC-113;		Jan.-2007 Dec.-2008
- develop, try out and implement sealed installation 924.78.051 for rectifying cleaning of CFC-113 prior to technological application;		Jan.-2007 Dec.-2008
- develop, try out and implement automated installation 924.46.101 for cleaning, flushing of parts and assembly units of high-precision mechanics devices of the leak-proof design;		Jan.-2008 Dec.-2009
- develop, try out and implement methods, technologies and equipment for ultrafine purification of solvent CFC-113 after its usage in processes of working and balancing fluids removal.		Jan.-2009 Dec.-2010
Space rocket industry companies transfer to ozone safe and ozone saving technologies:		
8.1 Implement in OAO «NPO Energomash named after acad. V. P. Glushko»:		

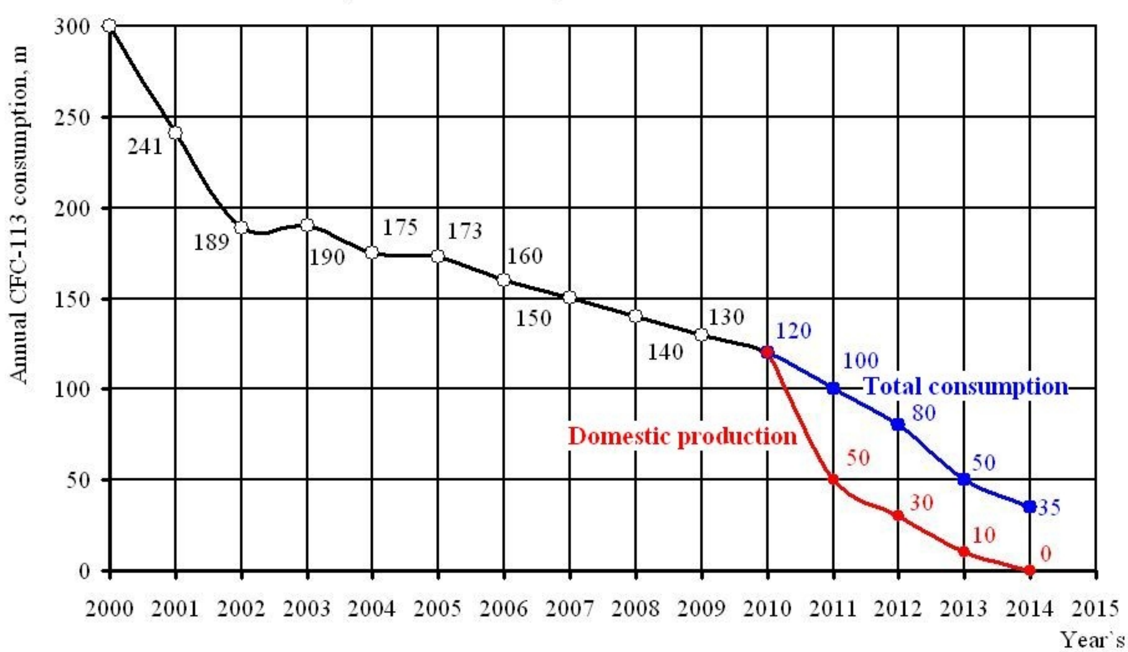
Description of efforts	Subcontractor	Due Date Commencement Completion
- the technologies of cleaning, degreasing of parts and assembly units of liquid propellant rocket engines within universal installation 924.46.087 with the use of HCFC-141b (FORANE 141b DGX);	OAO «NII «Germes», FGUP «NPTs AP named after academician N.A.Pilugin»	Sep.-2008 Dec.-2009
- the technologies of cleaning, degreasing of parts and assembly units of liquid propellant rocket engines by the methods of submerging into solvent HCFC-122 (or HCFC-141b).		Jan.-2011 Dec.-2012
8.2 Implement in FGUP «GKNPTs named after M.V. Khrunichev»:		
- the technology of cleaning, degreasing of parts and assembly units with the use of aqueous detergents «Detalant AL»;	OAO «NII «Germes», FGUP «GKNPTs named after M.V. Khrunichev»	Jan.-2007 Dec.-2008
- the technology of cleaning, degreasing of parts and assembly units with the use of HCFC-141b (or methylene chloride) within installation 924.46.102;		Jan.-2010 Dec.-2011
- an installation for ultrasonic cleaning of parts and assembly units of complicated difficultly flushed designs with the use of HCFC-141b (or HCFC-122).		Jan.-2011 Dec.-2012
8.3 Implement in company «KB KhA»:	OAO «NII «Germes», OAO «KB KhA»	
- the technology of cleaning, degreasing of parts and assembly units of liquid propellant rocket engines with the use of HCFC-141b (FORANE 141b DGX) within installation 924.46.102;		Sep.-2008 Dec.-2009
- the technology of cleaning, degreasing of parts and assembly units of liquid propellant rocket engines by the method of submerging into solvent HCFC-122 (or HCFC-141b).		Jan.-2011 Dec.-2012
8.4 Implement in OAO «ISS» named after acad. M.F. Reshetnev:	OAO «NII «Germes», OAO «ISS» named after academician M.F. Reshetnev	
- the technologies of flushing of thermal loops parts and assembly units of the spacecraft thermal control system with the use of HCFC-141b (FORANE 141b DGX) within an installation for ultrasonic cleaning;		Jan.-2009 Dec.-2010
- the technologies of flushing (including, in particular, from thermal liquids residue) of thermal loops of the spacecraft thermal control system with the use of benzene –solvent Nefras 80/120		Jan.-2010 Dec.-2011
- The technologies of circulating flushing of heat pipes of the spacecraft thermal control system with the use of HCFC-141b (FORANE 141b DGX) within an installation for hydrodynamic cleaning.		Jan.-2009 Dec.-2010

Description of efforts	Subcontractor	Due Date Commencement Completion
8.5 Implement in FGUP «NPTs AP named after acad. N.A.Pilugin»:	OAO «NII «Germes», FGUP «NPTs AP named after academician N.A.Pilugin»	
- the technologies of interoperational cleaning of parts and assembly units of control system devices after machining with the use of mixed solvent HCFC-122 + benzene-solvent Nefras 80/120;		Jan.-2011 Dec.-2013
- the technologies of cleaning, flushing of parts and assembly units of control system devices within installation of type 924.46.101 with the use of alternative solvents.		Jan.-2011 Dec.-2013

This Program is agreed upon with companies - subcontractors:
FGUP «NPTs AP named after academician N.A.Pilugin»,
OAO «NPO Energomash named after academician V.P. Glushko»,
OAO «KB KhA»,
OAO «ISS» named after academician M.F. Reshetnev,
FGUP «GKNPTs named after M.V. Khrunichev»,
FGUP «RNTs «Applied Chemistry»,
FGUP «Krasmash»

(FGUP –federal state unitary enterprise; NPTs – scientific & production center; OAO – open joint stock company; NPO - scientific & production association; GKNPTs – state space scientific & production center; RNTs – Russian scientific center; KB KhA – design bureau for chemical automatic devices)

Illustration 2 "The dynamics of general decrease of annual CFC-113 consumption by the space rocket industry of the Russian Federation"



8 Foams Technical Options Committee (FTOC) Progress Report

The primary challenge for the foams sector is the phase-out of HCFCs in developing countries under Decision XIX/6. The blowing agent usage patterns in developed countries are now relatively mature, although there is still some limited migration from HFCs to hydrocarbons for cost reasons where performance characteristics can be met. There is a possibility that further high-GWP HFC substitution in non-Article 5 countries could be precipitated under a new Montreal Protocol amendment and this would certainly place challenges on the industry, particularly since funding is not available for enterprises in non-Article 5 countries. The TEAP response to Decision XX/8 provides an important overview of the technology options. Meanwhile the management of ODS banks in the foam sector offers both challenges and opportunities to limit the emissions of these greenhouse gases. Funding mechanisms will be a key component of solutions in both non-Article 5 and Article 5 countries.

8.1 Transitional Status

The 2006 Report of the Flexible and Rigid Foams Technical Options Committee was issued in April 2007. Subsequent updates have highlighted changes in technology and resulting transitions that have occurred in the intervening years and have particularly focused on the impacts of Decision XIX/6 (accelerated phase-out of HCFCs) on the future direction of regional foam strategies and technology selections. Decision XIX/6 still remains a key focus of the Foams TOC along with the ongoing challenges presented by ODS bank management. The following sections list key conclusions from this process as follows:

8.1.1 Transition Status – Article 5 Parties

- Decision XIX/6 continues to place pressure on the validation of HCFC alternatives in a developing country context. Pilot projects are proving to be particularly important in this process, since developed country experience is limited with a number of technologies. Two projects have already been approved for methyl formate and one for methylal. Hydrocarbon and low-GWP unsaturated HFCs (HFOs) projects are also being considered.

- Pre-blended or directly injected hydrocarbons may have a significant role to play for smaller enterprises, but safety concerns persist. The results of any pilot projects will need to be conclusive.

- The inclusion of ‘second conversions’ is currently a key component for compliance with Decision XIX/6

- Decision XX/8 highlights the interest in avoiding high-GWP alternatives to HCFCs but methodologies for evaluating the climate impact of technology transitions are still not in widespread use

- Interest in bank management opportunities continues and there are now some interesting pilot projects emerging around the major conurbations – particularly in Latin America

- Work continues on XPS technology solutions in several developing countries, including China and Turkey. This remains important because of the rate of growth of the sector and the unique XPS manufacturing equipment in use.

8.1.2 Transition Status – Non-Article 5 Parties

- Transitions to high-GWP HFC solutions are still occurring in the XPS sector in North America as the industry strives to meet the 2010 deadline for HCFC phase-out in the United States. Although the blowing agent was undisclosed in a recent press announcement, it is believed that this will primarily be HFC-134a.

- HFC use is continuing to decline in the polyurethane sector as hydrocarbon technologies continue to mature. An example is the achievement of fire performance requirements with hydrocarbon technologies in the steel-faced panel sector.

- Further optimisation of hydrocarbon technologies has largely closed the gap in thermal performance with HFC technologies. This has been partially achieved by improvements in cell morphology (size and orientation).

- The demand for innovative insulation solutions is growing as buildings become a more important component of national climate policies. There is a particular need to identify solutions for the refurbishment of existing buildings. This is stimulating the insulation industry to think creatively on the use of their products and it is clear that a broad range of technology options needs to be available. In this context, PU Spray Foam continues to be recognised as an efficient means of retrofitting a number of building types because of its versatility and low application cost..

- A series of low-GWP unsaturated HFCs are emerging as potentially significant alternative blowing agents, although the evaluation of performance, toxicity and environmental fate needs to be completed. Potential candidates exist in gaseous form at room temperature for XPS, one component foam, etc. while liquid blowing agents are potentially available for polyurethane foams. Flammability limits vary but there are some options, which might well be applicable in key applications currently using high-GWP HFCs for safety reasons (e.g. PU Spray Foam). Commercial supply is likely to be, as a minimum, 2 years from now for all except HFO-1234ze, which is already commercially available for one-component foams in Europe.

- ODS bank assessment and management is becoming a more pressing agenda item in developed countries as attention moves to building insulation as well as foams contained in domestic refrigerators.

- The potential role of carbon finance is being actively considered in both Europe and North America, although there is concern that the framework for such funding is sufficiently robust to avoid misuse of such mechanisms. There are a number of emerging methodologies to address this concern, although an international registry would also be an important component of any such plan.

8.2 Technology Update

The following table illustrates the main substitute technologies currently considered or already used in the polyurethane, extruded polystyrene/polyolefin and phenolic foam sectors. Recognising that the technology choices across the world are likely to become more homogeneous with time, the future technology choices are now listed as ‘global’.

FOAMS TOC UPDATE REPORT 2009 - TECHNICAL OPTIONS TABLE

SECTOR	DEVELOPED COUNTRIES	DEVELOPING COUNTRIES	GLOBAL	COMMENTS
	CURRENT	CURRENT	FUTURE	
POLYURETHANE RIGID				
Domestic refrigerators and freezers	c-pentane, cyclo/iso pentane blends, HFC- 245fa, HFC-134a	c-pentane, cyclo/iso pentane blends, HCFC-141b or HCFC-141b/22	c-pentane, cyclo/iso pentane blends, low GWP HFCs	
Other appliances	c-pentane, cyclo/iso pentane blends, HFC- 245fa, HFC-365mfc/227ea blends, Methyl Formate	HCFC-141b, c-pentane, cyclo/iso pentane blends, Methyl Formate	c-pentane, cyclo/iso pentane blends, low GWP HFCs, Methyl Formate	
Transport & reefers	c-pentane, cyclo/iso pentane blends, HFC- 245fa, HFC-365mfc/227ea blends	HCFC-141b, HCFC-141b/22	c-pentane, cyclo/iso pentane blends, low GWP HFCs	Potentially HFCs but no known use
Boardstock	c-pentane, n-pentane, cyclo/iso pentane blends, HFC- 245fa, HFC-365mfc/227ea blends	Limited, if any, commercial production in Art 5.1	c-pentane, n-pentane, low GWP HFCs	HFC for stringent product fire standards.
Panels – continuous	c-pentane, n-pentane, HFC- 245fa, HFC-365mfc/227ea blends	HCFC-141b & minor use of C-pentane, n-pentane	c-pentane, n-pentane, low GWP HFCs	HFC for stringent product fire standards
Panels discontinuous	HFC- 245fa, HFC-365mfc/227ea blends, c-pentane, n-pentane	HCFC-141b	c-pentane, n-pentane, low GWP HFCs, Methyl Formate	HFCs, not HCs, for SMEs
Spray	HFC- 245fa, Supercritical CO_2 CO_2 (water),	HCFC-141b	HFC- 245fa, Supercritical CO_2, CO_2 (water),	
Blocks	c-pentane, n-pentane, HFC- 245fa, HFC-365mfc/227ea blends	HCFC-141b	c-pentane, n-pentane, low GWP HFCs, Methyl Formate	HC use increasing
Pipe-in-pipe	c-pentane, n-pentane, HFC- 245fa, HFC-365mfc/227ea blends	HCFC-141b	c-pentane, n-pentane, low GWP HFCs, Methyl Formate	
One Component Foam	Mixtures of propane, butane and dimethyl ether, HFC-134a, HFO-1234ze	HCFC-22, HFC-134a	Mixtures of propane, butane and dimethyl ether, HFO-1234ze	HC use driven by cost and legislation
POLYURETHANE FLEXIBLE				
Integral Skin	CO_2 (water), HFC-134a, HFC- 245fa, HFC-365mfc/227ea blends, n-pentane	CO_2 (water), HCFC-141b	CO_2 (water), n-pentane, low GWP HFCs	HFC-134a is main HFC
Shoe Soles	CO_2 (water), HFC-134a	CO_2 (water), HFC-134a	CO_2 (water), low GWP HFCs	HFC-134a is main HFC
PHENOLIC				
Board & block	Isopentane, n-pentane, minor use of HFC-365mfc/227ea blends	HCFC-141b	HCs	HFCs are used to retain fire performance in some markets
EXTRUDED POLYSTYRENE				
Boardstock	HCFC-142b/(22), HFC-134a, HFC-152a, CO_2, CO_2/ethanol, (HCs in Japan), blends of CO_2/hydrocarbons	Mainly HCFC-142b/22 but growing HCFC-22. Some minor use of HCs	CO_2, blends of CO_2/ ethanol or CO_2/hydrocarbons, low GWP HFCs	HCFC-142b use in North America until 2010. Final choice is end-product specific
NOT-IN-KIND INSULATION				
Domestic Buildings	Glass fibre, rock fibre, cellulose	Limited NIK insulation types	Awaiting new technology	Fibre insulation is default based on cost
Non-domestic Buildings	Glass fibre, rock fibre	Limited NIK insulation types	Awaiting new technology	Market share reducing on efficiency grounds
Industrial applications	Mostly rock fibre, calcium silicate	Limited NIK insulation types	Awaiting new technology	Choice driven by operating temperature

9 Halons Technical Options Committee (HTOC) Progress Report

The Halons Technical Options Committee (HTOC) met in Brussels, Belgium on March 9 -11, 2009. HTOC members in attendance were from Article 5 countries: China, India, Jordan, Kuwait, and South Africa; CEIT: Russian Federation; and the non-Article 5 countries: Canada, Denmark, Italy, Japan, United Kingdom, and United States. The following is the update for 2009.

9.1 Halon 2401 Uses and Supplies.

It was previously reported that significant quantities of halon 2402 that were produced under an Essential Use Exemption, were used as a process agent in the Russian pharmaceutical industry. As the supply decreased and the price of halon 2402 increased, its use as a process agent stopped.

It is now being reported, however, that halon 2402 is being commercialised in a new specialty flame retardant paint, where the halon is encapsulated and only released when it gets hot, presumably from exposure to a fire. It is unclear how much halon 2402 may get used in this application.

In addition, Ukraine was reported to have 640 MT of halon 2402 in 2004 but reports from 2008 now only identify 300-340 MT. It is unclear what has happened to this halon.

As reported in the response to Decision XIX/16, there is no apparent immediate shortage of halon 2402 on a global basis, but there are regional disparities (primarily in defence and aviation) where users are having problems meeting their demands for recycled halon 2402 today. HTOC expects that it is likely that this will continue in the future, with the cost of the recycled halon 2402 being a major issue. New uses beyond traditional fire protection or other losses as process agents, etc., will make the situation worse. For the short term, excesses in the United States and the European Union may provide relief to the regional imbalances. The HTOC will continue to monitor the situation and plans to increase information on halon 2401 supplies, demand and emissions in the 2010 assessment.

9.2 Update on Halon 1301 Use as a Feedstock

It has been reported to the HTOC that there are now ten plants in China producing halon 1301 for use as a feedstock in the manufacture of the pesticide, Fipronil. It appears that their significant former capacity to make halon 1301 for fire protection use is now being used to support the feedstock requirements.

9.3 International Civil Aviation Organization (ICAO) Update

Owing to a changeover of personnel at the ICAO, the finalisation of changes to their Annexes has taken longer than originally anticipated. As a result, it is expected that the recommended dates for mandatory use of halon alternatives in commercial aircraft may slip by one or two years. The recommended dates in ICAO resolution, A36-12, adopted in September 2007, were as follows:

- 2011 for lavatories for new production aircraft
- 2011 for lavatories, hand-held extinguishers, engine nacelles and auxiliary power units for aircraft for which a new application for type certification has been submitted
- 2014 for the replacement of halon in hand-held extinguishers for new production aircraft

The HTOC anticipates that the 2011 and 2014 dates will likely slip to 2013 and 2015, respectively, and are the likely final dates for implementation by ICAO.

9.4 Regional Emissions of Halons

Unpublished data on the emissions of halon 1211 and 1301 for NW Europe, using the methodology described in Greally, B. R., et al. (2007)[1], have been obtained. The data are provided in Table 9-1 below and show that emissions of both halon 1211 and 1301 either remained relatively constant or increased during the period when non-critical halon systems had to be removed from service and halons properly disposed of in accordance with European Regulation (EC) No. 2037/2000. This regulation limited the use of halon to only very specific critical uses listed in Annex VII of that regulation.

Table 9-1: Unpublished Estimated NW European Emissions, Kilotons (metric) / year (uncertainty a factor of 2) using methodology described by Greally, B. R., et al. (2007)

	Halon 1301 (kt)	Halon1211 (kt)
1999	0.35 ±0.14	0.41 ±0.09
2000	0.36 ±0.08	0.37 ±0.07
2001	0.35 ±0.13	0.36 ±0.08
2002	0.39 ±0.12	0.44 ±0.10
2003	0.56 ±0.14	0.47 ±0.09
2004	0.66 ±0.21	0.47 ±0.08
2005	0.27 ±0.14	0.27 ±0.06
2006	0.23 ±0.13	0.29 ±0.07
2007	0.36 ±0.18	0.43 ±0.08

The installed quantities or bank of halons reported by the European Commission for all Critical Uses in all 27 European Union (EU) Member States for the year 2006 total approximately 0.95 kt of halon 1301, 0.250 kt of halon 1211 and 0.060 kt of halon 2402. Assuming that only these Critical Uses of halons remain in the EU, and scaling the NW Europe data in Table 9-1 to all 27 EU Member States based on Gross Domestic Product (scaling factor of 1.6), the average emissions of halon 1301 would be 0.37 kt in 2006 and 0.58 kt in 2007.

Comparing these with the reported installed quantities gives an average emissions rate for halon 1301 of 39% in 2006 and 61% in 2007 – both extremely high and unsustainable emission rates. Doing the same calculations for halon 1211, reveals that the emissions are higher than the reported installed base of Critical Uses for both years. Therefore, it appears that there are additional quantities of halons either installed, in storage and/or discarded that are also contributing to the measured annual halon emissions.

It is possible to estimate the smallest size of the bank of halons that would lead to these emissions by using the lower end of the emission estimate from Table 9-1 and dividing that value by the higher end of the average emission rate previously reported. For halon 1301, the highest average emission rate is 3% based on the average of 2% ±1%. For 2006, the lowest emission is 0.16 kt (1.6 x(0.23 kt - 0.13 kt)) and for 2007 it is 0.29 kt (1.6x(0.36 kt – 0.18 kt)).

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[1] Greally, B. R., et al., (2007) Observations of 1,1-difluoroethane (HFC-152a) at AGAGE and SOGE monitoring stations in 1994–2004 and derived global and regional emission estimates, J. Geophys. Res., 112, D06308, doi:10.1029/2006JD007527,

The estimated smallest bank of halon 1301 is 5.3 kt and 9.7 kt for 2006 and 2007 respectively for all 27 EU countries. This is consistent with the HTOC model estimates of an average of 6 kt for 2006 – 2007. Similarly for halon 1211, the highest average emission rate is 6% based on an average of 4%±2%. The estimated smallest bank of halon 1211 is 5.9 kt and 9.3 kt for 2006 and 2007 respectively for all 27 EU countries.

This is significantly lower than the HTOC model estimate of an average of 15 kt for 2006 – 2007, which will warrant further evaluation in the future. None-the-less, for both halon 1301 and halon 1211 the estimated installed base within Europe appears to be much larger than the reported quantities contained within the European Union Critical Uses.

A recent publication in the Journal of Environmental Science and Technology provided 2004-2006 measurements of ODS and their alternatives from the US and Mexico.[2] The results indicated that halon 1211 emissions from the U.S. were 0.6 (0.3-0.8) kt/yr (Gg/yr) and Mexico were 0.1 (0-0.3) kt/yr.

The results for the U.S. match well with the HTOC model estimate of 0.6 kt/yr emissions. The emissions for Mexico appear to be in line with estimating techniques that calculate usage and emissions based on Gross Domestic Product.

The results for halon 1301, however, are surprising. The emissions in both the U.S. and Mexico are listed at Non Detected. However, upon further investigation it was determined that the Non Detected was somewhat of a misnomer. The halon 1301 data have more scatter, which lessens the ability to correlate measured atmospheric concentrations to annual emissions. The fact that the report lists halon 1301 as Non Detected does not mean that its emissions are less than those of halon 1211 necessarily. More data on halon 1301 is expected in the near future. None-the-less, collectively, these findings may point to the increasing trend of reducing halon emissions where halon has its highest market value. This is consistent with the measured very low losses in Japan and the potentially higher emissions in Europe where halon in non-critical uses has lost its market value and may in fact be a financial liability.

[2] Millet, D. B., et al., (2009) Halocarbon Emissions from the United States and Mexico and Their Global Warming Potential, Environ. Sci. Technol., 2009, 43 (4), 1055-1060, Publication Date (Web): 22 January 2009.

10 Response to Decision XIX/16: Follow-up to the 2006 Assessment Report by the Halons Technical Options Committee

Executive Summary

In the Halons Technical Options Committee (HTOC) 2006 Assessment Report, the HTOC predicted potential regional imbalances of the halons 1211, 1301, and 2402, and the HTOC expressed concern that these imbalances could affect the availability of these halons to meet the future needs of applications that Parties' may consider critical.

In Decision XIX/16, the Parties asked the Technology and Economics Assessment Panel (TEAP) to further investigate these regional imbalances and to investigate and propose mechanisms to better predict and mitigate such imbalances in the future.

Nineteen Parties, the International Maritime Organization (IMO) secretariat, and the secretariat of the International Civil Aviation Organization (ICAO) voluntarily provided information used in this study. In addition, the contractor for the Multilateral Fund (MLF) "Study on Challenges Associated with Halon Banking in Developing Countries" provided summary information, and HTOC members contacted several Parties and the European Commission directly for additional information. Of concern to the HTOC was the need to ensure that Parties were represented in the study that have, or potentially will have, problems with halon availability to meet needs that they deem critical. Nevertheless, many Parties did not provide any comment on the availability of halon within their country and, more importantly, did not express any concern over their ability to get halons to meet their important uses. If information was not available to an HTOC member, then no response from a Party was assumed to mean that the Party had enough halon, or access to enough, to meet needs they considered critical now and for their foreseeable future.

In order to understand fully the study findings, it should be noted that the regional variation in the distribution of halons does not constitute necessarily a regional imbalance. The term "imbalance" relates to the parity of supply with demand not the actual quantities of halons present in a region. Also, the study did not judge fully the potential use of alternatives as a means to further reduce a Party's or sector's demand for halon. Instead the study has used the demands as presented by Parties or sectors to assess regional imbalances.

The results of this study are summarised as follows:

Halon 1211

Model projections place over 60 percent of the world's halon 1211 in Article 5 Parties, with the clear majority being in handheld extinguishers and unused stocks in China. In China, a large production over recent years to support projected requirements, regulations that require the decommissioning of handheld extinguishers without a clear pathway for their disposal or reuse, and the recent classification of unused halon 1211 as a hazardous waste, appear to be the major contributors to the build up of stocks. Although adequate quantities of recycled halon 1211 appear to exist globally to meet demand at this time, there are strong indications that, outside of China, sufficient quantities may not be available to meet the future projected demand. In the European Union, Russian Federation, and the United States, there is concern that the future needs of uses in the aviation and military sectors may not be met completely without access to additional supplies from outside their regions/countries.

National regulations in China and other countries are limiting the flow of excess halon 1211 to uses in other places that are observing a steady demand but reduction in supply, e.g. the United States whose tax on imported recycled halon 1211 acts as a "de facto ban" on imports, limiting the supply in the United States to the installed base. National regulatory authorities may wish to explore ways to increase the flow of halon 1211 from China to other Parties to mitigate this imbalance, although without some action by the Parties, a large stock of newly produced but unused halon 1211 would not be able to be exported in bulk, only in equipment such as portable extinguishers.

Halon 1301

In contrast to the halon 1211 situation, the HTOC model projects that Article 5 Parties have less than 20 percent of the world's halon 1301. Although Article 5 Parties were not traditionally large users of halon 1301, its future availability is a cause of concern for some Article 5 Parties that traditionally imported newly produced halon 1301. In carrying out halon banking projects funded by the MLF, some Implementing Agencies interpreted a decision taken at the Eighteen Meeting of the Executive Committee of the MLF to require the banning of all imports of halon – including recycled. For Parties trying to implement halon banking, the unavailability of recycled halon has been problematic. The HTOC has always advocated the free movement of recycled halon world-wide in order to enable halon banking to function where needed. Parties may wish to consider removing barriers to the free trade in recycled halons.

China indicated that its stocks of halon 1301 may not meet all the future needs of uses it considers critical, and they are considering a nomination for an essential use production exemption for halon 1301. This is surprising since although China has been a major producer of halon 1301, traditionally they have not been a major consumer. In addition, China may wish to consider destroying some of their excess halon 1211 to create ODP credits that could then be used for additional production/consumption of halon 1301 without the need for an essential use production exemption.

No non- Article 5 Parties expressed concern about the availability of halon 1301 to meet the needs of their uses or of its future availability. This might be due to the market penetration of alternatives in areas traditionally served by halon 1301 making the removed halon readily available for recycling. Japan, the military, and aviation sectors continue the installation of new fire protection systems based on halon 1301. Japan has a single organisation that maintains strict reporting requirements for stocks and emissions of halon 1301, and which controls system recharge for existing and new installations. Given its preference for manually activated halon systems, it is not surprising that Japan has low emissions, an increasing percentage share of world-wide halon 1301, and an accurate prediction of its future needs. This type of predictive model may not be suitable for all Parties and sectors. However, other sectors or Parties with high demand, such as the United States, may wish to consider getting a better understanding of existing emissions to enable them to better predict future availability of recycled halons. User/supplier sponsored voluntary reporting of system recharges may help accomplish this.

Halon 2402

National and/or international regulations that inadvertently complicate or prohibit the transfer of halons between Parties have less influence on the problem of regional imbalances of halon 2402 than were initially reported. While there is no apparent shortage of halon 2402 on a global basis, there are regional problems in some sectors (primarily in defence and aviation) where users are having problems meeting their demands for halon 2402, and will continue to do so in the future, with the cost of recycled halon 2402 being a major factor.

Halon 2402 has had small market penetration outside of the former Soviet Union and Parties that purchased military equipment from the Soviet Union. As such, the availability of data outside of the major consuming Parties, Russia and the Ukraine, is scarce, and both of these report a balance of availability and demand for now and the foreseeable future. Based on the small bank of halon 2402 that exists world-wide, Parties or sectors with an ongoing need for halon 2402 may wish to consider assessing their requirements and taking advantage of the existing and predicted short-term availability of unwanted agent in the United States and the European Union before these excesses are considered for destruction.

Halon Banking in Article 5 Countries

Halon banking, the recycling of existing halons, and the free movement of supplies to meet demands, are crucial to the continued availability of halons for life safety applications without the need for an essential use production exemption. The MLF has funded thirty-eight projects within the halon banking category whose results have been a mixed. A study done in 2004 for UNEP DTIE OzonAction found that 80 percent of decommissioned halon in Africa was too contaminated for reusing or recycling with equipment normally supplied with projects funded by the MLF. Only about 20 percent of the country/regional halon banks that have been established considered themselves capable of recycling halons for reuse within the country/region. This will directly impact future halon supply/demand in the affected countries. Parties may wish to consider strategies and propositions that will help non-functioning halon banking operations to become functional and bank managers to ensure the long-term sustainability of their halon banking operations.

Aviation

Aviation is a sector that has a long term need for all three halons both for in-production and in-service aircraft. Currently, while aircraft manufacturers and operators do not appear to be experiencing shortages of recycled halons to meet their needs, there is some evidence that, in some regions/countries, their suppliers are finding it more difficult to meet their requirements. As a global sector that has a long term need for halons, the aviation industry will likely experience shortages of halon 1211 in some regions/countries in the near future. Although alternatives are available for lavatory extinguishing systems, hand-held extinguishers, and engine nacelle and auxiliary power unit extinguishing systems, in some instances the practicalities of using them on the existing fleet of aircraft are very challenging and costly.

Predicting and Mitigating Imbalances

This study provides an overview of the availability of halons 1211, 1301, and 2402 in the countries that principally rely on them for fire protection purposes. It also highlights the disproportionate distribution of the remaining quantities of these halons, areas where supply costs are impacting demand, and where future supplies may not be available at any cost.

The disproportionate distribution of halons does not necessarily equate to an imbalance in supply and demand, although in the case of halon 1211 this is what is happening. Parties may wish to explore ways to encourage the flow of halon 1211 on the international market to mitigate this imbalance.

The situation with halon 1301 is less clear, with only one Party expressing a serious concern about availability. The market penetration of alternatives in areas traditionally served by halon 1301 is likely making the recovered halon readily available for recycling and the servicing of important uses. Parties may wish to explore ways to increase the market penetration of alternatives in order to encourage the flow of halon 1301 from applications where there are alternatives to those where there are not.

The world-wide bank of halon 2402 is small and the majority of it is held by the two major consuming Parties, who indicate an ongoing need. Nevertheless, currently there is a predicted short-term surplus on the international market that may satisfy the needs of Parties with demand but no internal supply. Parties may wish to explore ways to assess their needs and ensure that halon 2402 is not destroyed before existing demands are met.

Finally, without significantly more regional and sectoral information, e.g., detailed surveys from Parties, there does not appear to be any way to formulate a predictive model to project future or pending regional imbalances between supply and demand. Where the costs of recycled halons can be tracked, these may be indicative of local imbalances in supply/demand. However costs are not the only influencing factor.

10.1 Introduction

10.1.1 Task

This Report responds to the following requests of the Parties to the Montreal Protocol as set out in Decision XIX/16:

Decision XIX/16: Follow-up to the 2006 assessment report by the Halons Technical Options Committee

Welcoming the 2006 assessment report of the Halons Technical Options Committee of the Technology and Economic Assessment Panel,

Welcoming also the continuing reduction in global halon use,

Noting the concern expressed by the Halons Technical Options Committee about the availability of certain halons around the world,

1. To request the Technology and Economic Assessment Panel to undertake a further study on projected regional imbalances in the availability of halon 1211, halon 1301 and halon 2402 and to investigate and propose mechanisms to better predict and mitigate such imbalances in the future;

2. To request the Technology and Economic Assessment Panel, when undertaking the study, to consult with the Secretariat of the Multilateral Fund on the outcomes of its study on the operation of halon banks around the world and to use such information from that study as may be relevant to its own review;

3. To request the Ozone Secretariat to make available 2004, 2005 and 2006 halon consumption figures by type of halon to the Technology and Economic Assessment Panel for its study;

4. To request the Technology and Economic Assessment Panel to submit its study in time to allow the Twentieth Meeting of the Parties to consider its results;

5. To encourage Parties which have requirements for halon 1211, halon 1301 and halon 2402 to provide the following information to the Ozone Secretariat by 1 April 2008 to assist the Technology and Economic Assessment Panel with its study:

(a) Projected need for halon 1211, halon 1301 and halon 2402 to support critical or essential equipment through the end of its useful life;

(b) Any difficulties experienced to date, or foreseen, in accessing adequate halons to support critical or essential equipment;

6. To encourage Parties, on a regular basis, to inform their critical users of halons, including the maritime industries, the aviation sector and the military, of the need to prepare for reduced access to halons in the future and to take all actions necessary to reduce their reliance on halons;

7. To request the Ozone Secretariat to write to the International Maritime Organization secretariat and to the secretariat of the International Civil Aviation Organization to draw their attention to the decreasing availability of halons for marine and aviation uses and to the need to take all actions necessary to reduce reliance on halons in their respective sectors.

In responding to the Decision, the Technology and Economic Assessment Panel requested its Halons Technical Options Committee (HTOC) to continue the investigative work begun during its 2006 Assessment, which led it to express concern about the availability of certain halons around the world.

10.1.2 Structure of the Study

The study looked at the availability of halons by considering type of halon, major use sectors, and traditional regional marketing/use patterns. Early on it became clear that, because of the specialised and world-wide application of all halons in the Aviation and Merchant Shipping sectors, these sectors should be considered on a global rather than regional basis. Also, owing to the almost exclusive application of halon 2402 to equipment supplied by the former Soviet Union, the availability of halon 2402 in the regions was also studied from a world-wide perspective. For halon 1211 and halon 1301, the study focused on countries in regions where halon marketing and application dependencies had been similar. The study report is thus structured as follows:

Halon 1211 & Halon 1301

Asia; Europe; Middle East, North and West Africa; South and Central America; North America and Australia; South America.

Halon 2402

World-wide

All Halons

Aviation; Merchant Shipping.

10.1.3 Data Gathering

During December 2007, the HTOC co-chairs assisted the Ozone Secretariat in the preparation of required letters to the International Maritime Organization (IMO) secretariat, to the secretariat of the International Civil Aviation Organization (ICAO) and to each Party. The HTOC met January 21st to 23rd 2008 in Manchester, U.K. to discuss currently available data, the structure of the study and the schedule for the report delivery. The HTOC also met March 9th to 11th 2009 in Brussels, Belgium to finalise the report and ensure that the most recent data were included in it.

Direct responses to the Ozone Secretariat's information requests were received from IMO, ICAO, and nineteen Parties. In addition, HTOC members contacted several Parties and the European Commission directly for additional information. Of concern to the HTOC was the need to ensure that Parties having problems with halon availability to meet the needs that they deem critical were represented in the study. Nevertheless, many Parties did not provide any comment on the availability of halon within their country and, more importantly, did not express any concern over their ability to get halons to meet their important uses. If information was not available to the HTOC, then no response from a Party was assumed to mean that the

Party had enough halon, or access to enough, to meet the needs that it considered critical now and for the predicted future.

The MLF "Study on Challenges Associated with Halon Banking in Developing Countries" began in October 2008. At the time of writing, the study is not complete and no report has been made available for the HTOC's use. However, the study contractor has made available relevant information that was collected during the information gathering stage of the project that has been used by this study.

10.1.4 Study Delivery

In Decision XIX/16, the Parties to the Montreal Protocol requested that the Technology and Economic Assessment Panel submit its study in time to allow the Twentieth Meeting of the Parties to consider its results.

In order to meet this deadline it was necessary that information from Parties be available by April 1st 2008 and that the MLF "Study on Challenges Associated with Halon Banking in Developing Countries" be available during this study's investigations. Unfortunately, these were not available and it was decided to give Parties more time to respond and the MLF more time to complete its study. The new schedule called for this report to be available in time for the twenty-ninth meeting of the Open Ended Working Group.

10.1.5 Regional Imbalances

The regional disparity in the distribution of halons does not constitute necessarily a regional imbalance. The term "imbalance" is meant to relate to the parity of supply with demand not the actual quantities of halons present in a region. For example, Japan has a large percentage of the global bank of halon 1301 but also has a high demand, and therefore this does not represent a regional imbalance. Likewise, the United States has a small amount of halon 2402 available but an even smaller demand, while Vietnam and India have unfilled demands. This constitutes a regional imbalance.

This study has not judged the potential use of alternatives as a means to further reduce a Party's or sector's demand for halon. Instead the study has used the demands as presented by Parties or sectors to assess regional imbalances.

10.2 Halon 1211 and Halon 1301

10.2.1 Summary

The estimated global inventories of halon 1211 and halon 1301 are essentially unchanged from those presented in the HTOC 2006 Assessment. Based on those estimates, the HTOC is still of the opinion that adequate stocks of both halons currently exist globally to meet the future servicing and replenishment needs of existing fire equipment until the end of their useful lives. Nevertheless, in order for this to occur, some rethinking on the part of regulators and users may be necessary, particularly in the area of import/export of recycled halons.

Model projections estimate that over 60 percent of the world's halon 1211 is in Article 5 countries, with the majority being in handheld extinguishers and unused stocks in China. A large production over recent years to support projected requirements, and recent regulations that require the decommissioning of handheld extinguishers without a clear pathway for their disposal or reuse, appear to be the major contributors to the build up of stocks. Nevertheless, some A5 Parties report that the price of halon 1211 is rising, indicating that past production from China is being replaced by more costly recycled halon. In some Article 5 countries, e.g. India and parts of Africa, virtually no recycling of halon 1211 is taking place owing to severe contamination of the agent with other products such as CFC-12.

In contrast to the halon 1211 situation, Article 5 Parties have less than 20 percent of the world's halon 1301. Although Article 5 Parties were not traditionally large users of halon 1301, its future availability is a cause of concern for some Article 5 Parties, particularly China, where additional production capacity has been diverted to feedstock for use in the production of the pesticide Fipronil. In addition, some Article 5 Parties that traditionally imported newly produced halon 1301 have banned all imports of halon – including recycled – as a condition of MLF funding of halon banking projects. For Parties trying to implement halon banking, the unavailability of recycled halon has been problematic. The HTOC has always advocated the free movement of recycled halon world-wide in order to enable halon banking to function where needed. The contamination of halon continues to be a problem for Article 5 Parties trying to operate recycling facilities. The results of halon projects funded by the MLF have been a mixed. Negatively affected Parties may wish to investigate what additional actions they should take to improve their ability to meet their future halon needs.

In non-Article 5 countries, recycled halon 1211 has recently become more expensive, indicating that supplies are lessening. In the European Union there is some concern that the future needs of their critical uses in the aviation and military sectors may not be met fully without access to additional supplies from outside the region. Similarly, in the United States, a penalising and rising tax on the importation of recycled halon 1211 is impeding access to additional supplies from outside the country in a tightening market. No non-Article 5 Party expressed concern about the availability of halon 1301 to meet the needs of its applications current or future. Japan has by far the largest bank of halon 1301, and on a percentage basis this will grow in time. This is because Japan is an excellent steward of its halon 1301 bank and its emissions are very low. Japan has elected to rely on halon 1301 in systems that some might not consider critical, rather than move to alternatives that may bring other environmental problems. Its halon management system promotes recovery and recycling of halons, the prevention of unnecessary emissions, and the strict reporting of recharging of systems. Halon availability in Japan is considered to be well balanced with needs, and no surplus is available for export.

The United States relies on market forces to determine the criticality of a use and supplements domestic recycled halon supplies with imports from other nations. Since there is no central reporting, the HTOC cannot confirm existing model predictions. The United States may wish to consider the voluntary disclosure of annual system recharge quantities to facilitate this.

10.2.2 Introduction

In its 2006 Assessment, the HTOC updated the inventory and emission models of halon 1211 and halon 1301 taking into account reported data on destruction, inventories and emissions, where available, and additional expert opinion on past practices. Additional data received since then does not significantly affect the predictions of the 2006 HTOC Assessment Report. The 2006 Assessment estimated that at the end of 2005 the global halon 1211 bank was approximately 90,000 metric tonnes (MT), and the global bank of halon 1301was approximately 50,000 MT. Based on these estimates, the HTOC is of the opinion that adequate global stocks of halon 1211 and halon 1301 currently exist to meet the future service and replenishment needs of Parties' critical or essential halon 1211 and halon 1301 fire equipment until the end of their useful lives.

Figure 10-1: Breakout of Global Inventories (Bank) of Halon 1211 by HTOC Model Regions

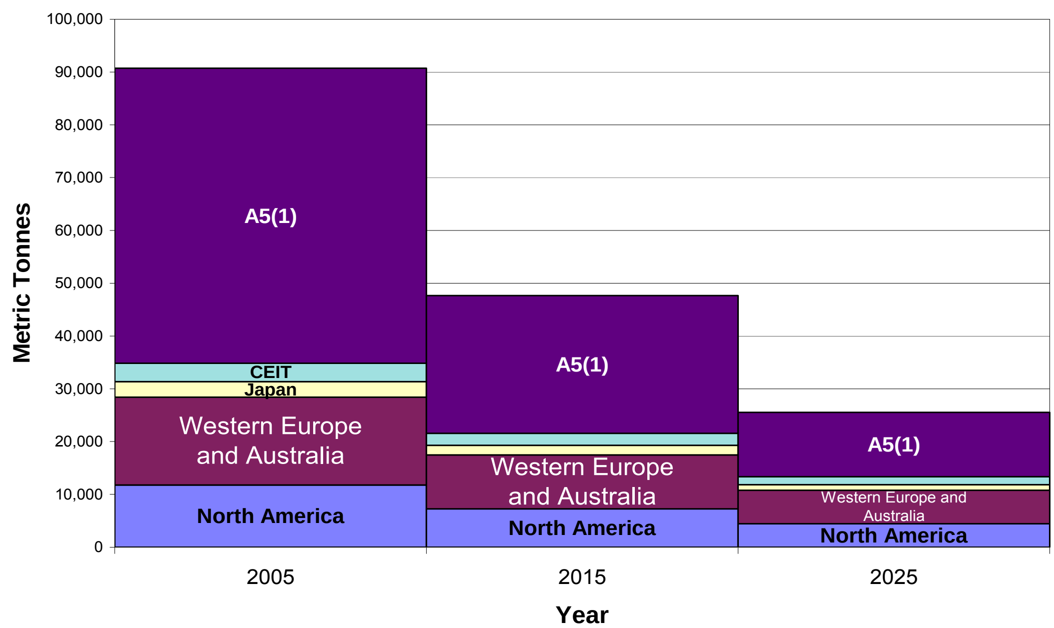
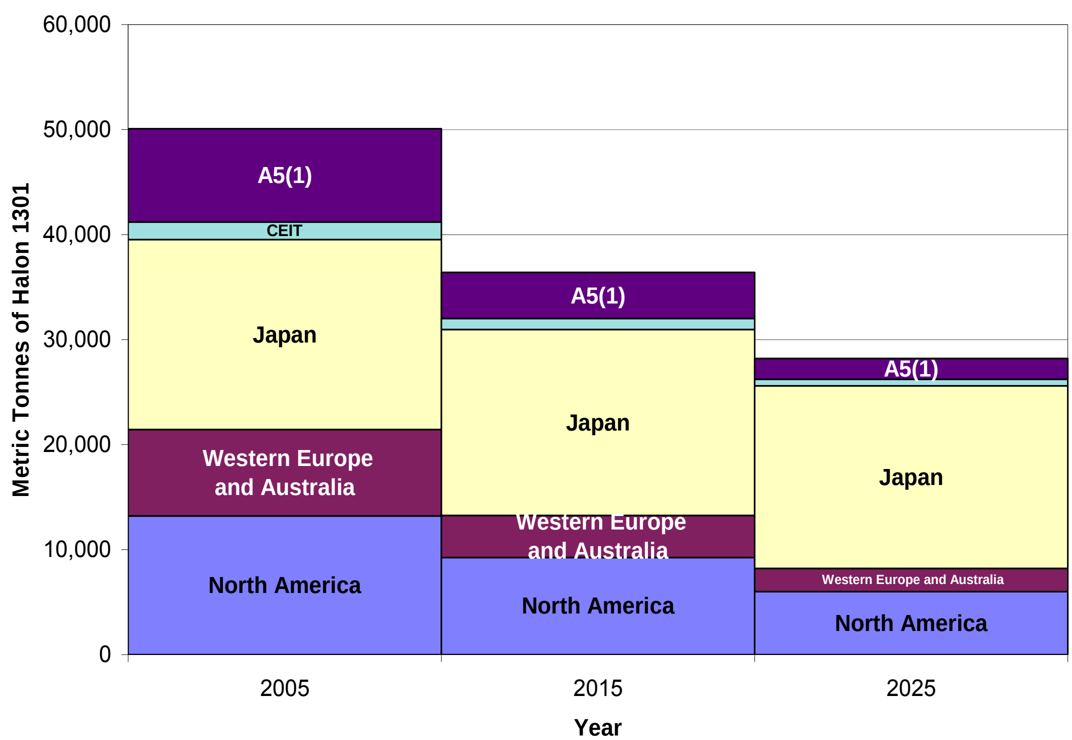


Figure 10-2: Breakout of Global Inventories (Bank) of Halon 1301 by HTOC Model Regions



10.2.3 Asia

It appears that adequate supplies of halon 1211 and halon 1301 should be available on a global basis through 2025. Model projections for halon 1211, based on Article 7 reporting of production and consumption, estimate over 60 percent of the halon 1211 to be in Article 5 countries (see Figure 10-1), with the majority being in handheld extinguishers and unused stocks in China. Over 35 percent of the global stock of halon 1301 is projected to be in Japan by 2025 (see Figure 10-2). By 2025 the majority of the bank of halons is likely to be in Asia.

Two Parties still produce halons in Asia; the Peoples Republic of China and the Republic of Korea. However, both will have ceased production for fire protection applications by January 1, 2010.

10.2.3.1 Japan

Following adoption of Decision X/7 at the 10th Meeting of the Parties, Japan developed a National Halon Management Strategy. They established a halon management system primarily through the Fire and Environment Protection Network and other stakeholders such as the Fire Service Authorities and private bodies in the Japanese fire service industry. Japan manages its halon by promoting recovery and recycling of halons, preventing unnecessary emissions, and ensuring the fire protection and safety of buildings in accordance with the Strategy.

Halon 1211 is mainly used in portable extinguishers, which are considered essential for the safety of life and buildings in Japan, and it is a practice that they intend to continue.

Halon 1301 is widely used in fire fighting systems in buildings, civil vessels, civil aircraft, military and government agency applications, as required by the Japanese Fire Service regulations, with new systems still allowed. Currently, 100 to 200 MT of halon 1301, out of approximately 17,000 MT installed, are recovered annually from existing fire protection systems (0.6 to 1.2 percent) and recycled for new installations. Furthermore, emissions due to fire suppression are approximately 10 to 20 MT (0.06 to 0.1 percent) per year.

The military has secured its own halon supply from the market. Japan has the lowest halon emissions rates and manages its halon very well. Although the Government of Japan is pressing for fire protection system changes to halon alternatives, the current halon management strategy is generally considered by them to be the better option for both the environment and fire protection in Japan. There is concern by the Japanese Fire Service that forced changes to alternatives will result in a fear of uncertainty amongst halon users, which may lead to illegal halon release. According to its 2008 study of halon needs, no surplus for export is predicted nor imports required at this time.

10.2.3.2 China

By the end of 2005, China had completed the phase-out of halon 1211 production. However, the producer had stockpiled approximately 2400 MT halon 1211. Meanwhile, it is estimated that a large amount of halon 1211 portable extinguishers are in the hands of end-users, and a lot of halon 1211 is coming out of service as these portables reach 5-year servicing dates – recharge is not permitted. It is not known what is happening to the halon although it has been reported that it is now classified as a hazardous waste. China reported that the stockpiled halon 1211 is in excess of its needs and this recent classification as a hazardous waste may restrict its availability to the international market. Previously, China reported that it was planning to start recycling of halon 1211 from out-of-service portable extinguishers and, if this was successful, China could provide recycled halon 1211 to the international market. Exporting halon 1211 from China could alleviate some of the civil aviation industry's concerns regarding a shortage to meet world-wide civil aviation needs.

Since 2006, the production ceiling for halon 1301 has been 100 MT per year, and production will continue until the end of 2009. According to the information provided, China will have a need for halon 1301 for applications that it considers critical beyond 2010. The quantity required has not yet been calculated. China is planning to start recycling halon 1301, and hopes that this recycled material partially will meet the needs of uses that it deems critical.

Separately from fire protection, China's halon 1301 production capacity is being used to produce halon 1301 for use as a feedstock in the production of the pesticide Fipronil. Over the past few years approximately ten plants have started to manufacture Fipronil in China.

The Chinese Ministry of Environmental Protection has indicated that it is highly unlikely that stocked and recycled halon 1301 will meet all the future needs of uses that it considers critical, and China is considering a future nomination for an essential use production exemption for halon 1301. This is surprising since although China has been a major producer of halon 1301, traditionally it has not been a major consumer. In addition, China could destroy some of its excess halon 1211 to create ODP credits that could then be used for additional production/consumption of halon 1301 without the need for an essential use production exemption.

China is an example of a country that has a supply and demand imbalance, with significant excess supply of halon 1211 and a potential shortfall in supply of halon 1301.

10.2.3.3 Republic of Korea

The Republic of Korea continues to produce both halon 1211 and halon 1301. The most recent production figures are shown below in Table 10-2.

Table 10-2: Republic of Korea Halon Production

	2006	2007	2008	2009 (Forecast)
Halon 1211 MT	80	0	246	123
Halon 1301 MT	123	110	110	147
Total MT	203	110	356	270

Korea has not exported any halon for at least two years. For the past five years it has been importing bulk halon 1211 and approximately 60 MT per annum of halon 1211 in the form of small portable fire extinguishers from China. For the year 2008, it is believed that the amount of halon 1211 imported into Korea from China increased to 90 MT.

There has been no serious shortage of halon in Korea despite a price increase of 20 percent for halon 1211 and 30 percent for halon 1301 in 2008.

10.2.3.4 India

As reported in 2000-2001, the quantity of halon 1211 installed in portable extinguishers, mobile and fixed local flooding systems was 3,000 MT. However, most of this has since leaked away owing to poor quality extinguishers and maintenance practices. There is no recovery, recycling or refilling of halon 1211 taking place because of the poor quality of the agent, which has been mixed with CFC-12 and other contaminants. Surplus extinguishers are disposed of without agent recovery. It is estimated that the Indian military will need approximately 100 MT of halon

1211 over the next 15 to 20 years. The current halon 1211 inventory is approximately 100 MT, with users being the military, aviation, and some telecommunications and electronic industries. As well as leakage, the reduction in inventory is also partially due to the replacement of halon 1211in portable extinguishers with carbon dioxide, dry powder, and halocarbon alternatives.

As reported in 2000-2001, the installed quantity of halon 1301 was 1,000 MT. This has since been reduced to approximately 600 MT, with major users being the military, the power, oil, telecommunications, and electronic industries. Some decommissioned systems have been replaced with carbon dioxide and halocarbon alternatives, but the extent of this is not known. Emissions from existing systems are small, and no new systems are being installed in the private sector. However, the military continues to use halon 1301 for applications that it considers critical. It is estimated that the military needs approximately 100 MT of halon 1301 over the next 15 to 20 years.

The National Halon Recycling facility is now operating. Halon is recycled and reclaimed for applications that India considers critical on a regular basis and free of charge for the users. No technical problems have been found in running the National Halon Recycling facility so far. Also, there have been no reported cases in the private sector of Indian users having problems finding halon 1211 or halon 1301 for applications that India considers critical. The private sector seems to use the halon recycling centres operated on a commercial basis by private fire equipment companies in preference to the National Halon Recycling facility. The halon for recycling comes primarily from the break-up of decommissioned ships. This material is supplemented by imported recycled and virgin halon to meet needs that India considers to be critical. The National Halon Recycling facility does not hold an inventory of halon 1211 or halon 1301.

Within the country, consumption of halons has been reduced from 3650 ODP tonnes in 1991 to 70 ODP tonnes in 2004. Halon 1211 and halon 1301 are still extensively used in the military and, although continued use in these applications beyond 2010 is permitted, there is concern that availability of supply will be a serious problem in the future. It appears that there is a lack of co-ordination between the three military services and the National Halon Recycling facility.

Each of the three military services is in the process of establishing independent banking facilities to support their own service equipment. These banks are spread throughout India with more than one facility supporting each individual service. The scope and capability of these facilities are not known, nor how much, if any, stockpile is held at these facilities to support the equipment. Some within the services also mistakenly believe that recycled halons reduce the efficiency of the product and that considerable losses occur during the recycling process.

Although there is no legislation for mandatory decommissioning of halon systems, no new systems will be allowed after 2010, except for certain applications for which alternatives do not exist. It is anticipated that these uses may require a total of 100 MT of each of halon 1211 and halon 1301 over the next 10-15 years. Much of this will have to be imported, recycled material. Difficulties are expected because recycled halon costs four to five times more than past virgin halon imports. India does not currently anticipate a future need for an essential use production exemption to meet its halon 1211 and halon 1301 requirements.

10.2.3.5 Pakistan

Pakistan has reported that it implemented a project funded by the MLF to establish a national halon banking facility too late, and that remaining halon users are not utilising the bank due to the lack of regulations requiring them to do so. The current installed base of halons is unknown as is the potential future needs of Pakistan; however, it is believed there are not many halon systems in service any more. It is reported that many users and organisations switched to halon alternatives before the banking facility was established.

10.2.3.6 South East Asia – Indonesia, Malaysia, Singapore, Thailand

Basically, there is a plentiful supply of halon 1301 in the region of South East Asia. Most of the halon comes from the decommissioning of ship fire protection systems. As a major regional ship repair and maintenance centre, Singapore has more than an adequate supply of halon for itself from this source. Most of the halon is channelled to aviation use for aircraft that are sent there for servicing. There are no buyers from neighbouring countries such as Malaysia, Indonesia and Thailand, which implies that these Parties are probably not facing any supply problems.

The Indonesian Halon Bank was officially launched in 2003 and was intended to receive halon from uses considered non-critical by them in order to supply recycled halon to uses that they consider to be critical. The implementation was assisted by the MLF with project completion in 2006. The banking operations include storage and recycling/reclamation. The MLF project included a survey of halon systems and extinguishers in Indonesia and found a reported 31.5 MT of installed halon. It is believed that there is as much again in unreported halons currently in use. The vast majority of the country's installed base is halon 1301 with a small remaining quantity being halon 1211. The national halon facility has collected 18 MT of halon, which remains in storage for uses that they consider to be critical. Indonesian regulations prohibit selling or supplying halon from the national bank except to users that they consider have critical applications. There are currently only three companies that they list in this category; two oil companies and an aviation organisation that services the global aircraft fleet. To date there have not been any requests from the military services. The national bank manager believes that they have enough halon 1301 for their critical users, but they will need to purchase halon 1211 for the aviation sector in the near future. The national halon banking activities are conducted by a private company, PT GMF-Aero Asia (a subsidiary of Garuda Indonesia), and it has indicated that without additional financial support, the operations are not sustainable for the foreseeable future.

In 1996, Malaysia received assistance from the MLF to establish a halon bank. In 2000, the management of the halon bank was assumed by the Fire and Rescue Department. To date they have collected approximately 10 MT of halon 1211 and 157 MT of halon 1301 from surrendered fire suppression equipment and systems. This halon has been recycled to supply uses such as in the aviation sector and the military. Malaysia does not anticipate any need to import halon from outside sources.

Thailand received assistance from the MLF to establish a Halon Management Programme including a recycling/recovery and banking facility. It has indicated it will not be implementing a physical halon bank and instead has opted for a virtual bank. Thailand anticipates completing the implementation of the Halon Management Programme in mid-2009. It has indicated that it will need to develop requirements for selling and purchasing halon. However, it is not yet clear what exactly will be those needs and whether they can be met by supplies within the country.

Given the above, the South East Asia region is considered to be currently in balance for supply/demand of halon 1211 and halon 1301, but that importation of halon 1211 will likely be required in the future.

10.2.4 Europe

10.2.4.1 European Union

In the 27 Member States of the European Union, halon 1211 and halon 1301 are controlled substances in Group III of Annex I to Regulation (EC) No 2037/2000 on substances that deplete the ozone layer ("the Regulation"). The Regulation prohibits the production of the halons and restricts their use to certain critical uses set out in Annex VII to the Regulation. It also prohibits all non-critical (i.e., non-listed) halon uses; those non-critical halon systems must, since 2003, be converted to alternatives or be decommissioned. The listed critical uses can be supported only by using stocks of recovered and recycled material from decommissioned systems and extinguishers, storage facilities or the commercial market.

The Regulation also controls trade. Imports of halons into the European Union from Parties to the Montreal Protocol are permitted for the Annex VII critical uses, subject to quantitative limits determined annually and the issue of an import licence by the European Commission. Imports of halons, or products that contain them, are not permitted from States that are not Party to the Montreal Protocol.

The export of halons from European Union Member States is permitted until the end of 2009, provided that the substances are intended for use in critical uses as defined under the Regulation and provided that they come from a storage or recycling facility authorised or operated by the competent authority (normally the environment ministry) of a Member State. The exports are subject to annual authorisation in advance by the European Commission. After 2009, exports will only be permitted when the halons are incorporated in products or equipment that are considered to be critical use applications. Thus, export of bulk quantities of recovered halons will not be permitted.

Member States' governments are also required to report annually on their critical uses of halons, providing information on the quantities installed, used and emitted, and on the progress being made in replacing them with alternatives.

The Regulation will change at the beginning of 2010. The new Regulation will remove the current time limit on export of recovered halons for uses deemed critical. Import and export will therefore be allowed, subject to authorisation and licensing in advance.

The Regulation's Annex VII is also under review because of the increased availability of alternatives since the list was last amended. The intent is to reduce the number of permitted uses and introduce end-dates for those remaining uses. This will provide a clear incentive to users to replace halons wherever feasible.

Halon uses that are considered to be critical by Member States are found in the defence (primarily in ships, submarines, armoured vehicles and military aircraft), civil aviation (aircraft and airports), oil and petrochemical and nuclear power sectors. Halons continue to be used also in some commercial cargo vessels, military and civilian command and communications facilities, and in the Channel Tunnel infrastructure and railway rolling stock.

The total installed quantities reported by Member States for the year 2006 were approximately 950 tonnes of halon 1301 and 250 tonnes of halon 1211. Of these totals, approximately 60 percent is contained in the military applications, mainly in ground combat vehicles (30 percent) and surface ships (25 percent). In civilian applications, approximately 15 percent of the total is accounted for by commercial aviation. A similar quantity is contained in commercial cargo ships, though the industry has made considerable progress in replacing halon machinery space and engine room fire protection systems, which are not considered to be critical uses by the regulatory authorities.

Some dedicated stocks of recovered and recycled halons are held by critical user organisations or by commercial fire protection or other companies on their behalf. This is particularly the case for military users in the larger Member States where dedicated storage and recycling facilities exist with sufficient stocks to support their critical use equipment until the projected end of life of the equipment concerned. The stocks are maintained by recovery of halons from retiring or converted equipment and are carefully managed to minimise losses and emissions. The larger defence ministries are, at the moment, not reliant on the commercial market and there would seem to be little flow of halons between the government and commercial sectors. However, smaller defence ministries may be obtaining the supplies they need from commercial suppliers and fire protection companies.

The larger European commercial airlines have made arrangements with fire protection companies to hold and supply stocks of halon 1211 and 1301 to meet current needs. Smaller airlines may not have made such arrangements. Other commercial sectors are similarly reliant on these companies, but do not seem to have made arrangements to hold stocks for the future. Concern was expressed about the difficulty in getting approval for the export of contaminated halons for recycling because it is not permitted by the European Union Regulation (EC) No. 2037/2000. This may therefore hinder supply and re-use of small quantities of halons by some Parties unless the halons can be recycled closer to the source.

Member States report annual usage of halons (in terms of the quantities supplied to refill extinguishers and system cylinders) and the quantities that are stored to support critical use equipment. This information is more difficult to obtain and so probably less reliable than data on installed quantities. However, across all user sectors in all Member States, usage in 2006 was reported as being approximately 3 percent of the installed quantity, which would be consistent with the 2.5 percent used for halon 1301 and 3.5 percent used for halon 1211 in the 2006 HTOC Assessment.

Across all user sectors in all Member States, the quantities of halon 1211 and halon 1301 available in 2006 to supply the identified critical uses were reported to be approximately 450 tonnes. Not all of this would be available to all users, or to the commercial market. At the current rate of demand, this represents approximately 10-15 years supply, for both halons. However, if the commercial shipping, defence and other sectors continue to make good progress in halon replacement, annual demand will continue to fall, and an additional few hundred tonnes should become available to supplement stocks over the next 5-10 years.

A number of Member States have provided additional information in response to the Decision XIX/16 request for information. None reported current, or projected, problems with obtaining sufficient supplies of halon 1301 to meet demand. Two Member States reported that the cost of halon 1211 was increasing, consistent with demand beginning to exceed supply, and expressed some concern that difficulties may arise with supplying critical aviation and military uses in the future. Some fire protection companies have also indicated that they are finding it increasingly difficult to obtain supplies of halon 1211 to meet the projected needs of their customers.

10.2.4.2 Georgia

Georgia has implemented a halon project funded by the MLF to develop a national Halon Management Programme. It is recovering/recycling and storing halons for uses that it considers to be critical. Georgia believes it has accurate information on installed quantities of halon and it does not foresee any requirements for selling/purchasing halon in the near future.

10.2.4.3 Moldavia

Moldavia reported that it has no uses of halons that it considers to be critical and no stocks.

10.2.4.4 Norway

In Norway, production, import, export, sale and use of halons are controlled through a national regulation entitled “Regulation on ozone depleting substances”, which constitutes Chapter 6 of a broader piece of legislation entitled “Regulations relating to restrictions on the manufacture, import, export, sale and use on chemicals and other products hazardous for health and the environment (Products regulation)”. Although not a Member State of the European Union, Chapter 6 of the Products regulation implements the main points of Regulation (EC) No 2037/2000 on Ozone Depleting Substances.

With regard to fixed fire-extinguishing equipment and hand-held extinguishers containing halon, phase-out is addressed in § 6-10 and §6-11 of the regulation. According to § 6-10, installation and possession of such products and equipment has been illegal since 1st January 2004. However, the regulation allows, through § 6-11, import and sale of halon fire extinguishing products and equipment for Norway’s critical uses. These critical use areas of halon are presented below.

Norwegian critical uses of halon 1301 are:

- in aircraft, for the protection of crew compartments, engine nacelles, cargo bays and dry bays and fuel tank inerting,
- in military vehicles, for the protection of spaces occupied by personnel and engine compartments,
- for the making inert of occupied spaces where flammable liquids and/or gas release could occur in the following areas:
- movable installations in the oil, gas and petrochemical sector,
- existing cargo ships.

Norwegian critical uses of halon 1211 are:

- in military vehicles, for the protection of spaces occupied by personnel and engine compartments,
- in aircraft hand-held fire extinguishers,
- in aircraft, for the protection of crew compartments, engine nacelles, cargo bays and dry bays.

In 2003 and 2004, the Danish Institute of Fire and Security Technology (DIFT) prepared a report on halon in the Nordic countries, on behalf of the so-called Nordic Ozone Group (NOG), a sub-group of the Nordic Chemicals Group under the Nordic Council of Ministers. The report is entitled**:** “Halon Critical Uses and Alternatives – A Nordic Perspective”. It gives an overview of halon use in the Nordic countries and provides information on current and future alternative fire extinguishing systems. As indicated in this report, the only Norwegian sectors that presently accommodate critical use of halon are the aviation and military sectors.

10.2.4.5 Switzerland

The in-service installed base of halon 1301 in Switzerland is approximately 176 MT, and the stored quantity for servicing either at user premises or equipment manufacturers is approximately 40 MT. Apart from applications considered by Switzerland to be critical, e.g., the safety of people in aircraft, army vehicles and nuclear power plants, the recharging of halon systems has been banned since the end of 2002. Users with other similar applications can apply for an exemption to the ban. The projected need for Switzerland's critical applications is estimated to be approximately 0.5 MT per annum for the foreseeable future.

Halon may be exported from Switzerland for "critical uses" in other countries. The importer has to provide written information, that the halon will only be used in installations deemed critical in its country. After a large sale of 22 MT to the US military a few years ago, only Israel has imported halon from Switzerland over the last few years (about 12 MT).

Halon 1211 is only used for the recharging of aircraft portable extinguishers and the quantities are small.

10.2.4.6 Other Parties

No other European Parties reported halon stock quantities or problems meeting the needs of their uses.

10.2.4.7 Supply/Demand Summary

Given the above, the European region is considered to be in balance for supply/demand of halon 1301 since any excess halon 1301 has been and continues to be made available to the world market. With respect to halon 1211, the European region is currently in supply/demand balance but anticipates a shortage of supply in the future.

10.2.5 Middle East, North and West Africa

10.2.5.1 Middle East

In the Middle East, some Parties have successful and operational halon bank projects, e.g., Jordan and Syria, developed by projects funded by the MLF, whereas others still face administrative or other problems. To date, there are insufficient data on the installed base or emissions of halons in the region to determine if an imbalance actually exists. However, there is anecdotal information that there is a lack of all types of halons, which would lead to a regional imbalance.

Syria indicates that it is receiving contaminated halons that are taking up valuable storage space and represent a financial burden for disposal. The extent of the contamination is unclear and therefore whether or not the halon could be reclaimed with appropriate equipment. Syria does not foresee any requirement for either selling or purchasing halon in the future as the recovered and recycled halon is restricted to the Civil Defence and it reports the quantities available are sufficient.

2003 data indicated that Bahrain had an installed base of 8.2 MT halon 1211 and 86.9 MT of halon 1301. Bahrain has not imported halon since 2004 and does not anticipate a need to do so – it may be able to export halon 1301 in the future. Bahrain is part of a regional project that includes partners Qatar, Lebanon and Yemen. As part of the project, Bahrain received halon recycling equipment but the other partners did not. Owing to a lack of funding for halon storage, in particular storage tanks, and limitations of the recycling equipment, a fully functional regional halon bank is not in operation.

Whether or not there are sufficient quantities of halons within the Middle East or from alternate sources to meet the demands, good management and applicable business plans for any current or future banking operations will be needed. Parties in the region may wish to consider obtaining additional information on installed quantities and emissions in order to make projections of future demand and their ability to meet it.

10.2.5.2 Nigeria

Nigeria established a national halon bank with the assistance of the MLF. It has conducted an inventory of installed halons and determined, as of 2004, that it has 168.5 MT of halon1211 and 257.7 MT of halon 1301; however, Nigeria believes it missed over 30 percent of the potential users so the installed quantities may be much higher. It is currently in the process of selling some of its recycled halon 1301 to a company outside of Africa. Nigeria expects to have sufficient halons to meet its country's needs for the foreseeable future as systems are decommissioned. While its halon bank is considered a regional bank, it is not receiving halon from other Parties in the region due to the costs of transportation to the user of the halon. In addition, the halon users do not want to pay for the recovery, recycling, and storage of their halons. The halon bank is solely operated on behalf of the National Ozone Office by a private consultant and is not being funded by the State. While the bank may remain viable in the future, it may only serve the needs of Nigeria.

10.2.5.3 Benin, Burkina Faso, Cameroon, Congo, Congo DR

There is no functioning halon bank in Benin, Burkina Faso, Cameroon, Congo, or the Congo DR and they are not participating in the regional halon bank which is located in Nigeria. If they have halon requirements for applications that they consider critical, those needs have not yet been circulated to the members of the HTOC.

10.2.6 South and Central Africa

10.2.6.1 Botswana, Ethiopia, Kenya, Lesotho, Namibia, Tanzania, Zimbabwe

Botswana, Ethiopia, Kenya, Lesotho, Namibia, Tanzania, and Zimbabwe were assisted by MLF to establish a regional halon bank. Eventually the halon bank was established in South Africa (SA) and there is no known halon banking occurring in any of these countries. Some use has been made by these Parties of the SA Halon Bank. This has been on an informal basis, i.e., via end-users decommissioning through SA-based contractors, rather than through Government agencies. The HTOC has attempted to ascertain whether these Parties have halon bank management plans, halon applications that they consider critical, or any halon inventories. To date, no information has been forthcoming. A study was conducted in 2004 on the Eastern and Southern African Countries by the project funded by the MLF. Total installed capacity at that time was reported as 36 MT ODP and there was consumption of halon indicating the possibility of future need for halon. Based on the experiences of a private recycling and reclamation facility, the study concluded that over 80 percent of all installed halon in the region is expected to be contaminated and not recyclable/reclaimable using equipment normally supplied under projects funded by the MLF.

10.2.6.2 South Africa

Management of halon use, recycling and recovery is to a large extent facilitated by the Halon Bank of South Africa (SA), with the general co-operation of fire protection installation and servicing contractors and vendors. As countries neighbouring South Africa are mostly serviced by these SA-based contractors, halon management for the Southern African region is for most practical purposes also facilitated by the SA Halon Bank.

Although there is no local legislation enforcing restrictions on the use of halons, the requirements of the Protocol and Amendments are followed and promoted by the SA Halon Bank in the various services it provides.

In addition, the Southern African region is well served by fire protection contractors and vendors, many being agents for large international fire protection companies, which has resulted in a significant sales effort in replacing halons with alternative extinguishants.

Halon recovery equipment - provided some years ago by a project funded by the MLF - has recently been placed with a SA Halon Bank approved vendor, and is currently in the final stages of being commissioned. Once fully operational, this equipment will provide a capable regional recovery and reclamation plant that will further facilitate the region’s banking of halon.

Military requirements for halon appear to be minimal. In previous years, the SA Halon Bank was occasionally approached for stock supplies, but no such enquiries have been received since 2004.

Inventories of halon are not accurately known, but based on recent transaction records of the SA Halon Bank it is estimated that their Bank currently has a useable inventory of 11.8 MT of halon 1301. In addition, it is known that the SA Defence Force has at least 20 MT installed, and it is estimated that SA commerce has about 10 MT installed. Most of these installations are not considered by the SA Halon Bank to be in its critical use category, and could be replaced by acceptable alternative extinguishing agents or systems. It is possible that these quantities could be returned to the SA Halon Bank in the foreseeable future - thus increasing the stock holding.

Previous reports have stated that much of the halon 1301 is contaminated. Currently, about 300 kg is recorded as contaminated at the SA Halon Bank’s vendor site, which amount has been excluded from the 11.8 MT figure. Recent returns, particularly those for the 2009 and 2008, have not all been assayed for conformance with the ISO standard, and it may be that the usable inventory could be some 10 percent less than the above figure.

The SA Halon Bank anticipates receiving 34 MT of halon 1301 over the next 7 years, including 20 MT from the military. It is estimated that SA critical use refills – principally for the commercial aviation sector - will approximate 1 MT halon 1301 per annum for the foreseeable future. This means that the SA Halon Bank will be able to service these critical refills well beyond 2030. However, if the military retains its stocks then the SA Halon Bank will be unable to meet the needs of SA critical commercial users after 2029.

The SA Halon Bank currently has a useable inventory of 398 kg of halon 1211. In a recent survey by the SA Halon Bank of 50 major portable extinguishing companies servicing this Region, the vast majority of respondents stated that halon 1211 was last used or available many years ago. However, one respondent stated that 950 kg was in stock for servicing the aviation industry. As this respondent did not reveal the company’s name, this stock has not been included in the SA Halon Bank’s data. Although the available inventory is very small, it is of interest as it is used to service the portable extinguishers of this region’s aviation industry. Based on an estimated 30 kg to 70 kg annual usage, it is estimated that the SA Halon Bank’s stock of halon 1211 will last until 2015, after which refills for the Regions' aviation industry will not be available.

For halon 1301, the South and Central Africa region is considered to be in supply and demand balance for the foreseeable future. For halon 1211, the region is currently in supply and demand balance but will experience difficulties beyond 2015. However, as there is no prohibition on the import of recycled halon 1211, the affected Parties may wish to consider the option of importing recycled halon 1211 now to avoid future problems.

10.2.7 North America and Australia

North America and Australia have been considered as one region because their historic sales, installation and use patterns are similar, although their policies on halon use are different.

10.2.7.1 United States of America

In the United States (U.S.), halons 1211 and 1301 are available from retiring or decommissioned equipment and users are not reporting a shortage. However, suppliers are reporting increasing difficulty in securing a steady supply from domestic stocks, and the growing importance of imports of recycled halon 1301. Significant increases in prices for recovered material have been reported over the past year although this has not affected purchases. While U.S. regulations prohibit production, testing with, and unnecessary emissions of halons, use of recovered and recycled halons is allowed to continue and the migration of halons from applications considered non-critical by one user to those considered critical by another user is driven by market forces. U.S. regulations do not specify critical applications.

There is little centralised knowledge on quantities of halon in installed systems or stockpiles, availability or emissions. The U.S. Environmental Protection Agency (EPA) and the U.S. Customs and Border Patrol maintain records of import petitions for halons and actual imported amounts of recycled halons, respectively. EPA also maintains some, although incomplete, information on destroyed ozone-depleting substances including halons. For regulatory and policy purposes, EPA's Vintaging Model estimates U.S. consumption by and emissions from both halon-based and substitute-based fire protection end-uses. The modelling is based on the total consumption of chemical for fire protection in the U.S. and how that consumption changes over time in amount (metric tonnes) as well as type of chemical. The model annual loss rate accounts for total annual emissions from leakage, accidental discharges, and fire extinguishing, in aggregate, and equals a percentage of the total quantity of chemical in operation at a given time. A voluntary program that asks suppliers to disclose annual system recharge quantities would go a long way towards confirming existing model predictions.

