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On Substances that Deplete the Ozone Layer

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Co-ordination: Technology and Economic Assessment Panel

Composition of the report: Lambert Kuijpers and Meg Seki (UNEP)

Layout and formatting: Ozone Secretariat (UNEP)
Lambert Kuijpers (UNEP TEAP)

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Foreword

The TEAP 2010 Progress Report

The May 2010 TEAP Progress Report consists of two volumes:

**Volume 1** Decision XXI/9 Task Force Report, and
the “final” Decision XIX/8 Task Force Report

**Volume 2** TOC Progress Reports and Other Task Force Reports

**Volume 1**

Volume 1 contains: (1) the report of the Decision XXI/9 Task Force on the assessment of HCFCs and environmentally sound alternatives and (2) the final report of the Decision XIX/8 Task Force dealing with the “scoping study on HCFC alternatives under high ambient temperature conditions”.

**Volume 2**

Volume 1 contains the essential use report, TOC progress reports, the MBTOC-QPS report requested in decision XXI/10, the preliminary CUN evaluation report, as well as TEAP organisation issues and TEAP-TOC membership lists

This report is the Volume 2 report.

The UNEP Technology and Economic Assessment Panel:

Stephen O. Andersen, co-chair  USA  Marta Pizano  COL
José Pons-Pons, co-chair  VEN  Ian Porter  AUS
Lambert Kuijpers, co-chair  NL  Miguel Quintero  COL
Paul Ashford  UK  Ian Rae  AUS
Mohamed Besri  MOR  Helen Tope  AUS
David Catchpole  UK  Dan Verdonik  USA
Biao Jiang  PRC  Ashley Woodcock  UK
Michelle Marcotte  CDN  Masaaki Yamabe  J
Thomas Morehouse  USA  Shiqiu Zhang  PRC
Roberto Peixoto  BRA
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 x May 2010 TEAP Progress Report
1 Essential Uses

1.1 Executive Summary of Essential Use Nominations for Metered Dose Inhalers

MTOC received 7 essential use nominations requesting a total of 1,628.74 tonnes of CFCs for the manufacture of metered dose inhalers (MDIs) in 2011: 6 from Article 5 Parties (Argentina, Bangladesh, China, India, Iran, Pakistan); and 1 from a non-Article 5 Party (Russian Federation).

Table 1-1 summarises the recommendations of the Technology and Economic Assessment Panel (TEAP) and its Medical Technical Options Committee (MTOC) on nominations for essential use production exemptions for chlorofluorocarbons (CFCs) for MDIs. Recommendations are made in accordance with Decision XV/5(3), which requests TEAP and its TOC to make recommendations on nominations for essential use exemptions for CFCs for MDIs with reference to the active ingredient of the metered-dose inhalers in which the CFCs will be used and the intended market for sale or distribution. Recommendations are for a total of 1,291.8 tonnes of CFCs for the manufacture of MDIs in 2011.

<table>
<thead>
<tr>
<th>Party</th>
<th>2011</th>
<th>Active Ingredients</th>
<th>Intended Markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>106.7</td>
<td>Beclomethasone, budesonide, fenoterol, fluticasone, ipratropium, salbutamol, salbutamol/beclomethasone, salbutamol/ipratropium, salmeterol, salmeterol/fluticasone</td>
<td>Argentina</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>Salbutamol/ipratropium</td>
<td>Chile, Paraguay and Peru</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>38.65</td>
<td>Ciclesonide, fluticasone/salmeterol, ipratropium, ipratropium/salbutamol, salmeterol and tiotropium</td>
<td>Bangladesh</td>
</tr>
<tr>
<td>China</td>
<td>741.15</td>
<td>Beclomethasone, beclomethasone/clenbuterol/ipratropium, budesonide, datura metel extract/clenbuterol, dimethicone; ephedra, ginkgo, sophora favescens and radix scutellariae; ipratropium, ipratropium/salbutamol, isoprenaline, isoprenaline/guaifenesin, procatelor, salbutamol, salmeterol, cromoglycate</td>
<td>China</td>
</tr>
<tr>
<td>India</td>
<td>19.8</td>
<td>Ipratropium, ipratropium/salbutamol, tiotropium and tiotropium/formoterol</td>
<td>India</td>
</tr>
<tr>
<td></td>
<td>28.4</td>
<td>Ipratropium, ipratropium/salbutamol, tiotropium and tiotropium/formoterol</td>
<td>Colombia, Jamaica, Panama, Peru, Sri Lanka, Suriname, U.A.E., Uganda, Venezuela</td>
</tr>
<tr>
<td>Party</td>
<td>2011</td>
<td>Active Ingredients</td>
<td>Intended Markets</td>
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<tr>
<td>----------------------</td>
<td>--------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Iran</td>
<td>105 tonnes</td>
<td>Beclomethasone, salbutamol, salmeterol, cromoglycate</td>
<td>Iran</td>
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<td>Pakistan</td>
<td>39.6 tonnes</td>
<td>Beclomethasone, beclomethasone/salbutamol, fluticasone/salmeterol, ipratropium, salbutamol, salmeterol, triamcinolone</td>
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<tr>
<td>Russian Federation</td>
<td>212 tonnes</td>
<td>Salbutamol</td>
<td>Russian Federation</td>
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MTOC thanks the Shanghai Institute of Pharmaceutical Industry (SIPI) and the Ozone Secretariat for providing meeting venue sponsorship for the MTOC meeting held in Shanghai, China, 21-25 March 2010. SIPI provided a range of on-ground organisational assistance and in-kind support, such as printing. MTOC accepted hospitality including transportation, guides, meals and beverages.

In 2009, MTOC reported that it found it difficult to assess the nominations due to a lack of data provided on availability and affordability of alternatives to CFC MDIs. In particular, it reported that it was difficult to assess accurately the essentiality of quantities of CFCs intended for export when country-specific information was not provided in nominations on the quantity of CFCs required for each active ingredient in each market and the availability and affordability of alternatives. MTOC concluded that in future years, in the absence of country-specific information, MTOC would 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 excluded any countries considered to have an adequate range of alternatives.

Based on the information provided this year in nominations for 2011, MTOC continued to find it difficult to assess the nominations from Article 5 Parties in accordance with the criteria set out in Decision IV/25. In particular there was again a shortage of data in nominations on the availability and affordability of alternatives to CFC MDIs for Article 5 Parties importing products from MDI manufacturing/nominating Parties. However, MTOC had more data accessible to it from publicly available sources in 2010 than in 2009 on the availability and affordability of alternatives to CFC MDIs, both for the MDI manufacturing/nominating Parties and for Article 5 Parties importing their products. There has been substantial progress in the development and marketing of affordable CFC-free MDIs, especially those manufactured by Article 5 Parties.

MTOC considers that there is an adequate range of technically satisfactory and affordable CFC-free alternatives for CFC MDIs for beta-agonists (in particular, salbutamol) and inhaled corticosteroids (in particular, beclomethasone) available in many developing countries. Consequently, MTOC is unable to recommend any of the CFC quantities nominated to manufacture MDIs for beta-agonists and inhaled corticosteroids for intended export markets. Some importing countries may still consider salbutamol and/or beclomethasone CFC MDIs essential in 2011, including through concern for poorer patients, but MTOC was not provided evidence to support this. Parties may wish to request importing countries to demonstrate essentiality.

---

1 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 Article 5 Parties.
Beta-agonist and inhaled corticosteroid CFC MDIs can now be considered non-essential in many developing countries because the previous conditions for non-essentiality stated by MTOC in 2009 have been met:

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

There are some Parties where beta-agonist and/or inhaled corticosteroid CFC MDIs may still be needed for use in their own countries in 2011: Argentina, China, Iran, Pakistan and the Russian Federation. CFCs for MDIs in these therapeutic categories are recommended for these markets for 2011 while the conversion to CFC-free alternatives is underway and HFC MDI capacity is increasing.

It is technically difficult to formulate anti-cholinergic drugs, such as ipratropium bromide and tiotropium bromide, as HFC MDIs and only a limited range of CFC-free inhalers are currently available. New CFC-free inhalers (DPIs and HFC MDIs manufactured in both non-Article 5 and Article 5 Parties) for tiotropium and ipratropium (and combinations with other moieties) are beginning to become available. However MTOC does not yet believe they provide an adequate range of CFC-free alternatives to consider the CFC MDIs for these drugs to be non-essential. MTOC has recommended the nominated quantities for ipratropium and tiotropium (and combinations with other moieties) and their combinations to markets where they were considered essential for 2011 because of uncertainty about the range of available alternatives and the current capacity of the manufacture of these products. MTOC will revisit the developments in anti-cholinergic drug availability in 2011, as reformulation and marketing of CFC-free alternatives progress.

There are increasing numbers of combination products becoming available in Article 5 Party markets. In previous years, MTOC had 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, in 2009 for 2010 nominations, MTOC considered the CFCs requested for combination products with anti-cholinergics to be essential for the nominations received from Article 5 Parties. MTOC reconsidered, and reaffirmed this conclusion for nominations for 2011. MTOC is aware of several CFC-free combination products containing anti-cholinergics that have become available in Article 5 Parties. However, MTOC does not have sufficient information on price, availability, and manufacturing capacity to know whether the CFC MDI formulations are essential for 2011. 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 them as essential.

MTOC is unable 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, for which CFCs are requested in China’s essential use nomination for 2011. 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 and 2010, without significant additional health benefits, cannot be considered essential in 2011 under Decision IV/25.
1.2 Essential Use Nominations for Metered Dose Inhalers

1.2.1 Criteria for Review of Essential Use Nominations for MDIs

Decision IV/25 of the 4th Meeting and subsequent Decisions V/18, VII/28, VIII/9, VIII/10, XII/2, XIV/5, XV/5, XVI/12, XVIII/16, XX/3 and XXI/4 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 Montreal Protocol. Other essential use decisions relevant to these Parties are Decisions XVII/5, XVIII/7 and XIX/13.

1.2.2 Review of Nominations

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

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 Shanghai, China, 21-25 March 2010. 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, 2009) and subsequent Decisions of the Parties. Recommendations are made in accordance with Decision XV/5(3), which requests TEAP and its TOC to make recommendations on nominations for essential use exemptions for CFCs for MDIs with reference to the active ingredient of the metered-dose inhalers in which the CFCs will be used and the intended market for sale or distribution.

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

1.2.3 Observations

MTOC received 7 essential use nominations requesting a total of 1,628.74 tonnes of CFCs for the manufacture of metered dose inhalers (MDIs) in 2011: 6 from Article 5 Parties (Argentina, Bangladesh, China, India, Iran, Pakistan); and 1 from a non-Article 5 Party (Russian Federation). MTOC recommendations are for a total of 1,291.8 tonnes of CFCs for the manufacture of MDIs in 2011.

For the first round of nominations from Article 5 Parties in 2009, MTOC reported that it found it difficult to assess the nominations due to a lack of data provided on availability and affordability of alternatives to CFC MDIs. In particular, it reported that it was difficult to assess accurately the essentiality of quantities of CFCs intended for export when country-
specific information was not provided in nominations on the quantity of CFCs required for each active ingredient in each market and the availability and affordability of alternatives\(^2\).

MTOC concluded that in future years, in the absence of country-specific information, MTOC would 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 excluded any countries considered to have an adequate range of alternatives.

Based on the information provided this year in nominations for 2011, MTOC continued to find it difficult to assess the nominations from Article 5 Parties in accordance with the criteria set out in Decision IV/25. In particular there was again a shortage of data in nominations on the availability and affordability of alternatives to CFC MDIs for Article 5 Parties importing products from MDI manufacturing/nominating Parties.

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."

There were also substantial inconsistencies in some nominations, with some nominating Parties listing exports to Parties that have already declared CFC MDIs as non-essential.

However, MTOC had more data accessible to it from publicly available sources in 2010 than in 2009 on the availability and affordability of alternatives to CFC MDIs, both for the MDI manufacturing/nominating Parties and for Article 5 Parties importing their products. There has been substantial progress in the development and marketing of affordable CFC-free MDIs, especially those manufactured by Article 5 Parties. With economies of scale, and a range of different brands from local manufacturers, HFC MDIs are now becoming more competitively priced compared to CFC MDIs.

MTOC considers that there is an adequate range of technically satisfactory and affordable CFC-free alternatives for CFC MDIs for beta-agonists (in particular, salbutamol) and inhaled corticosteroids (in particular, beclomethasone) available in many developing countries. Consequently, MTOC is unable to recommend any of the CFC quantities nominated to manufacture MDIs for beta-agonists and inhaled corticosteroids for intended export markets.

Economic aspects, in particular those related to affordability, are important criteria for the assessment of essential uses under Decision IV/25. In their nominations, most Article 5 Parties have previously reported price differences between inhalers made in Article 5 Parties compared to imported inhalers from non-Article 5 Parties. The major change in 2010 has been the new widespread availability of CFC-free alternatives manufactured in Article 5 Parties. Some manufacturers have completed MLF funded projects (e.g. Cuba, Uruguay), while others are completing manufacturing conversion independently (e.g. Algeria, Croatia, Syria, Venezuela). The largest manufacturer in India, Cipla, has 51 different CFC-free

\(^2\) 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 Article 5 Parties.
products available. In Bangladesh, three manufacturers will have HFC MDIs for both salbutamol and beclomethasone on sale in 2010, with combined installed capacity to manufacture 25 million inhalers per year. Since domestic MDI use is currently 5 million inhalers per year, companies in Bangladesh will be competing with those from other Article 5 Parties to supply affordable HFC MDIs to many markets previously reliant on CFC MDIs manufactured and exported by Article 5 Parties. This new HFC MDI manufacturing capacity has the potential to reduce the prices of CFC-free inhalers. Finally, any importing Parties with difficulty in sourcing affordable CFC-free inhalers could potentially access them through the Asthma Drug Facility (an independent non-profit organisation managed by the International Union against Tuberculosis and Lung Disease www.globaladf.org).

Taking these issues into consideration, beta-agonist and inhaled corticosteroid CFC MDIs can now be considered non-essential in many developing countries because the previous conditions for non-essentiality stated by MTOC in 2009 have been met:

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

There are some Parties where beta-agonist and/or inhaled corticosteroid CFC MDIs may still be needed for use in their own countries in 2011: Argentina, China, Iran, Pakistan and the Russian Federation. CFCs for MDIs in these therapeutic categories are recommended for these markets for 2011 while the conversion to CFC-free alternatives is underway and HFC MDI capacity is increasing.

It is technically difficult to formulate anti-cholinergic drugs, such as ipratropium bromide and tiotropium bromide, as HFC MDIs and only a limited range of CFC-free inhalers are currently available. New CFC-free inhalers (DPIs and HFC MDIs manufactured in both non-Article 5 and Article 5 Parties) for tiotropium and ipratropium (and combinations with other moieties) are beginning to become available. However MTOC does not yet believe they provide an adequate range of CFC-free alternatives to consider the CFC MDIs for these drugs to be non-essential. MTOC has recommended the nominated quantities for ipratropium and tiotropium (and combinations with other moieties) to markets where they were considered essential for 2011 because of uncertainty about the range of available alternatives and the current capacity of the manufacture of these products. MTOC will revisit the developments in anti-cholinergic drug availability in 2011, as reformulation and marketing of CFC-free alternatives progress.

In those countries where the MLF is funding phase-out projects for different companies, it is likely that the previously stated conditions for non-essentiality 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 essential use criteria. Some companies have been successful in transition. Market leaders in HFC MDIs ought not to 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.

Furthermore, 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. The experience with phase-out in non-Article 5 Parties shows that in some cases reformulation may not be commercially viable or technically possible, while in other cases it was possible to reformulate a moiety as a DPI, but not as an MDI.
Pricing policies, tariffs, import taxes and restrictions have been implemented by some Parties to protect local industry. These policies favour locally made pharmaceuticals, including CFC MDIs, and discourage use of imported pharmaceuticals, including CFC-free alternatives. Parties may wish to consider pricing policies that will expedite the rapid transition to CFC-free inhalers, with the priority of protecting the health of patients.

Slow regulatory approvals processes have been cited as one reason for delays in the introduction of CFC-free alternatives. Given the phase-out of CFCs, Parties are encouraged to fast-track approvals of CFC-free alternatives.

1.2.4 Exported products

MTOC has noted previously the wide availability in Article 5 Parties of technically suitable alternatives to CFC MDIs from multinational companies. However, this has not prompted transition largely due to lack of affordability of these alternatives. Inhaler products sourced from manufacturers in Article 5 Parties are now substantially increasing the range of affordable alternatives. For example, Cipla, an Indian multinational pharmaceutical company, now markets 51 different CFC-free inhalers and has previously reported its commitment to phase out domestic supply of CFC MDIs by the end of 2009.

Several of the nominations included significant CFC quantities to manufacture MDIs intended for export to other Article 5 Parties. None of the nominations adequately demonstrated that these CFC MDIs were essential in the intended export markets or demonstrated that importing Parties had provided their prior informed consent for the import of the CFC MDIs in 2011. MTOC does not have the information from importing Parties to substantiate that these uses are essential. Furthermore, it is not clear whether importing Parties are specifically requesting the continued import of CFC MDIs despite the alternatives available, whether they simply import the cheapest available product even if it contains CFCs, or whether they are unable to switch to alternatives because of a lack of regulatory approval of the alternatives. There is an opportunity for importing Parties to help to drive the global phase-out of CFCs through judicious sourcing of CFC-free alternatives.

MTOC considers that there is an adequate range of technically satisfactory and affordable CFC-free alternatives for CFC MDIs for beta-agonists (in particular, salbutamol) and inhaled corticosteroids (in particular, beclomethasone) available in many developing countries. Argentina, China, Iran, Pakistan and the Russian Federation may need salbutamol and/or beclomethasone CFC MDIs in 2011 while the conversion to CFC-free alternatives is underway and HFC MDI capacity is increasing. However, MTOC is unable to recommend any of the CFC quantities nominated to manufacture MDIs for beta-agonists and inhaled corticosteroids intended for export. Some importing countries may still consider salbutamol and/or beclomethasone CFC MDIs essential in 2011, including through concern for poorer patients, but MTOC was not provided evidence to support this. Parties may wish to request importing countries to demonstrate essentiality.

MTOC reviewed the available data about alternatives from the nominations and other sources, including a dataset supplied by IPAC. Decision XIV/5 requests 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 much of the data is up to 10 years old and no longer relevant to today’s market. 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 Ozone
Secretariat will send a letter later this year to remind Parties of their obligation to report under Decision XIV/5.

Decision XII/2(3) also requests Parties, including Article 5 Parties, to notify the Ozone Secretariat of any CFC 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. Parties may wish to consider the decision 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 nomination process. Parties may wish to consider requesting nominating Parties to demonstrate that they have received informed consent of the government of any importing country for imports of CFC MDIs in any future nomination.

1.2.5 Other Issues

Decision XX/3 requests Parties to prepare preliminary plans of action by mid-2009 for the phase-out of salbutamol CFC MDIs. By March 2010, Argentina had not yet submitted its national strategy or preliminary plan of action.

There are increasing numbers of combination products becoming available in Article 5 Party markets. In previous years, MTOC had 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, in 2009 for 2010 nominations, MTOC considered the CFCs requested for combination products with anti-cholinergics to be essential for the nominations received from Article 5 Parties. MTOC reconsidered, and reaffirmed this conclusion for nominations for 2011. MTOC is aware of several CFC-free combination products containing anti-cholinergics that have become available in Article 5 Parties. However, MTOC does not have sufficient information on price, availability, and manufacturing capacity to know whether the CFC MDI formulations are essential for 2011. 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 them as essential.

MTOC is unable 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, for which CFCs are requested in China's essential use nomination for 2011. 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 and 2010, without significant additional health benefits, cannot be considered essential in 2011 under Decision IV/25.

China is still in the early stages of transition from CFC MDIs. Research and development of HFC MDIs by local companies started in China in 2002. Salbutamol HFC MDI files were submitted in 2004 but production has not yet started. Imported HFC MDIs and DPIs are more expensive than locally manufactured CFC MDIs, which could explain the lack of market penetration of CFC-free MDIs. No inhalers from other Article 5 Parties have yet been approved for use in China. China’s transition strategy plans phase-out of salbutamol CFC MDI by the end of 2016 and of beclomethasone CFC MDIs and all other active ingredients by the end of 2017. During the MTOC meeting in Shanghai, presentations were made by the Chinese pharmaceutical-grade CFC propellant manufacturer, Juhua, and two major MDI
manufacturers, Jinweim and Nuokang. Jinweim and Nuokang indicated that they might be able to phase out salbutamol CFC MDIs earlier than scheduled in the national strategy, provided there is a favourable fast-track regulatory approval process. The marketing date for the first salbutamol HFC MDI product is likely to be achieved by the end of 2011. MTOC recommends that consideration be given to implementing fast track regulatory processes to expedite approvals of CFC-free alternatives. Juhua manufactures pharmaceutical-grade CFCs and HFCs for all Chinese MDI manufacturers. CFC batches are made in a swing plant operating for 20-30 days per year, and the company has capacity to store about 500 tonnes of CFCs. As the phase-out of CFC MDIs nears completion, the quantities of CFCs needed to supply MDIs in China may be small. In the last years of the phase-out, China may need a final campaign production to supply remaining CFC MDI manufacture, since it may not be cost-effective to make small CFC batches of less than 200 tonnes. Chinese MDI manufacturers should consider an accelerated phase-out, and this could protect the health of Chinese patients if CFC supplies become uncertain.

1.2.6 Argentina

<table>
<thead>
<tr>
<th>Year</th>
<th>Quantity nominated</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>120.2 tonnes</td>
</tr>
</tbody>
</table>

Specific Use: MDIs for asthma and COPD

Active ingredients and intended markets for which the nomination applies:

<table>
<thead>
<tr>
<th>Active Ingredients</th>
<th>Intended markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beclomethasone</td>
<td>Argentina</td>
</tr>
<tr>
<td>Fenoterol</td>
<td></td>
</tr>
<tr>
<td>Ipratropium</td>
<td></td>
</tr>
<tr>
<td>Salmeterol</td>
<td></td>
</tr>
<tr>
<td>Budesonide</td>
<td>Argentina, Chile, Paraguay, Peru</td>
</tr>
<tr>
<td>Fluticasone</td>
<td></td>
</tr>
<tr>
<td>Salbutamol</td>
<td></td>
</tr>
<tr>
<td>Salbutamol/Beclomethasone</td>
<td></td>
</tr>
<tr>
<td>Salbutamol/Ipratropium</td>
<td></td>
</tr>
<tr>
<td>Salmeterol/Fluticasone</td>
<td></td>
</tr>
</tbody>
</table>

Recommendation:

Recommend 106.7 tonnes CFCs for MDIs for use in Argentina in 2011 for the active ingredients beclomethasone, budesonide, fenoterol, fluticasone, ipratropium, salbutamol, salbutamol/beclomethasone, salbutamol/ipratropium, salmeterol, salmeterol/fluticasone, and 0.5 tonnes for intended use in Chile, Paraguay and Peru for salbutamol/ipratropium.

Unable to recommend CFCs for MDIs for intended use in Chile, Paraguay and Peru for the active ingredients budesonide, fluticasone, salbutamol, salbutamol/beclomethasone, salmeterol/fluticasone.

Comments

The nomination from Argentina requests 120.2 tonnes of CFCs for MDIs. This is a 33 percent reduction compared to the 2010 nomination. The nomination for the domestic market is 106.7 tonnes (15 percent reduction) and for intended export markets is 13.5 tonnes (74
percent reduction). Almost 80 percent of the nomination is for salbutamol CFC MDIs (95.9 tonnes).

The quantities of CFCs requested appear to be consistent with historical trends for CFC MDI production in Argentina. The export of CFC MDIs is limited to three Latin American countries (Chile, Paraguay and Peru). Argentina contacted 13 export markets to ask whether there were any bans on the import of CFC MDIs, and was able to reduce the intended export markets to these 3 countries. However, no information was provided in the nomination on the alternatives available in those markets or their affordability. MTOC is aware of a range of affordable alternative CFC-free MDIs in these countries for budesonide, fluticasone, salbutamol, salbutamol/beclomethasone, salmeterol/fluticasone. MTOC is unable to recommend 13.0 tonnes for export to Chile, Paraguay and Peru for these active ingredients and combination products. MTOC has recommended approval of the nominated quantities intended for export of salbutamol/ipratropium CFC MDIs because anti-cholinergic drugs are technically more difficult to reformulate and only a limited range of CFC-free inhalers are currently available for this type of products.

<table>
<thead>
<tr>
<th>Active Ingredients</th>
<th>Intended markets and nominated quantities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Argentina</td>
</tr>
<tr>
<td>Beclomethasone</td>
<td>0.5</td>
</tr>
<tr>
<td>Budesonide</td>
<td>11.0</td>
</tr>
<tr>
<td>Fenoterol</td>
<td>1.0</td>
</tr>
<tr>
<td>Fluticasone</td>
<td>0.3</td>
</tr>
<tr>
<td>Fluticasone/Salmeterol</td>
<td>1.2</td>
</tr>
<tr>
<td>Ipratropium</td>
<td>1.0</td>
</tr>
<tr>
<td>Salbutamol</td>
<td>85.9</td>
</tr>
<tr>
<td>Salbutamol/Beclomethasone</td>
<td>2.3</td>
</tr>
<tr>
<td>Salbutamol/Ipratropium</td>
<td>1.5</td>
</tr>
<tr>
<td>Salmeterol</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>106.7</strong></td>
</tr>
</tbody>
</table>

MTOC understands that a national transition strategy is being developed through funding from the MLF, although it has not yet been submitted to the Ozone Secretariat. Neither has a preliminary plan of action for salbutamol CFC MDIs yet been submitted, which is contrary to Decision XV/5(4bis). An MLF-funded project has been approved for the conversion of the domestic inhaler manufacturers. The objectives of the project are: to eliminate the use of CFC at Pablo Cassara for the production of salbutamol CFC MDI; to eliminate the use of CFCs at Denver Farma for the production of salbutamol and budesonide; and to provide technical support for alternative formulations for four locally owned companies filling their own MDIs through third parties. Four MDI companies have signed preliminary agreements, but there is some delay for two other manufacturers. Pablo Cassara, which supplies 60-70 percent of the market, are included in the MLF project that plans to phase out salbutamol CFC MDI by 2014 using isobutane as a propellant. Phoenix, Raffo, Roux-Ocefa and Dallas have established HFC projects and seven other companies have research underway. Two of the multinational companies committed to stop manufacturing CFC MDIs at the end of 2009. Current total installed capacity for salbutamol HFC MDIs is more than sufficient to meet demand.

The MTOC considered the isobutane reformulation project. While an MDI formulated with isobutane propellant could be potentially beneficial in reducing greenhouse gas emissions due to HFC propelled MDIs, there has been no successful isobutane reformulation worldwide.
MTOC has identified toxicological concerns for isobutane in combination with a beta-agonist (Final report of the Safety Assessment of isobutane, isopentane, n-butane, and propane. *Int. J. Toxicology*, 1; 4: 127-142, 1982.). A safety study for an entirely novel MDI propellant in asthma COPD may require at least 12 months clinical trial experience in thousands of patients. This may be prohibitively expensive for this volume of production. Therefore MTOC has major concerns about the viability of this project, and its ability to provide a safe CFC MDI alternative in a timely fashion. In addition, a secure supply of pharmaceutical-grade CFCs is increasingly unlikely in 2012 and beyond, which may not provide protection for Argentine patient health if conversion does not occur well before 2014. The company already has HFC reformulation expertise since it has marketed a combination salbutamol/beclomethasone (“Butocort”) product since July 2006. There would appear to be no technical barriers for this company to reformulate its salbutamol CFC MDIs with HFCs. Pablo Cassara should urgently consider a faster and already proven HFC reformulation route for salbutamol CFC-free MDIs. Next year, if progress in Pablo Cassara’s isobutane reformulation is not demonstrated or a switch to HFC reformulation had not commenced, MTOC may be unable to recommend CFCs for its salbutamol MDIs in any future nomination.

MTOC has recommended the nomination for domestic use in 2011. While there is an adequate choice of CFC-free inhalers available in the domestic market, MTOC observes that the salbutamol HFC MDIs are more expensive than the salbutamol CFC MDIs made by Pablo Cassara. MTOC believes that adequate capacity to manufacture HFC MDIs will exist in Argentina but that post-marketing studies may yet be needed, meaning that the supply of CFC MDIs in 2011 will still be required. MTOC may be unable to recommend CFCs for use in salbutamol MDIs in 2012, in view of the availability of alternatives. Argentine patients would be best served by a rapid, safe transition to HFC MDIs.

### 1.2.7 Bangladesh

<table>
<thead>
<tr>
<th>Year</th>
<th>Quantity nominated</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>113.73 tonnes</td>
</tr>
</tbody>
</table>

*Specific Use:* MDIs for asthma and COPD

Active ingredients and intended markets for which the nomination applies:

<table>
<thead>
<tr>
<th>Active Ingredient</th>
<th>Intended market</th>
<th>Quantity (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beclomethasone</td>
<td>Bangladesh</td>
<td>8.89</td>
</tr>
<tr>
<td>Ciclesonide</td>
<td>Bangladesh</td>
<td>0.48</td>
</tr>
<tr>
<td>Fluticasone/Salmeterol</td>
<td>Bangladesh</td>
<td>9.78</td>
</tr>
<tr>
<td>Ipratropium</td>
<td>Bangladesh</td>
<td>1.34</td>
</tr>
<tr>
<td>Ipratropium/ Salbutamol</td>
<td>Bangladesh</td>
<td>25.32</td>
</tr>
<tr>
<td>Levosalbutamol</td>
<td>Bangladesh</td>
<td>0.87</td>
</tr>
<tr>
<td>Salbutamol</td>
<td>Bangladesh</td>
<td>65.32</td>
</tr>
<tr>
<td>Salmeterol</td>
<td>Bangladesh</td>
<td>1.10</td>
</tr>
<tr>
<td>Tiotropium</td>
<td>Bangladesh</td>
<td>0.63</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>113.73</strong></td>
</tr>
</tbody>
</table>

*Recommendation:*

Recommend 38.65 tonnes of CFCs for MDIs for use in Bangladesh for ciclesonide, fluticasone/salmeterol, ipratropium, ipratropium/salbutamol, salmeterol and tiotropium.
Unable to recommend CFCs for MDIs for active ingredients beclomethasone, levosalbutamol and salbutamol.

Comments

Bangladesh nominated a total of 113.73 tonnes of CFC for use in MDIs in 2011. The CFCs are for the manufacture of MDIs for domestic consumption only, as Bangladesh does not export CFC MDIs. There are multiple HFC alternatives on the market in Bangladesh for salbutamol and beclomethasone and there are single HFC or DPI alternatives for budesonide, fluticasone/salmeterol, ipratropium, ipratropium/salbutamol and salmeterol. There are as yet no CFC-free alternatives for ciclesonide and tiotropium. Many of the CFC-free products are manufactured locally.

Bangladesh developed a national transition strategy for phasing out the use of CFCs in MDI manufacture in Bangladesh in 2007. CFC-free MDIs have been introduced starting in 2006 and it appears their adoption has continued to grow. Currently, three companies commenced manufacturing HFC-MDIs while two companies manufacture DPI inhalers. In general, the pricing of these alternatives is comparable to their CFC counterparts and this fact should help with continued uptake.

In a 2010 update to its transition strategy, Bangladesh states that it will phase out CFC use completely by 2012, four years earlier than was originally proposed in last year’s nomination. This development has been aided by the UNDP funding of plant conversion projects which appears to have progressed well and accounted for availability of multiple HFC products (for salbutamol and beclomethasone) to meet domestic needs. Bangladesh is to be commended for being proactive and diligent in pursuing its transition strategy from CFC MDI products.

In light of the availability of a number of alternatives for salbutamol and beclomethasone CFC MDIs, MTOC is unable to recommend CFC quantities for these products. Also, MTOC does not regard levosalbutamol (an isomer of salbutamol) as essential given the availability of multiple salbutamol products. Therefore MTOC recommends 38.65 tonnes of CFC needed for the manufacture of MDIs only for the active ingredients ciclesonide, fluticasone/salmeterol, ipratropium, ipratropium/salbutamol, salmeterol and tiotropium.

MTOC believes that continued manufacture of CFC products beyond 2010 for products for which multiple HFC or DPI alternatives already exist will compete with the CFC-free alternatives and slow down the transition. Bangladesh is encouraged to continue to pursue its transition to CFC-free alternatives for all its asthma and COPD products so that no further nomination for CFCs beyond 2011 will be necessary.

1.2.8 People's Republic of China

<table>
<thead>
<tr>
<th>Year</th>
<th>Quantity nominated</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>809.91 tonnes</td>
</tr>
</tbody>
</table>

Specific Use: MDIs for asthma and COPD, and acute pulmonary oedema.
Active ingredients and intended markets for which the nomination applies:

<table>
<thead>
<tr>
<th>Active Ingredients</th>
<th>Intended markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beclomethasone</td>
<td>Burma, Cambodia, Chile, China, Dominica, Ethiopia, Fiji, Kenya, Mali, Mexico, Moldova, Mozambique, New Guinea, Nigeria, Pakistan, Peru, Sierra Leone, Sri Lanka, Sudan, Suriname, Turkmenistan, Uzbekistan, Vietnam and Yemen.</td>
</tr>
<tr>
<td>Beclomethasone/clenbuterol/ipratropium</td>
<td>China</td>
</tr>
<tr>
<td>Budesonide</td>
<td>China</td>
</tr>
<tr>
<td>Ciclosporin</td>
<td>China</td>
</tr>
<tr>
<td>Cromoglycate</td>
<td>China</td>
</tr>
<tr>
<td>Datura metel extract/clenbuterol</td>
<td>China</td>
</tr>
<tr>
<td>Dimethicone</td>
<td>China</td>
</tr>
<tr>
<td>Ephedra, Ginkgo, Sophora Favescens and Radix Scutellariae</td>
<td>China</td>
</tr>
<tr>
<td>Ipratropium</td>
<td>China</td>
</tr>
<tr>
<td>Ipratropium/Salbutamol</td>
<td>China</td>
</tr>
<tr>
<td>Isoprenaline</td>
<td>China</td>
</tr>
<tr>
<td>Isoprenaline/Guaifenesin</td>
<td>China</td>
</tr>
<tr>
<td>Procaterol</td>
<td>China</td>
</tr>
<tr>
<td>Salbutamol</td>
<td>Burma, Cambodia, Chile, China, Dominica, Ethiopia, Fiji, Kenya, Mali, Mexico, Moldova, Mozambique, New Guinea, Nigeria, Pakistan, Peru, Sierra Leone, Sri Lanka, Sudan, Suriname, Turkmenistan, Uzbekistan, Vietnam and Yemen.</td>
</tr>
<tr>
<td>Salmeterol</td>
<td>China</td>
</tr>
</tbody>
</table>

**Recommendation:**

Recommend 741.15 tonnes CFCs for MDIs intended for China for the active ingredients beclomethasone, beclomethasone/clenbuterol/ipratropium, budesonide, datura metel extract/clenbuterol, dimethicone; ephedra, ginkgo, sophora favescens and radix scutellariae; ipratropium, ipratropium/salbutamol, isoprenaline, isoprenaline/guaifenesin, procaterol, salbutamol, salmeterol, cromoglycate.

Unable to recommend 62.71 tonnes CFCs for MDIs intended for export to Burma, Cambodia, Chile, Dominica, Ethiopia, Fiji, Kenya, Mali, Mexico, Moldova, Mozambique, New Guinea, Nigeria, Pakistan, Peru, Sierra Leone, Sudan, Suriname, Turkmenistan, Uzbekistan, Vietnam, Yemen for the active ingredients salbutamol and beclomethasone, and 6.051 tonnes CFCs for MDIs intended for China for the active ingredient ciclesonide.
Comments

The People’s Republic of China nominates 747.20 tonnes for domestic market use and 62.71 tonnes for export to a number of countries. The nomination states that of the 809.91 tonnes requested, 686.19 tonnes are for two active ingredients, salbutamol (589.38 tonnes) and beclomethasone (96.81 tonnes). The estimated consumption of CFCs during 2010 is reported to be about 300 tonnes less than the quantity of 972.2 tonnes that was approved for 2010. About 8 percent of the requested CFC quantity is for the manufacture of MDIs intended for export, only for salbutamol and beclomethasone.

The transition strategy has been formulated and submitted to the Ozone Secretariat. 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, which will officially begin on December 31, 2013 and be completed by December 31, 2015. The strategy anticipates that CFC MDIs will co-exist on the market with HFC MDIs for a period of one year. Consequently, phase-out of salbutamol CFC MDIs will be completed by December 31, 2016. Consumption of CFCs for salbutamol MDIs represents about 73 percent of the total CFC quantity requested. The second largest quantity requested (accounting for another 12 percent) is for beclomethasone, which will no longer be essential when two CFC-free alternatives are available from two different producers. Phase-out of beclomethasone will officially begin on December 31, 2014 and be completed by December 31, 2017. The remaining active ingredients will be phased out during this period.

MTOC notes that research and development of HFC MDIs by local companies started in China in 2002. Salbutamol HFC MDI files were submitted in 2004 but production has not yet started. The nomination states that drug regulatory approvals can take many years. The marketing date for the first salbutamol HFC MDI product is likely to be achieved by the end of 2011. MTOC recommends that consideration be given to implementing fast track regulatory processes to expedite approvals. At least one imported salbutamol HFC MDI manufactured by a multinational is already on sale in China, which could provide clinical experience that might allow an expedited process for those drug products.

There are imported HFC MDIs (e.g. salbutamol) and DPIs (e.g. formoterol and budesonide) available. The current retail prices of locally produced CFC MDIs are considerably cheaper than the prices of imported CFC-free inhalers (MDIs or DPIs). Therefore pricing is an important reason for the lack of market penetration of imported CFC-free inhalers in China, and therefore, government pricing policies could be reviewed to consider pricing for local and imported inhalers that do not discourage CFC-free inhalers.

Between 2004 and 2009, CFC consumption for MDI manufacture had an annual growth rate of up to 24 percent. Because of the impact of the recent international financial crisis, the nomination for 2011 (taking into consideration that CFC consumption is estimated to be about 300 tonnes less than the approved amount for 2010) reflects the predicted same growth rate per year from 2009. This is justified by China as an increasing number of patients are treated with CFC MDI therapy. It reflects the reform and enlargement of medical insurance, basic medicine and the special support for chronic diseases including asthma and COPD.

No specific data were provided in the nomination on pre- and post- 2010 stocks of CFCs held by companies. These data would be included in the accounting framework next year. According to the submission from China, there will be a license management process in place for the Government to control production and consumption of CFCs on an annual basis, and manage surplus CFCs. MTOC understands that currently there may be significant stocks of bulk CFC in China. Paragraph 3 of Decision XVI/12 calls on nominating Parties to take into consideration existing stocks of banked controlled substances, when preparing essential use nominations, with the objective of maintaining no more than one year's operational supply.
MTOC will consider this when reviewing accounting frameworks received in 2012. With diminishing demand for CFCs in the future, careful management of the stockpile will be needed to keep it within the one-year level and to avoid CFC destruction at the completion of phase-out.

For traditional Chinese medicines, the Chinese Government will organize re-evaluation and substitution studies. If re-evaluation considers these as non-essential or ready for complete substitution, they will not be included in future EUN applications. MTOC requests information from the outcomes of this re-evaluation to be provided in any nomination submitted for 2012.

As with the nomination for 2010, the CFC quantity to manufacture ciclesonide MDIs cannot be recommended for 2011 because the product has not been launched and is still under regulatory review in 2010.

The nominated quantities of CFCs for essential uses in domestic and export markets for the nominated active ingredients in 2011 (metric tonnes) are:

<table>
<thead>
<tr>
<th>Active Ingredients</th>
<th>China</th>
<th>Export</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beclomethasone</td>
<td>82.06</td>
<td>14.75</td>
<td>96.81</td>
</tr>
<tr>
<td>Beclomethasone/clenbuterol/ipratropium</td>
<td>0.8</td>
<td>0</td>
<td>0.8</td>
</tr>
<tr>
<td>Budesonide</td>
<td>5.996</td>
<td>0</td>
<td>5.996</td>
</tr>
<tr>
<td>Ciclesonide</td>
<td>6.051</td>
<td>0</td>
<td>6.051</td>
</tr>
<tr>
<td>Cromoglycate</td>
<td>14.01</td>
<td>0</td>
<td>14.01</td>
</tr>
<tr>
<td>Datura metel extract/clenbuterol</td>
<td>2.5</td>
<td>0</td>
<td>2.5</td>
</tr>
<tr>
<td>Dimethicone</td>
<td>0.21</td>
<td>0</td>
<td>0.21</td>
</tr>
<tr>
<td>Ephedra, ginkgo, sophora flavescens, radix scutellariae</td>
<td>15</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Ipratropium</td>
<td>9.3</td>
<td>0</td>
<td>9.3</td>
</tr>
<tr>
<td>Ipratropium/salbutamol</td>
<td>1.3</td>
<td>0</td>
<td>1.3</td>
</tr>
<tr>
<td>Isoprenaline</td>
<td>61.5</td>
<td>0</td>
<td>61.5</td>
</tr>
<tr>
<td>Isoprenaline/guaifenesin</td>
<td>3.3</td>
<td>0</td>
<td>3.3</td>
</tr>
<tr>
<td>Procaterol</td>
<td>3.5</td>
<td>0</td>
<td>3.5</td>
</tr>
<tr>
<td>Salbutamol</td>
<td>541.42</td>
<td>47.96</td>
<td>589.38</td>
</tr>
<tr>
<td>Salmeterol</td>
<td>0.25</td>
<td>0</td>
<td>0.25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>747.2</td>
<td>62.71</td>
<td>809.91</td>
</tr>
</tbody>
</table>

MTOC believes that continued manufacture and export by China of CFC-containing salbutamol and beclomethasone MDIs to countries that already have a number of suitable CFC-free alternatives may not be essential. Therefore, MTOC is unable to recommend 62.71 tonnes of CFCs for MDIs intended for export to Burma, Cambodia, Chile, Dominica, Ethiopia, Fiji, Kenya, Mali, Mexico, Moldova, Mozambique, New Guinea, Nigeria, Pakistan, Peru, Sierra Leone, Sudan, Suriname, Turkmenistan, Uzbekistan, Vietnam, Yemen for the active ingredients salbutamol and beclomethasone.

**1.2.9 India**

<table>
<thead>
<tr>
<th>Year</th>
<th>Quantity nominated</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>192.3 tonnes</td>
</tr>
</tbody>
</table>
Specific Use: MDIs for asthma and COPD

Active ingredients and intended markets for which the nomination applies:

<table>
<thead>
<tr>
<th>Active Ingredients</th>
<th>Intended Markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beclomethasone</td>
<td>Algeria, Bahrain, Bolivia, Brazil, Brunei, Colombia, Ethiopia, Guatemala, Guyana, Hong Kong, India, Iran, Iraq, Jamaica, Kenya, Libya, Madagascar, Malaysia, Maldives, Mexico, Oman, Palestine, Puerto Rico, Peru, Sri Lanka, Suriname, U.A.E., Uganda, Venezuela, West Indies, Yemen, Zaire</td>
</tr>
<tr>
<td>Beclomethasone/</td>
<td>India</td>
</tr>
<tr>
<td>Formoterol</td>
<td></td>
</tr>
<tr>
<td>Beclomethasone/</td>
<td>Benin, Bolivia, Brazil, Chile, Colombia, India, Jamaica, Libya, Peru, Singapore, Somaliland, Venezuela, West Indies, Yemen, Zambia</td>
</tr>
<tr>
<td>Salbutamol</td>
<td></td>
</tr>
<tr>
<td>Budesonide</td>
<td>Algeria, Benin, Chile, Colombia, India, Kenya, Mauritius, Peru, Sri Lanka, Tanzania, Thailand, U.A.E., Yemen</td>
</tr>
<tr>
<td>Budesonide/</td>
<td>Bolivia, India, Kenya, Libya, Mauritius, Sri Lanka, U.A.E.</td>
</tr>
<tr>
<td>Formoterol</td>
<td></td>
</tr>
<tr>
<td>Fluticasone</td>
<td>Chile, Colombia, Guatemala, India, Iran, Libya, Oman, Peru, Sri Lanka, U.A.E.</td>
</tr>
<tr>
<td>Formoterol/</td>
<td>India</td>
</tr>
<tr>
<td>Fluticasone</td>
<td></td>
</tr>
<tr>
<td>Ipratropium</td>
<td>Colombia, India, Iran, Jamaica, Panama, Peru, Singapore, South Africa, Sri Lanka, Suriname, U.A.E., Uganda</td>
</tr>
<tr>
<td>Ipratropium/</td>
<td>Colombia, India, Iran, Peru, Philippines, U.A.E., Venezuela</td>
</tr>
<tr>
<td>Salbutamol</td>
<td>India, Peru</td>
</tr>
<tr>
<td>Levasalbutamol</td>
<td></td>
</tr>
<tr>
<td>Salbutamol</td>
<td>Algeria, Benin, Bolivia, Brazil, Burkina Faso, Burundi, Cameroon, Chile, Colombia, Costa Rica, Ethiopia, Guatemala, Guyana, India, Jamaica, Jordan, Kenya, Liberia, Libya, Macau, Madagascar, Malaysia, Malawi, Mali, Mauritius, Mexico, Mozambique, Myanmar, Nigeria, Oman, Peru, Puerto Rico, Republic of Congo, Sri Lanka, Singapore, U.A.E., Venezuela, West Indies, Yemen, Zambia</td>
</tr>
<tr>
<td>Salmeterol</td>
<td>India, Oman, Sri Lanka, U.A.E., Yemen</td>
</tr>
<tr>
<td>Salmeterol/</td>
<td>Chile, Guatemala, India, Kenya, Mauritius, Morocco, Peru, Sri Lanka, U.A.E.</td>
</tr>
<tr>
<td>Fluticasone</td>
<td></td>
</tr>
<tr>
<td>Tiotropium</td>
<td>Colombia, India, Panama, Peru, Puerto Rico, Sri Lanka</td>
</tr>
<tr>
<td>Tiotropium/</td>
<td>Colombia, India, Panama, Peru, Puerto Rico, Sri Lanka</td>
</tr>
<tr>
<td>Formoterol</td>
<td></td>
</tr>
</tbody>
</table>

Recommendation:

Recommend 19.8 tonnes CFCs for MDIs for intended use in India for the active ingredients ipratropium, ipratropium/salbutamol, tiotropium bromide and tiotropium/formoterol.
Recommend 28.4 tonnes for intended use in Colombia, Jamaica, Panama, Peru, Sri Lanka, Suriname, U.A.E., Uganda, Venezuela for the active ingredients ipratropium, ipratropium/salbutamol, tiotropium bromide and tiotropium/formoterol.

Unable to recommend CFCs for MDIs for intended use in India and for intended use in export markets for the active ingredients beclomethasone, beclomethasone/salbutamol, beclomethasone/formoterol, budesonide, budesonide/formoterol, fluticasone, formoterol, formoterol fumarate/fluticasone, levasalbutamol, salbutamol, salmeterol, salmeterol/fluticasone.

Unable to recommend CFCs for MDIs for intended use in Iran, Philippines, Puerto Rico, Singapore, South Africa for ipratropium, ipratropium/salbutamol, tiotropium bromide and tiotropium/formoterol.

Comments

The Indian nomination requests 192.3 tonnes of CFCs for MDIs. Of this, 58.5 tonnes are for domestic use and 133.9 tonnes are for CFC MDI products intended for export to other Article 5 Parties. The nomination states that remaining stocks of bulk CFC will be exhausted by the end of 2010. The total nominated amount was for eight active ingredients in a total of sixteen products (alone or in combination). The nomination for 2011 represents a 33 percent reduction in domestic use and a 48 percent reduction in exports compared with the nomination for 2010.

The date for complete transition of all CFC products is now stated by India to be 2013, rather than 2012 as indicated in the National Transition Strategy submitted to the 56th Executive Committee Meeting. MTOC notes that the strategy aims to reformulate all existing CFC MDIs. However, some CFC MDIs may not be considered essential due to the available range of alternative CFC-free inhalers within each therapeutic category, and some may have ongoing technical difficulty in formulation.

The nomination notes that the use of MDIs in India continues to grow at 15 percent per annum. MTOC notes that one company (Cipla) produces 51 different CFC-free inhalers and has previously reported its commitment to phase out domestic supply of CFC MDIs by the end of 2009. There are also at least two other manufacturers of HFC MDIs in India. In addition, there is a wide range of available single- and multi-dose DPIs. The nomination claims that DPIs have a number of drawbacks and affordability of HFC MDIs and multi-dose DPIs remains an issue. However, a recent market research study by Bhome in 20093 suggested that both HFC MDIs and DPIs were considered affordable and equally effective by a sample of 150 patients in India.

Last year, MTOC expressed the view that the recommended and subsequently exempted amount of CFCs for India for 2010 would be sufficient to support Indian CFC MDI manufacturers that had not yet launched CFC-free alternatives. Taken together with the market research, and the wide range of CFC-free alternatives available for beta-agonists and inhaled corticosteroids, MTOC is unable to recommend the nominated CFCs for MDIs intended for India for the active ingredients listed above. However, MTOC considers that anti-cholinergics, ipratropium, ipratropium/salbutamol and tiotropium, either alone or in combination with formoterol, are the only products for which there could be insufficient CFC-free alternatives and does not yet consider the CFC MDIs for these drugs to be non-essential.

3 “Drug delivery systems and customer perceptions: an Indian viewpoint”, in Drug Delivery to the Lungs 20, The Aerosol Society, Portishead, United Kingdom, pp 30-33 (not peer-reviewed).
Therefore, this is the only part of the nomination for domestic use that MTOC recommends (19.8 tonnes). New CFC-free inhalers (manufactured in both non-Article 5 and Article 5 Parties) for tiotropium and ipratropium (and combinations with other moieties) are beginning to become available. MTOC will revisit the developments in anti-cholinergic drug availability in 2011. Without adequate information in any future nominations to demonstrate essentiality, MTOC may not be able to recommend CFCs for these drugs.

Although the nominated quantity for export is substantially less than for 2010, the nomination contains no information on the essentiality of the products intended for export to those specific markets. Furthermore, there are several inconsistencies in the nomination:

Several countries identified as intended export markets (Iran, Philippines, Puerto Rico, Singapore, South Africa and Thailand) have prohibited the import of CFC MDIs.

A volume was nominated for export of CFC-based sodium cromoglycate without identifying the intended market(s).

For formoterol and salmeterol, intended export markets were identified but without any nominated CFC quantity.

The West Indies is identified as an Article 5 Party, which it is not.

MTOC is concerned about the proposed export of CFC MDIs to Parties that have a number of technically suitable and affordable CFC-free alternatives. Some Indian companies with HFC MDIs and/or DPIs for salbutamol or beclometasone launched on the domestic market are simultaneously planning to export the equivalent CFC MDI to importing countries. However, MTOC recognises that for ipratropium, ipratropium/salbutamol and tiotropium, some CFC-free alternatives have only recently introduced in India, and may not yet be registered with importing Parties.

In light of the above, MTOC is unable to recommend CFCs for MDIs to be exported from India, for all but the anti-cholinergics, ipratropium, ipratropium/salbutamol and tiotropium, alone and in combination with formoterol to Colombia, Jamaica, Panama, Peru, Sri Lanka, Suriname, U.A.E., Uganda, Venezuela. However, for these anti-cholinergics, MTOC was unable to recommend CFCs for MDIs intended for export markets known to prohibit the import of CFC MDIs, specifically Iran, Philippines, Puerto Rico, Singapore and South Africa.

India did not provide a breakdown of nominated quantities for each intended export market so it was not possible for MTOC to deduct the quantities of CFCs for these countries for these active ingredients. In 2009, MTOC concluded that in future years, in the absence of country-specific information, it would 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 excluded any countries considered to have an adequate range of alternatives. In the absence of country-specific information from India, MTOC has therefore made its recommendation for 28.4 tonnes, which specifically excludes Iran, Philippines, Puerto Rico, Singapore and South Africa. Therefore India will not need the entire 28.4 tonnes, which was requested by India for anti-cholinergics for all intended export countries: the quantity is only recommended as an upper limit in the absence of better information.

Parties may wish to request that additional information be provided by India in time for the 22nd MOP when considering essential use authorisations to adjust the quantities to meet the needs of only Colombia, Jamaica, Panama, Peru, Sri Lanka, Suriname, U.A.E., Uganda, Venezuela, assuming these Parties indeed require anti-cholinergic CFC MDIs.
MTOC would expect progress in registration of CFC-free alternatives during 2010, and would require evidence of essentiality in importing countries to recommend as essential uses any CFCs intended for anti-cholinergics, and their combinations, next year.

<table>
<thead>
<tr>
<th>Active Ingredients</th>
<th>Intended markets and nominated quantities</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>India</td>
<td>Export</td>
</tr>
<tr>
<td>Beclomethasone</td>
<td>3.3</td>
<td>33.0</td>
</tr>
<tr>
<td>Beclomethasone/Formoterol</td>
<td>1.6</td>
<td>0</td>
</tr>
<tr>
<td>Beclomethasone/Salbutamol</td>
<td>6.4</td>
<td>9.0</td>
</tr>
<tr>
<td>Budesonide</td>
<td>4.0</td>
<td>4.6</td>
</tr>
<tr>
<td>Budesonide/Formoterol</td>
<td>5.8</td>
<td>1.6</td>
</tr>
<tr>
<td>Fluticasone</td>
<td>0</td>
<td>3.0</td>
</tr>
<tr>
<td>Fluticasone/Salmeterol</td>
<td>5.7</td>
<td>9.0</td>
</tr>
<tr>
<td>Formoterol</td>
<td>1.0</td>
<td>0</td>
</tr>
<tr>
<td>Formoterol/Tiotropium</td>
<td>2.0</td>
<td>0</td>
</tr>
<tr>
<td>Ipratropium</td>
<td>6.5</td>
<td>22.0</td>
</tr>
<tr>
<td>Ipratropium/Salbutamol</td>
<td>7.3</td>
<td>5.6</td>
</tr>
<tr>
<td>Levosalbutamol</td>
<td>3.0</td>
<td>0</td>
</tr>
<tr>
<td>Salbutamol</td>
<td>7.2</td>
<td>45.2</td>
</tr>
<tr>
<td>Salmeterol</td>
<td>0.7</td>
<td>0</td>
</tr>
<tr>
<td>Tiotropium</td>
<td>4.0</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>58.5</strong></td>
<td><strong>133.9</strong></td>
</tr>
</tbody>
</table>

1.2.10  **Iran**

<table>
<thead>
<tr>
<th>Year</th>
<th>Quantity nominated</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>105 tonnes</td>
</tr>
</tbody>
</table>

Specific Use: MDIs for asthma and COPD

Active ingredients and nominated quantities for which the nomination applies:

<table>
<thead>
<tr>
<th>Active Ingredients</th>
<th>Intended market</th>
<th>Quantity (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beclomethasone</td>
<td>Iran</td>
<td>14</td>
</tr>
<tr>
<td>Cromoglycate</td>
<td>Iran</td>
<td>5</td>
</tr>
<tr>
<td>Salbutamol</td>
<td>Iran</td>
<td>75.5</td>
</tr>
<tr>
<td>Salmeterol</td>
<td>Iran</td>
<td>10.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>105</strong></td>
</tr>
</tbody>
</table>

Recommendation:

Recommend 105 tonnes CFCs for MDIs for intended use in Iran for active ingredients beclomethasone, salbutamol, salmeterol, cromoglycate.
Comments

Iran’s nominated quantities for 2011 are identical to that exempted for 2010. Iran is awaiting regulatory approval for HFC inhalers for salbutamol and beclomethasone. Salmeterol HFC MDI is due for submission to regulatory authorities in late April 2010. MTOC recommends the nomination to allow Iran to procure CFCs should there be any unforeseen delays in HFC MDI launch. MTOC notes that Iran may not need to acquire any CFCs approved by Parties under an exemption for 2011, or may not need to acquire the entire amount, if the production of HFC inhalers proceeds as scheduled.