About half the purchased halon 1301 is currently being imported. No halon 1211 is being imported owing to an import tax that is currently US$74 per kilogram, increasing annually by US$3 per kilogram.

The Department of Defense (DoD) maintains a physical halon bank that currently meets the requirements for halon use on legacy systems and world-wide operations. The DoD has not purchased any halon 1211 for its bank, relying instead on recovered halons from existing systems and the adoption of alternatives. The DoD purchased the bulk of its halon 1301 stockpile in the 1996-7 timeframe, has purchased additional material since then to maintain its stockpile for the continued use of legacy systems, and has a strategic reserve in Australia through its National Halon Bank.

10.2.7.2 Canada

Canada has indicated that there is enough halon in the country to meet its future needs. Presently five of the twelve provinces and territories have mandated elimination of halons except for critical uses approved by the Government. As there is no commercially viable halon destruction facility in operation in Canada, halons becoming available from decommissioned systems and/or end-of-life portable extinguishers are exported for destruction or recycled for use in applications that meet their criteria as critical.

10.2.7.3 Australia

Australian regulations that became effective in 2005 established a national technician licensing system and trading permit system to control the use of ozone-depleting and synthetic greenhouse gases used in the fire protection sector. The regulations permit individuals (or industry sectors) to apply for a Halon Special Permit to use halon. The Australian National Halon Bank (NHB) is administered by the Department of Environment, Water, Heritage and the Arts and operated by DASCEM. The NHB has been set up on a commercial basis to collect halon 1211 and halon 1301 from decommissioned uses that Australia has not deemed critical. The NHB supplies halons to replenish military stocks (quantities are classified) and for commercial sales only for essential uses, defined as applications necessary for life safety and where no alternatives are available at a reasonable cost. Approximately 10 MT of halons are collected annually by NHB with the majority (90 percent) consisting of halon 1211 and the remainder halon 1301. The NHB is not aware of any use or demand for halon 2402. To date, the halon collected by the NHB has been reasonably clean with very little cross-contamination, so most can be reclaimed to either MILSPEC or ASTM standard for purity and are labelled accordingly. No halon 1211 has been destroyed since 2000 and no halon 1301 has been destroyed at all.

Continuing uses of halons in Australia that they consider to be critical include merchant shipping and aviation. Approximately 30 Australian-flagged merchant ships continue to use halon 1301 in their machinery spaces and pump rooms, but are expected to come out of service in the 2012-15 timeframe. State registered vessels over 500 dead weight tons (including ferries and tourist vessels) are allowed to use halon in their machinery spaces. Foreign vessels with discharged halon systems are provided with halon 1211 or halon 1301 to meet their seaworthy requirements (including a fully operating fire protection system). Continued use of halon is allowed for aviation only in aircraft systems and not land-based support applications such as fire trucks and service vehicles. The major airlines maintain a small stockpile for use by their service contractors.

10.2.7.4 Supply/Demand Summary

Given the above, for halon 1301 the North America and Australia region appears to be in supply/demand balance as it either has enough or imports unneeded agent from other country's surplus. With respect to halon 1211, the region is currently in supply/demand balance but anticipates a shortage of supply in the future.

10.2.8 South America

South American Parties maintain a close watch on the use, storage, recycling and emissions of the controlled halons. Nevertheless, halons are still an important agent for fire protection in government controlled areas such as transportation and communications systems, control rooms of government-owned factories, e.g. steel mills and aluminium plants, oil refineries and oil tanker ships, civil and military aviation.

All South American Parties have laws that do not permit the import or export of halons, and most Parties do not allow the installation of new fire protection systems using halon 1301. Halon banks are in operation in most South American countries and they are a national resource for the delivery / sale of unused halons, and a source for halons for use in priority protection at maritime and aviation areas.

Halon 1211 is not available in most South American countries, and portable fire extinguishers are refilled using an HCFC blend or HFC-236fa.

It has not been possible to get accurate information on the quantities of halons in use and / or in storage in each country, as the information provided when asked for changes by large quantities without any apparent reason.

The HTOC believes that while the South American region currently appears to be in supply/demand balance for both halon 1211 and halon 1301, in the future demand may exceed supply. Affected Parties may wish to consider investigating their long-term needs.

10.2.9 Halon Banking in Article 5 Countries

Between 1998 and 2007, thirty-eight projects within the halon banking category were approved to receive MLF support; the scope of these projects was to inventory existing halons (primarily halon 1211 and halon 1301), to develop halon management plans, and in many cases to provide recycling and recovery equipment/facilities. The 52nd meeting of Montreal Protocol's ExCom issued Decision GLO/HAL/52/TAS/281, "Study on challenges associated with halon banking in developing countries". This study began in October 2008 and at the time of writing was not yet complete and no report had been made available for the HTOC's use. However, the study contractor has made available relevant information that was collected during the information gathering stage of the project that has been used by this study. Some of the preceding country reports in this section came from this study. From those who responded to the contractor's questionnaires, it appears that only about 20 percent of the country/regional halon banks that have been established consider themselves capable of recycling halons for reuse within the country/region. Reasons for this vary but include: no business plan; no halon bank management plan; no equipment delivered or equipment not suitable for requirements; contaminated halons; trading outside of the bank; lack of infrastructure; not scoped for actual needs; lack of standards, training, and workshops on halon alternatives; and a requirement to ban all halon imports.

This low success rate is reason for concern as it will directly affect the balance of halon supply/demand within affected Article 5 countries. Also, a study done in 2004 for UNEP DTIE OzonAction found that 80 percent of decommissioned halon in Africa was too contaminated for reuse or recycle with equipment normally supplied with projects funded by the MLF. After the full MLF study report is available and its conclusions/recommendations considered, Parties may wish to consider strategies and propositions that will help non-functioning banks to become operational and bank managers to ensure the long-term sustainability of their halon banking operations.

10.3 Halon 2402

10.3.1 Summary

Halon 2402 had been produced nearly exclusively in the former USSR, and production was continued by the Russian Federation after 1991 until the end of 2000. From 1994, production was continued under the essential use exemption procedure, approved by the Parties to the Montreal Protocol. Use of halon 2402 by the chemical industry as a process agent substantially reduced the total inventory of halon 2402 in Russia.

The demand for halon 2402 from outside sources ranges from minor demand in some EU Member States to an Indian demand estimated at 7 – 9 MT/year. Supply offers from the U.S. and Europe have eased the servicing situation in India, as has conversion to alternatives in some military vehicles. However, the needs of some Parties for halon 2402 could not be estimated due to the unavailability of market information, but it should be assumed that a demand for halon 2402 for the servicing of operating equipment exists and that halon from outside sources will be required.

Russia and the Ukraine, traditionally recognised as potential sources of halon 2402 for other Parties, still have large installed bases of halon 2402, but their markets can be estimated as currently well balanced with no surplus available for export. Analysis shows that the U.S. has quantities of halon 2402 (over 30 MT) coming out of service over the next few years for which it has limited need, and this could be used to support the current needs of other Parties. Further analysis would be necessary to determine the status of potential stocks of halon 2402 in the EU, but total stocks are likely to be relatively small.

National and/or international regulations that hinder or prohibit the transfer of halons between Parties have less influence on the problem of regional imbalances of halon 2402 than were initially reported. In effect, while there is no apparent shortage of halon 2402 on a global basis, there are regional problems (primarily in defence and aviation) where users are having problems meeting their demands for recycled halon 2402 today and will continue to do so in the future, with the cost of the recycled halon 2402 being a major issue. Unless the expected U.S. over-supply of halon 2402 continues, the global demand will exceed supply with regional imbalances certain.

10.3.2 Introduction

Halon 2402 is a low pressure fluid with a boiling temperature of 47.5 ^{o}C, which makes it particularly easy to handle. Containers are stored at low pressure and pressurised with nitrogen when installed in applications.

The properties of halon 2402 allow it to be used in:

- Fixed systems as a local application agent
- Portable equipment.

Examples of the main applications of halon 2402 include:

- Military uses: combat vehicles, armoured vehicles, naval ships, and aircraft.
- Other uses: nuclear power stations, oil platforms, compressing and pumping gas stations, civil aviation, main computer centres in banking facilities, and telecommunication facilities, etc.

In the former USSR, halon 2402 was commonly used for civilian applications and dominated all halon fire protection use in the military. All equipment associated with halon 2402 systems was manufactured in the USSR until its dissolution in 1991, and in the Russian Federation and the Ukraine since. In other countries of the former Eastern Bloc (e.g., Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia etc.) use of halon 2402 was associated with the use of Russian military equipment and civilian aircraft. Halon 2402 based fire protection equipment was also exported to some Asian countries together with Russian products, mostly military vehicles, ships and aircraft.

10.3.3 Parties That Still Use Halon 2402

Parties that still use halon 2402 as a fire protection agent can be grouped as follows:

- Russian Federation, Ukraine, Belarus;
- Former USSR and other countries of the former Eastern Bloc;
- Caucasus: Armenia, Azerbaijan, Georgia;
- Central Asia: Kazakhstan, Kyrgyzstan, Tadzhikistan, Turkmenistan, Uzbekistan;
- Non-EU states of East-South Europe: e.g., former Yugoslavia etc;
- EU member states: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia; and
- South-East and East Asia: India, Vietnam, Japan.

Some military and aviation equipment employing halon 2402 may still be in use in countries that purchased equipment from the USSR, and later from Russia, e.g. Afghanistan, Algeria, China, Cuba, Egypt, Libya, Mongolia, Peru, and Syria. Fire extinguishers using halon 2402 purchased from an Italian company were sold in very small quantities in Venezuela and Brazil.

10.3.4 Halon 2402 Supply and Demand

10.3.4.1 Russia

Emissions, transformation and consumption of halon 2402 by the chemical industry as a process agent substantially reduced the total inventory of the halon 2402 in Russia.

According to data obtained in May 2008, the total amount of halon 2402 installed in Russia is estimated to be 947 MT. Main users are the military, Gazprom, civil aviation and merchant shipping. By 2015, merchant shipping and commercial uses are expected to cease. However, military demand is expected to increase.

About 10 MT of the halon 2402 were available for purchase in 2007 - 10 times less than in 2006 - and approximately 80 MT of halon 2402 were recycled during 2007. Current prices are still in the same range as in 2006 (US$ 23/kg to US$ 25/kg). The cost increases and reduced availability of halon 2402 have resulted in the halon no longer being used as a process agent in Russia. The market can be estimated as currently well balanced with no surplus available for export. According to current forecasts, this situation will continue through 2015 (see Table below):

Table 10-3: Russian Bank of Halon 2402 Forecast

	2007*	2008	2009	2010	2011	2012	2013	2014	2015
Necessity in recycling, MT	80.0	160.0	160.0	160.0	50.0	50.0	30.0	30.0	30.0
Annual offer of free agent, MT	10.0	20.0	20.0	20.0	50.0	50.0	30.0	30.0	30.0
Possible losses, MT	8.0	16.0	16.0	16.0	5.0	5.0	3.0	3.0	3.0
Total bank, MT	947.0	931.0	915.0	899.0	894.0	889.0	886.0	883.0	880.0

*Data obtained May 2008

As shown in Table 10-3, about 160 MT of halon 2402 will need to be recycled annually through 2010. It is also expected that during this period no more than 20 MT of halon 2402 will appear on the free market annually for purchase. As a result, the spread between the annual availability of free agent and possible losses of the agent will not exceed 4 MT in the period 2008 – 2010.

Four Russian companies offer recycling and banking services, with at least 20 companies operating as collecting agencies. In addition, the military sector and Gazprom have banking facilities to support their own needs. Maximum recycling capacity is about 800 MT/year. The recycling facilities could be used by any company or country.

Russian national regulations restrict the export of ozone depleting substances, including halons. According to a Decision of the Russian Government (No. 1368, adopted 09.12.1999), export requires special permission from the Ministry of Natural Resources and only is allowed for uses deemed to be critical. Similarly, an application for special critical use permission from the Ministry of Natural Resources is required for the installation of halon 2402 in new fire suppression systems in the Russian Federation.

Russia stopped the use of halon 2402 and its blends in their new generation tanks in the mid-1990s. For example, the T-90 is now equipped with halon 1301 systems for both in crew and engine compartments. Portable extinguishers for armoured fighting vehicles in the former Soviet Union used CO_2, halon 2402, or halon 2402 and its blends in the 1980s and early 1990s. New equipment now uses CO_2 or dry chemical portable extinguishers. A similar situation exists with military aircraft, both fighters as well as transport, and helicopters. New generation tanks, aircraft and ships no longer require halon 2402.

10.3.4.2 Ukraine and Belarus

During the preparation of a draft National Halon Management Strategy for the Ukraine for the period 2004-2030 (final version of the document was adopted by the Decision of the Ukrainian Government No. 256, 04.03.2004), it was concluded that the installed base of halon 2402 in the Ukraine ranges from 552 MT to 602 MT. According to some Ukrainian experts, the current Ukrainian bank of halon 2402 is estimated at 300-340 MT (1.5 – 2 times lower than in 2003). The main users are the military sector, oil and gas industry, transport system and telecommunication facilities. In contrast to the situation in Russian, there are no signs that halon 2402 was used as a processing agent in the Ukraine. Fire suppression equipment contains approximately 182 MT of halon 2402. As Ukrainian national regulations require a 100 percent reserve of halon to support existing fire suppression units, this means that the total bank of halon 2402 in the Ukraine is less than is necessary to support uses that it deems to be critical. A market price for halon 2402 cannot be estimated because free agent ready for purchase cannot be found. Ukrainian experts believe that this situation is not a problem for the country because it is accelerating the substitution of halon 2402 with alternatives.

At least one local company offers recycling and banking services in the Ukraine. Approximately 6-7 MT of halon 2402 were recycled during 2007.

Ukrainian national regulations restrict the export of ozone depleting substances, including halons. Export is allowed to support the needs of Article 5 Parties, but special permission from the Ukrainian government is required for the export.

According to a Decision of the Belarussian Government (No. 1741, adopted 13.11.1998), export/import operations of ozone depleting substances are banned in Belarus. Main users of halon 2402 are the military sector, oil - gas industry and civil aviation. At least one local company offers recycling and banking services in Belarus. Information on the Belarussian halon bank is not available.

10.3.4.3 European Union

As with the other halons, in Member States of the European Union (EU), halon 2402 is a controlled substance in Group III of Annex I to Regulation (EC) No 2037/2000 on substances that deplete the ozone layer (see Section 2.4.1 for more details) and permitted critical uses are defined in Annex VII of the regulation. In general there is only a small demand for halon 2402 in the EU: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia. The majority of halon 2402 applications have been switched to other agents and technologies, but a small sector of industry and the military continue to use halon 2402. In particular, 2.6 MT of halon 2402 is used in Poland by the military sector and by some users in industry. Although Poland has enough halon 2402 to support its projected needs, the installed capacity of halon 2402 in the other mentioned countries is not sufficient to support critical uses via recovery and recycling.

The installed quantities of halon 2402 reported by Member States for the year 2006 total approximately 60 MT – these would be critical uses only. This halon 2402 tends to be installed in older equipment that is more likely to be decommissioned in the short to medium term. Small quantities, 2MT – 5MT per annum, may therefore continue to become available to other critical users over this period.

Although the reported usage is small (less than one MT in 2006), little information is available to HTOC on the quantities available to support remaining critical uses. Critical users of halon 2402, especially in commercial and military aviation, may find it increasingly difficult to obtain supplies in the near future unless remaining users in the commercial shipping sector, and those responsible for military vehicles and naval vessels, continue with conversion and replacement programmes and make the recovered material available to other critical users

10.3.4.4 United States

The amount of reclaimed halon 2402 held by U.S. halon recyclers is about 11 MT. The product is ready for purchase and can be used to support the needs of any customer. The supplier is responsible for all export paperwork and any duties; the buyer is responsible for import paperwork, taxes and duties. In addition, a further 10 MT to 15 MT per year of halon 2402 is anticipated to become available for recycling during the next few years.

10.3.4.5 Japan

In Japan, halon 2402 is mainly used for floating roof tank protection in the petrochemical industry. It was also used for explosion suppression systems, but these may have already been replaced and the halon 2402 collected and destroyed (about 30 MT). Total installed halon 2402 in applications other than merchant shipping, aviation and the military was estimated at 198 MT at the end of 2007. With respect to merchant shipping, aviation and the military, as of April 2008 the installed base was about 4 MT.

Halon 2402 is currently considered critical for the fire safety of oil tanks in Japan and the timing of decommission/replacement of halon 2402 fire protection systems is not clear. Therefore it is unlikely that halon 2402 would be exported at this time.

10.3.4.6 India

As reported in 2000-2001, the installed quantity of halon 2402 was 200 MT. In India, halon 2402 and its blends, e.g. halon 2402 and ethyl bromide, are only used in military equipment purchased from the former Soviet Union, e.g. ships, submarines, aircraft, and ground based T-54, T-60, T-70 and T-80 vehicles produced in the 1990s. According to 2008 estimates, the total installed base is now about 70 MT. Losses during decommissioning, servicing and a small number of fires account for the reduced inventory.

According to military estimates, the Army needs a total of 50 MT over the next 15 years to support ground vehicles, and the navy and military aviation sectors are looking for totals of 60 MT and 23 MT respectively for their servicing needs over the next 15 – 20 years. Based on this, annual demand to support uses that India considers critical can be estimated as 7 – 9 MT/year. Licenses are needed to import halon but there are no other barriers apart from agent cost – recycled agent is significantly more expensive than virgin agent, which is no longer produced.

The National Halon Recycling facility is not currently providing a support role for users, and there appears to be no awareness of this bank with the representatives of the military services.

In 2007, India received 9 MT of halon 2402 from the Russian Ministry of Defense. Current requests have received some responses in US and Europe, but it is not known if any transactions have taken place. To overcome the problems, the Army is looking at conversion to halon 1301 in the crew/engine compartments of ground vehicles and at halon 1211 pressurised with CO_2 for portables; other alternatives (e.g., HFC-236fa) are also being tested. The navy is planning to replace a few halon 2402 systems with HFC-227ea. These responses and changes have somewhat eased the shortage of halon 2402 in India for servicing.

10.3.4.7 Vietnam

Vietnam has requested an immediate purchase of 3 MT of halon 2402 with an anticipated additional 7 MT later this year. This agent is required for non-military applications, e.g. petrochemical sector.

Vietnam also has a demand for halon 2402 to support critical military applications. Information on how much they need is unavailable, but it is known that an attempt to find the product from the Russian market was unsuccessful.

10.3.4.8 Kyrgyzstan

Most automatic fire suppression systems in Kyrgyzstan use halon 2402, however the installed capacity and demand is not known.

Kyrgyzstan has halon recycling equipment capable of removing oil, acid and moisture but not any pressurising nitrogen. The equipment was supplied by UNIDO as part of a country project. Additional funding would be needed to create a national halon bank. The import of halon including recycled has been banned since June 2008. This could curtail Kyrgyzstan's ability to service equipment that uses halon 2402 that it deems critical.

10.3.4.9 Other Parties

Information on the installed capacity and demand for halon 2402 in Armenia, Azerbaijan, Croatia, Georgia, Kazakhstan, Tadzhikistan, Turkmenistan and Uzbekistan is not currently available. Similarly, data with regard to halon 2402 demand for Afghanistan, Algeria, Egypt, China, Cuba, Mongolia, Libya and Syria is not available. However, based on other countries' experiences, it should be assumed that a demand for halon 2402 for the servicing of operating equipment exists and that halon from outside sources will be required.

10.4 All Halons – Aviation and Merchant Shipping

10.4.1 Summary

At this time, the aviation industry is able to meet its world-wide needs for halon 1301, halon 1211, and halon 2402.

Key aviation stakeholders are confident that the supply of halon 1301 should be sufficient for the next ten years, but none of them are willing to predict beyond that point.

Concern was expressed about the supply of halon 1211, sources of which are becoming more difficult to find, and the legislative barriers that are impeding the world-wide free flow of halon 1211.

Based on the small bank of halon 2402 that exists world-wide, the HTOC believes that commercial and military aviation outside of Russia and the Ukraine may find it increasingly difficult to obtain supplies of halon 2402 in the near future unless remaining uses in other sectors, e.g., commercial shipping, naval vessels, military vehicles, retire from service or convert to alternatives and make the recovered material available to the aviation sector.

The merchant shipping sector is fully prepared for a future without halons, with most fire protection retrofit going to CO_2. Demand for halon is declining and procedures are in place to move ships with a discharged halon system to a port with halon supplies. Discharge rates are low owing to manually activated systems.

10.4.2 Introduction

Owing to the specialised and world-wide application of all halons in the aviation and merchant shipping sectors, they have been considered on a sectoral rather than regional basis.

10.4.3 Aviation

As a result of actions to implement Decision XV/11, an ICAO resolution (A36-12) was adopted in September 2007 that sets the following timeframes for the replacement of halons in commercial aircraft:

- 2011 for lavatories for new production aircraft

- 2011 for lavatories, hand-held extinguishers, engine nacelles and auxiliary power units for aircraft for which a new application for type certification has been submitted

- 2014 for the replacement of halon in hand-held extinguishers for new production aircraft

In March 2008, ICAO issued a letter to all 190 Member States urging them to advise their aircraft manufacturers, airlines, chemical suppliers and fire-extinguishing companies to move forward at a faster rate in implementing halon alternatives in engine and auxiliary power units, handheld extinguishers and lavatories; and in investigating additional halon replacements for engine nacelles/auxiliary power units, and cargo compartments. This task is included in the ICAO Business Plan for 2008-2010.

Other than lavatory systems, there has been limited development activity necessary to certify aircraft with halon alternative fire protection systems. It is estimated that the certification process could take as long as six years to complete. The recommended dates as listed above will likely slip.

In response to Decision XIX/16, the HTOC contacted key stakeholders in the civil aviation industry to obtain information on their future requirements and the availability of halons. Unlike other user sectors, civil aviation continues to be dependent on halons for new designs and new production. For example, there were 1046 aircraft in China in 2006 and this number increased by 158 in 2007. Further increases are anticipated annually for the next 5-10 years. Most new aircraft are old designs that rely totally on halon, e.g., Boeing 737s and Airbus A320s.

Key stakeholders in the industry indicate that stocks and supplies of halons are available at present and are sufficient to support their commercial needs. There is confidence that the supply of halon 1301 should be sufficient for the next ten years, but none of them are willing to predict beyond that point. Concern was expressed about the supply of halon 1211. At this time supplies are available to meet operational needs but it is becoming more difficult to find sources. The tax on imports of recycled halon 1211 into the United States acts as a “de facto ban” on imports, limiting the supply of halon 1211 in the United States to the installed base.

A request was made of stakeholders to provide their estimated halon requirements for the next 5-25 years, but despite assurances and follow-up communications, no clear data on future needs was received. Given the 25-30 year lifespan of commercial aircraft, the industry’s dependence on halons is likely to continue beyond the time when recycled halon stocks are available to meet demand. This is a disturbing fact that may lead to future requests for essential use halon production unless addressed. The HTOC's 2006 estimates of global halon supply are often cited by aviation stakeholders as evidence that sufficient stocks of halons will be available to meet their long-term needs, but this logic ignores the fact that much of this supply is already held in private or government-owned banks and may never be available for them to purchase.

In Norway, the Norwegian Pollution Control Authority (SFT) has contacted representatives of the Norwegian airline companies SAS Braathens, Norwegian, and Widerøe requesting information on the matter. So far, SFT has received one preliminary piece of information, indicating that, currently, Norwegian airline companies do not seem to be experiencing difficulties in obtaining halon for their uses. With regard to projected needs and difficulties, however, the matter is still under investigation by these companies.

Halon 2402 was installed in military and civil aircraft built in the former Soviet Union. In 2005, it was estimated that the total number of Russian-built commercial aircraft represented approximately 13 percent of the world-wide fleet of commercial aircraft. Further, it was estimated that these aircraft contained approximately 160 MT of halon 2402. The HTOC has not been able to obtain data on any problems that owners of these aircraft may be having with servicing of the halon 2402 systems, or to what extent these aircraft may have been retrofitted with other halons or alternative fire suppression systems. Based on the small bank of halon 2402 that exists world-wide, the HTOC believes that commercial and military aviation outside of Russia and the Ukraine may find it increasingly difficult to obtain supplies of halon 2402 in the near future unless remaining uses in other sectors, e.g., commercial shipping, naval vessels, military vehicles, etc., retire from service or convert to alternatives and make the recovered material available to the aviation sector.

On rare occasions, the South African Bank receives a request for halon 2402 - for refill of Russian manufactured aircraft. Fulfilling this request by way of importing has not been feasible, resulting in the applicant having to send the extinguishing containers to foreign service-facilities for refilling. This has resulted in extended grounding of aircraft - not a desirable situation. An improvement in the method of bank-to-bank importation of halon 2402 in small quantities is thus indicated.

The HTOC is concerned that the apparent, current aviation strategy puts the industry in the precarious position of not being able to predict its world-wide future halon needs and/or mitigate potential shortfalls in regional supplies. Parties may wish to consider requiring their aviation industry stakeholders to work together to develop a plan that ensures that their own stockpiles of halons are adequate to meet the needs of aircraft dependent on halons for the rest of their service life. Parties may also wish to consider removing any legislative barriers that prevent the stakeholders from achieving that goal. This may require that airlines, aircraft manufacturers, and aircraft service companies report and review their available stocks and predicted future needs on an annual basis.

10.4.4 Merchant Shipping

The International Maritime Organization (IMO) has led numerous initiatives within the maritime sector to address global environmental challenges regarding ozone depletion, including efforts to reduce halon emissions from ships. In this regard, through its Subcommittee on Fire Protection, IMO is currently working towards enhancing the standards for the approval of equivalent fixed gas fire extinguishing systems, which can be used to approve replacements for existing halon systems, so that the maritime sector is well prepared for a future when halons for such systems may no longer be available. In addition to the above effort, IMO's Marine Environment Protection Committee (MEPC) has instructed the Subcommittee on Bulk Liquids and Gases (its Working Group on Air Pollution, in particular) to develop proposals for the introduction of a record-keeping requirement for the on-board handling of ozone depleting substances other than cargoes.

Annex VI (Regulation for prevention of air pollution from ships) to the 1973/78 MARPOL Convention, which references the Montreal Protocol, is presently undergoing a general revision. The expected completion date was October 2008, but at this time there is no information on the outcome of the review.

The MEPC, at its fifty-seventh session in April 2008, and the MSC, at its eighty-fourth session in May 2008, approved MSC-MEPC.1/Circ.3, which addresses the decreasing availability of halons for marine use and, in particular, requests:

- Ship-owners, ship operators, shipping companies and all other parties concerned, to take appropriate action to reduce their reliance on halons; and

- Member governments to collect data on halons from the maritime sector, in particular to collect information on the number of ships equipped with halon systems (e.g. the total amount of halons installed for their merchant fleets), and to convey this information directly to the Ozone Secretariat.

This sector is fully prepared for the future with most fire protection retrofit going to CO_2. Demand for halon is declining and procedures are in place to move ships with a discharged halon system to a port with halon supplies. Discharge rates are low owing to manually activated systems.

10.5 Predicting and Mitigating Imbalances

The previous sections provide an overview of the availability of halons 1211, 1301, and 2402 in the countries and sectors that principally rely on them for fire protection purposes. They also highlight the disproportionate distribution of the remaining quantities of these halons, areas where supply costs are impacting demand, and where future supplies may not be available at any cost.

The disproportionate distribution of halons does not necessarily equate to an imbalance in supply/demand, although in the case of halon 1211 this is what is happening. China has a low demand for halon 1211 but has stocks far in excess of its needs. National regulations in China and other countries are limiting the flow of this excess to uses in other places. Halon 1211 demand for those uses is steady, but supply is declining. The aviation industry is a good example of a world-wide sector that has a long term need for halon 1211 for handheld extinguishers but which is beginning to experience shortages in some countries. Although alternatives are available, the practicalities of using them on the existing fleet of aircraft are very challenging and expensive. Parties may wish to explore ways to increase the flow of halon 1211 from China to other countries to mitigate this imbalance, although without some action by the Parties, a large stock of newly produced but unused halon 1211 would not be able to be exported in bulk, only in equipment such as portable extinguishers.

The situation with halon 1301 is less clear. With the exception of China, no country or sector reported problems with the availability of halon 1301 now, or anticipated them in the future. This is likely due to the market penetration of alternatives in areas traditionally served by halon 1301, making the removed halon readily available for recycling. With the exception of Japan and military and aviation sectors, the installation of new fire protection systems based on halon 1301 is not occurring in any significant quantity. Japan has a single organisation that maintains strict reporting requirements for stocks and emissions of halon 1301, and which controls system recharge for existing and new installations. Given Japan's preference for manually activated halon systems, it is not surprising that Japan has low emissions, an increasing percentage share of world-wide halon 1301, and an accurate prediction of its future needs. The type of predictive model used by Japan may not be suitable for all Parties and sectors However, other sectors or Parties with high demand, e.g., the United States, may wish to consider getting a better understanding of existing emissions to enable them to better predict future availability. User/supplier sponsored voluntary reporting of system recharges may help accomplish this.

Halon 2402 has had small market penetration outside of the former Soviet Union and countries that purchased military equipment from the Soviet Union. As such, the availability of information outside of the major consuming countries, Russia and the Ukraine, is scarce, and both of these report a balance of availability and demand for now and the foreseeable future. Based on the small bank of halon 2402 that exists world-wide, countries or sectors with an ongoing need for halon 2402 may wish to consider assessing their requirements and taking advantage of the existing and predicted short-term availability of unneeded agent in the United States and the European Union before these excesses are considered for destruction.

Without significantly more regional and sectoral information, e.g., detailed surveys from Parties, there does not appear to be any way to formulate a predictive model to project future or pending regional supply/demand imbalances. Where the costs of recycled halons can be tracked, these may be indicative of local imbalances in supply/demand but costs are not the only influencing factor.

11 Decision XIX/8: Alternatives to HCFCs at High Ambient Temperatures

11.1 General

11.1.1 Introduction

At MOP-19 in Montreal, the Parties took Decision XIX/8 related to HCFC alternatives and specific climatic conditions, which reads as follows:

1. To request the Technology and Economic Assessment Panel to conduct a scoping study addressing the prospects for the promotion and acceptance of alternatives to HCFCs in the refrigeration and air-conditioning sectors in Article 5 Parties, with specific reference to specific climatic conditions and unique operating conditions, such as those as in mines that are not open pit mines, in some Article 5 Parties;

2. To request the Technology and Economic Assessment Panel to provide a summary of the outcome of the study referred to in the preceding paragraph in its 2008 progress report with a view to identifying areas requiring more detailed study of the alternatives available and their applicability.

In preparing the response to this Decision, the RTOC Co-Chairs under the auspices of the TEAP assembled a Subcommittee with seven RTOC members from India, The Netherlands and the USA in the beginning of 2008. If needed, the Subcommittee decided to draw on other individuals with specific expertise from Article 5 and non-Article 5 countries as needed, specifically those engaged in air conditioning design in warm climates and deep mine air conditioning. A summary of the scoping study as requested in XIX/8 could not be presented in the 2008 TEAP Progress Report, since the start of the work was delayed until the first quarter of 2008, owing to a number of logistic and technical difficulties. Difficulties of logistic type also prohibited timely publication before the MOP-20 meeting of the Parties.

In order to prepare the final study for the 2009 TEAP Progress Report, the subcommittee was slightly expanded. It consisted of the RTOC members Radhey Agarwal, Jim Calm, Jim Crawford, Denis Clodic, Sukumar Devotta and Fred Keller, with Ken Hickman, Martien Janssen, Michael Kauffeld, Lambert Kuijpers and Roberto Peixoto as reviewing members.

The CLAs responsible were Jim Crawford and Fred Keller (unitary air conditioning), Denis Clodic (commercial refrigeration) and Jim Calm (air conditioning for mines). Drafts were circulated for review, and they were also reviewed by the RTOC meeting at its meeting in Montreal, 26-27 March 2009. A final draft was then composed and reviewed by the subcommittee, and submitted to the TEAP for final review for inclusion in the 2009 progress report. After the TEAP review, 26-30 April 2009, the subcommittee finalised the draft for the 2009 progress report on the basis of TEAP comments received.

The study focuses on three topics, which are being elaborated upon below.

11.1.2 HCFC-22

HCFC-22 is the most widely used refrigerant in refrigeration and air-conditioning equipment. It is being phased out globally, and since recently, under an accelerated phase-out schedule in Article 5 Parties, pursuant to Decision XIX/6. Because of this accelerated schedule for Article 5 Parties, the performance of alternatives and replacements to HCFC-22 under extreme weather conditions has become an important issue for commercial refrigeration and unitary air conditioning equipment.

The critical temperature of a refrigerant is an important parameter in the effectiveness of equipment. In the conventional vapour compression cycle the condensing temperature is kept well below the critical temperature, because thermodynamic principles result in declining capacity and efficiency as heat-rejection (refrigerant condensing) temperatures increase and approach the critical temperature. One of the important parameters in the study is therefore related to the critical temperature of HCFC-22 refrigerant alternatives, next to a large number of other criteria.

The study focuses on three different issues, which are elaborated upon below.

11.1.3 Refrigerants for High-ambient Temperature Air Conditioning

The driving concern here is the impact of refrigerant replacements for air conditioners operating at high ambient conditions, such as those operating in equatorial regions, the Middle East, and northern Africa. Most small, packaged equipment, in common usage world-wide, employs HCFC-22 as a refrigerant. The primary global replacement, especially for the dominant air-cooled designs, is R-410A, a blend of hydrofluorocarbon (HFC) refrigerants. One component of this blend, HFC-125, has a comparatively low critical point temperature (66^{o}C), resulting in rapidly declining capacity and efficiency as condensing temperatures approach the critical temperature of the blend. Another blend of HFC refrigerants, R-407C, is also used in air conditioning equipment; however, one component of this blend is again HFC-125, with thermodynamic consequences as described above. The RTOC 2006 Assessment Report mentions that, for unitary air conditioning, HFC-134a, HC-290 (propane) and carbon dioxide (R-744) may be the only pure fluid replacement options for HCFC-22.

This study examines the suitability of R-410A, as well as the suitability of a large number of other candidate HCFC-22 alternatives for very hot climates such as encountered in the identified regions. It pays attention to:

- Global Warming Potential,
- capacity at elevated ambient temperatures,
- input power and related impacts on electricity supplies,
- efficiency and its implications,
- availability of the alternatives and suitable equipment.

11.1.4 Refrigerants for High-ambient Temperature Refrigeration

The focal concern is the impact of refrigerant replacements for commercial use for food preparation, storage, and marketing operating at high ambient conditions, such as those operating in equatorial regions, the Middle East, and northern Africa. The fundamental concerns are similar to those for unitary air conditioners but for both R-22 and R-502, the latter a blend containing HCFC-22 and a chlorofluorocarbon (CFC-115). This blend has already been phased out in non-Article 5 Parties, and will soon be phased out in Article 5 Parties. The primary global replacement for commercial refrigeration is R-404A, a blend of HFC refrigerants. Two components of this blend are HFC-125 and HFC-143a, both having relatively low critical temperatures; the result is that compression systems show a rapidly declining capacity and efficiency as condensing temperatures approach the critical temperature of the blend.

The application conditions for the refrigeration sector differ in several significant ways, among them the temperature at which heat is removed – generally categorised as low temperature (for frozen foods), medium temperature (for fish, meats, and prepared foods), and high temperature (for dairy products and typical beverages) – are colder than for comfort air-conditioning. The equipment used is factory designed and assembled, but systems require a much higher degree of application engineering and often are based on more diverse component selections with more significant piping considerations and burdens. In addition, internal refrigerant volumes and charge amounts generally are much higher, based on application and especially store layouts, and more prone to system and catastrophic failure leakage. This study examines the suitability of R-404A, as well as the suitability of a number of other, possible candidate HCFC-22 alternatives for very hot climates such as encountered in the identified regions. While the application conditions and system options differ, the key examination issues (five preceding bulleted items) are the same for refrigeration as for high-ambient temperature air conditioning (see section 1.2).

11.1.5 Refrigerants for Deep Mines

The questions for deep mines are rather different than for high-ambient temperature operation. The ambient heat rejection (refrigerant condensing) temperatures generally are less extreme. In addition, heat rejection typically employs cooling towers rather than air-cooled condensers, so the governing performance parameter is wet-bulb rather than dry-bulb temperature. Moreover, high-ambient temperature locations actually have an advantage in this regard, since they typically are dryer and have greater wet-bulb depression. Conversely, they often are in regions with more-limited water supplies, evaporated to reject heat (by exploiting the latent heat of vaporisation of water). In contrast, the heat absorption temperatures often are lower for chillers for deep mines, to minimise pumping burdens since equipment generally is installed at the surface. Extra cold water, ice slurries, and less commonly brines or other heat transfer fluids are used for heat transport to depths currently as low as 3.8 km (2.4 miles) with expected extension to depths approach 5 km (3.1 miles) in coming years. The virgin rock temperatures will increase from the current 55°C to 59°C, demanding continuous cooling on year-around basis to enable miners to survive. The required equipment sizes are quite large, resulting in significant energy requirements and heightened concerned with energy-related greenhouse gas emissions. Most mine chillers in the last decade have used HFC-134a, or ammonia (R-717); neither is considered an ozone-depleting substance. However, some older and some small mines use HCFC-22 and some newer installations use HCFC-123 to attain high efficiencies. Some recent systems use water (R-718) as a refrigerant in a vacuum, vapour-compression flash cycle to produce ice slurries directly. Some proposed systems would use air (R-729) in air-standard Brayton cycles. Older equipment tends to be retired more quickly, than with systems for comfort conditioning, based on sustained versus intermittent operation.

While the technologies are in place to deal with the ODS issue for deep mines, refrigerant questions remain with respect to future acceptability of options. For deep mines the study has not yet been finalised and a next visit is planned to South Africa in May 2009. It is envisaged to meet with leading mining companies, the engineering firms supporting them, researchers, and possibly government contacts to verify the problems and confirm needs; thereafter the RTOC subcommittee should again list the options with a final evaluation.

11.1.6 Properties of Refrigerants Dealt with in this Report

The properties of the refrigerants dealt with in this report are given below in Table 11-1. They will be referred to in the different chapters.

It concerns

- CFC-12 and R-502 (both refrigerants have been phased out where it concerns consumption and production by 1/1/2010 in the developing countries)
- HCFC-22 (accelerated phase-out is taking place in the developing countries)
- HFC-134a, HFC-32, R-404A, R-407C, R-410A and R-422B (HFCs)
- HFC-1234yf (unsaturated HFC with low GWP)
- HC-290, HC-600a and HC-1270 (hydrocarbons)
- R-717 (ammonia)
- R-744 (carbon dioxide)

Table 11-1: Properties of the different refrigerants dealt with in this report

	CFC-12	**R-502 (1)**	**HCFC-22**	**HFC-134a**	**HFC-32**
ODP	1	0.25	0.055	0	0
GWP	10900	4700	1780	1430	720
Mol mass (g/mol)	120.9	111.6	86.5	102	52.0
Normal boiling point	-29.8	-45.2	-40.8	-26.1	-51.7
Critical pressure (MPa)	4.13	4.02	4.99	4.06	5.79
Critical temperature	112	80.2	96.1	101.1	78.1

	R-404A (2)	**R-407C (3)**	**R-410A**	**R-422B**	**HFC-1234yf**
ODP	0	0	0	0	0
GWP	3900	1800	2100	2500	4
Mol mass (g/mol)	97.6	86.2	72.6	108.5	114
Normal boiling point	-46.2	-43.6	-51.4	-41.3	-29
Critical pressure (MPa)	3.73	4.63	4.90	3.96	3.27
Critical temperature	72.0	86.0	71.4	-41.3	95.0

	HC-290	**HC-600a**	**HC-1270**	**R-717**	**R-744 (CO_2)**
ODP	0	0	0	0	0
GWP	20	20	20	0	1
Mol mass (g/mol)	44.1	58.1	42.1	17.0	44.01
Normal boiling point	-42	-11.7	-47.7	-33.3	-78.4
Critical pressure (MPa)	4.25	3.64	4.55	11.33	7.38
Critical temperature	96.8	134.7	92.4	132.3	30.98

(1) R-22/115 (49.8/51.2%) (2) R-125/143a/134a (44/52/4%) (3) R-32/125/134a (23/25/52%)

Note: HFC-1234yf is a new refrigerant developed for replacing HFC-134a in mobile air conditioning but it might also be used in future as a replacement for HFC-134a in other applications.

11.2 Refrigerants for High Ambient Temperature Air Conditioning

Air conditioning around the world is generally done using either unitary (air-to-air) equipment or liquid chillers. Air-to-air systems are the primary focus of this analysis and consist of many sub-categories. On a global basis, air-cooled air conditioners and heat pumps range in sizes from 2.0 kW to 420 kW. For higher capacities, water-cooled chillers tend to be the dominant technology. Nearly all air-cooled air conditioners and heat pumps manufactured prior to 2000 used HCFC-22 as the working fluid.

Air-cooled air conditioners and heat pumps generally fall into four distinct categories, based primarily on capacity or application: small self-contained air conditioners (window-mounted and through-the-wall air conditioners); non-ducted or duct-free split residential and commercial air conditioners; ducted, split residential air conditioners; and ducted commercial split and packaged air conditioners.

The objective of this study is to assess the impact of high ambient conditions (above 40 °C) on the performance of the current HCFC-22 replacements for air conditioners. The governing thermodynamic principles result in a declining capacity and efficiency for all refrigerants as the heat-rejection (refrigerant condensing) temperature increases, even for HCFC-22. However, some of the HCFC-22 replacements exhibit greater degradation in capacity and efficiency than HCFC-22 under high ambient conditions. The vast majority of the installed base of unitary equipment in usage world-wide employs HCFC-22, although some older equipment and niche applications utilise other refrigerants /Cal04, UNEP06/.

Currently, the most widely applied replacements for HCFC-22 in unitary air conditioning applications are HFC blends, primarily R-410A and R-407C. However, hydrocarbons are also being used in some low refrigerant-charge applications.

R-410A and R-407C both have lower critical temperatures[1] than R-22. This occurs because HFC-125 --a component of both R-407C and R-410A-- has a comparatively low critical point temperature of 66.0°C (150 °F). The critical point temperature is important because refrigerants having a low critical point temperature will exhibit a steeper decline in capacity with increased ambient (outdoor) temperatures than refrigerants having higher critical point temperatures. This steeper decline in capacity is of particular importance in geographic regions, which have cooling design temperatures approaching the critical point temperature of the refrigerant.

Table 11-2 shows typical air conditioning design condition data from the ASHRAE Handbook of Fundamentals for several cities. These data show that there are many regions globally where outdoor design conditions are high enough to result in condenser temperatures near or above the critical temperature of HFC-125.

For example, it can be observed that a high temperature of 50.4°C is expected once every 5 years at Kuwait International Airport (Table 11-2). It is difficult to forecast how these temperatures will change over the next decades with a increasing radiative forcing of the atmosphere (climate change).

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[1] *Critical temperature is the temperature above which a refrigerant cannot be condensed regardless of pressure. Being above critical temperature prohibits condensation on the heat rejection side of the conventional vapour-compression cycle.*

Table 11-2: n-Year Return Period for Extreme Design Dry Bulb Temperatures

Location	10 Years	20 Years	50 Years
Phoenix, Arizona	47.5	48.2	49.2
Sacramento, California	43.5	44.5	45.7
Imperial, California	49.9	51.0	52.5
Salt Lake City, Utah	40.0	40.7	41.7
Las Vegas, Nevada	46.0	46.6	47.5
Bahrain Intl Airport	45.6	46.4	47.5
Kuwait Intl Airport	51.0	51.6	52.3
Jeddah, Saudi Arabia	47.7	48.9	50.4
Riyadh [ASUD AFB], Saudi Arabia	46.6	47.1	47.6

Source: ASHRAE Handbook of Fundamentals CD, Chapter 28, 2005

11.2.1 Methodology

This analysis has used two methodologies to assess the high ambient performance of HCFC-22 replacements:

1. the use of cycle analysis to assess the high ambient performance of the most commonly considered HCFC-22 replacements, and

2. the use of published performance data of commercially available air-conditioners which use HFC blends.

11.2.2 Refrigerant Options

To limit the scope of the study, the refrigerants compared herein are those already commercialised as well as those prominently addressed in prior published studies /Cal04, Dom02, Mot00, Pay02/, namely:

HCFC-22, HFC-32, HFC-134a, HC-290 (propane), R-407C, R-410A, HC-600a (isobutane), HC-1270 (propylene), R-32/600 (95.0/5.0), R-32/600a (90.0/10.0) and CO_2.

The analysis of CO_2 was based on a simple transcritical cycle analysis, which results in lower efficiencies than would be expected with a fully optimised CO_2 system since a fully optimised CO_2 system would likely utilise additional components (a suction line heat exchanger, expander or ejector) to partially offset the efficiency losses associated with the transcritical operation.

Some parameters of selected refrigerants were given in Table 11-1.

11.2.3 Cycle Analysis (Computation Model)

The various refrigerants under consideration were evaluated in a modified ideal cycle analysis using the NIST program Cycle_D /Dom03/. The Cycle_D input conditions selected for the analysis were consistent with those used in prior studies /Cal04/. The conditions and assumptions used are given below.

The various refrigerants under consideration were evaluated in a modified ideal cycle analysis using the NIST program Cycle_D /Dom03/. The Cycle_D input conditions selected for the analysis were consistent with those used in prior studies /Cal04/. The conditions and assumptions used for unitary air-conditioners are given below.

CYCLE_D requires the system capacity as one of its inputs. Thus, the capacity does not decrease as the condensing temperature. Instead, the Cycle_D model calculates the compressor volumetric displacement (or flow) required to deliver the specified cooling capacity. However, the inverse of the calculated volumetric capacity provides a good estimate of the expected cooling capacity decrease with increasing ambient temperatures. For each refrigerant, the outdoor ambient was allowed to increase to the point where CYCLE_D provided a warning that the conditions were within 15 K of the critical temperature, because the model accuracy above this temperature is in doubt.

Parameter	
Average Evaporating Temperatures	
Input Temperature	10 C (50 F)
Superheat	5 C (9 F)
Average Condensing Temperatures	
Input Temperature	40 – 80 C (104 – 176 F)
Subcooling	5 C (9 F)
Compressor Efficiencies	
Isentropic	73%
Volumetric	100%
Motor	92%
Piping Losses	
Suction	None
Discharge	None
Suction or Discharge Line Heat Exchanger	None
Fan and Control Power	
Indoor Fan	None
Outdoor Fan	None
Controls	None

11.2.4 Cycle Analysis Results

For the equipment, the capacity and efficiency decrease rather significantly as the outdoor temperature increases. The principal focus in the model run outputs was on system efficiency. The Coefficient of Performance (COP) results are presented in Table 11-3. The corresponding data plots are shown in Figure 11-1.

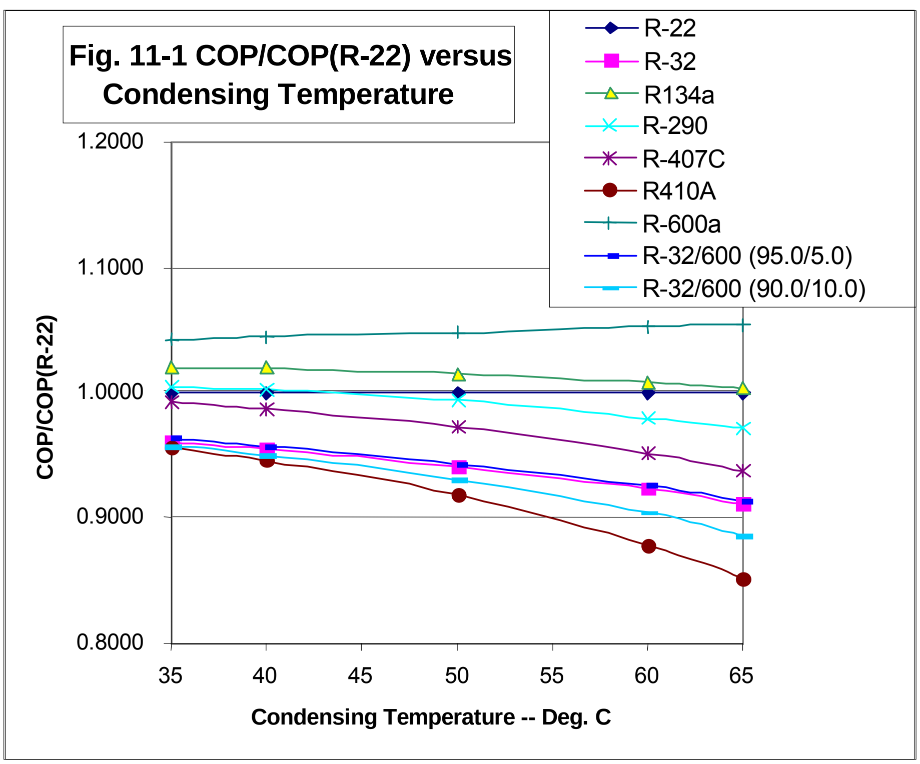
Table 11-3: COP as a function of the condensing temperature (C)

Refrigerant	**Condensing temperature (C)**					**Refrigerant**
	35	**40**	**50**	**60**	**65**	
HCFC-22	6.28	5.08	3.57	2.64	2.29	HCFC-22
HFC-32	6.03	4.85	3.35	2.43	2.09	HFC-32
HFC-134a	6.41	5.18	3.62	2.66	2.30	HFC-134a
HC-290	6.31	5.09	3.54	2.58	2.23	HC-290
R-407C	6.23	5.01	3.47	2.51	2.15	R-407C
R-410A	6.01	4.800	3.27	2.32	1.95	R-410A
HC-600a	6.54	5.30	3.74	2.78	2.42	HC-600a
R-32/600 (95.0/5.0%)	6.05	4.86	3.36	2.44	2.09	R-32/600 (95.0/5.0%)
R-32/600a (90.0/10.0%)	6.01	4.82	3.32	2.38	2.03	R-32/600a (90.0/10.0%)

Figure 11-1 clearly illustrates the decrease in efficiency as the ambient temperature increases. The efficiency decreases by about one-half from the moderate condition of 25°C ambient to a temperature in the range of about 50°C ambient that was shown to be representative of the extreme temperatures in the hottest climates. This is a direct result of the fact that the "thermal head" against which the air conditioner is working nearly doubles between the moderate and extreme conditions.

The theoretical analysis also shows that some refrigerant options will experience a greater decline in COP than others and may be more suitable for use in high ambient applications if the systems are properly designed to utilise these alternate refrigerants.

Even where COPs are similar, these refrigerants are not necessarily interchangeable. Each of these refrigerants has unique characteristics that may make it more suitable for different applications. For example, HC-290 is highly flammable and may not be suitable for high charge applications but this refrigerant could potentially be used in low charge applications where the flammability of the refrigerant can be safely addressed. In addition, for some of the refrigerants the efficiency and capacity degrade less at high ambient temperatures than others (for example R-407C versus R-410A). Therefore, R-407C could be an alternative to R-410A in geographic regions where extensive operation at extreme ambient temperatures is likely to occur. In addition some of the lower pressure refrigerants such as R-134a and HC-600a are generally more suitable for large systems such as centrifugal chillers than for unitary equipment.



11.2.5 Published Performance Data

Published performance data for HCFC-22 and R-410A showing high ambient performance is available for many commercially available products. The following Table 11-4 compares the performance of two 3 ton air conditioners one using HCFC-22 and the other using R-410A.

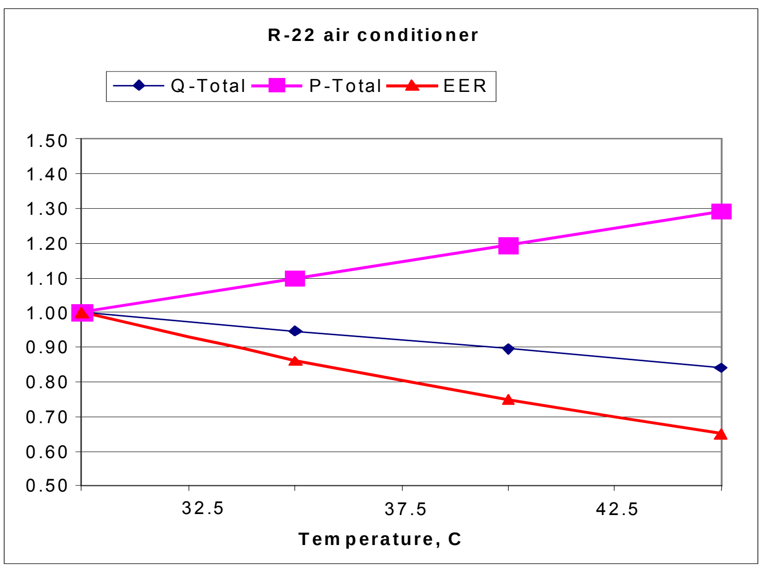
Table 11-4: Performance comparison of HCFC-22 and R-410A Air Conditioners

Refrigerant		Outdoor Ambient °C		
		35	**46**	**52**
HCFC-22	Capacity (kW)	9.9	8.9	8.45
	COP	3.13	2.37	2.02
R-410A	Capacity (kW)	9.9	8.8	8.1
	COP	3.19	2.30	1.91

Source: Carrier Product Data, Catalog 24ABS3-4PD and 24ABBB3-4PD

The following figures show similar data for 3-ton air conditioners from another manufacturer. Figures 11-2 and 11-3 illustrate the effects of ambient temperature on the capacity of typical equipment. The case used here is the actual product data for a physical system, nominally rated at 3 tons capacity under the standard ARI rating conditions.

Figure 11-2: Load (Q), power consumption (P) and energy efficiency (EER) as a function of the ambient for a typical HCFC-22 unit

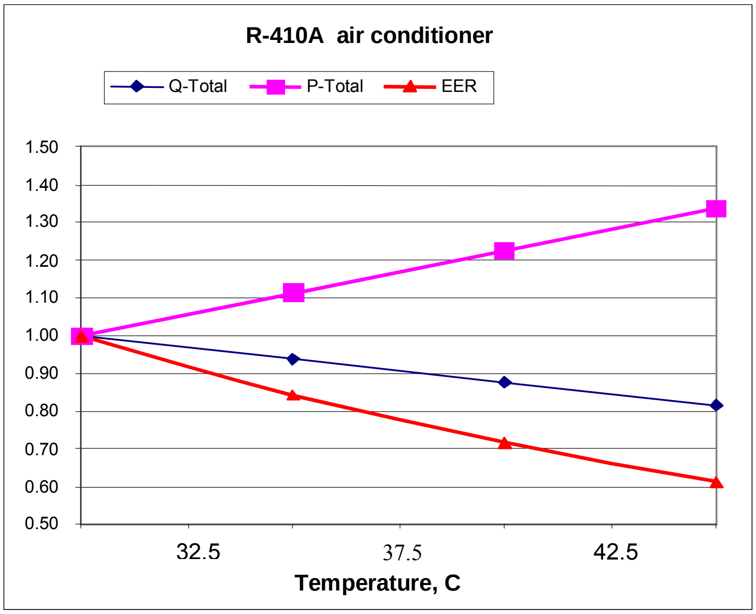


For this example, the chosen indoor conditions were 24°C dry bulb temperature and 15°C wet bulb, for a relative humidity of about 49%.

Figure 11-2 shows that while the ambient condition increases from 29.4°C to 46.1°C, the capacity for the R-22 unit decreases by about 16%, and the efficiency decreases by 35%.

Figure 11-3 shows that while the ambient condition increases from 29.4°C to 46.1°C, the capacity for the R-410A unit decreases by about 18% and the efficiency decreases by 39%.

Figure 11-3: Load (Q), power consumption (P) and energy efficiency (EER) as a function of the ambient for a typical R-410A unit



Data presented by Bullock /Bul99/ and Ward /Wel99/ show similar reductions in performance at high ambient temperatures. Bullock also reported that system design factors (coil face velocity and internal volume) can improve the performance of R-410A systems at high ambient temperatures. Therefore, variations in the high ambient performance can be expected between different product designs.

11.2.6 Overview

The current refrigerants of choice for unitary air conditioning are HCFC-22, R-407C and R-410A. R-410A is the most widely used replacement for HCFC-22 in developed countries, but R-407C is also used as a replacement in some applications. The following are the most likely replacements for HCFC-22 for use in high ambient temperature climates.

11.2.6.1 R-410A

R-410A systems have been demonstrated to operate acceptably at ambient temperatures up to 50 °C. The performance (capacity and efficiency) of R-410A air-conditioners falls off more rapidly than HCFC-22 systems at high ambient temperatures (above 40 °C) as shown in Table 11-3, and Figures 11-2 and 11-3. However, the optimum selection of compressor, airflow, condenser design and expansion device can reduce the performance losses at high ambient temperatures /Bat04/.

Even with optimised designs, when applying R-410A systems that will operate a significant number of hours at high ambient temperatures, the system designer should take into consideration the reduced high ambient capacity when sizing the equipment.

11.2.6.2 HC-290

HC-290 has performance characteristics similar to HCFC-22. The characteristics are close enough that the current products that employ R-22 could be re-engineered to employ HC-290.

HC-290 has successfully been commercialised as an HCFC-22 replacement in low charge, room and portable air-conditioners applications of less than 4 kW /Dev09a/.

IEC standard 60335-2-40 has established the criteria for determining the maximum charge limit for highly flammable refrigerant applications. Application of IEC 60335-2-40 would limit refrigerant charges to less than 250g in most designs.

The reason for limiting the refrigerant charge is concern about the safety of larger charges of hydrocarbons. In direct expansion (DX) systems, a single refrigerant line or heat exchanger failure could discharge the refrigerant into the conditioned space; potentially allowing the refrigerant concentration in the space to exceed the lower flammability limit, LFL of the refrigerant. Since the energy of combustion of these hydrocarbons is close to 50 MJ/kg, a significant leak could result in a substantial safety risk.

Safely and cost effectively applying hydrocarbons to larger unitary systems will be a significant technical challenge and could require the use of an intermediate refrigerant loop in addition to other safety considerations. This would result in a decrease in overall system efficiency on the order of 10-20%. Furthermore, flammability risks still remain to be addressed in the factory and for the installer and service technicians.

11.2.6.3 R-407C

R-407C systems will typically perform in nearly the same way as HCFC-22 systems at typical ambient temperatures. Since R-407C refrigerant requires only modest modifications to existing HCFC-22 systems, it has also been used as a transitional refrigerant in equipment originally designed for HCFC-22.

At ambient temperatures above 40°C, R-407C systems show less degradation of capacity and efficiency than R-410A systems --typically having capacities and efficiencies somewhat less than similar HCFC-22 systems but above those of R-410A systems.

There are currently R-407C air conditioning products widely available in Europe, Japan and other parts of Asia.

11.2.6.4 HFC-134a and HC-600a

HFC-134a and HC-600a would seem attractive from the point of view that they have similar performance to HCFC-22 at high ambient temperatures. However, both of these refrigerants are low-pressure refrigerants. Therefore, extensive redesign of the base system components would be required in order to achieve the same capacity and efficiency of the HCFC-22 system.

Design changes would include larger displacement compressors, increased heat exchanger areas and increases in the piping sizes used in heat exchangers and inter-connecting tubing. All of these changes would lead to substantial increases in the product costprice.

Also, HFC-134a does not have a GWP much lower than HCFC-22 or the HFC blends R-410A and R-407C. In addition, additional design changes would be required with HC-600a to address the high flammability of this refrigerant. Therefore, HFC-134a and HC-600a are not considered the most viable options to replace HCFC-22 in unitary air-conditioning applications.

11.2.6.5 CO_2

Carbon dioxide (R-744) offers a number of desirable properties as a refrigerant: readily available, low-toxicity, low GWP and low cost. These desirable characteristics are offset by the fact that CO_2 has a very low critical temperature (31°C) and will operate above critical point conditions in most air-conditioning applications. Operation at these conditions results in a significant degradation in both capacity and COP.

These losses can be partially offset by the addition of internal cycle heat exchangers and expanders or ejectors. However, CO_2 systems are not expected to provide a good alternative to HCFC-22 or HFC refrigerants when being applied in high temperature regions (> 40°C).

11.2.6.6 HFC Replacements

Alternatives to HFC refrigerants for air-conditioning applications are in the early stages of development. A number of new refrigerants are being investigated to replace R-407C and R-410A, including HFC-1234yf. Additional candidate refrigerants, which are mixtures of known refrigerants have also been proposed or are under study by refrigerant suppliers.

While refrigerant manufacturers are believed to be working to qualify other chemicals or blends that might be new, their development has not progressed to the point where they are available to unitary equipment manufacturers for evaluation and equipment development.

Therefore, it is premature to recommend alternatives to R-410A or R-407C at this early stage of the development other than HC-290, which may be applicable in very low charge (< 250 g) applications when appropriate safety and application requirements are considered.

11.2.7 Concluding Remarks

These studies have highlighted the primary refrigerant options that could be utilised to design both low-ODP and low-GWP replacements for HCFC-22 in air-conditioning applications for use in high ambient environments. In the near term, regions with hot climates should be able to rely on the refrigerants and technologies that are currently commercially available to replace HCFC-22 (R-407C, R-410A and HC-290).

However, when replacing HCFC-22 products with those using R-410A or R-407C the application engineer will need to take into consideration the reduced capacity at the design ambient temperature when sizing the equipment for the design cooling load. The application engineer should consult the application data published by the manufacturer when making sizing decisions. In most cases R-410A or R-407C will only need to be sized 5-15% larger than HCFC-22 equipment to compensate for the lower capacity at ambient temperatures up to 50 °C.

When replacing HCFC-22 in low charge applications (small window and portable room air conditioners), the system designer may want to consider the use of HC-290. When replacing HCFC-22 with HC-290 it may be needed to limit the usage of HC-290 to low charge applications (<250 g) and make the appropriate design changes to comply with all applicable codes and standards. It is stressed that HC-290 should not be used as a retrofit solution, since appropriate safety considerations need to be addressed in the fundamental design of the product.

HFC-134a and HC-600a would seem attractive from the point of view that they have similar performance to HCFC-22 at high ambient temperatures. However, both of these refrigerants are low-pressure refrigerants. The use of these low pressure refrigerants would require extensive redesign of the base system components in order to achieve the same capacity and efficiency of the HCFC-22 system. Therefore, R-134a and HC-600a are not considered cost effective options to replace HCFC-22 in unitary air-conditioning applications.

A number of low GWP alternatives to HFC refrigerants are currently under development. However, because these refrigerants are in the early stages of development it is premature to list them as options to the current HCFC alternatives.

In the longer term, as non-ODP and low-GWP technologies are developed to replace current HCFC-22, R-407C and R-410A products, equipment designed to operate with acceptable efficiency and capacities at the extreme environment conditions should become widely available in both developed and developing countries.

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11.3 Refrigerants for High Ambient Temperature Commercial Refrigeration

11.3.1 Introductory Comments

Commercial refrigeration covers a wide variety of equipment: stand-alone equipment, condensing units, and centralised systems. According to the type of system, the refrigerant charge varies from some hundreds grams to thousand kilograms. Moreover, depending on the system type, the refrigerant choice is different. To summarise the usual choices, HFC-134a with a relatively low volumetric capacity is used in small equipment (nearly all stand-alone equipment and some condensing units) whereas refrigerants such as HCFC-22 or R-404A, with a large volumetric capacity, are used in large commercial systems and in most condensing units.

In order to define a range of temperatures, moderate climate exhibits an yearly average temperature between 12 and 15°C with 2 to 3 months where the average temperature are around 20 to 25°C and for some hours of the day up to 35°C. Hot climates exhibit average yearly temperatures around 20°C with several months with average temperature in the vicinity of 30°C and many hours of the day with temperature higher than 40°C.

It has to be mentioned that, since the 1970's, Europe has progressively enforced a lower temperature for frozen food: from -15°C to -18°C at the core of the frozen products. The consequence has been the progressive shift from HCFC-22 to R-502, because the consequence of a lower temperature of the product is a lower evaporating temperature moving from typically -35°C to -38°C or even lower. This change of evaporating temperature has, even in moderate climate, led to a too high discharge temperature at the high pressure side of compressors using HCFC-22. R-502 (a blend of 51.2 % of CFC-115 and HCFC-22) exhibits a lower discharge temperature because CFC-115 has a lower heating capacity. R-404A and R-507 have been formulated in order to replace R-502 and comprise also high molecular weight molecules leading to lower discharge temperatures compared to HCFC-22. In summary, HCFC-22 is not the best designed refrigerant molecule for high ambient temperatures, if the evaporating temperature is lower than -35°C.

Hot climates imply high condensing temperatures and, for the usually applied refrigerants, high condensing pressures. Those high pressures and temperatures have several consequences:

- The energy penalty for a single-stage system is about 1.5% per K of higher condensing temperature, meaning that COPs of medium and low-temperature commercial systems are about 15 to 25% lower in hot climates compared to moderate ones;

- For low-temperature applications (frozen food), the discharge temperatures of the compressor with HCFC-22 are so high that liquid injection is necessary either at the suction port or at an intermediate stage if the compressor design allows such an injection.

High temperatures at the compressor discharge line imply energy losses and possible decomposition of the lubricant when temperatures become higher than 140°C. As indicated above, HCFC-22 is not the best refrigerant to be used in a direct expansion system for low-temperature applications (evaporating temperature below –35°C) with a condensing temperature above 50°C. Several technical options have been developed over time in order to improve energy efficiency for low-temperature applications and also to limit the discharge temperature at the compressor discharge port.

11.3.2 Refrigerants for Small Commercial Refrigeration Systems in Hot Climates

Table 11-1 (in chapter 11.1) summarises the main thermodynamics and environmental properties (the GWP and ODP values have been taken from the 2006 RTOC report) of refrigerants that have been used or could be used in small commercial refrigeration equipment

Stand-alone equipment and some condensing units (those with smaller refrigeration capacity) have been developed successively with CFC-12 and then HFC-134a. The use of isobutane (HC-600a) in domestic refrigeration began in Europe in 1994. The significant introduction of this refrigerant in this application has also led to the use of this refrigerant in small commercial equipment such as water fountains, for ice cream freezers and all equipment requiring larger cooling capacities compared to water fountains the preferred choice for HCs is propane (HC-290). Due to their critical temperatures (see Table above), HFC-134a as well as HC-600a are well suited to hot climate applications. It has to be noted that HC-290 presents a lower discharge temperature compared to HCFC-22 and so has a possible larger operation span in hot climate. The limitation for the use of HC-600a or HC-290 is the refrigerant charge, due to safety. For larger systems as condensing units or stand alone display cases the refrigerant choices are usually the same as those presented in the following section for large commercial systems.

11.3.2.1 CO_2

For larger refrigerant charges (in the range of several hundreds grams) due to flammability risks, some global companies have decided to develop the use of CO_2 (R-744) for vending machines. Because of the low critical temperature of this refrigerant (31°C), those systems experience very high pressure (above 10 MPa) and there is no more condensation at the high-pressure side, so the usual phase-change cycle (condensation at the high pressure and evaporation at the low pressure) becomes a trans-critical cycle (cooling of a dense gas phase at the high pressure and evaporation at the low pressure). The efficiency of such a trans-critical cycle is relatively low and additional components such as liquid/vapour heat exchangers are necessary to reach acceptable energy efficiency at high temperature. In summary, CO_2 is not a suitable fluid for hot climates, due to relatively poor energy efficiency under those temperature conditions.

11.3.2.2 HFC-1234yf

Based on the European directive 40/2006, HFC-134a will be banned in mobile air-conditioning systems in Europe progressively from 2011 to 2017. This regulation has led the main chemical companies to develop new refrigerants with very low GWP. The first one that has been thoroughly studied is 2,3,3,3 tetra-fluoro-pro-1-ene, named HFC-1234yf (also commercialised under HFO). The thermodynamic properties of this refrigerant are very close to the ones of HFC-134a (see Table 11-1), it is very moderately flammable, and its toxicity is low and comparable to HFC-134a. It is expected that HFC-1234yf will be mass-produced at some time; this will determine the time when it can be used at large scale in mobile air conditioning. It can be used in small commercial refrigeration similarly to HFC-134a with small adaptation of capillary tubes. It has to be noted that, due to the fact that this refrigerant consists of a larger molecule than HFC-134a, its discharge temperature is significantly lower and it may therefore be more adapted for hot climates.

In summary, three possible refrigerants can be easily used at high ambient temperature conditions applying current refrigeration technologies for small equipment; these are HFC-134a, HC-600a and HC-290. Where it is too early to make any definite statements at present, the range may possibly be expanded by HFC-1234yf in future.

11.3.3 Refrigerants for Large Commercial Refrigeration Systems in Hot Climates

This section addresses not only refrigerant choices but also some design issues, which are of interest to enhance energy efficiency of low temperature refrigerating systems and to also expand the options for refrigerant choices.

11.3.3.1 Current Refrigerants in Use

HCFC-22 is the refrigerant still in use in many developed countries, especially in the U.S.A and in all developing countries under a wide range of ambient temperature conditions, but with very different evaporating temperatures. In many cases, the evaporating temperature will be fixed at a level where the discharge temperature of the compressors is still acceptable (below 140°C). Because of the more stringent regulation (2037/2000), Europe has banned HCFC-22 in new commercial refrigeration equipment as of 2000. Nevertheless, the installed base using HCFC-22 is still important and intermediate HFC blends such as R-422D or R-427A have been developed in order to enable an easy retrofit from HCFC-22 to those blends. Those blends having HFC-125 as a component exhibit lower discharge temperatures compared to HCFC-22. Nevertheless, all HFC-125 based blends have high GWPs. R-404A, which has replaced R-502 and sometimes also HCFC-22 in commercial centralised systems presents a lower energy efficiency under hot ambient temperatures (high temperature condensing conditions) due to its relatively low critical temperature (T_c = 72°C) compared to R-502 (T_c = 80°C).

It has to be emphasised that a “free” sub-cooling of the refrigerant is available when supermarkets are air-conditioned: the refrigerant leaves the high pressure receiver at for example 50°C or above, the long liquid lines (about 100 m or more) are installed in the sales area, which temperature is about 25°C and so the refrigerant enters the expansion valve at about 30°C, this temperature gain leads to a better energy efficiency for the refrigerating systems but it has been paid by the energy consumption of the air conditioning system.

In the absence of the “free” cooling, an interesting design has been developed in order to improve the cooling capacity and the energy efficiency in very hot outdoor conditions. It consists of installing a small refrigerating system working typically with HFC-134a whose purpose is only to cool the liquid phase of R-404A (or even HCFC-22) after the condensation in order to generate a large sub-cooling typically down to 10°C. The drawback in this case is that the liquid line has to be insulated all along.

11.3.3.2 Hydrocarbons and HFCs

In Northern Europe, some equipment manufacturers have developed refrigeration systems using hydrocarbons, either HC-290 (propane) or HC-1270 (propylene). For centralised systems, two different types of equipment can be distinguished:

- condensing units with refrigerant charge of HC-290 up to 5 kg in direct expansion systems. The number of those systems can be estimated at several hundreds, mainly in Germany, the United Kingdom and Denmark
- centralised indirect systems with HC-1270 or HC-290 or R-404A as primary refrigerants.
- in Germany, many so called “discounter” supermarkets (specific type in Germany) use HC-290 for display cases with short lines as the so called distributed systems. The charges vary between 500 g and 2.5 kg.

For centralised systems, due to the large refrigerant charge and the number of fittings when some hundreds of evaporators are installed in the sales area, it is impossible to use direct expansion systems with flammable refrigerants. Indirect systems have been used in commercial refrigeration for more than ten years. They consist of circulating a heat transfer fluid (HTF) in the heat exchanger (formerly evaporator) of the display cases. This HTF cools air as the refrigerant was doing before and the HTF is then cooled by the refrigerant in the machinery room in a primary heat exchanger or primary evaporator. This design allows reduction of the refrigerant charge by more than 50% and the refrigerant could be either an HFC or an HC depending on local regulations on the use of flammable refrigerants and also the policy of the commercial company.

Taking into account the practices in all European countries, the main refrigerant in use for medium and low temperatures in centralised systems is R-404A as a replacement for R-502 and HCFC-22. It has to be noted that for very high ambient conditions, R-404A with a critical temperature of 72 °C, shows significant limits of efficiency. As indicated above, complementary sub-cooling by a small refrigerating unit dedicated only to sub-cool R-404A in liquid phase after condensation could be an interesting and relatively low cost provision; this sub-cooling unit normally works with a high temperature suited refrigerant such as HFC-134a. Equal to air conditioning in the case of R-410A, it may also be more advantageous at high ambient temperatures to go to a solution in which R-407A is applied instead of R-404A.

For HCs, indirect systems with refrigerant charges up to 50 kg have been installed in separate machinery rooms equipped with refrigerant monitoring and high ventilation rates in order to mitigate the risk of explosion in case of refrigerant leaks. A German company has developed such a system with HC-1270. The number of these systems can be estimated to be around 50 in the whole of Europe.

11.3.3.3 Ammonia (R-717)

Ammonia can be used in indirect systems so that ammonia (which is toxic and moderately flammable) can be contained in the machinery room. Ammonia is used in Europe in some commercial refrigeration supermarkets but the use is not widespread due to the safety issues. For a cascade system, ammonia can be used at the two levels of temperatures that are applied (-15°C and –35 °C), but it is much more efficient to use a cascade system with ammonia for the high temperature level and CO_2 for the low temperature.

11.3.3.4 Design issues

Design of large refrigerating commercial systems in hot climates is characterised by specific criteria such as larger condenser surfaces to limit the difference of temperature between the refrigerant and air. Specific liquid refrigerant sub-cooling equipment can also be installed. Those design choices are made independent of the choice of the refrigerant.

Commercial refrigeration has always been driven by initial costs and simplicity of design, and as a consequence, a general design rule for refrigerating systems has not been applied in the case of low evaporating temperatures (which corresponds to conservation of frozen food and ice creams).