1.2.11 Pakistan

<table>
<thead>
<tr>
<th>Year</th>
<th>Quantity nominated</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>39.6 tonnes</td>
</tr>
</tbody>
</table>

Specific Use: MDIs for asthma and COPD

Active ingredients and intended markets for which the nomination applies:

<table>
<thead>
<tr>
<th>Active Ingredient</th>
<th>Intended Market</th>
<th>Quantity (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beclomethasone</td>
<td>Pakistan</td>
<td>4.5</td>
</tr>
<tr>
<td>Beclomethasone/Salbutamol</td>
<td>Pakistan</td>
<td>19.3</td>
</tr>
<tr>
<td>Fluticasone/Salmeterol</td>
<td>Pakistan</td>
<td>6.2</td>
</tr>
<tr>
<td>Ipratropium</td>
<td>Pakistan</td>
<td>0.5</td>
</tr>
<tr>
<td>Salbutamol</td>
<td>Pakistan</td>
<td>8.8</td>
</tr>
<tr>
<td>Salmeterol</td>
<td>Pakistan</td>
<td>0.2</td>
</tr>
<tr>
<td>Triamcinolone</td>
<td>Pakistan</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>39.6</strong></td>
</tr>
</tbody>
</table>

Recommendation: Recommend 39.6 tonnes CFCs for MDIs for intended use in Pakistan for the active ingredients beclomethasone, beclomethasone/salbutamol, fluticasone/salmeterol, ipratropium, salbutamol, salmeterol, triamcinolone.

Comments

Ipratropium, salmeterol and triamcinolone are included in the 2011 nomination when they were not included in the nomination for 2010. While the nomination made no explanation for this, MTOC notes that the Annex to Executive Committee document UNEP/OzL.Pro/ExCom/54/19 refers to these active ingredients being produced as CFC MDIs in Pakistan in 2008. All of the products are for domestic use and not for export.

In Pakistan there are three local CFC MDI manufacturers: Macter, Zafa and GSK Pakistan. The majority of CFC MDIs manufactured in Pakistan was by GSK Pakistan as salbutamol until the company committed to stop all CFC MDI manufacture at the end of 2009. GSK Pakistan also imports HFC MDIs. The halt in manufacturing at GSK Pakistan has resulted in a substantial drop in Pakistan’s nomination for 2011. GSK Pakistan launched an imported salbutamol HFC inhaler (Aerolin) in 2007. A range of other CFC-free products is also available in Pakistan.
Macter, now the major user of CFCs for MDIs in Pakistan, continues to manufacture a range of CFC MDIs products including salmeterol and fluticasone. MTOC notes that Macter has more than doubled its CFC consumption for salbutamol MDIs since 2008.

A national transition strategy for the phase-out of CFCs in MDIs for Pakistan was submitted in July 2008. It describes the baseline data of current manufacturing capability and outlines plans for the conversion of MDI production, the projected costs and planned timelines. The investment in the MLF project is for education and awareness as well as legislative and regulatory measures. The 2008 national phase-out strategy anticipates complete transition by the end of 2012.

If the GSK Pakistan conversion is delayed, there could be insufficient capacity from the other two companies to supply the Pakistan market with affordable salbutamol CFC MDIs. The 2011 nomination states that in case of any delay in the GSK Pakistan conversion project, the only substitute for the locally manufactured CFC MDIs will be imported HFC MDIs. The prices of these imported products are currently considerably higher than locally produced CFC MDIs. For example, the price of locally made CFC MDI has remained close to Pakistan Rupees 85 (almost US$1) per inhaler. Imported HFC MDIs range between Rupees 600 – 1000 (about US$7–10) per inhaler. The high price of imported salbutamol HFC MDIs may significantly limit patient access to this therapy. The Government of Pakistan may need to carefully manage the price of imported salbutamol HFC MDIs to ensure affordability and accessibility of these products.

Furthermore, as the world’s pharmaceutical-grade CFC supply is decreasing and becoming more uncertain, the price of CFCs has increased. Before the Pakistan conversion process started, CFCs were available at the rate of $4-4.5 per kilogram. Recent information from the Government of Pakistan indicates that the price of CFCs has increased 3-4 fold. This would significantly increase the cost of CFC MDI production and may narrow the price gap between imported HFC MDI and domestic CFC MDI products.

Due to the uncertainty in the short-term supply of affordable MDIs in Pakistan while GSK Pakistan completes conversion, MTOC recommends the nomination for 2011.

1.2.12 Russian Federation

<table>
<thead>
<tr>
<th>Year</th>
<th>Quantity nominated</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>248.0 tonnes</td>
</tr>
</tbody>
</table>

Specific Use: MDIs for asthma and COPD

Active ingredients and intended markets for which the nomination applies:

<table>
<thead>
<tr>
<th>Active Ingredient</th>
<th>Intended market</th>
<th>Quantity (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salbutamol</td>
<td>Russian Federation</td>
<td>248.0</td>
</tr>
</tbody>
</table>

Recommendation:

Recommend 212 tonnes CFCs for MDIs for intended use in the Russian Federation for the active ingredient salbutamol.

Comments

The Russian Federation nomination requests 248 tonnes for domestic use only for the manufacture of salbutamol CFC MDIs by two manufacturers. This nomination represents a
17 percent increase over the exempted quantity for 2010. The Russian Federation does not expect to have any domestic manufacture of CFC-free salbutamol inhalers in 2011; the majority of patients will continue to use domestically made CFC MDIs.

The manufacturing conversion from salbutamol CFC MDIs has been repeatedly delayed in the Russian Federation due mainly to a lack of finance. The TEAP/MTOC mission on “Issues affecting the Transition from CFC metered dose inhalers in the Russian Federation” has reported on these issues in more detail under its response to DecisionXXI/4(8) in Chapter 3. GEF funding is currently being investigated and the Russian Federation has stated that, if this funding becomes available, phase-out could be achieved by the end of 2012.

MTOC requests evidence of substantial progress with the conversion projects for its consideration of any future essential use nomination. This includes demonstration of funding commitment, installation of filling lines, and HFC product registration with the health authorities. During the recent TEAP/MTOC mission, the Russian Federation authorities recognized the necessity of accelerating the conversion process. They proposed the establishment of a Working Group, chaired by the Ministry of Health, with members from government and industry, to facilitate progress and provide MTOC with quarterly updates on the progress of the conversion to CFC-free alternatives. MTOC understands that the first meeting of this Working Group took place prior to this report. MTOC welcomes this new development, and the urgency with which the Russian Federation is meeting this challenge.

However, there is a range of imported CFC-free short-acting beta-agonists (SABAs), predominantly salbutamol HFC MDIs, on the market. According to IMS data, some of these are available at inhaler prices comparable to the domestically manufactured CFC MDIs. The average price per inhaler for the salbutamol HFC MDI from Cipla, India, is 3.04 USD (200 doses) compared with the average price per inhaler for the Russian-made salbutamol CFC MDIs of 2.89 USD (90 doses). However, these affordable CFC-free MDIs do not appear to be widely available in pharmacies. The price per dose for imported SABA HFC MDIs ranges from 0.015 to 0.051 USD, while the price per dose for domestically manufactured salbutamol CFC MDI is 0.032 USD. A more detailed account of inhaler prices is given in Chapter 3.

Consumption of CFCs to manufacture salbutamol MDIs in the Russian Federation has remained steady at about 240 tonnes for 2007-2009. Parties approved an exemption for 212 tonnes for the Russian Federation for the year 2010. For 2011, MTOC again recommends 212 tonnes of CFCs, instead of the nominated 248 tonnes requested to supply an anticipated increase in demand for salbutamol MDIs. MTOC believes that available imported HFC MDIs could meet any increased demand for salbutamol MDIs in 2011. If Parties approve an essential use exemption for 2011, this would give time for the proposed manufacturing transition to be achieved or, if funding is not approved during 2010, there would be time for imported CFC-free inhalers to increase their market share by the necessary factor of 4 (from 25 to 100 percent of the market) to provide adequate CFC-free alternatives by the start of 2012. Without demonstrated progress in manufacturing transition, MTOC may not be able to recommend any future essential use nomination.

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4 IMS Health is an international company that supplies the pharmaceutical industry with sales data.
2 Medical Technical Options Committee Progress Report

2.1 Executive Summary

The Medical Technical Options Committee (MTOC) thanks the Shanghai Institute of Pharmaceutical Industry (SIPI) and the Ozone Secretariat for providing meeting venue sponsorship for the MTOC meeting held in Shanghai, China, 21-25 March 2010. SIPI provided a range of on-ground organisational assistance and in-kind support, such as printing. MTOC accepted hospitality including transportation, guides, meals and beverages.

The global use of CFCs to manufacture MDIs in 2009 is estimated to be about 2,300 tonnes. Article 5 Parties used about 1,700 tonnes and the Russian Federation and the United States used about 580 tonnes of CFCs for the manufacture of MDIs in 2009.

Parties reported that there are about 1,017 tonnes of pharmaceutical-grade CFCs available in stockpiles in the United States and Venezuela (total of about 951 tonnes of CFC-11 and -12, with 367 tonnes of CFC-114 that may not be consumed since it is less commonly used in MDI formulations). Stockpiles are available for export under commercial agreement with holders of those stocks.

Production of pharmaceutical-grade CFCs is now limited to a few sources. Honeywell, in the United States, has a swing plant producing HCFC-22 that can also produce CFCs. However, regulatory processes to allow export of newly produced CFCs would likely take more than a year to complete. The 60th Executive Committee Meeting, April 12-15, 2010, decided to modify the production sector agreements for China and India to allow the production for export of pharmaceutical-grade CFCs for 2010, with an annual review, for purposes of meeting essential use requirements of other countries provided that the exporting countries had specified reporting and verification systems in place. Any new source of supply of CFCs will require that CFC MDI producers validate the suitability of the newly sourced propellant in each specific MDI product.

CFC stockpiles available in Venezuela and the United States may or may not be enough to cover estimated CFC requirements for MDIs for 2010, 2011 and 2012 (about 1,397 tonnes) excluding China, the Russian Federation and the United States. This depends on, inter alia, Parties’ decisions regarding essential use exemptions for 2011, whether stockpile is acquired under commercial arrangements, and also whether the CFC mix and specifications of the stockpile meets the needs of the MDI manufacturers. However, it could be possible to complete the phase-out of CFC MDIs with careful management of existing global CFC stockpiles, provided that pharmaceutical-grade CFCs in China continues to supply its own needs and those of the Russian Federation.

A cautious approach to CFC production is advisable since transition is moving quickly and Parties may wish to avoid CFC production that is surplus to actual needs, which subsequently would require costly destruction. The welfare of patients with asthma and COPD and of the environment would be best served by a rapid transition to CFC-free inhalers.

Technically satisfactory alternatives to CFC MDIs to treat asthma and COPD are available in almost all countries worldwide. MTOC has noted previously the wide availability in Article 5 Parties of technically suitable CFC-free alternatives to CFC MDIs manufactured by multinational companies in developed countries. CFC-free inhalers manufactured in developing countries are now substantially increasing the range of affordable alternatives.
2.2 Global use of CFCs for MDIs

The global use of CFCs to manufacture MDIs in 2009 is estimated to be about 2,300 tonnes. Article 5 Parties used about 1,700 tonnes and the Russian Federation and the United States used about 580 tonnes of CFCs for the manufacture of MDIs in 2009. The total use of CFCs by Article 5 Parties was reduced by about 200 tonnes between 2008 and 2009, with some countries increasing (e.g. China) and others decreasing (e.g. India) consumption. There has been significant global progress in the transition of CFC MDIs to CFC-free inhalers, with substantial capacity to manufacture CFC-free inhalers expected by 2011-2012.

Decision XXI/4 encouraged Parties with stockpiles of pharmaceutical-grade CFCs potentially available for export to notify the Ozone Secretariat by 31st December 2009. As a result of this request, Parties reported that there are about 1,017 tonnes of pharmaceutical-grade CFCs (about 225 tonnes CFC-11, 425 tonnes CFC-12, 367 tonnes CFC-114) available in stockpiles in the United States and 301.4 tonnes of pharmaceutical-grade CFC-12 available in Venezuela. CFC-114 may not be fully consumed since it is less commonly used in MDI formulations. Stockpiles are available for export under commercial agreement with holders of those stocks. Regulatory processes for exporting CFCs from the United States’ stockpiles for essential uses are not complicated. The cost of CFCs available from stockpiles has increased the price of pharmaceutical-grade CFCs from about $4-5/kg to $12-16/kg, which may help to encourage transition. Any remaining stockpiles in the European Union are not available for export due to regulations prohibiting the production and export of CFCs from 1st January 2010.

Production of pharmaceutical-grade CFCs is now limited to a few sources. Honeywell, in the United States, has a swing plant producing HCFC-22 that can also produce CFCs. However, regulatory processes to allow export of newly produced CFCs would likely take more than a year to complete. China and India both have production facilities capable of manufacturing pharmaceutical-grade CFCs but they are subject to MLF production phase-out agreements. Under its existing CFC production phase-out agreement, China is allowed to manufacture pharmaceutical-grade CFCs for authorised essential uses for itself and for export to the Russian Federation only. Decision XXI/4 requested the Executive Committee to consider reviewing both of the CFC production phase-out agreements with China and India with a view to allowing production of pharmaceutical-grade CFCs to meet authorised levels of CFC production for essential uses. The 60th Executive Committee Meeting, April 12-15, 2010, decided to modify the production sector agreements for China and India to allow the production for export of pharmaceutical-grade CFCs for 2010, with an annual review, for purposes of meeting essential use requirements of other countries provided that the exporting countries had specified reporting and verification systems in place.

Any new source of supply of CFCs will require that CFC MDI producers validate the suitability of the newly sourced propellant in each specific MDI product. Validation takes time to complete, and in some cases would require the approval of health authorities. Total time to register a new source could be up to 6 months.

MTOC estimates that less than about 1,100 tonnes of pharmaceutical-grade CFCs might be required in 2010 to supply CFCs for essential MDI uses excluding China, the Russian Federation and the United States (see Table 2-1). If India supplies its own essential use requirements for 2010, this is estimated to be about 344 tonnes, and could be less given the

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1 Decisions taken at the 60th Executive Committee meeting allow CFC production for export in 2010 for the purposes of meeting essential use requirements under modified production sector agreements with China and India. Conclusions for 2011 and onwards do not assume continued production for export by China (other than to the Russian Federation) or by India since this would be the subject of annual review by the Executive Committee.
pace of transition in that country. Estimates of CFC requirements for 2010 are based mainly on quantities exempted by Parties, although not all of this quantity may be needed given the rate of transition in some countries. If Parties approve MTOC’s recommendations for essential use quantities of CFCs at the 22nd Meeting of the Parties, less than 250 tonnes of pharmaceutical-grade CFCs might be required in 2011 to supply CFCs for essential MDI uses excluding China, the Russian Federation and the United States. For 2012 onwards, estimated CFC consumption for essential MDI uses might be about 55 tonnes in countries excluding China, the Russian Federation and the United States.

CFC stockpiles available in Venezuela and the United States (total of about 951 tonnes of CFC-11 and -12, with 367 tonnes of CFC-114 that may not be consumed) may or may not be enough to cover estimated CFC requirements for MDIs for 2010, 2011 and 2012 (about 1,397 tonnes) excluding China, the Russian Federation and the United States. This depends on, inter alia, Parties’ decisions regarding essential use exemptions for 2011, whether stockpile is acquired under commercial arrangements, and also whether the CFC mix and specifications of the stockpile meets the needs of the MDI manufacturers. However, it could be possible to complete the phase-out of CFC MDIs with careful management of existing global CFC stockpiles, provided manufacture of pharmaceutical-grade CFCs in China continues to supply its own needs and those of the Russian Federation. For example, India may not need to produce any CFCs to meet its own requirements for 2010 onwards and could potentially supply its needs from available global stockpile, especially given the capacity of HFC MDI and DPI production and speed of transition in that country.

Table 2-1: Estimated CFC usage for nominating Parties, 2010-2014+

<table>
<thead>
<tr>
<th>Country</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014 +</th>
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<td>Algeria</td>
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<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>Argentina</td>
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<td>107</td>
<td>3</td>
<td>0</td>
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<td>Bangladesh</td>
<td>156.7</td>
<td>38.7</td>
<td>27</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>China</td>
<td>652.0</td>
<td>741.2</td>
<td>650</td>
<td>400</td>
<td>345</td>
<td>2,788.2</td>
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<td>-</td>
<td>-</td>
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</tr>
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<td>-</td>
<td>-</td>
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</tr>
<tr>
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<td>0</td>
<td>0</td>
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<td>0</td>
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<td>30</td>
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<td>0</td>
<td>454.0</td>
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<td>0</td>
<td>44.7</td>
</tr>
<tr>
<td>United States</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>92.0</td>
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<tr>
<td>Uruguay</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.0</td>
</tr>
<tr>
<td>Venezuela</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.0</td>
</tr>
<tr>
<td>Total, excluding China, Russian Federation and the United States</td>
<td>1,101.3</td>
<td>241.2</td>
<td>55.0</td>
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<td>0.0</td>
<td>1,397.4</td>
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<tr>
<td>Total</td>
<td>2,057.3</td>
<td>1,194.3</td>
<td>735.0</td>
<td>400.0</td>
<td>345.0</td>
<td>4,731.6</td>
</tr>
</tbody>
</table>

2 For 2010, usage data is based on exempted quantities or estimates provided by countries in 2011 essential use nominations. For 2011, MTOC estimates are based on essential use quantities recommended by MTOC and does not pre-judge decisions taken by Parties. For Iran, MTOC recommended 105 tonnes for 2011 to allow CFCs to be available if there are unforeseen delays in HFC MDI launch. In this table, MTOC has assumed consumption of zero for Iran for the purposes of estimating global consumption for 2011. For 2012 onwards, estimated usage does not take into account whether use meets the essential use criteria.
A cautious approach to CFC production is advisable since transition is moving quickly and Parties may wish to avoid CFC production that is surplus to actual needs, which subsequently would require costly destruction. The welfare of patients with asthma and COPD and of the environment would be best served by a rapid transition to CFC-free inhalers.

**Figure 2-1: Estimated CFC usage\(^3\) for MDIs for nominating Parties, 2010-2014**

![Graph showing estimated CFC usage for MDIs for nominating Parties, 2010-2014.](image)

2.3 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 worldwide. Since 1994, the propellant in MDIs has been gradually replaced with HFCs, and there are now sufficient HFC MDI alternatives available to cover all key classes of drugs used in the treatment of asthma and COPD. It is estimated that approximately 250 million HFC MDIs are currently manufactured annually worldwide, using approximately 4,000 tonnes of HFCs. A barrier for transition from CFC to CFC-free MDIs in developing countries has been that replacement HFC MDIs manufactured by multinational companies in developed countries can be more expensive than CFC MDIs manufactured in developing countries, meaning that poor patients cannot afford them. The MLF has funded projects in developing countries mainly focussed on technology transfer and institutional strengthening to convert CFC MDI manufacture to HFC MDIs, which may in some cases take a few more years to complete.

Dry powder inhalers, which do not require a propellant, provide a not-in-kind alternative to MDIs. DPIs fall into two categories; single-dose and multi-dose. Single-dose DPIs, which have been in use for more than 60 years, utilise a single capsule inserted into the device. They are less expensive but may be more susceptible to humidity than some more recent multi-dose DPIs. Multi-dose DPIs, which have been in use for more than 20 years, typically contain enough doses for at least 1 month’s treatment. Multi-dose DPIs made by

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\(^3\)For 2010, usage data is based on exempted quantities or estimates provided by countries in 2011 essential use nominations. For 2011, MTOC estimates are based on essential use quantities recommended by MTOC and does not pre-judge decisions taken by Parties. For 2012 onwards, estimated usage does not take into account whether use meets the essential use criteria.
multinational companies in developed countries generally have a similar price to the equivalent dose of drug in an MDI produced by multinational companies in developed countries, except for salbutamol, which is more expensive in multi-dose DPIs. However DPIs remain more expensive than MDIs manufactured in developing countries. Single-dose DPIs have the advantage in developing countries that they permit low-income patients to avoid the expense of buying one month’s therapy at a time.

There are two types of multi-dose DPI, one with individual doses pre-metered during manufacture, and the second that loads a measured amount for inhalation from a reservoir in the device. Older reservoir multi-dose DPIs can suffer from water ingress in high humidity environments that leads to clumping of the powder formulation. Some HFC MDIs are also affected by high humidity. Both can be partially addressed by supplying the device in a foil pouch opened on first use. Newer multi-dose DPIs function equally well in areas of high humidity, such as experienced in many developing countries. DPIs can be easier for the patient to use because the drug delivery is achieved by the patient’s inhalation, and they do not require as much patient co-ordination as MDIs. Studies4 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 percent of patients cannot use an MDI efficiently, although issues of co-ordination may be overcome through use of a spacer or breath-activated inhaler. Indeed, the MDI used with a spacer may be the only device suited for treating the very young or the elderly and for treating acute asthma attacks; it has been estimated that up to 30 percent of elderly COPD patients could not achieve satisfactory inspiratory flows through common DPIs5.

CFC-free product launches continue to occur around the world. Comparison between 2008 and 2009 of marketed products available from companies in the International Pharmaceutical Aerosol Consortium (IPAC)6 shows a net increase of 127 CFC-free products, 80 of which were in Article 5(1) Parties. In addition to CFC-free products manufactured in and/or exported from Article 5(1) Parties, there are a total of 168 salbutamol CFC-free products launched by IPAC member companies across 92 Article 5(1) Party markets. Furthermore, there are 235 corticosteroid CFC-free products (beclomethasone, budesonide or fluticasone) available in a total of 65 Article 5(1) Parties. By contrast, there are only 30 CFC-free products from IPAC member companies containing ipratropium bromide available in 29 Article 5 Parties.

IPAC has also analysed progress in the transition to CFC-free alternatives based on available prescribing data. Although not wholly accurate for information from some developing countries, IMS7 data show an encouraging global trend towards CFC-free therapy. CFC MDIs in 2009 form only 30 percent of all MDI sales, compared to 47 percent in 2007. This is


6 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.

7 IMS Health is a company that gathers and analyses pharmaceutical market data. IMS Health granted IPAC permission to submit this data to MTOC/TEAP.
against a background of an 8 percent increase in global MDI usage over the same period. Assuming that MDIs require 2 puffs for 1 dose, whereas DPIs only require 1 puff, then CFC MDIs now represent only 19 percent of the total number of doses taken.

Unfortunately, this global picture can be contrasted with the trends in developing markets. Generally in Latin America, Africa and Asia CFC MDI usage has not declined but remained constant or slightly increased over the last 3 years. The reduction in CFC usage has, as might have been expected, been driven by a reduction in developed country markets, excepting Russia. MTOC believes that there could be difficulties in some markets with IMS data collection. For instance, CFC usage in India appeared to increase by 18 percent over 2007-2009 in contrast to the decline demonstrated in information provided in the nomination for India. The difficulty in obtaining accurate data is further illustrated with China, where the use of MDIs appeared to remain constant over the last 3 years despite historic consumption data in China’s nomination showing an almost doubling in the quantity of CFCs used in MDI manufacture.

MTOC has noted previously the wide availability in Article 5 Parties of technically suitable CFC-free alternatives to CFC MDIs manufactured by multinational companies in developed countries. However, this has not prompted transition, largely due to the lack of affordability of these alternatives. CFC-free inhalers manufactured in developing countries are now substantially increasing the range of alternatives. For example, Cipla, an Indian multinational pharmaceutical company, now markets 51 different CFC-free inhalers and has previously reported its commitment to phase out domestic supply of CFC MDIs by the end of 2009.

Several of the nominations included significant CFC quantities to manufacture MDIs intended for export to other Article 5 Parties. None of the nominations demonstrated that these CFC MDIs were essential in the intended export markets or demonstrated that importing Parties had provided their prior informed consent for the import of the CFC MDIs in 2011. MTOC does not have the information from importing Parties to substantiate that these uses are essential. Furthermore, it is not clear whether importing Parties are specifically requesting the continued import of CFC MDIs despite the alternatives available, whether they simply import the cheapest available product even if it contains CFCs, or whether they are unable to switch to alternatives because of a lack of regulatory approval of these alternatives. There is a clear opportunity for importing Parties to help to drive the global phase-out of CFCs through judicious sourcing of alternatives.

### 2.4 Transition strategies

In response to Decision XII/2, transition strategies developed by seven Parties are listed on the Ozone Secretariat’s website. 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 website. On April 14, 2010, the US FDA published in the Federal Register its final rule to remove the essential-use designations for CFC MDIs where the active ingredients are flunisolide, triamcinolone, metaproterenol, pirituberol, salbutamol and ipratropium in combination, cromolyn, and nedocromil. For triamcinolone and cromolyn, the effective date of removal of essential use designation is December 31, 2010; for metaproterenol and nedocromil, the effective date is 60 days after publication in the Federal Register on April 14, 2010; for flunisolide, the effective date is June 30, 2011; for pirituberol and for salbutamol and ipratropium in combination, the effective date is December 31, 2013.

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The publication also notes that after the effective date of this rule there will remain only three designated essential uses of ODSs in the United States: anaesthetic drugs for topical use on accessible mucous membranes of humans where a cannula is used for application; metered dose atropine sulfate aerosol human drugs administered by oral inhalation; and sterile aerosol talc administered intrapleurally by thoracoscopy for human use. MTOC was previously unaware that these applications were designated as essential ODS uses under United States’ regulation. MTOC notes that there are suitable, commonly used CFC-free alternatives for all of these applications, including common methods of anaesthesia without the use of ODS, anti-cholinergic drugs as a superior medical alternative to atropine, and an aqueous suspension of sterile talc used for pleurodesis. As these are not essential uses approved under the Montreal Protocol, MTOC supposes that either the applications are no longer produced with CFCs but retain regulatory status in the United States as designated essential uses, or the applications are manufactured with CFCs produced prior to 1996.

For Article 5 Parties, Decisions IX/19(5bis) and XV/5(4bis) set out requirements for the development of national transition strategies and preliminary plans of action for the phase-out of salbutamol CFC MDIs respectively.

Decision IX/19(5bis) states:

“To require Parties operating under paragraph 1 of Article 5 submitting essential-use nominations for chlorofluorocarbons for metered-dose inhalers for the treatment of asthma and chronic obstructive pulmonary disease to present to the Ozone Secretariat an initial national or regional transition strategy by 31 January 2010 for circulation to all Parties. Where possible, Parties operating under paragraph 1 of Article 5 are encouraged to develop and submit to the Secretariat an initial transition strategy by 31 January 2009. In preparing a transition strategy, Parties operating under paragraph 1 of Article 5 should take into consideration the availability and price of treatments for asthma and chronic obstructive pulmonary disease in countries currently importing chlorofluorocarbon-containing metered-dose inhalers;”

Decision XV/5(4bis) states:

“That no quantity of chlorofluorocarbons for essential uses shall be authorized after the commencement of the Twenty-First Meeting of the Parties if the nominating Party operating under paragraph 1 of Article 5 has not submitted to the Ozone Secretariat, in time for consideration by the Parties at the twenty-ninth meeting of the Open-ended Working Group, a preliminary plan of action regarding the phase-out of the domestic use of chlorofluorocarbon containing metered-dose inhalers where the sole active ingredient is salbutamol;”

Decision XVII/5(3bis) requests nominating Article 5 Parties to submit a date to the Ozone Secretariat prior to the Twenty-Second Meeting of the Parties, by which time a regulation or regulations to determine the non-essentiality of the vast majority of chlorofluorocarbons for metered-dose inhalers where the active ingredient is not solely salbutamol will have been proposed. Decision XV/5(6) requests Parties to submit to the Ozone Secretariat specific dates by which time they will cease making nominations for essential use nominations for CFCs for MDI where the active ingredient is not solely salbutamol.

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.
This report provides an overview of the national strategies submitted to the MTOC for its review at its 2010 meeting. MTOC has noted, from its experience reviewing Essential Use Nominations, that Parties engaged in transition from CFC MDI to CFC-free alternatives encounter challenges and struggles of various kinds that could result in changes to dates, alteration in project timelines and product availability. Notwithstanding, MTOC believes that a well-articulated national transition strategy can provide the necessary road map for a country to accomplish the transition.