The rule, which is respected in all large industrial low temperature refrigerating systems, is the following. When the difference of temperature between evaporation and condensation is larger than 70 °C, a two-stage system has to be chosen. A limited number of technical option exits for such a two-stage design: one of them is a cascade system where a low temperature refrigerant as CO_2 is used in the low temperature stage and a higher temperature refrigerant such as ammonia (R-717) in the high temperature stage. HCFC-22 and HFC-134a can also be used in the high temperature stage. This two-stage structure has gained much interest in the last five years in Europe in commercial refrigeration; this specifically in order to reduce (limit) the charge of HFCs.

A preliminary conclusion can be drawn at this stage. The replacement of HCFC-22 in commercial refrigeration in hot climates may be addressed by introducing two-stage systems:

- a normal cascade system;
- a so called injection cycle where the same refrigerant is used in the two stages. Sub-cooling of the liquid and cooling of the vapour are realised at an intermediate temperature.

These two-stage designs increase the energy efficiency significantly (up to 30%) depending on the (outdoor) ambient temperature.

11.3.3.5 Refrigerants for Centralised Systems under Hot Conditions

The use of indirect systems would be possible in countries with high ambients because there is no significant variation of the evaporation temperature. It would be possible to replace HCFC-22 in large commercial refrigeration systems with HFC blends (with high GWP), such as R-404A or even R-422D or R-427A. However, for these blends the refrigerating capacity could be about 5% lower than for HCFC-22 and the efficiency could also be in the order of 5 to 10% lower, compared to HCFC-22.

R-407C is used in centralised systems in Japan (R-407C has the lowest GWP (1800) of all HFC blends). HCs such as HC-290 and HC-1270 could be used under hot ambient temperature conditions and they exhibit relatively low discharge temperatures compared to HCFC-22. However, refrigerant quantities have to be limited for safety reasons and direct expansion systems should have an almost completely welded circuit in order to limit refrigerant leaks. One of the most important safety precautions that needs to be taken here is charge reduction.

11.3.4 Concluding Remarks

The above studies have highlighted the refrigerant options that could be utilised to design replacements for HCFC-22 in commercial refrigeration for use in high ambient environments. In the near term, the regions with hot climates should be able to rely on the refrigerants and technologies that are currently commercially available to replace HCFC-22 (R-404A, R-407A and R-407C and HC-290).

However, when replacing HCFC-22 products with those using R-404A or R-407C the application engineer will need to take into consideration the reduced capacity at the design ambient temperature when sizing the equipment for the design cooling load. E.g. R-407C will only need to be sized 5-10% larger than HCFC-22 equipment to compensate for the lower capacity at ambient temperatures up to 50°C.

Low GWP alternatives to HFC refrigerants (partially fluorinated alkenes such as HFC-1234yf) are currently being developed. HFC-1234yf may be a candidate to replace HFC-134a in small equipment. Because refrigerant alternatives of this kind for larger equipment are assumed to be in the early stages of development it is premature to list them as definite options to the current HCFC-22 alternatives.

When replacing HCFC-22 in low charge applications (commercial vending units etc.) one could consider the use of HC-290. This could also be done for distributed systems in supermarkets with relatively low charge.

Design of large refrigerating commercial systems in hot climates is characterised by specific criteria such as larger condenser surfaces to limit the difference of temperature between the refrigerant and air. Specific liquid refrigerant sub-cooling equipment can also be installed. Those design choices are made independent of the choice of the refrigerant.

The replacement of HCFC-22 in commercial refrigeration in hot climates may be addressed by introducing two-stage systems:

- a normal cascade system;
- a so called injection cycle where the same refrigerant is used in the two stages. Sub-cooling of the liquid and cooling of the vapour are realised at an intermediate temperature. These two-stage designs increase the energy efficiency significantly depending on the (outdoor) ambient temperature.

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11.4 Refrigerants for Deep Mines

11.4.1 Background

Mine refrigeration has been practised since the 1860s in the USA, originally with transport of naturally produced ice from the surface by returning emptied ore cars into the mines /McP93/. Vapour-compression refrigeration, currently the most widespread method of mine air-conditioning, appears to have been used for mine cooling as early the 1920s in Brazil and the UK and the 1930s in South Africa and India. Application escalated in the 1960s with large centralised refrigeration plants, located underground, in the South African gold mines. Limitations on the heat rejection capacity of return air, development of energy recovery devices for water pipelines in shafts, and improvements in chilled water and brine distribution systems led to renewed preference for surface plants.

As mine depths now increase to 4-5 km (2.5-3.1 mi), virgin rock temperatures approach 60-70 °C /del88, JMV06, MVS06, Ram01, Ros08/. A second factor adds to the cooling loads, namely *auto-compression*. Since air pressure increases as mines go deeper into the earth, similar to water pressure increases with depth in oceans, compression of ventilation air also increases its temperature /Eco07/. For a mining depth of 4 km (2.5 mi) the temperature increase due to auto-compression is approximately 16 °C (29 °F) /Ram01/.

While both effects imply high and nearly continuous requirements for heat removal, neither implies a high-temperature cooling condition. Instead, refrigerant condensing (heat rejection) temperatures are governed by approach to wet-bulb temperatures for the surface-located cooling towers. Refrigerant evaporating (heat absorption) temperatures are governed by approach to the chilled-water or other HTF supply temperature, economically selected to maximise the temperature lift and thereby reduce pumping burdens because of the significant distribution distances (depth). Use of ice slurries is gaining acceptance to capitalise on the latent heat of vaporisation to minimise mass transport requirements over single-phase options. Doing so implies a chiller evaporating temperature below 0 °C (32 °F), or a higher thermal lift than for conventional comfort-conditions, but not high-ambient operation.

The problem is compounded in open-systems in which the chilled water (or other HTF) is loop is open at mining depth, for example in spray cooling. Just as air-warms by auto-compression (see above), the column of chilled water within a vertical supply pipe for underground delivery heats up by pressurisation. Water chilled to 2 °C (36 °F) at the surface warms to 4.5 °C (40 °F) at 1000 m (3300 ft) depth /Xst05/. Typical mine installations have open water reservoirs at several below-ground depths water to manage piping pressurisation and simplify depth increases since deep and especially ultra-deep mines typically progress in depth with time.

11.4.2 Deep Mines

The focal questions for deep mines differ in several respects from those for applications addressed in preceding sections of this report.

Unlike air-cooled systems for which high outdoor temperatures lower efficiency and capacity, the ambient operating conditions for deep mines generally are less extreme. High-ambient-temperature operation in very warm climates increases cooling and, for many applications, also refrigeration loads.

Additionally and generally more significantly, it results in both high thermodynamic lift and refrigerant condensing at temperatures approaching the thermodynamic critical point. In contrast, most deep mines are in more moderate climates and heat rejection (refrigerant condensing) typically employs cooling towers rather than air-cooled condensers. The governing metric for refrigerant condensing (heat rejection) in mine cooling systems, therefore, is wet-bulb rather than dry-bulb temperature. High-ambient temperature locations actually have an advantage in this regard, since they typically are dryer and have greater wet-bulb depression.

The heat absorption temperature, and therefore the refrigerant evaporating temperature, generally is lower than for comfort air conditioning to minimise the pumping burdens to deliver cooling to significant depths, far more distant from the cooling.

With exception of in-situ refrigeration systems once competitive for shallow mines, nearly all deep mines use chillers located above ground /del88/ and pump a heat transfer fluid (HTF sometimes also identified as a secondary loop coolant or incorrectly as a “secondary refrigerant”) below ground for indirect rather than direct-expansion (DX) cooling. As mining depths increase, phase-change ice slurries become more attractive than single-phase HTFs, such as water or glycol-inhibited water or similar brines. These ice slurries capitalise on the latent heat of vaporisation and thus reduce the mass transport burden compared to single-phase, sensible (thermally) cooling approaches.

The cooling requirement is nearly continuous and the required equipment sizes are quite large, resulting in significant energy requirements and heightened concerned with energy-related greenhouse gas emissions. Thermal loads for deep mines are nearly independent of climatic factors since the primary cooling load is from geothermal heat from the earth and temperature increases resulting from depth-induced compression /Eco07/, rather than solar-driven heat gains.

Also, the cooling load profile is more uniform predicated on nearly constant geothermal heat and less diurnally- and seasonally-controlled influences of weather. The high load-profiles, required reliability, and practically required system durability change the economics of system operation to support very efficient systems with entailing multiple (never single) chillers typically with excess aggregate capacity to enable maintenance and accommodate individual unit failures.

While use of cooling towers instead of air-cooled condensers offers advantages for these large systems, deep mines often are in regions with more-limited supplies of suitable water, evaporated to reject heat (by exploiting the latent heat of vaporisation of water). Additional water is used to control mineral and other contaminant compositions in cooling water and to make up for amounts lost in wind-induced drift. While water may be available from mine drainage in most mines, it may be unsuitable due to high mineral or corrosive content and forcing use of water or scarce water from other sources.

11.4.3 Requirements and Outlook

The deep mine study has been taken up in 2008, but could not be finalised due to logistics problems in planning visits. Further study of the deep mine issue will be deferred pending additional data gathering. For this, a next visit is planned to South Africa in May 2009.

The key data requirements have been identified:

a. Confirmation of typical evaporating temperature or ranges of evaporating temperatures used;

b. The most common equipment capacities for deep and ultra-deep mines;

c. Results to date with use of water as a refrigerant particularly when integrated with ice-slurry delivery;

d. Any additional considerations or constraints.

11.5 Conclusions

In the chapters above, an analysis has been conducted concerning the suitability of HCFC-22 alternatives in air conditioning and commercial refrigeration equipment at high ambient temperatures. The analysis for the application of alternatives to HCFC-22 in mines is still underway and depends on results expected to be obtained in a next visit to South African mines.

A. In the case of unitary air conditioning the following can be mentioned.

The use of propane could be preferred for those types of equipment where the amount of refrigerant charge would not present a major risk in case of leakage. However, compared to HCFC-22 propane performs well, but slightly worse compared to HCFC-22. Design modifications could well lead to a similar performance.

Due to a relatively low critical temperature, the performance of R-410A --as well as R-407C-- is lower at all ambient temperatures compared to HCFC-22, but the energy efficiency penalty is largest at the highest ambient temperature and could be in the order of 10% lower compared to the application of HCFC-22. Refrigeration capacity also tends to decrease faster than the capacity of HCFC-22 with high ambient temperatures.

In a first instance this reduction in energy efficiency could be reduced by enlarging the surface area of components such as condenser or the subcooling pipeline. Optimisation of the design would be a first requirement.

It should be borne in mind that the design has to take into account the highest ambient temperature, but the performance through the entire year is much less impacted by the highest ambient temperatures since lower temperatures occur during a large part of the year. This would lead to different conclusions for the energy efficiency integrated over the entire season. This kind of study could be easily performed if enough seasonal data (per hour per day) for certain places with high ambient temperatures would be available; it may need further consideration.

HFC-134a and HC-600a would seem attractive from the point of view that they have similar performance to HCFC-22 at high ambient temperatures. However, both of these refrigerants are low-pressure refrigerants. The use of these low pressure refrigerants would require extensive redesign of the base system components in order to achieve the same capacity and efficiency of the HCFC-22 system. Therefore, R-134a and HC-600a are not considered cost effective options to replace HCFC-22 in unitary air-conditioning applications.

Once low GWP options (of the type of HFC-1234yf, however, with a higher pressure temperature characteristic) would become available, these could be further considered. However, there are still too many uncertainties regarding the possible development of this type of refrigerants in order to give any reasonable forecast for future application.

B. In the case of commercial refrigeration the following can be mentioned.

Where it concerns small commercial refrigeration equipment (stand alone equipment) the use of HC-600a should be considered compared to HFCs or HFC blends. Charges would be relatively small and the energy efficiency and capacity decrease with high ambient temperatures would be smaller than in the case of HCFC-22. In the case of smaller units in a supermarket (with the condenser in the indoor atmosphere) the external air conditioning will provide constant ambient temperatures and the issue of high ambient temperatures is negligible.

Due to a relatively low critical temperature, the performance of R-404A --as well as R-407C-- is lower at all ambient temperatures compared to HCFC-22, but the energy efficiency penalty is largest at the highest ambient temperature and could be in the order of 10% lower compared to the application of HCFC-22. Refrigeration capacity also tends to decrease faster than the capacity of HCFC-22 with high ambient temperatures.

In a first instance this reduction in energy efficiency could be reduced by enlarging the surface area of components such as condenser or the subcooling pipeline. Separate cooling of the subcooling liquid line with an external refrigeration loop might be a solution to drastically improve the capacity at high ambient temperatures. In summary, optimisation of the entire design would be a first requirement.

As mentioned for unitary air conditioning, the equipment design has to take into account the highest ambient temperature, but the performance through the entire year is much less impacted by the highest ambient temperatures since lower temperatures occur during a large part of the year. This would lead to different conclusions for the energy efficiency integrated over the entire season.

In choosing alternative refrigerants, the refrigerants HFC-134a and HC-290 seem attractive from the point of view that they would behave similar or better than HCFC-22 at high ambient temperatures. So far there is no equipment manufactured for HFC-134a for an entire large system since it would imply a significant increase in the volume of the compressor and the piping of heat exchangers, which would lead to a substantial increase in costprice. It would be advantageous to consider distributed systems for a supermarket in which case low charges of HFC-134a or HC-290 can be applied, which would also mitigate to a large degree the safety risks in the application of propane. In the case of these distributed systems, it is still assumed that the condenser would be mounted outside. Compared to HCFC-22 propane performs well in these systems, and the application in smaller units is certainly worth considering.

In case of larger supermarket systems, the solution to cope with high ambient temperatures can be found in two stage refrigeration systems, or systems with a secondary loop. If well designed the systems with a secondary loop will provide comparable efficiencies than the one stage HCFC-22 systems if high efficiency refrigerants are applied and the secondary loop is characterised by good heat transfer characteristics.

Application of two stage refrigeration systems (with HFC-134a or a hydrocarbon in the first loop, and e.g. carbon dioxide in the second loop) would provide less dependency on the ambient temperature (important in the case of refrigeration capacity) and would also lead to better energy efficiencies. This, however, will imply a certain cost increase dependent on the design and the size of the system.

The replacement of HCFC-22 in commercial refrigeration in hot climates may be addressed by introducing two-stage systems:

- a normal cascade system;
- a so called injection cycle where the same refrigerant is used in the two stages. Sub-cooling of the liquid and cooling of the vapour are realised at an intermediate temperature. These two-stage designs increase the energy efficiency significantly, however, much dependent on the (outdoor) ambient temperature.

12 Methyl Bromide - Interim response to Decision XX/6. Report of the TEAP Quarantine and Pre-shipment Task Force

Executive Summary

Decision XX/6 requested TEAP to review all relevant, currently available information on the use of MB for QPS applications and related emissions; to assess trends in the major uses, available alternatives, other mitigation options and barriers to the adoption of alternatives; and to determine any additional information or action that may be required to meet those objectives.

TEAP set up a revitalised Quarantine and Preshipment Task Force (QPSTF) made up of 10 experts, 4 from A5 and 6 from non A5 countries, to respond to aspects of Decision XX/6 directed to TEAP. This interim report is provided for 29OEWG, with a full report available for 21MOP.

Reported global production and consumption for QPS was approximately constant over the 2004-2007 period, though showing substantial fluctuations annually. Reasons for these fluctuations have not been identified.

Global consumption for QPS has averaged nearly 11,000 metric tonnes a year since 1995, with some variation from year to year, with minimum consumption of less than 8000 tonnes in 1998, with peaks in 1999, 2003 and 2006 at 12,425, 12,286 and 12,207 tonnes respectively.

Non-A5 Parties accounted for approximately 62% and 46% of reported global consumption in 2006 and 2007, respectively. Two Parties accounted for 82% of total non-A5 consumption in 2007. USA reports a wide annual variation in QPS consumption, peaking at 5,089 metric tonnes for 2006 and reduced to 2,930 tonnes in 2007. QPS consumption in A5 countries has increased since 2000, particularly in the Asian region, while in non-A5 countries it has declined. A5 consumption amounted to 38% of total global consumption in 2006 and 54% in 2007. QPS treatments are frequently carried out at point of export to meet requirements of the importing country.

Despite data gaps and uncertainties, able to make preliminary estimates of the volumes of uses covering more than 77% of total reported QPS consumption. The QPSTF estimated that at least 66% of total global consumption resulted from 5 main categories of use: fresh fruit and vegetables (8% of identified uses); grain, including rice (12%); soil (14%); whole logs (21%); and wood and wood packaging material (13%). All of these categories have at least some instances where alternatives are not technically available

Despite recent surveys and submission of further data by various Parties, additional quantative data on consumption for major uses is required from Parties to permit satisfactory assessment of usage trends.

There is a discrepancy of about 1,300 tonnes for non-A5 Parties for 2007 between total consumption estimated by ‘bottom-up’ analysis and total consumption reported as per Article 7 data. This difference apparently arises from undefined use in one Party. A discrepancy of similar magnitude is apparent yearly over the period 2003-2007. Further clarification is being sought on this portion of QPS usage.

Development of methyl bromide alternatives for QPS applications on commodities continues to be a difficult process, exacerbated by the multitude of commodities being treated, the diverse situations where treatments are applied, a constantly changing trade and regulatory landscape, requirements for bilateral agreement on QPS measures, requirement for very high

levels of proven effectiveness and lack of patent coverage or other commercial protection for some potential alternatives. Regulations prescribing methyl bromide treatment alone are a major barrier to adoption of alternatives as often there is little incentive for the regulation to be changed. A key barrier to development of alternatives for soil treatment for growing plants of certified high health status is the rigorous testing required to prove an alternative effective.

So far, TEAP has identified the treatment of a) Export coffee (Vietnam); b) Export rice and cassava chips (Thailand, Vietnam); and c) Soil to produce propagation material (USA), as categories of use that have been classified as QPS by some Parties but not by others.

TEAP will publish a list of applications for which technically feasible alternatives have not been identified in the September report. TEAP encourages Parties to submit additional quantitative data on consumption for major uses as soon as possible.

12.1 Mandate and scope of the report

Following Decision XX/6, TEAP set up a revitalised Quarantine and Pre-shipment Task Force (QPSTF), to report to the Parties on those parts of Decision XX/6 that requested TEAP's response. TEAP, in consultation with the International Plant Protection Convention (IPPC) secretariat, has been requested to review all relevant, currently available information on the use of MB for Quarantine and Pre-shipment (QPS) applications and related emissions, to assess trends in the major uses, available alternatives, other mitigation options and barriers to the adoption of alternatives, and determine what additional information or action may be required to meet those objectives. The full text of Decision XX/6 is included in Annex 1 of this chapter for reference.

In particular, the assessment is required to consider:

- Volumes of MB used for QPS, by major uses and target pests;
- Technical and economic availability of alternatives for the main MB uses, by volume, and of MB recovery, containment and recycling;
- QPS applications for which no alternatives are available and an assessment of why alternatives are not technically or economically feasible or cannot be adopted;
- Illustrative examples of regulations that directly affect the use of MB for QPS treatment;
- Barriers preventing the adoption of alternatives to MB;
- Projects demonstrating technically and economically feasible alternatives, including technologies for recapture and destruction of methyl bromide for QPS
- Opportunities for reducing MB use or emissions for QPS

In addition, Decision XX/6 requested TEAP to provide the following information in its draft report to the twenty-ninth meeting of the Open-Ended Working Group:

Paragraph 5: *"To request the Technology and Economic Assessment Panel to present a draft report based on the analysis of the available information to the Open-ended Working Group at its twenty-ninth meeting, indicating areas where the information is not sufficient, explaining, where appropriate, why the data were inadequate and presenting a practical proposal for how best to gather the information required for a satisfactory analysis;"*

Paragraph 7: *"To request the Technology and Economic Assessment Panel, in accordance with its terms of reference, to list categories of use it has identified that have been classified as quarantine and pre-shipment use by some Parties but not by others by the twenty-ninth meeting of the Open-ended Working Group and that those Parties are requested to provide the information on the rationale for doing so to the*

Technology and Economic Assessment Panel in time for inclusion in its final report to the Twenty-First Meeting of the Parties:"

This interim report provides in particular, a response to paragraphs 5 and 7 of Decision XX/6. It also describes work in progress and preliminary findings related to the remaining tasks under Decision XX/6, which will be addressed in the Final Report of the QPSTF due to be submitted by TEAP for the 21st Meeting of the Parties.

12.1.1 Background to the report

Production and consumption of methyl bromide, an ozone-depleting substance, for quarantine and pre-shipment uses is exempted from control under Article 2H, para. 6 of the Montreal Protocol. Parties have been required to report their production and consumption for QPS purposes (Beijing Amendment, Art. 1, para. O).

Parties have been encouraged to use alternatives to methyl bromide for QPS purposes where technically and economically feasible (Decisions VI/11(c), VII/5) and XI/13, XVI/11).

Nevertheless, consumption of methyl bromide for QPS purposes continues to be substantial. TEAP (2004) estimated QPS use of MB to be about 28% of global methyl bromide consumption in 2002, equivalent to 11,245 tonnes. In 2006, MBTOC (2007) reported that although production of MB for QPS purposes (Ozone Secretariat data) had been approximately constant over the period 1999-2004 at around 10,500 metric tonnes per annum, it showed an increase of about 30% in 2005. The increase came at a time when 'controlled' uses of methyl bromide decreased rapidly as a result of progress with phasing out of MB in both Article 5 and non-Article 5 countries.

In 2007, the most recent year for which the Ozone Secretariat has complete data as at May 2009, reported global production of MB for QPS uses was 12,984 metric tonnes, after a lower reported production in 2006 of 12,075 metric tonnes. Global production of MB for non-exempt uses, has been falling rapidly in response to the phaseout activities for methyl bromide for both Article 5 and non-A5 Parties and in 2007, at 12,875 metric tonnes, this fell below that for QPS for the first time. It is expected to exceed production for non-exempt uses substantially in 2008, with the continued downward trend in non-exempt uses.

Around 90% of the methyl bromide applied in QPS uses (calculated from MBTOC 2002) is emitted and thus potentiallypresents a risk to the ozone layer. An exception is when recapture systems are fitted and emissions are reduced substantially, At this time, only a small fraction of total applied methyl bromide is recaptured. This is probably less than 0.1% of applied methyl bromide, but the exact quantity recaptured and reused or destroyed is not known.

Uses of methyl bromide for QPS are diverse, but there is a well-established set of specific uses. TEAP and its MBTOC have reported on this issue in several reports (TEAP, 1999, 2003, 2006; MBTOC 1998, 2002, 2007). They noted that individual tonnages for methyl bromide uses for quarantine and pre-shipment treatment of particular commodities were not available on a comprehensive and worldwide basis, though specific surveys or datasets were available for a number of countries. In many countries, records of QPS usage by application have not been routinely kept or easily assessed. However, following Dec XI/13, all EC Member States are required to use logbooks recording QPS uses and quantities, and data are available since 2004 in many cases.

In 2004 a survey of QPS uses by individual Parties was carried out in response to Decision XI/13(4). This survey provided data on uses for less than 50% of reported global consumption. Decision XI/13(6) urged Parties to implement procedures to monitor the QPS uses of methyl bromide by commodity and quantity, but these may not have been in place by the time the survey was conducted, limiting the availability of the information requested. Decision XVI/10(4) requested Parties that had not already submitted data to provide best available data on QPS uses and associated quantities to the Quarantine and Pre-shipment Task Force before 31 March 2005. Both Decisions requested information from the Parties on what alternatives were available to the individual Party for particular QPS applications, and specifically for the five largest consuming applications. Responses by Parties to the 2004 survey and subsequent information provided under Decision XVI/10(2) covered about 65% of the total reported annual consumption for QPS during the 2002-2004 period. Responses from Parties indicate wide variation in the kinds of data collected by individual Parties and the precision with which they can report to the Protocol commodity by commodity use.

Decision XX/6 urges those Parties that have not yet done so to report data on the use of methyl bromide for quarantine and pre-shipment applications by April 2009 and to report such data in accordance with existing Protocol requirements and decisions annually thereafter. It further encourages Parties to put in place a national strategy involving actions to help reduce the use of methyl bromide for phytosanitary measures and/or reduce emissions of methyl bromide and make such strategies available to other Parties through the Ozone Secretariat in accordance with the recommendation of the third meeting of the Commission on Phytosanitary Measures under the IPPC (IPPC, 2008).

12.1.2 Fulfilment of Decision XX/6 – Process

In response to Para. 4 of Decision XX/6, TEAP conformed a streamlined and revitalised QPS task force (QPSTF) under the coordination of two co-chairs, one from an A5 country and one from a non-A5 Party. The task force is presently composed of ten members including the co-chairs, six from non-A5 Parties and four from developing (A5) Parties, with broad regional representation. Names and details of QPSTF members can be found in Annex 2.

QPSTF work was conducted though conference calls and electronic communication. A private website for posting documents was created with the help of the Ozone Secretariat to help progress work. Communication has been established with the IPPC in response to the Decision mandate. Cooperation of the Parties, either directly or via the regional UNEP Compliance Assistance Programmes (CAP) was sought through the Ozone Secretariat. Responses and valuable information has been received directly from twenty one Parties, and permission to use data from surveys, previously considered confidential, was obtained.

The QPSTF further conducted extensive reviews of published literature, conference proceedings, QPS regulations from different countries, consultation with experts and others, to access relevant information to the best extent possible.

Draft reports were tabled at the MBTOC-Soils and MBTOC-QSC meetings (April 2009) and then at the TEAP meeting (April 2009) for discussion, review and input.

No face to face meetings of the full QPSTF have been held and none have been scheduled at this time, although it is possible that such a meeting may be needed around September 2009 in order to finalise the report to be presented during the 21^{st} MOP according to mandate.

In keeping with Decision XX/6 the QPSTF has considered categories of use and options for adopting alternatives to methyl bromide for QPS uses in relation to IPPC rules and measures. In particular reference has been made to the IPPC recommendation “For the replacement or reduction of MB as a phytosanitary measure” (IPPC, 2008).

12.2 Availability of information: response to paragraph 5 of Decision XX/6

In response to paragraph 5 of Decision XX/6, QPSTF analysed the available information and identified the key data gaps. Table 12.1 provides a summary of the findings related to each topic listed in Decision XX/6. The following Sections provide a description for the major topics.

12.2.1 Volumes of MB used for QPS

National statistics on the production, import and export of MB intended for QPS have been submitted to the Ozone Secretariat by a number of Parties in their annual reports under Article 7 of the Protocol. The 'Data Access Centre' on the Ozone Secretariat's website contains the data on MB production for QPS, and QPS consumption. The available data lie in the period from 1986 to 2007, although there are many gaps in the early years. QPS reporting was not specifically required under the Articles of the Montreal Protocol until the Beijing Amendment was adopted in 1999. The Beijing Amendment inserted into Article 7(3) a requirement for Parties to report the annual amount of MB used for QPS (Beijing Amendment, Art. 1, para. O). This Amendment entered into force in 2002 or 90 days following a Party's ratification date. Some Parties have not ratified this Amendment at the present time.

A number of Parties submitted QPS data to the Ozone Secretariat for the years before the Beijing Amendment came into force as a result of several Decisions. In 1997 Decision IX/28(6) revised the official formats for reporting Article 7 data and stipulated that, when reporting on QPS, Parties should report the amount 'consumed' (imports, production, exports) rather than actual 'use'. Decision X/11(4) reminded Parties of the need to report on the volumes of MB consumed for QPS as set out in Decision IX/28. Most recently in 2008 Decision XX/6(1) urged Parties that have not yet reported QPS data under Article 7 to do so by April 2009, and annually thereafter.

12.2.2 Overview of QPS production and consumption

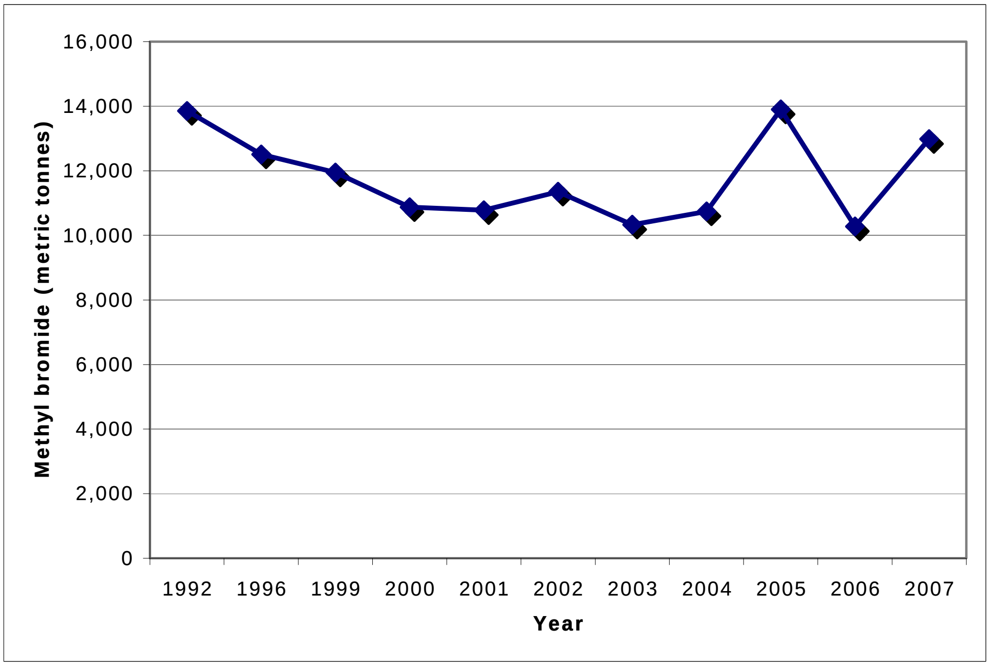
Data have been submitted by 7 Parties that produced MB for QPS in the period 1991-2007. Table 1 indicates the recent years for which the data and totals are complete and incomplete, and the number of data gaps in each year. The Data Access Centre indicates gaps in significant areas in the period 1991-1998, and as a result the total volume of QPS is substantially under reported. However, the data on MB production for QPS is complete for the years 1999 and 2002-2007. After 1999, the data is absent for one Party (China) and only for the years 2000 and 2001. The QPSTF has estimated this missing data values by assuming a linear trend between 1999 and 2002 reported values.

12.2.2.1 Total Global Production for QPS Purposes

Production data, both in aggregate and for individual Parties provide a useful check on the adequacy of reported consumption data. Data on production and consumption by individual Parties has not previously been available publicly, but was released under Decision XX/6(2)

Global production showed a steady decline from 1992 till 1999 but then was relatively stable at approximately 10,500 metric tonnes from 2000 to 2004. Since 2004, there have been substantial fluctuations in total reported production for QPS, with values of 13,815, 10,275 and 12,984 tonnes for 2005, 2006 and 2007 respectively (Fig 12.1).

Figure. 12.1. Estimated global production of methyl bromide for QPS uses 1991 - 2007



Source: MBTOC, 1994, 1998; MBTOC estimates; Ozone Secretariat data, April 2009

Table 12.1: MB production for QPS, available data for 1997-2007

Year	Reported MB production (tonnes)	Number of data gaps
1997	7784	1
1998	8118	1
1999	11950	0
2000	9793	1
2001	9496	1
2002	11269	0
2003	10246	0
2004	10660	0
2005	13815	0
2006	10275	0
2007	12984	0

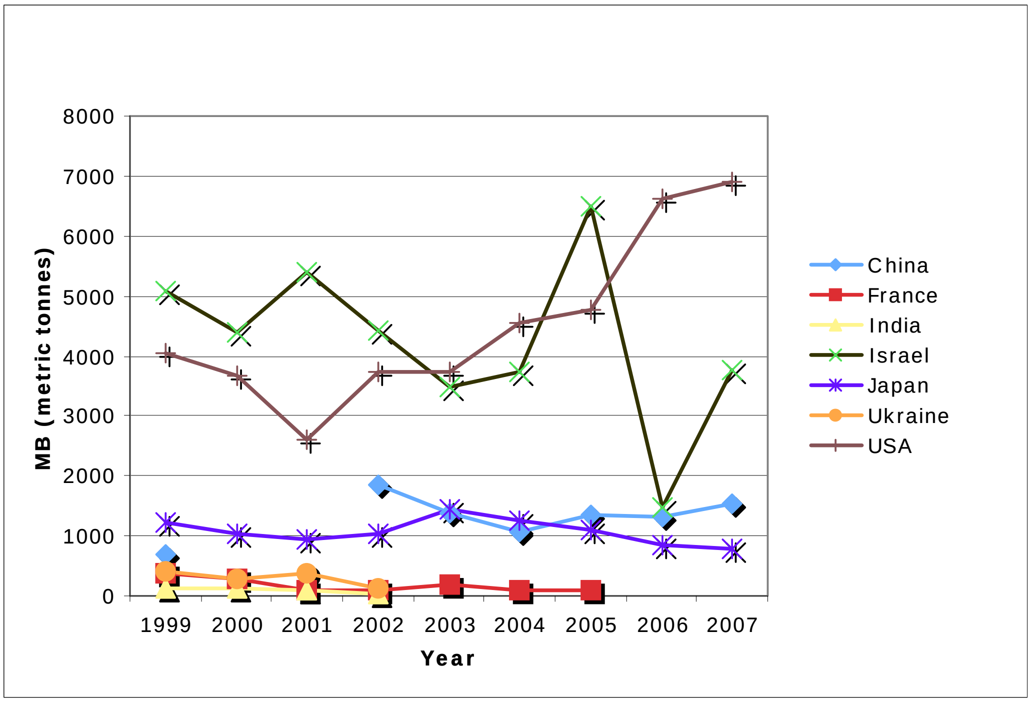
Source: Ozone Secretariat Data Access Centre, May 2009. Data rounded to the nearest whole tonne.

12.2.2.2 Production by Party for QPS Uses

Seven Parties to the Montreal Protocol have reported production of methyl bromide for QPS uses: five non-Article 5 Parties - France, Israel, Japan, Ukraine and the United States; and two Article 5 countries – China and India. Fig. 12.2 below shows great variation in production levels for some Parties.

The fluctuations in total global methyl bromide production for QPS are refected by those in production reported from Israel. Reasons for this fluctuation have not been identified at this stage. Inventory changes are a possibility.

Figure 12 2. Production of methyl bromide for QPS uses by Party, 1999 – 2007



Source: Ozone Secretariat Data, 2009

12.2.2.3 Consumption by Party for QPS uses

In the period 1991-2007 QPS consumption data has been submitted to the Ozone Secretariat for some years by 41 non-A5 Parties and 67 A5 Parties, giving a total of 108 Parties. QPS consumption figures are available for as early as 1986 for some Parties but not for others. Because information gaps make it difficult or impossible to conduct a proper analysis, the QPSTF considered it best to use data from 1999 onwards for consumption when data for most Parties is available.

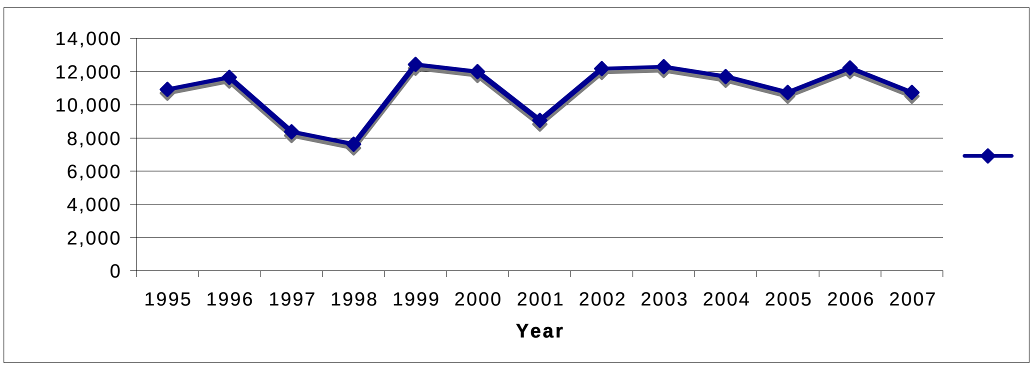
As per Ozone Secretariat guidelines, "QPS consumption" is taken to mean QPS Production plus QPS Imports minus QPS Exports. ‘Consumption’ may thus be different to ‘use’. Differences between the two data sets may arise from several factors, notably changes in inventory during the year of reporting. Drawdown of stocks of material gives a lower calculated consumption compared with reported use, while stockpiling leads to higher calculated consumption compared with reported use.

Among the 15 non-A5 Parties (counting the EC-27 as one Party), 9 Parties have submitted data points for at least 9 years continuously in the period 1999-2007, allowing longer term trends to be analysed. Data for 1999-2007 are available for the major QPS users i.e. Parties that have consumed more than 100 tonnes in any year since 2002. The available data for non-A5 Parties since 1999 are sufficient for QPSTF to make estimates of the totals using the Ozone Secretariat data alone.

Among the A5 Parties, 28 have submitted data points for at least 9 years, while 34 Parties have reported data for at least 4 of the last 5 years (2003-2007). Thirteen A5 Parties have reported QPS consumption >100 tonnes in any year since 2002. In most cases, these large MB-users have reported data since 2002 or much earlier.

Global consumption for QPS has averaged nearly 11,000 metric tonnes a year since 1995, with minimum consumption of less than 8000 tonnes in 1998, with maxima in 1999, 2003 and 2006 at 12425, 12,286 and 12,207 tonnes respectively, as seen in Fig. 12.3 below.

Figure 12.3: Reported global consumption of methyl bromide for QPS uses, 1995-2007



Source: Ozone Secretariat Data, 2009

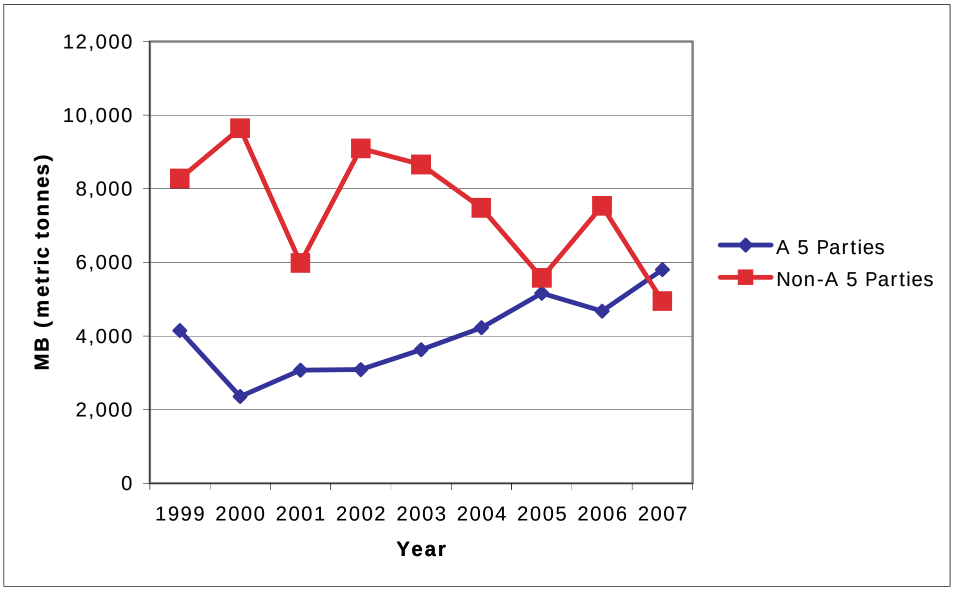
Control measures under the Montreal Protocol typically apply differently to Article 5 and non-Article 5 members. In the discussion below, data for these two groupings is presented separately, following this precedent. However it should be noted that QPS treatments are often associated with international trade and consumption in one (exporting) country is frequently to meet the requirements of another (importing) country. This is in contrast to the situation with most other ODS where consumption usually occurs within the country, though they may be included in manufactured items for export.

Figure 12.4 shows the reported QPS consumption in A5 Parties and non-A5 Parties from 1999 to 2007. When consumption is considered in the light of regional groupings of A5 and non-A5 countries, the following trends are evident:

- In 2007 reported consumption for QPS in A5 countries exceeded that in non-A5 for the first time.
- Total consumption of MB for QPS uses peaked in non-Article 5 Parties in 2000 with a reported consumption of 9,646 metric tonnes. In 2006 consumption was reported at 7,536 tonnes, reducing to 4,949 tonnes in 2007.
- In contrast, reported consumption for QPS uses in Article 5 countries has grown approximately linearly since 2000, from 3,990 tonnes to 5,803 tonnes in 2007.

Evolution of reported consumption for A5 and non-A5 Parties is illustrated in Figure 12. 4 below.

Figure 12.4: Total reported consumption by Article 5 and non-Article 5 Parties over the period 1999 – 2007



Source: Ozone Secretariat Data, 2009

12.2.2.4 Consumption in Non-Article 5 Parties

Consumption and use of methyl bromide for QPS purposes for treatment of commodities in trade can occur in either the importing or exporting country. Often the exporting country is an A5 Party. There is a trend for the NPPOs of many countries to encourage specified quarantine treatments to be carried out at point of export, not at import. This is designed to ensure only consignments free of quarantine pests are brought within the country's borders, giving improved border security and ecosystem protection. A result of this process is to move the methyl bromide consumption or use in these instances from the importing country's methyl bromide account to that of the exporting one. This contrasts with the consumption of methyl bromide for controlled uses (fumigation of soils, commodities and structures) where all the methyl bromide consumption and use occurs in the country requiring the fumigation. Detailed global statistics are not available for how much QPS fumigation occurs in originating country and how much in importing (destination) country.

It may be speculated that the reasons for the increases QPS consumption in Article 5 countries with corresponding decrease in non-A5 countries results from a combination of the trend towards increased treatment at country of origin prior to shipment, much increased trade from A5 countries that are at risk of infestation by quarantine pests and requiring QPS fumigation and concurrent adoption of non-methyl bromide alternatives in non-A5 countries. As examples, it was estimated (US response to Decision XVI/10) that of the 498 tonnes used for commodity fumigation in the US in 2004, 252 tonnes (52%) was used on exports to meet the quarantine requirements of the importing country. In New Zealand at least 84% of the methyl bromide was used in 2007 on export commodities to meet the quarantine requirements of the importing country. This use of MB is directly related to the trends in trade of logs and lumber.

There has been increasing fumigation in countries in the Asian region following introduction of the AFAS (Australian Fumigation Accreditation Scheme) replacing treatments formerly carried out in Australia. The scheme (AFAS 2009) is designed to ensure a high standard of quarantine fumigation is carried out in countries exporting to Australia so that overseas fumigations can be recognised by Australian quarantine authorities, avoiding the need for treatment or retreatment at point of entry into Australia.

Nine non-A5 Parties reported consumption of MB for QPS purposes in 2006 and 2007. Together, they accounted for approximately 62% and 46% of total global consumption in 2006 and 2007 respectively. Two Parties, Japan and the USA, represent 82% of total non-A5 consumption in 2007. The USA reports a wide variation in QPS consumption, peaking at 5,089 metric tonnes for 2006. There is no obvious trend in reported consumption for Japan since 2004. Both are major destinations for commodities shipped from A5 countries with stringent quarantine requirements to safeguard the environment, human and animal health and agriculture and both have had major incursions of exotic organisms that have caused severe economic and environmental damage. All other Parties reflect a downward trend in MB consumption for QPS purposes. Details on such consumption may be found in Table 12.2 and Fig 12.5 below.

Table 12.2: Large volume* consumers of MB for QPS uses in non-Article 5 regions (metric tonnes).

Party	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Australia	352	352	425	517	475	415	441	390	360	359	294
European Community	910	782	1328	2855	790	800	758	880	474	342	194
Israel	853	986	225	319	337	437	501	416	331	277	210
Japan	2175	1620	1450	1637	1408	1525	2845	1277	1166	1105	1107
New Zealand	56	96	60	58	51	100	140	205	126	215	170
Russian Federation		209	223	250	117	1612[a]	117	157	113	148	33
Ukraine	315	315	409	257	-356[b]	-24[b]					
United States			4038	3663	3079	4127	3722	4116	2931	5089	2930

Source: Ozone Secretariat Data, 2009, rounded to the nearest tonne

(a) This value is being checked.
(b) As per the definition of consumption (production, plus imports minus exports), when exported quantities (which could come from stocks) are larger than those imported or produced for a given year a negative value arises.
* Large volume users have reported QPS consumption of >100 tonnes a year in 2006 or 2007

An analysis of regional consumption for non A5 Parties indicates the following trends as illustrated by Fig 12.5 below:

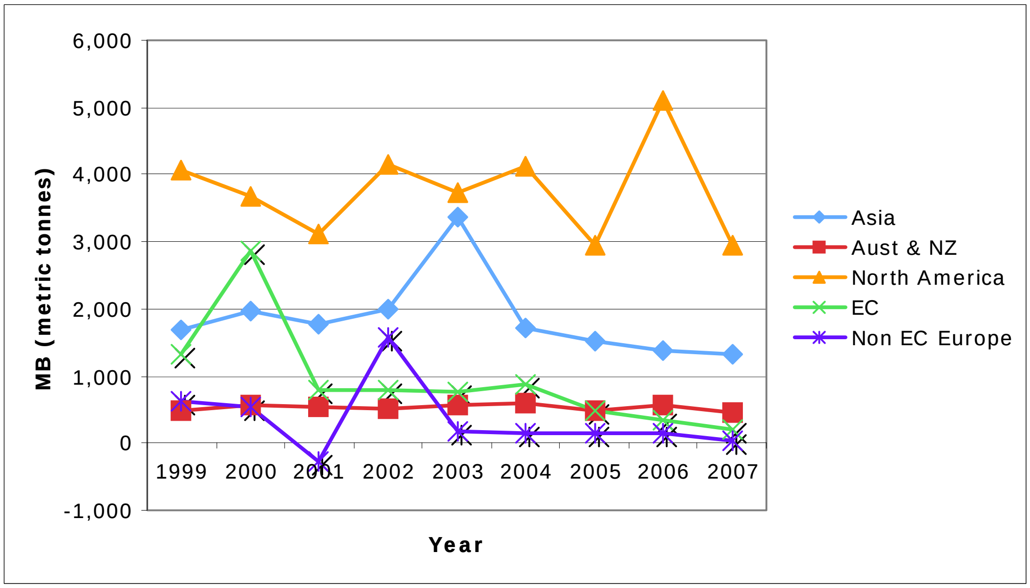
- Aggregate reported consumption in Australia and New Zealand has remained stable at around 500 tonnes in the period considered.

- The EC, Japan and Israel show a general downward trend although there were was increased consumption in the EC in 1999 and 2000 when reported consumption reached 2855 metric tonnes, and in 2003 for Asia (Japan and Israel) with 3357 tonnes.

➢ Similarly, Non-EC European Parties report peak consumption in 2002, due in particular to significantly increased consumption in the Russian Federation for that year[21].

➢ Reported consumption in North America (USA and Canada) has ranged from approximately 2,900 to 5,800 tonnes. Although lower in 2007 than in 1999, consumption showed a sharp increase in 2006 when the United States reported 5106.2 metric tonnes consumed for QPS purposes.

Figure 12.5: Reported MB consumption for QPS purposes in non-A5 Parties in various regions



Source: Ozone Secretariat data, April 2009

12.2.2.5 Consumption in Article 5 Parties

Analysis of QPS consumption data reported in 2006 and 2007 by A5 Parties (Ozone Secretariat data) indicates that forty-three countries reported consumption in 2006 and 39 in 2007. In aggregate, A5 consumption amounted to 38% of total global consumption in 2006 and 54% in 2007. Consumption trends for A5 Parties can be summarised as follows:

➢ In 2006, ten A5 Parties reported consumption of MB for QPS purposes that was larger than 100 metric tonnes. Aggregate consumption for this group of Parties was 84% of the total reported consumption for this group in 2006.

➢ The remaining 26% was composed of three medium volume users consuming between 50 and 100 tonnes (accounting to 6% of total A5 use for that year), eleven small volume users (between 5 and 50 tonnes) and nineteen low volume consumers (LVC) with usage below 5 metric tonnes.

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[21] The value for the Russian Federation for 2002 is being checked. It appears anomalously high compared with previous and subsequent years.

- In 2007, eleven countries reported usage at or above 100 metric tonnes for QPS purposes. Together, this accounted for 5100 tonnes or about 87% of total A5 consumption in that year.
- The remaining 23% was composed of four medium users (between 50 and 100 metric tonnes of MB) summing 5% of the total A5 consumption for the year, ten small users (between 5 and 20 tonnes) and fourteen LVC.

The largest volume consumers of MB for QPS purposes (consumption at or above 100 tonnes for 2006 and/or 2007) appear in Table 12.3 below. Several countries in different world regions show a sustained increase in consumption. Preliminary discussion on particular categories of use and key pests is included in this interim report and will be addressed in detail in the final QPSTF report.

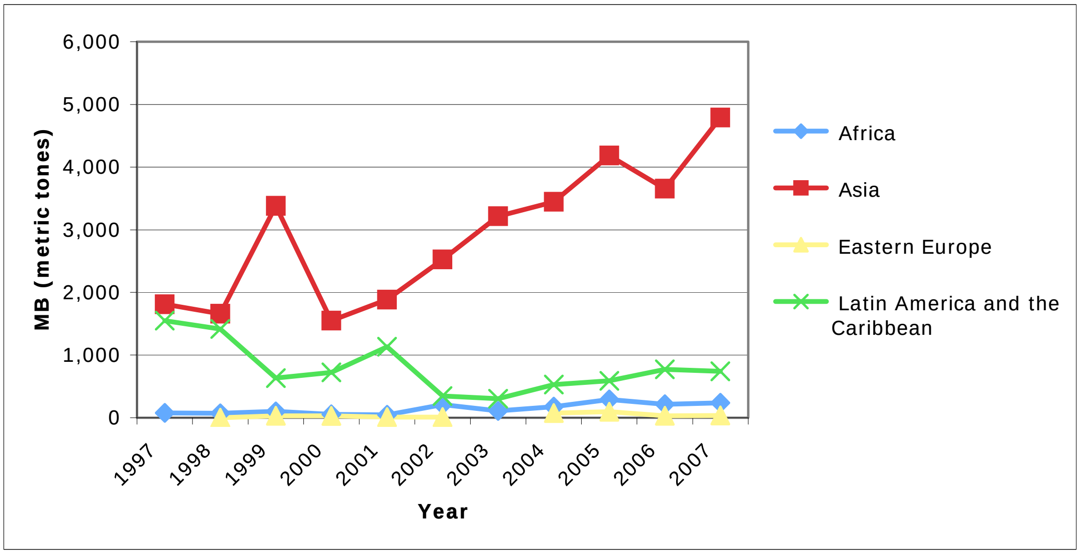
Table 12.3: Large volume* A 5 consumers of MB for QPS (metric tonnes).

Party	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Brazil							52	107		223	167
China		67	889	223	121	1118	1291	725	1519	1029	1855
Egypt						200	54	89	160	150	138
India	182	207	210	308	295	114		389	301	330	361
Indonesia	169	147	210		189	252	252	252	337	211	250
Malaysia	46	61	93			168	156	171	252	285	300
Mexico	1252	1106	312	359	715	155	96	135	240	239	260
Republic of Korea	950	390	884	350	516	543	377	536	425	288	381
Singapore	40	37	231	109	35	35	52	46	85	98	153
Thailand	259	253	458	146	208		375	620	455	539	558
Vietnam	70	330	380	250	325		336	530	599	656	677

Source: Ozone Secretariat Data, 2009, rounded to the nearest tonne
*Large volume users have a reported QPS consumption of >100 tonnes a year in 2006 or 2007

An analysis of methyl bromide consumption for QPS uses per region reveals that largest consumers are located in Asia as seen in Fig. 12.6. Further, that QPS consumption in that part of the world is increasing. This was also found in a recent survey of QPS uses conducted through CAP for Region of Asia and Pacific (ROAP), where total estimated QPS consumption for the Asia/ Pacific (including Taiwan, PRC and Pacific Islands) in 2005 was estimated to be about 34% of the global QPS production for that same year (UNEP/ ROAP, 2008). To a lesser extent, an upward tendency with respect to consumption of MB for QPS uses is also observed in Latin American countries since 2002, following a decline to a low point then.

Figure 12.6: Regional QPS consumption in Article 5 Parties 1997 – 2007 (metric tonnes)

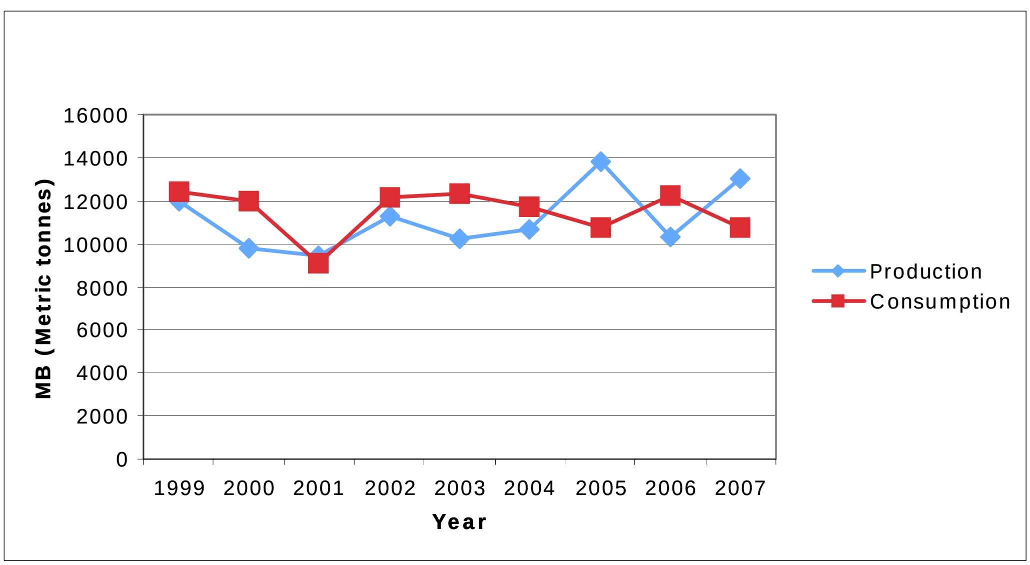


Source: Ozone Secretariat Data, April 2009

12.2.2.6 Global production vs. global consumption

As seen in Fig. 12.7 and table 12.4 below, between 1999 and 2007 reported production of MB for exempted QPS uses has been roughly at the same level as reported consumption. Data prior to 1999 for reported consumption by country is incomplete and thus the comparison can only be made to totals subsequent to 1999. Differences between production and consumption between 2002 and 2007 exceeded 1000 tonnes on a yearly basis, possibly reflecting stock changes. The aggregate values over this period were closely similar (production, 69,265 tonnes; consumption, 69,882 tonnes).

Figure 12.7: Global production of MB for QPS uses compared to global consumption



Source: Ozone Secretariat Data, April 2009

Table 12.4: Analysis of available QPS information, data gaps, and preliminary proposals for gathering information (under paragraph 5 of Decision XX/6)

No	Information topics to be reviewed under Decision XX/6 paragraphs 4-7	Areas where information is available or not sufficient, and reasons	Proposals on how to gather information required for a satisfactory analysis
1	Review of all relevant currently available information on the use of MB for QPS applications	For QPS consumption data: many gaps in A5 data, some gaps in non-A5 data. For major applications: data gaps for some major users. New data received for Parties in response to Dec XX/6. A number of Parties have not reported QPS consumption data to the Ozone Secretariat. Inadequate responses to surveys in 2004-2006 (. New surveys available for Asia Australia, New Zealand 21 Parties have responded to Dec XX/6	Encourage Parties to collect and report data. Questionnaires could be sent to national phytosanitary experts. If necessary IPPC could be encouraged to place questionnaire to NPPOs on its website.
2	Review of related emissions	Estimates are available in previous MBTOC & TEAP reports.	Update of estimates conducted by QPSTF, to be completed in final report..

No	Information topics to be reviewed under Decision XX/6 paragraphs 4-7	Areas where information is available or not sufficient, and reasons	Proposals on how to gather information required for a satisfactory analysis
3	Assessment of trends in the major uses	TEAP has carried out detailed surveys in the past. Data showing trends for major uses over several years is only available for some Parties. More data would be very useful for trend analysis. Protocol does not require Parties to report a breakdown of major uses. This type of information is not routinely collected in many large volume consuming countries. However useful information has been received from several Parties	Targeted questionnaires to specific countries that consume MB for major use categories; or assistance from NPPOs and national experts. Standardise type of information required (IPPC categories for example)
4	Review of available alternatives	Data available for this task in past MBTOC and TEAP reports. Presently updating.	Updating from phytosanitary treatment manuals and national phyto websites, and ongoing research in many countries
5	Review of other mitigation options	Sufficient information can be compiled	QPSTF assessment pending
6	Review of barriers to the adoption of alternatives	Sufficient information can be compiled	Preliminary assessment conducted. Further assessment pending
7	Additional information or action to meet those objectives [Alternatives? Mitigation? Emission reduction?]	Sufficient information can be compiled	QPSTF assessment pending

No	Information topics to be reviewed under Decision XX/6 paragraphs 4-7	Areas where information is available or not sufficient, and reasons	Proposals on how to gather information required for a satisfactory analysis
8	Description of the majority of the volumes of MB used for QPS, by the major uses and target pests	Refer to no. 3. For target pests sufficient information can be compiled	Updating from phytosanitary treatment manuals and national phyto websites of major QPS users
9	Technical and economic availability of alternatives for the main MB uses, by volume	Information on technical availability is available for some major users. Data on economics can be compiled however this work will be time-consuming.	Economic data can be obtained from companies who use alternatives, as illustrative examples or case studies
10	Technical and economic availability of technologies for MB recovery, containment and recycling	Sufficient technical information is available. More information to be compiled on economics	Preliminary findings presented. Economic data can be obtained from companies who use alternatives, as examples
11	QPS applications for which no alternatives are available to date	Past MBTOC and TEAP reports have published lists; these can be updated	QPSTF assessment pending
12	Assessment of why alternatives are not technically or economically feasible or cannot be adopted (see 11)	Sufficient information can be compiled	QPSTF assessment pending

No	Information topics to be reviewed under Decision XX/6 paragraphs 4-7	Areas where information is available or not sufficient, and reasons	Proposals on how to gather information required for a satisfactory analysis
13	Illustrative examples of regulations or other measures that directly affect the use of MB for QPS, including information requested in Decision X/11 (Dec X/11(3): To request the Parties to submit a list of regulations that mandate the use of MB for QPS	Examples compiled. Useful information received from several Parties. Further work will be conducted	Preliminary findings presented
14	Barriers preventing the adoption of alternatives to MB for QPS	Sufficient information can be compiled	Preliminary findings presented. Further assessment pending
15	Projects demonstrating technically and economically feasible alternatives	Sufficient information can be compiled. Information received from some Parties (i.e. Canada)	QPSTF assessment pending
16	Projects demonstrating technologies for recapture and destruction of MB for QPS	Sufficient information can be compiled	QPSTF assessment pending
17	Highlight areas where sufficient information indicates opportunities for reductions in MB use or emissions for QPS	Information can be compiled	QPSTF assessment pending

No	Information topics to be reviewed under Decision XX/6 paragraphs 4-7	Areas where information is available or not sufficient, and reasons	Proposals on how to gather information required for a satisfactory analysis
18	List of available MB recapture technologies	Sufficient information can be compiled – see no. 10	Preliminary findings presented. Further QPSTF assessment pending
19	Where information is insufficient, a final proposal for further data gathering	Sufficient information can be compiled	Preliminary findings presented. Further QPSTF assessment pending
20	List categories of use that have been classified as QPS by some Parties but not by others	Further information on the particular circumstances of uses would be useful	List included. Preliminary analysis presented. Further QPSTF assessment pending responses from Parties

12.3 Major QPS uses and volumes

At various stages since 1994, TEAP and MBTOC has carried out surveys and/or contacted national experts in order to compile information about major QPS uses, and to estimate volumes in some cases (e.g. MBTOC 1995, 1998, 2003, 2007). Parties are not required to report information about major QPS uses under the Montreal Protocol. Nevertheless, data have been made available by some Parties. In 1999 Decision XI/13(6) urged Parties to implement procedures to monitor the uses of MB by commodity and quantity (using a form shown in TEAP's report of April 1999, if necessary). In 2004 Decision XVI/10 requested Parties to submit data on individual QPS categories of use to TEAP, who then reported to Parties on the issue (TEAP 2006). Some Parties have indicated that their data were based on estimates rather than precise record keeping or surveys.

While there remain some data gaps and uncertainties, QPSTF has been able to make preliminary estimates of the volumes of uses covering more than 77% of total reported QPS consumption, with 66% of total global consumption resulting from 5 major categories of use.

In keeping with Decision XX/6, QPSTF adopted categories of use for QPS in conformity with those used by the IPPC, with some additions and modifications. These were as used in Annex 6 of 3CPM – *Recommendation for the replacement or reduction of the use of methyl bromide as a phytosanitary measure* (IPPC, 2008) and are given in Table 12.5.

Table 12.5: Main categories of MB use for QPS purposes

Category	Uses
Commodities	Bulbs, corms, tubers and rhizomes (intended for planting)
	Cut flowers and branches (including foliage)
	Fresh fruit and vegetables
	Grain, cereals and oil seeds for consumption including rice (not intended for planting)
	Dried foodstuffs (including herbs, dried fruit, coffee, cocoa)
	Nursery stock (plants intended for planting other than seed), and associated soil and other growing media
	Seeds (intended for planting)
	Soil and other growing media as a commodity, including soil exports and soil associated with living material such as nursery stock*
	Wood packaging materials
	Wood (including sawn wood and wood chips)
	Whole logs (with or without bark)
	Hay, straw, thatch grass, dried animal fodder (other than grains and cereals listed above)
	Cotton and other fibre crops and products
	Tree nuts (e.g. almonds, walnuts, hazelnuts)
Structures and equipment	Buildings with quarantine pests (including elevators, dwellings, factories, storage facilities)
	Equipment (including used machinery and vehicles) and empty shipping containers and reused packaging
Soil as agricultural land	Preplant and disinfestation fumigation of agricultural land*
Miscellaneous small volume uses	Personal effects, furniture, air and watercraft, artifacts, hides, fur and skins

Source: IPPC, 2008 list of categories; *Not on IPPC 2008 list

Designation of a particular use as QPS is dependent on interpretation of the definitions of QPS set out in Decisions of the Parties. In the analysis below, uses for QPS were as reported by the individual Party. This includes cases where the category of use was identified as one where it was classified as quarantine and pre-shipment use by some Parties but not by others (see Section 12.8**).**

12.3.1 Definitions of 'Quarantine' and 'Pre-shipment'

The scope of the QPS exemption set out in Article 2H para. 6 has been clarified in Decisions VII/5 and XI/12 of the Protocol relating to the terms 'Quarantine' and 'Pre-shipment'. TEAP (2002) provided some discussion and examples of cases that might or might not fall within the QPS exemption. There is also discussion of the scope of the exemption from control under the Protocol for QPS uses of methyl bromide in the UNEP/IPPC (2008) publication ‘Methyl Bromide: Quarantine and Preshipment Uses’.

Differences in interpretation of the scope and application of the QPS exemption by individual Parties has led to some differences in the uses that were reported as QPS in the data accessed by the QPSTF and, presumably, in the aggregate consumption of methyl bromide for QPS purposes reported under Art. 7, as amended in the Beijing Amendment Para. O. This is discussed in section 12.5.3 below.

Specifically, the Seventh Meeting of the Parties decided in Decision VII/5 that:

a) *“Quarantine applications”, with respect to methyl bromide, are treatments to prevent the introduction, establishment and/or spread of quarantine pests (including diseases), or to ensure their official control, where:*
   i. *Official control is that performed by, or authorised by, a national plant, animal or environmental protection or health authority;*
   ii. *Quarantine pests are pests of potential importance to the areas endangered thereby and not yet present there, or present but not widely distributed and being officially controlled*

b) *"Pre-shipment applications" are those treatments applied directly preceding and in relation to export, to meet the phytosanitary or sanitary requirements of the importing country or existing phytosanitary or sanitary requirements of the exporting country;*

In the International Plant Protection Convention, the following definitions apply:

“Quarantine pest” - a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled;

“Regulated non-quarantine pest” - a non-quarantine pest whose presence in plants for planting affects the intended use of those plants with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party.

The QPSTF notes that '*not yet present there'* is referring to exotic pests, rather than an endemic pest. Exotic pests may be long established in defined regions of a country, but still subject to quarantine measures for regions where they are not established.

The definition of a quarantine pest under the Montreal Protocol differs from that under the IPPC by one word, "economic": the Montreal Protocol refers to *"pests of potential importance"* while the Convention definition refers to "*pests of potential economic importance"*. However, under the IPPC, it has been clarified in a supplement to ISPM No. 5 that "economic" includes environmental considerations.

The IPPC deals with pests of plants, and not of livestock, which would have potential economic impact, again including environmental considerations. The scope of the IPPC covers the protection of cultivated plants in agriculture (including horticulture and forestry), uncultivated/unmanaged plants, wild flora, habitats and ecosystems.

The IPPC definition of a quarantine pest relates to official control, which means established, authorised or performed by a national plant protection organisation.

The Montreal Protocol's definition covers environmental and other pests that might endanger a region without direct quantifiable economic loss. An interpretation of Decision VII/7 is that the use of methyl bromide as a quarantine treatment may only be for pests that are officially recognised as quarantine pests and must be officially authorised by a competent authority. The IPPC definition of a quarantine pest relates to official control, which means established, authorised or performed by a national plant protection organisation. Under the Montreal Protocol definitions, "competent authorities" include not only national plant protection organisations, but also national animal or environmental protection authorities or national official health authorities. An interpretation is that simple, commercial and contractual arrangements to supply fumigated or pest-free commodity do not qualify a treatment as 'quarantine'.

QPS treatments under the Montreal Protocol relate not only to official phytosanitary treatments, but may also apply to "sanitary" treatments, e.g., against human or animal pathogens and vectors (e.g. mosquitoes), covered by multilateral agreements such as the World Animal Health Organisation (OIE) and World Health Organization (WHO). It is estimated that about 1% of total quarantine QPS use by volume may fall in this category (UNEP/ IPPC, 2008).

Pre-shipment treatments target non-quarantine pests that may be present in both the exporting and importing country. These pests are usually ones that affect storage or end-use quality of the exported commodities, and are outside the scope of the IPPC. Exceptionally, these commodities may be seeds for planting, with the associated pests being 'regulated non-quarantine pests' in IPPC terminology.

The definition of 'Pre-shipment' is unique to the Montreal Protocol. It is given and elaborated in Decisions VII/5 and XI/12. The Eleventh Meeting of the Parties decided in Decision XI/12 that pre-shipment applications are "those non-quarantine applications applied within 21 days prior to export to meet the official requirements of the importing country or existing official requirements of the exporting country".

As per decision VII/5, official requirements are those, which are "performed by, or authorised by a national plant, animal, environmental, health or stored product authority".

12.3.2 Overview of QPS use by category of use

A general analysis on categories of use by volume was conducted, on the basis of information received from Parties in response to Decision XX/6 supplemented by data from previous surveys of QPS uses (TEAP 2006, UNEP/ROAP 2008). Data received was most complete for 2007. In consequence, that year was taken as representative for the analysis. Where data was not available for that year, the most recent year for which detailed information was used as an estimate for 2007, without adjustment. All data used was for 2004 or later.

It was the Task Force's opinion that is was unlikely that there had been major changes in the overall proportions of use in the 2004 – 2007 period. This is supported by the lack of change in global reported QPS consumption during that period.

Total consumption reported by A5 Parties to the QPSTF in response to Decision XX/6 and consumption identified from other sources as explained, amounted to approximately 5,044 metric tonnes of methyl bromide. Total consumption reported by A5 Parties to the Ozone Secretariat for 2007 as per Article 7 was 5,803 tonnes. This leaves 759 tonnes for which uses have not been allocated. However, nearly 90% of this figure corresponds to thee Parties – India (reported 2007 QPS consumption of 360.5 tonnes), Singapore (153 tonnes) and Brazil (167 tonnes

For non-A5 Parties, total consumption reported to the QPSTF or identified from other sources amounted to 3,472 metric tonnes, whilst total consumption reported as per Article 7 data for 2007 was 4949 tonnes. This leaves an unidentified amount of 1,477 tonnes.

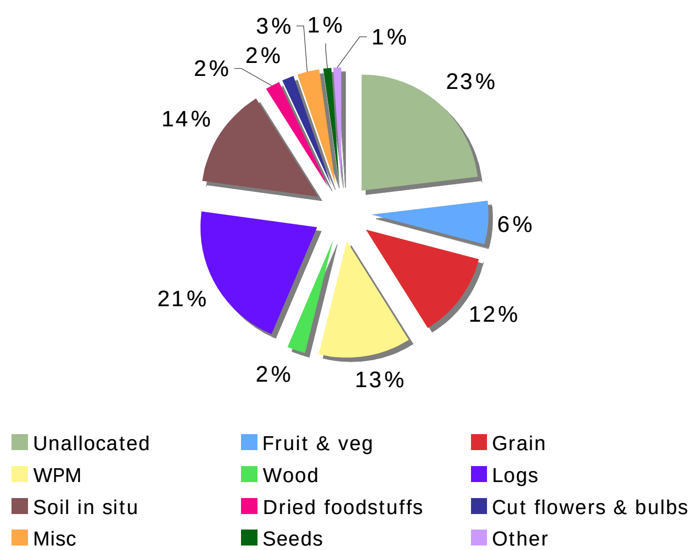
The only large volume non-A5 QPS consumer for which data was not available is Israel, which reported a consumption of 210 tonnes for 2007. The remaining difference of 1,267 tonnes apparently arises from unidentified use in the US, which submitted a breakdown of QPS uses for an estimated 1,969 metric tonnes in 2005, in response to Decision XVI/10.Total consumption reported for that year (Article 7) was 2,931 tonnes. Data gathering for the US is ongoing, but there is an indication that the quantity of QPS accounted for is much lower than reported consumption and that there is a continuing surplus of reported consumption over identified use of 1000 tonnes or more each year over the period 2003-2007.

Table 12.6 and Fig. 12.8 below present QPS use categories at the global level by volume. Figs 12.9 and 12.10 illustrate the main regional uses by A5 and non-A5 Parties by volume of methyl bromide used.

Table 12.6: Volumes (metric tonnes) and percentage of MB used for QPS by category in A5, non-A5 countries, and globally.

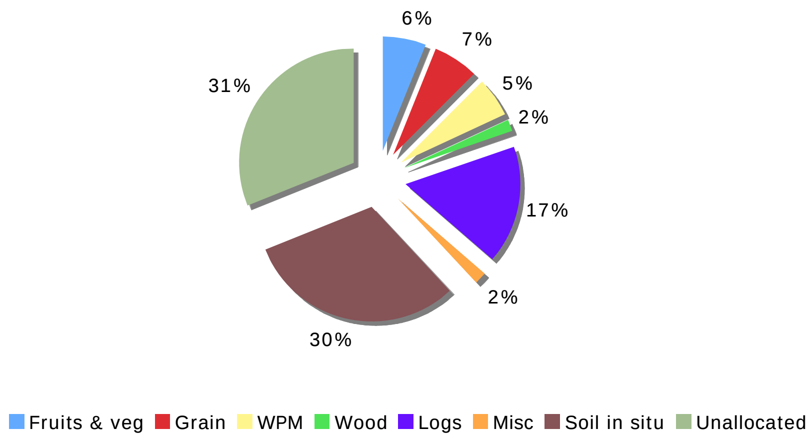
Use category	A 5 Parties		Non- A 5 Parties		Global	
	Tonnes	%	Tonnes	%	Tonnes	%
Fruit and vegetables	355	6%	291	6%	646	8%
Grain	948	16%	324	7%	1272	12%
Wood Packaging Material	1122	19%	263	5%	1385	13%
Wood	160	3%	84	2%	244	2%
Logs	1432	25%	804	17%	2236	21%
Soil in situ	0	0	1489	30%	1489	14%
Dried Foodstuffs	215	4%	5	<1%	220	2%
Cut Flowers and bulbs	168	3%	7	<1%	175	1%
Equipment	82	1%	8	<1%	<1%	<1%
Seeds	116	2%	10	<1%	126	1%
Miscellaneous	133	2%	99	3%	263	2%
Undefined or Other	322	4%	91	<1%	2%	1%
Total - identified uses	5053	87%	3472	70%	8486	77%
Total - as per A7 data	5803	100%	4950	100%	10614	100%
Difference - unidentified	750	13%	1477	30%	2558	23%

Fiureg 12.8: Global categories of MB use for QPS purposes



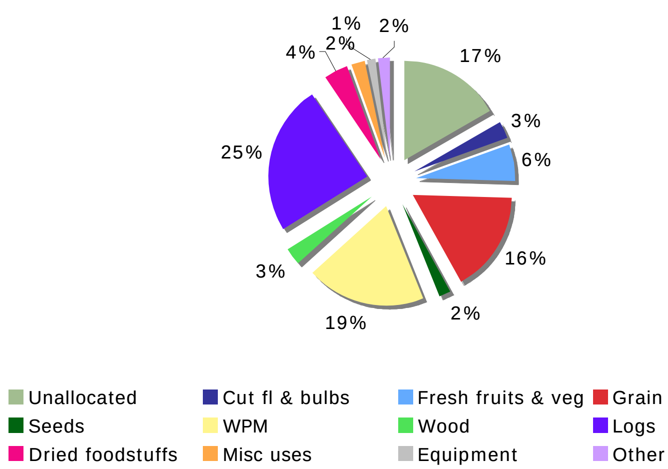
Source: Data received from Parties in response to Decision XX/6; UNEP/ROAP, 2008; Banks, 2008

Figure 12.9: Major categories of use for MB (QPS) in non-A5 Parties, 2007



Notes: Data for Australia and USA are for 2005.

Figure 12.10: Main categories of MB use for QPS in A5 countries



Notes: Data for Asia/Pacific Parties are for 2005 and taken from UNEP/ROAP survey (2008) except for Malaysia and Vietnam (who submitted updated data for 2007). Data for Chile and Argentina are for 2005

QPSTF is compiling additional information to address all of the topics listed in Decision XX/6 and this information will be provided to the Parties in a TEAP report of October 2009.

12.4 Emissions data

Precise information on emissions is not available, since it varies from one situation to another. However previous MBTOC and TEAP reports have provided estimates of the emissions of MB from major uses. Available data including recent reports (e.g. US CCSP, 2008) will be reviewed and updated where necessary, for the QPSTF final report.

12.5 Available Alternatives

12.5.1 Manuals and other data sources for approved treatments

Further discussion on availability of alternatives for QPS will be presented in the final QPSTF report.