In 2010, transition strategies were received as part of the Essential Use Nominations from five Parties (Bangladesh, China, India, Iran and Pakistan), and from one other country, Egypt. These strategies are not yet posted on the Ozone Secretariat website. Argentina has not yet submitted its national transition strategy. In the submitted strategies, each Party provides a status update on the transition to CFC-free alternatives in its country. Progress reported includes the increased availability of CFC-free salbutamol and beclomethasone MDIs in most countries. In all these countries – Bangladesh, China, Egypt, India, Iran, and Pakistan – MDI products are mostly manufactured locally. In addition, Egypt imports CFC-free inhalers from either Article 5 or non-Article 5 countries. In 2009, about 10 percent of the CFC-free inhalers consumed in China were from imports.

The national strategies highlight challenges that have been faced in the transition by each of the Article 5 Parties manufacturing MDIs. These challenges have included financial limitations, lack of local expertise, lack of access to technology, intellectual property issues, equipment conversion timelines, cost, and regulatory processes for approval of CFC-free alternatives.

2.4.1 Patient access and phase-out criteria

The submitted national transition strategies all include key elements for protecting patient access to products needed for the treatment of asthma and COPD. The Parties express a desire to balance withdrawal of CFC MDIs with the introduction of alternatives so that management of asthma and COPD is not compromised.

However, while some of the submitted strategies include a patient focussed approach for the safe withdrawal of CFC MDIs from the market, others do not.

China provides a strategy that is based on CFC MDI phase-out moiety-by-moiety as well as category-by-category. A systematic withdrawal of each product category from the market is planned to occur only when alternatives ranging from one to five (depending on the number of CFC products in the category) become available on the market in adequate quantities. In the case of salbutamol, China has indicated that it will require at least five CFC-free MDIs on the market, and four different products for beclomethasone.

Egypt and Iran have developed broad criteria for phase-out of a CFC MDI. These criteria do not follow a moiety-by-moiety or category-by-category approach. Instead they include the following requirements:

- Any new CFC-free inhaler is at least as safe as the corresponding CFC inhaler;
- Any new CFC-free inhaler is as effective as the CFC inhaler it is intended to replace;
- There should be sufficient quantities of the alternative(s) available to assure an uninterrupted supply of medication;
- Post-marketing surveillance data must confirm the safety of the alternative product(s); and
• There should be sufficient types of alternatives available to meet the needs of different patient sub-groups.

_Bangladesh_ has developed a strategy that is not driven by the substitution of specific asthma/COPD drugs, but rather by a general assessment of adequacy of manufacturing facilities to produce the alternatives. Its national strategy mentions the need for available alternatives by the time CFC products are to be phased out. Bangladesh has a number of HFC/DPI alternatives for salbutamol and beclomethasone for instance, and single alternatives for most of the other asthma/COPD drugs including combinations. These CFC-free alternatives are being manufactured locally. On this basis, Bangladesh has decided that it could phase out CFC MDI by 2012 when domestic manufacturing of the alternatives will be adequate to meet the needs of its asthma/COPD population. Bangladesh states that it will maintain a stockpile of CFC MDIs for products other than salbutamol and beclomethasone for 2010-2012, to ensure COPD patients are protected.

_India_ will ensure continued availability of affordable MDIs for patients by having simultaneous availability of CFC MDI and CFC-free alternatives for a stipulated period.

_Pakistan_ recognises the need for expeditious transition so as not to put patients at risk.

The submitted transition strategies also highlight additional steps to be taken by the Parties to ensure success of the HFC alternatives in the market place. These include pricing and differentiated labelling initiatives as well as use of policies and regulations. For example, in order to support the transition to CFC-free inhalers, India proposes partial licensing of CFC MDI manufacturing beyond 2009; bans on licensing of any new formulations or MDI products with CFC, and bans on the import of new CFC MDIs. Additionally, India is considering fiscal incentives for adopting CFC-free alternatives and fast track regulatory procedures, to reduce product approval times from the standard two years to nine months for the approval of CFC-free alternatives. Similarly, Egypt plans to reduce its regulatory approval time for the CFC-free alternatives from two years to nine months. China plans to fast track regulatory approval processes for the CFC-free products supported by a ‘strengthened’ post-marketing surveillance system to ensure safety of the new products.

Most of the submitted national strategies mention that differential pricing between CFC MDI and CFC-free alternatives is a factor in the on-going transition. For example, China states that the price of domestic made CFC MDIs is one third to one tenth of imported CFC-free MDIs and DPIs. In contrast, in Bangladesh CFC-free MDIs and CFC MDIs are now similarly priced.

### 2.4.2 Timeline and final date for phase-out

In the national strategies submitted, each Party has described the processes involved in the product development, manufacturing facility installation or conversion and regulatory procedures in the transition to CFC-free alternatives. These steps are pre-requisites for availability of the alternatives and thus withdrawal of the CFC MDIs from the market. While acknowledging current and potential challenges in the transition process, each of the five Parties provided a target date for complete phase-out of CFC use in MDIs.

Egypt anticipates phase-out of CFC MDIs in early 2010. Iran has banned imports of CFC MDIs since 2008 and expects to phase out CFC MDIs completely by the end of 2010 or early 2011. Bangladesh plans to complete its phase-out by 2012. Pakistan expects to complete phase-out of CFC MDIs by the end of 2012. India states that it will complete CFC MDI phase-out in 2013, rather than 2012 as previously indicated in the national transition strategy submitted to the 56th ExCom. China is planning to phase out salbutamol CFC MDIs by the end of 2016 and remaining asthma/COPD CFC MDI products by the end of 2017, at least 4
years later than any other Party. China’s strategy also addresses the use of relatively small volumes of CFCs used in Chinese Traditional Medicines and dimethicone aerosol, both of which are unique to China. Re-evaluation and substitution studies are planned for Chinese Traditional Medicines. CFC use in these products will only cease if the studies suggest they are non-essential or if substitution is feasible. China states that it will continue to request essential use CFCs for dimethicone each year, but did not state an end-date for use of CFCs in the product.

2.4.3 Education

The national strategies submitted to MTOC include plans for the education of the stakeholders on the phase-out process. The Parties outlined the educational steps that have occurred so far as well as future strategies. In general, the submitted strategies include plans to develop educational training packages, arrange symposia and clinics, and organize training and awareness campaigns, involving media, schools and written materials. These programs are aimed at healthcare providers, the pharmaceutical industry, policy developers and patients. The objectives include raising awareness of the environmental reasons for the CFC phase-out, efforts that have been made to develop alternatives and the timelines for the phase-out. In many of the countries, these campaigns plan to utilize a variety of media including posters, leaflets, advertising, conferences, interviews, symposia etc.

As an example, in its transition strategy, Iran states that it strongly believes that an education campaign will be the core of its strategy. As a result, Iran’s educational campaign will include cooperation between the professionals involved on a local or regional basis to discuss how the transition is to be implemented. It proposes to involve all healthcare professionals, patient associations, and the pharmaceutical industry to ensure that all patients receive adequate information, both orally and in writing. Other Parties provided similar details of their plans to educate the stakeholders in the transition process.

2.4.4 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 2010, progress reports about progress made with implementation of national transition strategies were received within essential use nominations. Argentina has not yet developed its national transition strategy.

It is 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 requests CFCs for intended export of CFC MDIs in its essential use nomination for 2011. MTOC was unable to recommend CFCs for intended export to Thailand.

2.5 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 2010, a report was received from Canada9. Twenty-two Article 5 Parties have submitted data pursuant to Decision XIV/5 since

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its inception, but much of the data is up to 10 years old and no longer relevant to today’s markets. These Parties are Argentina, Belize, Bosnia and Herzegovina, Brazil, China, Costa Rica, Croatia, Cuba, Eritrea, Georgia, Guyana, India, Indonesia, Jamaica, Malta, Mauritius, Namibia, Oman, Singapore, South Africa, Sri Lanka, and Uruguay. The Ozone Secretariat has agreed to send a letter later this year to remind Parties of their obligation to report under Decision XIV/5.

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. Parties may wish to remind all Parties of Decision XII/2(3) to notify the Ozone Secretariat of any MDI products determined to be non-essential.

Given the complexity and fluidity of export markets, Parties may wish to consider requesting nominating Parties to demonstrate that they have received informed consent of the government of any importing country for imports of CFC MDIs in any future nomination.

2.6 Export Manufacturing Transition Plans in response to Decision XVIII/16

Decision XVIII/16(7) requests:

“…each Party receiving essential-use exemptions for the production or import of chlorofluorocarbons to manufacture metered-dose inhalers for export to Parties operating under paragraph 1 of Article 5 to submit to each importing Party a detailed export manufacturing transition plan for each manufacturer where the exports of an active ingredient to that Party exceed 10 metric tonnes, specifying the actions that each manufacturer is taking and will take to transition its exports to chlorofluorocarbon-free metered-dose inhalers as expeditiously as possible in a manner that does not put patients at risk;”

Paragraph 10 of that Decision requests each Party to submit a report summarising the export manufacturing transition plans as part of the Party’s essential use nomination, and paragraph 11 requests the TEAP to consider such reports in its assessments of essential use nominations.

No export manufacturing transition plan has been submitted under this Decision because the threshold has not been exceeded (10 metric tonnes of CFCs for an active ingredient for exports to a Party).
3 Response to Decision XXI/4(8): Technical, Economic and Administrative issues affecting the Transition from CFC Metered Dose Inhalers to CFC-free Alternatives in the Russian Federation

3.1 Background to Decision XXI/4(8)

Decision XXI/4(8) requested the Technology and Economic Assessment Panel and its Medical Technical Options Committee to “organize and undertake a mission of experts to examine the technical, economic and administrative issues affecting the transition from CFC metered-dose inhalers to CFC-free alternatives in the Russian Federation, and to report the results of this mission to the meeting of the thirtieth Open-Ended Working Group. The Technology and Economic Assessment Panel is requested to examine:

(a) The status of transition in the enterprises manufacturing CFC MDIs;
(b) Technical, financial, logistical, administrative or other barriers to transition;
(c) Possible options to overcome any barriers and facilitate the transition”.

3.2 Organisation

Experts in the team that went on the mission to the Russian Federation were selected by the co-chairs of the Medical Technical Options Committee (MTOC) in consultation with the Technology and Economic Assessment Panel (TEAP). The selected experts were: Dr Tom Batchelor, Belgium; Dr Olga Blinova, Russian Federation; Mr Christer Carling, Sweden; and Dr Helen Tope, Australia (MTOC co-chair).

Funding for the mission was provided through the Ozone Secretariat by grants from the Governments of Sweden and Finland, and from the two companies in the Russian Federation that manufacture CFC MDIs.

The TEAP/MTOC team visited the Russian Federation from 8 to 12 February at the invitation of the Ministry of Health and Social Development, which coordinated a number of meetings. The team met with a range of experts from the Russian Federation including: the Ministry of Health and Social Development; the Federal Service for Health Supervision (FSHS; also known in the Russian Federation as Roszdravnadzor); the Ministry of Natural Resources and Environment; the State Federal Unitary Enterprise “Federal Centre of Geo-ecological Systems”; the Ministry of Industry and Trade; the two Russian Federation companies manufacturing CFC MDIs (JSC Moschimpharmpreparaty and JSC Altayvitaminy); the Russian Federation company that imports pharmaceutical-grade CFCs (JSC Phyton); Academicien Alexandre Chuchalin, Russian Academy of Medical Science; and importers of HFC MDIs and DPIs (Chiesi and TEVA).

During the mission, the team accepted hospitality including transportation, lunch and beverages, from JSC Moschimpharmpreparaty, as the host.
3.3  **Background to the transition from CFC to CFC-free MDIs in the Russian Federation**

3.3.1  **Asthma and COPD and healthcare in the Russian Federation**

Data from Global Initiative on Asthma and from the Ministry of Health and Social Development show the incidence of asthma in the Russian Federation to be approximately 9 percent or 13 million people; and the incidence of chronic obstructive pulmonary disease (COPD) is estimated to be about 1-2 percent or 1-3 million people, although some estimates are as high as 8 million people.

The Russian Government determines the priorities for health care where one of the main goals is the treatment of diseases categorised as socially important, which includes lung diseases. The Ministry of Health determines a list of life-saving drugs that provides the basis for government reimbursed medicines, which makes affordability of medicines very important to the Government. The list is updated annually and includes medicines for treating asthma including some, but not all, MDI products. About 5 million asthma patients classified as "disabled" are eligible for free medicines from regional authorities.

The Federal Service of Health Supervision is the government authority responsible for the control of medical products, including their registration and market authorisation. This Service also regulates the maximum wholesale prices for medicines on the government list of life-saving drugs. Retail mark-up of drugs included on this list is determined by the regional authorities and limited to 30 percent of the wholesale price. Price regulation does not apply to all asthma drugs, only those that are included on the government list of life-saving drugs.

In August 2008, the Russian Ministry of Industry and Trade announced a new draft strategy for the development of the Russian pharmaceutical industry, called “*Industry Development to 2020*”, which focuses on increasing the capacity of the domestic industry in the Russian Federation to produce medicines according to international quality standards and increasing patient access to innovative drugs. By 2020, the government aims to increase the market share of domestically produced pharmaceuticals to 50 percent. The Russian Federation currently manufactures about 70 percent of the MDIs sold on the market, and therefore this national strategy aims to ensure that domestically produced pharmaceuticals include future MDI production.

3.3.2  **Salbutamol MDIs in the Russian Federation**

In 1984, the manufacture of CFC MDIs began in the Russian Federation, and currently there are two domestic manufacturers of salbutamol CFC MDIs. Another manufacturer of MDIs (JSC St. Petersburg Pharmaceutical Factory) entered the market in June 2009 with a beclomethasone HFC MDI, having not previously manufactured the corresponding CFC MDI. Multinational companies also import a variety of inhalation products, as HFC MDIs and DPIs. Therefore there is a range of domestically produced and imported MDI products that currently meet patient demand.

Data available from IMS Health\(^1\) show that direct pharmacy sales\(^2\) of salbutamol MDIs (where patients pay the full retail price) dominate the market, compared to MDIs available

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\(^1\) IMS Health is an international company that supplies the pharmaceutical industry with sales data.

\(^2\) In this report, direct pharmacy sales are used to describe pharmacy sales of MDIs where patients pay the full retail price.
through hospital and government reimbursement sectors. In 2009, direct pharmacy MDI sales were 92 percent of the salbutamol MDI market in units (of a total of about 8 million units) and 83 percent in sales value. Full retail price MDI sales were increasing in units in 2006-2008, while hospital and reimbursement purchases were declining in 2006-2009. This means that the cost to the government for MDIs has been reducing in recent years, as more patients are directly buying MDIs themselves at the full retail price. This recent trend means that the affordability of medicines has become important to more patients. All purchases of MDIs declined in 2009, probably because of the global economic crisis.

Salbutamol is a short-acting beta-agonist (SABA) that accounts for the majority of asthma/COPD treatments. Other drugs in this category are therapeutically equivalent treatments to salbutamol, and because salbutamol CFC MDIs are still being produced in the Russian Federation, the SABA category warrants specific attention in this report. SABA products available on the Russian market include salbutamol inhalers (CFC MDIs from the Russian manufacturers; HFC MDIs from Cipla, GlaxoSmithKline (GSK) and TEVA; dry powder inhalers (DPIs) from TEVA) and fenoterol HFC MDIs (from Boehringer Ingelheim (BI)) (Table 3-1). In 2009, Russian-made salbutamol CFC MDIs accounted for 73 percent of the total market in numbers of units, 56 percent of the total wholesale sales, and 70 percent (or about 5 million units) of the market share for direct pharmacy sales. Russian-made salbutamol CFC MDIs therefore dominate the Russian Federation market.

### Table 3-1: Imported CFC-free inhalers which are alternatives to salbutamol CFC MDI in the Russian Federation

<table>
<thead>
<tr>
<th>Drug</th>
<th>Manufacturer</th>
<th>Inhaler type</th>
<th>Launch date in Russian Federation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astalin (salbutamol)</td>
<td>Cipla</td>
<td>HFC MDI</td>
<td>Launched date (N/A)</td>
</tr>
<tr>
<td>Berotec N (fenoterol)</td>
<td>Boehringer Ingelheim</td>
<td>HFC MDI</td>
<td>April 2000</td>
</tr>
<tr>
<td>Berodual N (fenoterol)</td>
<td>Boehringer Ingelheim</td>
<td>HFC MDI</td>
<td>July 2002</td>
</tr>
<tr>
<td>Cybutol (salbutamol)</td>
<td>TEVA</td>
<td>DPI</td>
<td>N/A</td>
</tr>
<tr>
<td>Salamol Eco (salbutamol)</td>
<td>TEVA</td>
<td>HFC MDI</td>
<td>August 2001</td>
</tr>
<tr>
<td>Salamol Eco Easi-Breathe</td>
<td>TEVA</td>
<td>HFC MDI</td>
<td>June 2002</td>
</tr>
<tr>
<td>Ventolin (salbutamol)</td>
<td>GSK</td>
<td>HFC MDI</td>
<td>Launched (date N/A)</td>
</tr>
</tbody>
</table>

The average price in the retail sector of all SABA CFC and HFC MDIs is $3.13 per unit (inhaler)\(^3\). In this report, a “unit” means an inhaler containing 90 or 200 doses. The average retail price of Russian-made salbutamol CFC MDIs (90 doses) is $2.89. The average retail prices of imported SABA HFC MDIs range from $3.04 (Astalin, Cipla, 200 doses, 1 percent market share) to $19.07 (Berodual, BI, 200 doses, combination product fenoterol/ipratropium). The average price of the major imported salbutamol HFC MDI on the Russian market is $5.24 (Ventolin, 200 doses, 14 percent market share), which is 45 percent more expensive per unit than the Russian-made CFC MDIs (90 doses at $3.13 per unit), but similar in price on a per dose basis. The TEAP/MTOC team visited a Moscow pharmacy to make its own small sample comparison of SABA inhalers to find a similar pattern in prices (Table 3-2).

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3 Data is for the 2\(^{nd}\) quarter of 2009. The rouble was valued at 32.2 roubles to the US dollar on 15 May 2009.
Table 3-2: MTOC sample of retail sector pharmacy prices of SABA CFC and HFC MDIs

<table>
<thead>
<tr>
<th>Drug</th>
<th>Doses</th>
<th>Price per unit (Roubles$)</th>
<th>Price per dose (Roubles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altayvitaminy salbutamol CFC MDI</td>
<td>90</td>
<td>65</td>
<td>0.72</td>
</tr>
<tr>
<td>Ventolin (salbutamol) HFC MDI</td>
<td>200</td>
<td>145</td>
<td>0.73</td>
</tr>
<tr>
<td>Berotec (fenoterol) HFC MDI</td>
<td>200</td>
<td>386</td>
<td>1.93</td>
</tr>
</tbody>
</table>

IMS data show that the price per unit of Russian-made CFC MDIs is cheaper than the average price per unit of all SABA inhalers, and the cheapest SABA inhalers, but their average price per dose is higher than some imported HFC MDIs (Table 3-3).

Table 3-3: Sample of average unit retail price and price per dose for SABA inhalers (IMS data)

<table>
<thead>
<tr>
<th>Drug</th>
<th>Doses</th>
<th>Price per unit ($)</th>
<th>Price per dose ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salbutamol CFC MDI (Russian-made)</td>
<td>90 doses</td>
<td>2.89</td>
<td>0.03</td>
</tr>
<tr>
<td>Astalin HFC MDI (Cipla imported)</td>
<td>200 doses</td>
<td>3.04</td>
<td>0.02</td>
</tr>
<tr>
<td>Salamol Eco HFC MDI (Teva imported)</td>
<td>200 doses</td>
<td>4.67</td>
<td>0.02</td>
</tr>
<tr>
<td>Ventolin HFC MDI (GSK imported)</td>
<td>200 doses</td>
<td>5.24</td>
<td>0.03</td>
</tr>
<tr>
<td>Berotec N (fenoterol) HFC MDI (BI imported)</td>
<td>200 doses</td>
<td>10.29</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Pharmacies supply Russian-made salbutamol CFC MDIs more often than imported SABA HFC MDIs because they have the lowest unit price. Imported MDIs are reportedly not always as readily available in pharmacies as Russian-made MDIs, except for Ventolin that is widely distributed. Russian manufacturers, multinational importers and government told the mission that patients are very conscious of their out-of-pocket purchase expenses. So the unit price becomes a threshold for whether a purchase is made or not. The majority of patients seek the lowest unit price, which is the main driver in purchasing decisions. It was not clear why Cipla’s Astalin, which is almost the same unit price and half the price per dose, is not widely available to patients. If the product were more readily available in pharmacies, it would present a highly affordable alternative.

In the government reimbursement sector, imported SABA HFC MDIs have 98 percent and Russian-made salbutamol CFC MDIs have 2 percent market share. The average price for reimbursed products in this sector is $6.43 per unit. The implications of these data are that

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4 The rouble was valued at 32.262 roubles to the US dollar on 10 February 2010.
most sales on the Russian market of MDIs are without government reimbursement and paid at full retail cost by the consumer at a pharmacy.

Originally three producers, the JSC “Moschimpharmpreparaty” named after N.A., Semahko”, Moscow, JSC “Altaavitaminy” Biysk, Altay Region and JSC “OCTYABR” (now ICN Ltd.), St Petersburg, consumed CFC-11 and -12 for the manufacture of medical aerosols in the Russian Federation. However, JSC “OCTYABR” was later purchased by ICN Ltd. (USA). ICN ceased production of CFC aerosols before 2000. According to accounting framework reports submitted by the Russian Federation in relation to its essential use exemptions, CFC consumption for MDI manufacture ranged from 330 tonnes in 2003 to 396 tonnes in 2006, declining to and remaining stable at about 240 tonnes from 2007 to 2009 (Figure 3-1). The Russian Federation was approved an essential use exemption of 212 tonnes for 2010 and has submitted a nomination for 248 tonnes of CFCs for MDI use in 2011.

The objective of the two companies, Altaavitaminy and Moschimpharmpreparaty, is to manufacture affordable MDIs for the regional markets within the Russian Federation. Altaavitaminy supplies mostly Siberia, the Far East, Altay and Ural regions of the Russian Federation. Moschimpharmpreparaty supplies mostly the European part of the Russian Federation. They have stated that they “…work as colleagues and not as competitors on the national market, both trying to provide affordable products to patients”. They have informal agreements on market split across Russia and on the price of products to make them competitive with imported products. These companies have good distribution channels that reach even the more remote regions of the Russian Federation. They each produce about 50 percent of the Russian-made salbutamol CFC MDIs.

Figure 3-1: CFCs exempted, used and on stock for the Russian Federation 1997-2009

Altayvitaminy is a 60-year old private company with 150 shareholders that had its beginnings in vitamin manufacture. Its early vitamin manufacture included the use of natural raw materials, such as sea buckthorn oil, which remains the signature product line of this company. It is one of the ten most significant pharmaceutical companies in the Russian Federation. Aerosol products are the most significant income source for Altayvitaminy, which produces a range of medical aerosols. Production of salbutamol CFC MDIs started in
2000. It produces about 6 million salbutamol MDI units per year, which makes up about 25 percent of the company’s total revenue and was reported by the company to be “the most important factor” for the company’s financial survival. According to the company, demand for Altayvitaminy’s salbutamol MDI is determined by the remoteness of the regions it supplies and its strategic location for supplying those regions, the argued difficulty for importers to supply MDIs to those regions, and established channels for its other product lines. Altayvitaminy is also registered to supply CFC MDIs to 6 other countries of the former USSR, including Kazakhstan, Uzbekistan and Belarus but has not supplied these countries for a number of years.

Moschimpharmpreparaty is a 125-year old state-owned company with about 100 pharmaceutical products. Its salbutamol MDI plant produces about 6-7 million units per year. According to the company, MDIs are very important to Moschimpharmpreparaty’s revenue although not as significant to overall revenue as for Altayvitaminy. Because Moschimpharmpreparaty is a state-owned enterprise, with Board members including the Ministry of Industry, the continued manufacture of MDIs is also seen as an important social issue for the lower income patients supplied by Russian-made MDIs.

3.3.3 Efforts to phase out CFCs in MDIs in the Russian Federation

In the early 1990s, the international community recognised the difficulty that Countries with Economies in Transition (CEITs) in Eastern Europe and the former Soviet Union would have in meeting their obligations under the 1990 London Amendment to the Montreal Protocol, namely the elimination of Annex A and B Ozone Depleting Substances (ODS) consumption and production by 31 December 2000. In 1996 a project entitled “Russia Ozone Depleting Substance Consumption Phase-out Project” was established with a total budget estimated at $104 million, comprising $60 million grant from the Global Environmental Facility (GEF) and co-financed by $44.3 million by Russian Federation companies. As non-Article 5 Parties under the Montreal Protocol, the Russian Federation was not eligible for international assistance available under the Multilateral Fund. As a consequence, the GEF formally opened an Ozone Focal Area in 1995 for CEITs that had country programmes endorsed by the Montreal Protocol and had ratified the London Amendment. The World Bank was a key participant in the development of the Ozone Focal Area in the early 1990s.

Unlike GEF initiatives in other CEITs, this Project was initially limited to phase out investment in only two high consumption sectors (non-medical aerosol and refrigeration equipment). It became evident that the CFC Phase out Programme in the Russian Federation did not include technical assistance for phasing out CFCs in the production of Metered Dose Inhalers (MDIs) because this was considered a lower priority while there was provision for essential use exemptions for CFCs under the Montreal Protocol.

During 2006-2007, two investment projects, one for Altayvitaminy and one for Moschimpharmpreparaty were prepared by the World Bank with the participation of a local bank within the “Russia Programme for Organization of Investments for Environment Protection”. These two investment projects dealt with the provision of financial assistance to both companies in making the conversion from CFC-based MDI production to CFC-free MDIs. However, both companies were unable to accept the associated credit terms of the local bank because the terms of the loan were too short with prohibitively high interest rates (1.5-2 years at 18-20 percent where 3-3.5 year loans were needed at lower rates) and unacceptable loan terms (real estate required as security which is not feasible with the state-owned Moschimpharmpreparaty). Consequently, the World Bank returned the unspent GEF funds to the GEF.
In 2004, the Ministry of Natural Resources and Environment submitted to the Montreal Protocol Ozone Secretariat a National Plan of Action to phase out the use of CFCs in the manufacture of MDIs in the Russian Federation by 2008. The Plan included a series of activities to be implemented by the two CFC MDI manufacturers. In addition to this plan, the Russian Government implemented an overarching Plan of Action for phase-out of remaining ODS consumption and fulfillment of commitments for protection of Ozone layer over 2005-2008. Item 5 of this Plan stated that CFC-free MDIs would be developed and launched by the end 2008 and CFCs would no longer be required in 2008. The phase-out was not achieved in the MDI sector for the reasons outlined above.

In 2008, the Ministry of Health and Social Development through FSHS requested UNIDO to render technical assistance in developing an MDI project to phase out the use of CFCs in MDI manufacture in the Russian Federation. On 20 September 2009, the Ministry of Natural Resources and Environment officially requested UNIDO to formulate an MDI project. UNIDO plans to submit the project identification form (PIF) to the GEF in April 2010 under the GEF5 programme. Funding for the project has yet to be committed. The Russian Federation brought the issue of difficulties in its transition from CFC to CFC-free MDIs to the attention of the 21st Meeting of the Parties in late 2009, which was the basis for Decision XXI/4(8) and the TEAP/MTOC mission.

3.3.4 Supply of CFCs for MDI manufacture in the Russian Federation

As a result of the implementation of the ODS phase out programme, CFC production ceased in 2000 in the Russian Federation. Import of CFCs for MDI production is regulated by an annual quota from the Ministry of Natural Resources and Environment or supplied from the stockpile. Russia has been importing pharmaceutical-grade CFCs from China, and on one occasion from India, since 2002. A local company, Phyton, is the importer and supplier of pharmaceutical-grade CFCs in the Russian Federation primarily from one CFC producer, Zhejiang Juhua Group, located in Shanghai, China. The China CFC production phase-out agreement under the MLF allows for the production and export of CFCs to meet essential use exemptions of non-Article 5 Parties such as the Russian Federation after 2009.

Imported CFCs must meet Russian specifications and indicators of quality. Pharmaceutical-grade CFC prices were reported to be increasing before the economic crisis but the price remained stable from 2008-2009. Phyton has also had discussions with a US CFC producer but did not consider the potential arrangements to be practical. CFCs are imported in multiple monthly deliveries by sea and then transferred into smaller containers before delivery to the MDI manufacturers. Phyton stockpiles will support CFC-MDI production in the Russian Federation for a maximum of 3 months. MDI manufacturers also carry small stockpiles of CFCs for MDIs and have very limited stockpiling capacity. At the end of 2009, only 1.6 tonnes of stockpile was carried in the Russian Federation. Phyton is also working towards supplying pharmaceutical-grade HFC-134a to Russian MDI manufacturers in due course.

3.4 Status of transition in the Russian Federation

3.4.1 Status of transition in the companies manufacturing CFC MDIs in the Russian Federation

With the realisation that the original GEF funding was unavailable to the Russian MDI manufacturers, in 2004 Altayvitaminy and Moschimpharmpreparaty started research and development of new HFC formulations for salbutamol to replace the salbutamol CFC MDIs. Altayvitaminy and Moschimpharmpreparaty have funded all reformulation work to date without government support. From information contained in previous essential use
nominations, HFC-227ea was initially investigated as a potential MDI propellant for the new formulation. HFC-134a is now the preferred MDI propellant in the Russian Federation.

Formulation of new salbutamol HFC MDIs has been completed and initial dossiers including pre-clinical tests have been submitted to the FSHS by Altayvitaminy, and also more recently by Moschimpharmpreparaty. Clinical trials (phase III), for which FSHS would specify the test criteria and review the results, are yet to be finalised by the companies. FSHS will also perform certain laboratory studies of the formulation. If not given special priority, this entire “subject examination” might take 18-24 months. Following delivery, installation and validation of production lines (estimated to take about 18 months after order), stability tests on product from three full-scale commercial batches have to be produced and analysed (6 months) before approval by FSHS (3 months) and grant of license for commercialisation. This would, with some prioritisation, bring the total time to obtain the product certificates necessary to market the product up to about 2 years.

Altayvitaminy and Moschimpharmpreparaty will both source all MDI components from outside Russia. Quality certificates, required by the FSHS, are yet to be obtained for active ingredient, excipients and components. For the active ingredient, salbutamol, sources are known but contracts are yet to be agreed, and sourced material is yet to be assessed against international quality standards. For HFC-134a, the potential supplier has been identified in China, but contracts are yet to be agreed. For excipients such as ethanol, sources are known (European producers) but contracts have yet to be agreed. For valves and canisters, sources are known but contracts have yet to be agreed.

By comparison, JSC St. Petersburg Pharmaceutical Factory produced its first beclomethasone HFC MDI in June 2009. This company’s experience was that product registration took about two years to complete, and there were many difficulties with equipment commissioning.

Equipment commissioning is critical for the timeline of the project. Upon financing, companies will need to order the equipment and follow its delivery and installation with high priority.

Both companies need additional financial and some technical assistance to replace their present filling lines to allow for production of CFC-free MDIs. Funds required to complete the conversion of the local companies are estimated to be in the order of $4-6 million. Both companies have been and are ready to continue to co-finance the project with previous and future commitments of up to $10 million. Some technical assistance will be needed to complete documentation and other requirements to meet with the licensing requirements required by the FSHS and the requirements of Good Manufacturing Practice.

The Ministry of Natural Resources and Environment has officially requested UNIDO to formulate an MDI project to provide the financial and technical assistance necessary to achieve transition of CFC to HFC MDI manufacturing. UNIDO is preparing a project for submission to the GEF to request funding to implement the project.

3.5 Barriers to transition

3.5.1 Financial aspects to transition

Financing for technology conversion and equipment investment is needed urgently to complete the conversion. Company investment is limited due to a range of factors including the global financial crisis, devaluation of the rouble, falling company revenue, rising raw material costs and competing company investment priorities. Local bank loans have been investigated but the interest is too high and the term too short. Government assistance
through the Ministry of Finance to access local bank loans with favourable terms requires more time than is available, and would be difficult to negotiate.

GEF funding with co-financing from the MDI manufacturing companies is being explored as an option. However further urgent work is required to determine the viability of this option as a source of finance, given the competing demands on GEF funding in other sectors not related to ozone layer protection. Bilateral funding between the Russian Federation and one or more donor countries also remains an option to be explored. Since the time to complete the transition commences when the finance is secured, securing finance as soon as possible is by far the most important governing factor if the transition to CFC-free MDI production in the Russian Federation is to be completed by the end of 2012.

The Government controls wholesale prices of essential drugs on a list of life-saving medicines, which currently includes some salbutamol MDIs, but the prices of drugs not on the list can increase. The unit price of Russian-made salbutamol CFC MDIs is cheaper than average price for drugs in this therapeutic category, and the cheapest in this category. However the average price per dose for Russian-made salbutamol CFC MDIs is higher than some imported HFC MDIs.

Pharmacies supply Russian-made salbutamol CFC MDIs more often than imported SABA HFC MDIs. Imported SABA HFC MDIs are not always as readily available in pharmacies as Russian-made salbutamol CFC MDIs. These findings indicate that the patient’s ability to purchase is governed by how much they are willing to pay or can afford to pay at one time. Affordability and accessibility of asthma inhalers are important for Russian patients, and price affects both. Therefore replacement of Russian-made salbutamol CFC MDIs with more expensive inhalers could have potential adverse financial and health impacts, especially for low-income patients. The average price per inhaler for the Russian-made salbutamol CFC MDIs is 2.89 USD (90 doses). The Russian reformulated salbutamol HFC MDIs might be more expensive than their own CFC MDIs if they contain 200 doses per unit. Although, Russian manufacturers have said that they aim to provide competitively priced MDIs.

3.5.2 Technical aspects to transition

As well as financial assistance, some technical assistance is also needed to complete the conversion of CFC MDI to HFC MDI manufacture. In particular, technical assistance with equipment installation and commissioning is required, as well as facilitation of equipment and component procurement. This technical assistance is likely to come from the manufacturer of the equipment supplied to the companies to manufacture HFC MDIs.

The overall total time for conversion of the 2 companies is estimated to be about 24 months once finance becomes available. If finance becomes available by the 3rd quarter of 2010, then projected CFC MDI phase-out could be by about mid-2012. This assumes that remaining steps of the product documentation, licensing approval and production equipment commissioning proceed smoothly. In response to questions regarding its essential use nomination for 2011, the Russian Federation stated, “If the GEF funds are available the phase-out is going to be achieved by the end 2012”.

3.5.3 Regulatory and administrative aspects to transition

Government ministries and agencies with crucial roles in the transition of the Russian CFC MDIs to HFC MDIs include the Ministry of Health, Federal Service of Health Supervision, Ministry of Natural Resources and Environment, the State Federal Unitary Enterprise “Federal Centre of Geoecological Systems”, Ministry of Trade and Industry, Ministry of Finance, and Ministry of Economy. The first two have the largest influence on a successful
transition. Other Ministries have important supportive roles, which will be even more essential if GEF funding is not available e.g. Ministry of Finance. All discussions during the TEAP/MTOC mission showed strong cooperation and willingness between the parties to facilitate the transition to CFC-free MDIs.

Information for healthcare providers and patients is necessary for the final stages of the transition, and needs to be planned well in advance of HFC MDI product launch.

### 3.5.4 Logistical aspects to transition

The overall time for conversion of the 2 companies is estimated to be about 24 months once finance becomes available. To meet this schedule, the regulatory authorities and the companies agreed that most of the activities associated with the transition must be carried out in parallel.

Delays in the transition to Russian-made CFC-free MDIs could threaten patient health because imported CFC-free inhalers may be less affordable or available for poor patients. Imports of sufficient quantities of HFC MDIs are technically feasible for the Russian market, but the individual unit purchase price may be higher. Two multinational importers, with whom the team consulted, stated that HFC MDI imports could be increased within a year to meet demand for patient care in the Russian Federation, if domestically produced MDIs cannot be produced. Salbutamol HFC MDIs from multinational companies in Article 5 Parties might provide a cost-effective alternative. The average price per inhaler for the salbutamol HFC MDI from Cipla, India, is 3.04 USD (200 doses) compared with the average price per inhaler for the Russian-made salbutamol CFC MDIs of 2.89 USD (90 doses), and the price per dose of the Cipla product is considerably less than the Russian-made product. However, these affordable CFC-free MDIs do not appear to be widely available in pharmacies. If these products were more readily available, they would present highly affordable alternatives.

### 3.6 Recommendations and conclusions

Financial support is critical for successful transition in the Russian Federation. The potential for GEF funding should be investigated urgently. National commercial loans with better terms should be investigated as another option, but this would take much longer. Bilateral funding between the Russian Federation and one or more donor countries also remains a possible option to be explored. Once funding is secured, about 24 months will be needed for overall conversion of the two companies. Since the time to complete the transition commences when the finance is secured, securing finance as soon as possible is by far the most important governing factor if the transition to CFC-free MDI manufacture in the Russian Federation is to be completed by the end of 2012.

Accelerated processes by FSHS could further facilitate approvals – give the ‘green light’ as soon as possible to the key regulatory steps. Regulatory approvals and company activities should be carried out in parallel as much as possible to reduce time. Government, companies and suppliers should continue the established co-operative approach. This includes the preparation and delivery of information for healthcare providers and patients, which will be needed in time for the launch of any domestically produced HFC MDI.

Russian-made salbutamol CFC MDIs have the cheapest unit price and dominate the market. Russian patients are price-sensitive to pharmaceutical expenses and increases in the price of their inhalers may exceed the threshold price that they can afford to pay. Some imported products are competitively priced based on price per dose, and one imported product (Cipla) is competitively priced based on price per unit. Market transition to imported CFC-free
inhalers is technically feasible but patient perceptions of price and/or sensitivity to unit price could be a barrier. If CFCs become unavailable before the Russian Federation companies complete the transition to HFC MDIs, or transition is delayed by lack of finance, HFC MDI imports will need to be increased to protect patient health.

The TEAP/MTOC mission requested Russian Government Ministries, including the Ministry of Health and the Ministry of Natural Resources and the Environment, and the two Russian companies to keep MTOC informed of any developments during 2010. In this way, MTOC can also keep the Parties informed. The TEAP/MTOC mission recommended quarterly updates from the Ministry of Health on progress in the transition, covering for example progress with finance, regulatory approvals and dates for market launch. This suggestion was favourably received. In response, at the final meeting with the TEAP/MTOC team on 12 February, the Ministry of Health proposed the formation of an inter-Ministerial Working Group chaired by the Ministry of Health with representatives from the Ministry of Natural Resources and the Environment, the Federal Service of Health Supervision, the Ministry of Trade and Industry, and from industry, to develop and coordinate Plans of Action, to exchange information and provide updates to MTOC. This Working Group first met in March 2010. MTOC recommends that a representative from the Working Group provide an update to MTOC at the end of each quarter.

As soon as funding is approved, the two companies and the Government will need to work quickly to achieve transition in the anticipated 24 months. The proposed inter-Ministerial Working Group would be crucial to maintaining momentum and facilitating transition once finance is approved.

Provided funding becomes available, the period of the Russian Federation’s most recent essential use nomination for 2011 overlaps with the period of transition to HFC MDI manufacturing, with possible conclusion by the end of 2012. The 6th MOP in 1994 agreed the first essential uses in 1996. It is now 13 years since the Russian Federation was first approved an essential use exemption for CFCs in 1997. The National Plan of Action submitted in 2004 by the Russian Federation stated that the two companies would phase out their use of CFCs for MDIs by 2008, but this was not achieved due to lack of funds. Nonetheless the Parties have continued to approve CFCs past the time that the Russian Federation said it would complete the transition.

Consumption of CFCs to manufacture salbutamol MDIs in the Russian Federation has remained steady at about 240 tonnes for 2007-2009. Parties approved an exemption for 212 tonnes for the Russian Federation for the year 2010. For 2011, MTOC has again recommended 212 tonnes of CFCs, instead of the nominated 248 tonnes requested to supply an anticipated increase in demand for salbutamol MDIs. MTOC believes that available imported HFC MDIs could meet any increased demand for salbutamol MDIs in 2011. If Parties approve an essential use exemption for 2011, this would give time for the proposed manufacturing transition to be achieved or, if funding is not approved during 2010, there would be time for imported CFC-free inhalers to increase their market share by the necessary factor of 4 (from 25 to 100 percent of the market) to provide adequate CFC-free alternatives by the start of 2012. Without demonstrated progress in manufacturing transition, MTOC may not be able to recommend any future essential use nomination.
4 Chemicals Technical Options Committee (CTOC) Progress Report

4.1 Executive Summary

This report responds to decisions XVII/6, XXI/6 and XIII/7 on process agents, laboratory and analytical uses, and n-PB, respectively; assesses a new essential use nomination of CFC-113 from Russian Federation; updates destruction technologies identified in the 2002 TEAP Task Force Report under the decision XXI/2 (3), and presents new information on several emerging destruction technologies submitted to the Ozone Secretariat. Also the CTOC updated the list of ODS feedstock application and the estimated emission from those feedstock uses.

Process Agents

The USA and the EC submitted data on their process agent uses in 2008 to the Ozone Secretariat. Six process agent applications (No.1, 2, 6, 8, 24 and 28 in table A of decision XIX/15) are still in use in the USA, but the EC reported the phase out of three process agent uses:

- **No. 5** CTC in the manufacture of isobutyl acetophenone
- **No. 11** CFC-113 in the production of perfluoropolyether-peroxide intermediate for the production of perfluoropolyether diester
- **No. 27** CTC for the production of radio-labelled cyanocobalamin

Therefore, the CTOC recommends deleting process agent uses No.5, 11 and 27 in table A of decision XIX/15).

Table B of decision X/14 was updated by adding reported data in 2008 (submitted in 2009) as shown in Table 4-1. The make-up limit for EC was slightly exceeded in 2008, and countermeasures are taken in EC to comply with the make-up quantities specified in table B. As of 4 May 2010, Armenia, Australia, Canada, Cyprus, Hungary, Jamaica, Macedonia, Morocco, Panama, Poland, Saint Lucia and Sweden have reported that no process agent applications are in use in those Parties. The CTOC recommends that countries phasing out process agent uses be removed from table B and that submission of annual data to the Ozone Secretariat is required only for the Parties using ODS process agents. The CTOC notes that the EC may wish to investigate the 54 facilities with considerable quantities of CTC emissions to water and the 17 facilities with significant quantities of CTC emissions to air and to clarify whether these emissions arise from process agent, feedstock, inadvertent production, or other uses. [http://prtr.ec.europa.eu/PollutantReleases.aspx](http://prtr.ec.europa.eu/PollutantReleases.aspx)

The Swiss government asked the CTOC to consider a confidential process agent application for a new manufacturing process utilizing CTC. The CTOC requested, but did not receive, necessary information on the process, amounts of CTC to be used and its expected emissions. Further discussion revealed that the proposed use was as feedstock.

TEAP and its CTOC have started work related to the reporting of the feasibility of phasing out process agent applications. The information collected so far did not make it possible to include a short report in this 2010 TEAP report and work is therefore still in progress. TEAP and its CTOC would like to bring to the attention of the Parties that the quadrennial assessment report of CTOC due to be completed by the end of 2010 will already contain some relevant information on the subject. The joint report by TEAP and the Executive Committee of the Multilateral Fund --as requested by decision XXI/3 (5) and decision XVII/6 (6)-- on
progress with phasing out process agent applications will be prepared for submission to the OEWG in 2011.

Laboratory and Analytical Uses of ODS

According to the requests of Decision XXI/6, the TEAP and its CTOC will report comprehensive studies of laboratory analytical uses of ODSs to the 30th OEWG meeting.

CTOC’s work on decision XXI/6 paragraphs 5 and 6 is still ongoing. CTOC will endeavour to provide some further information at MOP-22. TEAP and its CTOC would appreciate having information from the Article 5 Parties if they have any laboratory and analytical uses that are already banned from the exemption. The information would enable TEAP and its CTOC to carry out the task under decision XXI/6 paragraph 6.

Recommendations are made for removal of a range of laboratory and analytical uses, mainly of carbon tetrachloride (CTC), from the general exemption of laboratory and analytical uses because suitable alternatives are available (Table 4-2). It is recommended that the general exemption be maintained for a small number of uses (Table 4-3). Full details of the investigation of the reasons for use of ODS and of suitable alternatives are presented in the Appendix to this report.

Briefings by CTOC members under decision XXI/6 (10) have already commenced with a presentation at the regional meeting of South Asia and South East Asia Pacific ozone officers in Chiang Mai, Thailand, in October 2009, and at the meeting of Europe and Central Asia and South Asia ozone officers in Istanbul, Turkey, in April 2010.

The CTOC recently determined that CTC uses have been widespread in biochemical research for inducing liver fibrosis in the research of the role of oxidative and classical reductive metabolism related to liver toxicity. The quantities of CTC used in each research project are likely small but, worldwide consumption is unknown. This use resembles an approved use for another ODS, methyl bromide, in ‘laboratory toxicological studies’ (decision XVII/10).

Essential Use Exemptions of CFC-113 in the Russian Federation

The CTOC reviewed this nomination and acknowledged the reductions with the projected use reaching 35 metric tonnes in 2014. Accordingly the CTOC recommends the Essential Use Exemptions for 100 metric tonnes of CFC-113 in 2011 for manufacturing the missile and space equipments for the Russian Federation, but also recommends greater efforts for the introduction of appropriate alternatives, of materials compatible with non-ODS alternative solvents, and adoption of newly designed equipment to complete phase-out of CFC-113 within an accelerated time schedule.

n-Propyl Bromide (n-PB) Update

Obtaining more complete and accurate information continues to be difficult. No governmental records are available on emission or uses since n-PB is not a controlled chemical substance like CFCs, and HCFCs (ODS class I and II) nor designated as a hazardous air pollutant in the Clean Air Act in the USA or reportable compound for pollution release (emission) and transfer (PRTR) in Europe and Japan. The US EPA is proposing to allow n-PB in some, but not all, end uses as a solvent, with a TLV (Threshold Limit Value) of 10ppm as an 8-hour time-weighted average of exposure (TWA) through its SNAP (Significant New Alternatives Policy) Program. Although n-PB has a finite ODP range of 0.02-0.1 similar to those of HCFCs and some chlorinated carbons, its use cannot be monitored and the growth of its use is unchecked. Thus, Parties may wish to establish a reporting system so accurate data for n-PB can be considered by the TEAP and CTOC.


**Destruction Technologies**

The interest of the Montreal Protocol is to quantify the ODS destroyed and eligible for remanufacture and to assure environmental, occupational, health and safety. There is an additional interest to quantify the carbon value of ODS destroyed for possible consideration under national and private emissions trading schemes designed to protect climate.

The CTOC identified at least 176 destruction facilities in 27 countries operated by a variety of technologies far wider than those reported in the 2002 TEAP Task Force Report. Current destruction technologies other than the twelve TEAP recommended technologies have been evaluated by the performance criteria of their own countries, as well as by those of the Task Force Report.

The CTOC also observes that technology transfer to Article 5 countries has begun. This is likely to increase since ODS destruction can be expected to become more important in Article 5 countries.

The TEAP/CTOC has received information on four kinds of emerging destruction technologies for evaluation. Although these technologies are still confidential, the CTOC expects to be able to give advice on their acceptability through further communications. A US patent revealed a new technology to convert halons and CFCs to unsaturated fluoromonomers like vinylidene fluoride, which is useful for the production of poly vinylidene fluoride. Another proposal concerns the applicability of current destruction technologies to methyl bromide, which is very difficult to destroy by incineration. An emerging destruction technology is attempted by contacting methyl bromide with a thiosulphate solution in a liquid scrubber to yield methyl thiosulphate ions.

In the revision of destruction technologies, technical guidelines for methyl bromide as well as authorized methods for newly developed destruction technologies might be required.

**Feedstocks**

The CTOC has updated the list of common feedstock applications and the estimated emissions from those feedstock uses. The list includes 16 feedstock applications and the total emissions from feedstock uses are estimated on the order of 4,000 metric tonnes (1,600 ODP tonnes).

**4.2 Introduction**

The CTOC met on March 10-12, 2010 in Beijing, China. The meeting was held on the campus of the Beijing University hosted by CTOC member, Professor Jianxin Hu, and his students. Fourteen of the 17 CTOC members that attended were from Australia, China, India, Japan, Kuwait, Mauritius, Netherlands, Russia and USA.

The primary purpose of the meeting was to discuss the response for the requests of the Parties in decisions XVII/6, XXI/6 and XIII/7 on process agents, laboratory and analytical uses, and n-PB, respectively. Furthermore, the CTOC reviewed a new essential use nomination of CFC-113 from the Russian Federation under decisions IV/25 and VIII/9, and also reviewed those destruction technologies identified in the 2002 TEAP Task Force Report under the decision XXI/2 (3) and new information on several emerging destruction technologies submitted to the Ozone Secretariat for their recognition. The CTOC also updated the list of common feedstock applications and the estimated emissions from those feedstock uses.
4.3 Process Agents

The CTOC reported in its 2009 Progress Report, a revision of table A of decisions X/14 and XIX/15 and of table B of decision X/14.

The CTOC is reporting again the revision of table A and table B according to the decisions XVII/6 (7) and XVII/6 (8), respectively for consideration at the 22nd MOP in 2010.

Decision XVII/6 regarding process agents was taken at the Dakar MOP in 2005 and included the following paragraphs:

6. To request the Technology and Economic Assessment Panel and the Executive Committee to report to the Open-ended Working Group at its twenty-seventh meeting in 2007, and every other year thereafter unless the Parties decide otherwise, on the progress made in reducing emissions of controlled substances from process-agent uses; the associated make-up quantity of controlled substances; on the implementation and development of emissions-reduction techniques and alternative processes and products not using ozone-depleting substances;

7. To request the Technology and Economic Assessment Panel to review the information submitted in accordance with the present decision and to report and make recommendations to the Parties at their Twentieth Meeting in 2008, and every other year thereafter, on process-agent use exemptions; on insignificant emission associated with a use, and process-agent uses that could be added to or deleted from table A of decision X/14;

8. To request Parties with process-agent uses to submit data to the Technology and Economic Assessment Panel by 31 December 2007 and 31 December of each subsequent year on opportunities to reduce emissions listed in table B and for the Technology and Economic Assessment Panel to review in 2008, and every other year thereafter; emissions in table B of decision X/14, taking into account information and data reported by the Parties in accordance with that decision, and to recommend any reductions to the make-up and maximum emission on the basis of that review. On the basis of these recommendations, the Parties shall decide on reductions to the make-up and maximum emissions with respect to table B;

The implications are that the following reports would be required: 2007, 2009, 2011 ... progress made in reducing emissions, make-up quantities and implementation and development of emissions-reduction techniques and alternative processes and products.

2008, 2010, 2012 ... process-agent use exemptions, insignificant emissions and uses that could be added to or deleted from table A of decision X/14;

However, decision XXI/3 taken at Port Ghalib in 2009 included the following paragraphs:

5. To request the Technology and Economic Assessment Panel and the Executive Committee of the Multilateral Fund to prepare a joint report for future meetings, reporting on progress with phasing out process-agent applications, as sought by Decision XVII/6 (paragraph 6);

6. To revisit this issue at the 30th Meeting of the Open-ended Working Group;
TEAP and its CTOC have started work related to the reporting of the feasibility of phasing out process agent applications. The information collected so far did not make it possible to include a short report in this 2010 TEAP report and work is therefore still in progress. TEAP and its CTOC would like to bring to the attention of the Parties that the quadrennial assessment report of CTOC due to be completed by the end of 2010 will already contain some relevant information on the subject. The reference in paragraph 5 of decision XXI/3 to paragraph 6 of decision XVII/6 means that the joint report by TEAP and the Executive Committee will be required in the first quarter of 2011, in time for submission to Parties for discussion at the OEWG-31.

New process agent uses, mostly in Article 5 countries, have been added to Table A of decision X/14 in recent years as parties learned more about the activities in the chemical industry sectors. The cut-off date, before which a process must have commenced in order to qualify the use of ODS as process agent, 30 June 1999, means that the number of such ‘discoveries’ should soon reduce to zero.

On the other hand, some process agent uses have ceased when the production is discontinued or alternatives to ODS have been introduced, and are removed from Table A of decision X/14. The MLF has been active in providing financial and technical assistance for such changes, and more cessations can be anticipated. The small number of uses that might remain on Table A of decision X/14, say in five years’ time, will be those that for economic or technical reasons are unlikely to be phased out or replaced by the use of alternatives.

Emissions from process agent uses have not been well reported, and so it has not been possible for the CTOC to identify cases with excessive emissions for which remedial financial and technical assistance might be required. For the same reasons, it has not been possible to make creditable estimates of total emissions and to point to systematic reduction in emissions.

4.3.1 Review of Table A of the decision X/14

Data submitted by USA
The US has reported the following process agent uses in the US:

1. Elimination of NCl3 in the production of Cl2/NaOH (1)*
2. Recovery of chlorine in tail gas from production of Cl2 (2)*
3. Manufacture of chlorosulphonated polyolefin (CSM) (6)*
4. Manufacture of synthetic fiber sheet (8)*
5. Bromination of a styrenic polymer (24)*
6. Production of high modulus PE fiber (28)*
*Reference number in table A

Data submitted by EC
The EC has reported that the following process agent uses have ceased in the EC:

1. CTC in the manufacture of isobutyl acetonaphenone (5)*
2. CTC for the production of radio-labelled cyanocobalamin (27)*
3. CFC-113 in the production of perfluoropolyether-peroxide intermediate for the production of perfluoropolyether diester (11)*
*Reference number in table A

The CTOC recommends deleting the three mentioned process agent uses reported by EC from table A, if no other countries than EC have these applications.
4.3.2 Review of Table B of the decision X/14

Table 4-1 shows table B of decision X/14 with reported data in 2008 (submitted in 2009). Not all the data have been available, but the reported data by USA are in line with table B of decision X/14. The make-up limit for EC was slightly exceeded in 2008; countermeasures are being taken in the EC to be in compliance with the make-up quantities as mentioned in table B. As of 4 May 2010, Armenia, Australia, Canada, Cyprus, Hungary, Jamaica, Macedonia, Morocco, Panama, Poland, Saint Lucia and Sweden have reported that no process agent applications are in use in those Parties. 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 emission regarding table B of decision X/14. The CTOC recommends that countries having no process agent uses be removed from table B.

Remark: The make-up quantities for the EC were mainly based on the quantities brought forwards in 1998 and no significant changes have been made, even not when new process agent applications with significant make-up quantities were added to table B in later years.

### Table 4-1: Updated table B of decision X/14 (Expressed by metric tonnes per year)

<table>
<thead>
<tr>
<th>Countries/Regions</th>
<th>Maximum make-up or consumption</th>
<th>Reported make-up or consumption (2008)</th>
<th>Maximum emissions</th>
<th>Reported emissions (2008)</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Community</td>
<td>1083</td>
<td>1159*</td>
<td>17</td>
<td>1.6</td>
</tr>
<tr>
<td>United States of America</td>
<td>2300</td>
<td>No data?</td>
<td>181</td>
<td>82</td>
</tr>
<tr>
<td>Canada</td>
<td>13</td>
<td>No data</td>
<td>0</td>
<td>No data</td>
</tr>
<tr>
<td>Japan</td>
<td>0</td>
<td>No data</td>
<td>0</td>
<td>No data</td>
</tr>
<tr>
<td>Russian Federation</td>
<td>800</td>
<td>No data</td>
<td>17</td>
<td>No data</td>
</tr>
<tr>
<td>Australia</td>
<td>0</td>
<td>No data</td>
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<td>New Zealand</td>
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<td>No data</td>
<td>0</td>
<td>No data</td>
</tr>
<tr>
<td>Norway</td>
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<td>No data</td>
</tr>
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<td>Switzerland</td>
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<td>TOTAL</td>
<td>4201</td>
<td>?</td>
<td>215.4</td>
<td>83.6</td>
</tr>
</tbody>
</table>

In view of the reporting of process agent uses and emissions required by the decision of the 21st MOP, the CTOC expects to be able to provide a more comprehensive report in 2011 when this reporting is completed by Parties in 2010. Parties were sent a reminder from the Ozone Secretariat in April 2010.