Previous MBTOC and TEAP reports have reviewed existing alternatives for various QPS uses (e.g. MBTOC 1995, 1998, 2002, 2007; TEAP 1999, 2006). The 2002 MBTOC Assessment (MBTOC 2002) provided detailed discussion of alternatives to QPS methyl bromide use on commodities in specific circumstances. An updated, comprehensive discussion on alternatives was included in the 2006 MBTOC Assessment Report (MBTOC, 2007). A detailed report on QPS and alternatives is given in TEAP (2003), produced in response to Decision XI/13(4).

MBTOC (2002) recognised thirteen different categories of alternative treatments such as heat, cold and irradiation that are approved by regulatory agencies as QPS treatments in one or more countries for disinfestation of perishable and durable commodities. The MBAIS database (AQIS 2009a) provides a listing of references to methyl bromide alternatives for QPS and other uses.

Existing alternatives to MB for QPS treatment of perishable and durable commodities are based on (1) pre-harvest practices and inspection procedures; (2) non-chemical (physical) treatments; and (3) chemical treatments. Edited to here TB comments

For perishable products (e.g. fresh fruits and vegetables, cut flowers), pest control based on pre-harvest practices, as part of the systems approach, must describe the cultural techniques leading to pest reduction, they must have an agreement on the area of the pest-free zones, and be subject to inspection in order to receive certification. In these cases, regulatory approval depends on a number of factors including knowledge of the pest-host biology, evidence of commodity resistance to the pest, trapping and field treatment results, monitoring of pests and diseases, and careful documentation. Additionally, some countries maintain a pest-free zone by placing restrictions on the movement of commodities into the zone and/or by disinfesting vehicles and commodities that are categorised as high risk before or on entry. There are a number of examples of this systems approach in place that avoid use of QPS methyl bromide.

Non-chemical treatments kill pests by exposure to changes in temperature and/or atmospheric conditions, or high energy processes such as irradiation and microwaves, or physical removal using air or water jets. Often a combination of these is required to kill pests or pest complexes because they can tolerate a single treatment.

Non-chemical treatments for QPS purposes as alternatives to methyl bromide tend to be specific to particular commodities and pests. Many commodities will not tolerate particular treatments or the treatment may not be effective against the broad range of pests that may be present. These processes have most utility where there is a consistent through-put of product to justify the costs of construction and maintenance of facilities and trained staff. Mangos from Brazil are treated by hot water before shipment to the USA to ensure that living exotic tephritid fruit flies are not transported in the shipment. Irradiation of tropical fruit from Hawaii to the USA mainland is another example of a treatment to prevent introduction of certain fruit fly species found in Hawaii to the other USA states.

Many quarantine treatments are post-entry where a treatment is required only if inspection finds a quarantine organism in the shipment at the port of entry. Typically, a treatment, usually methyl bromide fumigation, is ordered before the commodity can be released for distribution.

MBTOC (2002) noted more than 300 individual alternatives approved for quarantine treatment of perishables and more than 70 approved as QPS treatments for durable commodities. These examples are often specific to a particular commodity and export trade and are drawn from a few categories of alternatives.

National Plant Protection Organisations typically keep listings of approved treatments for imports, with specifications varying according to phytosanitary requirements of receiving countries and pest risk. In many cases, methyl bromide fumigation may be specified as a quarantine treatment, but often there are also approved alternative treatments or processes given.

Examples of manuals of approved quarantine treatments include:

USA - APHIS PPQ manuals –
http://www.aphis.usda.gov/import_export/plants/manuals/index.shtml

Australia – AQIS Import Conditions database -
http://www.aqis.gov.au/icon32/asp/ex_querycontent.asp

New Zealand - Approved Biosecurity Treatments for Risk Goods Directed for Treatment -
http://www.biosecurity.govt.nz/files/regs/stds/bnz-std-abtrt.pdf

Some National Plant Protection Organisations also keep listings of treatments required to meet the quarantine and preshipment requirements of importing countries (e.g. PHYTO (AQIS 2009)). These can include both methyl bromide and approved alternatives.

Some international standards produced by the IPPC (ISPMs) detail specific treatments for quarantine pests. These are:

ISPM 15 – dealing with the disinfestation of wood packaging material in international trade as a quarantine measure against various pests of wood and forests. The standard contains specifications for both heat treatment and methyl bromide fumigation. The standard acknowledges that methyl bromide is an Ozone-Depleting Substance. It states *"In the absence of alternative treatments being available for certain situations or to all countries, or the availability of other appropriate packaging materials, methyl bromide treatment is included in this standard."* (IPPC 2006, 2009b)

ISPM Nos 18 and 28 – dealing with irradiation treatment of fruit flies and some other pests to quarantine standards. Irradiation is an accepted treatment by some countries that may replace methyl bromide for control of some important quarantine pests, notably various species of pest tephritids (fruit flies). These are important objects of quarantine in many countries. It is particularly useful for treatment of tropical fruit that do not tolerate methyl bromide fumigation well, and as an alternative to heat treatments (IPPC, 2003, 2009a).

Additionally, several ISPMs deal with aspects of establishment of pest-free areas as a phytosanitary measure. Pest-free areas, where agreed, can provide a means to avoid precautionary quarantine fumigations of various fruit exports/imports with methyl bromide, particularly against exotic tephritids (fruit flies).

12.5.2 Availability of alternatives and technologies for the main methyl bromide uses

Globally, the main categories of use of methyl bromide for QPS by volume (>300 tonnes a year) identified from data presented in Section 12.3 are:

- Fresh fruit and vegetables
- Grain including rice
- Soil in situ
- Whole logs
- Wood and wooden packaging material.

These main categories represent about 85 % of the uses for which detailed information is available at this time (i.e. excluding unidentified uses) and % of total reported uses. Further clarification is being sought on the unidentified portion of the QPS usage. But, from the judgement of the QPSTF and in view of the high level of coverage already achieved, it is unlikely that further major uses will be identified in the final report.

All of these categories have approved non-methyl bromide alternatives in at least some applications. Specific alternatives may not be available for a particular trade or situation because of the risk or presence of particular quarantine pests, lack of approval by the importing NPPO, or lack of registration or commercial supply of the particular treatment.

A brief description of alternatives for the main categories follows, with some examples. A comprehensive analysis of alternatives, both available (approved) and under development, will be contained in the QPSTF final report.

12.5.2.1 Fresh fruit and vegetables

As stated in the previous section, this is a complex category comprising a large group of products such as apples, grapes, cucurbits, tomatoes, various other vegetables and other similar perishable foodstuffs. There are a wide variety of measures available, applied individually or in combination, which can be used to achieve pest reduction to quarantine requirements. Treatments are against a wide variety of insect and mite pests of quarantine significance, varying according to origin and country of destination. In many cases, approved treatments are limited to a particular situation, i.e. a particular commodity with a particular pest from a particular country or region and a particular quarantine concern of the importing country. (MBTOC, 2007). A more detailed analysis of alternatives available and under development for this category will be included in the QPSTF final report.

12.5.2.2 Alternatives for Wood and Wood Packaging Materials

ISPM 15, for treatment of wood packaging materials, recognises heat as an approved and accepted alternative to methyl bromide. The 2009 revision (IPPC 2009) did not recognise other alternatives, but several potential alternatives are under continued testing. Many countries presently comply with the ISPM 15 standard entirely with heat treatments and without using methyl bromide. The EC has published a manual of options and alternatives to comply with ISPM 15 without using MB (Vermeulen and Kool, 2006).

12.5.2.3 Alternatives for grain, including rice

MB fumigation continues to be used for pre-shipment treatment of cereal grains where either logistical constraints or importing country specifications preclude the use of phosphine, the principal accepted fumigant alternative. Heat treatment, and chemicals such as dichlorvos (where permitted) are also possible alternatives Methyl bromide fumigation is often the treatment of choice or sole approved and available treatment for the situations where a quarantine treatment is required, though it is recognised that it may not be ideal for this purpose (MBTOC, 2007).

12.5.2.4 Alternatives for whole logs

Treatment of whole logs, with bark or debarked, against many quarantine pests continues to rely heavily on methyl bromide for many international trades. New Zealand has successfully treated some 6 million m3 of exported softwood bark on logs in the past six years with phosphine in the holds of ships to China replacing around 1,420 tonnes of methyl bromide. The target concentration is a minimum 200 ppm for 10 days to treat quarantine Cerambycidae and Scolytidae. Due to sorption of the gas by the logs (Zhang, 2004) top-up of phosphine is required 5 days into the voyage to prevent the concentration falling below 200 ppm. A technician is required to be onboard by IMO to monitor the fumigation. In transit tests have shown an even gas distribution throughout the loaded ship holds is rapidly achieved.

One of the major disadvantages of phosphine when compared to methyl bromide is the long exposure time (up to 10 days) required. Considerable efficacy data has been developed in support of this application (Frontline Biosecurity 2003; Crop and Food 2004; Hosking and Goss 2005; Zhang 2003; Zhang and van Epenhuijsen 2005) . Trials have shown that quarantine pests such as the New Zealand dry wood termite *Kalotermes brouni*, Cerambycidae eggs and larvae (*Arhopalus tristus* and *Prionoplus spp.)* and Scolytidae (*Hylurgus/Hylastes)* can be controlled by a 72 hour phosphine treatment. For example: *Arhopalus* eggs, 100% mortality was achieved at a CT of 300 g phosphine/h/m3, *Hylurgus/Hylastes* and *Prionoplus* larvae, 100% mortality was achieved at a CT of 100 g phosphine/h/m3.

Research in China and Japan has demonstrated that phosphine killed 10 species of forest insects including Cerambycids, scolytids and platypodids. Oogita *et al.* (1997) fumigated the cerambycids (*Semanotus japonica, S. japonicus*), *Callidiellum rufipenne* and *Monochamus alternatus*, the scolytids (*Phloeosinus perlatus, Cryphalus fulvus* and *Xyleborus pfeili*) and the platypodids (*Platypus quercivorus* and *P. calamus*) with phosphine at concentrations of 1.0 and 2.0 g m³ for 24 and 48 hours at 15°C and 25°C. *S. japonica* and *P. perlatus* eggs were killed at 2.0 g m³ for 24 hours at 15°C, but larvae and pupae of all species were not killed at 2.0 g m³ for 48 hours at 15°C. At 2.0 g m³ for 48 hours at 25°C, all stages of *C. fulvus* and *X. pfeili*, except larvae of *C. fulvus*, were killed. The work concluded that more than 48hrs was required.

Debarked *Pinus radiata* logs from New Zealand do not require fumigation for market access into China or Malaysia.

In Japan, the developments of alternative chemicals to methyl bromide for imported logs has been carried out by research institute on plant protection of MAFF (Ministry of Agriculture, Forestry and Fisheries, 2009), manufactures and other bodies concerned MB use because MB use for logs is the largest in total MB use in plant quarantine.

Some of research activities using methyl iodide were reported from 2003. Nine kinds of insect pest species for logs, smaller Japanese ceder longicorn (*Callidiellum rufipenne*), Japanese pine sawyer (*Monochamus alternatus*), cryptomeria bark borer (*Semanotus japonicus*), pine bark beetle (*Cryphalus fulvus*), Iarch ips (*Ips cembrae*), ambrosia beetle (*Xyleborus pfeili)*, alnus ambrosia beetle (*Xylosandrus germanus*), yellow-spotted pine weevil (*Pissodes nitidus*), pine weevil (*Shirahoshizo rufescens*) were fumigated with methyl iodide and found the egg stages were more susceptible. Besides, larval and pupal stages showed similar susceptibilities. All tested species except for smaller Japanese ceder longicorn (*C. rufipenne*) were killed completely with the fumigation of methyl iodide 50g/m3 for 24 hours at 15C (Naito *et al*., 2003). Mortality tests for pine wood nematode (*Bursaphelenchus xylophilius*) which indicated almost equal tolerance to methyl iodide with above mentioned nine species provided more than 99% of mortality for nematode that were fumigated with methyl iodide 30g/m^3 at 15C and 100% mortality was obtained at the test with 40g/m3 of dosage (Soma *et al*., 2005). Subsequently, large scale mortality test for pine wood nematode was examined at three different temperature and 10,800, 33,500 and 22, 400 individuals were killed completely at 10C with 60g/m^3, 15C with 40-50 g/m^3 and 25C with 30g/m^3, respectively (Soma *et al*., 2005). It is therefore, 87,800 nematodes in total were completely killed by lower dosages than the nominated standards of plant quarantine expecting for adopting in near future.

The research report of the mixture fumigant of SF and MITC (Sulfuryl fluoride 30%, MITC 30% and carbon dioxide 40%, w/w) was presented from 2004. All stage of three kinds of forest insect species, alnus ambrosia beetle (*X. germanus*), ambrosia beetle (*X. pfeili*) and pine bark beetle (*C. fulvus*) and adult stage of smaller Japanese ceder longicorn (*C. rufipenne*) were killed 100% at the dosages of SF15g/m^3 + MITC 15g/m^3 and of SF 21g/m^3 + MITC 21g/m^3 at temperature range with 18.3-21.2°C although achieving of complete kill for each of species tested were difficult when they had been fumigated with single gas of SF or MITC (Soma *et al.*, 2004). These four species were considered less tolerant to mixture fumigant than pine wood nematode (*B. xylophilius*) and large scale mortality test using pine wood nematode provided complete kill of 97,400, 59,500 and 22,700 individuals with SF 27g/m^3 + MITC 27g/m^3 at 10C, SF 21g/m^3 + MITC 21g/m^3 at 15C and SF 15g/m^3 + MITC 15g/m^3 at 25°C, respectively (Soma *et al*., 2006).

Both the sulfuryl fluoride/methyl isothiocyanate mixture and also methyl iodide have been registered as agrochemicals in Japan.

12.5.2.5 Alternatives for soils in situ

A very large amount of research and experience has been devoted to the development and adaptation of alternatives to methyl bromide for pre-plant soil fumigation (MBTOC, 2007, TEAP, 2008, 2009). There is widespread adoption of these alternatives. The production of propagation materials (i.e. bulbs, cuttings, seedlings, young plants, slips, and trees) is subject to high health standards and often certification requirements, which are readily achieved with methyl bromide.

In the case of strawberry runners for example, MB is used to meet the certification standards for strawberry runner stock. The certification typically specifies a low tolerance of particular pests and diseases. Since a single strawberry runner grown in year one can expand to several million runners by year five, the adverse impacts of pests is of particular importance. The same is true for stock plants used for producing cuttings of many ornamental plants.

In spite of these requirements, there are several measures accepted as alternatives to MB for production of propagative material. Methyl iodide and 1,3-D/ Pic for example, are proving extremely effective for several US nursery sectors (e.g. Kabir *et al.,* 2005). A recent version of NIPM Item #7 "Approved treatment and handling procedures to ensure against nematode pest infestation" lists 1,3-D (Telone II) and iodomethane (methyl iodide) together with methyl bromide, as alternative treatments to achieve certification requirements related to nematode control (CDFA, 2009), although iodomethane is not currently registered in California. 1,3-D/Pic and Pic alone have totally replaced the use of MB in the Spanish strawberry runner industry (García-Méndez *et al.,* 2008; López-Medina *et al.,* 2007; De Cal, 2004) and are showing excellent results for sweet potatos, forest nurseries and perennial tree nurseries (Quicke *et al.,* 2007; 2008; Enebak *et al,* 2007; Shrestha, *et al*., 2008, Hanson *et al,* 2008; Weiland *et al,*, 2008, Schneider *et al*., 2009). Substrates are becoming increasingly adopted as they avoid the need for methyl bromide in many countries (Stoddard *et al.,* 2008; Walter *et al.,* 2008).

An alternate approach to chemical soil treatments is the production of nursery stock in containers of different types, using soil-less substrates (MBTOC, 2007). Production systems where this approach is economically feasible and allows for the production of high quality products have been identified. In Japan for example, a simple, economically feasible system using trays filled with substrate is proving particularly useful for the production of strawberry runners. Various materials are used as substrates (e.g. rock wool, peat moss, rice hulls, coconuts husk and bark) and can be reused after sterilising with solar heat treatment or hot water (Nishi and Tateya, 2006). In the USA, production of strawberry plugs has proven successful since many years (Durner *et al,* 2002) as well as in other countries. Steam is in wide use for cleaning substrates before reutilisation (EC Management Strategy, 2008).

12.5.3 Applications for which no alternatives are available

In the past several MBTOC reports have listed the QPS applications for which the committees had not identified technically feasible alternatives (e.g. TEAP April 1999 p.57-58). QPSTF will be able to update these lists relating to technical feasibility. However, availability is country-specific and even site-specific. Depending on how 'available' is defined for this specific task, it could potentially require the compilation of a very large database for each country/commodity /pest combination, and would require very large resources which are beyond the scope of the QPSTF. On the other hand it would be feasible in the time available to evaluate the lack of availability in a more general manner, by technology type, or to examine the lack of availability in a few selected countries, as illustrative examples.

12.6 Regulations that directly affect the use of MB

Decision X/11 asked Parties to submit to the Ozone Secretariat in 1999 a list of regulations that mandate the use of MB for QPS. No responses are available to QPSTF. Nevertheless, information on regulations that require the use of MB is available in phytosanitary treatment manuals and treatment schedules published on the official national phytosanitary authorities, and related publications. Often, the actual regulations are found on the internet. QPSTF has already compiled information for key countries and major QPS uses, and has found it to be complicated as many regulations may cover a single use.

At this stage, the QPSTF has been able to establish that regulations and the interpretation of regulations for QPS use vary widely between countries. For instance certain countries strictly adhere to the need for MB in a phytosanitary certificate only when it has been prescribed by a National Plant Protection Organization or for preshipment when an importing country has published official phytosanitary requirements prescribing its use. Other regulations interpret that QPS MB use as a treatment that maintains freedom of pests and diseases irrespective of their status as a quarantine pest. In some regulations nil tolerance to a pest is expected whereas in others the commodity (or soil) is expected to be essentially free of pests and diseases.

The QPSTF is compiling a list of regulations to present in the final report.

12.7 Barriers to adoption, mitigation options

Past MBTOC and TEAP reports have reported on some of the barriers to adoption of MB alternatives and mitigation options (e.g. MBTOC 1998, 2002, 2007; TEAP 1999, 2000, 2006, 2007). For some countries such information has been published in papers about QPS issues produced by national phytosanitary authorities and national experts. Further analysis on this topic will be included in the QPSTF final report

Development of methyl bromide alternatives for QPS applications continues to be a difficult process, exacerbated by the multitude of commodities being treated, the diverse situations where treatments are applied, and a constantly changing trade and regulatory landscape.

A variety of technologies are potentially suitable as replacements for some commodities and some circumstances. In many cases, uncertainty about phytotoxic effects and effectiveness against the target pests constrain use of alternatives. There may be considerable cost, effort and time associated with the registrations and approvals that are required for many quarantine uses.

Changing quarantine regulations and bilateral quarantine agreements are the responsibility of governmental agencies but, in many countries, pesticide registrations are initiated by the private sector. In the past, pesticide companies have been reluctant to invest money to register and market pesticides for small markets represented by many of these quarantine uses, or where patent protection is lacking. Alternatives that do not require registration such as heat, cold and inert gases may be more easily adapted in cases where their use is appropriate to the tolerance of the commodity, the situation and where they show sufficient efficacy. However, these treatments still require bilateral quarantine agreement or regulation in the importing country before use will be allowed.

The required standard of efficacy for quarantine uses is extremely high because the consequences of exotic pests surviving treatments can be catastrophic to regions where the new pest becomes established. As compared to normal pest control and pre-shipment treatments, quarantine treatments seek to absolutely prevent entry of any pest individuals into a country and as such must be as close to 100% effective as possible. A common quarantine standard is probit 9, which states that 99.9968% of pests in the shipment must be killed or made reproductively sterile by the treatment—an extremely difficult target to reach. Proof that an alternative treatment reaches this specification is a costly and onerous task, often required for particular combinations of commodity and pest.

Pre-shipment uses on the other hand, are usually for widely distributed pests that are already found in the importing country. Consequently, the efficacy standard does not need to be as severe as in the case of quarantine and research requirements to establish efficacy can be less rigorous as well. It would appear that there are fewer obstacles to adopting alternatives for pre-shipment methyl bromide uses than for quarantine uses.

Regulations prescribing MB treatment alone are a major barrier to adoption of alternatives as often there is little incentive for the regulation to be changed. Also, often the data has not been generated to prove effective control of all pests with an alternative to a standard similar to MB and Parties are unwilling to take on the possible increased risk.

A key barrier to development of alternatives for soil treatment for plants of certified high health status is the rigorous testing required to prove an alternative effective, however MB is accepted as the effective standard and requires no testing to validate its performance.

Other barriers to adoption of alternatives have been summarised by the EC in its Report on QPS Applications sent to QSC (Touchdown, 2009) and include;

- Importing countries specifications mandating the use of MB
- Alternative is uneconomical, logically impractical or unregistered
- The technical expertise to assess a pest risk is not available

12.8 A list of categories of use identified by TEAP that have been classified as QPS by some Parties and not by others

Paragraph 7 of Decision XX/6 requests TEAP to list MB use categories that have been classified as QPS by some Parties but not by others, and submit them to the 29OEWG.

QPSTF was able to identify three specific categories of use that are considered to fall under the QPS exemption by some Parties, but others would apparently not consider them to be QPS under the same technical conditions. All these examples have consumption or use at greater than 50 tonnes a year of methyl bromide. These categories may include some methyl bromide applications against pests of quarantine concern.

The three categories of current QPS uses listed by the QPSTF are:

1. Treatment of export coffee for QPS, as reported by Vietnam (UNEP/ ROAP, 2008).
2. QPS treatment of export rice and cassava chips from Thailand and Vietnam (UNEP/ ROAP, 2008).
3. Fumigation of soil used to produce propagation material in the United States (i.e. strawberry runners, sod or turfgrass, forest nursery seedlings, ornamental nursery material for propagation purposes), when such material needs to be moved across administrative boundaries within the country (e.g. across State borders).

Vietnam is the only Party to report substantial use of methyl bromide for QPS disinfestation of export coffee (UNEP/ROAP, 2008). Other coffee-producing countries control the pests of coffee in storage by other means. No pests of quarantine concern requiring methyl bromide treatment have been identified associated with coffee shipments from Vietnam, though coffee berry borer (*Hypothenemus hampei*) may be of concern to some import destinations. Infestation of raw coffee by the coffee bean weevil (*Araecerus fasciculatus*) and other storage insect and mite pests is typically controlled by good storage practices, particularly storage at low moisture content (equilibrium relative humidity). Typically, raw coffee in store is fumigated with phosphine to control storage pests if it should become infested. This can include fumigation prior to shipment if required contractually by the importer. It may be that the methyl bromide fumigations are conducted for contractual reasons, not to meet official phytosanitary requirements.

With regard to rice exports from Vietnam and rice and cassava chip exports from Thailand, there are similar concerns over whether some or most of the methyl bromide treatments would be classified as QPS by many Parties. Some treatments may be to ensure that shipments do not carry khapra beetle (*Trogoderma granarium*), a pest of quarantine concern to several countries. However, most of the methyl bromide used may be for contractual reasons to ensure shipments are free of common storage pests, widespread in both exporting and receiving country, and not for official phytosanitary requirements of the importing country (UNEP/ ROAP, 2008)

In the case of pre-plant fumigation of soil with MB, only one Party, USA, classifies methyl bromide treatment of soil for domestic production of high plant health propagation material for strawberry runners, sod or turf, forest seedlings, ornamentals as a quarantine measure. Other Parties, such as Australia, EC, Chile and Argentina, have classified this activity as normal use of methyl bromide, subject to phaseout, and have now or in the past applied for CUEs to permit methyl bromide use post-phaseout, where they considered alternatives were not available, technically or economically. However, part of the US QPS use on soils is against exotic pests that are declared objects of quarantine (quarantine pests, see below), but most appears to be for production of propagation material of high plant health status as discussed above.

Table 12.7 lists some Parties that do and do not consider production of strawberry runners of high plant health status to be QPS.

In IPPC terminology, the target of the treatment may come under the category 'regulated non-quarantine pests' (see Section 12.5.1), as the pests and diseases that are to be controlled with the treatment are established in both the production and receiving areas and may not come under 'quarantine pest' according to an interpretation of Decision VII/5.

Table 12.7: Parties that may and may not consider preplant fumigation of soil during production of strawberry runners of high plant health status to be QPS [(a)]

Country	Use considered quarantine by the Party and exempted as QPS?
Australia	No, CUN submitted
Canada	No, CUN submitted
EC	No, CUN submitted
Israel	No, CUN submitted
USA	Yes, CUN for intra area use only
Chile	Yes, at one time, but no longer so [(b)]
Argentina, Lebanon	No, MLF phaseout project accepted

(a) A similar situation exists for other propagation material mentioned below (Table 12.6) with only the US considering this use as QPS.

(b) Chile provided information in response to Decision XIV/10 that listed fumigation of soil for production of strawberry runners as QPS, but this classification was later changed to non-QPS.

Pre-plant fumigation of soil with MB was declared to qualify for a QPS exemption under the final rule published in the US Federal Register on January 2, 2003 (68 FR 238). The final rules states that '*the exemption for quarantine applications applies to methyl bromide used for growing propagative material if the methyl bromide is being used to grow propagative material to meet official quarantine requirements of the destination to which the propagative material will be transported*'. The final rule only cites strawberry rhizomes as examples of propagative material, but EPA clarifies that '*the exemption also covers other propagative material, including tree seedlings, when the methyl bromide is used to meet an official quarantine requirement of the destination to which the propagative material will be transported*'.

The exemption is for MB used to grow propagative material (also referred to as 'plants for planting') that qualifies under the following parameters: a) is to be transported from one locality to another, where official quarantine requirements apply; b) is performed to meet official quarantine requirements specifying that "underground portions of the propagative material are to be free from quarantine pests".

Use of MB to meet this exemption was estimated at 477 tonnes for the state of California in 2005 (Trout 2007). Quantities of MB exempted as QPS use for the production of propagative material was reported in CUNs submitted by the USA in 2004 and appear in Table 12.8 below.

Table 12.8: Quantities of MB used for soil fumigation for the production of propagative material in USA in 2004, exempted as QPS use.

Propagative material	tonnes
Bulb growers	261
California deciduous nurseries	127
California rose nurseries	136
Forest nurseries	174
Strawberry nurseries	463
Turfgrass (sod)	266
Western raspberry nurseries	.25
Misc.	24
Total	1476

Source: US Response to Decision XVI/10, rounded to nearest tonne.

The use of methyl bromide to produce plants for propagation is distinct from treatments of soil to eliminate recognised quarantine pests either in soil transported as a substrate or treated in situ. For example:

- Soil or substrate that is either imported or exported as a commodity (to grow plants in) is sometimes fumigated with MB as a quarantine measure. This use is for example reported by Malaysia (UNEP, 2006) (usage of 5.05 tonnes was reported for 2007 in this category).
- The potato cyst nematode *Globodera pallida* is a quarantine pest in the United States with occurrence limited to the state of Idaho. Regulations 301.86 to 301.89 impose restrictions on the movement of materials from the state and designates quarantined areas within the state. (Federal Register Vol 73 No. 177, Sept 11, 2008; USDA 2007). An eradication program presently covers a total of eight fields comprising approximately 445 ha, which are fumigated with MB once a year usually in the spring. In both 2007 and 2008, 217 tonnes was used for this purpose.The fumigation is followed by a 1,3-D/ chloropricrin fumigation 6 months later. (Vick, 2009, pers. comm.; USDA 2007). The programme is expected to take several years to complete.
- In a similar quarantine operation, to eradicate golden nematode from an infested area in New York state, USA, 9.3 ha of soil was fumigated with methyl bromide using 4.5 tonnes in 2008.
- In Australia, approximately 19 tonnes of methyl bromide were used in both 2007 and 2008 to control an incursion of potato cyst nematode. Methyl bromide as a soil treatment was used prior to 2006 to control and eliminate branched broomrape, an exotic quarantine pest (parasitic plant) of limited distribution within Australia.

In accordance with Decision XX/6(7), Vietnam, Thailand, and USA are requested to provide the information on the rationale for classifying the listed categories as QPS to the Technology and Economic Assessment Panel in time for inclusion in its final report to the Twenty-First Meeting of the Parties

The QPSTF believes that, in the responses submitted by Parties, it would be necessary for such information to contain:

- The context in which the MB is used for QPS, such as a description of the goal of the QPS treatment and the target pest(s);
- The number of days between treatment and shipment;
- The destination country or countries;
- Legislative requirements that have influenced the use of MB for QPS in the exporting and/or importing country or countries;
- The time of the year when the treatment is carried out
- Other information relevant to the QPS use of MB.

In order for the information to be analysed and discussed by the QPSTF, the information should be sent to TEAP no later than 1 September 2009.

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Annex 1 to CHAPTER 12 - Decision XX/6

Decision XX/6 - Actions by Parties to reduce methyl bromide use for quarantine and pre-shipment purposes and related emissions

Recognizing that methyl bromide use for quarantine and pre-shipment purposes is an important remaining use of an ozone-depleting substance that is not controlled pursuant to paragraph 6 of Article 2H of the Montreal Protocol and that the 2006 assessment report of the Scientific Assessment Panel indicated that "emissions associated with continued or expanded exemptions, QPS … may also delay recovery [of the ozone layer]"

Recalling that Article 7 of the Montreal Protocol requires Parties to report on the annual amount of methyl bromide used for quarantine and pre-shipment applications and that decision XI/13 urges Parties to implement procedures to monitor the uses of methyl bromide by commodity and quantity for quarantine and pre-shipment,

Recalling decision VII/5 urging Parties to refrain from using methyl bromide and to use non-ozone depleting technologies wherever possible and decision XI/13 encouraging Parties to use recovery and recycling technologies where technically and economically feasible until alternatives are available,

Reaffirming the importance of managing and, when economically and technically feasible, replacing quarantine and pre-shipment applications of methyl bromide, as stated in the preamble to decision XVII/15,

Stressing that methyl bromide is a potent ozone-depleting substance and that it and many of its alternatives are hazardous substances that have caused serious human health impacts, notably on workers in ports and warehouses in some Parties,

Recognizing that many Parties have relied on methyl bromide for trade and the conservation of biodiversity and will continue to do so until alternatives become available and accepted for all quarantine and pre-shipment uses,

Acknowledging the efforts made by Parties to phase out or reduce the use and emissions of methyl bromide for quarantine and pre-shipment purposes whether through adoption of alternatives or the use of recapture technologies,

Acknowledging with appreciation the joint efforts of the Ozone Secretariat and the

International Plant Protection Convention in reviewing alternatives to methyl bromide for phytosanitary purposes, particularly under ISPM-15, and the Convention's recommendation encouraging Parties to develop and implement strategies to replace and/or reduce methyl bromide use for phytosanitary applications,

Mindful that the use of methyl bromide for quarantine and pre-shipment purposes is still increasing in some regions of the world,

Recognizing current data gaps and the need for better information to monitor and analyse trends in quarantine and pre-shipment use and further to identify opportunities for reducing global amounts of methyl bromide required for quarantine and pre-shipment applications under the Montreal Protocol,

1. To urge those Parties that have not yet done so to report data on the use of methyl bromide for quarantine and pre-shipment applications, as required under paragraph 3 of Article 7, by April 2009 and to report such data in accordance with existing Protocol requirements and decisions annually thereafter;

2. To request the Ozone Secretariat:

    a) To update the definition of pre-shipment in paragraph 5.6 of the Instructions/Guidelines for data reporting to reflect decision XI/12;

    b) To post on its website, production and consumption data reported by the Parties under paragraph 3 of Article 7 for methyl bromide used for quarantine and pre shipment applications;

3. To request the Implementation Committee to consider the reporting of methyl bromide used for quarantine and pre-shipment applications under paragraph 3 of Article 7, in accordance with the Non-Compliance Procedure of the Montreal Protocol;

4. To request the Technology and Economic Assessment Panel, in consultation with the International Plant Protection Convention secretariat, to review all relevant, currently available information on the use of methyl bromide for quarantine and pre-shipment applications and related emissions, to assess trends in the major uses, available alternatives and other mitigation options, and barriers to the adoption of alternatives or determine what additional information or action may be required to meet those objectives; the assessment should consider:

    a) A description of the majority of the volumes of methyl bromide used for quarantine and pre-shipment applications, by the major uses and target pests;

    b) The technical and economic availability of alternative substances and technologies for the main methyl bromide uses, by volume, and of technologies for methyl bromide recovery, containment and recycling;

    c) Quarantine and pre-shipment applications for which no alternatives are available to date and an assessment of why alternatives are not technically or economically feasible or cannot be adopted;

    d) Illustrative examples of regulations or other relevant measures that directly affect the use of methyl bromide for quarantine and pre-shipment treatment (including information requested in decision X/11);

    e) Other barriers preventing the adoption of alternatives to methyl bromide;

    f) Projects demonstrating technically and economically feasible alternatives, including technologies for recapture and destruction of methyl bromide for quarantine and preshipment applications;

5. To request the Technology and Economic Assessment Panel to present a draft report based on the analysis of the available information to the Open-ended Working Group at its twenty-ninth meeting, indicating areas where the information is not sufficient, explaining, where appropriate, why the data were inadequate and presenting a practical proposal for how best to gather the information required for a satisfactory analysis;

6. To request the Technology and Economic Assessment Panel to present a final report highlighting areas where sufficient information indicates opportunities for reductions in methyl bromide use or emissions for quarantine and pre-shipment purposes, including a list of available methyl bromide recapture technologies for consideration by the Parties

and, where there is insufficient information, a final proposal for further data gathering for the consideration of the Twenty-First Meeting of the Parties;

7. To request the Technology and Economic Assessment Panel, in accordance with its terms of reference, to list categories of use it has identified that have been classified as quarantine and pre-shipment use by some Parties but not by others by the twenty-ninth meeting of the Open-ended Working Group and that those Parties are requested to provide the information on the rationale for doing so to the Technology and Economic Assessment Panel in time for inclusion in its final report to the Twenty-First Meeting of the Parties

8. To request the Ozone Secretariat, in cooperation with the Technology and

   Economic Assessment Panel, the International Plant Protection Convention secretariat and other relevant bodies, to organize in the margins of the Twenty-First Meeting of the Parties a workshop to discuss the report of the assessment referred to in paragraph 4 of the present decision and other relevant inputs with a view to determining possible further actions;

9. To request the Ozone Secretariat to strengthen cooperation and coordination with the International Plant Protection Convention secretariat in accordance with decisions XVII/15 and XVIII/14;

10. To encourage Parties in accordance with the recommendations of the third meeting of the Commission on Phytosanitary Measures under the International Plant Protection Convention to put in place a national strategy that describes actions that will help them to reduce the use of methyl bromide for phytosanitary measures and/or reduce emissions of methyl bromide and make such strategies available to other Parties through the Ozone Secretariat, where possible before the Twenty-First Meeting of the Parties; the strategy may include the following areas for action:

    a) Replacing methyl bromide use;

    b) Reducing methyl bromide use;

    c) Physically reducing methyl bromide emissions;

Accurately recording methyl bromide use for phytosanitary measures.

13 Methyl Bromide Technical Options Committee (MBTOC) Progress Report 2009

This chapter updates trends in methyl bromide (MB) production and consumption, and gives progress in the development and adoption of alternatives for preplant soil use, and post harvest and commodity uses of MB . Information on registration, re-registration and deregistration of in-kind methyl bromide alternatives is also presented in conformity with Decisions Ex. I/4(i) and Ex. I/4(j).

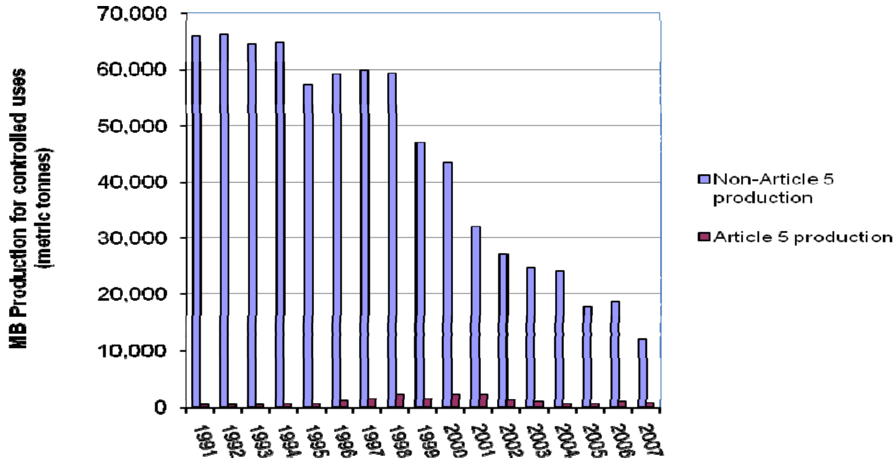
13.1 MB production and consumption update

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 in March 2009. 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 controlled by 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. At the time of writing this report, all Parties had submitted data for 2007 and the database for MB is much more complete than in the past.

13.1.1 Production trends

Trends in the reported production of MB for all controlled uses (excluding QPS and feedstock) in all non A5 and A5 countries are shown in Figure 13.1 and have been falling consistently from 1998 to 2004. In 2005, the total was 18,141 metric tonnes, which represented 27% of the production baseline (67,376 tonnes). In 2006, the global MB production for controlled uses increased to 19,635 tonnes (29% of baseline), although the consumption in both A 5 and Non-Article 5 countries decreased from the preceding year (details can be found in section 13.1.2). Production in 2007 continued the downward trend, totalling 12,877 tonnes or 19% of the baseline.

Figure 13.1: Historical trends in reported global MB production for all controlled uses, excluding QPS and feedstock, 1991 - 2007 (metric tonnes)



Data for 1991 and 1995-2007 were taken from the Ozone Secretariat dataset of March 2009. 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 (2007).

Non-Article 5 countries reduced their MB production for controlled uses from about 66,000 tonnes in 1991 (non-A5 baseline) to less than 17,603 in 2005. Non-Article 5 production for controlled uses increased to 18,666 tonnes in 2006 due to increased production in Israel. It decreased again in 2007 to approximately 12,191 tonnes, which included production for export to Article 5 countries.

Article 5 countries reduced their production for controlled uses from a peak of 2,397 tonnes in 2000 to about 536 tonnes in 2004. It increased to 969 tonnes in 2006. MB production in Article 5 regions fell from 70% of baseline (1,375 tonnes, average 1995-98) in 2003 to 39% of baseline in 2004. For 2007 the production amount is 686 tonnes, which represents 50% of the baseline. At present, production of MB for controlled uses in Article 5 countries takes place entirely in China and a MLF project to phase-out this activity is approved and underway.

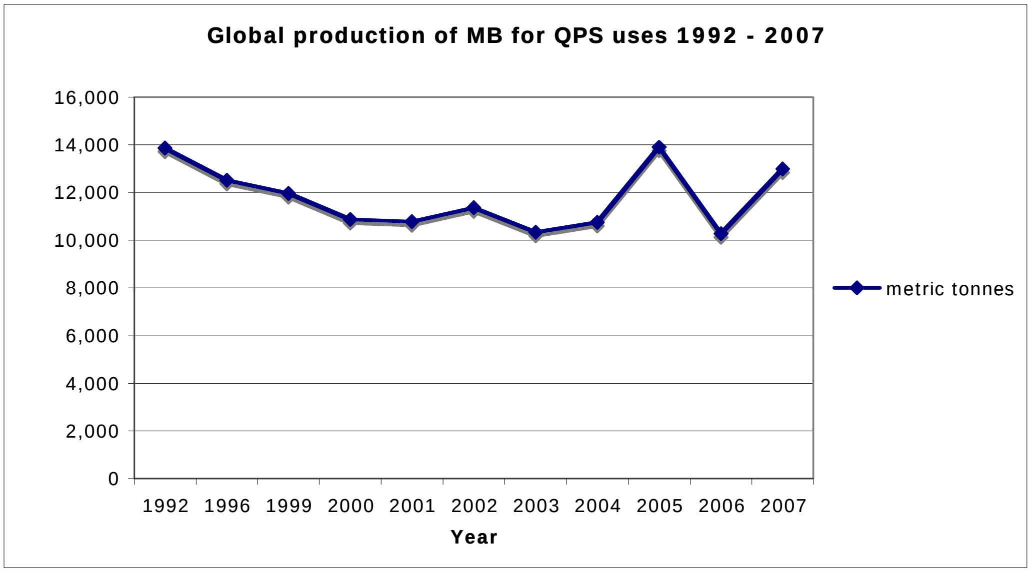
A list of known MB production facilities was published in the MBTOC Assessment Report of 2006 (Table 3.3). In 2007, MB was produced for controlled uses in one Article 5 country (China) and three Non-Article 5 countries (Israel, Japan and USA).

13.1.1.1 Production for QPS purposes

Decision XX/6 required the Ozone Secretariat to post on its website, MB production and consumption data reported by the Parties for exempted uses (QPS) under paragraph 3 of A 7. The following analysis is based on such data, as well as estimates made by MBTOC in past reports (TEAP, 2006; MBTOC, 2002; 2007).

Reported MB production for exempt QPS uses, as reported to the Ozone Secretariat by Parties, rose substantially in 2005 over the long term and decreasing trend. Data reported for 2006 shows a return to the expected trend, however, 2007 again reflects an increase (Fig. 13.2). There has been speculation as to the reasons for the sudden increase shown in 2005. These include stock issues, impact of adoption of ISPM 15 on demand and inclusion of uses previously not considered as QPS.

Figure 13.2: Reported or estimated QPS production 1990 - 2006

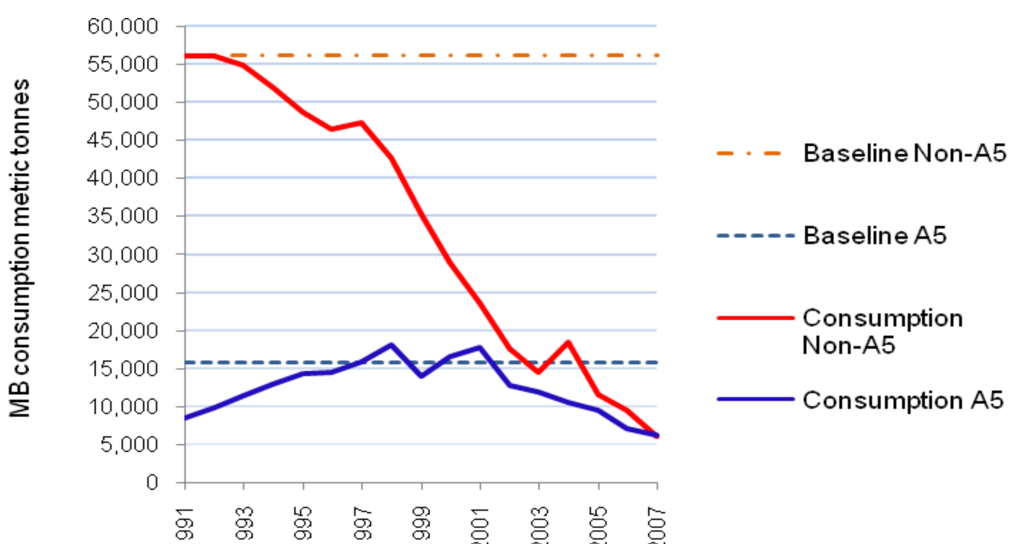


Source: MBTOC, 1994, 1998; MBTOC estimates; Ozone Secretariat data, April 2009

13.1.2 Global consumption

On the basis of Ozone Secretariat data, global consumption of MB for controlled uses was estimated to be about 64,420 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 12,183 tonnes in 2007 as illustrated by Fig 13.3 below.

Figure 13.3: Baselines and trends in MB consumption in Non-Article 5 and A 5 regions, 1991 – 2007 (metric tonnes)



Source: MBTOC estimates calculated from Ozone Secretariat data of April 2009.

13.1.2.1 Consumption trends in Non-Article 5 countries

Figure 13.3 shows the trends in MB consumption in Non-Article 5 countries for the period between 1991 and 2007. The official baseline for Non-Article 5 countries was 56,043 tonnes in 1991 and since the consumption has declined steadily. By 2003, this consumption had been reduced to about 14,520 tonnes, representing 26% of the baseline. In 2004, consumption appeared to increase to 18,454 tonnes (33% of baseline), however this occurred primarily because 3,310 tonnes scheduled for export to Article 5 countries were not shipped before 31 December of that year and this consignment was counted as part of the official national consumption of a Non-Article 5 Party. In 2007 the estimated consumption based on quantities approved or licensed amounted to 8,475 tonnes or about 15% of the baseline. For 2008 about 6,966 tonnes were approved or licensed which is a further reduction to 12% of the baseline (figure not shown in graph as information for Article 5 Parties is not at this date fully available).

Trends in MB consumption in major Non-Article 5 regions can be summarised as follows:

- In 1991 the USA, European Community, Israel and Japan used 95% of the MB consumed in Non-Article 5 countries.
- For 2008, permitted levels amounted to 21%, 1%, 24% and 7%, in the same order, whilst for 2009 these figures came down to 17%, 0%, 17% and 5% respectively.
- In the past, MB was consumed for controlled uses by 40 out of 45 Non-Article 5 countries. The majority of these countries no longer use MB (Table 13-1).
- Of the eleven Parties applying for MB for CUEs in 2007 only five have sought CUEs in 2009.

Table 13-1 summarises national MB consumption as a percentage of national baseline in Parties that were granted critical use exemptions (CUE). In general, Parties have made significant reductions in CUE. The EC has not submitted critical use nominations (CUN) since 2008.

Table 13-1: Summary of MB consumption in Article 5 and Non-Article 5 countries

Status of MB use	**Number of Parties**		
	Non-Article 5 Parties in 2009	**Article 5 Parties in 2006**	**Total**
Parties using MB	5	44	**49 (26%)**
Parties that used MB in 1991 and now have zero consumption (a, b)	35	48	**83 (43%)**
Parties with no MB consumption since 1990 (b)	5	54	**59 (31%)**
Total	**45**	**146**	**191 (100%)**

(a) MB consumption reported by Ozone Secretariat. (b) Excluding QPS

Table 13-2 presents consumption in Non-Article 5 Parties as a proportion of national baselines.

Table 13-2: MB consumption[(a)] in relation to national baselines in Non-Article 5 Parties that currently use MB

Party	MB consumption [(a)], tonnes (percentage of national baseline)						
	1991	**2003**	**2005**	**2006**	**2007 (a)**	**2008 (a)**	**2009 (a)**
Australia	704	182 (26%)	116 (16%)	55 (8%)	49 (7%)	50 (7%)	38 (5%)
Canada	200	58 (29%)	62 (31%)	42 (21%)	53 (27%)	42 (21%)	39 (20%)
EC	19,612 (b)	5,162 (26%)	2,431 (13%)	1,487 (8%)	522 (3%)	213 (1%)	0 (0%)
Israel	3,580	992 (28%)	1,072 (30%)	841 (23%)	967 (27%)	861 (24%)	611 (17%)
Japan	6,107	1,430 (23%)	595 (10%)	489 (8%)	636 (10%)	444 (7%)	305 (5%)
New Zealand	135	35 (26%)	30 (22%)	27 (20%)	18 (13%)	0 (0%)	0 (0%)
Switzerland	43	11 (24%)	4 (9%)	4 (9%)	0 (0%)	0 (0%)	0 (0%)
United States	25,529	6,755 (26%)	7,255 (28%)	6,475 (25%)	6,230 (24%)	5,356 (21%)	4,262 (17%)c

MB consumption data for 1991-2007 from Ozone Secretariat dataset of April 2009. Figures for 2007-2008 are authorised or licensed CUEs from reports of Meetings of the Parties and licensing data

(a) Calculations of baselines does not account for pre 2005 stocks (b) Authorised or licensed CUEs (actual MB consumption has not yet been reported) (c) Baseline of the 25 EC countries that were member states in 2005

13.1.2.2 Consumption trends in A 5 and CEIT countries

Figure 13.3 shows the trend in MB consumption in Article 5 countries in the period between 1991 and 2007. Trends can be illustrated as follows:

- The Article 5 baseline was 15,703 tonnes (average of 1995-98), rising to a peak consumption of more than 18,125 tonnes in 1998. A 5 consumption was reduced to 67% of baseline in 2004 (10,512 tonnes) and 40% in 2007 (6,226 tonnes).

- Since 2003, total Article 5 consumption has fallen by 1,420 metric tonnes per year on average (2003-2007), as shown in Fig 13.4 below. Article 5 consumption may therefore be expected to be about 4,726 tonnes in 2008 and 3,306 tonnes in 2009.

- All but two Article 5 Parties have continued to make substantial progress in achieving reductions in MB consumption at a national level, as illustrated by the following information. Further details are presented in Tables 13.3 and 13.4.

Trends at national level can be described as follows:

- The vast majority of Article 5 Parties achieved the national freeze level in 2002.

- By 2004, 87% of Article 5 Parties (125 out of 144) had achieved the 20% reduction step earlier than the scheduled date of 2005. Only 19 remaining Parties needed to take action to meet the 20% reduction step in 2005.

- In 2007, 88% of Article 5 Parties (127 Parties) reported national consumption of less than 50% of the national baseline. Only seventeen Article 5 Parties consumed more than 50% of their national baseline.

- 74% of Article 5 Parties (107 Parties) reported zero MB consumption in 2007. This shows continued progress since 2002 when 50% of Article 5 Parties reported zero MB consumption.

- According to latest reported consumption data (for 2007) only two Article 5 countries (Ecuador and Honduras) were in non-compliance with the 20% reduction step of 2005. Reported consumption for Honduras lies within the commitment set forth in Decision XVII/34 (225 ODP tonnes in 2007).

- 84% of Article 5 Parties (120 Parties) reduced their national MB consumption to less than 50% of national baseline in 2006 (Table 13-3).

Table 13-3: National A5 MB consumption as percentage of national baseline, 2003-2007

Status of national MB consumption	**2003**	**2004**	**2005**	**2006**	**2007**
MB consumption was 0% of national baseline	87	91	96	101	107
MB consumption was 1 – 50% f national baseline	19	22	19	29	22
MB consumption was 51 – 80% of national baseline	11	10	21	10	13
MB consumption was more than 80% of national baseline	25	19	8	4	2
Total number of A5 parties examined	142	144	144	144	144

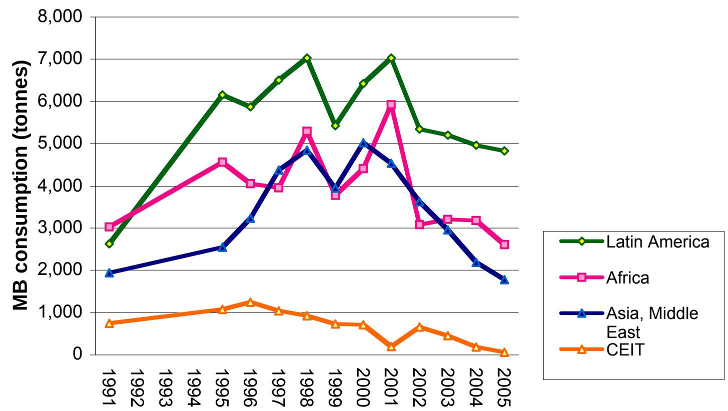
Analysis of zone Secretariat Data, April, 2009.Data for 2003, 2004 and 2005 were taken from Table 3.10 of MBTOC 2006 Assessment Report

At regional level, the decrease in consumption has been greatest in CEIT countries, followed by Asia and Africa, while Latin America is the region with smaller relative reductions, and is the only region that consumes more MB now than in 1991 (Fig. 13. 4). Some agricultural sectors in Latin America are still reporting significant use of MB, including melons in Central America, strawberries in Chile and Argentina, and cut flowers in Ecuador.

The status of MB phase-out in Article 5 regions in 2007, compared to the regional baselines (1995-98 average) is as follows:

- Latin America has phased-out 40.7% of its regional baseline
- Africa has phased-out 76.2% of its regional baseline
- Asia has phased-out 68.5% of its regional baseline
- CEIT region has phased-out 99.7% of its regional baseline

Figure 13- 4: MB Consumption trends in Article 5 and CEIT countries 1991 - 2007



Source: Ozone Secretariat database, 2009

Substantial progress has been achieved in Article 5 countries that consumed the greatest quantities of MB. Only 12 Parties still report consumption between 100 and 500 tonnes and only two countries remain in the usage category above 500 tonnes. The top 15 MB consuming countries together accounted for 80% of the Article 5 baseline in the past, and about 86% of total Article 5 consumption in 2000/1. National details are provided in Table 13-4 below. The top 15 countries reduced MB consumption by 65% from 2001 to 2007 (from 14,932 tonnes in 2001 to 5,284 tonnes in 2007).

- In the last 3 years alone, the top 15 countries have reduced MB by 43% (from 9,399 tonnes in 2004 to 5,284 tonnes in 2007).
- In 2007, MB consumption in the top 15 countries was only 42% of the baseline on average (Table13. 4 column 4).
- By 2007 these large consumers have phased out 73% of their historical peak use of MB.

Many Article 5 countries are finishing or 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, which together accounted for 80% of the A5 baseline consumption). The exception is South Africa, which is currently preparing a GEF project for MB phase-out. Notably, two Parties in this group, Brazil and Turkey, which reported consumption larger than 500 tonnes in the past, have now phased out completely and reported zero consumption in 2007.

Table 13-4: Fifteen largest Article 5 consumers of MB in the past

Country	National MB consumption (MT)			MB eliminated from peak year to 2007	MB eliminated from baseline year in 2007	MLF project
	In peak year [a]	Baseline (1995 – 98)	2007 (% baseline)			
China	3,501	1,837	603 (33%)	83%	67%	Yes
Morocco	2,702	1,162	440 (38%)	84%	62%	Yes
Mexico	2,397	1,885	1,491 (79%)	38%	21%	Yes
Brazil	1,408	1,186	0 (0%)	100%	100%	Yes
Zimbabwe	1,365	928	36 (4%)	97%	96%	Yes

Country	National MB consumption (MT)			MB eliminated from peak year to 2007	MB eliminated from baseline year in 2007	MLF project
	In peak year [a]	Baseline (1995 – 98)	2007 (% baseline)			
Guatemala [b]	1,311	668	485 (73%)	63%	27%	Yes
South Africa	1,265	1,005	100 (0%)	92%	90%	No [c]
Turkey	964	800	0 (0%)	100%	100%	Yes
Honduras [b]	852	432	414 (96%)	51%	4%	Yes
Argentina	841	686	496 (72%)	41%	28%	Yes
Thailand	784	305	203 (67%)	74%	33%	Yes
Costa Rica [b]	757	571	397 (69%)	8%	31%	Yes
Egypt	720	397	310 (78%)	57%	22%	Yes
Chile	497	354	280 (79%)	44%	21%	Yes
Lebanon	476	394	30 (8%)	94%	92%	Yes
Total of top 15 countries	19,840	12,610	5,284 (42% av.)	73% average	58% average	

[a] Maximum national MB consumption in the past
[b] Melon producers in these countries increased consumption greatly in recent years. Guatemala and Honduras are implementing projects designed to bring compliance
[c] South Africa was not considered eligible for a MLF project and was invited to prepare a GEF project

13.2 Alternatives for soil treatments

13.2.1 Key alternatives

Major chemical alternatives, 1,3-D/Pic, chloropicrin, metham sodium and metham potassium, used alone and/ or in combination with other alternatives continue to prove as effective as MB and are now widely adopted in many preplant soil applications (TEAP, 2005 a,b; Mann *et al*. 2005; CDPR PUR data, 2007; Spotti, 2004; Carrera *et al.* 2004; Porter, 2005; MBTOC 2007). The recent registration of methyl iodide and adoption of a 3 way fumigant system (1,3-D/ chloropicrin/metham sodium) (Culpepper *et al.*, 2008) in the USA have offered further options for many of the remaining uses proving difficult to control with other alternatives. Various parties previously applying for CUNs particularly in strawberry fruit, tomatoes and vegetable crops, have adopted these alternatives on a wide scale. This includes control of soilborne pathogens in the more difficult nursery and replant industries where high levels of disease control are required to meet quality standards (e.g. certification requirements).

Formulation changes and more adequate application methods continue to improve the effectiveness of several alternatives (Pic EC, 1,3-D/Pic EC) and wider adoption has occurred where these are available. In many instances, this has involved a change in cropping practice, i.e. slightly longer plant back times and a greater awareness of soil conditions which improve the efficiency of alternatives; modification to application machinery, sometimes with economic implications have sometimes been also necessary. Some sectors that were formerly heavily reliant on methyl bromide have completely switched to other chemical alternatives and improved crop rotation practices; others have adopted more diverse types of alternatives including substrates, steam and various combinations of fumigants, other pesticides, resistant varieties and grafted plants adopted alone or in combinations with fumigant and not fumigant nematicides (Porter *et al,* 2007).

Combinations of fumigant alternatives (1,3-D/Pic, MNa/Pic) with a range of herbicides have been shown to be effective for nutsedge (*Cyperus* spp), which is the key target weed for several critical uses (Gilreath *et al,* 2004; Belcher *et al* 2007; Culpepper *et al*, 2007).

Methods which avoid the need for methyl bromide, such as cropping in substrates, grafting plants onto resistant rootstocks and using resistant varieties, continue to expand in the ornamental and vegetable industries (Cantlifee and Vansickle, 2003; Cantliffe *et al*, 2003; Savvas, 2003; Trout and Damoradan, 2004; Tognoni *et al*, 2004; TEAP 2005 a, b).

One key transitional strategy to reduce MB usage has been the adoption of MB:Pic formulations with lower concentrations of methyl bromide (e.g. MB:Pic 50:50 or less). Their use can be achieved with application machinery that allows co-injection of methyl bromide and chloropicrin or by using premixed formulations. These formulations have proven equally effective for controlling soilborne pathogens as formulations containing higher quantities of methyl bromide (e.g. 98:2, 67:33) (e. g. Porter *et al.* 1997; Melgarejo, 2004; López-Aranda *et al*. 2004).

Low permeability barrier films, LPBF, (e.g. VIF or equivalent) allow increased retention of MB and extended effective exposure periods for pests, thus controlling pathogens and weeds at reduced MB application rates compared to those used with conventional films (e.g. Gilreath *et al*., 2003; Gilreath *et al*., 2005; Hamill *et al*., 2004; Minuto et. al., 2003; Santos *et al.*, 2005; Wang *et al*., 1997). These films allow for substantial reductions in dosage rates of MB compared with the minimum effective rate under standard polyethylene film. Reductions are typically between 25 – 50% less for MB/Pic 98:2 formulations as well as other formulations (67:33, 50:50 and 30:70). Studies are also proving their use for effective dosage reduction of alternatives, such as 1,3-D, Pic and methyl iodide (Gilreath *et al.*, 2004; Noling, 2004; Hamill *et al.*, 2004; Fennimore *et al.*, 2004; Austerweil *et al*., 2006; Ou *et al*., 2007, MBTOC 2007). This is important because dosage reduction may increase areas available to be treated with specific fumigants that are limited by township caps and may lead to further reduction in MB use and possibly reduce the buffer zone requirements which limit adoption of alternatives in some countries (Gilreath *et al.*, 2003; Fennimore *et al.*, 2004; Fennimore *et al*., 2003; Ou *et al.*, 2007).

Adoption of barrier films has increased substantially for uses in several countries still applying for critical us exemptions to methyl bromide, including Japan, Israel and the south eastern states of the USA. At present, California prohibits the use of barrier films (VIF) with methyl bromide, over concerns of possible worker exposure to MB when seedlings are planted or the film is removed (California Code of Regulations Title 3 Section 6450(e)), however barrier films can be used to improve efficacy of alternative fumigants.

Another treatment which is increasing in use is a soil heat treatment by hot water and vapour heat treatment which is currently applied in Japan (Kita, 2004 ; Nishi, 2005, Uematsu *et al*., 2003; Takeuchi, 2004). This treatment is applied for the sterilization of the soil for bag culture, nursery and tray culture. Soil reduction redox potential method is now widely applied for soil disinfestation in combination with solarization. (Momma 2008; Kubo et al 2004; Shinmura 2004; Takeuchi 2004).

13.2.2 Update on registration of chemical alternatives:

13.2.2.1 Europe

The EC has completed the review of existing pesticides that were on the market before 1993. This review examined about 1000 active pesticide substances and removed over two-thirds of them from the market. A new EU list of approved pesticide active substances has been established (Ministerio de Medio Ambiente , 2009).

As a result of this review the following changes apply in the EU as of March 2009:

- Authorisations for pesticides containing MB were withdrawn by 18 March 2009, with a grace period, if any, allowing the use of existing stocks until 18 March 2010. Since no CUEs were allowed in the EC for 2009 and 2010, MB stocks can only be used for QPS;
- Authorisation for dazomet will cease by 31 December 2010, with a grace period ending 31 December 2011; whether an application for re-registration of dazomet will be submitted is not known;
- Unless new submissions are made for re-registration, authorisations for chloropicrin are scheduled to cease by 31 December 2010, with a grace periods expiring 31 December 2011. Submissions are expected;
- The grace period for 1,3-D expired on 20 March 2009. A number of EU countries have authorised or are expected to authorise temporary permits allowing 1,3-D to be used where it appears necessary (under the EC plant protection products directive). A submission has been made for re-registration of 1,3-D. New studies have been reviewed and the national authority leading the risk assessment reported that the new information has resolved earlier concerns about impurities and groundwater (Ministerio de Medio Ambiente 2009). A study in five European countries demonstrated negligible contamination of groundwater with 1,3-D or its metabolites in different locations where this fumigant had been used over severalyears (Terry *et al.,* 2008).
- A risk assessment for metham (both metham sodium and metham potassium) was completed and reviewed, but no further action taken.

13.2.2.2 Registration of chemical alternatives in the USA

Methyl iodide now holds a permanent registration in the US in all states except California, New York and Washington. Methyl iodide is registered for use on strawberries, peppers, tomatoes, field grown ornamentals, stone fruits, tree nuts, vines (table, raisin and wine grapes) and nurseries (forest, strawberry, stone fruit and tree nuts).

DMDS has a pending registration application for uses on tomatoes, peppers, eggplants, cucumbers, squash, melons, onions, field grown ornamentals and forestry nursery crops. Annex 1 of this chapter includes a detailed table with registration information for all substances presently considered to be alternatives for MB for both preplant and postharvest uses.

13.2.2.3 Registration of chemical alternatives in Japan

1,3-D is registered for the control of MNSV of melon, however it can cause phyototoxicity and its efficacy can be variable.

A mixture of azoxystrobin and metalaxyl M is now under registration review for the control of root rot disease of ginger, Table 13-5 below lists alternatives already registered and in process of evaluation or registration in Japan.

Table 13-5: Registration status of chemical alternatives to MB in Japan

Use category	Alternatives available	Status of registration	Alternatives under development	Possible date of registration
Chestnut (Commodity)	None		Methyl iodide	Unknown
Cucumber (Soil)	None		Attenuated virus	Unknown
Ginger (field & protected, soil)	Chloropicrin	Registered	Methyl iodide	Unknown
	Dazomet	Registered	Amisulbrom	Unknown
	Metham sodium	Registered	Sodium phsphite	Unknown
	1,3-D/ Pic	Registered	Mixture of azoxystrobin + metalaxyl-M	Unknown
	Mixture of 1,3-D + MITC	Registered		
	Metalaxyl	Registered		
	Propamocarb	Registered		
	Cyazofamid	Registered		
Green & hot pepper (Soil)	None		Attenuated virus	Unknown
Melon (Soil)	Mixture of 1,3-D/ Pic	Registered	Methyl iodide	Unknown
			Attenuated virus	
Watermelon soil	None		Attenuated virus	Unknown

13.2.2.4 Registration of chemical alternatives Australia

The main alternatives registered in Australia remaining MB user, the strawberry nursery industry, appear in Table 13-6 below

Table 13-6: Registration status of chemical alternatives to MB in Australia

Use category	Alternatives available	Status of registration	Alternatives under development	Possible registration date
Strawberry Nurseries	Chloropicrin	Registered	Weed control ineffective, not recommended in regulations	Methyl iodide
	1,3- D	Registered	Phytotoxic in cool conditions, not recommended in regulations	Cyanogen
	Metam Sodium	Registered	Variability in results, not recommended in regulations	
	Dazomet	Registered	Variability in results and cost, not recommended in regulations	

Methyl iodide and ethanedinitrile both have registration applications pending with the APVMA (Australian Pesticides and Veterinary Medicines Authority).

13.2.2.5 Registration of chemical alternatives in Canada

Pic-100 has been registered by PMRA (Pest Management Regulatory Agency) for use by the remaining MB user, a strawberry nursery grower, but has not received clearance by the Prince Edward Island authorities due to groundwater contamination concerns.

13.2.2.6 Registration of chemical alternatives in Israel

In general, there is no change in the status of registration for fumigants since the last progress report. Details are presented in Table 3.17 below. Current status of the main alternatives is as follows:

- *Metham sodium* is registered for potato, eggplant, tomato, cucurbits, lettuce, brassicae, peanuts, flowers, avocado, replant of various perennials and potting media. However, there is no effort at present to extend registration to other crops.
- *Choropicrin* is not registered, however initial registration procedures are under way for cucurbits (Pic in pure form and combined with DMDS)
- *DMDS* is not presently registered for any crop. A registration package is expected to be submitted by the end of 2009 for nematode control in tomato and cucumber.
- *1,3- D* is registered for cucurbits, carrots, tomato, potato, gerbera, sweet potato, annual and perennial flowers, herbs, strawberries.
- *1,3-D/Pic* has restricted availability in Israel. It is registered in potato, tomato eggplant, peppers, strawberry and some cucurbits (watermelon and melon). There is no manufacturing facility in Israel and its importation is problematic.
- *Dazomet* is only registered for melon, watermelon and tomato.
- *Methyl iodide* is undergoing an application for registration, with preliminary trials undertaken this year.

Table 13-7: Registration of chemical alternatives to MB in Israel

Use category	Alternatives available	Status of registration	Alternatives under development	Possible date of registration
Cucumber	1,3D	Registered	DMDS	Unknown
	Chloropicrin	Not Registered		
	Dazomet	Registered		
	Metham sodium	Registered		
	1,3-D/ Pic	Not Registered		
	Metalaxyl	Registered		
	Cadosaphos, oxamyl, fenamifos			
Melon	1,3D	Registered	DMDS	Unknown
	Chloropicrin	Not Registered	Methyl idoide	Unknown
	Dazomet	Registered		
	Metham sodium	Registered		
	1,3-D/ Pic	Registered		
	Cadosaphos, oxamyl, fenamifos	Registered		
Flowers indoor	1,3-D	Registered		
	Chloropicrin	Not Registered		
	Dazomet	Registered		
	Metham sodium	Registered		
	1,3-D/ Pic	Not Registered		

Use category	Alternatives available	Status of registration	Alternatives under development	Possible date of registration
	Mixture of 1,3-D + MITC	Not Registered		
	Cadosaphos, oxamyl, fenamifos			
Flowers	Chloropicrin	Not Registered		
	Dazomet	Registered		
	Metham sodium	Registered		
	1,3-D/ Pic	Not Registered		
	Cadosaphos, oxamyl, fenamifos			
Strawberry	1,3D	Registered	DMDS	Unknown
	Chloropicrin	Not Registered		
	Dazomet	Not Registered		
	Metham sodium	Registered		
	1,3-D/ Pic	Registered		
	Cadosaphos, oxamyl, fenamifos	Registered		
Sweet potato	1,3D	Registered		
	Chloropicrin	Not Registered		
	Dazomet	Not Registered		
	Metham sodium	Registered		
	1,3-D/ Pic	Not Registered		
	Metalaxyl	Registered		
	Cadosaphos, oxamyl, fenamifos			

13.2.3 Crop specific strategies

This section below provides an overview of the main strategies adopted in both A 5 and on-A 5 Parties, for those crops presently applying for critical use of MB (CUNs).

13.2.3.1 Vegetables

a. Tomatoes

Effective alternatives adopted in the tomato sector include combinations of chemicals such as 1,3-D/Pic metham sodium, dazomet, methyl iodide and non-chemical methods (e.g. substrates, grafting, resistant varieties, biofumigation, solarisation) Besri, 2007a, 2007b,).

MB use for tomatoes has been entirely phased out from all European countries, as Australia and Israel (except for the control of broomrape, *Orobanche* spp). The main alternatives adopted are soilless culture often in combination with other options such as resistant cultivars and grafting, grafting, alone or grafting in combination with fumigants such as 1,3- D Pic, MS, and MI (methyl iodide), mostly to limit the damages of root knot nematodes (Mann *et al.,* 2005, Besri 2007a, 2007b, Runia, 2006, Culpepper *et al.,*, 2008).

Adoption of grafting continues to increase and is now commonly used in Eastern Europe, Northern Africa, Central America, and North America. In the USA, grafting is still largely limited to greenhouse production and small organic producers but new research is underway to help establish this technology (Louws, 2008; Kubota, 2008). Introduction of this technology to open fields has potential efficacy as an IPM tool to reduce soil fumigants in vegetable production (tomato, eggplant, melons, and cucumbers), but with some limitations (Besri 2008, Kokalis-Burelle 2008, Davis *et al.,* 2008, Lin et al 2008, Rivard *et al* 2008).

Kokalis-Burelle *et al* (2008) evaluated the combination of grafting + fumigants (MB, MI/ Pic, DMDS/ Pic) under metalized barrier films.

In Mediterranean countries grafting represents a viable alternative effective against vascular wilts and root rots (Besri, 2008). In Morocco, grafting is now implemented on 100 % of the protected tomato producing area. In Turkey, yields in tomato increased by about 35% when using grafted plants, although this proportion varied with the rootstock used (Yilmaz *et al.*, 2008). In Spain, grafting was introduced to protect plants from pathogens such as various races of *Fusarium oxysporum*, *Verticillium dahliae*; *Phytophthora* spp.,and *Pyrenochaeta* sp. and the nematodes (*Meloidogyne* spp). Grafting is now common in watermelon and tomato, but less in pepper, eggplant, melon and cucumber (Dianez *et al*., 2007).

In Japan, grafting is used singly or in combination with alternative chemicals for nematode control (1,3-D, Pic, MS and fosthiazate) for 60% of the regular tomatoes and 90% of the cherry tomatoes produced in the Kumamoto region where a high proportion of the country's production is concentrated (Nishi and Tateya, 2006a). Recently, a grafting robot including an automatic seedling feeder system has been developed. It reduces labour and increases efficiency and accuracy. Commercial availability of this device is expected soon (Kobayashi 2005, Kobayashi 2008, Kobayashi 2008). The robot has been introduced in the US for the production of grafted vegetables (Kokalis-Burelle 2008). In Taiwan grafted tomatoes represent a viable solution against bacterial wilt (Lin *et al*., 2008).

In Florida, Telone C-35 was reported to be as effective as MB for controlling root-knot nematodes in tomatoes (Dickson, 2007). Nutsedge control has been efficiently achieved in the USA with the herbicide halosulfuron. Acrolein combined with other chemicals such as Eptam (EPTC), halosulforon or dazomet enhanced control of nutsedge and other weed species without adversely affecting yield. Yields were comparable or higher than those obtained with MB. (Belcher *et al.*, 2007).

Methyl iodide applied under metalized mulch controlled nutsedge as well as MB at various dosages, with highest obtained at 252 kg/ha. Metalized mulch also reduced incidence of bacterial wilt (*Ralstonia solanacearum*) to a greater extent than VIF (Olson and Kreger, 2007; Bernal, 2007; Thomas *et al*., 2007).

Welker *et al* (2008) reported that fumigation with DMDS / Pic 80:20 kills inoculum to a depth sufficient to produce an economical harvest.

In Turkey, solarisation has been extremely successful at replacing MB in polyhouses (Yilmaz *et al*, 2008). In addition, soil solarization in combination with biocontrol agents (BCA); rifampicin resistant *Pseudomonas fluorescens* strain (PfT-8) and a carbendazim resistant *Trichoderma harzianum strain* (ThM-1) were introduced and evaluated as a potential disease management strategy for tomato damping-off caused by *Pythium spp*. (Jayaraj and Radhakrishnan, 2008). Incidence of damping-off disease was significantly suppressed in solarized plots containing BCA compared to control plot.

b. Eggplant

Adoption of grafting continues to expand in the eggplant sector as new and more suitable rootstocks become available. In Turkey for example, yields of grafted eggplants were shown to increase by 25-30% in comparison to non-grafted plants. Fruit quality was much improved and although planting density remains largely unchanged, growers find it possible to leave grafted plants in production for several years, especially when grown on previously solarised soil treated with alternative fumigants (Yilmaz *et al*, 2007b).

c. Peppers

Various chemical alternatives have proved efficient for the control of soilborne pathogens and weeds. For example, methyl iodide/ Pic 50:50 with VIF, DMDS/ Pic and a combination of Telone II /Pic and dazomet under LDPE and barrier films were tested in Georgia (USA) on bell pepper with excellent results (Culpepper *et al*., 2007, 2008).

In Spain, biofumigation has proven successful for peppers grown in the Murcia and Castilla-La Mancha regions (Bello *et al.,* 2008). Biofumigants most commonly applied include goat, sheep and cow manure, organic matter from rice, mushroom, olive, brassicae, and garden residues. The effect of pepper residues on *Meloidogyne incognita* populations was also evaluated by Piedra-Buena *et al*. (2007).

Solarization in combination with chemical and non-chemicals alternatives has been extensively studied for pepper production in different countries (Morra *et al*., 2007, Santos *et al*., 2008, Sogut and Elekcioglu, 2007, Yucel *et al*., 2007; Saha *et al*., 2007). The efficacy of soil solarization in combination with *Trichoderma* spp., dazomet and fresh chicken manure for the control of root knot nematodes was studied by Sogut and Elekcioglu, (2007) in Turkey. All alternatives significantly reduced nematode incidence and damage. In the USA, Morra *et al*., (2007) found that cultivation of grafted peppers in solarised soil was a promising technical solution to substitute chemical treatments of soil disinfection. The impact of solarization in combination with soil fumigants (MB/ Pic, 1,3-D/ Pic, metham sodium) on hot pepper production in high-tunnels was studied in Costa Rica (Santos *et al*., 2008), where nematode damage was significantly reduced and yields improved.

d. Cucurbits

Production of grafted cucurbits continues to expand in Mediterranean countries. When combined with other treatments, grafted plants do not need for MB fumigation (De Miguel, 2004b, Beltrán *et al*, 2008). In Italy, grafted plants are used with alternative fumigants (e.g. 1,3-D or Pic) (Spotti, 2004). Rootstocks resistant to soilborne pests and pathogens such as *Meloidogyne* sp. and *Fusarium oxysporum* are available for melon, watermelon and cucumber; *Monosporascus cannonballus* and *Didymella bryoniae* for melon; and *Phomopsis sclerotiodes* for cucumber (Blestos, 2005; De Miguel 2004 a, b, c; López-Galarza, *et al.* 2004; Crinó et al, 2007).