**CTC Emissions**

In the EC the emission to air in 2007 (excluding incidents 1.2 tonnes) was 63 metric tonnes, references: [http://prtr.ec.europa.eu/PollutantReleases.aspx](http://prtr.ec.europa.eu/PollutantReleases.aspx). These emissions were from 17 facilities in the EC. The threshold for reporting was 100 kg. Besides the emission to air there are 54 facilities in the EC that have emissions to water from more than 1 kg per year in 2007. It seems likely that the use of CTC in these facilities is not all feedstock use or process agent use. In some cases CTC might be formed during the process and afterwards emitted. This emission level is significantly higher than the reported process agent emissions of 5 metric tonnes in 2006 from the EC. The CTOC recommends that the EC investigates these processes and their emissions and clarifies whether they arise from process agent, feedstock, inadvertent production or other uses.
4.3.3 Request of Switzerland

The Swiss government asked the CTOC to consider an application for process agent exemption for a new manufacturing process utilizing carbon tetrachloride (CTC). The CTOC notes that this process was not in operation prior to 1999 and therefore would not qualify for a process agent exemption. However, further discussion revealed that the proposed use was as feedstock.

4.4 Laboratory and analytical uses of ODS

Decision XXI/6 included the following points that are addressed in this report.

5. To request the TEAP and its Chemicals Technical Options Committee to complete the report as requested under Decision XIX/18 and to provide for the 30th Open Ended Working Group

(a) A list of laboratory and analytical uses of ODS, including those uses where no alternatives exist.

(b) To identify the international and national standards that require the use of ODS and to indicate the corresponding alternative standard methods not mandating the use of ODS.

(c) To consider the technical and economical availability of those alternatives in Article 5 and non-Article 5 parties as well as to ensure that the alternative methods show similar or better statistical properties (for example accuracy or detection limits).

6. To request TEAP while continuing its work as described in paragraph 5, to evaluate the availability of alternatives for those uses already banned under the global exemption in Parties operating under Article 5(1), considering technical and economical aspects. By the 30th meeting of the Open Ended Working Group TEAP should present its findings and recommendations whether exemptions would be required for parties operating under paragraph 1 of Article 5 for any of the uses already banned.

The CTOC reminds that the following conditions apply to the exemption for laboratory and analytical uses and are listed in Annex II of the report of the 6th MOP:

1. Laboratory purposes are identified at this time to include equipment calibration; use as extraction solvents, diluents, or carriers for chemical analysis; biochemical research; inert solvents for chemical reactions, as a carrier or laboratory chemical and other critical analytical and laboratory purposes. Production for laboratory and analytical purposes is authorized provided that these laboratory and analytical chemicals shall contain only controlled substances manufactured to the following purities:

   - CTC (reagent grade) 99.5 %
   - 1,1,1-trichloroethane 99.0 %
   - CFC-11 99.5 %
   - CFC-13 99.5 %
   - CFC-12 99.5 %
   - CFC-113 99.5 %
   - CFC-114 99.5 %
   - Other w/Boiling P>20o C 99.5 %
   - Other w/Boiling P<20o C 99.0 %
2. These pure controlled substances can be subsequently mixed by manufacturers, agents, or distributors with other chemicals controlled or not controlled by the Montreal Protocol as is customary for laboratory and analytical uses.

3. These high purity substances and mixtures containing controlled substances shall be supplied only in re-closable containers or high pressure cylinders smaller than three litres or in 10 millilitre or smaller glass ampoules, marked clearly as substances that deplete the ozone layer, restricted to laboratory use and analytical purposes and specifying that used or surplus substances should be collected and recycled, if practical. The material should be destroyed if recycling is not practical.

4. Parties shall annually report for each controlled substance produced: the purity; the quantity; the application, specific test standard, or procedure requiring its uses; and the status of efforts to eliminate its use in each application. Parties shall also submit copies of published instructions, standards, specifications, and regulations requiring the use of the controlled substance.

CTOC’s work on decision XXI/6 paragraphs 5 and 6 is still ongoing. CTOC will endeavour to provide some further information at MOP22. TEAP and its CTOC would appreciate having information from the Article 5 Parties if they have any laboratory and analytical uses that are already banned from the exemption. The information would enable TEAP and its CTOC to carry out the task under decision XXI/6 paragraph 6.

4.4.1 Uses already banned

Recalling Decisions VII/11, XI/15, XVIII/15 and XIX/18 that already eliminated the following uses from the global exemption for laboratory and analytical uses:

(a) Refrigeration and air conditioning equipment used in laboratories, including refrigerated laboratory equipment such as ultra-centrifuges;

(b) Cleaning, reworking, repair, or rebuilding of electronic components or assemblies;

(c) Preservation of publications and archives;

(d) Sterilization of materials in a laboratory;

(e) Testing of oil, grease and total petroleum hydrocarbons in water;

(f) Testing of tar in road-paving materials;

(g) Forensic finger-printing;

(i) Testing of organic matter in coal

4.4.2 Methyl bromide exemptions

In 2006 the Parties decided (Decision XVII/10) that ‘subject to the conditions applied to the exemption for laboratory and analytical uses contained in Annex H to the report of the Sixth meeting of the Parties, to adopt a category of laboratory and analytical critical use to allow methyl bromide to be used:
(i) As a reference or standard:
- To calibrate equipment which uses methyl bromide;
- To monitor methyl bromide emission levels;
- To determine methyl bromide residue levels in goods, plants and commodities;

(ii) In laboratory toxicological studies;

(iii) To compare the efficacy of methyl bromide and its alternatives inside a laboratory;

(iv) As a laboratory agent which is destroyed in a chemical reaction;

4.4.3 Recommendations

The methods presented in the 2009 Progress Report have been further investigated and in almost all cases suitable alternative procedures have been identified, confirming the advice provided in 2009. The Appendix to this report contains details of the uses and analyses, including the reasons why ODS were used.

Based on this investigation, TEAP/CTOC recommends that the following procedures (Table 4-2) be removed from the global exemption for laboratory and analytical uses of ODS.

**Table 4-2: Recommendation of procedures to be removed**

<table>
<thead>
<tr>
<th>Kinds of ODS</th>
<th>Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methyl Bromide</td>
<td>Laboratory uses as a methylating agent</td>
</tr>
<tr>
<td>Carbon tetrachloride (CTC)</td>
<td>Reaction solvents except reactions involving N-bromosuccinimide (see below)</td>
</tr>
<tr>
<td>CTC</td>
<td>A solvent for IR, Raman and NMR spectroscopy</td>
</tr>
<tr>
<td>CTC</td>
<td>Grease removal and washing of NMR tubes</td>
</tr>
<tr>
<td>CTC</td>
<td>Iodine partition and equilibrium experiments</td>
</tr>
<tr>
<td>CTC</td>
<td>Analysis of hydrocarbon oils and greases in water, soil or oil mist in air</td>
</tr>
<tr>
<td>CTC</td>
<td>Analysis of polydimethylsiloxane and medicinal products such as simethicone that contain this substance</td>
</tr>
<tr>
<td>CTC</td>
<td>A solvent for assay of cyanocobalamin (Vitamin B_{12})</td>
</tr>
<tr>
<td>1,1,1-trichloroethane (TCA)</td>
<td>Determination of bromine index</td>
</tr>
<tr>
<td>CTC and other ODSs</td>
<td>Analysis involving selective solubility, including analyses of cascarosides, thyroid extracts and polymers, and in formation of picrates</td>
</tr>
<tr>
<td>CTC</td>
<td>Preconcentration of analytes in liquid chromatography (HPLC) gas chromatography, adsorption chromatography of organic substances, atomic absorption spectroscopy and X-ray fluorescence analysis</td>
</tr>
<tr>
<td>CTC</td>
<td>Detection of the end point in titrations involving iodine and thiosulphate (iodometry) for analysis of iodine, copper, arsenic, hypochlorite, chlorate, bromate or sulfur</td>
</tr>
<tr>
<td>CTC</td>
<td>Determination of iodine index</td>
</tr>
</tbody>
</table>
### Table 4-3: Recommendation of procedures to be retained

<table>
<thead>
<tr>
<th>Kind of ODS</th>
<th>Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTC</td>
<td>Determination of jellification point of agar, cement analysis and gas-mask cartridge breakthrough</td>
</tr>
<tr>
<td>CTC</td>
<td>Determination of porosity of activated carbon,</td>
</tr>
</tbody>
</table>

TEAP/CTOC recommends that the general exemption for laboratory and analytical uses of ODS should be retained for the following procedures in Table 4-3.

**4.4.4 Briefings by CTOC**

Decision XXI/6 also included the following clause:

10. To encourage UNEP to invite representatives of the Chemicals Technical Options Committee to regional network meetings to raise awareness of ODS alternatives for laboratory and analytical uses where problems have been specifically identified by members of that network. Where considered necessary other representatives from competent authorities of Parties could be invited to participate in the meeting.

This work has already commenced, with a presentation by a CTOC co-chair at the regional meeting of South Asia and South East Asia Pacific ozone officers in Chiang Mai, Thailand, in October 2009. In April 2010 a CTOC member made a presentation at the meeting of Europe and Central Asia and South Asia ozone officers in Istanbul, Turkey. UNDP has also supported the provision of advice to laboratory users in Chile, Paraguay and Bolivia.

**4.4.5 Use of CTC in biomedical research**

This use is widespread in biomedical research but has only recently come to the attention of the CTOC.

Damage to liver cells can lead to their replacement by scar tissue and development of fibrous tissue (fibrosis), a condition that is often identified under the heading of ‘cirrhosis’. Alcoholic poisoning is a well-known cause of this condition but there are other causes and congenital hepatic (liver) fibrosis may be present. In order to study the condition, its effect on other body functions and progression and recovery of the condition, liver fibrosis is induced in experimental animals by dosing with chemical substances, among which is CTC. A typical experiment would involve intraparenteral injection of CTC (1 ml/kg) twice weekly for 4-12 weeks. Oral gavages may also be used for CTC administration.

Because CTC has been used in this way for many years, there is a large body of research on biochemical modes of action, the role of oxidative and classical reductive metabolism related
to liver toxicity. These are benchmarks against which new results can be assessed. Modern studies frequently use CTC in conjunction with ethanol or paracetamol (other classical liver toxins) to investigate genetic responses to liver damage. The research is directed at improvements to human health. A review that describes the research field, including the use of CTC and other hepatic toxins, was published in 2008 (K. Wallace, A.D. Burt and M.C. Wright, ‘Liver fibrosis’, *Biochemical Journal*, 411 (1), 1-18 (2008)). Further detail is available in the journal *Methods in Molecular Medicine*, 117 2005, in particular in C. Constandinou, N. Henderson and J.P. Iredale, ‘Modeling Liver Fibrosis in Rodents’, *Methods in Molecular Medicine*, 117, 237-250 (2005).

Other substances can be used to induce fibrosis – dimethylnitrosamine, thioacetamide, pig serum – and it may also be induced by feeding a diet deficient in two essential substances (methionine and choline). Each of these alternatives produces its own particular type of liver damage but for certain research directions the use of CTC is essential. Also, CTC is by far the most widely used hepatotoxin. A Google search identified over 3000 articles using and referencing the use of CTC in liver fibrosis research on mice over the five year period 2005-2010.

In any one institution, the quantities of CTC used are small but world-wide consumption is unknown. Because of the method of administration to experimental animals (mice) there are no emissions to air. Some of the CTC may be converted *in vivo* to non-ozone depleting substances. Any residual material is disposed of in bio-hazardous waste for which the disposal technology involves incineration.

This resembles an approved use for another ODS, methyl bromide, in ‘laboratory toxicological studies’ (Decision XVII/10).

### 4.5 Essential Use Exemptions of CFC-113 in the Russian Federation

The Ministry of National Resources and Ecology of the Russian Federation has sent a new request for Essential Use Exemptions of 100 metric tonnes of CFC-113 for manufacturing the missile and space equipments in the year 2011, to the Ozone Secretariat on January 14, 2010.

The TEAP/CTOC has reviewed this nomination and recommends the EUE for 100 metric tonnes of CFC-113 in 2011 for the Russian Federation.

#### 4.5.1 Background of the nomination

Decision XXI/5 in MOP-21 approved an essential use exemption of 120 metric tonnes of CFC-113 in 2010 for applications in the missile and aerospace industries in the Russian Federation, taking into consideration the TEAP/CTOC findings that no appropriate alternatives to CFC-113 currently exist for some uses in the aerospace industries in the Russian Federation and that the search for alternatives continues, as confirmed in the TEAP May 2009 Progress Report Vol.1 (p60-79)

#### 4.5.2 The CTOC comments on EUE of CFC-113 in 2011 by the Russian Federation

The Russian Federation has been successful in reducing the annual consumption of CFC-113 in the missile and space industry from 241 metric tonnes in 2001 to 120 metric tonnes in 2009 as shown in the Illustration 2 (TEAP May 2009 Progress Report Vol.1, p79). However, the Russian industry has found no solvents comparable to CFC-113 from viewpoints of cleaning efficiency, versatility and compatibility with structural materials.
The new request by the Russian Federation for an Essential Use Exemption for 100 metric tonnes of CFC-113 in the year 2011 describes and explains in detail, why this application is urgent for health and safety or vital for the society, what efforts are made to investigate currently available alternatives, why they are insufficient or unsuitable, and also efforts for minimizing emission of CFC-113.

Unique physicochemical properties, and high processing and operational characteristics of CFC-113 ensure the required cleanliness levels of parts and assembly units, and high tightness levels of the missile and space equipment. Faultless and reliable operation in those applications, and consequently, the life and health of spacecraft crews, personnel and communities in launching area depend on proper selection of the cleaning solvent for those parts and equipment. In particular failures of gyro instruments of the launch vehicle or space vehicle control system can lead to fatal situations and faulty liquid-propellant rocket systems, which use liquid oxygen as an oxidizer, can result explosions during launching.

So far, solvents tested to replace CFC-113 have included ozone-safe organic solvents, chlorocarbon solvents, aqueous detergents, transitional HCFC solvents (HCFC-122, HCFC-122a, HCFC-141b and HCFC-225), fluorocarbons and n-PB.

But none of those candidates could meet the requirements for the replacement of CFC-113.

In order to minimize emissions of CFC-113, recirculation and stock accumulation have been attempted, but recycled and accumulated stock of CFC-113 is not available in sufficient quality for the expected application.

The Russian new nomination satisfies the following criteria to qualify as “Essential” under the decision IV/25.

1. It is necessary for the health, safety or critical for the functioning of the society.

2. There are no available technically and economically feasible alternatives or substitutes that are acceptable from the standpoint of environment and health.

3. An action has been attempted to minimize emission of CFC-113.

### 4.5.3 Conclusions

The TEAP/CTOC recommends the Essential Use Exemptions for 100 metric tonnes of CFC-113 in 2011 for the Russian Federation.

Taking into account the reductions achieved so far and assuming the timely conversion of the missile and space industry to technologies that avoid or restrict application of CFC-113, the Russian Federation has forecasted the future reduction plan as follows: ~80 metric tonnes in 2012, ~50 metric tonnes in 2013 and ~35 metric tonnes in 2014.

The TEAP/CTOC acknowledges the projected reduction, but recommends greater efforts for the introduction of appropriate alternatives, of materials compatible with non-ODS alternative solvents, and adoption of newly designed equipment to complete phase-out of CFC-113 within an accelerated time schedule.
4.6 n-Propyl Bromide (n-PB) Update

Under Decision XIII/7, the TEAP has been requested to report annually on n-PB use and emissions.

The properties of n-PB including its ODP remain the same and its field of application has not significantly changed from what has been reported in the 2008 CTOC Progress Report except that there were some recommendations from the manufacturers that it could be used as replacement for hydrocarbons or chlorinated solvents for paint application.

The global production level is still estimated to be around 20,000-30,000 metric tonnes (2007) as reported in the 2008 Progress Report. It is assumed to be produced in China, France, India, Israel, Japan, Jordan and the USA. China is estimated to have produced around 20,000 metric tonnes in 2008, of which approximately 40% were exported. Solvent use in Japan was 1,100-1,200 metric tonnes in 2009 showing that the use is leveling off in Japan as mentioned in the 2008 progress report. No information is available for other regions.

Obtaining more complete and accurate data on production and uses of n-PB, as well as its emissions, continues to be difficult. No governmental records are available on emission or uses since n-PB is not classified or registered as a controlled chemical substance like CFCs, and HCFCs (ODS class I and II) nor designated as a hazardous air pollutant in the Clean Air Act in the USA or reportable compound for pollution release (emission) and transfer (PRTR) in Europe and Japan. Although n-PB has a finite ODP range of 0.02-0.1 similar to those of HCFCs and organo-halogens, its use cannot be monitored and its use growth is kept unchecked. Thus, Parties may wish to establish a reporting system so accurate data for n-PB can be considered by the CTOC and TEAP.

The situation of n-PB toxicity study remains the same as described in the 2006 and 2008 CTOC Progress Report. It has low acute toxicity but its complete toxicological profile
necessitates a low exposure guideline. ACGIH and Israel have set an exposure guideline of 10ppm, with Europe setting the lowest 8-hour occupational exposure limit (OEL) value in humans and enforcing the tightest labeling classification. The US EPA is proposing to allow n-PB in some, but not all, end uses as a solvent, with a TLV (Threshold Limit Value) of 10ppm as an 8-hour time-weighted average of exposure (TWA) through its SNAP (Significant New Alternatives Policy) Program, although OSHA has not yet issued a Permissible Exposure Limit (PEL) for n-PB. (2007 Final and Proposed Regulations for n-PB by US EPA)

4.7 Destruction Technologies (related to decision XXI/2 (3))

4.7.1 Review of 2002 Task Force Report

The 2002 TEAP Task Force on Destruction Technologies considered 45 technologies candidates and sixteen destruction technologies were screened-in. In addition the Task Force reported suggested minimum standards of DRE (destruction and removal efficiencies (99.99 % for concentrated sources and 95% for ODS in foams) and criteria for atmospheric emissions such as PCDDs/PCDFs, HF, and so on. The “screened-in” technologies were evaluated further with emphasis on actual data about ODS destruction performance. Of these, twelve technologies met the recommended criteria.

From the documents distributed by the Ozone Secretariat until October 2009, the CTOC identified at least 176 destruction facilities in 27 countries, which are being operated. Present destruction facilities are operated by a variety of technologies far wider than those listed in the 2002 Task Force technologies. The technologies applied are classified into four categories, i.e. high temperature incineration, furnaces dedicated to manufacturing, plasma, and other non-incineration. Furnaces dedicated to manufacturing include cement kilns, lime rotary kilns, electric furnace, sulfuric acid recovery furnace and lightweight aggregate kilns. Other non-incineration technologies include catalytic destruction, chemical treatment and solid-phase alkaline reactor. As indicated in the 2002 Task Force report, the suggested minimum standards of technical performance are guidelines for selecting the destruction technologies.

Current destruction technologies other than the twelve TEAP recommended technologies were evaluated against the performance criteria of their own countries, as well as by those of the 2002 Task Force report. The United States of America, for instance, has established their domestic technologies permitted by RCRA requirements and ODS has been destroyed under MACT (Maximum Achievable Control Technology) standards for destruction efficiency (DE) and atmospheric emissions. In European countries, ODSs are destroyed by the technologies recommended by the 2002 Task Force report and by a variety of incinerators that are used for PCB/POPs destruction. Japan has permitted the destruction technologies based on the Law of Fluorocarbon Recovery and Destruction.

The CTOC also observes that technology transfer to Article 5 countries has begun. The ODS destruction project in Indonesia using cement kiln project was supported by the Japanese government and a private company. Such assistance to Article 5 countries is likely to increase since ODS destruction can be expected to be more important in such countries.

Owing to the existence of above-mentioned facilities, since 1993 the EU and US have destroyed 114,603 and 38,278 tonnes of ODS, respectively. Japan has destroyed 25,925 tonnes of CFCs, HCFCs and HFCs. Recently, Korea, China, Brazil and some Article 5 countries have started destruction of ODS.
4.7.2 **Emerging Destruction Technologies**

The CTOC has received information on four kinds of emerging destruction technologies for evaluation (Table 4-4). Although these technologies are still confidential, the CTOC expects to be able to give advice on their acceptability. Appropriate advice has been sent to the developers regarding technical performance of these technologies and suitable substances to be destroyed under destruction conditions. Since details of the technical information are not available presently, these technologies will be evaluated by further communication.

One technology, Newcastle process, is covered by a US patent 0036719 (2009) to Kennedy, et al. Halons or CFCs have been processed on a pilot scale, 25 kg/hour, with 99.8% conversion and vinylidene fluoride as a major product. At higher temperatures, the conversion efficiency is over 99.99% for halons and CFCs. No dioxins have been detected.

Another proposal concerns the applicability of current destruction technologies to methyl bromide (MB). Although MB among ODS is the most difficult to destroy by incineration\(^1\), annual amounts of MB destruction ranging from year of 1991 to 2003 were reported by US (May 2009). Amount destroyed in 2002 was 4,713 metric tonnes (Table 4-5).

Commercial recapture systems for MB have been developed based on adsorption of MB from treatment containers and chambers on activated carbon. An emerging destruction technology was attempted by contacting MB released from activated carbon with a thiosulphate solution in a liquid scrubber to yield methyl thiosulphate ions.

**Table 4-4: Proposed Emerging Destruction Technologies**

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Nation</th>
<th>Fluorocarbons Destroyed</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesni A/S</td>
<td>Denmark</td>
<td>CFCs, HFCs</td>
<td>Destruction of dilute fluorocarbons by catalytic cracking</td>
</tr>
<tr>
<td>Midwest Refrigerants, LLC</td>
<td>United States of America</td>
<td>CFCs, HCFCs, HFCs, PFCs, Halons</td>
<td>Transformation of fluorocarbons by pyrolytic conversion</td>
</tr>
<tr>
<td>SGL Carbon GmbH</td>
<td>Germany</td>
<td>HCFCs, HFCs, CCl(_4)</td>
<td>Destruction of concentrated sources by a porous reactor</td>
</tr>
<tr>
<td>University of Newcastle</td>
<td>Australia</td>
<td>Halons, CFCs</td>
<td>Transformation of fluorocarbons to fluorinated vinyl monomers</td>
</tr>
<tr>
<td>SRL Plasma Pty Ltd</td>
<td>Australia</td>
<td>Methyl bromide</td>
<td>Applicability of present destruction technologies to methyl bromide</td>
</tr>
</tbody>
</table>
Table 4-5: Destruction of Methyl Bromide in the United States of America

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Methyl bromide destroyed</td>
<td>264,227</td>
<td>53,953</td>
<td>47,20</td>
<td>84,956</td>
<td>2,257,735</td>
<td>300,431</td>
<td>562,872</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>1998</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methyl bromide destroyed</td>
<td>323,943</td>
<td>634,830</td>
<td>611,938</td>
<td>1,145,955</td>
<td>4,713,595</td>
<td>2,237,757</td>
</tr>
</tbody>
</table>

References


4.8 Feedstocks

The CTOC has updated the list of common feedstock applications and the estimated emissions from feedstock uses of ODSs since the CTOC reported them in 2008.

Carbon tetrachloride (CTC), trichloroethane, halons, chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) serve as chemical building blocks in the preparation of other chemicals. In their use as a raw material, they are fully converted to other products except for de minimus residues. As a result, their environmental impact is avoided with the exception of very small amounts. These could be residual levels in the ultimate product (which are typically miniscule) or by fugitive leaks in the production, storage and/or transport processes.

Montreal Protocol definitions

The Montreal Protocol defines “Production” as: “Production means the amount of controlled substances produced, minus the amount destroyed by technologies to be approved by the Parties and minus the amount entirely used as feedstock in the manufacture of other chemicals. The amount recycled and reused is not to be considered as Production.” Based on this definition, continuing use of feedstocks is allowed.

4.8.1 Where they are used

CTC, halons, CFCs and HCFCs can be feedstocks either by being fed directly into the process as a raw material stream or as an intermediate created during the synthesis of another product. Losses can occur during production, storage, transport, if necessary, and transfers. Intermediates are normally used at the same site and so fugitive leaks are somewhat lower in this case.
Common feedstock applications include, but are not limited to the following:

- Conversion of Halon-1301 in manufacture of pesticides and pharmaceuticals

- Conversion of HCFC-21 in the synthesis of HCFC-225 which finds application as a solvent

- Conversion of CFC-113 to chlorotrifluoroethylene. The latter is subsequently polymerized to polychlorotrifluoroethylene, a barrier resin used in moisture-resistant packaging.

- Conversion of CFC-113 and CFC-113a to HFC-134a and HFC-125. As this is the route to much of the HFC volumes, it is a high volume use.

- Conversion of HCFC-22 to tetrafluoroethylene (TFE). TFE forms the building block of many fluoropolymers both by homopolymerization and copolymerization. This is a very high volume use.

- Conversion of 1,1,1-trichloroethane (TCA) as a feedstock in the production of HCFC-141b and HCFC-142b. This can continue until 2040 at high volume for emissive uses of these products and can continue long-term for uses related to conversion to polymers as noted below. Note that the cap and subsequent reduction of HCFC volumes globally will eventually reduce this use.

- Conversion of HCFC-142b to vinylidene fluoride which is polymerized to polyvinylidene fluoride or to copolymers. These are specialty elastomers. This use of HCFC-142b is not subject to phase-out

- Conversion of carbon tetrachloride (CTC) to CFC-11, CFC-12, etc. This has historically been a very high volume application. However, as the phase-out of CFC production progressed and production became limited to essential uses, the volume of CTC for this application has diminished significantly.

- Conversion of CTC to chlorocarbons which, in turn, are used as feedstocks in production of HFC-245fa and other fluorochemicals.

- Reaction of CTC with 2-chloropropene to eventually lead to production of HFC-365mfc.

- CTC is used in reaction with vinylidene chloride for preparation of HFC-236fa with production volumes under 1 million pounds annually.

- CTC is converted to DV acid chloride in the manufacture of synthetic pyrethroids

- Conversion of HCFC-123, HFC-123a and HFC-133a in manufacture of pharmaceuticals which are not subject to phase-out.

- Conversion of HCFC-123 in the production of HFC-125. While this usually occurs as an intermediate, it is possible that this could be done using HCFC-123 as a starting material. We are not aware of using HCFC-123 as a starting material at this time.

- HCFC-124 can be used as a feedstock to prepare HFC-125.
4.8.2  Estimated emissions of ODS

The IPCC recommends that emissions can be estimated from production facilities at 0.5% for HFCs and 0.2% for SF6. This includes fugitive and transport emissions. If one accepts that 0.5% is an appropriate guidance level for products transported and used as raw materials, calculations from 2008 production data suggest that:

CFC-113 used in production of HFCs = 351,000 tonnes
Emission volume of ODS = 1758 tonnes
ODP impact of emissions = 1406 ODP tonnes

HCFC-22 used in production of fluoropolymers = 307,000 tonnes
Emission of ODS = 1364 tonnes
ODP impact of emissions = 68 ODP tonnes

TCA used in production of HFCs = 175,000 tonnes (2008)
Emission volume of ODS = 870 tonnes
ODP impact of emissions = 87 ODP tonnes

CTC used in production of CFCs = 2859 tonnes (yr. 2008)
Emission of ODS = 14 tonnes
ODP impact of emissions = 17 ODP tonnes

These data are only for emissions associated with manufacture and do not include any emissions related to uses. Therefore, total emissions from feedstock use are on the order of 4,000 metric tonnes and contribute about 1600 ODP tonnes. Numbers could be higher if actual emissions were higher than the 0.5% guideline.
Appendix to Chapter 4: Details of Laboratory and Analytical Uses of ODS

A1 Laboratory uses of ODS

The laboratory and analytical uses of methyl bromide and other ODS were discussed in the 2006 Progress Report of the TEAP. The 2008 TEAP Progress report contained details of a number of these procedures and the non-ODS alternatives, and the 2009 TEAP progress report contained an extensive tabulation of methods using ODS and approved or recommended non-ODS alternatives.