In Israel, grafting is also showing promising results, particularly when this system is carefully adapted to particular growing conditions of each region (Cohen *et al*., 2005, 2007; Koren, 2002). Grafting is commercially adopted for watermelons and is successful for prostrate melon cultivars, however some incompatibility constraints remain for trellised cultivars.

In Morocco, grafting of cucurbits enjoys wide commercial adoption. Many rootstocks with resistance to most of the soil borne pathogens (except *Meloidogyne*) are now available. Grafting is used as a component of IPM program (Besri 2008).

In the USA, the main focus is still on alternative fumigants, combined with herbicides when additional weed control is necessary (Culpepper *et al.,* 2007). Methyl iodide applied under metallized tarps has shown to be as efficacious as MB (Hausbeck and Cortright, 2007; Olson and Kreger, 2007), but this fumigant is not yet registered for cucurbits. In Florida, 1,3D /Pic showed better control of soil borne pathogens of melon than MB/Pic formulations (Olson and Kreger, 2007). In Georgia, fumigant combinations using 1,3-D, chloropicrin and metham-sodium were as effective as methyl bromide for controlling *Meloidogyne incognita* (Kofoid & White), *Pythium irregulare*, *Rhizoctonia solani* and *Cyperus esculentus* in squash crops (Desaeger *et al*, 2008).

Non-chemical alternatives such as grafting, physical barriers and biofumigation are being increasingly tested in the US. For example, physical barriers were tested for weed control: yellow nutsedge emergence in transplanted cantaloupe was suppressed by the combined effects of thin-film mulches and competitive size differential provided by using cantaloupe transplants (Johnson & Mullinix, 2007).

Kokalis-Burelle *et al* (2008) evaluated the combination grafting + fumigants under metalized film . Grafted watermelons show potential in the USA for production without MB, but commercial growers are reluctant to adopt this technology due to economic concerns. Several studies are presently being conducted to address this (Cushman and Huan, 2008; Taylor *et al*., 2008**).**

Grafting combined with either avermectin, fosthiazate or calcium cyanamide are efficient alternatives to MB presently in use in China for cucumber production (Cao, 2009 pers. comm).

13.2.3.2 Ornamental crops

Alternatives such as fumigants, production in substrates and steam, have been been widely adopted (including A5 Parties) and only two Non-Article 5 Parties presently request CUNs for ornamentals, Israel and the United States..

Floriculture is a complex industry with many flower types, production cycles and cropping systems involved. As a result, shifting to alternatives often requires growers to change production practices substantially and implement IPM, but these have been shown to be extremely effective (e.g. UC Davis, 2009). This may include transition to soilless systems, at times with increased investment, but often with improved quality and yields (Savvas, 2003; Graffiadelis, 2000; Grillas *et al.,* 2001; Akkaya *et al.,* 2004; Minuto *et al*., 2005; Vos and Bridge, 2006; Yilmaz *et al.,* 2008; 2007 ab).

Constraints to adoption of alternatives include regulatory issues (e.g. township caps in USA), and registration. However, alternatives that do not need registration such as steam and substrates are used by many growers around the world particularly for flowers grown in protected environments. Effective results have also been obtained with solarisation, for example in Israel, Italy, Turkey and the state of Florida in the United States (McSorley *et al.*, 2006; McSorley *et al.,* 2008; Gullino and Garibaldi, 2007; Yilmaz *et al.,* 2007a).

Roses, carnations and gerberas are the flowers most commonly grown in substrates, but other flower types – particularly bulbs of many types - are also produced with this cropping system (Nucifora, 2001; Gullino *et al.,* 2003; Grillas *et al.,* 2001; Pizano, 2005; Savvas, 2003; Akkaya *et al*, 2004; Yilmaz *et al,* 2007a, 2008; Rea, 2008).

Steaming, although expensive, controls soil fungi at levels that are comparable to MB when properly applied (O'Neill *et al*. 2005; Reuven *et al.* 2005; Barel, 2003). It is of particular importance to adjust boiler capacity, fuel type and steam delivery options to each particular situation (Fennimore *et al.,* 2008ab*).* Steam is generally suited for protected flower production and for sterilizing re-utilised substrates. Costs associated with steaming may be reduced through implementation of IPM strategies and by considering different types of fuels, boiler types and steaming systems (Runia 2000).

Chemical alternatives are increasingly used in ornamental production around the world and include dazomet, metham sodium, 1,3- D, with and without Pic and methyl iodide (Rosskpf *et al.,* 2008;. Reuven *et al.*, 2005; Schneider *et al.,* 2003, Gerik, 2005 a and b, Gerik and Green, 2004, Gerik *et al.*, 2006; Mann *et al,* 2005; Tostovrsnik *et al*, 2005; Klose *et al,* 2007; 2008). Application of fumigants with barrier films, such as VIF, is allowing for reduced rates of chemicals, including MB (Klose *et al,* 2007). Commercial adoption of methyl iodide is taking place at a very fast rate in US states such as Florida where it has recently become registered (US CUN Ornamentals, 2009).

13.2.3.3 Strawberries

a. Chemical alternatives in strawberry fruit sector

Formulations of 1,3-D/Pic, Pic alone and metham sodium combined with other fumigants have been adopted widely throughout industries applying for CUN's, and replaced 85% of the production area previously treated with MB/ Pic mixtures. Of the Parties previously applying for CUN's, most have completely implemented these alternatives. Australia and France phased out in 2005, the United Kingdom in 2006 and Italy, New Zealand and Spain in 2007 (EC 2008). In 2009, USA and Israel are the only non- A 5 countries continuing use of MB for this use.

Recent trials on strawberry fruit in Australia, Spain and the US confirm that MI/Pic and DMDS/Pic performed as well as MB/Pic (e.g. Santos *et al*, 2007, López-Aranda *et al*., 2007, Mann *et al* 2007, Noling 2008), and others . Dazomet + 1,3-D and Pic alone were also very effective (López-Aranda *et al*, 2008). In Florida, field studies were conducted to compare the performance of several chemical alternatives on the control of sting nematode (*Belonolaimus* spp.) and marketable yield of 'Camarosa' strawberry (Gilreath *et a*l., 2008). 1,3-D/Pic and dazomet, 1,3-D/Pic, Pic and MNa, and fosthiazate/ Pic all proved equally effective as MB/Pic for strawberry plant vigor, sting nematode control, and early and total marketable yields.

In the EC, a range of chemical alternatives have been adopted to fully replace MB, including 1,3/D, MS, dazomet and Pic although as stated previously their registration is under revision.

In China, a new formulation of 1,3-D/Pic in capsules has been developed, as well as methyl iodide and MI/Pic capsules. Initial results showed that there was no significant different between 1,3-D capsule application and injection application. Avermectin is registered as a nematicide and is in wide use (Cao, 2008 pers. comm.).

b. Non-chemical alternatives in strawberry fruit sector

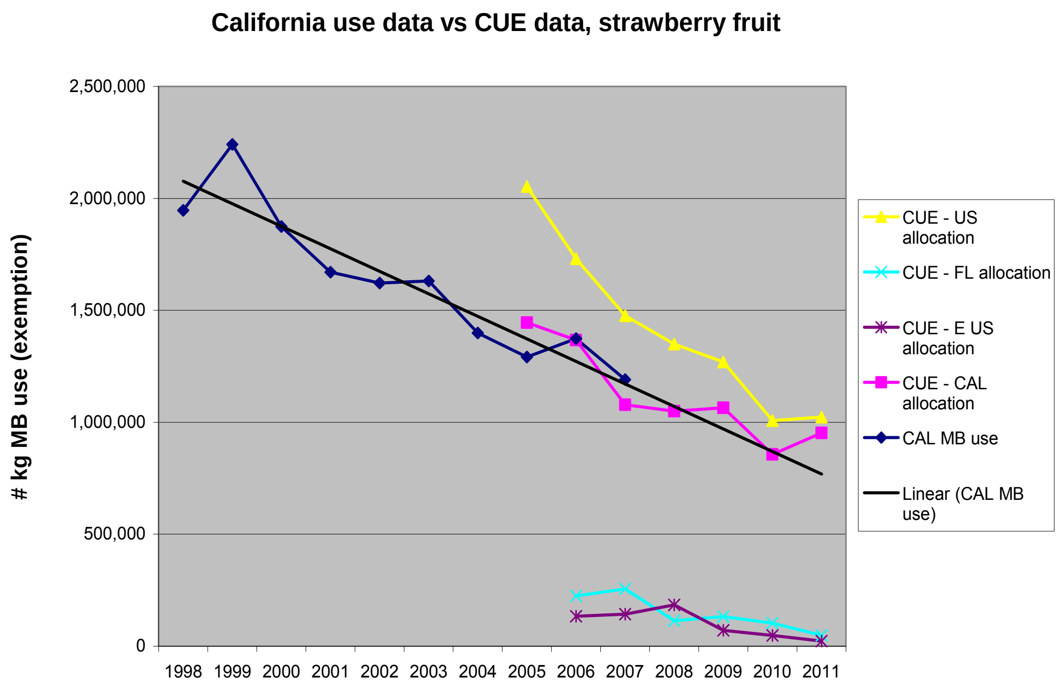
Strawberry production in substrates accounts for approximately 5% of world production. It occurs mainly in greenhouses and in cool climates with short cropping cycles, targeting early season markets or niche markets. The Netherlands, Japan, Italy, New Zealand, UK and China are some of the key producers using substrates for strawberry fruit production (Lieten, 2004; López-Medina, 2004; Nishi and Takeya, 2006). Efforts to reduce initial set up costs for substrate systems are expected to increase their adoption as a MB alternative worldwide for this crop.

c. Adoption of alternatives in the California Strawberry fruit sector

The California strawberry fruit industry is the largest remaining critical use for MB worldwide using around 1000 tonnes of MB. To further evaluate progress in uptake of alternatives, MBTOC conducted a study of historical MB use data in strawberry fruit in California using the following sources: http://calpip.cdpr.ca.gov/cfdocs/calpip/prod/main.cfm and California strawberry commission acreage survey information (Figure 13. 6.).

Conclusions of this study where that despite a large range of regulations which restrict use of alternatives, there has been steady progress in reducing reliance on MB over the years up until 2010 (Figure 13.5). Data shows that some regions have almost eliminated use of MB (eg. Oxnard), however others have not reduced reliance on MB (Figure 13.6). As an example, in Watsonville/ Salinas, the total production area has grown significantly since 2005 and the use of MB, being still at 75% of the production area.

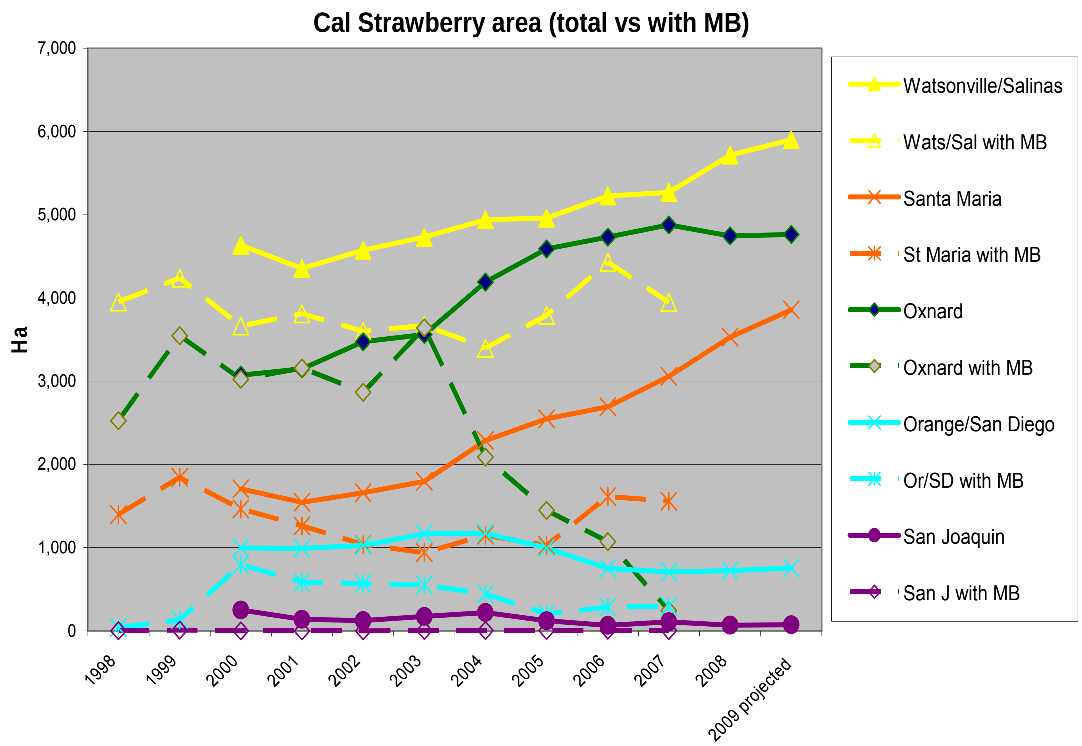
Figure 13.5: MB use by the Californian strawberry sector 1998 - 2010



Sources: http://calpip.cdpr.ca.gov/cfdocs/calpip/prod/main.cfm and US CUN data.

In Fig. 13.6. below, the solid lines indicate growth of production area within counties, the dashed lines show the production areas within the same county using MB. (Source: CalDPR data: www.cdpr.ca.gov/docs/pur/purmain.htm)

Figure 13.6: California strawberry production areas vs areas using MB



13.2.3.4 Strawberry nurseries

MB is used for the production of strawberry runners to meet strict certification standards for virtually pest-free strawberry runner stock. Since a single strawberry runner grown in year one can expand to several million runners by year five, the adverse impacts of pests is of particular importance and mean an alternative should give the same level of risk as MB or better. For this reason only a few alternatives are suitable and these include methyl iodide, 1,3-D/Pic in some situations and substrate production of plug plants are the alternatives being adopted. In particular, MI is becoming accepted as a one to one replacement for this industry and trials continue to prove effective in Australia, China, Spain and the USA (Mann *et al*., 2007; Cao, pers comm., 2008).

In other studies, a range of alternative fumigant combinations (MI/Pic, and 1,3-D/ Pic followed by dazomet, Pic followed by dazomet) controlled weeds at levels comparable to MB/Pic (Fennimore *et al*., 2008 ab).

In Japan, a simple, economically feasible system using trays filled with substrate is proving particularly useful for the production of strawberry runners. Various materials are used as substrates (e.g. rock wool, peat moss, rice hulls, coconuts husk and bark) and can be reused after sterilising with solar heat treatment or hot water (Nishi and Tateya, 2006b).

13.2.3.5 Nurseries and propagation material for other crops

Many types of propagation material (bulbs, cuttings, seedlings, young plants, sweet potato slips, and trees) are subject to high health standards. Alternatives to MB need to provide a level of pest and pathogen control sufficient to achieve an acceptable yield and quality from a clean root system or clean bulbs. This is critical to prevent the spread of economically important pests and pathogens from the nursery fields to the fruiting or production fields.

For certified nursery stock, regulations might specify either a level of control that must be achieved or approved soil treatments that are accepted as meeting certification standards (CDFA, 2009). For non-certified stock, the market sets the standard that must be met. In either case, lack of a clean root system could mean a 100% loss in marketable product for the grower. MB has commonly been used to meet clean propagative material standards. In some cases, sufficient data and grower experience have allowed growers to transition from the 98:2 formulations of MB that were commonly used in the past to 67:33 or 50:50 formulations depending on the pest or pathogen to be controlled and level of severity of the infestation [Porter *et al.,* 2007]. In other cases, only the amount of MB is specified in certification requirements, regardless of the formulation (CDFA, 2009). The California Dept of Food and Agriculture has recently approved the use of 1,3-dichloropropene as a certified nursery stock soil treatment for certain crops under specific conditions and methyl iodide, if and when it is registered for use in California (CDFA, 2009). Research trials (Schneider et. al, 2009), indicate some materials (such as MI) and some combinations (such as 1,3-D /Pic) show promise as MB alternatives for specific circumstances.

The requirement for broadacre treatment of nursery soil (to avoid recolonization from adjacent, untreated soil) has hindered adoption of barrier films (LPBF) in some areas (such as the US) where gluing of LPBF for broadacre treatment is not commercially available. Recent progress to this respect is however being made in trials in California (Fennimore and Weber, 2008).

An alternate approach to the use of soil treatments is the use of containerized, or soil-less substrate, production systems where this approach is economically feasible and is able to produce a product, i.e, root system, of acceptable size and quality to the marketplace.

13.2.3.6 Other crops

a. Potatoes and Sweet potatoes

No CUE was submitted for potato production in 2009 indicating good progress toward adoption of alternatives for this crop.

Nominations were submitted for sweet potatoes used for obtaining high quality disease-free transplant material. MB is required to control soilborne fungal, bacterial and nematode pests affecting production. T Stoddard *et al* (2008) tested a number of alternative to MB for sweet potato slips including Pic, PicChlor 60, solarization, 1,3-D combined with dazomet, plus additional treatments (napropamide, dicloran, thiabendazole and flumioxazin). Solarization and untreated control plots required significant hand weeding. 1,3-D and dazomet, and Pic alone yielded better and provided greater financial returns than MB although the latter case had 10% higher weeding costs than MB.

b. Ginger

Pythium sp. (*Pythium zingiberis*) is the major concern for ginger production. In the absence of resistant cultivars, disease control is dependent on detecting the pathogen in soil and in propagation materials and by planting pathogen-free propagative materials in clean areas. Several non chemical control methods have been considered for managing the impact of ginger diseases. These include improving drainage of the soil through appropriate ploughing, carefully regulating the watering practices and using pathogen-free water sources. Sanitation practices should ensure that tools and clothing are free of pathogens before being introduced into ginger fields. Infected plants should be immediately removed. Cyazofamid has been recently registered for rhizome rot disease of ginger in Japan. Propamocarb is also available. These two products are applied as a soil drench around the individual ginger plants. A mixture of azoxystrobin and metalaxyl M is under registration review. Methyl iodide is not yet registered but seems to offer promising effectiveness, however no data are available as to potential phytotoxicity. Phosphorous acid based compounds are also under evaluation as potential controls. Finally soilless cultivation has been tested but is still an experimental application to ginger cultivation (Hayden *et al*., 2004).

13.2.3.7 Replant diseases

Replant disease is a serious problem affecting certain orchards of perennial fruit trees and grapevines. The disorder still represents a major economic threat and challenge to growers. Replant is poorly understood as it is often caused by undefined pathogen complex that can be complicated by abiotic factors such as soil type and nutrition. A major factor contributing to the problem is the persistence of old, well developed and established deep seated roots from the previous crop, which can act as a reservoir and inoculum source of disease for the new trees/vines. Fumigation or other methods are thus not only needed against the pathogens, but also to kill the old roots. Non-fumigation management practices therefore can include the nearly impossible physical removal of such roots. Killing prune roots by means of systemic herbicides and using a persistent nematicide has been described by McKenry *et al*., (2007).

A number of alternatives to MB are presently in use in many countries, not only where specific pathogens are known to contribute to the problem but also where the disease complex is of unknown aetiology such as in many instances of specific and non-specific apple replant disease (Van Schoor *et al.,* 2009). These include agronomic practices such as rotation where possible, resistant rootstocks, organic soil amendments in the United States (Mazzola *et al.,* 2009), partially replacing old soil with fresh soil, appropriate macro- and micronutrient supplementation in South Africa (Van Schoor *et al.,* 2009), biofumigation and (Nyczepir *et al.,* 2007) solarisation in the US (Tanner *et al.,* 2006) , singly or in combination. The most appropriate chemical alternatives now include methyl iodide: Pic (MI/Pic 50:50). 1,3-D used singly or with Pic, Pic alone, metham sodium and dazomet is used successfully where the required dosage rates are allowed under prevailing local regulation (Browne *et al*., 2003; Tostovrnisk *et al.,* 2005; Reginato *et al*., 2008). Methods to replant orchards and vineyards successfully without MB have been reported (McKenry *et al.,* 2007, 2006). Widespread commercial use of mixtures occurred in Australia before phase out of methyl bromide (Tostovrnisk *et al.,* 2005; VDPI 2004, 2005). Performance of re-planted sweet cherry rootstocks was evaluated in Chile in soils treated with MB and 1,3-D, with equally effective results (Reginato *et al.,* 2008). No critical use applications have been submitted in the past years requesting MB specifically for apple replant disease.

Constraints to adoption of alternatives exist in the US and are mainly of regulatory nature. Methyl iodide has not yet been registered in a few states of which California is the more important. Although 1,3-D is effective in killing old roots and successfully used in light sandy soils, the dosage needed for the heavy soils (560-750 kg/ha) exceeds the maximum of 370 kg/ha allowed under California regulations (McKenry, 2005).

A major hurdle in replant research is the extended period needed to obtain meaningful and reliable results in contrast to research on annual crops. Trials were initiated in 2007 under the Pacific Area Wide Pest Management Program for Integrated Alternatives to Methyl Bromide of the USDA-ARS. Results are not expected within 4 years (Wang *et al*., 2008; Lampinen *et al.,* 2006)

Almond replant disease can be successfully controlled by Pic if the disease is not mediated by nematodes (Browne *et al*., 2006). Further studies are being conducted on almonds and other stone fruit with alternative fumigants at reduced rates in California (Browne *et al*., 2007; Browne *et al*., 2008; Coates *et al,* 2007) showing promising preliminary results of global positioning (GPS) placed spot treatments using Pic alone or in combination with 1,3-D. The Pacific Area-Wide Pest Management Program focuses on IPM including the use of minimum fumigant rates and fumigated areas, targeted fumigant methods (minimising non-targeted emissions), non-chemical approaches and risk-based management guidelines (Browne *et al,* 2008). Similar trials are underway with walnut (Kluepfel *et al*., 2007).

13.2.3.8 Weeds

a. Broomrape

Broomrapes (O*robanche spp.)* are root parasites of higher plants that depend entirely on their hosts for nutrients. they parasitize a wide range of economically important hosts, such as tomato (in greenhouses and in the open field), sunflower, chickpeas, groundnuts, potato, crucifers, carrots, herbs, melon and watermelon, rendering soils useless for crop production. Many alternatives to MB have been reported but unfortunately no single method of control provides complete protection against these pathogens, which makes an integrated approach combining various techniques necessary. The main challenge with broomrape is reducing the seed bank in heavily infested soil, which is no longer in production such as processing tomato fields in Israel. Abanga *et. al* (2007) have described a community-based integrated management approach for controlling broomrape in seven countries in the Near East and North Africa (NENA) where this weed causes serious problems. Nadal *et al*. (2008) have demonstrated that glyphosate is a suitable herbicide for the control of *O. crenata* in narbon bean for Southern Spain, however, this treatment can be phytotoxic for some high value crops such as tomatoes. Recently Muller *et al*., (2009) reported the potential use of *Fusarium* as a biopesticide against *O. ramosa.*

b. Nutsedge

Yellow and purple nutsedge, *Cyperus* spp are a key target for critcal use of MB that still requires effective alternatives. In the past year, trials involving combinations of herbicides and combinations of fumigants have been shown to be effective.

Webster *et al*., (2008) showed that glyphosate minimized nutsedge tuber production, is economical, and poses no herbicide carryover issues to vegetables. Also, in Alabama (US) a field study in tomatoes showed that yellow nutsedge was controlled with acrolein in combination with other herbicides and metham sodium. The successful combinations included acrolein with either Eptam, halosulfuron or metham sodium. (Belcher, *et al*, 2007). In Florida, Gilreath and Santos (2008) have combined fumigation programs with either Pic and fosthiazate or 1,3-D/Pic + metham sodium together with herbicides (napropamide+ trifluralin) in pre-emergence and post-directed trifloxysulfuron and shown improved control of nutsedge. In a separate study, Santos (2009) showed that the combinations are either napropamide and S-metolachlor or EPTC followed by metham-K provided similar levels of control as MB/Pic.

In a Florida study, DMDS, under VIF and metalized film, controlled yellow nutsedge as well as MB/Pic in a tomato field trial (Olson and Kreger, 2007). Thomas *et al*., (2009) used colored plastic mulches with Telone C35, which controlled weeds and prevented nutsedge penetration, by retaining the fumigant and allowing passage of infra-red and red light through the film while restricting other photosynthetically active wavelengths. The IR and red lights changed the morphology of nutsedge from a hard plastic-penetrating point to a soft leafy structure that cannot tear the film.

In Georgia trials, MB/Pic (67/33), methyl iodide/Pic (50/50) and a three fumigant system of 1,3-/D followed by chloropicrin, followed by metham sodium were evaluated on peppers. Nutsedge was controlled similarly with MB/Pic, methyl iodide/Pic and the 1,3-D/Pic/metham combinations. DMDS did not perform as well as MB/Pic (Culpepper *et al.*, 2007).

13.2.3.9 Virus diseases of cucurbits and peppers

Cucumber green mottle mosaic virus (CGMMV), Kyuri green mottle mosaic virus (KGMMV), Melon necrotic spot virus (MNSV) and Pepper mild mottle virus (PMMoV) are important pathogens of watermelon, melon, cucumber (CGMMV, KGMMV , MNSV) and on peppers (PMMoV) worldwide. Seeds, grafted seedlings, soil, plant sap and cuscuta (*Cuscuta subinclusa* , *C. lupuliformis* , *C. campestris*) are the main means of dissemination for these viruses . However, the only country requesting a critical use to control them is Japan, which will nevertheless be phasing out this application by 2013 (Tsuda, 2008).

Except for 1,3- D/Pic, which is registered to control MNSV in Japanese melons, no other chemical alternatives are registered. However these viruses can be controlled with a thorough IPM program that includes seed treatment with heat (Nagai, 1981) and sanitation practices such as removing residues from the previous crop before transplant and immediate removal of infected plants, which are aimed at reducing virus inoculum. Soilless culture and treatment of soil with hot water or steam are also recommended control practices.

Pepper Mild Mottle Virus can be controlled by treatments that accelerate the degradation of low cost plant debris, such as wheat bran. Wrapping roots with paper can avoid the virus infection from infected soil during transplantation, and planting seedlings into pots that decompose can reduce virus infection. Preimmunization with an attenuated virus is a promising means of protection against aggressive strains. Combination of these control methods increases the efficiency of any individual technique for protection against PMMoV (Nishi *et al.*, 2008). Pepper varieties that are resistant to the P_{123} strain of PMMoV have been developed (Tsuda *et al.*, 1997), however another strain of PMMoV which overcomes resistance has been reported (Genda *et al.*, 2007).

Melon necrotic spotted virus can be controlled by resistant varieties selected for each melon producing region. 1,3-D/Pic is registered to control MNSV and risks of phytototoxicity can be avoided by changes application methods. Crop rotation with tomato and other cultural practices are under development to control MNSV (Ohoizumi T et al. 2008) and Kyuri green mottle mosaic virus of cucumber (Kubota, 2008).

13.2.4 Economic aspects of methyl bromide alternatives

The existing peer-reviewed literature on the economics of the impact of the methyl bromide phase-out can be divided into three categories:

* Articles that report only the changed (increased) costs of using MB alternatives;
* Articles that use partial budgeting techniques to assess the impact of MB alternatives on the revenues and costs of a particular application;
* Articles that report the impact of MB alternatives on the sector (e.g. California strawberries, cut flowers in Spain) as a whole.

To this end, a further four articles have been traced, all of which fall within the category of partial budgeting identified above, with all four focusing on economic aspects of soils use (Byrd *et al*, 2006 ab; Fennimore *et al*., 2008 ab; Sydorovych, *et al*., 2008; Taylor, *et al*., 2006).

Economic appraisal of CUNs remains difficult despite advice from the parties regarding the nature of the economic information to be provided in the nominations. This difficulty arises because of the absence of practical criteria for determining the financial and economic feasibility of alternatives.

13.3 MBTOC QSC Progress Report

This Progress Report for MBTOC QSC includes:

1. News reports of particular interest to the Parties;
2. A short report on the interrelation of the use of recapture equipment in the context of the upcoming ban on MB QPS use in the EU;
3. An interim report on progress in finding alternatives to high moisture dates;
4. A research update on alternatives to methyl bromide for post harvest uses (structural, commodity and quarantine).

The reference list for the QSC Progress Report and the QSC Interim CUN Report has been incorporated into the overall reference list at the end of this report.

13.3.1 News reports concerning MB alternatives

In this past year there have been three key news reports that can be expected to impact the use of methyl bromide and alternatives.

The deregistration of MB by the European Union for all uses, including quarantine use was announced in March 2009 (EU, 2009). Although the EC had not licensed the use of methyl bromide for critical uses for at least two years previously, there had been some remaining MB use for quarantine, both for imports and exports. However, as of March 18, 2010, even these uses will be phased out. In a press release announcing this and other regulatory matters for ozone depleting substances, the European Parliament noted that by being more restrictive than the Montreal Protocol Europe, the EU would continue to lead by example.

Other Parties may wish to assess whether the EU decision might enhance the potential for pest incursions from European shipments at import, and if so, the need for treatment. Bilateral agreements for quarantine treatments are difficult to attain and usually require a considerable and lengthy research investment and so Parties may find they need to strengthen efforts and investment at this time. Further discussion of the issues surrounding recapture of MB from QPS treatments will be found below.

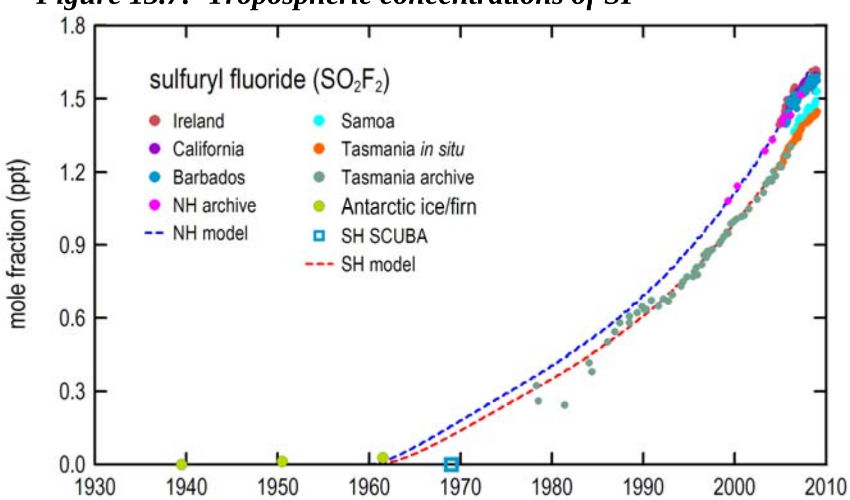
In the United States, Chemtura has filed for Chapter 11 bankruptcy, a legal action which protects assets and allows financial and corporate restructuring for a certain time period. Chemtura and its affiliated companies are the main supplier and distributor of methyl bromide (as well as other chemicals including alternatives to methyl bromide for soils uses (Reisch, 2009; Whaba, 2009)). The impact of this action on American methyl bromide users and the countries that import American methyl bromide remains unclear. It can take months to import MB from suppliers from other countries, and there can be a problem with incompatibility of shipping containers.

Recently published reports indicate that the fumigant, sulfuryl fluoride (SF), has a global warming potential higher than previously considered (Millet et al., 2009). Sulfuryl fluoride is being promoted as a direct replacement for methyl bromide for treatment against pests of many dry commodities and in flour mills, food processing facilities and for household termite control. In addition, MBTOC is aware of new pending registrations for sulfuryl fluoride as a soil fumigant.

The new Mühle et al paper estimates the "most likely" GWP for SF of about 4,800, a value similar to that of CFC-11 (Mühle et al., 2009, Muhle et al, 2009a; Papadimitriou et al., 2008). Previous reports indicated GWP ranged between 278 and 477 to as high as 8000. The concentration of sulfuryl fluoride in the atmosphere is increasing rapidly, with the global tropospheric background concentration of SO_2F_2 increasing by 5 ± 1% per year. Tropospheric concentrations rose from about 0.3 ppt (parts per trillion, dry air mol fraction) in 1978 to about 1.35 ppt in May 2007 in the Southern Hemisphere, and from about 1.08 ppt in 1999 to about 1.53 ppt in May 2007 in the Northern Hemisphere (Mühle et al., 2009a). SF is a relatively stable material in the stratosphere. Papadmitriou et al (2008) give an estimated stratospheric half-life of 630 years. These atmospheric observations and associated GWP estimates have generated much discussion and concern about the use of sulfuryl fluoride as a methyl bromide alternative (St. John, 2009; Dow AgroSciences, 2009).

Heat treatment is also a key alternative to MB for pest control in milling and food processing. It should be noted that the global warming impact of heat treatments has not been published. Determining whether, or how to reconcile the use of an alternative to an ozone depleting chemical when the alternative has been found to be of a high global warming potential will require a policy decision of the Parties and domestic regulatory authorities. However, informal reports from flour milling companies indicate concern that continued use of SF could negatively impact their efforts to decrease their climate change impacts.

Figure 13.7: Tropospheric concentrations of SF



13.3.2 Regulations Concerning QPS MB Use

MBTOC Notes that technically feasible methods are commercially available to reduce emitted MB by about 50% of the amount of MB used in container fumigation, but also notes these methods are not implemented into the various CUNs and the programs for QPS.

13.3.3 Issues Surrounding Methyl Bromide Recapture and Regulations Concerning QPS MB Use

Several companies have invested large amounts of money into the commercial development of MB recapture systems for treatment of containers and chambers holding MB-treated commodities. MBTOC has identified the following companies that are now providing MB recapturing services or equipment: Nordiko (Australia); Desclean (Belgium); Eco2 (Netherlands); Ruvoma (Netherlands); TIGG (United States). In addition, Value Recovery Systems (US) is offering, but has not yet built, MB recapture systems. These companies are commercially active and offering their techniques and equipment around the world.

The technique relies mainly on adsorption of MB from the air/gas mixture by activated carbon prior to release into the ambient atmosphere. Together with improved gas tightness of the container or chamber, about 50 % of the introduced gas can be recaptured and not emitted to the atmosphere. Costs for operations of recapture equipment have been estimated by the equipment suppliers to be an approximate 15 % increase over the cost for the fumigation without this technique.

Belgium and Netherlands had formerly been advanced in ozone protection by ensuring reduced emissions from quarantine MB use. Their regulations require that 80% of MB gas be recaptured at the end of quarantine treatments. Recently however, the EU has deregistered methyl bromide for all uses, including quarantine use. It was announced in March 2009 (EU, 2009) that as of March 18, 2010, QPS use of MB, and the use of recapture equipment will be eliminated.

As a result of the new EU regulation, importing counties may have to increase their MB fumigations when EU-originating commodities arrive in the importing countries. It could be argued that increased MB emissions may result because needed quarantine treatments may occur in countries that import commodities from the EU, and noting that the receiving countries do not use recapture equipment.

MBTOC notes there would be a significant reduction in MB atmospheric emissions if Parties were to adopt regulations requiring the use of recapture equipment from QPS container and chamber fumigations.

MBTOC suggests that meetings with experts in quarantine, trade, quarantine pest control and recapture might assist Parties to maintain quarantine security while reducing MB emissions. Such experts might already be members of MBTOC, IPPC and country quarantine committees.

13.3.4 Preliminary Report on Progress in Resolving the Problem of Pests in High Moisture Dates

Parties, particularly the North African countries of Algeria and Tunisia, have discussed with deep concern the problem of controlling pests in high moisture dates. Currently methyl bromide is used by several Parties to disinfest dates and prevent fermentation. In 2003, MBTOC noted that technically and economically effective alternatives have not been identified for fresh, high-moisture dates. The Parties then passed Decision XV/12 which noted the problem and its resulting impact on MB use in those countries. The Decision also indicated a need for a project to identify suitable alternatives and a workshop to share this information.

In 2008, UNIDO took the initiative to respond to Decision XV/12. Following consultation with MBTOC QSC, a scientific and technical expert (Patrick Ducom, France) was identified and a preliminary investigation of potential pest control techniques was launched. Five alternatives were tested at Ministry of Agriculture LNDS research institute in Bordeaux France, using dates sent by an Algerian date exporter and accompanied by scientists and technical experts from Algeria.

As a result of this study considerable information about potential alternatives was identified, and discussed below in the results of the workshop.

UNIDO held a workshop on the replacement of methyl bromide for disinfestation of high moisture dates in Vienna April 16-17, 2009. Since the workshop was held only one week before the MBTOC QSC meeting, and since the official workshop report was not available at time of preparation of the MBTOC report, our report on this workshop is interim.

Present at the workshop were executives from major date-exporting companies from Algeria and Tunisia; scientific and technical experts from those countries and Israel; MBTOC members from Canada, France, Germany, Morocco, United Kingdom and United States of America; ozone officers from North Africa; and UNIDO officers.

As a result of the study, and following discussions during the workshop, one key technical problem was resolved. It had previously been identified by MBTOC members that lack of information on moisture content of dates in various producing countries was preventing understanding of the issue. MBTOC members consider moisture content to be a key determinant of the selection of an effective disinfestant. After the presentation of information about date production in Algeria, Israel, Morocco, Tunisia and the USA, it became apparent that “dates at high moisture content” such as it appears in Decision XV/12 must be specifically defined.

Consequently, the following definition was proposed:

> “dates at high water content” are dates of the Deglet-Nour variety, with a moisture content from 30 to 40% (compared to the wet weight). The colour of such dates is light and somewhat transparent. These dates are marketed still attached to small branches. The relative humidity in equilibrium with these high-moisture dates allows the rapid development of yeasts resulting in fermentation, if the dates are either stored or fumigated in gas tight conditions. Gas tightness sufficient for fermentation can also occur in consumer packaging.

The results of the laboratory tests in France, and research in Israel, were discussed at the workshop, and the potential alternatives were evaluated.

Controlled atmosphere facilitated fermentation, resulting in a high loss of the quality of the fruit.

Sulfuryl fluoride and ethyl formate were both promising in that they controlled pests, they can be used in the existing vacuum chambers, and they only require short exposure times. Unfortunately, following discussion at the workshop, these potential alternatives had to be eliminated for use in North African countries. Sulfuryl fluoride is essentially not available in North African countries because of lack of registration and lack of suppliers.

Ethyl formate is not registered as an insecticide in the EU, the principal market of North African dates and no company seems eager to register it. So, although ethyl formate has been registered in Israel and found effective for the control of pests in high moisture dates, it is not available to North African date exporters. Therefore, these two alternatives will not be studied further in tests in 2009.

A phosphine product formulated as gas mixed with CO_2 was effective but it was determined to be not available to North African date producers because the product has been withdrawn from sale in the EU by its producer.

Phosphine generated in pure form (and not from formulations containing ammonia), was found to be technically effective for high moisture dates on branches, although using this technique resulted in the need to change treatment logistics. Managing treatment time when using this technique is important. If treatment time exceeds 72 hours, fermentation can result. Thus further work is needed to clarify this method.

Heat treatment, (50˚C for 2 hours with a 2 hr come-up time) was previously found to be effective for other date varieties and at drier moisture contents (Navarro *et al*, 2004; Finkleman *et al*, 2006). Recent preliminary studies in Israel found the same method to be quite promising for high moisture dates on branches. Work on this technique is ongoing. If not done properly, heat can produce a non-desirable effect of cracking and pasty texture. Thus further work is also needed to clarify this method for high moisture dates.

A date producer reported that deep freezing (- 25˚C) is currently used for the treatment of fresh Deglet-Nour in branches for the organic market. This treatment requires a very high investment and high operating costs so it was determined it could not be considered as an alternative for the entire production of fresh and high-moisture dates.

MBTOC notes clear and significant positive results from the preliminary laboratory work and the workshop. We appreciate the ongoing liaison with UNIDO, the project managers, researchers and the date producing and export sectors. The official report from UNIDO will identify further project work in this field.

13.3.5 Methyl Bromide Alternatives for Postharvest Uses -- Research Update

13.3.5.1 Alternatives used for control of pests in structures

MBTOC QSC has published several reviews of alternatives to the use of methyl bromide in structures with a substantive review of the technical efficacy of alternatives in flour milling in the May 2008 TEAP report.

MBTOC has noted previously that IPM programs designed specifically for each particular facility, properly carried out, monitored, documented and evaluated are a necessary pest control pre-requisite. In some cases, IPM programs have proved sufficient for pest control in some facilities.

However, treatments to control pests in milling and food processing facilities are the norm; two countries, Canada and the United States, continue to submit critical use nominations for MB. Two methods have become the main alternatives to methyl bromide for pest control in structures: heat treatment and sulfuryl fluoride fumigation. No new fumigants or methods have become commercially available since our last progress report, but there has been considerable research on the use of these methods, and on techniques to improve IPM approaches. One new aspect is the research focus on the use of heat to improve the effectivness of sulfuryl fluoride fumigation of mills and food processing facilities.

13.3.5.2 Research about Improvements in IPM Techniques

Aerosols can be useful as part of IPM programs; they are particularly used in warehouse environments where the combination of various foods and packaging in storage makes the use of treatments difficult or impossible. Arthur *et al* investigated the use of two commercially available aerosols in combination, finding that Esfenvalerate killed IMM eggs but not 5th instar larvae, but that methoprene was effective against 5th instar larvae, so a combination treatment was determined to be the best method. In the economic analysis the decision was that full rate of Esfenvalerate and full rate of methoprene was less risk. Cost for both optimum egg and larvae control was reported as US$1.17/10,000 ft^3 There is no special registration required to use these two aerosols in combination (Arthur *et al*, 2008).

Methods to evaluate the effectiveness of IPM programs and pest control treatments, under commercial conditions, was the subject of a paper by Campbell of USDA Agriculture Research Service. In a paper that evaluated a large number of fumigations, including repeat fumigations, as well as IPM components such as the use of aerosols, pest trapping methods and sanitation differences Campbell was able to recommend the use of aerosols as part of an enhanced IPM program, and the conduct of autumn fumigations instead of spring fumigations which resulted in slower pest population rebound (Campbell, 2008).

Working in flour mills in Northern Italy, Savoldelli and Panzeri, co-workers at the University of Milan Institue of Ag Entomology, evaluated IPM methods to see if IPM could be used to substitute for an annual fumigation. The goal was to suppress pest populations during the warm months of May and Oct. They conducted weekly pest monitoring, used several different kinds of traps and also used mass trapping as a pest control measure. Water and oil filled traps were more effective at this than were funnel traps. From previous pest observations they found that pests increased in May, so they focussed extraordinary cleaning in May. They found very high flour residues and IMM in the legs of equipment. They identified seven stored product species and several outdoor species which come in through open doors etc. also cockroaches which came up manhole covers connected to urban sewer system. They also had clothing webbing moths on the cotton covers of flour sacks. They fixed this last problem by cleaning out the air filters where they found larvae. Flour silos leaks were sealed with acrylic silicone. As a result of this work they determined they can substitute IPM for fumigation but they need weekly monitoring, investment in staff training and building improvements and higher costs for labor for cleaning (Savoldelli and Panzeri, 2008).

13.3.5.3 Research about Heat as a Stand-Alone Treatment

As discussed in the MBTOC review of alternatives for flour milling, heat treatment is one of two main pest control methods for control of pests in flour mills (TEAP, 2008). Heat treatment is an active commercial technique, and consequently there were few research reports available this year. Each year, Kansas State University in the United States offers a workshop on heat treatment of flour mills and food processing facilities. Interested readers should contact Kansas State Department of Grain Science and Industry.

13.3.5.4 Research about Sulfuryl Fluoride Fumigation

In North America, Dow AgroSciences is the leading supplier of sulfuryl fluoride for pest control in mills and food processing facilities. Williams and Thoms of Dow AgroSciences presented a summary of commercial acceptance of ProFume® the SF product they supply. Through September 2008, there were 419 confirmed commercial fumigations, of 567 individual structures at 234+ North American locations including 27 US states and Puerto Rico plus three Canadian provinces. Of these fumigations, 35% were repeat fumigations of up to 8 consecutive ProFume fumgations, comprising 29% with four or more consecutive SF fumes. In their fumigation records, the mean temperatures recorded in flour mills was 29°C; planned exposure time was 29.7 h. In previous MBTOC reports, it has been noted that temperatures above 26°C are recommended to ensure SF treatments kill pest eggs in mills (Williams and Thoms, 2008).

Dow AgroSciences also summarized the commercial acceptance of Profume in Europe. In 1991, MB food industry use in EU was 640,000 MT; Italy was formerly the No.1 country for MB use in EU. Now zero MB is used. Four production and imports to the EU remain relatively flat between 2002 and 2005; 45 million metric tonnes of wheat and rye milled each year. Pasta production is up slightly in the EU from 2002. Therefore, MB phase out has not caused disruption in flour or pasta production. In 2008, Dow AgroSciences and associated pest control companies conducted 255 SF fumigations in EU. Average size of fumigated structures is 7-25 x $1000m^3$ or about 250-900 x $1000ft^3$). The effectiveness of the fumigations was evaluated and it was determined that where insects were observed sooner than expected, an inadequate dosage rate was used at the temperature experienced (Stanislas, 2008).

The effect of sulfuryl fluoride fumigations and heat treatments in German flour mills was evaluated by Muck and Boye. Two northern Germany mills were observed; one that milled oats and maize ($23,000m^3$); and one that milled wheat and rye (volume $40,000m^3$). Exposure was 50 h for SF and 40 h for heat (50° C for 24 h). Monitoring done by dome traps for beetles and delta traps for moths. After SF only three insects were caught in total during three months monitoring. With heat treatment result was two beetles first month (two floors), and 18 on four floors by the second month. The researchers consider both methods valid since they used to get survivors after MB treatment as well (Muck and Boye, 2008).

Klemenz and co-workers at the Federal Research Center for Cultivated Plants in Berlin Germany looked at the use of sulfuryl fluoride in mills, residue of the gas and efficacy against *Tribolium castaneum* and *Esphestia kuehniella*. Max Concentration/Time (CT) for SF fumigations is 1,200 gh/m^3 and SF can only be used 3x/yr. Klemenz and co-workers asked if the recommended parameters were effective for mills in Germany. A mill of 60,000 m^3 was fumigated for 60 h and with a dosage rate of $1,200gh/m^3$. Pest control rate of all insects was 98%, and they had some eggs of each species and in one species they only had 92% control rate. Germany demands a 99.9% fumigation success rate (allowed survival of 1 out of 1000 pests). So they have determined that the SF parameters used in Germany are insufficient to meet the German regulation that demands 99.9% efficacy of fumigation. The next research focus of this team will be to look at combination SF and heat treatments plus other methods to improve treatment efficacy (Klemenz *et al*, 2008).

Reichmuth, from this same institute, reported later in 2008 that German millers say that 50% of mills have considerable surviving pests because of egg outgrowth after fumigation. Reichmuth suggested that the reason might be problems of scale up from lab methods to real world milling. For example, he noted that lab measurements suggest a MB dose of $5g/m^3$, but the standard structural dosage recommendation for MB fumigation is $20g/m^3$. Reichmuth suggested that combination of fumigants, heat and/or other methods be investigated to improve SF treatment efficacy (Reichmuth, 2008).

Maier and co-workers at Purdue University monitored environmental conditions during eight fumigations of three flour mills to create their Computational Fumigation Model. Seven fumigations were with SF; there was one MB fume followed by SF fume in the same facility. Exposure times $\leq$24 h. Half- loss time was 17 hours. Sealing appeared to prevent heat loss from the fumigated structure. Sealing did not result in pressure build up in the mill. Sealing efficacy, wind speed and direction, mill temperature (and the temperature difference night-versus-day) and circulation fan efficacy were the key contributors to fumigation efficacy. They advised that circulation fans should be left operating during the entire fumigation. Their model can assist mill operators and fumigators what the initial concentration should be under certain wind conditions (Maier *et al*, 2008).

In associated work, Chayaprasert evaluated the importance and implementation of pressure testing for structural fumigation. He presented the equations needed for pressure leaking and understanding the relationships (Chayaprasert *et al*, 2008).

Thoms and co-workers at Dow AgroSciences summarized the use to date of their sulfuryl fluoride products Vikane® and ProFume®. Vikane, the SF product used to kill termites in structures has been used on more than 1 million buildings. ProFume registrations have continued to progress with a 2008 registration in Greece, a 2007 registration in Ireland and Spain. Additionally, in 2008 the EU set temporary MRLs for fluorine residues resulting from SF fumigation. In North America there have been 455 ProFume structural fumigations in 182 locations in 25 states plus Canada and Puerto Rico. In 2007, there were 201 commercial fumigations in EU. In related case studies reported, they found SF works faster than PH3 to fumigate seeds with no losses of germination (Thoms *et al*, 2008).

13.3.5.5 Other Structural Research

As a reminder of the important role MB has played in controlling pests that destroy museum building components and historical artefacts, and to ensure that fumigation was conducted properly, Ferizli and Emekci from Turkey's Ankara University collaborated in the fumigation of Istanbul's Yildiz Palace. Built in 1880 this huge (40,000 m^3 or 500,000 square meters) is a national historic site. The building is two stories, made of timber and masonry and a basement; mother of pearl covers much of the surfaces. The treatment of removable historical artefacts was conducted with controlled atmospheres in cubes in the basement while the treatment of the building was conducted with MB. (Artefact treatment covered elsewhere in this report.) Methyl bromide treatment was conducted at 22°C and treatment was 25-32g/m^3 and for two days. The venting and ducting system required to fumigate such a large building was extensive. Ducts removed air from the building, mixed it with MB, and circulated through the building. The opposite was done during aeration. Since the fumigation museum staff have not found evidence of wood destroying insects. Now with the registration of sulfuryl fluoride, the researchers are intending to use it to fumigate other historical palaces (Ferizli and Emekci, 2008).

Ensuring effective fumigation of grains in concrete elevators is difficult because they usually do not have recirculation systems and are not well sealed, especially at the top. Yet ineffective fumigations are associated with pest resistance. An effective phosphine fumigation requires 200 ppm for 5 days to kill grain pests. USDA researchers Flynn and Reed, examined the effects of outside air temperature on movement of phosphine gas in concrete elevator bins trying to determine the reasons for failures in bin fumigation. Pest distribution in the grain mass in the bin starts with high populations on top of the grain in the summer then as cooler weather comes the pests move towards grain mass center. Their color illustration of time-lapsed modelling of gas movement showed how the fumigant moves through the bin over time under different grain temps and environmental conditions. They determined that when grain temperature is similar to or less than outside temperature, fumigant pellets can be applied equally all through grain mass. When grain temperature is warmer, it is best to apply fumigant to bottom half of the grain mass. The authors noted an ongoing a problem in killing all the pests on top of the grain, where the insect density is the highest. They recommended that engineers develop better ways to seal the bin vents and the loading hatches in concrete elevator bins. Also fumigators should improve the sealing of the unloading vent (Flinn and Reed, 2008).

13.3.6 Research into control of non-quarantine pests in commodities

There is a wider variety of treatments and methods used to control non-quarantine pests in commodities than there is for structures. And, in recent years, it seems there is a greater focus for pest control in commodities, perhaps because of heightened vigilance in avoiding pest incursions in food processing structures and retail facilities.

MBTOC's previous reports have reviewed the use of numerous pest control methods for commodities. Recent research has included pest control methods using phosphine (in various formats), controlled atmospheres, sulfuryl fluroride, and hermetic storage.

Yang and co-workers in Beijing China investigated the effect of different oxygen concentrations and temperature on respiration of *Tribolium castaneum.* Low O_2 is the preferred controlled atmosphere treatment in China because CO_2 is expensive but they can manipulate low O_2 by manipulating nitrogen, which is less expensive in China. Controlling pests with O_2 is considered green technology and includes the additional benefit of inhibiting fungi in grain. Oxygen concentrations of less than 2% for more than 15 days will control heavy grain infestation (such as when grain arrives at the warehouse). Another approach is to control the O_2 concentration to between 5-10% for more than 2 months which will both inhibit pest development and fungi (Yang *et al*, 2008).

Riudavets and co-workers in Spain worked to find methods to shorten the time required for effective modified atmosphere (MA) treatment of rice against rice weevil. Current MA methods take too long for effective treatment (at 40 – 100% CO_2) it takes 5 days for control of eggs of *S. oryzae*. Because of the difficulty to obtain registered fumigants in the EU, Ruidavets et al looked at combining CO_2 with SO_2 which in EU is accepted as a food additive. 3% SO_2 and 70% CO_2 worked well; increasing concentrations of SO_2 increased effectiveness. At 50 -150 ppm SO_2, the researchers did not report flavour problems but this aspect was preliminary and the subject of future work. Examining rice, flour and almonds for residues, they found wheat flour sorbs the SO_2 most. Aeration to obtain 50ppm which is the regulatory limit, would take 24 hr to 7 days depending on fumigant concentration (Ruidavets *et al*, 2008).

Wei and co-workers at Southwest University in Chongqing China reviewed the effectiveness of fumigants and controlled atmospheres against psocids, a growing problem pest for food processing companies world wide. Often overlooked because of their small size, psocids have been found in a wide range of mills, food processing and stored product facilities. Psocids can both damage, and contaminate food products. In this review, phosphine and ethyl formate were found to be the most effective and practical control methods, since psocids adapted to controlled atmospheres (Wei et al, 2008)

Navarro reviewed achievements in modified atmospheres and fumigation in Israel. Treatment by modified atmospheres is carried out in a wide variety of structures, including rigid structures, plastic structures, flexible silos lined with wire mesh, liners to enclose bag stacks and storage cubes. Commodities disinfested with modified atmospheres in Israel include organic wheat, grains, cocoa beans, bulbs, dried fruits and museum artefacts (Navarro, 2008)

Emecki and Ferizli in Turkey showed damage to museum artifacts resulting from furniture beetle (*Anobium punctatum*). Following the phase out of methyl bromide in 2004, they used high N_2 atmosphere in PVC cubes for control of damaging pests of museum artefacts. An automated control system was used to ensure effective control levels in a long term treatment (and to avoid errors that might damage the artefacts). The flexible PVC envelopes are inexpensive and can be reused many times. The modified atmosphere was 99% N_2 and 1% O_2, maintained for 30 days. Environmental temp was 19 – 25˚C and always high relative humidity (RH), since they are by the sea. There were no survivors. It is difficult to zip up the plastic cubes (other researchers have also noted this problem), but with practice a method was found (Emecki and Ferizli, 2008)

Bhadriraju, at Kansas State University in the US, worked with Thai producers of pet food and cat litter to determine methods to control mites in pet food packages. The mites, found in packages shipped to US from Thailand were identified by a Greek researcher as *Suidasia medanesis* . This mite is also found in house dust. The addition of 1% O_2 (which results in about 20% O_2) will kill all the mites. Ascorbic acid can be added to pet food pouches to do oxygen scavenging, since package purging inflates the package and reduces carton-packing efficacy. The oxygen scavengers are allowed to be incorporated into the packaging and they are approved for food contact surfaces in food packaging. He also looked at the packaging material to see if mites could penetrate them (Bhadriraju, 2008).

Becket, of CSIRO in Australia examined the response of *S. oryzae* eggs to diurnal interrupted doses of phosphine. Daily temperature cycles in the fumigation chamber or space result in phosphine dispersal patterns, causing repeated interrupted treatment or variable concentrations. *S. oryzae* eggs are tolerant to phosphine and the diurnally fluctuating treatment effect reduces efficacy and considerably lengthens treatment times. Lower phosphine concentrations reduced the impact on treatment time (Becket, 2008).

Noyes and Phillips of Oklahoma State University in the US developed a CTP model for optimum efficacy of closed loop fumigation (CLF system) in partially sealed storages. Their model was designed with the following assumption >200ppm PH_3>100 hours = kill all insects and no pest resistance. Partial sealing @P1/2 = 1 min. Also peak time using tablets is 40 – 60 h and pellets 12-24 h. These are at 25-30° C and 11-13% moisture content and also included a closed loop fan in operation at various times. Some grain storage facilities have been retrofitted and sealed to run on this model (Noyes and Phillips, 2008).

Waterford of CSIRO Australia worked with Peterson at the United States Department of Agriculture to investigate the potential for using ethanedinitrile (C_2N_2) against cereal pathogens. C_2N_2 devitalizes grain and it is used to disinfest timber against pests. In this instance, its effectiveness was examined against karnal bunt, dwarf bunt, boil smut and sorghum blowing mildew. The effective treatment was 120 mgL^{-1}, 75% RH from 0-5 days and 5-22°C. Efficacy improves as temperature improves. It was more difficult to kill the spores when present on bunted kernels than if they are naked spores (Waterford and Peterson, 2008).

Xiaoping and co-workers at Chengdu Grain Storage Institute in China examined the effect of sulfuryl fluoride on three stored product pests in grain. Sulfuryl fluoride was approved for grain treatment in China in 2008. They became interested in SF because they found 28% of pests were phosphine resistant. SF at low concentrations and also in combination with CO_2 (5.94 g/m^3 SF with 14.27 g/m^3 CO_2 for 30 days) was found to be effective against *Sitophilus oryzae*, *Rhyzopertha dominica* (Fabricus) and *Tribolium castaneum* (Herbst) (Xiaoping *et al*, 2008).

Elpano and Navarro used hermetic storage to control aflatoxin of high moisture corn under tropical conditions. Corn for animal feed is harvested in Philippines in unfavourable conditions (25.65% moisture content, and can be as high as 35% moisture content in harvest). This corn (Monsanto's Bt corn) needs to be stored gas tight, with minimal loss weight and quality. They used Grain-Pro cocoons and the sleeves which can line shipping containers. The test period was March to Sept and Sept to Jan. There were no significant change in starch or alcohol content over time. Carbohydrates were converted to lactic and acetic acids; protein content increased. RH and temp stabilized by 500 hr. During the first four days there is an increase in temp, but then respiration stops. Aflatoxin increased from 59 ppb to 90 ppb in one week and stayed at that level. There was no reduction in palatability and digestibility for cattle and swine growth (Elpano and Navarro, 2008).

Jonfia-Essien and co-workers conducted a project for the Ghana Cocoa Board to examine the effectiveness of hermetic storage in insect control and quality preservation of cocoa beans in Ghana. Ghana does not use MB to disinfest cocoa beans; phosphine is used. Insect infestation breaks down the nib and cocoa butter and it increases free fatty acids and causes flavour problems. Some insecticides cause residues which are not accepted by importers. They wanted to use modified atmospheres to biogenerate an O_2 deficient and CO_2 rich atmosphere for insect control. And they wanted to reduce operational costs and reduce use of insecticide. A bag stack was built inside the cocoon using *Tribolium castaneum*, *Lassioderma serricorne*, *Carpophilus hemipterus* and *Araecerus fasciculatus* as test insects in bags in the cocoon. The cocoons were left outside (temperature ranged from 28 – 32° C). O_2 content in the cocoon decreased constantly each day so that by day 17-18 there was zero O_2. In the cocoons after 6 weeks there was 100% mortality of both pests in the cocoons. Three weeks was not a sufficient treatment; the 3 week samples showed some pest survival. Pests crawled out of the cocoa bean and were found only on the bottom of the cocoon. The cocoon did not result in any condensation on the cocoa. After 9 weeks no change in quality was found. So, hermetic storage was better for pest control when they have extended storage periods, good for quality and more economical and convenient. They say this because their standard storage requires use of sand snakes for sealing fumigation sheets at floor level and insecticides, and these standard storage methods result in condensation which harms the cocoa. The researchers said that if not fumigated there are several insect species infesting cocoa beans with a usual infestation rate of about 40 – 60 insects per 60 kg bag (Jonfia-Essien *et al*, 2008).

Johnson, of USDA in California worked on vacuum treatment for California tree nuts, using GrainPro cocoons. Moisture content of the product and life stage of the pests can affect pest control efficacy, diapausing stages are very resistant. Structures used for modified atmospheres also hold vacuum and they can get a vacuum in 10 min. Looked at low, medium and high moisture content. At 25˚C, and higher moisture, and especially with diapausing pests they found lower levels of control. At 30˚C even in high moisture and with diapausing pests they achieved 100% mortality at 20 hours, except with walnuts where they never achieved 100% mortality even at 30˚C with diapausing pests. This researcher again reported difficulty zipping the cubes, but the problem was overcome with practise. They had to use sand snakes around stacks to prevent rodent incursion. In field trials there was the additional problem of decreasing ambient temp (as autumn progressed) which increased difficulty to kill pests. If ambient temp is below 25˚C, it is necessary to extend the treatment beyond 72 hours (Johnson, 2008).

Tebbets *et al* of USDA ARS in California used multifactor methods to improve the understanding of insecticidal efficacy and degradation of SF in stored walnuts. They detailed SF treatment schedules for *Amyelois transitella* eggs and diapausing coddling moth (*Cydia pomonella*) larvae, under both atmospheric pressure (NAP) and reduced pressure (100 mmHg) environments. In addition, they reported the relative influence of dose, pressure, temperature, and exposure duration on both insect mortality and levels of known residues (e.g., SO_2, FSO_3^{1-}, F^{1-}, SO_4^{2-}).4,5 . In light of environmental health concerns surrounding sub-ppm chronic exposures in diet and drinking waters, fluoride residue levels generated from SF hydrolysis were provided. In more practical context, the efficacy of SF relative to methyl bromide for treating stored walnuts infested with these pests was discussed. In conclusion, multivariate experimental techniques have a marked potential for streamlining the development of physicochemical–based approaches that reduce insect damage in perishable and durable commodities (Tebbets *et al*, 2008)

Two other research papers reported on the control efficacy of sulfuryl fluoride for dried fruit pests. Williams and Thoms, 2008, reported research, conducted between 2006 – 2008, with the California Dried Fruit Association. They examined the effect of SF on Dried Fruit Beetle (DFB) in dates in 141.6 M chamber. Temperature was 24° C (75°F), CT was 536-636 g/m^3 at 21-24°C gave 99.6% control of DFB at all life stages (exposure time was 15-16 h). Bioassays were conducted for 5 weeks (Williams and Thoms, 2008).

Baltaci and co-workers in Germany looked at efficacy of SF against Rust Red Grain Beetle and Merchant Beetle. The experimental laboratory data support that a ct product of 1500 gh/m³ is sufficient also to control all life stages of the investigated two beetles at all temperatures tested (Baltaci *et al*, 2008).

Phillips reported the work of a multi-state investigation which is trying to resolve the pest contamination problems seen in Southern-cured pork. This specialty food product of the Southern US is aged at room temp for months (with the assistance of salt and nitrate rubs) until the pork becomes shelf stable. The pork becomes infested with *Tyrophagus putrescentiae* (Ham or cheese mites), a ubitquitous part of the house mite complex with can also infest pet food) and *Necrobia rufipes* (Redlegged ham beetle), a predatory and cannibalistic pest of dry fish, dry eggs, cheese, meats. Currently, infested Southern cured pork in storage is treated with methyl bromide. All SF fumigations were conducted for 48 h at 23°C because this is the usual MB ham fumigation protocol. Tested 22g/m^3 for beetles and up to 100g/m^3 for mites. This resulted in 100% kill at 18-20g/m^3 for the beetle. However they did not even achieve 100% kill at 99g/m^3. (In the US the max dose allowed is 31.25g/m^3). Therefore SF was not considered to be a treatment for ham against mites. They are now investigating the potential effectiveness of phosphine, or low O_2 and high CO_2., however, they are concerned that the poorly structured traditional ham storage houses in the US won't hold the CO_2. (Phillips *et al*, 2008).

Sekhorn and co-workers at Mississippi State University were part of the multi-state project discussed above. They looked at the effect SF fumigation had on composition of Southern dry cure pork. They measured SF residue and F ion residue, because EPA limit for residues in pork is 20ppm. They looked at ham volatiles with gas spectrometry and gas chromatograph-olfactomer which measures aroma impact compounds. (This estimates intensity of an odour by human sniffing.) Even at fumigation concentrations of 72g/m^3 the F ion was only 14 ppm which is less than EPA level. Also SF residue levels were found to be below the EPA legal limit. There were odor differences between fumigated and non-fumigated samples, but these were judged to be minimal based on instrumental analysis. In their sensory tests, flavour analysis showed no effect up to 36g/m^3 fumigation level (Sekhorn *et al*, 2008).

Lagunas-Solar and co-workers assessed the effectiveness of radiofrequency disinfestation of almonds and rice. They tried to eliminate the thermal effects on the product while increasing temp of the pests. RF does this by combining the thermal and electrical effects. Insect pests are very greatly affected by oscillating electric fields (polarizing effects), this causes rapid heating of the pests, but the treatment is well tolerated by low-moisture foods. RF is especially useful to kill eggs that have been laid internally in the kernel. (Pests bore into the kernel, make a cavity, lay eggs and then deposit a chemical plug in the borehole to create an airlock that prevents easy access to fumigants.) They treated 12 kg per batch with 10-14 Mhz and a two minute treatment time. Lagunas-Solar noted that *Salmonella*, *E.coli* and insects are targeted with this method, with the bacterial killed beforehand. This method uses much less energy and it is expected to cost much less than other thermal heating methods. In paddy rice he looked at grain moths and *R. dominica* (a borer); killing *R. dominica* required 1-2 hours at 70˚C. These workers are now developing pre-commercial prototypes of equipment for this work with the Almond Board of California (Lagunas-Solar *et al*, 2008).

Chen and co-workers at Virginia Tech University in the US examined vacuum and vacuum+steam treatment of mold fungi to disinfest cotton bales. Low pressure vaccum has been shown to work on pests inhabiting wood, so they thought they would assess potential effectiveness on five types of fungi. The ISTMD4300 – 1 method was used for fungal inoculation. They added the inoculated cotton into three places within the highly compressed bales. They tried five cycles of vacuum with different vacuum and different temperatures, but they were aiming for 70°C for 60 min. Their vacuum-plus-steam method killed the fungi in 2 hours. Further work is needed to assess the effect on cotton quality (Chen *et al*, 2008).

13.3.7 Research about control of quarantine pests in commodities

Methyl bromide is very commonly listed as a quarantine treatment for a very wide range of food and non-food commodities. While quarantine use of MB is not controlled under the Montreal Protocol, many countries are trying to avoid the use of methyl bromide, either because of environmental, health or cost concerns. However, the establishment of quarantine agreements first requires lengthy research and then usually requires lengthy bilateral and international negotiations. Effective quarantine methods are very important; they help ensure the health of agriculture, forestry and environment. Parties are encouraged to focus and invest in researching and gaining agreement for effective non-MB quarantine methods.

Liu from USDA, in Salinas California, worked on ultra-low oxygen; low-temperature and low temperature plus phosphine for quarantine treatment for perishables. The perishables were: lettuce, broccoli and table grapes. The pests were Lettuce aphid, Western Flower thrips, Leafminer flies and pupae (although this method can not control pupae). Additionally, although not a common pest, the presence of Black Widow spiders in grapes has been reported in the media causing considerable consternation in the food chain when it is found. This method gives 100% mortality of Black Widow spider, at 1°C and 0.5% $O_{2.}$ The reason is that Black Widow spider has a poorly effective O_2 distribution system, so it is more susceptible than insects. Ultra-low oxygen effectively kills pests by suffocation, but can cause off flavour (because of generation of CO_2). Treatment usually takes a few days, but if the temp is lower, the treatment is usually more effective. The longer the treatment time, and the higher the temp, the better the quality; a balance must be found between treatment effects. The lettuce shows browning in heart-leaves and more severe browning colour in exterior leaves when the treatment is not done properly. But lettuce can be acclimatized to colder temps to avoid injury. There was good efficacy with broccoli and no negative quality effects. They noted an insufficient amount of work had been done on the problem of phosphine residues in the food. This treatment gives no effect on grape quality. He also looked at low temp and phosphine fumigation of same commodities and same pests. Phosphine was generated by the Horn Generator to treat an airtight commercial shipping container. They determined that 320 -940 ppm at 2.4°C an 18 h exposure was effective. The treatment was safe to quality of lettuce, broccoli, asparagus and strawberries. Thrips were controlled (Liu, 2008).

Emery of the Department of Agriculture and Food in Western Australia explained the very unusual case of an urban eradication of Khapha beetle in Western Australia. Australia does not have Khapra beetle, but in 2007, there was a postborder detection of Khapra beetle in the personal effects of a new immigrant family as they unpacked in Perth, Australia. The pest was identified by a local pest control company and confirmed by Australian authorities who immediately implemented an Emergency Pest Response Deed. The family was moved out of the house with only the clothes on their backs. Immediate spraying of house and car and gardens with insecticides was conducted to immediately knock the bugs down while awaiting full fumigation. Immediate fumigation of all empty cardboard packing boxes found in the garage was conducted (in a shipping container) and then they buried the boxes. The house and garage were shrink wrapped and fumigated with methyl bromide at $80g/m^3$ for 48h. The gas concentration was not allowed to fall below 20g/m^3. There were many social problems and new learnings concerning working with the family and neighbours, especially concerning negative effects of fumigating carpeting and household items. The fumigation and aeration took about 2 weeks because they kept finding high gas concentrations airing off/ from cushions, bins and water bottles. The Department of Agriculture is now trapping for two years in the house and at neighbours. No khapra beetle has been found in the 15 months following fumigation (Emery *et al*, 2008).

Leesch and Tebbets of USDA used ozone to control pests in export commodities. Perishables require quick treatments against quarantine pests. The pests of concern were: Bean thrips in navel oranges (although it overwinters in the orange only as adults), citrus mites, coffee berry borer (green coffee) and Black Widow spider in grapes. Oranges and bean thrips required 5,000ppm for 2 hr to get 100% efficacy at commercial scale. Waxing oranges avoided most of the damage caused by ozone treatment. (Ozone damage looks like dry brown cracked effect on the navel and stippling on the skin and red spots or cauterized wounds if there were pre-existing wounds on the orange.). Ozone was not effective against lemon and citrus mites. Ozone was not effective against coffee berry borer eggs, but 10,000 ppm for 6 hrs at 13$\pm$3°C was effective against other life stages. (Further work was conducted on this problem; see Armstrong *et al*, 2008 below). Ozone easily kills Black widow spider (sometimes present in grapes). Grapes tolerate the treatment well. Ozone treatment requires continual replenishment, which is accomplished by ozone generators on site. It is Generally Recognized As Safe by regulatory authorities so no registration is required (Leesch and Tebbets, 2008).

Armstrong and co-workers in Hawaii investigated the use of ozone as a quarantine process for green coffee imports to Hawaii. Green coffee has to be fumigated with methyl bromide (48 mg/liter MB for 8 h) upon import to the State of Hawaii, United States against coffee berry borer (CBB), *Hypothenemus hampei* (Ferrari) (Coleoptera: Scolytidae), life stages and coffee leaf rust (CLR), *Hemileia vastatrix* Berkeley & Broome (Basidiomycota: Pucciniales), urediniospores. CBB and CLR are two of the most destructive pests of coffee production worldwide and are found in all coffee producing areas except the Hawaiian Islands and Queensland, Australia. Coffee processing eliminates CBB life stages and CBB can not reproduce on green coffee. So, the CBB threat is hitchhikers. The results of O_3 fumigation efficacy tests with CBB demonstrated that fumigation with 10,000 ppm O_3 gas under -32 mm Hg vacuum at 13.0 ± 3.0°C for 6.0 h killed all CBB larvae, pupae, and adults, but did not kill all CBB eggs. However, because the drying methods used in coffee processing eliminate CBB from coffee, and because CBB cannot survive or reproduce in green coffee with a 9-12% moisture content, adult CBB hitchhikers would be the only life stage encountered in green coffee, and they would be eliminated by O_3 fumigation. The combination of drying methods used in coffee processing, maintaining green coffee MC at 9-12%, and fumigation with 10,000 ppm O_3 gas under -32 mm Hg vacuum at 13.0 ± 3.0°C for 6.0 h is a systems approach. The results of O_3 fumigation efficacy tests with CLR urediniospores demonstrated that fumigation with 10,000 ppm O_3 gas under -32 mm Hg vacuum at 13.0 ± 3.0°C killed all urediniospores within 1 h. Therefore, the O_3 fumigation at 6 h for CBB is more than adequate to ensure quarantine security against CLR urediniospores. The results of coffee quality studies demonstrated that fumigation with 10,000 ppm O_3 gas under -32 mm Hg vacuum at 13.0 ± 3.0°C for 6.0 h did not adversely affect coffee flavor or aroma, the two most important organoleptic properties of brewed coffee (Armstrong *et al*, 2008).

Flack *et al* 2008, reported collaborative research between USDA and Dow AgroSciences to investigate the proposed quarantine dosages for Pinewood Nematode (PWN) control with sulfuryl fluoride. Treatment schedules for PWN at 15°C have been published and were evaluated, but not approved for ISPM-15 for control of PWN in infested wood. ISPM wanted further test results on naked pests and in wood at different moisture content. The proposed quarantine dose rate is 1500 CT where they get no survival of any life stage at 25°C. At 20°C, however, they got survival at 2143 CT, perhaps resulting from higher wood moisture content. The new CT was increased by 200 g-h/m^3 for lower temps. SF is more likely to be used if the woodpacking material is already loaded with commodity or equipment and yet the pallets have been found to be not heat treated. The new treatment schedule has been submitted to ISPM.

Messenger *et al* examined the potential to use sulfuryl fluoride as a quarantine treatment against Emerald Ash Borer in logs and firewood. The emerald ash borer (EAB), *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae), is an important exotic pest of ash trees (*Fraxinus* spp.) which has spread across several US states and into Southern Ontario in Canada. Quarantines are in effect preventing movement of any potentially infested ash trees, logs, and firewood to areas where the EAB does not occur. The quarantine prevents the use of the wood for furniture making and other purposes. EAB has killed 40 million ash trees already. Currently no fumigation treatment allowed; the wood must be chipped or burned. Testing established that (15.6°C for 24 and 48 hrs; 21.1°C for 24 and 48 hrs) was effective in eliminating 100% of all temperature-acclimated larvae (typically the most tolerant stage) of the EAB inside infested ash tree logs using each SF dose at both temperatures and exposure times during chamber fumigation trials. In 2008, these SF doses applied in 24 and 48 hr commercial fumigations of hardwood logs with inserted infested EAB ash logs were 100% successful. Treatment: at 15.6°C SF dosage is 144g/m^3 for 24h or 128g/m^3 for 48h. At 21.1°C the SF dosage is 128g/m^3 for 24 h or 104g/m^3 for 48 h (Messenger et al, 2008).

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Common Acronyms

1,3-D	1,3-dichloropropene
A5	Article 5 Party
CUE	Critical Use Exemption
CUN	Critical Use Nomination
DOI	Disclosure of Interest
EC	European Community
EPA	Environmental Protection Agency
EPPO	European Plant Protection Organisation
MI	Methyl iodide (= Iodomethane)
IPM	Integrated Pest Management
LPBF	Low Permeability Barrier Film (including VIF films)
MB	Methyl Bromide
MBTOC	Methyl Bromide Technical Options Committee
MBTOC QSC	MBTOC Quarantine, Structures and Commodities
MBTOC S	MBTOC Soils Subcommittee
MITC	Methyl isothiocyanate
MOP	Meeting of the Parties
MS	Metham sodium
Non- A5	Non- Article 5 Party
OEWG	Open Ended Working Group
Pic	Chloropicrin
QPS	Quarantine and Pre-shipment
SF	Sulfuryl fluoride
TEAP	Technology and Economic Assessment Panel
TIF	Totally impermeable films
VIF	Virtually Impermeable Film
VOC	Volatile Organic Compounds

ANNEX 1 TO CHAPTER 13 - Registration Status of Alternatives to Methyl Bromide for the USA

Updated on March 3, 2009

Use Category	Alternatives Available	Status of Registration	Potential Alternatives	Status of Registration Submission
Commodities	Propylene Oxide	Registered	Ethyl Formate	Not registered
	Phosphine	Registered	Ethylene Oxide	Not registered
	Sulfuryl Fluoride	Registered	Methyl Formate	Not registered
Cucurbits	1,3-D	Registered	DMDS	Registration application under review
	Chloropicrin	Registered	Furfural	No registration package submitted
	Glyphosate	Registered	Methyl iodide	No registration package submitted but registrant intends to submit one
	Halosulfuron	Registered	Propargyl Bromide	Nothing pending; not registered
	Metham Sodium	Registered	Sodium Azide	Nothing pending; not registered
	Paraquat	Registered		
	1,3-D/ Pic	Registered		
Eggplant	1,3-D	Registered	DMDS	Registration application under review
	Chloropicrin	Registered	Furfural	No registration package submitted
	Halosulfuron	Registered	Methyl iodide	No registration package submitted but registrant intends to submit one
	Metham Sodium	Registered	Propargyl Bromide	Nothing pending; not registered
	Napropamide	Registered	Sodium Azide	Nothing pending; not registered
	Trifluralin	Registered		
	1,3-D + Napropamide + Trifluralin	Registered		
	1,3-D/ Pic	Registered		
	Metham Sodium + Pic	Registered		
Food Facilities	Phosphine	Registered	Ethyl Formate	Not registered
	Sulfuryl Fluoride	Registered	Ethylene Oxide	Not registered
			Methyl Formate	Not registered
Forest Seedlings	1,3-D	Registered	DMDS	Registration application under review
	Chloropicrin	Registered	Propargyl Bromide	Nothing pending; not registered
	Dazomet	Registered	Sodium Azide	Nothing pending; not registered
	Methyl iodide**	Registered		
	Metham Sodium	Registered		
	Metham Sodium + Chloropicrin	Registered		
	1,3-D/Pic	Registered		
Ham	Sulfuryl Fluoride*	Registered		
Nurseries: Raspberries	1,3-Dichloropropene	Registered	DMDS	Registration application under review
	Chloropicrin	Registered	Sodium Azide	Nothing pending; not registered
	Methyl iodide**	Registered	Propargyl Bromide	Nothing pending; not registered
	Dazomet	Registered		
	Metham Sodium	Registered		
	1,3-D/ Pic	Registered		
	1,3-D + Metham Sodium	Registered		
Nurseries:	1,3-D	Registered	DMDS	No registration package submitted

Use Category	Alternatives Available	Status of Registration	Potential Alternatives	Status of Registration Submission
Fruit and Nut Tree	Chloropicrin	Registered	Sodium Azide	Nothing pending; not registered
	Dazomet	Registered	Propargyl Bromide	Nothing pending; not registered
	Methyl iodide**	Registered		
	Metham Sodium	Registered		
	1,3-D/ Pic	Registered		
	1,3-D/Pic + Metham Sodium	Registered		
	1,3-D + Metham Sodium	Registered		
	1,3-D + Dazomet	Registered		
Nurseries: Roses	1,3-D	Registered	DMDS	No registration package submitted
	Chloropicrin	Registered	Sodium Azide	Nothing pending; not registered
	Dazomet	Registered	Propargyl Bromide	Nothing pending; not registered
	Methyl iodide**	Registered		
	Metham Sodium	Registered		
	1,3-D / Pic	Registered		
	1,3-D/ Pic + Metham Sodium	Registered		
	1,3-D + Metham Sodium	Registered		
Orchard Replant	1,3-D	Registered	DMDS	No registration package submitted f
	Chloropicrin	Registered	Sodium Azide	Nothing pending; not registered
	Dazomet	Registered	Propargyl Bromide	Nothing pending; not registered
	Methyl iodide**	Registered		
	Metham Sodium	Registered		
	Sodium Tetrathiocarbonate	Registered		
	1,3-D/ Pic	Registered		
	1,3-D + Metham Sodium	Registered		
	1,3-Di/Pic + Metham Sodium	Registered		
Ornamentals	1,3-D	Registered	DMDS	Registration application under review
	Dazomet	Registered	Furfural	No registration package submitted for
	Chloropicrin	Registered	Sodium Azide	Nothing pending; not registered
	Methyl iodide**	Registered	Potassium Tri-iodide	Nothing pending; not registered
	Metham Sodium	Registered	Propargyl Bromide	Nothing pending; not registered
	1,3-D/ Pic	Registered		
	Dazomet + Chloropicrin	Registered		
	Metham Sodium + Pic	Registered		
Peppers	Metham Sodium	Registered	DMDS	Registration application under review
	1,3-D	Registered	Furfural	No registration package submitted
	Chloropicrin	Registered	Sodium Azide	Nothing pending; not registered
	Methyl iodide**	Registered	Propargyl Bromide	Nothing pending; not registered
	Halosulfuron	Registered		
	Glyphosate	Registered		
	Paraquat	Registered		
	Metham Sodium + Pic	Registered		
	1,3-D/Pic	Registered		
	1,3-D + Metham Sodium	Registered		
Post-Harvest Uses	Phosphine	Registered	Ethyl Formate	Not registered
	Sulfuryl Fluoride*	Registered	Ethylene Oxide	Not registered
			Methyl Formate	Not registered
Strawberry	1,3-D	Registered	DMDS	Registration application under review
	Chloropicrin	Registered	Furfural	No registration package submitted for

Use Category	Alternatives Available	Status of Registration	Potential Alternatives	Status of Registration Submission
	Dazomet***	Registered	Propargyl Bromide	Nothing pending; not registered
	Methyl iodide**	Registered		
	Metham Sodium	Registered		
	Terbacil	Registered		
	1,3-D/Pic	Registered		
	1,3-D/Pic + Metham Sodium	Registered		
	Metham Sodium + Pic	Registered		
Strawberry Nursery	Chloropicrin	Registered	DMDS	No registration package submitted
	1,3-D	Registered	Furfural	No registration package submitted
	Methyl iodide**	Registered	Propargyl Bromide	Nothing pending; not registered
	Metham Sodium	Registered	Sodium Azide	Nothing pending; not registered
Tomato	1,3-D	Registered	DMDS	Registration application under review
	Chloropicrin	Registered	Furfural	No registration package submitted
	Dazomet***	Registered	Pebulate	Nothing pending; not registered
	Fosthiazate	Registered	Propargyl Bromide	Nothing pending; not registered
	Glyphosate	Registered	Sodium Azide	Nothing pending; not registered
	Methyl iodide**	Registered		
	Metham Sodium	Registered		
	Paraquat	Registered		
	Halosulfuron-methyl	Registered		
	s-Metolachlor	Registered		
	Trifloxysulfuron-methyl	Registered		
	Rimsulfuron	Registered		
	Metham Sodium + Pic	Registered		
	1,3-D+ Metham Sodium	Registered		
	1,3-D/ Pic	Registered		
Turf (sod)	1,3-D	Registered	DMDS	No registration package submitted
	Chloropicrin	Registered	Furfural	No registration package submitted
	Methyl iodide**	Registered	Sodium Azide	Nothing pending; not registered
	Metham Sodium	Registered		
	Dazomet	Registered		
	Dazomet + Chloropicrin	Registered		
	Metham Sodium + Pic	Registered		

*Research on-going to evaluate efficacy in controlling mites

** Federally Registered (as of October 2008). Not registered in California, New York, and Washington.

***The registration for Dazomet is limited to California only.

14 Evaluations of Critical Use Nominations for Methyl Bromide and Related Matters – Interim Report

14.1 Scope of the Report

This 2009 interim report provides evaluations by MBTOC of CUNs submitted for methyl bromide (MB) in 2010 and 2011 by Parties in accordance with Decision IX/6 (Annex I, MOP16). CUNs were submitted to the Ozone Secretariat by the Parties, in accordance with the timetable set out in the Annex I referred to by Decision XVI/4 (Annex II of this report).

This interim report also provides information from Parties on stocks (Decision Ex.1/4 (9f)), an update on registration issues affecting availability of alternatives for preplant and post harvest uses (Decision Ex. 1/4 (9i) and (9j)), partial information on actual MB consumption for critical uses (Decision XVII/9), apparent adoption rates of alternatives, as evidenced by trend lines on reduction of MB CUNs (Decisions XIX/9, XX/5), and consideration of national, sub national and local regulations and law on the use of MB alternatives (Decision XX/5). It is noted that trend lines on adoption do not necessarily indicate true adoption rates for alternatives, because the use of stocks of MB may be available to the same sector or areas of production may have fallen within the sector due to a range of circumstances.

Standard presumptions used in the 2009 round were the same as those used in the 2008 round. MBTOC Soils (MBTOC S) conducted a review of commercial use rates in countries for preplant soils use in March 2009. This review confirmed that most actual MB rates presently used commercially in sectors conformed with the present standard presumptions, unless CUNs identified regulations which required different rates. MBTOC S has updated references to substantiate its standard presumptions for MB dosage rates (Annex III). These standard presumptions are subject to continual review, however any changes are required to be approved by Party's at the preceding MOP to the year of assessment (Decision s.be presented to the MOP for notification of the Parties as required in Annex 1, MOP16.

MBTOC S has initial responsibility for the pre-plant uses and alternatives of MB. MBTOC Quarantine, Structures and Commodities (MBTOC QSC) has initial responsibility for issues concerning MB uses and alternatives for quarantine, pre-shipment, structural and commodity treatments. Evaluations of CUNs for the two categories are reported separately below. Outcomes from deliberations by the two MBTOC subcommittees were discussed and vetted via electronic communication. Recommendations made by MBTOC S were circulated to MBTOC QSC and vice versa, as part of the process of reaching consensus within the whole committee. The economists attended parts of both subcommittee meetings for MBTOC QSC in Rotterdam and MBTOC S in Agadir.

14.2 Critical Use Nominations for Methyl Bromide

14.2.1 Mandate

Under Article 2H of the Montreal Protocol the production and consumption (defined as production plus imports minus exports) of MB is to be phased out in Parties not operating under Article 5(1) of the Protocol, by 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 of the Protocol, which all such uses need to meet in order to be granted an exemption. TEAP and its MBTOC provide guidance to the Parties' decisions on critical use exemptions in accordance with Decisions IX/6 and Annex I of Decision XVI/4. Refer to Annexes I and II of this report for copies of these Decisions.

14.2.2 Fulfilment of Decision IX/6

Decision XVI/2 directed MBTOC to indicate whether all CUNs fully met the requirements of Decision IX/6. When the requirements of Decision IX/6 were met, MBTOC recommended the full amount of the nomination. Where some of the conditions were not fully met, MBTOC recommended a decreased amount depending on its technical and economic evaluation. The full text for Decision IX/6 can be found in Annex I at the end of this document. MBTOC reduced a nomination when a technical alternative was considered effective or, in a few cases, when the Party failed to show that it was not effective. 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 assessment.

MBTOC has again encountered difficulty in the assessment of some nominations for MB use on soils when yield losses presented in some nominations differ markedly from those reported in a large number of studies in similar circumstances and are not substantiated by recent references. This is important for economic assessments where several comparisons with alternatives are based on data from studies conducted many years ago, (some on different crops e.g. tomato for eggplant CUNs) and these may not account for data with the new alternatives and new application methods for established alternatives.

Now that technically effective alternatives have been identified for most applications, regulations on the use of these alternatives and comparative information on the economic feasibility/infeasibility of their use compared to MB are critical to the outcomes of present and future CUNs. Without this information, further CUNs may not be assessable, as MBTOC will be unable to analyse the impact of national, subnational and local regulations and law as required in Decision XX/5. In some cases, MBTOC has proposed existing commercially and economically feasible alternatives and potential research and regulatory issues to Parties that could assist the phase out of MB.

In paragraph 20 of Annex 1 referred to in Decision XVI/4, Parties, inter alia, specifically requested that, in cases where a nomination relies on the economic criteria of Decision IX/6, MBTOC's report should explicitly state the central basis for the Parties economic argument relating to CUNs.

14.2.3 Consideration of Stocks - Decision Ex.1/4 (9f)

One criterion for granting a critical use under Decision IX/6 is that methyl bromide for the use "is not available in sufficient quantity and quality from existing stocks of banked or recycled methyl bromide" (para. 1 (b) (ii)). Parties nominating critical use exemptions are requested under decision Ex.I/4(9f) to submit an accounting framework with the information on stocks. Since the consideration of stocks is an active area of negotiation for the Parties, MBTOC has not made an adjustment to a nomination to account for stocks held and has relied on Parties to make this adjustment.

In accordance with Decision XVIII/13(7), a summary of the data on stocks reported by the Parties from 2006 to 2009 for the preceding year and summarized in Table 14-1 to 14-4 below. Parties may wish to consider this information in the light of Decision IX/6 1(b)(ii).

Efficient functioning of commerce requires a certain level of "pipeline" 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.

Table 14-1: Quantities of MB (metric tonnes) 'on hand' at the beginning and end of 2005, as 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
EC	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

(a) 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 14-2: Quantities of MB 'on hand' at the beginning and end of 2006, as reported by Parties in 2007/2008 under Decision XVI/6.

Party	**Critical use exemptions authorized by MOP for 2006**	**Quantity of MB as reported by Parties (metric tonnes)**				
		Amount on hand at start of 2006	**Quantity acquired for CUEs in 2006 (production + imports)**	**Amount available for use in 2006**	**Quantity used for CUEs in 2006**	**Amount at the end of 2006**
Australia	75.1	0	55.308		55.308	0
Canada	53.897	3.713	41.969	45.682	44.114	1.568
EC	3 536.755	114.953	1 462.747	1 577.700	1 558.557	19.114
Israel	880.29	0	840.6	840.6	840.6	0
Japan	741.4	70.735	488.81	559.545	540.207	19.338
USA	8 081.753	9 974(a) 443(b)	6 924	16 898	6 425	8 170(c)

(a) Amount of pre-2005 stock on hand.
(b) Amount of stocks at the end of 2005 from production/imports specifically made for CUEs (acquired in 2005).
(c) The sum of 499 tonnes of stocks produced/imported in 2006 specifically for CUEs, plus 7,671 tonnes stocks acquired pre-2005.

Table 14-3: Quantities of MB 'on hand' at the beginning and end of 2007, as reported by Parties in 2008/2009 under Decision XVI/6.

Party	**Critical use exemptions authorized by MOP for 2007**	**Quantity of MB as reported by Parties (metric tonnes)**				
		Amount on hand at start of 2007	**Quantity Acquired for CUEs in 2007 (production +imports)**	**Amount available for use in 2007**	**Quantity used for CUEs in 2007**	**Amount on hand at the end of 2007**
Australia	48.553	0	45.832	45.832	45.832	0
Canada	52.874	0.897	38.073	38.970	38.622	0.348
EC	689.142	31.635	484.842	516.477	508.031	8.446
Israel	966.465	0	940.675	940.675	750.225	190.45
Japan	636.172	23.417	479.290	502.707	485.113	17.594
USA	6 749	7 671(a)	4 314	11 985	4 269	6 503(b)

(a) Amount of pre-2005 stocks
(b) The sum of 45 tonnes of stocks produced/imported in 2007 specifically for CUEs, plus 6,458 tonnes stocks acquired pre-2005.

Table 14-4: Quantities of MB 'on hand' at the beginning and end of 2008, as reported by Parties in 2009 under Decision XVI/6.

Party	**Critical use exemptions authorized by MOP for 2008**	**Quantity of MB as reported by Parties (metric tonnes)**				
		Amount on hand at start of 2008	**Quantity Acquired for CUEs in 2008 (production +imports)**	**Amount available for use in 2008**	**Quantity used for CUEs in 2008**	**Amount on hand at the end of 2008**
Australia	48.450	0	41.037	41.037	41.037	0
Canada	42.19	0.348	32.937	33.285	31.281	1.997
EC	245.146	6.409	206.146	212.555	212.463	0.092
Israel						
Japan	443.775	24.467	392.994	417.461	409.937	7.524
USA	5 336	1 730 6458(a)	3 036	9464	4 083	5381(b) 269(c)

(a) Amount of pre-2005 stocks
(b) Includes the pre-2005 stocks
(c). Amount of unused allocation for CUEs which will be reduced from following years production

14.2.4 Stocks

TEAP notes that the amount of MB stocks held by the US is now substantially greater than the total critical use allocation in a given year. In 2006, the US predicted that pre 2005 stocks for preplant soil uses would be exhausted by 2009, yet a major proportion of the pre 2005 stocks are still available. TEAP notes that the US has made allowances for some of the use of these stocks as critical allowances for CUNs and suggests that Parties may wish to seek clarification on how the remaining stocks will be apportioned.

14.2.5 Reporting of MB Consumption for Critical Use - Decision XVII/9

Decision XVII/9(10) of the 17th MOP 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 VI and VII). Not all Parties supply data under Table 2 of the accounting framework, set out on p. 65 of the Handbook on Critical Use Nominations (version 6 of December 2007). Data reported here for (a) and (b) above is thus incomplete.

Tables and figures in this report (Table 14-4, Figures 14-1 and 14-2) show the nominated MB amounts and the apparent rate of reduction in MB or adoption of alternatives achieved by Parties. It should be 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 alternative adoption since pre-2005 stocks may have been sold into the same sectors. Table 14-5 in particular shows the amounts nominated and approved for 'Critical Use' in 2009 and 2010.

14.2.6 Trends in Methyl Bromide Use for CUEs since 2005

As part of the requirements of Decision XVII/9, trends in phase out by Parties are shown below. Since 2005, there has been a progressive trend by all Parties to reduce their nominations for consumption for preplant soil uses and post harvest uses, although this has occurred at different rates. Figs 14-1 and 14- 2 show the trends in the reduction in amounts approved/nominated by Parties for 'Critical Use' from 2005 to 2011 for some key uses. The complete trends in phase out of MB by country, as indicated by change in CUE, are shown in Annexes V and VI.

Figure 14-1: Amounts of MB exempted for CUE uses in preplant soil industries from 2005 to 2010. Solid lines indicate the trend in CUE methyl bromide. Dashed lines indicate quantity of MB nominated by the Parties in either 2010 or 2011.

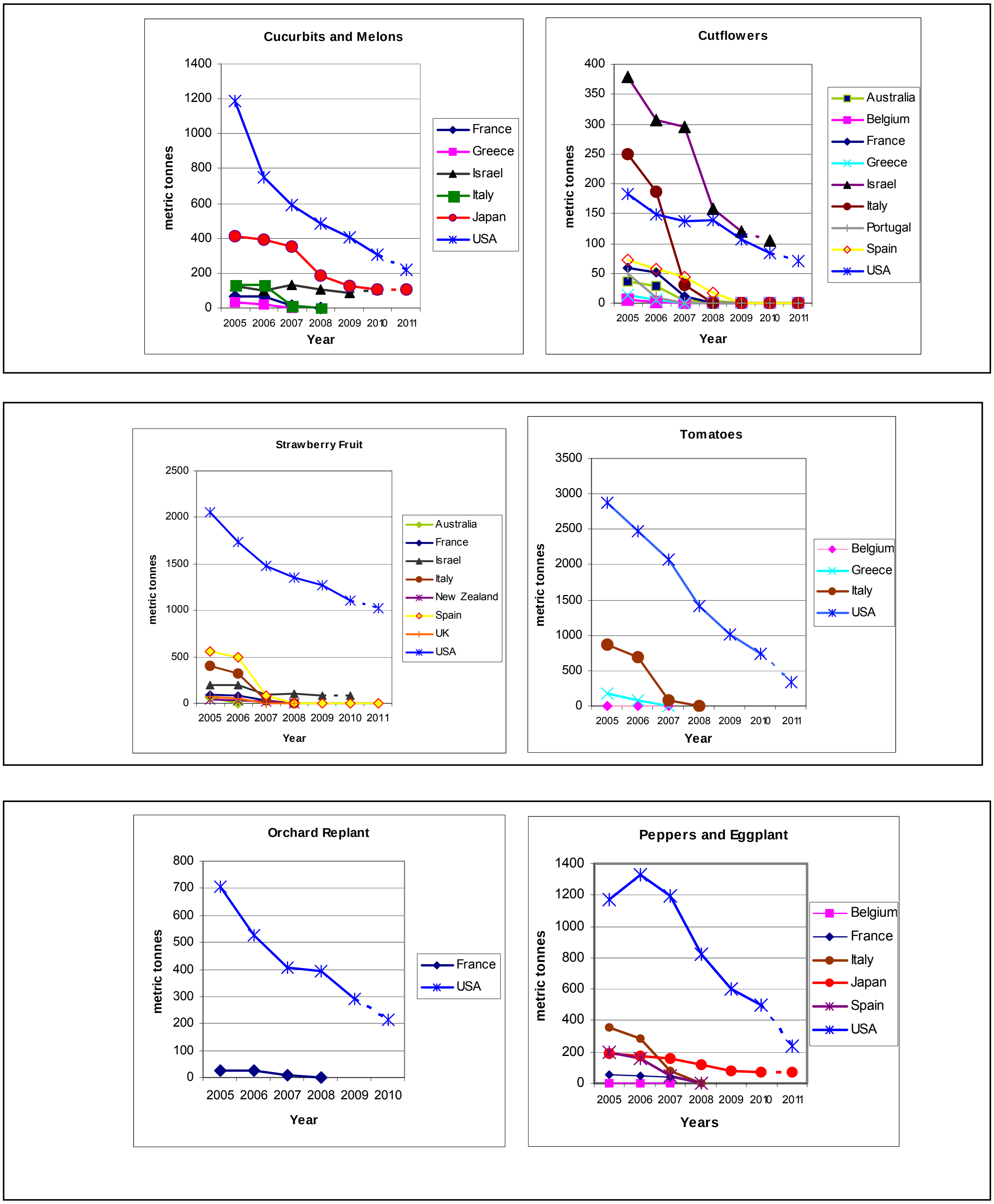


Figure 14-2: Amounts of MB exempted for CUE uses in mills and food processing facilities from 2005 to 2009. Solid lines indicate trend in CUE methyl bromide. Dashed lines indicate quantity of MB nominated by the Party in either 2007 or 2008.

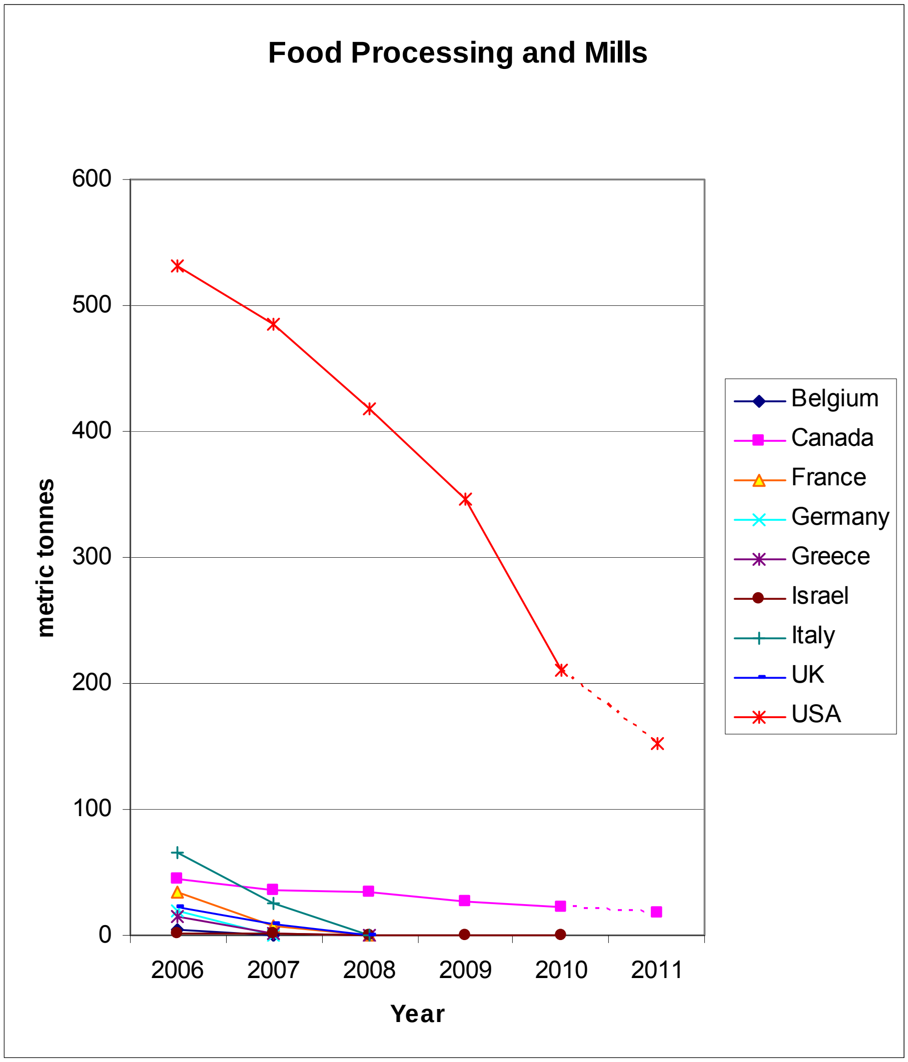


Table 14-5: Summary of Critical Use Nomination (2005 – 2011 in part) and Exemption (2005 – 2010 in part) Amounts of MB Granted by Parties under the CUN/CUE Process. (Note: A breakdown of CUN and CUE amounts by sector is given in Annex VI)

PARTY	QUANTITIES NOMINATED							QUANTITIES APPROVED						Quantities Recommended in this round	
	2005	2006	2007	2008	2009	2010	2011	2005 (1ExMOP and 16MOP)	2006 (16MOP+ 2ExMOP+ 17MOP)	2007 (17MOP + 18MOP)	2008 (18MOP + 19MOP)	2009 (19MOP)	2010 (20MOP)	2010*	2011*
Australia	206.950	81.250	52.145	52.900	38.990	37.610	35.450	146.600	75.100	48.517	48.450	37.610	36.440	0	27.220
Canada	61.992	53.897	46.745	42.241	39.115	35.080	19.368	61.792	53.897	52.874	36.112	39.020	30.340	3.529	19.368
European Community[1]	5754.361	4213.47	1239.873	245.00	0	0	0	4392.812	3536.755	689.142	245.146	0	0	0	0
Israel	1117.156	1081.506	1236.517	952.845	699.448	383.700	*	1089.306	880.295	966.715	860.580	610.854	*	290.914	*
Japan	748.000	741.400	651.700	589.600	508.900	288.500	249.420	748.000	741.400	636.172	443.775	305.380	267.000		239.746
New Zealand	53.085	53.085	32.573	0	0	0	0	50.000	42.000	18.234	0	0	0	0	0
Switzerland	8.700	7.000	0	0	0	0	0	8.700	7.000	0	0	0	0	0	0
USA	10753.997	9386.229	7417.999	6415.153	4958.034	3299.490	2388.128	9552.879	8081.753	6749.060	5355.976	4261.974	3232.856	0	2050.819
TOTALS	**18704.241**	**15617.837**	**10677.552**	**8297.739**	**6244.487**	**4044.380**	**2692.366**	**16050.089**	**13418.200**	**9160.714**	**6990.039**	**5,254.838**	**3566.636**	**294.443**	**2337.152**

* Not yet available.

[1] 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

14.2.7 Evaluations of CUNs – 2009 round for 2010 and 2011 exemptions

MBTOC met separately in subcommittees in April 2009 to conduct a review of CUNs as requested by Parties, to update reports, discuss issues of registration of alternatives and other matters. Two MBTOC economists attended both meetings, however the third member unfortunately could not attend due to other commitments and has since resigned. The meetings were held as required by the time schedule for considerations of CUNs given in Annex I referred to in Decision XVI/4. Consensus decisions were made in subcommittees, but all comments made by members were considered in final recommendations. Outcomes from deliberations by the two MBTOC subcommittees were discussed via electronic communication. Recommendations made by MBTOC S were circulated to MBTOC QSC and vice versa, as part of the process of reaching consensus within the whole committee.

During the meeting held in Agadir, Morocco (20-24 April, 2009) MBTOC S reviewed 27 nominations and made recommendations for all nominations. During the meeting, MBTOC S held a bilateral meeting with the US delegation to get further information relevant to the CUN assessment. Two new members, one from Brazil and one from Turkey have joined the subcommittee.

MBTOC QSC met in Rotterdam, The Netherlands (20-24 April, 2009). MBTOC QSC reviewed 9 nominations and one nomination from the Russian Federation, which is at this time on hold pending further correspondence from the Party. MBTOC made recommendations for all nominations. CUNs in this report relate to CUEs sought for 2009 and 2010. No nominations in this particular round were submitted for longer periods.

Two Parties (Israel and Canada) submitted nominations for the 2010 round and four Parties (Australia, Canada, Japan, and the USA) submitted nominations for 2011. These Parties have submitted nominations in previous CUN rounds. Israel submitted a nomination for preplant soil use of MB for broomrape eradication in polyhouses, which had not been applied for in the previous rounds, but has been applied for in open fields. The total number of nominations has been reduced from 42 nominations submitted by five Parties in the last round to 36 for the present round. In 2008, Japan indicated in correspondence prior to the 28th OEWG in Thailand that it plans to phase out all preplant soil uses of MB by 2013.

MBTOC has sometimes recommended quantities of MB for 2010 or 2011 which are different from those nominated. The grounds used for these recommendations are given in detail after the relevant CUNs in Tables 14-11 and 14-12. The adjustments for preplant soils use may in part be to account for presumptions given in Tables 14-8 and 14-9.

In paragraph 20 of Annex 1 referred to in Decision XVI/4, Parties, among other things, specifically requested that MBTOC explicitly state the specific basis for the Party's economic statement relating to CUNs. Tables 14-11 and 14-12 provide this information for each CUN. This information was prepared by MBTOC economists.

In general, CUNs resulted mainly from the following issues: regulatory restrictions on alternatives, scale-up of alternatives, economic issues and, to a much smaller degree, the technical unavailability of alternatives. This was as in the previous two years of CUNs. For the most part, technical alternatives exist. Additionally, MBTOC notes that some Parties continue to struggle with the ability to adapt previously identified alternatives to their circumstances, within their definition of economic feasibility.

14.2.8 Critical Use Nominations Review

In considering the CUNs submitted in 2009, as in previous rounds , both MBTOC subcommittees applied 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.

In evaluating the CUNs for soil treatments, MBTOC assumed that 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.

MBTOC evaluation of CUNs for preplant soil use relating to production of strawberries, tomatoes and some other crops was assisted by information provided by a large number of published studies on MB alternatives and by a meta-analysis of over 100 potential alternatives (Porter et al, 2006). Recent publications on these and other relevant crops appearing in scientific journals, conference proceedings, trade magazines and others were also extensively considered. The published studies assisted in providing additional transparency to MBTOC evaluations, as requested by the Parties in Decision XV/4. MBTOC also used information on the suitability of alternatives for a nomination by considering the commercial adoption of alternatives in regions nominated for CUNs.

Further, adoption in regions with similar climatic zone and cropping practices was used as an indication of the feasibility (technical and economic) of an alternative in a similar region. For example for preplant soil uses of MB, 1,3-dichloropropene/Pic (1,3-D/Pic), metham sodium alone or in combination with Pic, dazomet, substrates and the use of resistant varieties and grafted plants (for solanaceous crops, melons and other cucurbits) have been adopted to replace MB for a range of crops in industries applying for CUNs and in many regions where MB was once used.

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, while ensuring the costs were economically feasible in the context of that nomination, to the extent that could be determined.

Unless otherwise indicated, the most recent CUE approved by the Parties for a particular CUN was used as baseline for consideration of continuing nominations.

The standard presumptions, used by MBTOC to assess nominations, are given in the chapters ahead.

14.2.9 Disclosure of Interest

As in the past, all MBTOC members have prepared disclosure of interest forms relating specifically to their level of national, regional or enterprise involvement for the 2009 CUN process, according to a standardised format developed by TEAP. The Disclosure of Interest declarations are found in Annex VII at the end of this report. As in previous rounds, some members withdrew from a particular CUN assessment or only provided technical advice on request for those nominations where a potential conflict of interest was declared.

14.3 MBTOC Soils: Final Evaluations of 2009 Critical Use Nominations for Methyl Bromide

14.3.1 Summary of outcomes

In the 2009 round, 27 CUNs were submitted for soil uses, 9 for 2010 and 18 for 2011. Interim recommendations were made on all nominations of 382.140 tonnes for 2010 and 2,500.814 tonnes for 2011. The recommended amounts totalled 289.874 tonnes for 2010 and 2,154.467 tonnes for 2011 (Table 14-6).

MBTOC is recommending a greater transition rate for several nominations as it considers alternatives are available and can be adopted for a larger portion of the nomination by 2011 than those indicated. MBTOC made a slight reduction to the CUNs submitted by Japan only for sectors affected by plant viruses as MBTOC acknowledged the reduction schedule put forward in their Action Plan in 2008 (Figure 14-3). MBTOC considered that further reductions were feasible and made modest reductions in order to assist Japan meet its phase out by 2013. For some nominations, MBTOC adjusted for revised standard MB dosage rates (as presented at 19^{th} MOP) for vegetables, strawberries and strawberry runners, where either the Party had provided information to support the dose rate or where commercial use rates supported the presumptions.

Table 14-6: Summary of MBTOC S final recommendations for 2010 and 2011 by country for CUNs received in 2008 for preplant soil use of MB (tonnes)

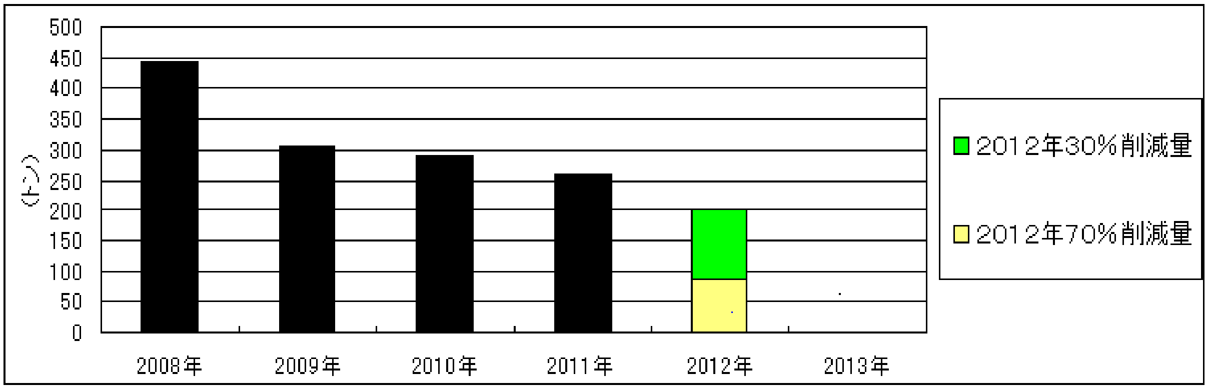
Country	**CUE approved at 20^{th} MOP**		**CUN for 2010 and 2011**		**MBTOC-S Interim Recommendation**	
	2009	**2010**	**2010**	**2011**	**2010**	**2011**
Australia		**29.790**		29.790		22.350
Canada		7.462		5.261		5.261
Israel	608.454		382.140		289.874	
Japan		261.600		244.070		234.396
USA		2998.948		2,221.693		1,892.460
Total	**608.454**	**3297.800**	**382.140**	**2,500.814**	**289.874**	**2,154.467**

Table 14-7: Summary of the amounts approved by Parties at 19th MOP for 2010, and amounts recommended by MBTOC S (in square brackets) for CUE's for preplant uses of MB (tonnes) for 2010 and 2011 submitted in the 2009 round.

Country and Sector	Years	
	2010	**2011**
1. **Australia**		
1. Strawberry runners	**29.790**	**[22.350]**
2. **Canada**		
1. Strawberry runners	**7.462**	**[5.261]**
3. **Israel**		
1. Broomrape protected	[12.500]	----------
2. Cucumber	[15.973]	----------
3. Cut flowers & bulbs protected	[63.464]	----------
4. Cut flowers open field	[28.554]	----------
5. Melon protected & open field	[70.000]	----------
6. Strawberry fruit - Sharon and Gaza	[57.063]	----------
7. Strawberry runners - Sharon and Gaza	[22.320]	----------
8. Sweet potatoes	[20.000]	
TOTAL	**[289.874]**	
4. **Japan**		
1. Cucumber	30.690	[27.621]
2. Ginger open field	53.400	[47.450]
3. Ginger protected	8.300	[7.036]
4. Melon	81.720	[73.548]
5. Pepper green & hot	72.990	[65.691]
6. Watermelon	14.500	[13.050]
TOTAL	**261.600**	**[234.396]**
5. **USA**		
1. Cucurbits	218.032	[195.698]
2. Eggplants (field)	19.725	[19.725]
3. Forestry nursery	93.547	[93.547]
4. Nurseries stock: fruits, nuts & flowers	7.955	[7.955]
5. Orchard replant	183.232	[183.232]
6. Ornamentals	64.307	[64.307]
7. Pepper (field)	206.234	[206.234]
8. Strawberry (field)	812.70	[812.709]
9. Strawberry runners	94.690	[4.690]
10. Sweet potatoes	11.612	[11.612]
11. Tomatoes (field)	292.751	[292.751]
TOTAL	**2,221.693**	**[1892.460]**

Figure 14-3: Stepwise reduction schedules for MB (metric tonnes) proposed in the Japanese Action Plan, forwarded as information for consideration during the 2008 round of CUN assessments and MBTOC recommendations.

(Plan suggests that in 2012, reductions will be between 30 and 70% of amount recommended in 2009 with total phaseout in 2013)



Source: Letter to Ozone Secretariat - August 22,2008

Year	2008	2009	2010	2011	2012	2013
MB amount (tonnes) shown in Japanese Action Plan	444	305	289	260	87 - 202	0
MBTOC Recommendations	444	305	267	234	-	-

14.3.2 Issues related to CUN Assessment for Preplant Soil Use

In general, CUNs for preplant soil use of MB resulted mainly from the following issues: regulatory restrictions on one or two specific alternatives, adoption times to implement alternatives, and economic infeasibility of some key technical alternatives, such as the use of methods which avoid the need for MB, i.e. use of grafted plants.

Key issues which influenced assessment and the need for MB in the 2009 round were i) registration of methyl iodide (MI or iodomethane) in most states of the USA (not California) in mid 2008 which has led to commercial adoption on 13,000 acres in the US and substantial reduction in the US nominations in SE and Florida (Chism, W., pers com, 2009; Allan, M., pers. comm., 2009) ii) acceptance of a 3 way fumigant strategy (1,3-dichloropropene, metham sodium, Pic) being effective for nutsedge and pathogen control in USA, iii) changing regulations on key alternatives, particularly 1,3-D township caps and buffer zones on 1,3-D, metham sodium and Pic used alone or in mixtures (iv) restrictions on use of high rates of Pic (greater than 200 kg/ha (20 g/m^2)) in some counties of California, and v) lack of studies in specific sectors i.e. orchard replant in heavy soils, and nursery industries. In the 2009 round, MBTOC also used adoption data of alternatives in specific regions where it was available, such as the Californian Department of Pesticide Regulation commodity and pesticide data to help with assessment.

Unusually large buffer zone restrictions on fumigant alternatives, particularly limit their adoption, especially in Israel. MBTOC urges Parties to consider review of these regulations in view of the ability of barrier films to reduce dose rates of MB and alternatives and associated emissions. As in the previous round, Parties have found alternatives more difficult to adopt for propagation materials, such as strawberry runners and nurseries, however the lack of research studies provided in CUNs has also led to difficulties in assessment. MBTOC considers that several of these do not to fully satisfy the requirements of Decision IX/6 and urges Parties to increase studies in these sectors. The impact of current reviews of VOC emissions in California may also have a major impact on MB use and the use of alternatives in California. MBTOC was also unclear whether barrier films can be used for MB uses under VOC regulations as this would impact on dose rates required for CUNs.

MBTOC also notes that a large proportion of MB has been nominated for uses where regulations or legislation prevent reductions of MB dosage. For many uses, the mandatory use of MB is specified at a high dosage for either treatment of certified propagation material or because bans are imposed on the 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. MBTOC urges the Parties to align their local policies and regulations with internationally accepted methodologies and to allow use of MB alternatives that lie within the Montreal Protocol's goals.

14.3.2.1 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*".

Reregistration Eligibility Decision (RED) documents for use of MB, Pic, MS, and dazomet for preplant soil fumigation were completed in the USA on July 15, 2008, with a comment period allowed until 30 October, 2008. Final decisions are scheduled to be available in June 2009. New safety measures such as buffer zones to protect bystanders, reduced application rates, health protection measures for workers are required in the RED. The mitigation required in the REDs will be implemented in two stages -- most of the measures not related to buffer zones will be implemented in 2010 with the buffer zones being implemented in 2011. 1,3-D, which was included in the fumigant cluster for comparative purposes only, completed reregistration in the U.S. in 1998, and no further mitigation is expected at this time.

The registration of formulations of a key alternative, 1,3-D/Pic is uncertain in Israel. IM, a major alternative to MB, is now registered in all but three states in the United States, including the south east region and Florida for field-grown ornamentals, peppers, strawberries and tomatoes. (Registration is still pending in California, Washington and New York). This registration has been expanded to include other crops in 2009, such as forest nurseries. Trials with MI continue being conducted in Japan, Australia, New Zealand, Turkey, Morocco, South Africa, Israel, Italy, Costa Rica, Guatemala, Brazil, Mexico and Chile, and the registration process is proceeding in most other countries applying for CUEs beside other states in the USA including Australia, Israel and Japan. To ensure that the mitigation measures for MI will be consistent with the measures being required for the other fumigants, the label requirements are presently being reexamined in the USA. 1,3-dichloropropene, may be subject to similar provisions when the soil fumigants are evaluated together again in 2013.

The EC has further reported that registration for 1,3-D and other alternatives including chloropicrin, dazomet ande metham, sodium are under review. A grace period for the registration of 1,3-D became due on 20 March 2009, but its future registration is uncertain. Recognising the role of 1,3-D as an alternative to MB, and to achieve the objectives of the Montreal Protocol, this grace period may be extended by a further 18 months, pending a review to assess the concrete impact of its withdrawal on the use of MB. The manufacturer of 1,3-D has compiled a dossier of additional technical information and intends to apply for re-registration of 1,3-D under Directive 91/414 (Dow AgroSciences 2007)". (EC Management Strategy, 2008).

A number of other chemicals which may be alternatives to MB are being considered for impending registration in specific countries recently, including dimethyl disulphide (DMDS) in Europe and the USA and MI in Australia respectively.

14.3.2.2 Update on rates of adoption of alternatives for preplant uses - Decision XIX/9

As of the 2008 round, Decision XIX/9 para. 3 requests: ' *the Technology and Economic Assessment Panel to ensure that recent findings with regard to the adoption rate of alternatives are annually updated and reported to the Parties in its first report of each year and inform the work of the Panel*'.

Technical alternatives exist for almost all uses requesting CUNs, but uptake of alternatives varies between countries, crops and the pest pressure. In general similar alternatives are being adopted by the same sectors throughout a number of countries, although the rate of adoption has varied depending on regulations on their use, differences in registration between countries and other market forces. In this round as in previous rounds of CUNs, MBTOC has recognised that time is needed to effect phase-in of alternatives and has accepted this as a reasonable technical argument for lack of availability to the end user sensu Decision IX/6.

Where possible, data is included in this report showing actual rates of adoption in key regions which have phased out MB recently. In particular, recent adoption data from the EC Management Strategy (2008) has been included to shows rates of transition to alternatives by several sectors in the Member States (Appendix IV). In addition, past adoption rates of alternatives in many countries is presented in previous Assessment Reports (MBTOC 2007). Figures 2.1- 2.2 in this report show the apparent reduction rates for MB use achieved by many Parties in a number of key sectors. As noted above, true reduction and adoption rates may vary from the rate of change of CUN/CUE because of factors such as use of stocks or transfer of approved MB between categories The CUN reviews presented in Table 14-11 also provide detail of some of the key alternatives that Parties have and should consider to further replace MB for the remaining uses.

For several major preplant soil uses, adoption data from other regions has shown that where industries have previously been heavily dependent on MB, e.g. strawberries, tomatoes and other vegetable crops (e.g. Australia, Italy, Spain, Belgium, Portugal, New Zealand) almost complete adoption of alternative technologies (especially those requiring similar application technologies) has been achieved in a 3 to 4 year period. For instance, a full list of adoption rates obtained within the EC is shown in Annex IV. These regions have similar pest complexes to those requesting CUNs, but may have different regulatory issues. Possible adoption rates for transition to alternatives for preplant soil uses have also been supplied recently by Japan in their National Action Plan. This plan indicates the expected rates of transition to alternatives to assist complete phase out of MB by 2013.

Further guidance from the Parties, giving expected rates of adoption of alternatives following registration, would assist MBTOC in evaluation of CUNs in future.

14.3.2.3 Sustainable alternatives for preplant uses

In a large proportion of CUNs, the most currently appropriate alternatives are chemical fumigant alternatives, which themselves, like MB, have issues related to their long term suitability for use. In both the EC and the USA in particular, MB and most other fumigants have been subjected to reviews that could affect future regulations over their use for preplant soil fumigation. For preplant soil uses of MB, the regulatory restrictions on 1,3-dichloropropene and Pic are preventing further adoption of these products in the USA, particularly California and this is putting pressure on industries to retain MB.

MBTOC urges Parties to consider the long term sustainability of treatments adopted as alternatives to MB, to continue to adopt environmentally sustainable and safe chemical and non-chemical alternatives for the short to medium term and to develop sustainable IPM or non-chemical approaches for the longer term. Decision IX/6 1(a)(ii) refers to alternatives that are 'acceptable from the standpoint of environment and health'. MBTOC has consistently interpreted this to mean alternatives that are registered or allowed by the relevant regulatory authorities in individual CUN regions, without reference to sustainability.

14.3.2.4 Frequency of allowed MB use for preplant uses

In the CUN round for 2009, reductions in MB for preplant (soil) uses could be achieved in some nominations, where effective alternatives were identified, by reducing the frequency of MB fumigations. Instead of all fumigation being made with MB, potential exists to reduce frequency by rotation with other methods (i.e. fumigants) in order to reduce MB use to every 2nd or 3rd year. In some production systems, MB is already used only every 3rd or 4th year as a result of uptake of alternative strategies and crop rotations.

Noting this effort, MBTOC has not automatically concluded that episodes when MB is not used mean a fully successful adoption of alternatives. There is no instruction from Parties as to how to consider renewed CUNs in the future that result from a potential need for MB in the years where reduced frequency of fumigation is to take place. Similarly, Parties may consider submission of renewed or expanded CUN requests should a key alternative cease to be available because of new regulatory constraints or loss of registration. MBTOC notes recent action by the European Commission (D(2009)410411) Article 3(a) Commission Decision 2007/619/EC which "*…concluded a phase out of 1,3-D is not likely to lead to critical uses of methyl bromide and that, therefore, the period of grace of 1,3-D should not be extended. In fact, other chemical alternatives to methyl bromide will remain available until at least March 2010… Spain (*and a number of other Member States*) did not agree with the Commission analysis*."

14.3.3 Standard presumptions used in assessment of nominated quantities.

The tables below (Tables 14-8 and 14-9) provide the standard presumptions applied by MBTOC Soils for this round of CUNs. 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 appear in Annex III. They 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. Actual dosage rate of MB in MB/Pic formulations is shown in Table 14-10 below.

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 (see Annex III). MBTOC considered the maximum MB application rate for 98% MB to be either 250 or 350 kg/ha (25 or 35 g/m^2), in conjunction with low permeability barrier films (e.g., VIF, or equivalent) and totally impermeable films (TIF) combined with extended exposure periods. Several Parties have indicated that 250 kg/ha (25 g/m^2) of 98:2 were effectively used in standard commercial application for many sectors, especially on sandy soils. MBTOC considers 100% MB or 98:2 MB/Pic formulations only necessary for CUE uses where other MB/Pic formulations are not registered or where regulations prescribe their use.

In cases where use of high Pic-containing mixtures of MB/Pic (approximately 67:33 or 50:50 or lower) and barrier films are considered feasible, maximum dosage rates of either 150 or 175 kg MB/ha (15.0-17.5 g/m^2) where nutsedge is the key pest and 125 or 150 kg/ha (12.5-15.0 g/m^2) for pathogens were considered for use as the maximum standard presumptions, unless there was a regulatory or technical reason indicated otherwise by the Party (see Table 14-9 below). MBTOC considers these dosage rates to give similar efficacy and yields at a similar cost to higher dosage rates of MB/Pic with barrier films. As a special case, MBTOC accepted a maximum rate of 200 kg/ha (20 g/m^2) with high Pic-containing mixtures with barrier films for certified nursery production, unless regulations prescribed higher rates. However, studies have indicated that rates of 200 kg/ha (20g/m^2) or less (Annex III) of MB: Pic 50:50 were effective with barrier films for production of 'certified' nursery material.

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.

During a bilateral meeting held in Alassio, Italy, August 2008, the US delegation indicated that they were not able to conform to dosage rates suggested by MBTOC for vegetables and strawberries at present (see Table 14-8 below) as they did not have enough trial information to confirm their use for specific circumstances. In view of the fact that the Party did not consider experiences from other countries and sectors valid for extrapolation to USA circumstances, MBTOC conducted a review of MB use rates being adopted with barrier films in early 2009 and in many cases rates less than the standard presumptions were shown to be used currently in the US (Schneider, pers comm.). In view of this finding, MBTOC applied the revised standard presumptions (as presented to 19th MOP) in this round.

Table 14-8: Standard presumptions used in assessment of CUNs for the 2009 round – soil treatments.

	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: Pathogen 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 broadacre 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 14-9: Maximum dosage rates for preplant soil use of MB by sector used in the 2009 round (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	**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

14.3.4 Adjustments for standard dosage rates using MB/Pic formulations

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, 45:55 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) (e. g. Porter *et al*., 1997; Melgarejo *et al*., 2001; López-Aranda *et al*., 2003; Santos *et al*., 2007; Hamill *et al.,* 2004; Carey and Godbehere, 2004; Gilreath and Santos, 2005; Hanson *et al.,* 2006). Where such formulations are registered or otherwise permitted, non-Article 5 countries have widely adopted formulations containing high proportions of Pic in mixtures with MB to meet Montreal Protocol restrictions. Their use can be achieved with similar application machinery which allows co-injection of MB and Pic or by use of premixed formulations. Consistent performance has been demonstrated with both barrier and non barrier films. Parties are urged to consider even lower dosage rates of MB by modifying MB/Pic mixtures used and adoption of barrier films where regulations permit as the basis for future CUNs. This includes rates as low as 75 kg/ha (7.5 g/m^2) in 250 kg/ha of 30:70 or 33:67 mixtures or 100 kg/ha (10 g/m^2) of MB in 250 kg/ha of 50:50 MB/Pic mixtures in conjunction with barrier films as these have shown similar effectiveness to higher rates of MB in 67:33 MB /Pic and 335 to 800 kg/ha (33.5 to 80 g/m^2) of MB 98% with standard polyethylene.

Table 14-10: 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 of 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 (Annex III) show that a dosage of 10g/m^2 (e.g. MB/Pic 50:50 at 200kg/ha with LP Barrier Films) is technically feasible for many situations and equivalent to the standard dosage of >20g/m^2 using standard PE films*

14.3.5 Use/Emission reduction technologies - Low permeability barrier films and dosage reduction

Decision IX/6 states in part 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 minimization techniques, requesting Parties “…to ensure, wherever methyl bromide is authorized for critical-use exemptions, the use of emission minimization techniques such as virtually impermeable films, barrier film technologies, deep shank injection and/or other techniques that promote environmental protection, whenever technically and economically feasible.”

As in past rounds, MBTOC assessed CUNs where possible for reductions in MB application rates and deployment of MB emission reduction technologies, such as use of LPBF, including VIF and totally impermeable films (TIF), or other appropriate sealing and emission control techniques including deep injection of MB, use of formulations with a lower proportion of MB and/ or reduced frequency of application.

The use of low permeability barrier films or other techniques, ensuring at least the same level of environmental protection, was compulsory in the 27 member countries of the European Union (EC Regulation 2037/2000) for MB before phaseout and currently for the alternative choropicrin in Italy and Spain for preplant soil uses. In other regions, LPBF films are considered technically feasible and large adoption has occurred, e.g. Israel and SE USA. In Florida the reported use of barrier films in vegetable crops has expanded to over 50,000 acres and it is also exclusively used with the alternative MI to assist its effectiveness at low dosage rates (Allan, pers. comm., 2008; Chism, pers.comm, 2009). An exception to the adoption of barrier films is in the State of California in the USA where a regulation currently prevents use of VIF with MB (California Code of Regulations Title 3 Section 6450(e)), but not with the alternatives. Barrier films are consistently improving the performance of alternatives at lower dosage rates. The regulation on MB has been set over concerns of possible worker exposure to MB when the film is removed or when seedlings are planted due to altered flux rates of MB. Recent VOC regulations appear to allow barrier films to be used with MB and it is unclear to MBTOC at this stage what impact the conflicting regulations may have on CUNs.

14.3.6 Use of disposable canisters of MB

One non Article 5 Party is still using small disposable canisters (i.e. 500 to 750g canisters) for application of MB for preplant soil use under plastic films under strict worker health guidelines. Canister applications have been eliminated for soil use in all other non Article 5 countries and various Article 5 countries as this application is considered to be less efficient for the control of soilborne pathogens than other methods. This treatment is considered to be more dangerous to workers than injection methods, because trained contractors are not generally involved in its application. This practice is not considered as effective for pathogen control as use of MB/Pic mixtures and also can lead to high emissions of MB as the MB gas is released immediately beneath the plastic sheets. According to the Party, canisters are used because they provide small-scale farmers with an easy application method and the ability to apply targeted amounts of MB to small areas where injection machinery may be difficult to use. In this case, farmers are reported to use strict controls.

Table 14-11: Final evaluations of CUNs for preplant soil use submitted in 2008 for 2010 or 2011

Country	Industry	CUE for 2005 (1ExMOP and 16MOP	CUE for 2006 (16MOP +2ExMOP+17MOP)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (addtl or new)
Australia	Strawberry runners	35.750	37.500	35.750	35.750	29.790	29.790	-	-	29.790	22.350
	MBTOC comments 2009: MBTOC recommends a reduced CUE of 22.350 tonnes be approved for 2011. The reduction by MBTOC is based on adoption of the reduced rate for MB of 187.5 kg/ha 18.75 g/m^2). The key pests affecting strawberry runner production are fungi (*Phytophthora, Pythium, Rhizoctonia, Verticillium* spp.) and weeds (*S. arvensis, Agrostis tenuis, Raphanus spp., Poa annua, Cyperus spp*). The CUN states that MB:Pic 50:50 at a MB dose of 25 g/m^2 is required to meet certification standards. The Party's request exceeds MBTOC's standard presumption of 20 g/m^2, but this rate continues to remain unregistered. The Party indicates that the registration authority (APVMA) requires 2 years of trials before approving a reduced rate. The Party has however one years data indicating that yields with reduced rates under barrier films, LDBF (MB:Pic 50:50 @ 375 kg/ha) provided similar yields to the currently registered standard of MB:Pic 50:50 @ 500 kg/ha. The second year's results will be available in August/September 2009. The Party has indicated that it is possible that the registration for the reduced rate of MB:Pic will occur in time for use in 2011. The Party states that the most promising alternative, MI/Pic has been demonstrated in small scale trials to compare with the efficacy to MB:Pic. Commercial scale-up trials are in progress and could lead to registration in 2011 or possibly beforehand. If MI:Pic is available, it would allow for further reduction of the nomination. 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 indicates that the Victorian Strawberry Certification Authority (VSICA) completed the first year of a 2-year development program for soil-less systems for production of foundation stock strawberry runners. 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. VSICA plans to establish a commercial facility by 2011 which, if successful, would eliminate VSICA's need for MB for foundation stock in 2011/2012. MBTOC encourages the Party to (1) expedite the registration of MI/PIC and EDN (Mattner et al, 2008) and (2) implement to the greatest extent economically feasible the use of soil-less systems for the production of foundation stock strawberry runners .										
	MBTOC comments on economics 2009: The nomination was not based on economic arguments. CUN states that "…the first of a two year trial that evaluates the economic and biological feasibility of production of foundation stock by soil-less systems was completed this year". It compared productivity with the status quo system of production in MB:Pic treated soil in insect proof cages. Results confirm the potential of the soil-less system are being used to design the second season's trial to be established in November 08." They conclude that "The economics of the system compare favourably with the current methods of production."										

Country	**Industry**	**CUE for 2005 (1ExMOP and 16MOP**	**CUE for 2006 (16MOP +2ExMOP+17MOP)**	**CUE for 2007 (MOP17+ MOP18)**	**CUE for 2008 (MOP18+ MOP19)**	**CUE for 2009 (MOP19+ MOP20)**	**CUE for 2010 (MOP20)**	**CUN for 2010**	**MBTOC rec. for 2010 (addtl or new)**	**CUN for 2011 (addtl or new)**	**MBTOC rec. for 2011 (addtl or new)**
Canada	Strawberry runners (PEI)	6.840	6.840	7.995	7.462	7.462	7.462	-	-	5.261	5.261
	MBTOC comments 2009: MBTOC recommends 5.261 tonnes for this use in 2011. The CUN for 2011 is based on a reduced rate for MB of 20 g/m^2 and MBTOC acknowledges the Party's reduction in the absence of formal registration for this dose rate. The Party has attempted to replace MB with1,3-D, but it was banned for use in Prince Edward Island in January 2003 due to ground water contamination. PIC 100 has been registered by the Pest Management Regulatory Agency (PMRA) but the PEI authorities have denied a permit for its use until further groundwater testing has been conducted. While MB:PIC 67:33 @ 500 kg/ha is the only use rate registered for strawberry runners, which exceeds MBTOC's standard presumption of 20 g/m^2 of MB, the grower has petitioned the PMRA to use a lower rate with barrier films. PMRA, in the absence of a formal label amendment, has granted permission to use a lower rate, but at the grower's own risk and liability. In 2008 the grower tested 25% and 30% lower rates under barrier films and results will be available in 2009. The permit for Pic 100 is still pending approval at PEI, even though Canada registered Pic in 2007. No studies on other potential alternative fumigants, such as Pic, DMDS, MI/Pic have taken place. MBTOC expects that future nominations will also demonstrate significant progress with key alternatives. MBTOC encourages the Party (1) to finalize the permits necessary for use of Pic100 and (2) consider the adoption of soilless cultures for at least part of the production cycle.										
	MBTOC comments on economics 2009: The nomination was not based on economic arguments. No economic arguments or data provided										
Israel	Broomrape	None	None	250.000	250.000	125.000	-	12.500	12.500	-	-
	MBTOC comments 2009: MBTOC recommends 12.500 tonnes for this use in 2010 for one year only. The nomination for 2010 is for greenhouse use in tomatoes and pepper and is additional to the outdoor field nominations in previous years. MB use for a national broomrape eradication project on outdoor field crops has been approved as a CUN for the years 2007, 2008 and 2009, but the allocated amounts have not been utilized. It is not clear to MBTOC why the allocated MB quantities can not be used to fumigate the 50 ha of green house for broomrape in tomato and pepper production, but have assumed that this amount is not available. MBTOC notes that in 2005 CUN the Party stated it would not apply for additional uses and MBTOC is unclear why this nomination has been submitted. MBTOC acknowledges that a registration for Pic is being considered in Israel and that this would possibly allow for lower dosages of MB to be used for *Orobanche* and other pathogens as a transition strategy. In the 2008 nomination, the Party reported that results of field trials with 1,3-D in sequence with metham sodium are promising and that registration is expected in 2009. In the 2009 nomination, the Party confirms that Telon EC is a very good chemical alternative for the control of *O. aegyptica* the main species parasitizing tomato. It is not clear from the nomination whether 1,3-D/Pic EC (Telon EC) has been registered. Telon EC suppresses broomrape when applied under plastic sheets through the drip irrigation system in tunnels or greenhouses. Its efficacy is further enhanced when applied in combination with MS. It is not clear if this fumigant can eradicate the parasitic plant .The Party has also identified some alternatives for controlling low infestations of Orobanche (e.g. solarization) but they are considered not adequate for controlling severe infestations of *O. aegyptiaca*. Field trials were carried out with sulfosulfuron, imazapic, and imazomox (Abanga *et al.,* 2007; Nadal *et al*.,2008; Miller *et al.*, 2009).										
	MBTOC comments on economics 2009: The nomination was not based on economic arguments. CUN states that "Biological control of broomrape with either the aid of a parasitic fly or with *Fusaria* do not provide economic answers for the broomrape problem" but provides no further supporting evidence.										

Country	Industry	CUE for 2005 (1ExMOP and 16MOP	CUE for 2006 (16MOP +2ExMOP+17MOP)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (addtl or new)
Israel	Cut flowers-bulbs-protected	303.000	240.000	220.185	114.450	85.431	-	72.266	63.464	-	-
	MBTOC comments 2009: MBTOC recommends a reduced amount of 63.464 tonnes for this use in 2010. The recommended amount is based on a further10% transition rate applied for adoption of substrates (lilium, calla lilies, gerberas, anemones and carnations outside the Ghaza area), and chemical alternatives in those species where the nomination states these are now registered. The nomination is for a variety of cut flowers produced under cover, which are mainly affected by weeds (*Cyperus* in particular), nematodes (root-knot but also ectoparasites such as *Longidorus*) and fungi. MBTOC does not consider MB essential for the control of ectoparasitic nematodes. MBTOC does not recommend the use of 1.75 tonnes for fumigating substrates used in rose production as alternatives, such as steam, are efficient for this use. Overall, there is very little change from nominations submitted in previous years, particularly in 2007 and 2008 and progress in phase out is still largely based on transitional measures - LPBF barrier films with reduced rates. In spite of this, registration of certain alternatives, such as metham sodium and 1,3-D, has now expanded to include additional flower types. Substrate production protocols are now available for many of the flowers presently treated with MB (Bar-Yosef *et al*, 2001; Gullino *et al*, 2003; Savvas and Passan, 2002; Urrestarazu, 2004; Urrestarazu, 2005). MBTOC is aware that carnation cultivars resistant to fusarium wilt are available, commercially used and accepted by international markets (Gullino and Garibaldi, 2007)**)**										
	MBTOC comments on economics 2009: The nomination was not based on economic arguments. No economic arguments or data provided.										
Israel	Cut flowers-open field	77.000	67.000	74.540	44.750	34.698	-	42.554	28.554	-	-
	MBTOC comments 2009: MBTOC recommends a reduced amount of 28.554 tonnes for this use in 2010. Overall, there is very little change from nominations submitted in previous years, particularly in 2007 and 2008. Progress towards phase-out is still based on transitional measures - barrier films with reduced rates of MB. The nomination is for open field production of cut flowers, which are mainly affected by weeds (*Cyperus* spp in particular) and nematodes (root-knot but also ectoparasites such as *Longidorus*) and fungi. MBTOC does not consider MB necessary for controlling ectoparasitic nematodes. Lack of registration of key alternatives on flowers such as 1,3-D+Pic, dazomet and metham sodium, continue to be the major constraints affecting substitution of MB at this time. MB formulations with higher Pic content are also not registered. In spite of this, registration of metham sodium and 1,3-D has expanded and now includes additional flower types. More expansion of registration is expected this year. Solarization has been proven to be an efficient alternative for some flower types (ref) and is being successfully used in combination with alternative chemicals such as metham sodium and 1,3-D. In keeping with the 2008 recommendation, a 25% transition rate has been applied to the nominated amount to allow for adoption of alternatives, including chemicals and solarization, which is being adopted successfully. The reduction has not been applied to the 10.125 t requested for nurseries of geophytes where high health plant material needs to be produced, although no certification issues are involved.										
	MBTOC comments on economics 2009: The nomination was not based on economic arguments. No economic arguments or data provided.										
Israel	Cucumber	None	None	25.000	18.750	-	-	18.750	15.937	-	-
	MBTOC comments 2009: MBTOC recommends a reduced amount of 15.937 tonnes for this use in 2010. The reduction is based on the adoption of grafted plants, improved sanitation and possible uptake of other alternatives (MS and 1,3-D) on 15% of the nomination. For 2010, the Party requested 18.750 t, which was the same amount approved by the Party's at the 18th MOP. The need for MB under the specific conditions of the intensive indoor cucumber cultivation in the central part of Israel could be considered as a niche request. The crop was not submitted for CUE in the years 2005 and 2006 since the crop's most pathogen control problems were										

Country	Industry	CUE for 2005 (1ExMOP and 16MOP	CUE for 2006 (16MOP +2ExMOP+17MOP)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (addtl or new)
	resolved commercially at a satisfactory level. Cucumbers are grown in open ended polyhouses in 3 cropping cycles per annum in the proximity of the residential houses of cooperative family and private family farms. A large proportion, 70%, of the critical use is concentrated in one village (Achituv), where the growers specialized for years in the cultivation of indoor cucumbers for the domestic market. The reasons for this nomination are the appearance of a new race of *F. oxysporum* f. sp. *radicis cucumerinum*. The pathogen is highly virulent and the infestation level particularly high in the affected location and it can devastate entire greenhouses in a short period of time. The required MB will be aimed at the eradication of the pathogen. Although MS and1,3-D is an effective alternative application of the mixture in winter at low temperature it may cause crop phytotoxicity and buffer zones limit its use. The Party also states that MS was subject to accelerated degradation in field studies. MBTOC acknowledges that alternatives, such as MS+1,3-D, 1,3-D/PIC, grafting, sanitation programs; soilless systems (López-Medina et al., 2004; Lieten, 2004; Savvas and Passam, 2002; Mutitu et al., 2006) may be feasible alternatives for part or all of the nomination. It encourages the Party to review the technical and economic feasibility of alternatives (grafting, substrates, and grafting + nematicides) and consider a reassessment the buffer zone for other chemical alternatives in use with barrier films and new application in methods in future nominations. **MBTOC comments on economics 2009:** The nomination was not based on economic arguments. No economic arguments or data provided.										
Israel	Melon - protected and field	125.650	99.400	105.000	87.500	87.500	-	87.500	70.000	-	-
	MBTOC comments 2009: MBTOC recommends a reduced amount of 70.000 tonnes for this use in 2010. The reduction is based on the adoption of chemical and non chemical alternatives (Pivonia *et al*., 2008) which have been shown to be effective for control of *Monosporascus cannonballus*, according to the information supplied by the Party, and uptake of grafted plants and other alternatives on 20% of the nomination. Monosporascus is the key pathogen in the Arava Valley. MB is being used for spring melon in the Arava because of low temperatures prevailing at planting time and short plant back. Regulatory restrictions do not play a role in this case. The requested amount at a rate of 250 kg/ha (25 g/m^2) of 98:2 MB under barrier films (LDPF) complies with MBTOC´s standard presumptions. While the Party's request for MB over the years first showed a reduction tendency due to the adoption of barrier films, during the last three CUN rounds, the request has stabilized at 87.5 tonnes. MBTOC, on the one hand, understands that the widely used formulations with more Pic (MB/Pic 67:33, 50:50) could be as effective as the currently used MB 98:2 formulations and urges the Party to make the necessary efforts to assess this situation under the criteria of Dec.IX/6 and reduce the nominated amounts. MBTOC understands an alternative fungicide has shown effective control of Monosporascus in Israel (Pivonia et. al; 2008; Israel melon CUN). MBTOC understands the transition to the alternatives is already ongoing and applied a transition rate based on other countries experience. Another encouraging alternative is grafted melon which shows potential in the medium-long term. The use of grafted vegetables in Israel is increasing rapidly. Grafted watermelons, for example, now account for 60 to 70% of the total cultivated area of this crop (Cohen et al, 2007). On melon, however, problems of scion-rootstock compatibility and fruit quality require an additional research effort**.** MBTOC notes that Pic and MB:Pic mixtures and the fungicide, fludioxonil, are effectively used for Monosporascus in other countries under similar conditions (e.g. Stanghelini et al. 2003; Martyn 2002).										
	MBTOC comments on economics 2009: The nomination was not based on economic arguments. CUN states that Basamid is not feasible economically since its price has increased considerably, and because of waiting period constraints. CUN also provides data (Section F) showing that the use of Basamid results in negative profit margins despite the fact that the cost of MB per kg is higher. The source of the data is not provided.										

Country	Industry	CUE for 2005 (1ExMOP and 16MOP	CUE for 2006 (16MOP +2ExMOP+17MOP)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (addtl or new)
Israel	Strawberry fruit - protected (Sharon and Ghaza)	196.000	196.000	93.000	105.960	77.750 (42.75 Sharon) 35.00 Ghaza	-	47.500 (Sharon) 50.000 (Ghaza)	32.063 (Sharon) 25.000 (Ghaza)	-	-
	MBTOC comments 2009: MBTOC recommends a reduced CUE of 32.063 tonnes for Sharon and a reduced amount of 25.000 tonnes for Ghaza totalling 57.062 tonnes. The key pests affecting strawberry fruit are fungi (*Rhizoctonia solani, Colletotrichum acutatum, Macrophomina phaseolina, Verticillium dahliae, Fusarium* spp.), nematodes (*Meloidogyne hapla*), and weeds (*Cyperus rotundus,* purple nutsedge). The reduction for Sharon is based on increased uptake of 20% for Telon EC followed by MS which has been shown to be effective. Telone EC has a smaller buffer than 1,3-D/Pic shank applied, i.e. 100 m compared to 250 m. The latter registration has been suspended. MBTOC has adjusted the nomination to the Ghaza Strip to conform with its standard presumption of 250 kg/ha used with barrier films in sandy loam soils. MBTOC urges the Party to (1) complete as soon as possible its reconsideration of buffers for MB alternatives when used under barrier films and (2) recommit resources to develop less costly soil-less cultures in suspended pot technology, which had been diverted in the past to other priorities, and (3) pursue the timely testing and registration of MI.										
	MBTOC comments on economics 2009: The nomination was not based on economic arguments. Regarding Sharon, the CUN provides comparative data on the net revenue of a range of alternatives to MB, seemingly showing that all alternatives result in higher profit margins. The per kg price of MB is higher than that of all the alternatives. Regarding Gaza, CUN argues that there are no alternatives to MB, which will mean that the crop can no longer be grown in the area, leading to "a genuine case of economic disruption." The argument appears to be based on the political realities of the area.										
Israel	Strawberry runners (Sharon and Ghaza)	None	None	0.000	31.900	28.075 15.825 (Sharon) 12.25 (Ghaza)	-	13.570 (Sharon) 17.50 (Ghaza)	13.570 (Sharon) 8.75 (Ghaza)	-	-
	MBTOC comments 2009: MBTOC recommends 13.570t for Sharon and a reduced CUE of 8.75 t for Ghaza for this use in 2010. The key pests affecting strawberry runner production are fungi (*Rhizoctonia solani, Verticillium dahliae, Fusarium and Phytophthora* spp.*, Sclerotinia sclerotiorum, Macrophomina phasoeolina)*, root knot nematodes and purple nutsedge. The Party stated that MB 98:2 at a rate of 500 kg/ha (50 g/m^2) with standard polyethylene films and 250 kg/ha (25 g/m^2) with barrier films are necessary to meet certification standards in Ghaza and Sharon respectively. The requested amount for the Ghaza region has been adjusted to MBTOC's standard presumption of 250 kg/ha for MB use in sandy loam soils. The Party stated that 1,3-D + PIC mixture has been the leading alternative; however, adoption of this alternative is limited by the required 250 m buffer which significantly limits its use in the Sharon strawberry nursery growing area which is heavily populated. Hot gas application method is used in the Ghaza Strip growing area because the plots are small, adjacent to houses and there are no injection tools or qualified applicators in the area. MBTOC urges the Party to continue trials with alternatives that meet the pathogen tolerance required to meet the certification standards. The reduction is based on barrier films being available.										
	MBTOC comments on economics 2009: The nomination was not based on economic arguments. No economic data or analysis provided.										

Country	Industry	CUE for 2005 (1ExMOP and 16MOP	CUE for 2006 (16MOP +2ExMOP+17MOP)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (addtl or new)
Israel	Strawberry runners and Fruit (Ghaza totals only)					28.075	-	67.500	33.75	-	-
	MBTOC comments 2009: Comments are included in text boxes above as the Party consolidated the Israel and Ghaza nominations. MBTOC urges the Party to assist with the availability of barrier films to Ghaza so that MB dosages can be reduced. The reduction is based on barrier films being available.										
Israel	Sweet Potatoes	None	None	None	111.500	95.000	-	20.000	20.000	-	-
	MBTOC comments 2009: MBTOC recommends 20.000 tonnes for this use in 2010. The Party states that they expect registration of MB alternatives by 2010 and that adoption of these alternatives was the basis for the reduction from 95 tonnes granted for use in 2009 for production of sweet potato transplants. Data from early trials indicate that Telone II + Adochem super at 400 l/ha appears to be an excellent alternative for MB once registration has been obtained. The MB rates stated in the CUN are consistent with MBTOC's standard presumptions and the use of barrier films. Trials conducted in the USA with Pic as an alternative indicate that it provides better yields and returns to growers than MB. Solarization also significantly increased yields and with more effective herbicides may also become a MB alternative (Stoddard, 2008)										
	MBTOC comments on economics 2009: The nomination was not based on economic arguments. CUN states that semi-commercial application of Telon on a total area of 100 ha in 2005 lead to unsatisfactory results and economic losses. CUN also provides data showing that Telon 200+MS 400 l/ha results in a 79% increase in net revenue compared to MB. The source of the data is not provided.										