Whether the ODS is recovered, consigned for destruction (together with other laboratory wastes) or released to the environment, the quantities involved are trivial when compared to those involved in chemical industry, although there is no accounting of them by Parties.

A1.1 Laboratory preparative uses

(i) methyl bromide  Methyl bromide has often been the reagent of choice for reactions in which the methyl group, CH$_3$-, is transferred from bromine to an atom such as oxygen, nitrogen, phosphorus or magnesium. The most common case is that of formation of quaternary ammonium salts:

\[
R_3N + CH_3-Br \rightarrow R_3N-CH_3^+ + Br^-
\]

Here, R represents other groups attached to the nitrogen. Ether linkages are established by reaction with oxygen, for example CH$_3$-O-R, but in the case of phosphorus the initial salt is reacted further (by reaction with base, to remove HBr) to an ylid containing the =CH$_2$ function:

\[
R_3P + CH_3-Br \rightarrow R_3P-CH_3^+ + Br^- \rightarrow R_3P=CH_2
\]

The ylid may be reacted further to transfer the =CH$_2$ moiety to another molecule. Sulfur-based ylids are also known: they are prepared and used in ways analogous to the phosphorus ylids.

Methyl bromide reacts with magnesium to form methyl magnesium bromide, CH$_3$-Mg-Br, from which the methyl group may be transferred to another molecule, and a new carbon-carbon bond established.

For all of these reactions there are alternatives to the use of methyl bromide, such as methyl chloride (chloromethane), methyl iodide, trimethyl phosphate and various methyl sulfonate esters. Cost and availability are not barriers to uptake of the alternatives, but long-term users of methyl bromide in these applications may need to experiment so as to adapt their practice to the alternative methylating agents.

A critical use exemption for ‘preparative’ uses of methyl bromide, in which the ODS is destroyed, was included in decision XVII/10.

(ii) carbon tetrachloride (CTC)  As with methyl bromide, these uses involve transfer of all or part of the CTC molecule to another molecule. A common reaction is the addition of CTC, via a free radical mechanism (involving and initiator radical and radical fragments Cl$^*$ and Cl$_3$C$^*$), to a carbon-carbon double bond:

\[
CCl_4 + -CH=CH- \rightarrow Cl_3C-CH-CH-Cl
\]
Except that a more complicated alternative synthesis pathway be adopted, possibly more complex and expensive, there are no alternatives to the use of CTC in such reactions.

In the Appel reaction, CTC reacts with triphenyl phosphine in a complicated way to replace the –OH group in an alcohol with chlorine while the CTC is converted to chloroform (trichloromethane):

\[
PPh_3 + CCl_4 + RCH_2OH \rightarrow OPPh_3 + RCH_2Cl + CHCl_3
\]

There is an analogous reaction with carbon tetrabromide, with bromine replacing chlorine in the above reaction scheme.

(iii) difluoromethylation with HCFC-22 HCFC-22, CHClF_2, may be used to transfer a –CF_2 group to another molecule, for example, an alkoxide formed from an alcohol:

\[
RO^- + CHClF_2 \rightarrow RO-CHF_2 + Cl^-
\]

This reaction can also be performed with halon 22B1, CHBrF_2, by displacement of bromine.

(iv) reactions with bromochloromethane (BCM) Reactions in which a halogen such as chlorine or bromine is displaced from the molecule of a controlled substance, with formation of a new bond between the carbon atom and a carbon, sulfur, oxygen or nitrogen atom, can be performed with BCM. It is even possible to perform stepwise reactions, with the bromine being displaced first, and the chlorine next (under more vigorous conditions):

\[
R(1) + CH_2BrCl \rightarrow R(1)-CH_2-Cl \\
R(2) + R(1)-CH_2-Cl \rightarrow R(1)-CH_2-R(2)
\]

There is an example in the industrial production of the antibiotic sultamicillin, for which the use BCM is used in large excess in the first step.

A1.2 Laboratory solvent uses

(i) CTC in chemical reactions CTC has been widely used as a solvent in synthetic organic chemistry for reactions in which two or more components are dissolved in the solvent and heated to form new substances. These are recovered by cooling followed by appropriate ‘work up’ often involving evaporation (and potential recovery) of the CTC. CTC is used in the chemical industry for one or more of the following reasons: reasonably good solvency, does not attack common materials including many elastomers used in reaction vessels, non-flammable and not easily degraded under conditions of use, easily removed by evaporation or distillation without excessive energy consumption, readily available at affordable prices.

Many of the industrial uses of CTC stem from patented procedures that were developed in laboratories. Where such laboratory work is destined to become an industrial process, consideration needs to be given to finding an alternative solvent at the outset. Trichloroethylene, which is not a controlled substance, meets many of the above criteria but must be handled with care because of toxicity concerns that also apply to CTC.

The one chemical reaction that the CTOC has been able to discover in which no alternative has been found for CTC is its use as a solvent in bromination reactions using N-bromosuccinimide (depicted below as succ-N-Br):

\[
\text{Succ-N-Br} + \text{CH}_3\text{C}≡\text{C}- \rightarrow \text{Succ-N-H} + \text{BrCH}_2\text{C}≡\text{C}-
\]
The reaction, conducted under mild conditions (with boiling CTC), is specific for conversion of –CH groups to –CBr when the CH is in an allylic position (one carbon away from a double bond or aromatic ring) as shown. During the reaction, the soluble Succ-N-Br is replaced by insoluble Succ-N-H as the reaction proceeds, and it is thought that this differential solubility in CTC is important to the success of the reaction. Some experiments have been conducted to identify a suitable alternative solvent, but so far without success.

(ii) chain transfer during polymerization Small quantities of CTC are included in reaction mixtures for free-radical-induced polymerization of methyl methacrylate to polymethyl methacrylate. The CTC functions as a chain-transfer reagent, stopping the growth of polymer chains with concomitant initiation of a new polymer chain. The overall effect is to limit chain size and so influence the properties of the resulting polymer.

Other chain transfer agents are available, and newer methods of polymerization are available that obviate the need for this technology. However, conservatism in the laboratory is likely to see only slow movement away from the use of CTC.

(iii) CTC in spectroscopy The use of CTC in analytical spectroscopy is detailed in section 3.2.1 below. However, there are non-analytical uses of this type that find a place in teaching and research laboratories. When an infrared spectrum of the C-H stretching region, say 2800-3200 cm⁻¹, is required, CTC has commonly been used as a solvent for the substance under investigation. Alternatives are tetrachloroethylene, as outlined below, fluorocarbons such as S-316, or for specialist applications, carbon disulfide (although the low boiling point, 46°C, and unpleasant odour of carbon disulfide act to limit its use).

For recording nuclear magnetic resonance (NMR) spectra arising from hydrogen (1H) nuclei in the sample under investigation, CTC has been used a solvent since its molecules have no hydrogen atoms and consequently do not contribute a background spectrum. However, CTC does not have sufficient solvent power to dissolve many substances, and so the use of deuteron-chloroform – CDCl₃, chloroform in which the hydrogen has been replaced by deuterium – has become more frequent although it is somewhat more expensive. Given the widespread availability and use of deuteron-chloroform, and its counterparts such as deuteron-acetone, the use of CTC in this application is easily replaced by alternatives.

CTC is also used as solvent for the recording of Raman spectra, a technique in which the sample is irradiated with ultraviolet light, and comparison is made between the light emerging and that of the incident beam. Differences in the two are due to characteristic vibrational spectrum of the sample being investigated, and in order to visualize the spectrum, a solvent that has no Raman spectrum is required. CTC meets this need, since its molecules are symmetrical and have no dipole moment, thus rendering its Raman spectrum as zero. It is often the case that infrared and Raman spectra are recorded for the same sample, and where C-H vibrations give rise to the bands of interest the solvent employed must not interfere. Carbon disulfide, and deuterated solvents are recommended as alternatives to CTC (B. Schrader, ed., Infrared and Raman Spectroscopy. Methods and Applications, VCH, Weinheim, 1995, pages 146-7 and 220-222).

(iv) grease removal and washing of NMR tubes Removing grease from glassware, especially the smooth surfaces of standard taper joints, may be done with paper or fabric wetted with a solvent, and CTC is one solvent that has been used in this way. Numerous alternatives are available, depending on the type of grease encountered, paraffin or synthetic, for example. Readily available solvents such as hexane or other petroleum hydrocarbons, chloroform and aromatic solvents such as benzene may be used at similar cost and under the same occupational health and safety conditions.
The sample tubes used in nuclear magnetic resonance (NMR) experiments are long (15 cm) and narrow (5 or 10 mm diameter), and they need to be washed to remove the last sample before they reused. In the case of $^1$H NMR there is an advantage in using CTC because any traces of the washing solvent remaining in the tube will not affect the subsequent use, since CTC has no hydrogen atoms in its molecule. When $^{13}$C spectra are being recorded, all traces of carbon-containing solvents – and that includes all organic solvents – must be removed. The best method involves rinsing the tubes with acetone, and then drying them (upside down to allow the escape of heavy vapors) in a ventilated oven at temperatures near 100°C.

(v) iodine partition and equilibrium experiments One of the traditional experiments in undergraduate physical chemistry laboratories concerns the distribution of iodine between an organic solvent, immiscible with water, and water or a solution containing other species that can react with iodine, and CTC was commonly prescribed as the organic solvent in this experiment. Two sets of measurements are made: (i) concentration of iodine in solvent and water after the two have been shaken to enable equilibrium distribution of the iodine; (ii) concentration of iodine in the solvent and of iodine and the complex ion I$_3^-$ in the water phase. The calculation from the measured data gives the distribution coefficient for iodine in the solvent/water pair, and the equilibrium constant for the reaction

$$I_2 + I^- \rightleftharpoons I_3^-$$

While older laboratory manuals prescribe the use of CTC as the organic solvent for this experiment, subsequent writers (for example, www.practicalchemistry.org/experiments) have used cyclohexane, the only significant difference being that, in the latter case, the solvent is less dense than water and forms the upper layer, whereas CTC is more dense and forms the lower layer. Clearly, other solvents such as chloroform or trichloroethylene (both denser than water) or hexane (less dense) could be used in this experiment.

A2 Analytical Uses of ODS

A2.1 ODS used as a solvent for spectroscopic measurements

(i) recording infrared and nuclear magnetic resonance spectra

The most common uses in this category are of CTC or CFC-113 which are used as solvents when measurements are being made by nuclear magnetic resonance or infrared spectroscopy. In the spectroscopic regions of interest, the solvent makes no contribution and so the contributions of the solute molecules are clearly visible and their intensities can be directly related to the concentrations of the solutes. The analyses may concentrate on the presence in the solute (sometimes called the analyte) of certain atoms or bonds that are not present in the solvent, and may be used to measure quantities of single substances, of mixtures, or of certain functional groups in molecules, as is the case with the hydroxyl index (OH groups measured).

Two specific analyses are discussed in (ii) and (iii) below, but this general exclusion may apply to other analytical methods, not all of which would be acknowledged standard methods, so analysts should be aware that alternatives to the use of ODS can be found in all cases.

(ii) hydrocarbons (oil and grease) in water or soil or oil mists in air

The molecules of these solvents have no carbon-hydrogen bonds, and so the infrared spectra are clear in the region where such bonds absorb, approximately 2900-3300 cm$^{-1}$. The molecules of oils and greases are rich in C-H bonds and vibrations of these bonds give rise to absorption peaks in this region of the infrared spectrum. The intensities of these absorption peaks are directly related to the concentration of oil or grease in the solution, and can be prepared with the intensities of peaks from solutions prepared with known concentrations that are used to calibrate this instrumental analysis.
The standard methods of analysis based on the use of CTC or CFC-113 as solvent are elegant in their simplicity. The sample is prepared for analysis by shaking the contaminate water with the solvent, or (in the case of soils and absorbent materials on which oil mists have been deposited) extracting with the solvent. The resulting solution of oil or grease in CTC or CFC-113 is dried and an infrared spectrum is recorded. Peak intensities are compared with standards. CTC is used as solvent in method ASTM D-3921 (total hydrocarbons extracted from water, wastewater and sediments), and in method APHA AWWA-WPCF 5520C (IR method) for hydrocarbon extraction from water and soils. Despite the fact that CFC-113 was already a controlled substance, ASTM method D3921-96, proposing its use, was introduced in 1996, and revised in 2003 (ASTM D3921-96(2003)e1).

The analysis may also be performed with tetrachloroethylene (perchloroethylene) as solvent, because this substance meets the necessary criteria of molecular structure and physical properties (solvent power and water-immiscibility) and is available in spectroscopic grades of high purity. Industrial grades of this solvent have been widely used in the dry cleaning industry. Health and safety aspects are about the same as those with CTC, and both of these chlorinated solvents need to be used with appropriate laboratory care. Although there is no standard method that describes the use of tetrachloroethylene, its use has been reported in the scientific literature and it has been introduced successfully as a replacement for CTC in the petroleum refining industry of Chile. Literature details may be found in: Farmaki, E., Kaloudis, T., Dimitrou, K., Thanasoulias, N., Kousouris, L and Tzoumerkas, F., 'Validation of an FT-IR method for the Determination of Oils & Greases in Water, with the use of tetrachloroethylene as the extraction Solvent', Proceedings of the 9th International Conference on Environmental Science and Technology, Rhodes Island, Greece, 1-3 September 2005. Farmaki, E., Kaloudis, T., Dimitrou, K., Thanasoulias, N., Kousouris, L and Tzoumerkas, F., 'Validation of an FT-IR method for the Determination of Oils & Greases in Water, with the use of tetrachloroethylene as the extraction Solvent', Desalination, 2007, 210 (1-3), 52-60.

The proprietary solvent S-316 (the dimer/trimer of chlorotrifluoroethylene) produced by Horiba has also been used successfully in a number of laboratories for the spectroscopic analysis of oil and grease. It is more expensive than other solvents but has very low toxicity and may be preferred on those grounds. A new standard method ASTM D 7066-04 (Test Method for Dimer/Trimer of Chlorotrifluoroethylene S-316 Recoverable Oil and Grease and Nonpolar Material by Infrared Determination) (Rintoul, S. (2005)) describes the use of this solvent.

There are several alternative, non-spectroscopic methods for analysis of oils and greases in these contexts. The most rudimentary, for which standard analysis exist, is a gravimetric method (Standard Methods for the Examination of Water and Wastewater, American Public Health Association, 20th edition, Washington, DC. Method 5520C (Partition-infrared. Method 5520B gravimetric method. US EPA (1978). US EPA (1978), Method 418.1: Petroleum Hydrocarbons, Total Recoverable, Storet No. 45501. ASTM (2003). ASRM (2003), Method D 3921-96: Standard Test Method for Oil and Grease and Petroleum Hydrocarbons in Water, ASTM International.) which involves the extraction of the oil or grease into a volatile hydrocarbon solvent (most often hexane), evaporation of the solvent and weighing of the residual non-volatile oily material. Volatile hydrocarbon fractions may be lost during this procedure, whereas they would be included in the spectroscopic analysis described above. However, the gravimetric method is cheaper – not having to rely on a spectroscopic instrument – and in the case of environmental samples where volatile material is likely to have been lost before the sample is collected for analysis, so the gravimetric method gives a true account of the quantity being analysed.

The most sophisticated method available for these analysis similarly collects the oil into an organic solvent and then analyses the mixture by GC-MS, a combination of gas chromatography (in which hydrocarbon components of the mixture are separated and
quantified) and mass spectroscopy (in which their molecular nature is revealed). The USEPA Method 8260B ‘Volatile organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)’ is a suitable method.

The use of ODS for ‘testing of oil, grease and total petroleum hydrocarbons in water’ was eliminated from the global exemption by Decision XI/15 (clause (a)) from 2002, but such uses have persisted, especially in developing countries. The availability of alternatives to ODS was further recognized in the TEAP Progress report 2009 and in Decision XXI/6.

(iii) simethicone (polydimethylsiloxane)

Polydimethylsiloxane is used as an internal medicine, marketed as Dimethicone (or Dimeticone) or, when mixed with silica, as Simethicone or Simeticone. The active ingredient can be identified and its concentration may be measured by infrared spectroscopic analysis. However, instead of monitoring peaks due to absorption by C-H vibrations, as in the case of the oil and hydrocarbon analyses discussed above, the analysis of the polydimethylsiloxane uses the intensity of the peak for vibration of the CH3-Si group near 1260 cm\(^{-1}\). Various references give the peak position 1254, 1259 and 1260 cm\(^{-1}\), and 7.9 \(\mu m = 1266\) cm\(^{-1}\), but the spectrometer resolution is usually on the order of 4 cm-1 so these figures are essentially the same. The solvent originally prescribed for this analysis in a number of standard reference works and in a research paper (G. Torrado, A. Garcia-Arieta, F. de los Rio, J.C. Menéndez and S. Torrado, ‘Quantitative determination of dimethicone in commercial tablets and capsules by Fourier transform infrared spectroscopy and antifoaming activity test’, *J. Pharmaceutical and Biomedical Analysis*, 1999, 19, 285-292) was CTC, which has no absorption peaks close to 1260 cm\(^{-1}\). Many other solvents in which the polydimethylsiloxane would be soluble would also have no absorptions near the peak to be measured, and both toluene and chloroform have been used in this analysis. Both the US Pharmacopeia 2009 (Vol 2, page 3555) and the British Pharmacopoeia 2010 (Vol 2, pages 1892-3), which also incorporates the requirements of the European Pharmacopoeia 6th edition, describe the use of toluene for the assay, and the latter reference also includes the spectrum of Dimeticone (Vol 4, page S41).

The availability of alternatives to ODS in this analysis was reported in the 2009 TEAP Progress report and recognized in Decision XXI/6.

A2.2 ODS used as a solvent for electrochemical methods of analysis

(i) cyanocobalamin

For the assay of cyanocobalamin, the British Pharmacopoeia 2010 (pages 607-608) recommends ultraviolet and visible absorption spectrophotometry of an aqueous solution (peak at 361 nm); thin layer chromatography using a mixed solvent (dilute ammonia, methanol and dichloromethane) after application of an aqueous ethanol solution of cyanocobalamin; and liquid chromatography using as mobile phase a mixture of methanol and aqueous disodium hydrogen phosphate. Similar conditions for liquid chromatography of radio-labelled cyanocobalamin\(^{[57}\text{Co}]\) and \(^{[58}\text{Co}]\) are given on pages 3383-3384.

The same conditions for liquid chromatography of radio-labelled cyanocobalamin are prescribed the US Pharmacopeia 2009 (pages 2008-2009) but the cobalamin radiotracer assay described on page 145 employs mixtures of cresol-carbon tetrachloride and butanol-carbon tetrachloride, followed by elution from an alumina column and measurement of the absorbance at 361 nm. In view of the later information contained in the British Pharmacopoeia, the use of organic solvents could be avoided.

(ii) bromine index

In a procedure used to measure the degree of unsaturation of hydrocarbon fractions by determining the uptake of bromine, the chemical reaction being represented by the equation:
The bromine is generated electrolytically in situ from bromide and bromate ions and its disappearance is monitored electronically, in a mixed solvent containing methanol and acetic acid (the components that hold inorganic salts in solution and promote conductivity) and 1,1,1-trichloroethane (the component that holds the hydrocarbon in solution). There are several standard methods for this assay, including ASTM D2710-99 ‘Standard Test Method for Bromine Index of Petroleum Hydrocarbons by Electrometric Titration’ and ASTM Method D1159 ‘Test Method for Bromine Number of Petroleum Distillates and Commercial Aliphatic Olefins by Electrometric Titration’, which describes the solvent as a mixture of glacial acetic acid, methanol, sulfuric acid and 1,1,1-trichloroethane. The procedure for determination of bromine Index closely resembles that used for Karl Fischer determination of traces of water, and the same apparatus may be used for both determinations, an example being the 796 Titroprocessor marketed by Metrhohm.

The need to replace 1,1,1-trichloroethane, an ozone depleting substance, had already been identified by the companies that market the analytical equipment for this specialised measurement. Methylene chloride, diethyl carbonate and 1-methyl-2-pyrrolidone were suggested as suitable alternatives. One bulletin (Mehrohm method 9) describes a mixture of glacial acetic acid, 1-methylpyrrolidone, methanol and sulfuric acid. A bulletin from another branch of the company (Metrohm, Application Bulletin 177/4e) describes the use of 1,1,1-trichloromethane but also comments that ‘if possible one should refrain from using chlorinated solvents. Our investigations have shown that carbon tetrachloride and 1,1,1-trichloroethane can be replaced by diethyl carbonate’. Further information may be found in Metrohm Application Bulletin 177/4e. Automatic determination of the bromine index and/or bromine number in petroleum products. (www.metrohm.co.uk/bulletins/177_e.pdf, accessed January 2008. Metrohm. Method 9 – Bromine index of heptane. www.metrohm.com/products/01/pac/oilpac/e/oilpac_method9_e.pdf, accessed January 2008.

The petroleum refining industry in Chile tested the alternatives and concluded that methylene chloride was the best alternative to 1,1,1-trichloromethane.

A2.3 Analyses involving selective solubility in the ODS

(i) cascariosides A number of medicines consist of, or are prepared from, natural material, and analytical procedures have been developed for measuring the amount of the active constituents in the natural materials. Cascariosides are bright yellow substances found in the bark of the tree Rhamnus puschiana DC (cascara bark, cascara sagrada) and they possess laxative properties. Cascariosides are listed in many pharmacopeias and the content of active constituents is prescribed (for example, European Pharmacopeia (Vol. 2), Council of Europe, Maisonneuve S.A., Sainte-Ruffine, France, 1971. p. 355, and USP 25 NF 20 - The United States Pharmacopeia; The National Formulary. 2002. Rockville, MD: The United States Pharmacopeial Convention, Inc.).

A common assay involves extraction of the active constituents with an organic solvent, followed by thin layer chromatography. The yellow spots on the chromatogram are compared for size with those of a standard solution of the active constituents. A solvent commonly used for this procedure is CTC but many other solvents can be used instead. For example, alcohols such as ethanol or iso-propanol, and solvents such as dichloromethane or ethyl acetate. A more advanced chromatographic method for this analysis has also been described (De Witte, P., Cuveele, J. and Lemli, J. ‘Determination of bicascarosides in cascara fluid by high-performance liquid chromatography’, Journal of Liquid Chromatography, 1991, 14, 2201-2206)
There is also an instrumental method in which the intensity of absorption of visible light in a spectrophotometer, by a solution of the active constituents in ethyl acetate, is used. So, in summary, many common organic solvents can replace CTC and a number of analytical methods are available.

(ii) thyroid extracts  A further example of the use of CTC in extraction of active constituents from natural materials is an application to thyroid glands removed from animals. This is an assay for the thyroid hormones which is based on the work of L.W. Riggs one hundred years ago (‘The Determination of Iodine in Protein Combinations’, *Journal of the American Chemical Society*, 1910, 32(5), 692-698).

Extraction of particular components from natural materials is not confined to medicinal products but also plays a part in research projects, and this is covered in the ‘laboratory’ section, above.

(iii) polymers  An ODS, typically CTC, could have found application as a solvent for selectively removing a polymer from a mixture, so that proportion of that component in the mixture could be measured, or so that the infrared of $^1$H nuclear magnetic resonance (NMR) spectrum of the polymer could be recorded for assay or identification purposes. However, very few polymers are soluble in such solvents and, in any case, other solvents can be found for these purposes. For recording NMR spectra, solutions of polymers in trifluoroacetic acid or hot o-dichlorobenzene have been used. Another kind of solvent use would be to remove some soluble impurity or additive (a plasticizer or flame retardant, for example) from a commercial polymer, for identification or assay purposes, but many other solvents are available for such purposes.

(iv) formation of picrates  Older methods for the identification of unknown organic substances are still practiced in some teaching laboratories in developing countries, whereas in developed countries and in the chemical industry these methods have been displaced by modern spectroscopic methods. These are more expensive and hence the survival of the old methods in developing countries. The identification of the unknown substance can involve its reaction with another chemical substance to form a ‘derivative’. The melting point of this derivative can be used, by referenced to standard tables and in conjunction with other properties of the unknown substance, to identify the unknown substance.

Under this procedure, polycyclic aromatic hydrocarbons such as naphthalene, anthracene, phenanthrene and other aromatic hydrocarbons can be reacted with picric acid to form 1:1 adducts known as picrates. Picric acid and the unknown substance are dissolved in a suitable solvent by warming, and upon cooling the picrate is recovered as crystals. CTC has often been used as the solvent, but most textbooks (for example, F.J. Smith and E. Jones, *A Scheme of Qualitative Organic Analysis* (1951); W.J. Hickinbotham, *Reactions of Organic Compounds* (1942); A.I. Vogel, *A Textbook of Practical Organic Chemistry* (several editions) prescribe the use of benzene, acetone, ethanol or acetic acid and so alternatives to the use of CTC are readily available, cheap and safe to use. Similar procedures can be adopted for the formation of analogous derivatives of hydrocarbons with picrolonic acid or 1,3,5-trinitrobenzene.

**A2.4 ODS used to preconcentrate the analyte**

A further development of the solvent extraction procedure described above is the dissolution, often involving pre-concentration, of a soluble or volatile substance prior to its introduction into the analytical instrument. Four examples are considered below.

(i) liquid chromatography (HPLC) of drugs and pesticides  The concentrated solution of the substance or mixture (the analyte = material to be analyzed) to be analyzed, is dissolved in
a suitable solvent and injected into the chromatography column. The flow of solvent to develop the chromatography – commonly a methanol-water or an acetonitrile-water mixture – is then passed through the column, eluting the components of the analyte and separating them. They may be identified in or recovered from the emerging solution. While CTC has been used in this application, many other solvents can replace it and CTC is not listed as a suitable solvent in the major texts and laboratory manuals (W.J. Lough and I.W. Wainer, eds., *High Performance Liquid Chromatography. Fundamental principles and Practice*, Blackie Academic & Professional, London, 1996, pages 168-169; M.C. McMaster, *HPLC. A Practical User’s Guide*, VCH, New York, 1994, page 137; S. Kromidas, ed., *HPLC Made to Measure. A Practical Handbook for Optimization*, Wiley-VCH, 2006, pages 350-351). According to Lough and Wainer, the sample should be ‘dissolved in the mobile phase’, or if this is not feasible, ‘in a liquid that is chemically very similar to the mobile phase’, and this makes CTC an unlikely choice. For pre-concentration of the sample, polar solvents such as dichloromethane or the Folsch mixture (2:1 chloroform:methanol) are recommended.

(ii) gas chromatography of organic chemicals such as steroids Similar techniques are used in this analysis, the difference being that the chromatogram is developed, and components thus separated, by a stream of inert gas (nitrogen or argon). The separated components may be trapped as they are eluted from the column. Again, many solvents are available for use in transferring the analyte to the chromatography column.

(iii) adsorption chromatography of organic chemicals Once again the aim of the analyst is to transfer the analyte to the chromatography column in the minimum volume of solvent and then to develop the chromatogram by successive elution with solvents. As in the two examples above, a range of suitable solvents is available for transferring the analyte to the column.

(iv) atomic absorption spectroscopy The aim of this analysis is to identify metals by subjecting them to intense heat in a flame or plasma and examining the light emitted at particular frequencies, characteristic of each element. The light intensity can also be used to make a quantitative analysis (= assay). Metal salts are typically soluble in water (or dilute acid) and so can be introduced into the hot zone in the form of aqueous solutions. A technique for pre-concentration of dilute samples, or when trace quantities are involved, is to make a solvent-soluble complex of the metal ion, dissolve the complex in a suitable organic solvent, and begin the analysis with this. While CTC has been used in this application, together with the complexing agents dithizone, a dithiocarbamate or 8-hydroxyquinoline, it is more common to use chloroform, methyl isobutyl ketone, xylene, or a phosphate ester (G.F. Kirkbright and M. Sargent, *Atomic Absorption and Fluorescence Spectroscopy*, Academic press, London, 1974, pp 49-497. *Preconcentration Techniques for Trace Elements*, CRC Press, 1992, p 124).