Country	Industry	CUE for 2005 (1ExMOP and 16MOP	CUE for 2006 (16MOP +2ExMOP+17MOP)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (addtl or new)
Japan	Cucumber	88.300	88.800	72.400	51.450	34.300	30.690	-	-	29.120	27.620
	MBTOC comments 2009: MBTOC recommends a reduced amount of 27.620 tonnes for this use in 2011. The recommended quantity represents a 10% reduction from the recommended amount at the 20th MOP approved amount based on uptake of available alternatives, e.g. steam, soil less culture, grafting, pathogen free seeds,1,3-D and Pic and cultural practices such as rotation, root isolation and sanitation. Japan had made public an action plan to complete phase out of MB for soil use in 2013 and submitted a revised national management strategy to the Ozone Secretariat in April 2008. MBTOC acknowledges that the Party will phase out MB by using a variety of alternatives in 2013. The nomination is based on the need to control particular viruses of cucumber, since 2005. Globally, such viruses are not considered as soil borne pathogens but can survive in crop debris for several years. The problem mainly arises from continuous monoculture. An integrated program including cultural practices e.g. sanitation, rotation with a non-host, removal and destruction of crop debris, cleaning and sanitation of the greenhouse and the surrounded area, and pathogen free seeds has proven very effective in similar situations around the world. The Party has indicated that rotation to non-susceptible hosts such as tomatoes and strawberries is an effective way to reduce virus incidence (Matsuo and Suga, 1993). As a transition strategy, MBTOC urges the Party to increase adoption of LPBF which allow for reducing MB doses by up to 50%. MBTOC recognises the unique farming system used for cucumber in Japan which has been in place for many years. However, in many countries cucumber production has already shifted to substrates in greenhouse conditions and has become the most widely used technique for eliminating a wide array of soil borne plant pathogens. Inexpensive and simple systems (buckets, bags, etc.) are available for this kind of production and are widely used in around the world. (Leoni & Ledda, 2004; Budai, 2002; Savvas and Passam 2002; Akkaya & Ozkan, 2004; Engindeniz, 2004). The Party is encouraged to consider substrate production, which implemented correctly can produce higher yields than MB (MBTOC, 2002, 2006; Batchelor 2000, 2002; Savvas and Passam 2002). Studies conducted in Japan support soilless culture as a feasible option (Fukuda and Anami 2002, Sakuma and Suzuki 1995). MBTOC notes however that even when growing in substrates there is a critical need for a high degree of sanitation and for the use of pathogen free transplants. Large numbers of growers can be trained to use substrates systems in a short period of time as experienced in many MLF projects (UNEP/TEAP, 2004). The CUN states that the Aichi Agricultural Research Centre (2005) identified the effectiveness of KGMMV control by methyl iodide in pot tests. MBTOC encourages the Party to continue to pursue the registration of methyl iodide for soil uses (methyl iodide was registered for imported timber in Japan in 2004, under JMAFF registration No. 21407).										
	MBTOC comments on economics 2009: The nomination was not based on economic arguments. CUN states that certain alternatives are being tested for technical and economic feasibility. These include inoculation of attenuated virus as vaccine and the bag cultivation system.										
Japan	Ginger (Field)	119.400	119.400	109.701	84.075	63.056	53.400	-	-	47.450	47.450
	MBTOC comments 2009: MBTOC recommends 47.450 tonnes for this use in 2011. MBTOC recognizes that the Party will phase-out all usage of MB by 2013 and that various regions will reduce their dosage rate as low as 16-20 g/m^2 under barrier films which are within or lower than MBTOC's standard presumptive rates. MBTOC recommends that all growing regions aim to reduce their rates to this level by 2011. The nomination is for control of *Pythium* spp. (*Pythium ultimum* var. *ultimum*, *Pythium zingiberium*) in open field cultivated ginger fields using MB (98:2) applied from small cans. MBTOC recognized the difficulties that growers have in adopting some alternatives and the time required to introduce alternatives and new disease management strategies. The CUN states that Cyazofamid controls Pythium efficiently but application rates and methods need to be investigated in more detail. The use of fungicides specific to Oomycetes, such as phosphonates, has been tested but data as to efficacy is not provided. This current nomination provides promise that alternative treatments to MB are now applicable to Japanese production systems for ginger.										

Country	Industry	CUE for 2005 (1ExMOP and 16MOP	CUE for 2006 (16MOP +2ExMOP+17MOP)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (addtl or new)
	MBTOC comments on economics 2009: The nomination was not based on economic arguments. CUN shows that hot water treatment is not economically feasible because of high initial and running cost, but provides no further details (i.e. data or sources). CUN also provides detailed data on the net revenue of alternatives (Dazomet, Metalaxyl) compared to MB, where both result in negative net revenue (in the case of Dazomet because of lower yields, and in the case of Metalaxyl because gross revenue is zero).										
Japan	Ginger (protected)	22.900	22.900	14.471	11.100	8.325	8.300	-	-	7.770	7.036
	MBTOC comments 2009: MBTOC recommends a reduced rate of 7.036 tonnes for this use in 2011. Currently three of five growing regions have good control of root diseases using a rate of 20-21 g /m^2 under impermeable film. MBTOC recommends that the other two regions adopt a rate of 25 g/m^2 (Wakayama and Miyazaki). This would reduce the nomination to 7.036 tonnes. The nomination is for control of *Pythium* spp. (*Pythium ultimum* var. *ultimum*, *Pythium zingiberium*) in protected ginger fields using MB (98:2) applied from small cans. MBTOC recognized the difficulties that growers have in adopting some alternatives and the time required to introduce alternatives and new disease management strategies. The CUN states that Cyazofamid controls Pythium efficiently, but application rates and methods need to be investigated in more detail. The use of fungicides specific to Oomycetes, such as phosphonates has been tested but data as to efficacy is not provided. Reduced emission technologies, such as low permeability barrier films, are now being used and should allow for much reduced dosage rates (e.g. 25 g/m^2 for 98:2 with LPBF). This current nomination has reduced the quantity by 15.2% from the 2010 application, but it is envisioned that alternative treatments to MB may be available by 2011 as several are pending registration for Japanese production systems for ginger. MBTOC suggests consideration be given to phosphonate fungicides (AG3) developed in Israel and shown to control Pythium and other Phycomycete induced diseases.										
	MBTOC comments on economics 2009: The nomination was not based on economic arguments. CUN states that Pic might cause a decrease in yield either by cutting short the harvest of the previous crop or a delay in planting, resulting in economic loss. CUN also shows that hot water treatment is not economically feasible because of high initial and running cost, but provides no further details (i.e. data or sources). CUN also provides detailed data on the net revenue of alternatives (dazomet, Metalaxyl) compared to MB, where both result in negative net revenue (in the case of dazomet because of lower yields, and in the case of Metalaxyl because gross revenue is zero).										

Country	Industry	CUE for 2005 (1ExMOP and 16MOP	CUE for 2006 (16MOP +2ExMOP+17MOP)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (addtl or new)
Japan	Melon	194.100	203.900	182.200	136.650	91.100	81.720	-	-	77.600	73.548
	MBTOC comments 2009: MBTOC recommends a reduced amount of 73.548 tonnes for this use in 2011. The recommended quantity represents a 10% reduction from the 20th MOP approved amount based on uptake of available alternatives, e.g. steam, soil less culture, grafting, pathogen free seeds,1,3 D+Pic and cultural practices such as rotation, root isolation and sanitation. Japan had made public of action plan of complete phase out of MB for critical use nomination for soil use in 2013 and submitted revised national management strategy to the Ozone Secretariat in April 2008. MBTOC acknowledges that the Party will phase out MB by using a variety of alternatives in 2013. The nomination is based on the need to control a particular virus of melons. Globally, this virus is not considered as a soil-borne pathogen but can survive in crop debris for several years. The problem mainly arises from continuous monoculture. An integrated program including cultural practices has been proven to be effective in many other countries. The Party has indicated that rotation to non-susceptible hosts such as tomatoes and strawberries is an effective way to reduce virus incidence (Matsuo and Suga, 1993). MBTOC urges the Party to increase adoption of LPBF which allow for reducing MB doses by up to 50%. MBTOC recognises the unique farming system used for melons in Japan which has been in place for many years. However, in many countries some melon production has already shifted to substrates in greenhouse conditions and has become the most widely used technique for eliminating a wide array of soil-borne plant pathogens. Inexpensive and simple systems (buckets, bags, etc.) are available for this kind of production and are widely used in around the world (Leoni and Ledda, 2004; Budai, 2002; Savvas and Passam 2002; Akkaya & Ozkan, 2004; Engindeniz, 2004). Substrate production, when implemented correctly can produce higher yields than MB (MBTOC, 2002, 2006; Batchelor 2000, 2002; Savvas and Passam 2002). Studies conducted in Japan support soil less culture as a feasible option (Fukuda and Anami 2002, Sakuma and Suzuki 1995). MBTOC notes however that even when growing in substrates there is a critical need for a high degree of sanitation and for the use of pathogen free transplants. Large numbers of growers can be trained to use substrates systems in a short period of time as experienced in many MLF projects (UNEP/TEAP, 2004). Resistant root stocks are now available in Japan. However, according to the party, the root stocks are not resistant to all the pathogen races. High yielding varieties resistant to the virus are available. Steam has also been found to control the virus, particularly in the upper soil layer.										
	MBTOC comments on economics 2009: The nomination was not based on economic arguments. CUN states that certain alternatives are being tested for technical and economic feasibility. These include inoculation of attenuated virus as vaccine and the bag cultivation system. CUN also shows, based on data from Chosei region, Chiba Prefecture that a resistant cultivar produces only 30.8% in net revenue compared with the conventional cultivar with MB.										

Country	Industry	CUE for 2005 (1ExMOP and 16MOP	CUE for 2006 (16MOP +2ExMOP+17MOP)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (addtl or new)
Japan	Pepper (green & hot)	187.200	200.700	156.700	121.725	81.149	72.990	-	-	68.260	65.691
	MBTOC comments 2009: MBTOC recommends a reduced amount of 65.691 tonnes for this use in 2011, which represents a 10% reduction from the approved amount in 2010. The Party nominated an amount which represented 6.49% reduction from the amount nominated for 2010. According to the Party, this reduction is due to the introduction and deployment of alternative technology, more distribution of low permeable barrier film with the dose rate reduction and reduction if the frequency of MB application to every two years. In comparison to the previous nomination, one region did not apply for 2011, resulting in 5 regions instead of 6. Japan provided a comprehensive National Action Plan detailing step wise phase out by 2013 using a range of alternatives. MBTOC acknowledges the excellent National Action Plan to phase out MB by 2013. They also provided details of an additional strategy which involves immunisation with avirulent virus strains, use of soil less culture and resistant varieties which the Party believes will be widely accepted in the future. According to the Party, the development of resistant varieties is progressing well for the control of some viral strains. The Party reported also that soil less culture (bag cultivation, Kaneko 2006) using various substrates (disease free soil from mountain, paddy field, peat moss, coconuts shell and timber bark) are being used. Also, resistant varieties (Bagu 1 gou and L4 Miogi) are currently available to some PMMoV strains, plant vaccination by attenuated virus (Kanda, 2008), grafting on resistant root stocks (Anou 4 gou and 5 gou) are feasible alternatives. Others such as biological control, wrapping the underground part of seedling with easily decomposing paper and soil amendments are under development.										
	MBTOC comments on economics 2009: The nomination was not based on economic arguments. CUN states that certain alternatives are being tested for technical and economic feasibility. These include inoculation of attenuated virus as vaccine and the bag cultivation system.										
Japan	Watermelon	129.000	98.900	94.200	32.475	21.650	14.500	-	-	13.870	13.050
	MBTOC comments 2009: MBTOC recommends a reduced amount of 13.050 tonnes for this use in 2011. The recommended quantity represents a 10% reduction from approved amount at the 20th MOP based on uptake of available alternatives, e.g. steam, soil less culture, grafting, pathogen free seeds, 1,3-D and Pic and cultural practices such as rotation, root isolation and sanitation. Japan had made public an action plan to complete phase out of MB for MB soil use by 2013 and submitted a revised national management strategy to the Ozone Secretariat in April 2008. MBTOC acknowledges that the Party will phase out MB by using variety alternatives in 2013. The nomination is based on the need to control a particular virus of watermelons. Globally, this virus is not considered as a soil-borne pathogen but can survive in crop debris for several years. The problem mainly arises from continuous monoculture. An integrated program including cultural practices has been proven to be effective in many other countries. The Party has indicated that rotation to non-susceptible hosts such as tomatoes and strawberries is an effective way to reduce virus incidence (Matsuo and Suga, 1993). MBTOC urges the Party to increase adoption of LPBF which allow for reducing MB doses by up to 50%. MBTOC recognises the unique farming system used for watermelons in Japan which has been in place for many years. However, in many countries some watermelon production has already shifted to substrates in greenhouse conditions and has become the most widely used technique for eliminating a wide array of soil-borne plant pathogens. Inexpensive and simple systems (buckets, bags, etc.) are available for this kind of production and are widely used in around the world (Leoni and Ledda, 2004; Budai, 2002; Savvas and Passam 2002; Akkaya & Ozkan, 2004; Engindeniz, 2004). Substrate production, when implemented correctly can produce higher yields than MB (MBTOC, 2002, 2006; Batchelor 2000, 2002; Savvas and Passam 2002). Studies conducted in Japan support soil less culture as a feasible option (Fukuda and Anami 2002, Sakuma and Suzuki 1995). MBTOC notes however that even when growing in substrates there is a critical need for a high degree of sanitation and for the use of pathogen free transplants. Large numbers of growers can be trained to use substrates systems in a short period of time as experienced in many MLF projects (UNEP/TEAP, 2004). Resistant root stocks are now available in Japan. However, according to the Party, the root stocks are not resistant to all the pathogen races. High yielding varieties resistant to CGMMV are also available. Steam has also been found to control the virus, particularly in the upper soil layer.										

Country	Industry	CUE for 2005 (1ExMOP and 16MOP	CUE for 2006 (16MOP +2ExMOP+17MOP)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (addtl or new)
	MBTOC comments on economics 2009: The nomination was not based on economic arguments. CUN states that certain alternatives are being tested for technical and economic feasibility. These include inoculation of attenuated virus as vaccine and the bag cultivation system.										
United States	Cucurbits	1,187.800	747.839	592.891	486.757	407.091	302.974	-	-	218.032	195.698
	MBTOC comments 2009: MBTOC recommends a reduced amount of 195.698 tonnes for this use in 2011. The reduction is based on adjustment for the standard dosage rates from 150-175kg/ha to 125-150 kg/ha for MB/Pic mixtures with barrier films, which are the highest use rates considered necessary by MBTOC for these crops. From the recommended amount, 13.095 t are for Georgia squash, 10.087 t for Georgia cucumber; 39.598 t for Georgia melon; 127.950 t for the Southeast region, and 4.969 t for Maryland and Delaware. MBTOC acknowledges the reduction made by the Party for transition to a 3 way combination of 1,3 D + Pic, followed by Pic alone, followed by metham-sodium, that shows good results against key cucurbit pests in spring season fumigation. MBTOC notes that MI is not yet registered for use in these crops, but the Party stated cucurbits could likely be added to the label during 2009 (Chism, pers. com. 2009). If this happens, MBTOC expects a considerable impact on future nominations. MBTOC is aware of progress reported on several recent studies showing halosulfuron will effectively control yellow and purple nutsedge and a number of other weeds common in vegetable production, alone or combined with other herbicides (Macrae *et al*., 2008; Trader *et al*., 2008; Brandenberger *et al*., 2005) on cucurbits and other related crops (Norsworthy, et al, 2007; Bangarwa, et al., 2008). Also glyphosate appears as a suitable tool for managing nutsedge between spring and autumn crops (Webster et al. 2008). The Party showed references which supported use of alternatives in combination with LDPF (Culpepper, 2006). Other studies on possible effective alternatives are available (Ristaino and Johnson, 1999, Babadost and Islam 2002, Johnston et al 2002, Driver and Lows 2003). A combination of 1,3-D or metham sodium with Pic + herbicides (Trifluralin, napropamide, halosulfuron, s-metalochlor) is considered as the best alternative strategy in Florida for nutsedge control in several crops. MBTOC stresses the need of considering also non chemical methods within an integrated pest management strategy. Hausbeck, Lamour and others (2004) have reported many efficient management strategies to control Phytophthora on pepper, including crop rotation with non susceptible hosts (carrots, beans, onions, asparagus, soybeans, alfalfa), cultural control (water management, plant density, soil amendments, protective mulch, raised beds etc.) and the use of registered fungicides (Mefonoxan, Dimethomorph, Zoxamide + Mancozeb, Copper hydroxide+dimethomorph). MBTOC notes the use of grafting and resistant varieties are considered as alternatives for long lasting crops in many Mediterranean countries (Bello, et al., 2001). Yellow nutsedge emergence in transplanted cantaloupe was suppressed by the combined effects of thin-film mulches and competitive size differential provided by using cantaloupe transplants (Johnson & Mullinix, 2007). Incorporating Brassica spp. residue to reduce populations of soilborne fungi of watermelon was also tested, with interesting results (Njoroge, 2008)]										
	MBTOC comments on economics 2009: According to the CUN, where nutsedges are severe, metham-sodium used alone is technically and economically infeasible due to planting delays, yield losses and inconsistent efficacy, while 1,3 D + Pic is economically infeasible in some areas due to a 21 day planting delay and yield losses. Economic data to support these arguments as well as the CUN generally are provided for all areas and all alternatives. CUN shows expected yield losses of 6 percent in Maryland and Delaware, 29 percent in the Southeastern states and 50% in Georgia. CUN notes these regions may experience lower prices because of missed market windows. The UGA-3-WAY research conducted at the University of Georgia is feasible and the CUN was adjusted to reflect this reduction in southern states in areas that do not face Karst geology issues as a replacement of a MB+ Pic spring time application.										

Country	Industry	CUE for 2005 (1ExMOP and 16MOP	CUE for 2006 (16MOP +2ExMOP+17MOP)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (addtl or new)
United States	Eggplant (field)	76.721	82.167	85.363	66.018	48.691	32.820	-	-	21.561	19.725
	MBTOC comments 2009: MBTOC recommends a reduced amount of 19.725 tonnes for this use in 2011. The reduction is based on adjustment for the standard dosage rates from 150-175kg/ha to 125-150 kg/ha for MB/Pic mixtures with barrier films, which are the highest use rates considered necessary by MBTOC for this crop. The Party has made a 35% reduction in MB use from the amount approved by the Party's for 2010. Of this amount, 8.745 t are for Georgia and 10.980 t are for Florida. The Party did not recommend a CUN for Michigan for 2011. US nomination is only for those areas where the alternatives are still under extensive evaluation and pest pressure (nutsedge, nematodes and P. capsici) is high. The Party is projecting rates of 150 kg/ha for pathogens and 175 kg/ha for nutsedge. MBTOC accepted rates nominated by the Party for use with barrier films. The Party states that the treatment, known as the "UGA 3-WAY", consisting of three successive soil fumigations, beginning with 1,3-D + Pic application, followed by a Pic application, followed by a metham-sodium or metham-potassium application (Culpepper, 2007a) is an alternative for MB in spring crops. For summer and fall crops, this system needs further development for use in areas with moderate to high nutsedge pressure. In addition, metham sodium and metham potassium in the fall require longer waiting periods for planting than MB. Delays could result in missed market windows. A further constraint to adoption of the UGA-3 WAY is that 1,3-D is restricted in areas of Karst topography where ground water is vulnerable to leaching from 1,3-D. The Party states that trials with dimethyl disulfide (DMDS) plus Pic are promising, but this combination does not effectively control certain grasses (MacRae and Culpepper, 2008). Trials will continue with this alternative. An application to register DMDS is under consideration at USEPA. MI is not registered for eggplant. The US nomination is only for those areas where the alternatives are still under extensive evaluation and pest pressure (nutsedge, nematodes and P. capsici) is high.. MBTOC accepted rates nominated by the Party for use with barrier films (1164-165 Kg/). MBTOC also accepted the Party's substantial reductions for uptake of other alternatives. The Party states that a 50:50 formulation (MB/Pic) is widely used in Florida but does not provide information about the formulation used in Georgia. MBTOC considers that further reductions in MB amount may be possible with changes to formulations of 30:70 used in combination with barrier films commercially feasible. According to the Party, non chemical alternatives such as grafting, soilless culture, are not suitable alternatives. MBTOC considers that the Party should develop these alternatives which are widely used in many countries and regions with similar climate and pest (Besri, 2008). It is important to note that MB is not used in any other non A5 country on eggplant.										
	MBTOC comments on economics 2009: The nomination is partly based on economic arguments. CUN notes that the treatment known as UGA-3-WAY is being tested, as is another potential alternative, Dimethyl disulfide (DMDS), with promising results. However, further testing of both is required. CUN provides detailed partial (and provisional) budgets for Georgia and Florida that show that the UGA-3-WAY Spring application may yield equal (Florida) or higher (Georgia) net farm income than MB but that the Fall application results in negative net farm income in both areas.										

Country	Industry	CUE for 2005 (1ExMOP and 16MOP	CUE for 2006 (16MOP +2ExMOP+17MOP)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (addtl or new)
United States	**Forestry nursery**	**192.515**	**157.694**	**122.032**	**131.208**	**122.060**	**117.826**	**-**	**-**	**106.043**	**93.547**
	MBTOC comments 2009: MBTOC recommends a reduced amount of 93.547 tonnes for this nomination in 2011 which includes 53.703 t for Southern Forest Nursery, 3.978 t for International Paper, 11.162 t for Weyerhaeuser (SE), 12.304 t for Weyerhaeuser (NW), 8.467 t for NE Forest & Conservation Nursery, and 3.933 t for Michigan Seedling Assoc. The nominated amount has been adjusted to 260 kg/ha (26 g/m^2) for nutsedge control and 200 kg/ha (20 g/m^2) for pathogens to conform to the standard presumption for dosage rate of MB/Pic formulation under HDPE. A 10% reduction has been made to the nominated amount to account for adoption of alternatives, particularly MI. Key pests are nutsedge, nematodes and fungi; propagative material requires a very high level of pathogen control in order to avoid their widespread distribution from the nursery to the production fields. The CUN is for nurseries with moderate or high pest pressure where alternatives are not effective. Nutsedge has no effect on certification, but the Party states that it does affect yield by 3-5%. MBTOC requests that further nominations clearly show the trend in yield loss caused by nutsedge, nematodes or fungal pathogens over the number of seasons following fumigation with MB and alternatives and a breakdown of the economic comparisons to MB treatment. For the Northeast Forest and Conservation Nursery, only 40% is for nutsedge control and 60% of the nomination was adjusted to conform to standard presumptions of 20 g/m^2. For Michigan Seedlings only 50% is for nutsedge control, so 50% of the nomination was adjusted to 20 g/m^2. The nomination is for certified forest seedlings produced in 6 forest nursery regions. The CUN is based on economic infeasibility of use of substrates and the lack of effective alternatives for control of nutsedge and a range of fungal pathogens and nematodes. The key alternatives are MI which has been recently registered, 1,3-D/Pic, 1,3-D /Pic/metham sodium and metham sodium + Pic. The Party acknowledged that Pic and metham when used in conjunction with barrier films (LPBF) may provide an effective technical alternative and avoid crop injury. Enebak et al. (2007) found that with LPBF, use rates of MB can be significantly reduced. Party states that gluing of LPBF that is necessary for broadacre fumigation of nursery stock is not commercially available, but progress has been made in this respect. LPBF will be adopted when the effective gluing technologies are locally, commercially available, however, MBTOC expects that future nominations will be based on its use. MBTOC observed a demonstration of an effective heat welding technique used with barrier films that was initially described for use with HDPE for solarization trials in Israel (Grinstein and Hetzroni, 1991; Grinstein, 1992). MBTOC considers that glyphosate can be used as a pre-treatment to reduce pressure from nutsedge. However, this herbicide has been shown to cause phytotoxicity under nursery conditions. MBTOC acknowledges the initiation of large scale demonstration trials for this sector by the Party now with promising results (Quicke, 2008; Weiland, 2008). A report from this trial on the first year of the 5 year trial, indicates that seedling counts similar to MB were achieved by several other treatments, but no indication of pathogen or weed pressure was given (Quicke et al., 2007). Limited substrate production of these crops is reported as economical for small niche markets; however, MBTOC is aware that International Company, one of the applicants within this CUN, produces over 40 million tree seedlings per year in substrates in their Brazil operation. Frequency of fumigation is once in two to four years, depending on crop. Rotation and cover crops are not fumigated. Research is on-going to reduce rates from 98:2 MB/Pic commonly used where nutsedge populations are severe to using reduced rates of 67:33 MB/Pic. This transition has already been made in 70 % of the forest nurseries in the south where nutsedge populations are not severe.										

Country	Industry	CUE for 2005 (1ExMOP and 16MOP	CUE for 2006 (16MOP +2ExMOP+17MOP)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (addtl or new)
	MBTOC comments on economics 2009: The nomination is partly based on economic arguments. CUN shows that MI provides the same yields as MB, but that fumigation and hand weeding costs increase. This results in a decline in net operating revenue for the Southern Forest Nursery Management Cooperative of 7%, for Arborgen of 10%, for Weyerhauser of 18%, for Northeastern Forest and Conservation of 14%, and for Michigan Seedling Association of 4%. CUN emphasizes that these results do not show other possible impacts due to a) a potential loss in efficacy if current studies overestimate yields using MI; b) the cost advantages in the forest in terms of lower pest pressure (e.g. faster growth, less use of pesticides) when MB is used; c) the fact that MI will have to be accepted by state control boards as meeting phytosanitary requirements for nursery shipments; d) the fact that fumigation contractors and nurseries do not currently have the equipment to broadcast MI; and e) lack of clarity as to whether the MI label (MIDAS) allows its use for production of deciduous tree seedlings, which are generally more valuable than conifer seedlings and have greater pest management requirements.										
United States	Nurseries stock (fruit, nut, flower)	45.800	64.528	28.275	51.102	25.326	17.363	-	-	7.955	7.955
	MBTOC comments 2009: MBTOC recommends a total of 7.955 tonnes for this use in 2010. This comprises 0.955 tonnes for roses, and 7.0 tonnes for fruit and nut trees. This nomination is for propagation materials that need to be certified as free of pests and diseases, even if certification is voluntary in this state. The rates in the nomination conform to MBTOC's standard presumptions. MBTOC recognises that propagative material requires a very high level of soilborne pest and pathogen control in order to avoid their wide spread distribution. MBTOC acknowledges the Party's adoption of MB:Pic formulations of 67:33 and 50:50 as is used in other countries. MBTOC acknowledges the federal registration of MI for use in nurseries, but also recognizes that it is not yet registered in California.										
	MBTOC comments on economics 2009: The nomination is not based on economic arguments. CUN concludes that 1,3-D+Pic is an economically feasible alternative to MB in California Rose production where Telone® restrictions do not apply. A similar conclusion is reached with regard to California deciduous fruit and nut nursery trees; however, township restrictions and certification restrictions hinder growers from using Telone® and render it technically infeasible.										
United States	Orchard replant	706.176	527.600	405.400	393.720	292.756	215.800	-	-	203.591	183.232
	MBTOC comments 2009: MBTOC recommends a reduced amount of 183.232 tonnes for this use in 2011. A 10% reduction has been made to the nominated amounts to account for uptake of alternatives proven to be effective (Browne *et al,* 2007; 2008; McKenry, 2006). The CUN is for orchard/vineyard replant disorder of unknown etiology; heavy soils or soils which cannot be treated to a sufficient depth to effectively use the reduced rates of 1,3-D now allowed in California. Regulatory constraints (maximum labeled rate) prevent the use of 1,3-D at the rates needed for effective kill of old roots and the associated pathogens in deeper soil layers for heavier (fine-textured) soils. Three alternatives,1,3-D alone and 1,3-D combined with Pic or metham sodium, are available technical alternatives according to the CUN for treatment in light soils. Although a two year fallow was found to be effective under Mediterranean conditions by Bello, *et al.*, 2004, Schneider, *et al.*, 2004 found that a four year fallow did not sufficiently eliminate the causative nematodes. Recent promising results with a one year fallow combined with Nemaguard rootstock have been reported by McKenry (2006). The Party confirms that MB/Pic 67:33 formulation is used for California stone fruit, raisin grapes and wine grapes and now as well for almond and walnut at a dose rate of 20g/m^2. Commercial adoption of 67:33 formulation and others containing lower amounts of MB (e.g. 50:50) were used predominantly for orchard replant treatment in other countries before switching to alternatives. The recommended amount is based on application of MBTOC's standard presumption of 200 kg/ha (20 g/m^2) for control of pests and pathogens without the use of LPBF. MBTOC recognizes that regulatory restraints prevent the use of LPBF barrier films with MB in California but urges the Party to consider continued evaluation of their use to improve the performance of alternatives.										

Country	Industry	CUE for 2005 (1ExMOP and 16MOP	CUE for 2006 (16MOP +2ExMOP+17MOP)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (addtl or new)
	MBTOC comments on economics 2009: The CUN states that the use of partial budgeting does not depict the real cost of orchard replant due to the fixed cost and the non-bearing years of the orchard. Instead, a cost benefit analysis with a 7% discount rate is used that takes these factors into account. *Walnut orchard:* The CUN refers back to the partial budget and mentions that MB results in about $530 more per hectare than a hectare treated with 1,3-D and Pic. However the NPV and IRR (close to 14%) of both alternatives are similar. *Almonds:* CUN states that the results of walnuts would also apply to almonds grown on heavier soils. Tree mortality has been estimated as high as 50% where almonds are replanted, with a 25- 40% yield loss with one year fallow and no fumigant treatment and a reduction of 24-35% compared to MB. Accordingly, the CUN argues that the use of MB adds value of $63.3 million annually to California nut production *California Stone Fruit:* CUN states that differences in net operating revenue for even small changes in yield can be substantial. This analysis suggests that the benefits of MB alone are approximately $125/hectare. A decrease of 12% in net operating revenue in the partial budget results, but both alternatives have a negative NPV although MB provides additional benefits. *California Grape:* In the case of California grapes MB shows no benefit over 1,3-D once a vineyard is in production. However in cases where 1,3 D cannot be used because of township caps MB results in an additional $270/perhectare compared to metham sodium and an additional cost of $400 compared to no fumigation. However the net present value using MB and 1,3 D results in negative figures which questions the viability of investing in grapes. The CUN concludes that MB and Pic contribute about $7.2 million annually to the California economy in area where 1,3D cannot be used.										
United States	Ornamentals	154.000	148.483	137.835	138.538	107.136	84.617	-	-	70.178	64.307
	MBTOC comments 2009: MBTOC recommends a reduced amount of 64.307 tonnes for this use in 2011. This includes 52.167 t for California and 12.141 t for Florida. MBTOC acknowledges the substantial reduction in Florida. MBTOC does not recommend the requested usage for New York as alternatives are available for replacing this use in *Anemone coronaria* cut flowers i.e. steam and substrates under protected cultivation (Fennimore *et al.,* 2008; Rea *et al.*, 2008). The nomination is for a large number of species, mostly grown in the field. In Florida, the main species using MB are gladioli, lilies and snapdragon. Additional species using MB in California include calla lily, delphinium, dianthus, eustoma, freesia, helianthus, hypericum, iris, larkspur, liatris, matthiola, and ranunculus. MB is needed to control diseases (e.g., *Fusarium* spp., *Pythium* spp., *Phytophthora* spp., and *Rhizoctonia* spp.), plant parasitic nematodes (e.g., root knot, root lesion, stunt and dagger), weeds (e.g. *Cyperus* spp. *Portulacca, Ambrosia* and others), and previous crop propagules. The Party has adjusted dosage rates for all regions to 20 g/m^2 which conforms to MBTOC's standard presumptions. MBTOC considers alternatives available for some flower types in California, for example 1,3-D/Pic, metham sodium and combinations (Klose et al., 2007, Klose, 2008) and has reduced the nomination by 10% for phase in of these alternatives. In Florida, MI is now registered and other alternatives are available, for example 1,3-D/Pic and solarization sometimes combined with chemicals (McSorley *et al*, 2006 ab; McSorley *et al*, 2008)										

Country	Industry	CUE for 2005 (1ExMOP and 16MOP	CUE for 2006 (16MOP +2ExMOP+17MOP)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (addtl or new)
	MBTOC comments on economics 2009: The nomination was not based on economic arguments. A major change in this CUN is the availability of MI in Florida (registered in 2008), but not in California and New York. Its economic impacts as an alternative to MB are relatively small. The partial budget of Florida lilies resulted in a 4% loss as a percentage of net operating revenue. However CUN mentions that loss figures may not be completely accurate since some nurseries are publicly owned (i.e. subsidized seedling prices and production cost). In addition few long-term trials have been implemented. With regards to substrates some crops (e.g. roses) experience yield gains however for most crops an increase in yield is not enough to offset the increased cost of production. A partial budget was also conducted for California Lily and Ranunculus using 1,3D+pic, Dazomet and Metham Sodium with significant losses (as a percentage of net operating revenue) compared to MB ranging from 194-243%. For New York anemones partial budgeting considered steam sterilization with 0%-10% and 20% yield losses due to the lack of research resulting in the absence of yield loss estimates. Losses (as a percentage of net operating revenue) range between 9.1 to 30%. CUN also mention that some growers have attempted using steam but switched back due to high costs and applications issues.										
United States	Peppers (field)	1,094.782	1,243.542	1,106.753	756.339	548.984	463.282	-	-	212.775	206.234
	MBTOC comments 2009: MBTOC recommends a reduced amount of 206.234 tonnes for this use in 2011. The reduction is based on adjustment for the standard dosage rates from 150-175kg/ha (15 to 17 g/m$^{2)}$ to 125-150 kg/ha (12.5 to15 g/m^2) for MB/Pic mixtures with barrier films, which are the highest use rates considered necessary by MBTOC for this crop. The Party has made a 53.4% reduction in MB use from the amount approved by the Party's for 2010. MBTOC acknowledges the substantial reduction by the Party for uptake of alternatives. Of this amount, 32.926 t is for Georgia, 164.158 t is for Florida and 9.150 t is for the Southeast. The Party did not submit a CUN for Michigan for 2011. The Party is projecting rates of 150 kg/ha (15 g/m^2) for pathogens and 170 kg/ha g/m^2) for nutsedge. In addition, the party states that the treatment, known as the "UGA 3-WAY", consisting of three successive soil fumigations, beginning with 1,3-D + Pic application, followed by a Pic application, followed by a metham-sodium or metham-potassium application (Culpepper, 2007a) is an alternative for MB in spring crops. For summer and fall crops, this system needs further development for use in areas with moderate to high nutsedge pressure. In addition, 1,3-D is restricted in areas of Karst topography where ground water is vulnerable to leaching from 1,3-D. In addition, metham sodium and metham potassium 1,3-D in the fall require longer waiting periods for planting than MB. Delays could result in missed market windows. The time limitations on the registration of Midas, a mixture of MI and Pic have been removed and this product has shown good efficacy against key pepper pests, including nutsedge, in a number of trials with peppers and related vegetables such as tomatoes. Midas has received state-level approval in 47 US states (California, Washington, and New York are the exceptions at this time). However, the Party states that some time will be necessary before Midas achieves a full adoption. Constraints: (1) the cost of MI formulations which is higher than MB, (2) growers and researchers will need time to evaluate MI use in the various local production conditions covered by this nominations, and (3) growers and applicators will need to make some equipment modifications to adapt to the lower flow rates typical with less expensive MI application rates and to avoid the corrosion of some metals that can occur with MI (Sumner 2005, Noling *et al*., 2006).The Party states that trials with dimethyl disulfide (DMDS) plus Pic are promising, but does not effectively control certain grasses. Trials will continue with this alternative. An application to register DMDS is under consideration at US EPA. MBTOC considers that further reductions in MB amount is possible with changes to formulations of 50:50 MB/Pic or less (e.g. to 30:70) used in combination with barrier films, however the reduction in the nominated amount was not based on use of these formulations.According to the Party, non chemical alternatives such as grafting soilless culture, are not commercially feasible. MBTOC considers that the Party should develop these alternatives which are widely used in many countries and regions with similar climate and pest. It is important to note that MB is not used in other country on pepper.										

Country	Industry	CUE for 2005 (1ExMOP and 16MOP	CUE for 2006 (16MOP +2ExMOP+17MOP)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (addtl or new)
	MBTOC comments on economics 2009: The nomination was partly based on economic arguments**.** CUN describes the economic impact of using MI as being negligible; as a result it appears to be technically feasible in all parts of the US where it has been registered. However, growers require time to transition; hence the amount of MB nominated has been adjusted downward. In Georgia, Florida, and the Southeastern U.S., the Georgia 3-Way on spring plantings and MI are considered technically (and thus economically) feasible alternatives, although some limitations exist. The loss of gross revenue using the Georgia 3-Way is negligible in Florida and the Southeastern U.S., while gains in gross revenue are expected in Georgia. Although no gains in gross revenue are expected when using MI, losses in net revenue are negligible. One drawback to the Georgia 3-Way is that yield losses are expected in fall plantings, with studies in Georgia's application show a 50% yield loss. These losses are not expected when MI is used. The Georgia 3-Way also cannot be used on peppers that are grown in karst soils since it contains 1,3-D; however, MI can.										
United States	Strawberry (field)	2,052.846	1,730.828	1,476.019	1,349.575	1,269.321	1007.477	-	-	1023.471	812.709
	MBTOC recommends a reduced amount of 812.709 tonnes for this use in 2011. The reduction is based on adjustment for the standard dosage rates from 150-175kg/ha to 125-150 kg/ha for MB/Pic mixtures with barrier films in the Eastern States, which are the highest use rates considered necessary by MBTOC for this crop, and greater uptake of alternatives (Pic EC, 1,3-D/Pic) and mixtures of MBPic with lower rates of MB (MB/Pic 50:50 or less) in California The recommended amounts are 751.596 tonnes for California, 20.009 tonnes for Eastern USA and 41.104 tonnes for Florida. For California, the Party nominated 952.543 t (4,856 ha at 196 kg/ha). However the volume that approved by the Party's for 2010 was 856.598 t on 4,370 ha and hence there is an increase in the area and amount requested. The nomination is based on township caps limiting further adoption of 1,3-D and county regulations affecting use of high rates of Pic in some counties on a case by case basis. The nomination states that two emerging disease problems in California and the persistence of yellow nutsedge are the main reasons why further adoption of alternatives is unlikely. In California the nomination was reduced to account for uptake of alternatives where township caps have not been exceeded and to account for greater uptake of formulations of MB/Pic 50:50. PUR use data for 2007 show that 98:2 and 67:33 formulations are still being used, and even though that 57:43 was used on 70% of the California strawberry area, MBTOC considers that transition to MB/Pic 50:50 is still possible (2.5% adjustment). The 2007 use rates of MB dose in formulations for 50:50 mixtures are 170 kg MB/ha (i.e. 170 kg Pic/ha) compared to 57:43 mixtures at 209 kg MB/ha (i.e. 158 kg Pic/ha) respectively. Both dose rates respect the restrictions on use of Pic and should enable 50:50 formulations to be used more widely. The most recent PUR data (2003-2007) showed that alternatives based on 1,3-D, Pic and metham have been widely adopted in some counties, but not others, (i.e. good adoption in Ventura but little adoption in Monterey) between 2000-2007. In California, 1,3-D use increased from 2,001 ha (2003) to 4,752 ha (2007) and metham sodium increased from 384 ha (2001) to 745 ha (2007). PUR data indicate that in Ventura county alone the adoption rate of MB alternatives has been about 800 ha per year, across the years between 2003 and 2007. In Monterey and Santa Cruz, the historical proportional use of MB in this expanding area has been approximately 75% of the production area and this shows no progress in adoption of MB alternatives. Data on 2009 township caps have shown that there is room for further uptake of alternatives based on 1,3-D and other alternatives in some counties (Pic EC, Metham and Pic) and MBTOC has calculated a 10% reduction for uptake of alternatives. In the areas affected by township caps, trials with alternatives that do not contain 1,3-D (such as Pic, Pic EC, Pic + metham, Pic + dazomet, often with LPBF) provided yields that are statistically comparable with MB (Ajwa et al., 2002, 2003, 2004, 2005, 2006; Nelson et al., 2001ab; Shem-Tov et al., 2005, 2006ab). Pic EC provided an average 99% yield compared to MB, with low variance (studies cited in TEAP, 2006). Further clarification of the restrictions on the use of alternatives is required in future nominations. VOC regulations may provide an opportunity for growers to use barrier films in California, and the Party is urged to to consider their implementation. These films can be used with alternatives and can reduce the										

Country	Industry	CUE for 2005 (1ExMOP and 16MOP	CUE for 2006 (16MOP +2ExMOP+17MOP)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (addtl or new)
	dosage rates required for effective pathogen and weed control. In California, weed management research showed that the herbicide oxyfluorfen can be applied safely to strawberry for control of common weed species in annual plasticulture strawberry production, thereby reducing time required for hand weeding (Daugovish *et al.*, 2008). In Eastern states, the Party reports a transition rate of 52%. MBTOC considers this transition appropriate progress, given that IM/Pic has been registered in 2008 and is technically feasible for the total nomination area, but note that the Party applies a dose rate above the standard presumptions (12.5-15 g/m^2). For Florida, the Party reports a transition rate of 53%. Given that technically and economically feasible alternatives are available, MBTOC commends this transition and made no futher adjustment based on uptake of alternatives, but did adjust dosage rates to conform to the standard presumptions.										
	MBTOC comments on economics 2009: The nomination was not based on economic arguments**.** CUN states that eastern growers that have access to IM experience a decline of 1-4% in gross revenue in the first year of use due to increased costs to retrofit application equipment (hoses, nozzles, flow meters) that will allow the use of IM. Southeastern and Florida strawberry growers that use IM are expected to experience no change in yield or quality. For California strawberry producers, there is no change in impacts from previous year estimates as IM is under registration review but registration is not expected in the near future. The loss to gross revenue for growers using the best alternative to MB is estimated to remain about 14%.										
United States	Strawberry runners	54.988	56.291	4.483	8.838	7.944	4.690	-	-	7.381	4.690
	MBTOC comments 2009: MBTOC recommends 4.69 tonnes for California, but does not recommend amounts for the south east. The CUN comprises 4.69 tonnes for California and 2.691 tonnes for SE. The key pests affecting strawberry runners are weeds (purple and yellow nutsedge), fungi (*Rhizoctonia* and *Pythium spp* in SE, *Phytophthora*, *Verticillium in California*), nematodes (root-knot, sting in CA). The CUN is for MB use on 28 ha of 2172 ha, however 99% of the hectares are exempted under QPS. MBTOC does not recommend use of MB for North Carolina and Tennesee, as IM/Pic formulations are registered and are technically feasible (TEAP, 2006). These formulations have been shown to give similar pathogen control in soils and will meet requirements of certification (Kabir et al, 2005; Fennimore *et al* 2007, 2008; MBAO). MBTOC also believes distribution of IM/Pic across 11 ha should be very rapid and training is possible within the two year period for total adoption. For California, MBTOC recommends the nomination, but expects that future nominations will show reports of trials with key alternatives over the last few years in order to satisfy the criteria of Decision IX/6. The CUN states that MB at a dosage of 26.3 g/m2 in CA and 25.5 g/m^2 in SE is required to meet the certification standards for strawberry runners. The Party's request exceeds MBTOC's standard presumption of 200 kg/ha (20 g/m^2) of MB which is considered effective for production of 'high health' strawberry runners using LPBF and other emission control technologies (TEAP 2005); however, California's certification requirements specify minimum amounts of MB that must be applied. Furthermore, California regulations prohibit the use of LPBF with MB. The Party indicates that key alternatives include 1,3-D + PIC followed by dazomet, PIC followed by dazomet and MI/Pic, but that these have not been sufficiently tested on a commercial scale. MBTOC encourages the Party to expedite the commercial scale testing of these alternatives as well as the registration of MI in CA and to consider changes to there certification regulations in CA.										

Country	Industry	CUE for 2005 (1ExMOP and 16MOP	CUE for 2006 (16MOP +2ExMOP+17MOP)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (addtl or new)
	MBTOC comments on economics 2009: The nomination was not based on economic arguments. CUN states that IM is under registration review in California; however registration is expected to be at least one year in the future. The loss to gross revenue for growers using 1,3-D + Pic followed by an application of metham sodium at a rate of up to 250 lb ai./ha is estimated to be about 11%. California strawberry nursery growers are not expected to see any yield or quality impacts with 1,3-D + Pic plus metham sodium. Eastern growers that have access to MI are expected to experience a loss of 13% in gross revenue in the first year of use due to increased costs to retrofit application equipment (hoses, nozzles, flow meters) that will allow the use of MI. Southeastern Strawberry nursery producers that use MI are expected to experience no change in yield or quality.										
United States	Sweet Potatoes slips	None	0.000	0.000	18.144	18.144	14.515	-	-	14.515	11.612
	MBTOC comments 2009: MBTOC recommends a reduced amount of 11.612 tonnes for this use in 2011. The nomination was based on a rate of 180 kg/ha of MB. The basis of the nomination is that township caps limit the use of 1,3-D and 1,3-D combinations, however MBTOC notes that fungal pathogens are the key problem and not nematodes. MBTOC considers MS and Pic should be considered. The industry sector is now carrying out extensive trials for replacing MB. A recent trial indicate that Pic is providing transplants that give yields and returns above that of MB and new herbicides can control weeds. Varieties with greater tolerance to nematodes are available. If Pic proves successful in the forthcoming trials, MBTOC considers it can be adopted as a suitable alternative and would anticipate substantial adoption by 2011. Telone, the alternative to MB, cannot be used in Dec-Jan and township caps are exceeded in Nov which is the fumigation window for slips. MBTOC recognizes the importance of producing pest free seed stock. Test of reduced rates of Telone are being carried out as this is the preferred fumigant of growers. Trials by Stoddard (2008) show Pic to be a good alternative and to provide better yields and returns to growers than MB.										
	MBTOC comments on economics 2009: The nomination was not based on economic arguments. CUN shows trial data that reflect that yield increases by 11% with the use of Pic, resulting in a gain in gross and net operating revenue of 7 and 22% respectively.										

Country	Industry	CUE for 2005 (1ExMOP and 16MOP	CUE for 2006 (16MOP +2ExMOP+17MOP)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (addtl or new)
United States	Tomatoes (field)	2,876.046	2,476.365	2,065.246	1,406.484	1,003.876	737.584	-	-	336.191	292.751
	MBTOC comments 2009: MBTOC recommends a reduced amount of 292.751 tonnes for this use in 2011. The reduction is based on adjustment for the standard dosage rates from 150-175kg/ha to 125-150 kg/ha for MB/Pic mixtures with barrier films, which are the highest use rates considered necessary by MBTOC for this crop. The Party has made a 54% reduction in MB use from the amount approved by the Party's for 2010. Of this amount, 19.411 t is for Georgia, 219.240 t is for Florida and 40.821 t is for the Southeast, 12.914 t is for Virginia and 0.365 t is for Maryland. The Party did not recommend a CUN for Michigan. The Party is projecting rates of 150 kg/ha for pathogens and 175 kg/ha for nutsedge. The transition rate included in the nomination is based on an estimate of projected use of the "UGA 3-WAY", consisting of three successive soil fumigations, beginning with 1,3-D + Pic application, followed by a Pic application, followed by a metham-sodium or metham-potassium application as well as the increased use of MI (Culpepper, 2007a). The UGA 3-WAY has been shown to be effective for tomatoes in Georgia, but has not yet been successful in other parts of the Southern US and needs further development. In addition, 1,3-D is restricted in areas of Karst topography where ground water is vulnerable to leaching from 1,3-D. The time limitations on the registration of Midas, a mixture of MI and Pic have been removed and this product has shown good efficacy against key pepper pests, including nutsedge, in a number of trials with peppers and related vegetables such as tomatoes. Midas has received state-level approval in 47 US states (California, Washington, and New York are the exceptions at this time). However, the Party states that some time will be necessary before Midas achieves a full adoption. Constraints: (1) the cost of MI formulations which is higher than MB, (2) growers and researchers will need time to evaluate MI use in the various local production conditions covered by this nominations, and (3) growers and applicators will need to make some equipment modifications to adapt to the lower flow rates typical with less expensive MI application rates and to avoid the corrosion of some metals that can occur with MI (Sumner 2005, Noling *et al*. 2006).The Party states that trials with DMDS plus Pic are promising, but DMDS is not registered in the US. An application to register DMDS is under consideration at USEPA (MacRae and Culpepper, 2008). According to the Party, non chemical alternatives such as grafting soilless culture, are not economically feasible. MBTOC considers that the party should develop these alternatives which are widely used in many countries and regions with similar climate and pest (Besri 2008). It is important to note that MB is not used in other country on tomato.										
	MBTOC comments on economics 2009: The nomination was partially based on economic arguments. CUN concludes that MI would be the economically feasible alternative for use in Eastern and Florida US tomato production in areas exhibiting karst topographical features, but a transition period is required. In areas where karst features are not present it appears that tomato growers can use a combination of three fumigants applied sequentially (1,3-D, Pic, and metham-sodium/potassium) and achieve yields that are comparable to those produced by using MB for spring crops only.										

14.4 Interim CUN Report – Issues Specific to MBTOC Quarantine, Structures and Commodities

MBTOC notes a continuing concern about the difficulty its Non(A) 5 members experience in obtaining funding to attend MBTOC meetings. It is not sustainable for Parties to continue to expect many MBTOC members to pay own their travel expenses to attend meetings during which they work on the requirements of Parties and the Montreal Protocol. The MBTOC QSC meeting was attended by 14 of 19 members for part or all of the meeting; in addition, two MBTOC economists attended for two days of the meeting.

The Russian Federation has not previously submitted a Critical Use Nomination for methyl bromide use post phaseout. However, this year a nomination was made to use methyl bromide for control of a wide range of stored product uses and pests, in structures and commodities in trade. Initial review by MBTOC QSC indicated that almost all the pests concerned are on various quarantine pest lists, including that of the Russian Federation NPPO. At least part of the nomination would thus fall under the QPS exemption, and thus should not be included in a critical use nomination. The Ozone Secretariat and MBTOC are in correspondence with the Russian Federation to clarify this issue. A revised nomination, if made, may be considered at the next MBTOC meeting or intersessionally.

Parties continue to make progress reducing MB use for many of the repeat critical use nominations. For example, use of methyl bromide in Canadian and US flour milling continues to decrease. Israel completed its transition to heat treatment this year for disinfestation of flour mills and did not submit a CUN for 2010. Use of MB for postharvest disinfestation of tree nuts in the US has also almost entirely transitioned to alternatives; only a small CUN for a small portion of the walnut harvest remains.

In some cases, however, progress in adopting alternatives has stalled. For example, lack of regulatory approval to expand the use of technically effective alternatives, and/or concerns about the increased costs of using alternatives, has stalled adoption of alternatives for treatment of Canadian pasta facilities, US pet food facilities and US rice mills.

There has been no adoption of alternatives for packaged rice in Australia. Australia reports this is because the exceptionally low harvest volumes have prevented conduct of appropriate proving trials and prevented investments in alternatives. The Australian applicant has, however, invested in expansion by purchasing rice processing facilities in the US.

Logistical difficulties caused by short times between harvest and product delivery slow the adoption of alternatives for dried beans and some dried fruit in the US.

Lack of effective and registered alternatives for US dry cured pork, fresh chestnuts in Japan and US cheese stores results in continuing CUNs for methyl bromide, although at lower levels than in previous years. An active research program is in place to investigate alternatives for these commodities.

Continuing CUNs for methyl bromide have been made for some date varieties in Israel and the United States. In Israel, a successful heat treatment, developed for Medjool dates, is being tested to see if it can be expanded to other varieties. The use of methyl bromide for high moisture dates by some date-producing countries continues, in spite of their deep concern about this. This concern is expressed in Decision XV/12.

Additionally, since some prominent retailers in date-importing countries have indicated they will not accept methyl bromide treated dates and other foods produced by A5 countries, there is concern about trade losses. This year, UNIDO launched a project, with a MBTOC QSC member as lead scientist, to try to develop suitable alternatives, followed by a workshop to share information among interested Parties and experts, including MBTOC. An interim report on this project and workshop can be found in the Progress report.

14.4.1 Standard Dosage Presumptions and Adjustments for standard dosage rates

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 minimize the critical use and any associated emission of methyl bromide'. Decision Ex.II/1 also mentions emission minimization techniques, requesting Parties "…to ensure, wherever methyl bromide is authorized for critical-use exemptions, the use of emission minimization techniques that improve gastightness 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 dosage rates for fumigation of 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 world wide. 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, the use of lower dosages, combined with longer exposure periods, can reduce MB use while maintaining efficacy. Since agreeing the standard presumptions in 2005, with very little delay, all postharvest and structural CUNs have adhered to those presumptions.

14.4.2 Details of evaluations

Parties have submitted nine CUNs for the use of MB in structures and commodities in 2009. This total does not include the Russian Federation CUN which is on hold as discussed below. The total MB volume nominated in 2009 for non-QPS post-harvest uses was 197.802 tonnes, not including the nomination for 135 tonnes from the Russian Federation.

In this 2009 round, two nominations were for 2010 for a total MB amount of 6.30 tonnes and seven were for 2011 for a total MB amount of 191.502 tonnes.

Of these nominations, MBTOC recommended 4.569 tonnes for 2010 and, for 2011, 182.686 tonnes. MBTOC did not recommend 1.731 tonnes for 2010 and 8.816 for 2011. MBTOC was able to assess all nominations, although the CUN from the Russian Federation is still on hold pending further correspondence,

Table 14-12 provides the MBTOC QSC interim recommendations for the CUNs submitted in 2009.

SUMMARY

	Total post harvest CUN amounts (metric tonnes)	Total recommended amounts
2010	6.30 (a)	4.569
2011	191.502	182.686

(a) Nomination for 135 tonnes by the Russian Federation not included

Table 14-12: MBTOC QSC Interim Recommendations for the CUNs Submitted in 2009

Country	Industry	CUE for 2005 (ExMOP1 and MOP16	CUE for 2006 (MOP 16 +ExMOP2+ MOP17)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (new)
Australia	Rice	6.150	6.150	9.205	9.200	7.820	6.650	-	-	5.660	4.87

MBTOC comments 2009: MBTOC recommends 4.87 tonnes, a 14% reduction of the nominated amount for packed rice for Australia in 2011. Australia nominated 5.66 tonnes. In preparing this calculation MBTOC reviewed the actual MB use for packaged rice as reported in the Party's accounting frameworks for 2006, 2007 and 2008. Using the average of these three years as a baseline (6.085 tonnes), we then applied a 20% transition rate with the result of 4.87 tonnes. To date, Australia has not adopted any alternatives to methyl bromide for packaged rice. Other countries are achieving an average of 20% transition to alternatives per year. It is clear that phosphine treatment or controlled atmosphere treatments would provide the necessary pest efficacy for packaged rice and these alternatives are registered for this use in Australia. All other non-A(5) countries worldwide and many A(5) countries use methyl bromide alternatives for rice.

As we have noted in previous years, MBTOC does not find Australia's continued zero adoption of alternatives to be consistent with Decision IX/6. If it were to recommend the full 2011 nomination, MBTOC thought would be quite unlikely that there would be any adoption of alternatives, given the region's water allocation rules and arrangements and the drought described by the Party in this and previous CUNs. On page 5 of Party correspondence of March 31, the Party said "that the process of fumigating packaged rice is a quality control step, not a disinfestation step per se in order to guarantee a supply of high quality rice that is insect free. The applicant does not fumigate rice prior to processing nor are such facilities available to the applicant." MBTOC finds that the continued use of MB as a contingency against the possible presence of pests after milling, as opposed to using MB only in response to a known infestation, is an unacceptable use.

MBTOC comments on economics 2009:

This CUN is partly based on economic arguments. CUN states that two potential technically and economically feasible alternatives, namely sulfuryl fluoride and phosphine, have been identified. Sulfuryl fluoride, which requires less significant process changes and investment to implement, was registered in 2007 and trials commenced in January 2009. If trials prove it to be technically and economically feasible, the applicant indicates they may not require methyl bromide beyond 2012. On the other hand, phosphine fumigation is considered to be the best solution, both technically and economically, even though it would require a considerable change to processing methods and a substantial infrastructure investment. **It is not clear to MBTOC on what basis the applicant argues that phosphine is 'the best solution' in economic terms.** The CUN, in fact, relates the difficulties faced by the applicant in raising the capital for transition to phosphine. **Economic data are presented to show that the treatment costs with phosphine are expected to be 15.5 times as large as with methyl bromide, but this would not be the case if phosphine were to be used in the same way as MB for packaged goods**,.. CUN states further that the applicant has been unable to finance a transition to phosphine due to continued severe drought conditions in the growing area; hence it is unaffordable to them. **MBTOC cannot substantiate this claim based on an analysis of the financial statements of one enterprise. In late 2008, the applicant purchased a majority share in a US rice processing company. When questioned by MBTOC about the conflicting claim of its stated inability to invest in alternatives with this large investment in a facility, the applicant responded by pointing to the strategic nature of these investments during turbulence in the global rice market.**

Country	Industry	CUE for 2005 (ExMOP1 and MOP16	CUE for 2006 (MOP 16 +ExMOP2+ MOP17)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (new)
Canada	Mills	47 (included mills and pasta)	34.774	30.167 (included mills only)	28.650	26.913	22.878	-	-	14.107	14.107

MBTOC comments 2009:

MBTOC recommends the nominated 14.107 tonnes for the treatment of flour mills in 2011. The Party's nomination for 2011 is 38% less than the amount of MB approved by the Parties for 2010. The CUN includes 20 facilities, but the amount nominated only allows for one fumigation per year of 9 or 10 mills. Therefore the Party's nominated amount requires about 50% of the flour milling sector to transition to alternatives by 2011.

This is accomplished through two means: first, in the past few years the Party has conducted numerous trials and demonstrations of alternatives which have been reported to MBTOC. These trials, while not all entirely successful for pest efficacy, have allowed the sector to better understand and improve efficacy and management. Improvements in IPM techniques, including investments in new equipment and facility dust control, have also contributed to the reduced need for methyl bromide.

The Party has indicated concern about the difficulty in obtaining successful pest efficacy with alternatives and points out that Canadian mills are located in cold climate zones (defined as "considerable variation in ambient temperatures, including extended periods (4 to 5 months) of cold winter weather"). As a result the Party asserts that fumigations in winter months are essentially impractical. The CUN asserts that this heightens the importance of predictable and lasting (20 to 26 weeks) pest population control by chemical fumigation or heat treatment alternatives.

The Party has submitted test results indicating that the main mill pests require a higher than originally first considered dosage rate of sulfuryl fluoride to obtain sufficient efficacy. MBTOC acknowledges this and has seen this reported by Bell et al, 1999 and Bell et al, 2003. Reichmuth and Klementz, 2008 did examine methods to combine treatments to overcome the difficulty to obtain pest efficacy with some pest species found in mills during SF fumigations. As noted in MBTOC's review of flour milling alternatives, best efficacy with SF is seen when mill temperature is maintained throughout the fumigation period at or above 27˚ C, in all parts of the mill (TEAP, 2008).

The second factor allowing the Party's nominated transition to alternatives is that Canadian regulation now allows those companies which are included in the CUN to share the MB domestic allocation so that only those mills most in need of MB will receive the allocation. As part of its domestic regulations allowing this transfer of allocation, Government of Canada has further approval and reporting requirements, pursuant to Canada's Ozone-depleting Substances Regulations (ODSR 1998). 2008 was the first full calendar year in which the amended ODSR 1998 were in effect. Therefore, the mills which might be fumigated with MB may change each year, but only between the mills within the mill sector already included in the CUN.

The Party and MBTOC acknowledge the higher costs associated with alternative treatments. Additionally, MBTOC acknowledges that registration for sulfuryl fluroride in Canada is not yet complete and the lack of MRLs for fluorine residues arising from SF treatment makes the use of SF more difficult for some mills.

Differences in regulation between Canada and the US, the only other Party with a CUN for flour milling, only partly explain the differences in adoption of alternatives over time. As reported in TEAP 2008, MBTOC is examining sector structural differences to improve its understanding of the prospects for adoption of alternatives in the

Country	Industry	CUE for 2005 (ExMOP1 and MOP16	CUE for 2006 (MOP 16 +ExMOP2+ MOP17)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (new)

future. For example, in the US MBTOC has been told that 42% of mills also produce bakery or cereal mixes. On the other hand, the majority of the Canadian applicant's member companies are wheat milling establishments but the CUN also includes oat milling companies. Some of the mill locations participating in Canada's CUN for the flour milling industry operate bakery mix capacity that is co-located with the primary milling activity. Approximately 25% of mill locations participating in the CUN have bakery mix capacity on site. This difference may partly explain how Canada mills have been able to maintain a nearly similar transition rate to US mills even though the regulatory approval for sulfuryl fluoride is different in the two different countries.

MBTOC also notes the interconnection between Canadian CUNs for flour mills and pasta facilities. The CUN for flour mills includes four mills that process durum wheat into semolina used in the manufacture of pasta and one of these is both a durum mill and a pasta facility. Control of pests in the flour mill will then contribute to the reduction of pests coming into the pasta facility.

MBTOC comments on economics 2009:

This CUN is not based solely on economic arguments, although economic concerns are indicated. CUN argues that market penetration of the technically most viable alternatives is being hampered by:

Insufficient evidence that SF can be effective under Canada's typically cold weather conditions.

Lack of full registration of SF

Current market cost of heat treatment technology and services.

Concerns by the milling industry that repeat fumigations using phosphine may have a cumulative effect of corroding conductive metals present in electrical and electronic equipment and controls

CUN also states that, while the amount of sulfuryl fluoride required to fumigate for the exclusive presence of confused flour beetle is comparable in cost and volume to methyl bromide, the results of field trials already completed have demonstrated that 2 to 6 times as much SF is actually required to fumigate when red flour beetles are present, which represents a significant increase in cost. CUE notes that the required use of alternatives within a short time period would add an estimated 2 to 4 per cent to manufacturing costs of wheat flour, semolina and other milled grain products. In the current economic climate this added cost cannot be passed on down the supply chain. Furthermore, there are still no subsidies available to offset these increased costs. **MBTOC notes that lack of government financial assistance programs has not been a consideration in assessments of economic feasibility.**

Country	Industry	CUE for 2005 (ExMOP1 and MOP16	CUE for 2006 (MOP 16 +ExMOP2+ MOP17)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (new)
Canada	Pasta	(see Canada mills)	10.457	6.757	6.067	4.74	-	4.740	3.529	-	-

MBTOC comments 2009:

MBTOC recommends 3.529 tonnes, a 25.5% reduction of the nominated amount for pasta facilities in 2010. The Party nominated 4.740 tonnes for 2010 which did not show any adoption of alternatives over the amount granted by the Parties for 2009. The CUN includes three pasta facilities, each requesting one MB fumigation per year. MBTOC's reduced nomination allows for just two fumigations in this sector, thus necessitating one facility to transition to alternatives.

The method for sharing the MB domestic allocation amongst companies included in the CUN in the same sector is allowed under Canadian regulations. As part of its domestic regulations allowing this transfer of allocation, Government of Canada has further approval and reporting requirements, pursuant to Canada's Ozone-depleting Substances Regulations (ODSR 1998). 2008 was the first full calendar year in which the amended ODSR 1998 were in effect.

MBTOC's recommendation allows for a consistent approach to that taken by the Party for flour milling. Furthermore MBTOC notes that the equivalent CUN from the US, (the reader is referred to MBTOC text box for US NPMA), which is the only other CUN for pasta, has declined significantly each successive year, including an over 50% reduction in the nomination for 2011.

MBTOC acknowledges that registration for sulfuryl fluroride in Canada is not yet complete and the lack of MRLs for fluorine residues arising from SF treatment makes the use of SF more difficult for some pasta processing facilities. In Canada full registration of SF, including MRLs for fluorine residues in food resulting from SF fumigation of the facility, is expected in 2009. If that occurs, the Party indicates it will conduct another full site trial.

In the meanwhile, the sector conducted one trial using sulfuryl fluoride in 2008, and two trials in parts of facilities in 2007. The result of these trials were submitted to MBTOC (CPMA, 2009). Red flour beetle was the test species and the Party has noted that this species, common in mills and food processing facilities in North America, is more difficult to kill than other species with SF. MBTOC acknowledges this and refers the reader to Canada flour mills text box for references. The Party reported tests in three plants achieved 100% mortality for adults, but egg stage resulted in some survival with egg mortality ranging from 69-94%. Pest rebound occurred faster in SF fumigation than in comparable MB fumigations. Again as noted in MBTOC's review of flour milling alternatives improved efficacy with SF is seen when mill temperature is maintained throughout the fumigation period at or above 27degrees C, in all parts of the mill (TEAP,2008). The cost of SF treatment was higher than methyl bromide treatment.

The CUN page 10 says they can not use heat because heat would damage finished goods. MBTOC believes there are methods of circumventing this problem by, for example, segregating finished goods from the treatment. CUN Page 10 also gives some heat cost estimates, but no supporting evidence is included. MBTOC continues to note that heat treatment is used in pasta facilities in other countries, for example, 13 pasta facilities in Italy use heat treatment to control pests. The CUN indicates concern about the potential of heat treatment to damage equipment and facilities, but the Party has not substantiated this concern with tests, engineering reports or otherwise. Pasta facilities operate at quite high temperatures resulting from the operation of equipment and just a small additional heat increase might be all that is needed to conduct efficient

Country	Industry	CUE for 2005 (ExMOP1 and MOP16	CUE for 2006 (MOP 16 +ExMOP2+ MOP17)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (new)
heat treatment. In addition, if pasta facilities had understanding of the location of pests and if that understanding indicated that pests were mostly located in one type of equipment, spot heat treatment with appropriate additional methods to prevent pest escape might also be used. The requirements for full site and spot heat treatment are reviewed in MBTOC's flour mill review (TEAP, 2008).											
MBTOC comments on economics 2009: This CUN is not based on economic arguments. CUN argues that heat treatment remains a costly alternative, estimating that the cost to carry out the heat treatment is twice the cost of doing a methyl bromide treatment. This increases to three or four times when the cost of monitoring (ensure comparable results) is included. **No cost data was supplied and MBTOC requires substantiation of these cost estimates.**											
Israel	Dates	3.444	2.755	2.200	1.800	None	2.100	1.56	1.04		
MBTOC comments 2009: MBTOC recommends a reduced nomination of 1.04 tonnes, about 60% of the nominated amount for dates in 2010. The Party nominated 1.56 tonnes and noted that methyl bromide is only used for those date varieties for which heat treatment or other alternatives have not been shown to be effective. The basis for the reduction in the nomination was to decrease the dosage rate to 20g m^{-3} from 30g m^{-3} as specified in correspondence. MBTOC had concern about the excessively high dosage rates reported in the CUN, page 17 which indicated a MB dosage rate of 300g per tonne of dates, however, the CUN also notes that the actual dosage rate used is 20 g m^{-3}, which is the dosage rate recommended by MBTOC as technically effective. Later correspondence indicated a dosage rate of 30g m^{-3}. The CUN gives a packing factor for non-Medjool dates as 400kg m^{-3}; the correspondence indicates 300kg m^{-3} . At 20 g m^{-3}, a reasonable rate, a well constructed product stack should use about 22 g for each 400kg (10% allowance for packing) or 55 g m^{-3}. Based on the reported dosage rate and the packing information examined, we surmise that the chambers used must have low load factors (lots of free space), which seems to be an inappropriately inefficient use of MB. MBTOC's recommendation is based on its understanding of reasonable packing density and dosage rates. MBTOC also notes that in April 2009, Vapormate™, a formulation of ethyl formate and CO_2, was registered for disinfestation of dried fruit in Israel. The use of ethyl formate is an effective disinfestation method for dried fruit, and Israel is currently testing to measure its efficacy on dates.											
MBTOC comments on economics 2009: This CUN is not based on economic arguments. CUN argues that the economic feasibility of heat treatment is clear because of the experience with the controlled drying of Medjool dates: it is critical in maintaining their quality. CUN states further that it is too early for economic feasibility for other (non-heat) alternatives to be evaluated at this stage, but that it is highly possible that this will reveal that one or more of these alternatives are economically feasible.											

Country	Industry	CUE for 2005 (ExMOP1 and MOP16	CUE for 2006 (MOP 16 +ExMOP2+ MOP17)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (new)
Japan	Chestnuts	7.100	6.800	6.500	6.300	5.800	5.400	-	-	5.350	5.35

MBTOC comments 2009:

MBTOC recommends the Party's nominated amount of 5.350 tonnes for 2011, which is a 1% reduction over the amounts granted by the Parties for 2010. Japan tried 14 different possible alternatives (reported in its CUN of 2005, JPN13, 2005) and decided that methyl iodide was technically and economically feasible. Now the party is awaiting registration for this purpose.

In Japan, there are two levels for registration: 1) toxicological assessment of methyl iodide that has been completed; 2) worker safety issues and food sanitation approval that still have to be completed by the Ministry of Health, Labour and Welfare (MHLW). The Ministry for Agriculture, Forestry and Fisheries (MAFF) sent a letter to MHLW to declare the need for a high priority for setting the corresponding MRLs. On March 6, 2009, the evaluation by MHLW was completed. Now, the release of the registration is expected for 2009. If this occurs, MBTOC expects that the Party will not authorize the full nominated amount of MB for 2011. On these grounds, MBTOC expects a significant and quick phase-in of the newly registered alternative.

In the instance that registration of MI for this purpose is not achieved, SF also works well to control pests of chestnuts, but Japan is concerned about the lack of full control of the eggs of the chestnut weevil *Curculio sikkimensis* (Soma *et al*, 2005; Kawakami, *et al*, 2003; Vinghes and Ducom, 2001). Japanese consumers use fresh chestnuts as special gifts and so the consumers might keep product in their homes for a few weeks. Under these circumstances, the presence of live eggs or larvae in chestnuts following SF treatment would be unacceptable.

Chestnut consumption in France and other countries is different in that the chestnuts are consumed directly after purchase. On the other hand, transition to SF has just occurred in France and it is yet unclear if consumers in France may eventually have the same complaints due to surviving eggs and larvae.

MBTOC asked about the use of hot water treatment, as used in some countries. But, the skin of hot-water-treated chestnuts becomes dull; as a result consumers might think the product is not fresh. CO_2 under high pressure (20 bar) is used in one location in Portugal for disinfestation of fresh chestnuts with existing pressure chambers, that are also used for other products. In 2003, Japan tested the efficacy of this method. Despite the sufficient efficacy, the high investment for the chambers (several million € per chamber) - when they would be intended to be used only for this purpose – was considered to be far too costly. This work was not continued because of the high investment costs for this treatment.

In Japan, disinfestations have to take place in numerous wide spread small farm holdings. So, there is a strong logistic argument against having a central facility that gathers product from several small farms. In the light of the scientific work of the Party and the lack of any alternative other than methyl iodide, the solution for the replacement of this difficult application seems to be quickly achievable when registration occurs.

MBTOC comments on economics 2009:

This CUN is not based on economic arguments.

Country	Industry	CUE for 2005 (ExMOP1 and MOP16	CUE for 2006 (MOP 16 +ExMOP2+ MOP17)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (new)
United States	Commodities	89.166	87.719	78.983	58.921	45.623	19.242	-	-	10.041	1.965

MBTOC comments 2009:

MBTOC recommends 1.965 tonnes methyl bromide for commodities in 2011. The Party nominated the following amount for the commodities listed: dates 2.009 tonnes; walnuts 1.17 tonnes; California Dried Plum Board 6.266 tonnes; beans 0.595 tonnes. The total nomination was 10.041 tonnes (USG has rounded its nomination). MBTOC's recommendation includes 0.0 tonnes for dates; 1.17 tonnes for walnuts; 0.2 tonnes for California Dried Plum Board. Of the commodities included in the California Dried Plum Board nomination, MBTOC did not recommend the use of MB for dried plums and raisins. Additionally, MBTOC recommends 0.595 tonnes for beans.

The US nomination for dates was for the Deglet-Noor variety harvested in California. In recent years there has been a lack of understanding of the impact of parameters such as date variety, conditions at harvest and particularly moisture content of the dates at time of fumigation, and how these parameters relate to control of pests and fungi in dates. Consequently, the US believed that its Deglet-Noor dates at harvest were similar to the Deglet-Noor dates harvested in North African countries. The North African countries have indicated considerable concern to Parties that alternatives for their high moisture dates were not currently known. In 2003, MBTOC agreed that it did not, at that time, know of pest control alternatives to high moisture fresh dates. However, MBTOC has recently gained the understanding that the moisture content of US dates at time of harvest is between 18-23%. In the instance of US dates it appears that the length of time needed to achieve date maturity on the tree, also results in considerable drying, while the dates are still on the tree. Thus, US dates were referred to as 'fresh' but the American definition stands in contrast to the Deglet-Noor dates of North African countries which are also harvested 'fresh' at maturity but are at 35-40% moisture content. It is the moisture content and not the freshness of recent picking that impacts the potential for alternatives to be effective. When dates are at 18-23% moisture content, they are a dried fruit. In the case of the US, the word 'fresh' in this instance is a marketing term. Therefore, the alternatives used for other dried fruit are technically effective. So, for example, heat, phosphine, controlled atmosphere and cold treatment would all be effective and registered for use in the US. In addition, sulfuryl fluoride is also registered for treatment of dates and recent trials have indicated efficacy, at least for adults and larvae. MBTOC believes that by 2011 it is reasonable to expect the US dates sector can adopt alternatives. For further discussion of date infestation and treatment issues, the reader is referred to the review of date treatment elsewhere in May 2009 TEAP/MBTOC Progress report .

Walnut sector has virtually completed its transition to sulfuryl fluoride for commodity exported to the EU; the remaining small use of MB is to allow for quick treatment of packaged product when the other treatments would be too slow. MBTOC expects that even this use will quickly diminish as logistics for SF treatment are improved. In the instance of a future CUN for walnuts, MBTOC will expect considerable information supporting that logistical problems still require MB in the face of the numerous alternatives that are available for walnuts and indicating practical phase out plans.

The California Dried Plum Board nomination has been disaggregated to 1.44 tonnes for dried plums, 4.637 tonnes for dried raisins and 0.2 tonnes for figs. MBTOC does not recommend methyl bromide for dried plums or raisins. Therefore MBTOC's recommendation for the California Dried Plum Board is 0.2 tonnes. Plums are dried using a heat process which also results in disinfestation. Plums can be stored in cool or cold storage without risk of sugar crystallization and if they are infested after drying they can be treated with phosphine. USG has not sufficiently substantiated a need for methyl bromide for dried plums. Figs are infested at harvest and need a treatment before storage. MBTOC has not been given the volumes of figs treated by alternatives and the volume of figs intended to be treated by MB, but from the MB volume nominated, it seems

<table>
<tr><th>Country</th><th>Industry</th><th>CUE for 2005 (ExMOP1 and MOP16</th><th>CUE for 2006 (MOP 16 +ExMOP2+ MOP17)</th><th>CUE for 2007 (MOP17+ MOP18)</th><th>CUE for 2008 (MOP18+ MOP19)</th><th>CUE for 2009 (MOP19+ MOP20)</th><th>CUE for 2010 (MOP20)</th><th>CUN for 2010</th><th>MBTOC rec. for 2010 (addtl or new)</th><th>CUN for 2011 (addtl or new)</th><th>MBTOC rec. for 2011 (new)</th></tr>
<tr><td colspan="12">MB is used for a small portion of the harvest. MBTOC recommends the nominated amount for figs, but encourages the Party to supply information substantiating the logistical need for MB in any future CUN, and indicating a practical phase out plan. MBTOC does not recommend the use of MB for raisins for 2011. Raisin sector can use phosphine, controlled atmosphere, sulfuryl fluoride or cool storage. Bean sector is currently quickly transitioning to sulfuryl fluoride and the remaining MB seems to be needed in the instance of lack of available treatment facilities or options.</td></tr>
<tr><td colspan="12">MBTOC comments on economics 2009:
This CUN is not based solely on economic arguments. CUN summarizes economic losses due to use of:
Phosphine. Losses arise from additional production downtimes due to longer fumigation time and from capital expenditures required to adopt an alternative. Economic losses due to downtime with phosphine are persistent. MBTOC agrees with this analysis.
Sulfuryl Fluoride. SF is shown to be a viable alternative to MB; costs per lb are comparable although application rates may be higher. Walnuts have inelastic demand; cost increase can be passed to consumers. Sulfuryl fluoride was found to be technically and economically feasible for walnuts, dried fruit, and dried beans</td></tr>
<tr><td>United States</td><td>NPMA food processing structures (cocoa beans removed)</td><td>83.344</td><td>69.118</td><td>82.771</td><td>69.208</td><td>54.606</td><td>37.778</td><td>-</td><td>-</td><td>17.365</td><td>17.365</td></tr>
<tr><td colspan="12">MBTOC comments 2009:
MBTOC recommends the nominated amount of 17.365 tonnes for food processing facilities in 2011. The Party's nomination reflects a 54% decrease in MB use in its food processing sector over the amount of MB granted by the Parties for 2010.
This CUN includes facilities that prepare processed foods (such as chips, crackers, cookies and pasta), spices and herbs processing facilities, and also cheese processing plants (with cheese present in storage). The food processing sector represents by far the largest portion of the MB nomination in this CUN (14.498 tonnes). Herb and spice blending facilities (1.055 tonnes) and cheese storages (1.812 tonnes) are relatively small.
Food processing facilities in the United States have reduced the number of methyl bromide fumigations by incorporating many different techniques to control pests. The most critical strategy implemented is IPM, especially sanitation, in all areas of a facility. Facilities are now being monitored for pest populations, using visual inspections, pheromone traps, light traps and electrocution traps. When insect pests are found, facilities will attempt to contain the infestation with treatments of low volatility pesticides applied to both surfaces and cracks and crevices; spot treatments with heat or phosphine will be used in areas that are suitable. Incoming ingredients are inspected for insect pests and may be treated with phosphine. These techniques contribute to reduced pest pressure and avoid the need for full site treatment.</td></tr>
</table>

Country	Industry	CUE for 2005 (ExMOP1 and MOP16	CUE for 2006 (MOP 16 +ExMOP2+ MOP17)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (new)
MBTOC notes that perhaps especially with herb and spice processing equipment, in the instance of pest infestation centered in a particular piece of equipment, spot heat treatment with additional measures to prevent pest escape might be effective. MBTOC described a suitable spot heat method in its flour milling review of TEAP, 2008. With this nomination, the Party has moved ahead of its transition plan indicated in earlier CUNs. The Party's CUN in 2007 indicated that 16% of the MB use included in its food processing nomination would not be able to transition. But, with the 2009 nomination, the transition to alternatives in food processing sector is now approaching the level previously indicated as unable to transition. MBTOC inquires if the part of the sector previously designated as unable to transition is now considered able to transition to alternatives? Although the other sectors included in this CUN have made very substantive reductions in MB nominated, cheese storage sector has not reduced its nomination. MBTOC acknowledges a lack of knowledge of currently technically effective MB alternatives. The CUN indicates that, "Cheese manufacturers may target their products during fumigations with methyl bromide when a mite infestation is identified by USDA inspection and a fumigation is ordered." MBTOC assumes that under these circumstances, records of the fumigation must be kept by government inspectors or by the processing facility. Therefore MBTOC requests that as part of any future CUN, actual MB use figures for cheese processing sector be submitted. MBTOC needs these records to monitor that the amounts it recommends are consistent with the amounts actually needed. The Party has reported that the ongoing multi-state research project on mite infestation in cured pork also includes investigations of mites in cheese. However, MBTOC also encourages the Party to contact EU and Canadian cheese producers to see how they manage pests in cheese storages without MB.											
MBTOC comments on economics 2009: This CUN is not based solely on economic arguments. CUN summarizes economic losses due to use of: Heat treatment. Heat treatments are technically and economically feasible in some cases. However, in very cold regions, heat is costly and production time is lost; in old facilities, high heat could inflict structural damage; heat is not feasible for treating commercial-scale commodity volumes, as heat is a poor penetrator of packaging, boxes, and commodities; structures with many concrete partitions are not good candidates for heat treatment because heat may not be evenly distributed. Economic losses due to downtime with heat treatment are persistent. **MBTOC does not agree that production time is lost, although the treatment cost may be higher.** Phosphine. Although phosphine kills insects, it is corrosive to components of the electronics that run the manufacturing equipment. Phosphine also requires a longer application time. Phosphine is not a suitable alternative to methyl bromide when rapid fumigations are needed to meet customer timelines. Resistance has also been reported for several stored product pests. Furthermore, cheese makers claim that phosphine causes damage to the cheese Carbon dioxide. Facilities in the United States are not airtight enough for modified atmospheres or carbon dioxide to be effective primarily due to age of the facility; specifically, most facilities are more than 25 years old. Sulfuryl fluoride. A portion of the food processing facilities can economically convert to sulfuryl fluoride. Other facilities cannot due to economic losses that would result from higher treatment costs which arise at lower temperatures. For a small percentage, SF is not technically feasible due to cold temperatures. Adding heat to increase the											

Country	Industry	CUE for 2005 (ExMOP1 and MOP16	CUE for 2006 (MOP 16 +ExMOP2+ MOP17)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (new)
efficacy of SF is also not an economically feasible option. **MBTOC requires substantiation of these claims**.											
United States	Mills and processors	483.000	461.758	401.889	348.237	291.418	173.023	-	-	135.299	135.299
MBTOC comments 2009: MBTOC recommends 135.299 tonnes, the nominated amount for 2011. In 2007, the Party implemented an acceptable transition plan for this sector requiring annual decreases of 18-20%, depending on the type of facility. This plan continues to be implemented, and sometimes exceeded, by the Party, although not in consistent year over year increments. Thus MBTOC notes that for 2011, the pet food and rice milling sector nominations have not decreased over 2010 levels, perhaps because earlier transitions were higher than originally planned. The CUN indicates that continued lack of regulatory approval for fluorine residues in pet foods and in food mixes that are sometimes present in rice mills is the reason for lack of progress in adopting alternatives in these sectors. However, MBTOC notes that this was also the reason given last year for a slowing of the adoption of alternatives in rice milling and pet food facilities. MBTOC continues to express its concern about the possibility of continued lack of adoption of alternatives in these sectors if research to overcome the problem of segregating commodities during SF fumigation of facilities is not conducted. In its text boxes of 2008, MBTOC noted, "Pet food facilities could, however, expand use of full site or spot heat treatment, utilizing appropriate pest barrier methods to prevent pest escape from spot heat treatments." And, "The three sectors included in this CUN are expected to work to improve treatment logistics that improve product segregation so that more adoption of alternatives can be accomplished even if regulatory barriers to the use of SF persist. When conducting SF fumigations where food mixes are present, the applicant could trial tarping off the food under positive pressure or removing food ingredients and mixes to non-fumigated areas or sealing off stored product warehouses to allow SF treatment of facility while ensuring that food is not exposed (TEAP October 2008)". Food isolation techniques during SF fumigations are commonly commercially used in Germany and the UK, for example. In the EU the need to segregate food commodities has not stymied the adoption of SF for food processing facilities and mills. The CUN for 2009 and Party correspondence indicated that this research recommended by MBTOC was not done. MBTOC indicates that without the conduct of suitable research to overcome the regulatory problem, it can not continue to recommend MB use in pet food and rice milling, particularly if there were to be another year of CUN without re-implemeting the previous years' transition rates. In addition to this concern, we note that CUNs and Party correspondence indicates there is a segment of the pet food facilities and rice milling that will be unable to transition to alternatives, at all. The CUN of 2008 and earlier years indicates about 5 tonnes of MB use in rice milling and 6 tonnes in pet foods sector will not be able to adopt alternatives at all. MBTOC has insufficient information to allow it to agree that there is a segment of these two sectors unable to transition at all to alternatives. Without very considerable information and examination of these sectors by the Party and MBTOC, we will assume that a transition of 18-20% of the entire sector is achievable. MBTOC notes that flour milling has continued its transition at acceptable levels and makes no further comment about this sector.											

Country	Industry	CUE for 2005 (ExMOP1 and MOP16	CUE for 2006 (MOP 16 +ExMOP2+ MOP17)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (new)
MBTOC comments on economics 2009: This CUN is not based solely on economic arguments. CUN summarizes economic losses due to use of: Heat treatment. Food processing facilities located in cold climates (which are able to convert to heat treatment) may experience economic losses from additional production downtimes associated with heat-up time. Economic losses in cold weather facilities due to downtime with heat treatment are persistent. Sulfuryl Fluoride. A portion of the food processing facilities can economically convert to sulfuryl fluoride. Other facilities cannot due to economic losses that would result from higher treatment costs which arise at lower temperatures. For a small percentage, SF is not technically feasible due to cold temperatures. According to the CUN adding heat to increase the efficacy of SF is also not an economically feasible option. **With regard to pet food, it would be desirable to analyze the cost of isolating product from exposure to sulfuryl fluoride.**											
United States	Cured pork	67.907	40.854	18.998	19.669	18.998	4.465	-	-	3.730	3.73
MBTOC comments 2009: MBTOC recommends the Party's nominated amount of 3.73 tonnes for Southern cured pork in 2011. The Party nominated 16% less MB for 2011 than was granted by the Parties for this use in 2010. This reduction was taken on the previous year's 25% reduction. Formerly, the frequency of fumigation was up to five times a year, and now fumigation is reported to occur only one time per year. The pork becomes infested with *Tyrophagus putrescentiae* (Ham or cheese mites) and *Necrobia rufipes* (Redlegged ham beetle) (Phillips et al, 2008). There is currently no technically effective and registered alternative for the treatment of these pests of cured pork, but decreases in MB use have resulted from IPM improvements in the processing facilities, reduced frequency of fumigations, and improvements in reporting historical MB use. This sector is collaborating in a multi-state research program (Phillips et al, 2008). This program has resulted in IPM improvements in the facilities which contributed to a reduced need for fumigation. Additionally, this research program has resulted in an improved understanding of the inter-reaction between ham curing time and the incidence of pest infestation. When cured pork is stored longer than 6 months, there is a higher incidence of infestation. So, managing the overall ham process might assist to reduce pest infestation. The use of sulfuryl fluoride as a pest control method was investigated through this program, but it was not effective on mites. Effective treatment was only achieved when 3x the allowed label rate was used, and at that point, fluorine residues were unacceptably high (Sekhorn et al, 2008). The researchers are now investigating the potential effectiveness of phosphine, or low O_2 and high CO_2, but they are concerned that the poorly structured traditional ham storage houses in the US won't hold the CO_2.											

Country	Industry	CUE for 2005 (ExMOP1 and MOP16	CUE for 2006 (MOP 16 +ExMOP2+ MOP17)	CUE for 2007 (MOP17+ MOP18)	CUE for 2008 (MOP18+ MOP19)	CUE for 2009 (MOP19+ MOP20)	CUE for 2010 (MOP20)	CUN for 2010	MBTOC rec. for 2010 (addtl or new)	CUN for 2011 (addtl or new)	MBTOC rec. for 2011 (new)

In its text box of October 2008, MBTOC recommended that the Party test the method used in Spain which involves dipping the hams in a mixture of oil and lard at 90°C. At the 2008 MBAO conference, the researchers informed us that they are planning to investigate these alternative techniques. When the researchers are ready to start these investigations they intend to contact MBTOC for more specific information.

MBTOC comments on economics 2009:

This CUN is not based on economic arguments.

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Common Acronyms

1,3-D	1,3-dichloropropene
A5	Article 5 Party
CUE	Critical Use Exemption
CUN	Critical Use Nomination
DOI	Disclosure of Interest
EC	European Community
EMOP	Extraordinary Meeting of the Parties
EPA	Environmental Protection Agency
EPPO	European Plant Protection Organisation
MI	Methyl iodide (or Iodomethane)
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
ISPM	International Standard Phytosanitary Measure
LPBF	Low Permeability Barrier Film (including VIF films)
MB	Methyl Bromide
MBTOC	Methyl Bromide Technical Options Committee
MBTOC QSC	Methyl Bromide Technical Options Committee Quarantine, Structures and Commodities Subcommittee
MBTOC S	Methyl Bromide Technical Options Soils Subcommittee
MDI	Metered Dose Inhalers
MITC	Methyl isothiocyanate
MOP	Meeting of the Parties
MS	Metham sodium
OEWG	Open Ended Working Group
Pic	Chloropicrin
QPS	Quarantine and Pre-shipment

QPSTF	Quarantine and Pre-shipment Task Force
SF	Sulfuryl fluoride
TEAP	Technology and Economic Assessment Panel
TIF	Totally impermeable films
USA	United States of America
VIF	Virtually Impermeable Film
VOC	Volatile Organic Compounds

ANNEX 1 TO CHAPTER 14 - 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 14 - Decision XVI/4

Review of the working procedures and terms of reference of the Methyl Bromide Technical Options Committee

Report of the Sixteenth Meeting of the Parties to the Montreal Protocol (Annex I), Prague, 22–26 November 2004), paragraph 15.

A. Working procedures of the Methyl Bromide Technical Options Committee relating to the evaluation of nominations for critical uses of methyl bromide

15. An annual work plan will enhance the transparency of, and insight in, the operations of MBTOC. Such a plan should indicate, among other things:

(a) Key events for a given year;

(b) Envisaged meeting dates of MBTOC, including the stage in the nomination and evaluation process to which the respective meetings relate;

(c) Tasks to be accomplished at each meeting, including appropriate delegation of such tasks;

(d) Timing of interim and final reports;

(e) Clear references to the timelines relating to nominations;

(f) Information related to financial needs, while noting that financial considerations would still be reviewed solely in the context of the review of the Secretariat's budget;

(g) Changes in the composition of MBTOC, pursuant to the criteria for selection;

(h) Summary report of MBTOC activities over the previous year, including matters that MBTOC did not manage to complete, the reasons for this and plans to address these unfinished matters;

(i) Matrix with existing and needed skills and expertise; and

(j) Any new or revised standards or presumptions that MBTOC seeks to apply in its future assessment of critical-use nominations, for approval by the Meeting of the Parties.

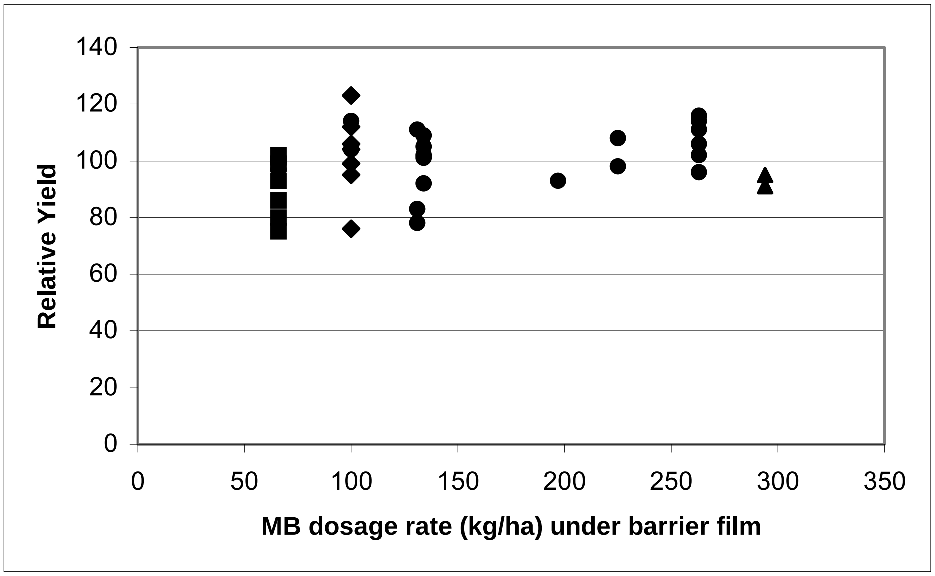
ANNEX III TO CHAPTER 14 - Relative effectiveness of MB/Pic formulations applied in combination with low permeability barrier films (LPBF) compared to the commercial standard MB/Pic formulation applied under standard low density polyethylene films (LDPF).

Country	Region	Commodity	Brand or Type of Barrier Film	Untreated	MB/Pic Mixtures (Product rate per treated area)													Notes	Reference
				Std film			Barrier Film – Relative yield compared to standard polyethylene												
				Yield	MB/Pic Formuln.	Product Rate	Not Spec	98:2	98:2	67:33	67:33	67:33	67:33	67:33	67:33	50:50	33:67		
						kg/ha	300	400	300	98	196	200	294	336	392	200	200		
MB Dosage rate (g/m2)								392	294	66	131	134	197	225	263	100	66		
Spain	Vinderos	Strawb. Runner	VIF – NotSpec	74	50:50	400											93	Fusarium, Phytophthora, Pythium, Rhizoctonia and Verticillium	De Cal et al 2004
	Navalmanzano			78	50:50	400											80		
Spain	Vinderos	Strawb. Runner	VIF - Not Spec	68	50:50	400										114	102	Fusarium, Cladosporium, Rhizoctonia	Melgarejo et al 2003
	Navalmanzano			34	50:50	400										76	75		
Spain	Avitorejo	Strawb. Fruit	VIF - Not Spec		50:50	400											97	2003 results	Lopez-Aranda et al 2003
	Malvinas				50:50	400											99		
Spain	Valencia	Strawb. Fruit	VIF - Not Spec	59	Not Spec	600	94											1998 Fusarium At 10cm & 30cm	Bartual et al 2002
				53	Not Spec	600	93											1999 results	
Spain	Avitorejo	Strawb. Fruit	VIF - Not Spec	80	67:33	400										112		Meloidogyne and weeds (unspec.)	Lopez-Aranda et al 2001
	Tariquejo			54	67:33	400										106			
Spain	Moguer/Cartaya	Strawb. Runner	VIF - Not Spec		50:50	392										99		Inoculum not specified	Lopez-Aranda et al 2001b
Spain	Cabeza, Nav.	Strawb. Runner	VIF - Not Spec	74	67:33	400						105, 92						1998 Two sites	Melgarejo et al 2001
	Arevalo, Nav.			84	50:50	400										104, 104		1999 results, nurseries	

Country	Region	Commodity	Brand or Type of Barrier Film	Untreated	MB/Pic Mixtures (Product rate per treated area)													Notes	Reference
				Std film			Barrier Film – Relative yield compared to standard polyethylene												
				Yield	MB/Pic Formuln.	Product Rate	Not Spec	98:2	98:2	67:33	67:33	67:33	67:33	67:33	67:33	50:50	33:67		
						kg/ha	300	400	300	98	196	200	294	336	392	200	200		
MB Dosage rate (g/m2)								**392**	**294**	**66**	**131**	**134**	**197**	**225**	**263**	**100**	**66**		
	Vinaderos, Nav.			49	50:50	400										95, 123		2000 results, nurseries	
Spain	Huelva	Strawb. Fruit	VIF - Not Spec	82	67:33	400						101						1997-1998 Inoc.unspecified	Lopez-Aranda et al 2000
				72	67:33	400						102						1998-1999 Inoc. Unspecified	
				68	67:33	400						109						1999-2000 Inoc. Unspecified	
Spain	Moncada	Strawb. Fruit	VIF - Not Spec	60	98:2	600			95									1998 No major pathogens but Fusarium buried 10cm&30cm.	Cebolla et al 1999
				54	98:2	600			91										
France	Douville	Strawb. Fruit	VIF - Not Spec	65	Not Spec	800		99										Inoculum not specified	Fritsch 1998
NZ	Havelock North	Strawb. Fruit	VIF - Not Spec	83	67:33	500								98				Phytophthora present	Horner 1999
USA	Florida	Pepper	VIF Plastopil	69	67:33	392					78							Nutgrass	Gilreath and Santos 2005
			VIF Plastopil	69	67:33	392				99								Present	
			VIF Vikase	69	67:33	392					83								
			VIF Vikase	69	67:33	392				86									
USA	Florida	Strawb Fruit, Cantaloupe	Barrier - Pliant, Metallised		98:2 67:33	Trials on 18 Commercial Farms between 2000-2004; no increase in disease or weeds when rates reduced up to 50% under VIF wrt. polyethylene												Nutgrass and pathogens present	Noling and Gilreath 2004
USA	California	Strawb. Fruit	VIF - Not Spec	72	67:33	336								108				Inoculum not specified	Ajwa et al 2004
				80	67:33	392									96				

Country	Region	Commodity	Brand or Type of Barrier Film	Untreated	MB/Pic Mixtures (Product rate per treated area)													Notes	Reference
					Std film			Barrier Film – Relative yield compared to standard polyethylene											
				Yield	MB/Pic Formuln.	Product Rate	Not Spec	98:2	98:2	67:33	67:33	67:33	67:33	67:33	67:33	50:50	33:67		
						kg/ha	300	400	300	98	196	200	294	336	392	200	200		
MB Dosage rate (g/m2)								**392**	**294**	**66**	**131**	**134**	**197**	**225**	**263**	**100**	**66**		
USA	Florida	Tomato	VIF - Not Spec	31	67:33	392					111		93		114			Nutgrass and rootknot nematodes	Hamill et al 2004
USA	California	Strawb. Fruit	VIF - Not Spec	75	67:33	392									106				Ajwa et al 2003
				83	67:33	392									111			Watsonville, high pathogen pressure	
				65	67:33	392									102				
USA	Florida	Tomato	VIF - Not Spec		67:33	392	"No significant reduction in yield"												Noling et al 2001
USA	California	Strawb. Fruit	VIF - Not Spec	45	67:33	364									116				Duniway et al 1998
USA	Georgia	Nurseries	VIF – not spec		67:33	389	See reference												Carey and Godbehere, 2004
					67:33	392													
USA	California	Roses			98˝2	392	See reference												Hanson et al, 2006
USA	Florida	Pepper	VIF – not spec		67:33	392	See reference												Santos and Gilreath, 2004
USA	Florida	Pepper	VIF – not spec		67:33	392	See reference												Santos et al, 2005
USA	California	Ornamentals	VIF – not spec		67:33	392	See reference												Klose 2007, 2008
Spain	Several	Strawberry nurseries					50:50 at 300 kg/.ha (15 g/ha)												Lopez Aranda, 2008
USA	California	Strawberries	VIF – Pliant Blockade				67:33 applied at 196 and 241kg/ha (ie. 13.1 and 16.1 g MB/ha)												Noling 2008
Unweighted averages (relative % yield)				66			94	99	93	93		102		103	108	104	91		

Figure 1: Relative yield of crops (strawberries, tomatoes, peppers, cantaloupes) grown under barrier films with different MB/Pic formulations compared to the standard commercial treatment using standard polyethylene from trials between 1998 and 2004



(▲MB/Pic 98:2; ● MB/Pic 67:33; ♦ MB/Pic 50:50; ■ MB/Pic 33:67). Data from Table 3.

ANNEX IV TO CHAPTER 14 - Methyl bromide reduction trends, based on historical rates of adoption in the EC

(EC National Management Strategy, 2008. CUNA = Critical Use Nomination Assessment; MS = Member State of the EC)

Major MB CUEs in 2006	1991 MB use estimate[1] (tonnes) (ha) (No. MSs)	2005 MB use[2] (tonnes) (ha) (No. MSs)	2008 MB quota allocation (tonnes) (ha) (No. MSs)	Short-listed existing MB alternatives[3]	Historical rates of adoption in individual MSs from Table 4.3, Annex 7.A (ha/year per MS)	Feasible adoption rates (derived from historical rates) and current status of CUEs
Tomato	> 4980 t > 7000 ha > 12 MS	733 t 2423 ha 4 MS	0 t 0 ha 0 MS	Fumigants: 1,3-D, PIC, Metham Sodium, Dazomet	up to 1193 ha/year/MS	Rate of up to 1193 + 1570 = 2763 ha/year/MS Adoption completed by end of 2007
				Grafting on resistant root stock	up to 1000 ha/year/MS	
				Substrates	up to 1570 ha/year/MS	
Strawberry fruit	~ 3420 t ~ 5200 ha (>8000 ha in yr 2000) > 12 MS	497 t 3879 ha 4 MS	0 t[4] 0 ha 0 MS	Fumigants: 1,3-D, PIC, Metham Sodium	up to 2090 ha/year/MS	Rate of up to 2090 + 80 = 2170 ha/year/MS. Adoption completed for commercial strawberry fruit production by end of 2006
				Substrates	up to 80 ha / year/MS	
				Resistant varieties	no data	

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1 Refer to Section 3 for data.

2 MB use data from EC Accounting Framework Report. Hectares calculated on doses stated in CUNs and CUNAs. If not stated, estimated based on mean dosage of MB for this use (tomato: 300 kg/ha; strawberry runners: 300 – 470 kg/ha; strawberry fruit: 100 – 300 kg/ha; cutflowers: 200 – 500 kg/ha; peppers: 150 – 300 kg/ha; mills and food processors: 20 g/m^3)

3 Further details and alternatives in Annex 4.C.

4 Excluding 151 kg for research on strawberry fruit and peppers in Spain in 2008.

Major MB CUEs in 2006	1991 MB use estimate[1] (tonnes) (ha) (No. MSs)	2005 MB use[2] (tonnes) (ha) (No. MSs)	2008 MB quota allocation (tonnes) (ha) (No. MSs)	Short-listed existing MB alternatives[3]	Historical rates of adoption in individual MSs from Table 4.3, Annex 7.A (ha/year per MS)	Feasible adoption rates (derived from historical rates) and current status of CUEs
Cut flowers	~ 1610 t ~ 1,800 ha > 12 MS	259 t 855 ha 6 MS	0 t[5] 0 ha 0 MS	Fumigants: 1,3-D, PIC, Metham Sodium, Dazomet	up to 313 ha/year/MS	Rate of up to 313 + 60 + 917 = 1290 ha/year/MS Adoption completed for commercial cut flower production by end of 2007
				Substrates	up to 60 ha/year/MS	
				Steam	up to 917 ha/year/MS	
				Resistant varieties	??	
Peppers	~ 2410 t ~ 3,000 ha > 11 MS	250 t 1336 ha 3 MS	0 t[6] 0 ha 0 MS	Fumigants: 1,3-D, Metham Sodium, Dazomet	up to 667 ha/year/MS	Rate of up to 667 + 175 = 842 ha/year/MS Adoption completed for commercial pepper production by end of 2007
				Substrates	175 ha / year/MS	
Strawberry runners	~ 740 t ~ 930 ha ~ 5 MS	346 t ~ 1500 ha 4 MS	212 t 1364 ha 2 MS	Fumigants: 1,3-D, PIC, Metham Sodium	up to 94 ha/year/MS	Rate of up to 94 + ? ha/year/MS Adoption of MB alternatives slower than expected. Adoption of alternatives to be completed by end of 2008
				Plug plants	??	

5 Excluding 25 kg for research on cut flowers in Spain in 2008..

6 Excluding 151 kg for research on strawberry fruit and peppers in Spain in 2008.

Major MB CUEs in 2006	1991 MB use estimate[1] (tonnes) (ha) (No. MSs)	2005 MB use[2] (tonnes) (ha) (No. MSs)	2008 MB quota allocation (tonnes) (ha) (No. MSs)	Short-listed existing MB alternatives[3]	Historical rates of adoption in individual MSs from Table 4.3, Annex 7.A (ha/year per MS)	Feasible adoption rates (derived from historical rates) and current status of CUEs
Mills and food processing structures	640t 12,800,000 m3 [7] ~ 15 MS	150 t ~7,500,000 m3 [8] 5 MS	0 t 0 m^3 0 MS	Heat + IPM	up to 3,500,000 – 4,600,000 m^3 / year/ MS	Rate of up to 3.5 to 4.6 + 0.2 + ?? million m^3/year/MS Adoption completed by end of 2007
				Sulfuryl fluoride (+ heat)		
				Phosphine (+ heat)	??	
				Modified atmosphere (structures)	200.000 m^3 / year	
Coffee beans	Modest use. No data	< 1.6 t <172,800 m^3 1 MS	0.5 t 54,000 m^3 1 MS	Phosphine solid formulations + heat if necessary	??	46,400 + ?? m^3/year/MS Adoption rate slower than expected. Adoption to be completed by end of 2008
				Phosphine gas generation	??	
				Vacuum-hermetic treatments, low pressure	??	
				Controlled atmosphere + heat if necessary	??	
				High pressure + CO2	46,400 m^3/year	

7 Assuming average dose was about 50 g/m^3 in 1991.
8 Assuming dose of about 20 g/m^3

ANNEX V TO CHAPTER 14 - Part A: Trend in Preplant Soil Applications

List of nominated (2005 – 2011 in part) and exempted (2005 – 2010 in part) amounts of MB granted by Parties under the CUE process for each crop or commodity.

Party	Industry	Total CUN MB Quantities							Total CUE MB Quantities					
		2005	2006	2007	2008	2009	2010	2011	2005	2006	2007	2008	2009	2010
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**	35.750	37.500	35.750	35.750	29.790	**29.790**
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					
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**	(a)14.792	6.840	7.995	7.462	7.462	**7.462**
Canada	Strawberry runners (Quebec)		1.826						(a)	1.826	1.826			
Canada	Strawberry runners (Ontario)										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				
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			

Party	Industry	Total CUN MB Quantities							Total CUE MB Quantities					
		2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
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**				250.000	250.000	**125.000**	
Israel	Cucumber - protected new 2007			25.000	18.750		**18.750**				25.000	18.750	-	
Israel	Cut flowers – open field	77.000	67.000	80.755	53.345	42.777	**42.554**		77.000	67.000	74.540	44.750	**34.698**	
Israel	Cut flowers – protected	303.000	303.000	321.330	163.400	113.821	**72.266**		303.000	240.000	220.185	114.450	**85.431**	
Israel	Fruit tree nurseries	50.000	45.000	10.000					50.000	45.000	7.500			
Israel	Melon – protected & field	148.000	142.000	140.000	87.500	87.500	**87.500**		125.650	99.400	105.000	87.500	**87.500**	
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**		196.000	196.000	93.000	105.960	**42.750**	
Israel	Strawberry runners (Sharon)	35.000	35.000		20	15.800	**13.570**		35.000	35.000	28.000	31.900	**15.825**	
Israel	Strawberry runners and fruit Ghaza				87.875	67.500	**67.500**						**47.250**	
Israel	Tomatoes			90.000							22.750			
Israel	Sweet potato					95.000	**20.000**					111.500	**95.000**	
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			
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	1030.000	418.000					871.000	697.000	80.000			
Japan	Cucumber	88.300	88.800	72.400	68.600	61.400	34.100	**29.120**	88.300	88.800	72.400	51.450	34.300	**30.690**
Japan	Ginger – field	119.400	119.400	112.200	112.100	102.200	53.400	**47.450**	119.400	119.400	109.701	84.075	63.056	**53.400**
Japan	Ginger – protected	22.900	22.900	14.800	14.800	12.900	8.300	**7.770**	22.900	22.900	14.471	11.100	8.325	**8.300**
Japan	Melon	194.100	203.900	182.200	182.200	168.000	90.800	**77.600**	194.100	203.900	182.200	136.650	91.100	**81.720**
Japan	Peppers (green and hot)	189.900	200.700	169.400	162.300	134.400	81.100	**68.260**	187.200	200.700	156.700	121.725	81.149	**72.990**
Japan	Watermelon	126.300	96.200	94.200	43.300	23.700	15.400	**13.870**	129.000	98.900	94.200	32.475	21.650	**14.500**
Malta	Cucumber		0.096							0.127				
Malta	Eggplant		0.128							0.170				

Party	Industry	Total CUN MB Quantities							Total CUE MB Quantities					
		2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Malta	Strawberry		0.160							0.212				
Malta	Tomatoes		0.475							0.594				
New Zealand	Nursery material	1.085	1.085							0.000				
New Zealand	Strawberry fruit	42.000	42.000	24.780					42.000	34.000	12.000			
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	17.000 (+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				
USA	Chrys. Cuttings/roses	29.412							29.412	0.000				
USA	Cucurbits – field	1187.800	747.839	598.927	588.949	411.757	340.405	**218.032**	1187.800	747.839	592.891	486.757	407.091	**302.974**
USA	Eggplant – field	76.761	101.245	96.480	79.546	62.789	34.732	**21.561**	76.721	82.167	85.363	66.018	48.691	**32.820**
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**
USA	Ginger	9.200							9.200	0.000				
USA	Orchard replant	706.176	827.994	405.415	405.666	314.007	226.021	**203.591**	706.176	527.600	405.400	393.720	292.756	**215.800**
USA	Ornamentals	210.949	162.817	149.965	138.538	137.776	95.204	**70.178**	154.000	148.483	137.835	138.538	107.136	**84.617**
USA	Nursery stock - fruit trees, raspberries, roses	45.789	64.528	12.684	51.102	27.663	17.954	**7.955**	45.800	64.528	28.275	51.102	25.326	**17.363**
USA	Peppers – field	1094.782	1498.530	1151.751	919.006	783.821	463.282	**212.775**	1094.782	1243.542	1106.753	756.339	548.984	**463.282**
USA	Strawberry fruit – field	2468.873	1918.400	1733.901	1604.669	1336.754	1103.422	**1023.471**	2052.846	1730.828	1476.019	1349.575	1269.321	**1007.477**
USA	Strawberry runners	54.988	56.291	4.483	8.838	8.837	7.381	**7.381**	54.988	56.291	4.483	8.838	7.944	**4.690**
USA	Tomato – field	2876.046	2844.985	2334.047	1840.100	1406.484	994.582	**336.191**	737.584	2476.365	2065.246	1406.484	1003.876	**737.584**
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**				18.144	18.144	**14.515**

ANNEX VI TO CHAPTER 14 – Part B: Post-harvest Structural and Commodity Applications

List of nominated (2005 – 2010 in part) and exempted (2005 – 2009 in part) amounts of MB granted by Parties under the CUE process for each crop or commodity.

Party	**Industry**	**Total CUN MB Quantities**						**Total CUE MB Quantities**				
		2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2005**	**2006**	**2007**	**2008**	**2009**
Australia	Almonds	1.900	2.100					1.900	2.100			
Australia	Rice consumer packs	12.300	12.300	10.225	9.200 +1.8	9.200	7.820	6.150	6.150	9.205	9.200	7.820
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			
Belgium	Food Processing premises	0.030	0.030					0.030	0.030			
Belgium	Food storage (dry) structure	0.120	0.120					0.120	0.000			
Belgium	Old buildings	7.000	0 .306					1.150	0.306			
Belgium	Old buildings and objects	0.450	0.282					0.000	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	(a)47	34.774	30.167	28.650	26.913
Canada	Pasta manufacturing facilities	(a)	10.457	6.757	6.067	4.740		(a)	10.457	6.757	6.067	
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			
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	0.45		
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			

Party	Industry	Total CUN MB Quantities						Total CUE MB Quantities				
		2005	2006	2007	2008	2009	2010	2005	2006	2007	2008	2009
Israel	Artefacts	0.650	0.650	0.600				0.650	0.650			
Israel	Dates (post harvest)	3.444	3.444	2.200	1.800	2.100		3.444	2.755	2.200	1.800	
Israel	Flour mills (machinery & storage)	2.140	1.490	1.490	0.800	0.300		2.140	1.490	1.040	0.312	
Israel	Furniture– imported	1.422	1.422	2.042				1.422	0.000			
Italy	Artefacts	5.500	5.500	5.000				5.225	0.000	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	7.100	6.800	6.500	6.300	5.800
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	
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	3.480		
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	0.000	0.479		
UK	Spices stored	0.030						0.030	0.000			
UK	Structures buildings (herbs and spices)	3.000	1.872	0.908				3.000	1.872	0.908		
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	89.166	87.719	78.983	58.921	45.623
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	83.344	69.118	82.771	69.208	54.606

Party	Industry	Total CUN MB Quantities						Total CUE MB Quantities				
		2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2005**	**2006**	**2007**	**2008**	**2009**
USA	Smokehouse hams (Dry cure pork products) (building and product)	136.304	135.742	40.854	19.669	19.699	4.465	67.907	81.708	18.998	19.699	18.998
USA	Mills and Processors	536.328	505.982	401.889	362.952	291.418	173.023	483.000	461.758	401.889	348.237	291.418

15 TEAP and TOC Organisation Issues

15.1 Current TEAP and TOC membership

Currently TEAP has 22 members; this number includes, the TEAP co-chairs, the TOC co-chairs, Senior Expert members and one temporary member. Of the 22 members, 8 are from Article 5 Parties and 14 are from non-Article 5 Parties.

As of Status April 2009, the total membership of the the TEAP and its six TOCs have 151 members, including 54 experts from Article 5 Parties and 97 experts from non-Article 5 Parties (which includes a small number of experts from non-A5 former CEITs in Eastern Europe and Central Asia). There are an additional 12 consulting (non-voting) members in the Halons and Refrigeration Technical Options Committees.

During the period between the end of the first quarter 2008 and the end of the first quarter 2009, 25 experts retired, resigned, or were asked to resign in the context of continuous efforts to rationalize the TEAP structure. In total, 12 new experts were appointed to the TEAP and the TOCs during that same period.

15.2 Financial constraints and challenges encountered by TEAP and TOC members

TEAP is grateful for the continuing support of national governments, the European Commission, associations and companies that finance time and expenses for the participation of experts in the TEAP, TOCs and Task Forces. Over the years it has become increasingly difficult for non-Article 5 experts, who work in the private sector, to find funding for travel and miscellaneous meeting expenses. Taking also into account the current financial circumstances, it is becoming almost impossible for non-Article 5 experts to get enough support from their employers to cover the time spent to complete tasks and to travel to and stay at meetings; as a result, the TEAP and TOC operations are becoming even more difficult. TEAP would like to remind Parties here that TEAP and its TOCs are producing reports and technical papers at a cost much lower than if consultants would be contracted for the same assignments, due to the fact that TEAP and TOC experts spend huge amounts of voluntary time in the completion of reports requested by Parties.

Mindful that Parties have repeatedly rejected requests for financing from the Ozone Trust Fund or other UN modalities, TEAP is urgently requesting all non-Article 5 Party governments to once more look into all possibilities to fund certain costs for their national experts. Individual TEAP and TOC members, from their side, will also continue to seek funding from governments, associations, and companies.

As also mentioned in earlier reports, TEAP and its TOCs continue to look for ways to minimise costs including: choosing cost-effective locations for meetings; seeking hosts for meetings and discounts for hotel rooms; and at the same time rationalising membership, as needed.

15.3 Technology and Economic Assessment Panel (TEAP)

Mr. Jose Pons-Pons, co-chair of the TEAP (and its MTOC), has indicated that he plans to resign from the TEAP by the end of 2010, after nineteen years of membership.

TEAP has also started to work out succession planning for several of its members, both TOC co-chairs and Senior Experts, and will report on progress made in its 2010 Progress Report.

TEAP --and its TOCs-- are concerned over the resignations and retirements of some of their most experienced members. It is important to maintain quality, objectivity, and timeliness of TEAP findings; currently much of this has been possible thanks to the motivation of many members, however, it is absolutely necessary to maintain this motivation and provide sufficient support to make the membership in TEAP and its TOCs feasible, desirable and professionally rewarding.

This also involves the addition or retirement of experts in some TOCs in order to adequately cope with the changing emphasis in many of the requests made by Parties for the submission of TEAP reports.

Of course, one of the main tasks of TEAP and all its TOCs is the completion of the assessment reports, where the next series of reports have to be submitted to UNEP by 31 December 2010 (following Decision XIX/20 taken in 2007).

15.4 Medical Technical Options Committee (MTOC)

The resignation of Mr. Jose Pons-Pons from TEAP will also lead to a vacancy in the co-chair group for the MTOC. While Mr. Pons plans to continue as an ordinary MTOC member after 2010, the MTOC co-chairs are investigating how the succession could best be handled and will report to Parties in the 2010 Progress Report. .

15.5 Methyl Bromide Technical Options Committee (MBTOC)

The recent strengthening and adjustment of the MBTOC has improved the efficiency of meetings and the consensus process. The two MBTOC Sub-Committees, Soils and QSC, have met in different locations in 2009, in order to reduce costs and to make important field visits.

TEAP and its MBTOC have established the QPS Task Force, which is chaired by Ms. Marta Pizano (MBTOC co-chair) and Dr. Jonathan Banks (MBTOC member). For the duration that the the Task Force will be active, Dr. Banks will be a temporary TEAP member, as set out in the TEAP Terms of Reference.

A first interim report by the QPS Task Force is part of this 2009 Progress Report.

15.6 Refrigeration, AC and Heat Pumps Technical Options Committee (RTOC)

Dr. Radhey S. Agarwal decided to resign as a co-chair of the RTOC, and will continue as an ordinary RTOC member. In a recent RTOC meeting, held in Montreal in March 2009, the RTOC members considered his resignation and decided by consensus that Dr. Roberto de Aguiar Peixoto from Brazil should be Dr. Agarwal's successor, dependent on the Parties approval of his appointment at MOP-21. Dr. Peixoto is a long-standing member of the RTOC and his possible co-chairmanship has already been supported in a letter to UNEP by the Brazilian government.

RTOC has reviewed its membership in 2008. This has resulted in a small reduction in the number of members; however, some new members were added to chapters where there was under-representation. The RTOC is still looking for an expert from non-Article 5 countries for the RTOC heat pump chapter (e.g. from the IEA Heat Pump Centre in Sweden and/or from certain institutions in Japan) and for some Article 5 members, who have adequate oversight in Article 5 regions in order to be able to report on the CFC phase-out process, on recovery and recycling, and on the management of banks of ozone depleting substances.

16 TEAP Member Biographies

The following contains the background information for all TEAP members as at April 2009.

Dr. Stephen O. Andersen
(Panel Co-chair)
Director of Strategic Climate Projects
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Stephen O. Andersen, Co-chair of the Technology and Economic Assessment Panel since 1989, is Director of Strategic Climate Projects in the Climate Protection Partnerships Division of the U.S. Environmental Protection Agency and previously Deputy Director of the Stratospheric Protection Division. He created EPA's first voluntary partnerships including accelerated phase-out agreements in food packaging foam, mobile AC, and solvents and he helped organise the Halon Alternatives Research Corporation and the Industry Cooperative for Ozone Layer Protection Prior to joining EPA he was a university professor, a consultant, and an employee of environmental, law, and energy NGOs. With K Madhava Sarma he is author of "Protecting the Ozone Layer: The United Nations History," (Earthscan 2002); with Durwood Zaelke he is author of "Industry Genius: Inventions and People Protecting the Climate and Fragile Ozone Layer," (Greenleaf 2003); with K. Madhava Sarma and Kristen N. Taddonio he is author of "Technology Transfer for the Ozone Layer: Lessons for Climate Change," (Earthscan 2007); and with Guus J.M. Velders, John S. Daniel, David W. Fahey, and Mack McFarland he is author of "The Importance of the Montreal Protocol in Protecting Climate," Proceedings of the National Academy of Sciences, 20 March 2007. He earned his M.S. and Ph.D. from the University of California Berkeley. He chaired and co-chaired the Solvents TOC from 1989 to 1995, chaired the 1999 HFC and PFC Task Force, and co-chaired several Task Forces. He served on the Steering Committee to the "IPCC/TEAP Special Report Safeguarding the Ozone Layer and the Global Climate System: Issues Related to Hydrofluorocarbons and Perfluorocarbons" and he participated in the Science Assessment Panel in 2006. Dr. Andersen's spouse works for the U.S. EPA Office of Pesticide Programs and Toxic Substances in a division that registers bio-pesticides, including potential substitutes for methyl bromide. The U.S. EPA makes in-kind contributions of wages, travel, communication, and other expenses and some travel is sponsored by the U.S. DoD. With approval of its government ethics officer, EPA allows expenses to be paid by other governments and organisations such as the United Nations Environment Programme (UNEP).

Mr. Paul Ashford
(Foams TOC Co-chair)
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Paul Ashford, Co-chair of the Rigid and Flexible Foams Technical Options Committee since 1998, is the owner and managing director of Caleb Management Services Ltd., a consulting company working in the chemical regulatory and sustainability arenas. He co-chaired the TEAP Task Force on the Supplement Report to the "IPCC/TEAP Special Report: Safeguarding the ozone layer and the global climate system: issues related to hydrofluorocarbons and perfluorocarbons" (2005) and the Task Force on Emissions Discrepancies in 2006. Paul Ashford has been involved in the work for the Task Force for Decision XX/8 and co-ordinated the Interim Report of the Task Force for Decision XX/7. Until 1994, he worked for BP Chemicals in the division that developed licensed foam technology using ODS and was responsible for the adoption of alternatives. He has over 25 years direct experience of foam related technical issues and has conducted numerous studies to characterise the foam sector and inform future policy development. His funding for TEAP activities, which includes some sponsorship of time, is provided jointly under contract by the Department of Business, Enterprise and Regulatory Reform (BERR) and the Department of Environment, Food and Rural Affairs (DEFRA) in the UK. Much of his earlier work on banks, emissions and foam end-of-life management, performed to inform both IPCC and TEAP processes was supported by the US EPA. There is increasing overlap with IPCC and UNFCCC climate objectives in support of greenhouse gas emissions reporting and reduction by Governments, including the assessment financial mechanisms to support this process. This and other related non-TEAP work is covered under separate contracts from relevant commissioning organisations including international agencies (e.g. UNMFS, UNDP and UNEP DTIE), governments, industry associations and corporate clients. A considerable portion of the work with private clients relates to the lifecycle assessment of products based on ODS alternatives and advice on carbon management strategies.

Dr. Jonathan Banks
(QPS Taskforce Co-chair)
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Dr. Jonathan Banks, Cochair of TEAP's QPS Task Force, is a private consultant. He was a member of the 1992 Methyl Bromide Assessment and from 1993 to 1998 and 2001 to 2005 co-chaired the Methyl Bromide TOC. He worked as a Research Scientist with the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO) from1972 to 1999 on grain storage technologies, including use of improved use of fumigants. He is co-inventor of carbonyl sulfide, an alternative fumigant to methyl bromide in some applications. Patent rights have been assigned to his employer, CSIRO. Dr Banks has no proprietary interest in alternatives or substitutes to ODSs, does not own stock in companies producing ODS or alternatives or substitutes to ODSs. He has stock in Brambles Ltd, a company that inter alia leases wooden pallets for freight. The pallets may or may not be treated with methyl bromide or alternatives. His spouse is co-owner of their commercial organic apple orchard. She has no financial interests relating to ozone-depleting substances. He has served on some national committees concerned with ODS and their control; within the last 4 years he has received contracts from UNEP, other institutions and public companies related to methyl bromide alternatives and grain storage technology--including training in fumigation (methyl bromide and alternatives), fumigation technology and recapture systems for methyl bromide. In 2005, 2006 and 2009 he received some support from UNEP for TEAP activities. Other funding for his current activities has been from personal contributions.

Prof. Mohamed Besri
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Prof. Mohamed Besri, is a full time Professor of Plant Pathology, ecology of soil borne pathogens, and Integrated Pest Management at the Hassan II Institute of Agronomy and Veterinary Medicine, Rabat, Morocco (HII IAVM). The HII IAVM has an interest in the topics of the Montreal Protocol because it houses specialists in Soil-borne Plant Pathogens and MLF projects (strawberries, bananas, cut flowers , vegetables). It advises the Ministry of Agriculture on all aspects of alternatives to Methyl Bromide. Dr Besri, his spouse, his business partner and dependant children have no proprietary interest in alternatives or substitutes to ODSs, nor do any of them own stock in companies producing ODS or alternatives or substitutes to ODSs. Dr Besri works occasionally as a consultant to UNEP, UNIDO and other international organisations on matters related to the Montreal Protocol. Costs associated to travel, communication, and others related to participation in the TEAP, MBTOC, and relevant Montreal Protocol meetings, are paid by UNEP's Ozone Secretariat.

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Mr. David V. Catchpole, Co-Chair of the Halons Technical Options Committee and Member of the Technology and Economics Assessment Panel since 2005, works part time for Petrotechnical Resources Alaska (PRA), an Anchorage, Alaska based company that provides consulting services to oil companies in Alaska. From 1991 to 2004 he was a member of the HTOC. From 1970 until 1999, he was an employee of the BP group of companies, most recently BP Exploration Alaska, where he worked for nine years in the environmental department on alternatives to halon and on halon banking. Mr. Catchpole advises BP Exploration Alaska on fire protection and halon issues as his main activity for PRA. BP Exploration Alaska has an interest in the topics of the Montreal Protocol because it uses halon 1301 for explosion prevention and fire suppression in its enclosed oil and gas processing modules on the North Slope of Alaska. Mr. Catchpole has no proprietary interest in alternatives or substitutes to ODSs, does not own stock in companies producing ODS or alternatives or substitutes to ODSs, however his retirement portfolio contains stock in BP plc. Mr. Catchpole's spouse does not work for or consult for any organisation that has an interest in the topics of the Montreal Protocol. His spouse has no proprietary interest in alternatives or substitutes to ODSs, does not own stock in companies producing ODS or alternatives or substitutes to ODSs and does not consult for organisations seeking to phase-out ODSs. Mr. Catchpole typically receives funding to support salary and travel to TEAP/TOC meetings from the United States Environmental Protection Agency and the United States Department of Defense; and the Halon Recycling Corporation and the Halon Alternatives Research Corporation, which are not-for-profit industry coalitions that in turn receive contributions for this funding from members. Contributors are: BP Exploration Alaska, ConocoPhillips Alaska, DuPont, Chemtura, American Pacific, Firetrace, Halon Banking Systems, Westco and Remtec.

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Dr Biao Jiang, Co-chair of the Chemicals Technical Options Committee and TEAP member since 2005, is Professor of Chemistry of Shanghai Institute of Organic Chemistry, Chinese Academy Of Sciences and a member of editorial advisory board of Chemical Communication, Royal Society of Chemistry, United Kingdom. He received his Ph. D. in 1988 form Lanzhou University. After two years as postdoctoral research in the organometallic chemistry at Shanghai institute of organic chemistry, he spent three years as a visiting scientist working on the medicinal chemistry in Dupont-Merck Pharmaceutical Co. at the Dupont experimental station, Delaware, USA. In 1995, he returned to SIOC, where he is currently professor of Chemistry and Director. The research projects of Professor Jiang's group involve the development new methodology of asymmetric synthesis, total synthesis of marine natural alkaloids and steroids, fluorine-containing bioactive molecular, as well as organic process research and development of green chemistry. Professor Jiang has no proprietary interest in alternatives or substitutes to ODSs, nor does he own stock in companies producing ODS or alternatives or substitutes to ODSs. Costs of travel, communication, and other expenses related to participation in the TEAP, its Chemicals TOC, and relevant Montreal Protocol meetings, are paid by UNEP's Ozone Secretariat.

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Dr. Sergey Kopylov, Halons Technical Options Committee (HTOC) Consulting Expert, is the Head of the Scientific Centre of the All-Russian Scientific Research Institute for Fire Protection (VNIIPO). VNIIPO has an interest in the topics of the Montreal Protocol as a body responsible for technical control of Montreal Protocol related issues in Russia. VNIIPO has no proprietary interest in alternatives or substitutes to ODSs, does not own or own stock in companies producing ODSs or alternatives or substitutes to ODSs. Dr. Kopylov works as a technical expert to the Russian government on matters related to the implementation of the Montreal Protocol. Dr. Kopylov's spouse does not work for or consult for any organisation or company. Dr. Kopylov's spouse and children have no proprietary interest in alternatives or substitutes to ODSs, do not own or own stock in companies producing ODSs or alternatives or substitutes to ODSs and do not consult for organisations seeking to phase-out ODSs. Dr. Kopylov's travel to HTOC meetings is paid for by UNEP's Ozone Secretariat.

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Lambert Kuijpers, Co-chair of the Technology and Economic Assessment Panel since 1992 and Co-chair of the Refrigeration, Air-conditioning and Heat Pumps Technical Options Committee since 1989, works on a part-time basis for the Department "Technology for Sustainable Development" at the Technical University Eindhoven, The Netherlands. He co-chaired the TEAP Replenishment Task Forces since 1996 (the last one being the 2008 TEAP Replenishment Task Force). He served on the Steering Committee to the "IPCC/TEAP Special Report "Safeguarding the ozone layer and the global climate system: issues related to Hydrofluorocarbons and Perfluorocarbons". Dr. Kuijpers co-chaired the 2005 Task Force for the TEAP Supplementary Report to the IPCC/TEAP Special Report, the 2006 Task Force on Emissions Discrepancies and the 2007 Task Force on the Response to Decision XVIII/12. He co-ordinated the activities for the Task Force on Decision XX/8 and was involved in the work of the Task Force for Decision XX/7. He was a Lead Author for both the Third and the Fourth IPCC Assessment Report. He also was a member of the Ozone Science Assessment Panel in 2005-2006. Until 1993, he worked for Philips Eindhoven (NL) in the development of refrigeration, air conditioning, and heat pump systems to use alternatives to ozone-depleting substances. He is financially supported (through the UNEP Ozone Secretariat) by the European Commission (and in certain years by some EU member state governments) for his activities related to the TEAP and the Refrigeration TOC. Dr. Kuijpers has no proprietary interest in alternatives or substitutes to ODS and does not own stock in companies producing ODS or alternatives or substitutes to ODS. He occasionally is a consultant to governmental and non-governmental organisations, such as the World Bank, UNIDO, UNEP DTIE and the Multilateral Fund. Dr. Kuijpers is also an advisor to the Re/genT Company, Netherlands, which he co-founded in 1993 and where he still has a minority interest (this company is involved in the R&D of components and equipment for refrigeration, air-conditioning and heating).

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Ms Michelle Marcotte was a member of the 1992 Methyl Bromide Assessment and subsequently a member of the Methyl Bromide Technical Options Committee between 1992 and 2005; she was confirmed as Co-Chair in 2005. Until 1993 she worked for MDS Nordion, a supplier of radiation processing equipment which is an alternative to the use of methyl bromide in some commodity and quarantine situations. Since then, Ms Marcotte, through Marcotte Consulting, has provided consulting services to governments and agri-food companies in eight countries on agri-environmental issues, food technology, regulatory affairs and radiation processing. Marcotte Consulting has an interest in the topics of the Montreal Protocol because of its long time market development work in food irradiation, an alternative to some methyl bromide uses, and because of its interest in food processing, food safety and trade. In the field of methyl bromide alternatives, Ms Marcotte has published case studies in pest control in food processing, in stored commodities, in alternatives for quarantine and in greenhouse use. She is a member of the Canada Industry-Government Methyl Bromide Working Group and the Canada-US Methyl Bromide Working Group; both organisations work to achieve the phase-out of methyl bromide in the agri-food sector. Marcotte has consulted to companies, industry associations, the International Atomic Energy Agency and US AID on irradiation as a methyl bromide alternative in food processing, quarantine and trade. She has also prepared consulting reports summarising research in methyl bromide alternatives and case studies on food processing for the U.S. Environmental Protection Agency. Ms Marcotte has no proprietary interest in alternatives or substitutes to ODSs, does not own stock in companies producing ODS or alternatives or substitutes to ODSs. Ms Marcotte's spouse works for United States Department of Agriculture managing research in methyl bromide alternatives and is a member of MBTOC. He does not have proprietary interest in alternatives or substitutes to ODS and does not own stock in companies producing ODS or alternatives or substitutes to ODSs. Ms Marcotte receives a consulting contract from the Government of Canada, Environment Canada. The funds for Ms Marcotte for travel to TEAP, MBTOC and Montreal Protocol meetings and to support her work on the MBTOC are provided by the the Government of Canada, Environment Canada.

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Thomas Morehouse, Senior Expert Member for Military Issues since 1997, is a Research Adjunct at the Institute for Defense Analyses (IDA), Washington D.C., USA. From 1989 until 1996 he co-chaired the Halons TOC. From 1986 to 1989 he was an officer in the United States Air Force responsible for developing alternatives to halon. From 1989 until 1994 his responsibilities as an Air Force officer included broader environmental and energy policy issues for the U.S. Department of Defense. IDA makes in-kind contributions of communications and miscellaneous expenses. IDA is a not-for-profit Federally Funded Research Center (FFRDC) that undertakes work exclusively for the US Department of Defense. Funding for wages and travel is provided by grants from the Department of Defense. He also occasionally consults independently to corporate clients, national laboratories and other government agencies on environmental and energy related issues. Mr. Morehouse's spouse consults occasionally for the U.S. National Oceanographic and Atmospheric Administration (NOAA) on management issues. NOAA conducts research on stratospheric ozone and climate. Mr Morehouse –and his spouse- have no proprietary interest in alternatives or substitutes to ODSs, nor do they own stock in companies producing ODS or alternatives or substitutes to ODSs.

Ms. Marta Pizano
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Ms Marta Pizano is a consultant on methyl bromide alternatives, particularly for cut flower production, and has actively promoted methyl bromide alternatives among growers in many countries. She is a regular consultant for the Montreal Protocol Multilateral Fund (MLF) and its implementing agencies. In this capacity, she has contributed to the methyl bromide phase-out programs in nearly twenty Article 5 Parties around the world, assisting growers with the adoption of sustainable alternatives and the implementation of IPM programs. She is a frequent speaker at national and international methyl bromide conferences and has authored numerous articles and publications on alternatives to this fumigant. She has been a member of MBTOC since 1998 and a co-chair since 2005. She became co-chair of the revitalised QPS Task Force in 2008. Neither Ms Pizano nor her husband or their children own stock or have proprietary interest in companies producing ODS or their alternatives or substitutes. Costs associated with travel, communication, and others related to participation in the TEAP, MBTOC, and relevant Montreal Protocol meetings, are paid by UNEP's Ozone Secretariat.

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Jose Pons, Co-chair of the Technology and Economic Assessment Panel since 2004 and of the Medical Technical Options Committee since 1991, is President of Spray Química C.A. . Spray Química had an interest in the topics of the Montreal Protocol because it used ODS in some of its aerosol products for industrial maintenance. Mr. Pons is president of the Venezuelan Chamber of Aerosols, CAVEA and has worked in ozone layer protection since 1989. He has participated in several TEAP Task Forces and on the Steering Committee to the "IPCC/TEAP Special Report Safeguarding the Ozone Layer and the Global Climate System: Issues Related to Hydrofluorocarbons and Perfluorocarbons". Mr Pons has no proprietary interest in alternatives or substitutes to ODS, does not own stock in companies producing ODS or alternatives or substitutes to ODS, does not have an interest in the outcome of essential use nominations, and does not consult for organisations seeking to phase out ODS. Mr Pons's spouse has no interest in matters before the Protocol; she is also a manager/engineer at Spray Química. Mr Pons has worked occasionally as a project reviewer for the MLF and implementing agencies on matters related to the Montreal Protocol. Travel related to participation in the TEAP and MTOC, and relevant Protocol meetings, are paid by UNEP's Ozone Secretariat. Spray Química makes in-kind contributions of wage, and miscellaneous and communication expenses.

Dr. Ian J. Porter
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Dr Ian Porter is an Associate Professor with LaTrobe University and Principal Research Scientist with the Victorian Department of Primary Industries (DPI), but takes leave from his organisation to conduct Montreal Protocol duties. DPI has an interest in developing sustainable alternatives to methyl bromide and integrated pest management strategies for control of plant pathogens and pests, and issues related to biosecurity. He has been a member of a number of National Committees regulating ODS, has led the Australian research program on methyl bromide alternatives for soils since 1992 and has 28 years experience in researching sustainable methods for soil disinfestation of plant pathogens with over 250 research publications. He has been a member of MBTOC since 1997, chair of the Soils sub committee from 2001 to 2005 and MBTOC Co-chair since 2005. Neither Ian, his wife or children have any proprietary interest in alternatives or substitutes to ODSs, nor own stock in companies producing ODS or alternatives or substitutes to ODSs. Dr Porter is presently leading national programs on integrated pest management and soil health in the Australian horticultural industries. He has acted as a key consultant for UNEP and UNIDO in developing programmes to assist China, Mexico and CEIT countries to replace methyl bromide. He regularly participates in workshops to assist countries with alternatives to methyl bromide and gives keynote addresses to international conferences on alternatives to methyl bromide in horticultural industries. He is presently funded by the European Commission through the Ozone Secretariat to support and attend MBTOC and TEAP meetings. In kind contributions from the Victorian Department of Primary Industries and Australian Federal Government Research Funds have provided past support.

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Prof. Miguel W. Quintero, Co-chair of the Foams Technical Options Committee since 2002, is a consultant in the area of polyurethane technology. He has been a professor at the Chemical Engineering Department at Universidad de los Andes in Bogota, Colombia, in the areas of polymer processing and transport phenomena during 2000- 2006. Prof. Quintero worked during 21 years (until 2000) for Dow Chemical at the Research & Development and Technical Service & Development Departments in the area of rigid polyurethane foam. In the period January 2007- October 2008, he returned to Dow Europe as Development Leader for Polyurethane Product Research, located in Freienbach, Switzerland. He owns stock in companies that now or previously manufactured ozone-depleting substances and products made with or containing ozone depleting substances and their substitutes and alternatives. He is a regular consultant for the Montreal Protocol's implementing agencies. Costs associated to travel, communication, and others related to participation in the TEAP, FTOC and relevant Montreal Protocol meetings are paid by UNEP's Ozone Secretariat.

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Dr. Rae, Co-chair of the Chemicals Technical Options Committee since 2005, is a Honorary Professorial Fellow at the University of Melbourne, Australia, and a member of advisory bodies for several Australian government agencies dealing with chemical issues and in particular the Stockholm Convention. He co-chaired the 2001 and 2004 Process Agent Task Forces. He is a member of the POPs Review Committee for the Stockholm Convention. On occasions, he acts as consultant to government agencies and to universities and companies and he has been an expert witness in a case involving alleged patent infringement involving HFC- 134a and its lubricants. Neither he nor his wife owns stock in any company dealing with ozone depleting substances or their alternatives. He contributes the time for his own participation in TEAP activities. The Australian Government Department of the Environment, Water, Heritage and the Arts finances the cost of travel and accommodation for Dr. Rae's attendance at meetings of the CTOC, TEAP, OEWG and MOP.

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K. Madhava Sarma, Senior Expert Member since 2001, and member of the Task Force on the TEAP Legacy, retired in 2000, after nine years as Executive Secretary, Ozone Secretariat, UNEP. Earlier, he was a senior official in the Ministry of Environment and Forests (MOEF), Government of India and held various senior positions in a state government in India. He works occasionally as a consultant to UNEP and is an unpaid member of the Technical and Finance Committee of the Ozone Cell, MOEF, Government of India. He has worked as consultant for two chemical companies to work out the likely amendments needed to the Montreal Protocol if HFCs were made controlled substances under the Protocol. He is working as consultant to the UNFCCC Secretariat to assist its Expert Group on Technology Transfer to prepare a Strategy for scaling up Technology Development, Deployment and Diffusion. Neither he or his spouse own stock in any company connected to ODS or alternatives or substitutes. Costs of travel, communication, and other expenses related to participation in the TEAP and relevant Montreal Protocol meetings, are paid by UNEP's Ozone Secretariat.

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Helen Tope, Co-chair Medical Technical Options Committee since 1995, is Principal Consultant of Energy International Australia and also Director of Planet Futures with whom she is an independent consultant providing strategic, policy and technical advice and facilitation services to government, industry and other non-governmental organisations on climate change, ozone-depleting substances, and other environmental issues. Dr Tope's business has an interest in the topics of the Montreal Protocol because her potential clients are also interested in these topics. Dr Tope has no proprietary interest in alternatives or substitutes to ODS, does not own stock in companies producing ODS or alternatives or substitutes to ODS, does not have an interest in the outcome of essential use nominations, and does not currently consult for organisations seeking to phase out

ODS. Dr Tope's spouse has no interest in matters before the Protocol. At the invitation of UNEP ROAP, Dr Tope participated as MTOC co-chair in the 2008 Langkawi regional workshop on MDIs. UNEP ROAP has contracted the National Asthma Council Australia to produce a package of resources on awareness raising on the transition to CFC-free MDIs to assist countries preparing for CFC MDI phase-out. At the invitation of the National Asthma Council Australia, Dr Tope is a member of the Advisory Panel for this project. In 2009 Dr Tope's funding for travel to MTOC, TEAP and Montreal Protocol meetings are provided from two sources. The Ozone Secretariat provides a grant for Dr Tope's travel to the MTOC and TEAP meetings from funds granted to the Secretariat unconditionally by the International Pharmaceutical Aerosol Consortium (IPAC), which is a non-profit corporation. The Australian Government Department of the Environment, Water, Heritage and the Arts provides funding for the cost of travel and accommodation for Dr Tope's attendance of the OEWG-29 and MOP-21.

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Dr. Daniel P. Verdonik, Co-Chair, Halons Technical Options Committee and Member, Technology and Economic Assessment Panel, is the Director, Environmental Programs, Hughes Associates, Inc. Dr. Verdonik is a full time, salaried employee at Hughes Associates, Inc., in Baltimore, MD and Arlington, VA providing consulting services in fire protection and environmental management. Hughes Associates, Inc. has an interest in the topics of the Montreal Protocol because it provides a wide range of fire protection research, design and consulting services to government and corporate clients, including work related to halons and halon alternatives. Dr. Verdonik has no proprietary interest in alternatives or substitutes to ODSs, does not own stock in companies producing ODSs or alternatives or substitutes to ODSs and through Hughes Associates, Inc. provides consulting services for organisations seeking to phase-out ODSs. Dr. Verdonik is a share holder in Hughes Associates, Inc., which does not own stock in companies producing ODSs, or alternatives or substitutes to ODSs. Dr. Verdonik currently provides consulting services through Hughes Associates, Inc, for the U.S. Army and U.S. Navy on matters related to the Montreal Protocol and has previously provided services through Hughes Associates Inc. for Implementing Agencies, U.S. EPA, U.S. Air Force and Chemtura (now DuPont). Dr. Verdonik's spouse works for the USEPA, which has an interest in the topics of the Montreal Protocol because the Agency is responsible for implementing national regulations and policies to meet the US commitments under the Protocol. Dr. Verdonik's spouse and dependent child have no proprietary interest in alternatives or substitutes to ODSs, do not own stock in companies producing ODSs or alternatives or substitutes to ODSs, and do not consult for organisations seeking to phase-out ODSs. Hughes Associates, Inc. typically receives funding to support Dr. Verdonik's salary and travel to TEAP/HTOC/TSB meetings from MLF, UNEP, the U.S. Department of Defense, the U.S. EPA, the U.S. National Aeronautics and Space Administration, the Halon Recycling Corporation, and the Halon Alternatives Research Corporation, who in-turn currently receives funding to support these efforts from the following sponsors: BP Exploration, Alaska; ConocoPhillips, Alaska; DuPont; American Pacific; Firetrace; Halon Banking Systems; Wesco; Remtec. From time-to-time, Hughes Associates, Inc may also provide support for labour and travel.

Prof. Ashley Woodcock
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Prof. Ashley Woodcock, Co-chair of the Medical Technical Options Committee and Member of the Technology and Economic Assessment Panel, is a Respiratory physician at the University Hospital of South Manchester, and Head of the School of Translational Medicine for the University of Manchester. The Hospital and University have no direct interest in the topics of the Montreal Protocol. Prof. Woodcock has no proprietary interest in alternatives or substitutes to ODS, does not own stock in companies producing ODS or alternatives or substitutes to ODS, does not have an interest in the outcome of essential use nominations. Prof. Woodcock carries out unrelated consulting, research and educational lectures for pharmaceutical companies, all of which are near completion of phase out of CFC MDIs. He advises companies on study design for new drugs, some of which have been ODS replacements. Prof. Woodcock's spouse has no interest in matters before the Protocol. Prof. Woodcock does not work as a consultant to the UN, UNEP, MLF or Implementing Agencies. In the past, he has responded to requests for technical information on CFC MDI phase-out from the European Community and the United Kingdom Government. Travel and subsistence for meetings of TEAP, MTOC, OEWG, MOP meetings is paid from Hospital and University funds, and Prof. Woodcock's employers allow leave of absence.

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Dr. Masaaki Yamabe, Co-Chair of the Chemicals Technical Options Committee since 2005, is a research advisor of the Research Institute of Science for Safety and Sustainability at the AIST. He was a member of the Task Force on the TEAP Legacy and he co-chaired the 2004 Process Agent Task Force. He was a member of the Solvents TOC during 1990-1996. Until 1999, Mr. Yamabe was Director of Central Research for Asahi Glass Company, which previously produced CFCs, methyl chloroform, and carbon tetrachloride, and currently produces and distributes HCFC, carbon tetrachloride, and HFCs. He is the co-inventor of HCFC-225, which is controlled under the Montreal Protocol as a transitional substance in the phase-out of ozone-depleting substances and is a substitute for CFC-113 in solvent and process agent applications. He owns stocks in Asahi Glass Company that produces ozone-depleting substances and their substitutes. He also works for the Japan Industrial Conference for Ozone Layer and Climate Protection (JICOP) as a senior advisor. AIST, JICOP and the Ministry of Economy, Trade and Industry (METI) share the financing involved in the travel and accommodation for Mr. Yamabe's attendance at the meetings of the CTOC, TEAP, OEWG and MOP.

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Dr. Shiqiu Zhang, Senior Expert Member for economic issues of the TEAP since 1997, is a Professor on Environmental Economics and Policy at the College for Environmental Sciences and Engineering of Peking University. She co-chaired the 2002, 2005 and 2008 Replenishment Task Forces. Dr. Zhang has no proprietary interest in alternatives or substitutes to ODSs, nor does she own stock in companies producing ODS or alternatives or substitutes to ODSs. Costs of travel, communication, and other expenses related to participation in the TEAP and relevant Montreal Protocol meetings, are paid by UNEP's Ozone Secretariat.

17 TEAP TOC Membership List Status April 2009

Co-chairs	Affiliation	Country
Stephen O. Andersen	U.S. Environmental Protection Agency	USA
Lambert Kuijpers	Technical University Eindhoven	Netherlands
Jose Pons Pons	Spray Quimica	Venezuela

Senior Expert Members	Affiliation	Country
Thomas Morehouse	Institute for Defense Analyses	USA
K. Madhava Sarma	Consultant	India
Shiqiu Zhang	Center of Environmental Sciences, Peking University	China

TOC Chairs	Affiliation	Country
Paul Ashford	Caleb Management Services	UK
Jonathan Banks	Consultant	Australia
Mohamed Besri	Institut Agronomique et Vétérinaire Hassan II	Morocco
Biao Jiang	Shanghai Institute of Organic Chemistry	China
David 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
Roberto de A. Peixoto (preliminary)	Maua Institute (IMT), Sao Paulo	Brazil
Marta Pizano	Consultant	Colombia
Ian Porter	Department of Primary Industries	Australia
Miguel Quintero	Consultant	Colombia
Ian D. Rae	University of Melbourne	Australia
Helen Tope	EPA, Victoria	Australia
Ashley Woodcock	Wythenshawe Hospital Manchester	UK
Daniel Verdonik	Hughes Associates	USA
Masaaki Yamabe	National Inst. Advanced Industrial Science and Technology	Japan

TEAP Chemicals Technical Options Committee (CTOC)

Co-chairs	Affiliation	Country
Biao Jiang	Shanghai Institute of Organic Chemistry	China
Ian D. Rae	University of Melbourne	Australia
Masaaki Yamabe	National Inst. Advanced Industrial Science and Technology	Japan

Members	Affiliation	Country
D. D. Arora	The Energy and Research Institute	India
Steven Bernhardt	Honeywell	USA
Olga Blinova	Russian Scientific Center for Applied Chemistry	Russia
Nick Campbell	Arkema Group	France
Bruno Costes	Airbus Industries	France
Jianxin Hu	College of Environmental Sciences & Engineering, Peking University	China
A.A. Khan	Indian Institute of Chemical Technology	India
Michael Kishimba	University of Dar-es-Salaam	Tanzania
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
Shuniti Samejima	Asahi Glass Foundation	Japan
John Stemniski	Consultant	USA
Fatemah Al-Shatti	Kuwait Petroleum Corporation	Kuwait
Peter Verge	Boeing Manufacturing	USA
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
Chris Bloom	Dow	USA
Kyoshi Hara	JUFA	Japan
Mike Hayslett	Maytag/AHAM	USA
Mike Jeffs	ISOPA	Belgium
Candido Lomba	ABRIPUR	Brazil
Yehia Lotfi	Technocom	Egypt
Christoph Meurer	Solvay	Germany
Ulrich Schmidt	Haltermann/Dow	Germany
Bert Veenendaal	RAPPA	USA
Shigeru Wakana	Dow	Japan
Mark Weick	Dow	USA
Tom Werkema	Arkema	USA
Dave Williams	Honeywell	USA
Allen Zhang	Owens Corning	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		
Tareq 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
Michelle M. Collins	Consultant- EECO International	USA
Salomon Gomez	Tecnofuego	Venezuela
Andrew Greig	Protection Projects Inc	South Africa
Bryan Jolly	European Aviation Safety Agency (EASA)	UK
Zhou Kaixuan	CAAC-AAD	PR China
H. S. Kaprwan	Consultant – Retired	India
Nikolai Kopylov	All Russian Research Institute for Fire Protection	Russian Federation
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