(v) X-ray fluorescence Sample preparation is the same for a related technique for metal analysis, in which the sample is irradiated with high energy X-rays or gamma rays, and the emitted (secondary) X-rays are recorded and analyzed for the presence of frequencies characteristic of the various metals.

A2.5 Titration of iodine with thiosulfate (iodometric analyses)

Volumetric analysis or titration, in which a reagent of known concentration is added from a burette, to a sample to be analyzed, has been the backbone of laboratory analysis for well over a century and still finds a place in many laboratories despite the availability and sophistication of modern instrumental methods of analysis. Of course the old technique is inexpensive, except for the time of the analyst, and that is one reason why it has persisted. The most common applications of the technique involve acid-base reactions, the acid normally in the burette and the base, together with an indicator substance that will change colour at the
equivalence point (‘end point’ of the titration), in the receiving flask. Electrometric methods can also be used to detect the end point.

In the titrations under consideration here, the reagent in the burette is sodium thiosulfate, \( \text{Na}_2\text{S}_2\text{O}_3 \), and the solution in the flask contains iodine \( \text{I}_2 \), the quantity of which is to be measured in the volumetric analysis. Because the iodine has limited solubility in water, it is normally held in solution as the more soluble \( \text{I}_3^- \) ion, which releases iodine as the titration progresses. During the titration the iodine is converted (reduced) to iodide ion, \( \text{I}^- \), and the brown colour of the iodine fades gradually to yellow and disappears at the end point.

The final change from pale yellow to colourless can be hard to detect by eye and so two methods have been developed for visualizing it. In the first of these, as the end point approaches and iodine concentration is already low, a solution of starch is added so that a deep blue starch-iodine complex forms in solution. When the last traces of iodine are gone, the blue colour disappears. The second visualization method is based on the intense violet colour of iodine solutions in organic solvents that have no oxygen in their molecules. CTC has been used in this method. A few mL are added to the titration solution in the flask, forming a globule at the bottom (since CTC is much denser than water) and dissolving the iodine. As the iodine is removed from the solution during the titration, the violet colour fades and the end point – colourless – is easily detected.

In this second visualization method, CTC (relative density 1.59) can be replaced with another solvent that has no oxygen and also meets the requirements of water immiscibility and density. Chloroform (\( \text{CHCl}_3 \), relative density 1.48), dichloromethane (\( \text{CH}_2\text{Cl}_2 \), 1.33 ) and trichloroethylene (\( \text{C}_2\text{H}_3\text{Cl}_3 \), 1.46 ) all meet these criteria, and chloroform has been found to be quite successful. Like CTC, these solvents can be recovered and reused, and this is often done if a laboratory has many such titrations to perform. The use of chloroform as an alternative to CTC is described in standard texts such as Vogel’s *Quantitative Inorganic Analysis*.

There are many applications that rely on the generation of iodine in solution, in equivalent to the amount of the substance being analyzed. Some representative examples are given below.

**(i) iodine** Titrations of the kind described above are performed in a number of situations where iodine is handled. One example is the monitoring of iodine content in medicinal preparations containing iodine as disinfectant or antiseptic. Another is the assay of residual iodine in water from which solid iodine has been removed in the commercial production of iodine from mineral deposits. Chloroform, has been shown to serve well in this application.

**(ii) copper** In the volumetric method for determination of copper in solution, the copper is reacted with iodide ion, oxidizing it so that a quantity of iodine, equivalent to the amount of copper, is generated in the solution. The copper is concomitantly reduced, changing its oxidation state from Cu(II) to Cu(I). The quantity of iodine is determined by means of the titration described above and thus the quantity of copper can be calculated. As before, the iodine may be titrated with sodium thiosulfate to the end point that can be detected with starch or an organic solvent such as chloroform. There is no necessity for the use of CTC since alternatives are available.

**(iii) arsenic** Arsenic, in its pentavalent As(V) state – that is, the form of arsenate ion, \( \text{As}_2\text{O}_4^{3-} \), or arsenic pentoxide, \( \text{As}_2\text{O}_5 \) - can be determined in more or less the same way, since its reaction with iodide ion converts an equivalent amount of iodide to iodine, the arsenic being reduced to the trivalent (+3) state. As before, the iodine may be titrated with sodium thiosulfate to the end point that can be detected with starch or an organic solvent such as chloroform. There is no necessity for the use of CTC since alternatives are available.
(iv) hypochlorite, chlorate and bromate Each of these species is a powerful oxidizing agent, capable of converting iodide ion to iodine in amount equivalent to the quantity of oxidizing agent. The quantity of iodine, and therefore of the oxidizing agent, can be determined as above by titration with thiosulfate.

(v) sulfur Sulfur can be determined by means of a related volumetric method that involves converting the sulfur to sulfur dioxide or sulfite ion, $\text{SO}_3^{2-}$, and titration with iodine, which oxidizes the sulfite to sulfate, $\text{SO}_4^{2-}$. The procedure is the converse of the above titrations, and is properly termed iodimetry (a term frequently misused in the literature). The end point, the first appearance of uncombined iodine in solution, may be detected by the methods described above for monitoring the disappearance of iodine in the process of iodometry – that is, blue colour with starch, or violet colour in an organic solvent. An excellent example is provided in a recent article (M. Gros, J-P. Morand and A. Bezos, ‘Determination of Total Sulfur Contents in the International Rock reference Material SY-2 and other Mafic and Ultramafic Rocks Using an Improved Scheme of Combustion/Iodometric Titration’, *Geostandards and Geoanalytical Research*, 2007, 29(1), 123-130) where starch indicator is used. Determinations of this type are sometimes performed by ‘back titration’ with thiosulfate following the addition of a known excess of iodine to the sulfur-containing solution, but the approximate amount of sulfur must be known in order for the excess to be calculated. Sulfur may also be determined by instrumental methods such as X-ray fluorescence (XRF), pyrohydrolysis/ion chromatography, inductively coupled plasma mass spectrometry (ICP-MS), and electron microprobe analysis (EMPA).

**A2.6 Iodine Index (iodine value, iodine number)**

The Iodine Index is an indicator of the extent to which the molecules being studied possess $\text{C} = \text{C}$- linkages (double bonds or unsaturation). Such unsaturation may be in hydrocarbons, but the petroleum industry generally uses the closely related Bromine Index, rather than the Iodine Index, to express the degree of unsaturation in their products. The Iodine Index is commonly used when the unsaturation is in the components of natural fats and oils, and so edible oils and fatty foods such as butter are studied in this way, and products such as biodiesel that are derived from fats and oils.

The methodology involves the addition of a solution of iodine chloride (ICl) in acetic acid – named after the inventor of the technique as ‘Wijs Solution’ – to a solution of a weighed amount of the oil or fat in an organic solvent. Since a wide range of sample may need to be analysed, with differing solubilities, the mixed solvent ensures that the whole sample is in solution. CTC was for many years the organic solvent used in the Wijs method but a number of other solvents can be used as alternatives.

An excess of Wijs solution is used in the determination. The rate of the chemical reaction - addition of the ICl to the double bonds - is slow, and so a waiting time of at least an hour is necessary. After this time, an aqueous solution of potassium iodine is added and this reacts with the excess ICl to form iodine. The amount of iodine is measured in the usual way, by titration with sodium thiosulfate and visualization of the end point (when all of the iodine has been consumed by the thiosulfate) by starch, which forms a deep blue colour with iodine. The end point is the disappearance of the blue colour. Since the amount of Wijs reagent was known, and the excess was measured (as iodine) the quantity of ICl consumed can be calculated. The amount of sample is known, so the Iodine Index may be calculated.

The Association of Official Analytical Chemists has published a standard procedure for determination of the Iodine Value using CTC (AOCS method Cd 1-25, (1989) but even at the time the method was being developed by the American Oil Chemists’ Society (AOCS) it was acknowledged that CTC would have to be replaced and (later) that CFC-113 was not recommended as a replacement ‘because of environmental concerns’. Subsequently, AOCS
Recommended Practice Cd 1b-87 gave cyclohexane as the best replacement for CTC but acknowledged that ‘erratic results may be obtained for oils with iodine values’ in the range 100-120.

ASTM D5768-02 (2006) is another standard methods for performing this analysis. The ASTM ‘method was developed in order to replace the hazardous solvent, carbon tetrachloride, used in Test Method D 1959 with the less hazardous and more available solvents, iso-octane and cyclohexane. As data on the satisfactory use of other solvents becomes available, this test method will be amended to include those solvents’. The German organization Deutsches Institut für Normung E.V. has developed method DIN 53241-1: 1995 Determination of iodine value - Part 1: Methods using Wijs solution, but details are not available.

A recent publication describes a method in which the unsaturated material being tested is reacted with iodine in a water-alcohol mixture at 50°C, with excess iodine being measured by thiosulfate titration as in the standard method. The method revives a procedure first described in 1924, and compares the results favourably with those achieved with the standard method described above. The new method is not (yet) a standard method although it was published in the AIST journal and so has been brought to the attention of the standard-setting organization (J.A. Aricetti, A.J. da S. maciel, O.C. Lopes and M. Tubino, ‘A Simple Green method for Biodiesel Iodine Number Determination’, *Journal of ASTM International* 7 (1), 1-8 (2010).

### A2.7 Miscellaneous analyses

(i) **stiffness of leather** Earlier indications that ODS were used in this standard method were in error and so this procedure (ASTM D2821) is not of concern.

(ii) **jellification point** CTC is used in small quantities in the measurement of the jellification point of the seaweed-derived product, agar. As far as can be ascertained, this use is confined to a single company, where CTC is used because it is heavy (relative density 1.59) and immiscible with water. Following discussion with a CTOC co-chair, the company is seeking and should be able to find an alternative (non-ODS) that meets its requirements.

(iii) **cement analysis** This analysis was described in the 2008 TEAP Progress Report, in which it was observed that the original standard method using CTC had been replaced by another (ASTM C 243-95 Standard test method for Bleeding of Cement Pastes and Mortars) using 1,1,1-trichloroethane (TCA), but since this was also a controlled substance the method was withdrawn in 2001. There has been available for many years the standard test ASTM C 188-44, revised in 1967, in benzene is used as solvent and CTOC has received information that this method is acceptable to the industry. Hence, there is no justification for the continued use of CTC or TCA.

(iv) **gas mask cartridge breakthrough** As noted in the 2009 TEAP Progress Report, Japanese researchers have found that cyclohexane is a suitable alternative to CTC in the standard test of breakthrough time of a gas mask cartridge (M. Furuse, S. Kanno, T. Takano and Y. Matsu, ‘Cyclohexane as an Alternative Vapor to Carbon Tetrachloride for the Assessment of Gas Removing Capacities of Gas masks’, *Industrial Health*, 39, 1-7 (2001). ‘Carbon tetrachloride (CCl4) vapor has long been used’, the authors observe, ‘as a representative organic vapor for testing breakthrough times of gas mask cartridges and canisters in the National Approval Test of Respirators as well as in respirator tests in manufactures’. However, a suitable alternative, cyclohexane, is available.

(v) **porosity of activated carbon** Impurities in gases or liquids can be removed by adsorption onto the surface of ‘activated carbon’, a kind of char that is produced by heating woody material in the absence of oxygen. Some of the best grades are made from coconut husks. The activated carbon has very high porosity, and therefore very high surface area, and
this important property can be measured by measuring the uptake (g/100 g) of an organic chemical substance by grains of the activated carbon. The ASTM Method of long standing, D3467-04 (2009), Standard Test Method for Carbon Tetrachloride Activity of Activated Carbon, describes how this can be done using CTC. However, some years earlier, following criticism of the use of CTC, a new method using butane was developed (ASTM D5228-92 (2005)) Standard test method for Determination of Butane Working Capacity of Activated Carbon. When an analyst changes to a new standard test method, the question always arises about the relationship of the new result to those obtained with the older method, and so, foreseeing such concern, ASTM has published a correlation graph that enables the old and new results to be viewed on a common scale: CTC activity = 2.55 x butane activity ($R^2 = 0.935$). This is included in ASTM D5742-95 (2005) Standard Test Method for Determination of Butane Activity of Activated Carbon.
5 Foams Technical Options Committee (FTOC) Progress Report

5.1 Overview Paragraph on Foams

- The primary challenge for the foams sector continues to be the phase-out of HCFCs in developing countries under Decision XIX/6. Alternatives such as methyl formate and methylal are being evaluated as specific alternatives to meet these challenges, even though experience of these alternatives has been limited in developed countries.

- The blowing agent usage patterns in developed countries are now relatively mature, although there is still some limited migration from saturated HFCs to hydrocarbons in the polyurethane sector for cost reasons where performance characteristics can be met. There is also an interest in the potential role of unsaturated HFCs in the domestic refrigeration sector, particularly in North America, where saturated HFCs have a significant market, and in PU Spray foam both in Europe and North America. One of these (HFC-1234ze) has found some initial use in Europe as a replacement for HFC-134a in PU One Component Foams.

- The extruded polystyrene sector has successfully made its transition out of HCFCs in North America, although, for the most part, this has been to solutions involving various combinations of saturated HFCs. There is interest in Europe, primarily driven by market pressure to move to low GWP alternatives. Those evaluated include Dimethyl Ether and unsaturated HFCs.

- Meanwhile the management of ODS banks in the foam sector offers both challenges and opportunities to limit the emissions of these greenhouse gases. The evaluation conducted by the TEAP Task Force responding to Decision XX/7 indicated that costs of recovery and destruction of blowing agents were substantially higher than those relating to refrigerants. Although significant progress has been made in establishing ODS protocols to facilitate carbon finance, the inclusion of foam blowing agents has been limited by the lack of a solid understanding of the business-as-usual baseline in many developing countries.

5.1.1 Transitional Status

Decision XIX/6 still remains a key focus of the Foams TOC as it seeks to identify and document relevant technology options – particularly for developing countries. The following sections list key conclusions from this process as follows:

Transition Status - Developing Countries

- Pilot projects have been approved and, in some cases, are close to completion on a number of key technology options. A recent workshop in Brazil has confirmed that the use of methyl formate is becoming established in Australia, Brazil and the USA in integral skin, specialty flexible and most rigid foam applications, while some use in China, New Zealand and South Africa has been noted.

- Pre-blended or directly injected hydrocarbons may have a significant role to play for medium-sized enterprises but safety concerns persist. A pilot project has been approved for Egypt and another has been prepared for China.

- A further project is being progressed in the polyurethane sector on methylal (Brazil) while projects with HFC-1234ze (Turkey) for the XPS sector and super-critical CO₂ (Colombia) for the PU Spray foam have been approved.
The TEAP Report responding to Decision XXI/9 provides a review of options that might avoid saturated HFCs in the foam sector and offers a current commentary on minimising the climate impact of transitions. There is growing concern in the foam sector that a provision for quantifying climate impacts of technology transitions is not yet available. Pilot projects on the end-of-life management of domestic refrigerators have been identified and are in the process of development. Various stakeholders in the carbon market (e.g. the Climate Action Reserve (CAR) and the Voluntary Carbon Standard (VCS)) have developed ODS destruction protocols, but these are unlikely to be operable in developing countries for foam blowing agents because of concerns over the definition of baselines.

**Transition Status - Developed Countries**

- Transition out of HCFCs has been completed in the North American XPS sector, with the primary choice of blowing agent being various combinations of saturated HFCs.
- Market pressures in Europe are encouraging some XPS manufacturers to investigate alternatives to saturated HFCs.
- HFC use is continuing to decline in the polyurethane sector as hydrocarbon technologies continue to mature. Increasing interest in climate mitigation strategies might add further impetus to this process.
- 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).
- Although the construction sector is depressed as a result of the current economic crisis, the insulation industry continues to grow in most regions based on higher insulation requirements in new buildings and a number of efforts to stimulate building refurbishment.
- Unsaturated HFCs are being investigated in a number of foam applications and HFC-1234ze is already in commercial use within some polyurethane (PU) One Component Foam (OCF) products in the niche market for larger cans.
- The cost-effectiveness of bank management in the foam sector has been the subject of much study in non-Article 5 countries. In many regions, end-of-life management of foam in refrigerators is mandated. In others, it is the subject of wider producer responsibility requirements. In still others, such activities may attract credits under carbon financing initiatives. However, it is still unclear whether the end-of-life management of foams in buildings will be technically and/or economically viable in many cases.

### 5.1.2 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 2010 - Technical Options Table

<table>
<thead>
<tr>
<th>SECTOR</th>
<th>DEVELOPED COUNTRIES</th>
<th>DEVELOPING COUNTRIES</th>
<th>GLOBAL</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>POLYURETHANE RIGID</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic refrigerators and freezers</td>
<td>c-pentane, cyclo/iso pentane blends, HFC-245fa, HFC-134a</td>
<td>c-pentane, cyclo/iso pentane blends, HCFC-141b or HCFC-141b/22</td>
<td>c-pentane, cyclo/iso pentane blends, unsaturated HFCs</td>
<td></td>
</tr>
<tr>
<td>Other appliances</td>
<td>c-pentane, cyclo/iso pentane blends, HFC-245fa, HFC-365mfc/227ea blends, Methyl Formate</td>
<td>HCFC-141b, c-pentane, cyclo/iso pentane blends, Methyl Formate</td>
<td>c-pentane, cyclo/iso pentane blends, unsaturated HFCs, Methyl Formate</td>
<td></td>
</tr>
<tr>
<td>Transport &amp; reefers</td>
<td>c-pentane, cyclo/iso pentane blends, HFC-245fa, HFC-365mfc/227ea blends</td>
<td>HCFC-141b, HCFC-141b/22</td>
<td>c-pentane, cyclo/iso pentane blends, unsaturated HFCs, Methyl Formate</td>
<td>Potentially HFCs but no known use</td>
</tr>
<tr>
<td>Boardstock</td>
<td>c-pentane, n-pentane, cyclo/iso pentane blends, HFC-245fa, HFC-365mfc/227ea blends</td>
<td>Limited commercial production in Art 5.1 but HCFC-22 in use</td>
<td>c-pentane, n-pentane, unsaturated HFCs</td>
<td>HFC for stringent product fire standards</td>
</tr>
<tr>
<td>Panels – continuous</td>
<td>c-pentane, n-pentane, HFC-245fa, HCFC-141b &amp; minor use of C-pentane, n-pentane, HCFC-22</td>
<td>n-Pentane, HCFC-141b, Methyl Formate</td>
<td>c-pentane, n-pentane, unsaturated HFCs, Methyl Formate</td>
<td>HFC for stringent product fire standards</td>
</tr>
<tr>
<td>Panels discontinuous</td>
<td>HFC-245fa, HFC-365mfc/227ea blends, c-pentane, n-pentane</td>
<td>HFC-141b</td>
<td>c-pentane, n-pentane, unsaturated HFCs, Methyl Formate</td>
<td>HFCs, not HCs, for SMEs</td>
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<tr>
<td>Spray</td>
<td>HFC-245fa, Supercritical CO₂ (water),</td>
<td>HCFC-141b, Methyl Formate</td>
<td>HFC-245fa, Supercritical CO₂ (water),</td>
<td></td>
</tr>
<tr>
<td>Blocks</td>
<td>c-pentane, n-pentane, HFC-245fa, HCFC-141b, HCFC-141b</td>
<td>HCFC-141b</td>
<td>c-pentane, n-pentane, unsaturated HFCs, Methyl Formate</td>
<td>HC use increasing</td>
</tr>
<tr>
<td>Pipe-in-pipe</td>
<td>c-pentane, n-pentane, HFC-245fa, HCFC-141b</td>
<td>HCFC-141b</td>
<td>c-pentane, n-pentane, unsaturated HFCs, Methyl Formate</td>
<td></td>
</tr>
<tr>
<td>One Component Foam</td>
<td>Mixtures of propane, butane and dimethyl ether, HFC-134a, HFC-1234ze</td>
<td>HCFC-22, HFC-134a</td>
<td>Mixtures of propane, butane and dimethyl ether, HFC-1234ze</td>
<td>HC use driven by cost and legislation</td>
</tr>
<tr>
<td><strong>POLYURETHANE FLEXIBLE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integral Skin</td>
<td>CO₂ (water), HFC-134a, HFC-245fa, HCFC-141b</td>
<td>CO₂ (water), HFC-134a</td>
<td>CO₂ (water), n-pentane, Methyl Formate, unsaturated HFCs</td>
<td>HFC-134a is main HFC</td>
</tr>
<tr>
<td>Shoe Soles</td>
<td>CO₂ (water), HFC-134a</td>
<td>CO₂ (water), HFC-134a</td>
<td>CO₂ (water), Methyl Formate, unsaturated HFCs</td>
<td>HFC-134a is main HFC</td>
</tr>
<tr>
<td><strong>PHENOLIC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Board &amp; block</td>
<td>Isopentane, n-pentane, minor use of HFC-365mfc/227ea blends</td>
<td>HCFC-141b</td>
<td>HCs</td>
<td>HFCs are used to retain fire performance in some markets</td>
</tr>
<tr>
<td><strong>EXTRUDED POLYSTYRENE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boardstock</td>
<td>HFC-134a, HFC-152a, CO₂, CO₂/ethanol, (HCs in Japan), blends of CO₂/hydrocarbons</td>
<td>Mainly HCFC-142b/22 but growing HCFC-22. Some minor use of HCs</td>
<td>CO₂, blends of CO₂/ ethanol or CO₂/hydrocarbons, unsaturated HFCs, dimethylether</td>
<td>HCFC-142b use in North America until 2010. Final choice is end-product specific</td>
</tr>
<tr>
<td><strong>NOT-IN-KIND INSULATION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic Buildings</td>
<td>Glass fibre, rock fibre, cellulose</td>
<td>Limited NIK insulation types</td>
<td>Awaiting new technology</td>
<td>Fibre insulation is default based on cost</td>
</tr>
<tr>
<td>Non-domestic Buildings</td>
<td>Glass fibre, rock fibre</td>
<td>Limited NIK insulation types</td>
<td>Awaiting new technology</td>
<td>Market share reducing on efficiency grounds</td>
</tr>
<tr>
<td>Industrial applications</td>
<td>Mostly rock fibre, calcium silicate</td>
<td>Limited NIK insulation types</td>
<td>Awaiting new technology</td>
<td>Choice driven by operating temperature</td>
</tr>
</tbody>
</table>
6  Halons Technical Options Committee (HTOC) Progress Report

The Halons Technical Options Committee (HTOC) met in Montpellier, France on March 9 - 11, 2010. HTOC members in attendance were from Article 5 countries India, Jordan, Kuwait, South Africa, and Venezuela, from CEIT, Russian Federation, as well as from the non-Article 5 countries Canada, Japan, United States and three member states of the European Union. The following is the update for 2010.

6.1  Update on Alternative Agents

Four new alternative agents are not yet commercialized but are in the advanced stages of development. These agents will be described in the 2010 Assessment Report.

6.2  Update on Halon Uses

It was previously reported that halon 2402 is being commercialized 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. Other extinguishing agents are now being similarly encapsulated and the flame retardant paint has been commercialized in Russia. Ukraine also has an interest in commercialization of this paint for local markets.

6.3  Update on Halon 1301 Use as a Feedstock

Halon 1301 (CF$_3$Br) continues to be produced in China and France for use as a feedstock in the manufacture of the pesticide Fipronil. The total halon production quantities in these countries are unknown to the Committee but have been increasing annually in China since 2005.

6.4  Halon Recovery and Recycling in Article 5 Countries

Recent information indicates that there has been a further decline in recovery and recycling operations on Article 5 countries since the HTOC’s last report. Operational costs have been increasing and technological skills have been found to be in short supply in many cases. For example, in India the civil recycling and storage facility is not working effectively so each of the armed forces is setting up its own facility. This is resulting in little or no reclaimed stock availability, particularly for halon 1211. In some other cases, halons contaminated with other fluorocarbons cannot be purified without a reclamation process based on distillation. The necessary equipment is expensive and unavailable in Article 5 countries, and thus stocks of contaminated but unrecyclable halons are accumulating. This is imposing a financial and operational burden on some recycling facilities.

Parties may wish to consider strategies and propositions that will help non-functioning halon recovery and recycling operations become functional, to ensure the long-term sustainability of these halon banking operations. These will be needed to provide for regional forecasted critical halon use requirements.

6.5  Contaminated Recycled Halons

The UK Civil Aviation Authority (CAA) reported to the European Aviation Safety Agency (EASA) that contaminated halons had made their way into the civil aviation industry. It is alleged that a UK halon recycler falsified third party laboratory test reports that indicated
contamination to show that the halon met specification. The halon was then sold on to aviation fire protection equipment suppliers, thus compromising the effectiveness of on-board aircraft fire protection. The concern is primarily halon 1211, but contaminated halon 1301 has also been found - details are still being consolidated.

Contaminants found in halon 1211 include R-11, R-12, Halon 2402, R-134a, R-141b, R-22, R-152a (flammable), R-125, carbon tetrachloride, and isobutane (flammable). These have been found in varying quantities, and in some cases the total contaminant content is in excess of 30%. It has been estimated that over 30,000 extinguishers could be affected. EASA and the US Federal Aviation Administration (FAA) have issued airworthiness directives as the affected extinguishers have also been found outside of Europe. Testing of suspect extinguishers continues and the HTOC has recommended that analysis of the halon purity be done using a gas chromatography/mass spectroscopy (GC/MS) method. The HTOC is also working closely with ASTM International to fast track a halon 1211 Standard that utilizes this analysis method so that halon recyclers and purchasers can refer to it for purity determination. The existing ASTM halon 1301 Standard will have its analysis test method updated in accordance with the new halon 1211 Standard. The HTOC recommends strict adherence to these standards to avoid potential risks from reduced fire extinguishing performance or increased agent toxicity.

6.6 Response to Decision XXI/7

At the request of the International Civil Aviation Organization (ICAO) Secretariat, one co-Chair and one member of the Technology and Economic Assessment Panel’s Halons Technical Options Committee (HTOC) participated in a three day meeting, 1-3 December 2009, to discuss progress on eliminating halons in civil aviation. This meeting was a follow-up to the ICAO General Assembly Resolution (equivalent to a Montreal Protocol decision of the Parties) A36-12 that requested the ICAO Council to consider a mandate to require halon alternatives for lavatory, handheld extinguisher and engine/auxiliary power unit fire protection systems. In addition to HTOC, the Deputy Executive Secretary of the Ozone Secretariat also attended the meeting. Attendees from civil aviation included the ICAO Secretariat, International Coordinating Council of the Aerospace Industries Associations (ICCAIA), Boeing, Airbus, the International Air Transport Association (IATA), US Federal Aviation Authority (FAA), Air Transport Canada, European Aviation Safety Agency (EASA), and commercial industry suppliers of aviation fire protection equipment.

The working group developed the following draft text for consideration as a Resolution for the 37th General Assembly in September of 2010.

- **Requests** that the Council consider a mandate to be applicable in the:
  - 2011 timeframe for the replacement of halon in lavatories for new production aircraft.
  - 2014 timeframe for the replacement of halon in hand-held extinguishers for new production aircraft.
  - 2014 timeframe for the replacement of halon in engines and auxiliary power units for aircraft for which a new application for type certification (sometimes referred to as new designs) has been submitted.

- **Urges** States to issue guidance material for halon alternatives and fire detection systems in cargo compartments for new production aircraft.

- **Encourages** States to promote aircraft and engine manufacturers research on halon alternative fire suppression systems.
- **Urges** States to take note of its halon reserves and report back at the next regular assembly meeting.

The Ozone Secretariat and the HTOC note that the dates in the new draft Resolution are up to three years delayed from those originally agreed upon in Resolution A36-12. ICAO had not yet adopted any changes to their Annexes, which would need to be made in order to require implementation of halon alternatives. The reason for the proposed changes is that the Chicago Convention requires a minimum of three years, from the date of a change to required aircraft design criteria, called Annex 8, to implement the change. The earliest that the ICAO Secretariat could make the change and get the Annex approved through their system would be 2011. Therefore, the earliest date that we could require halon alternatives to be implemented would be 2014. This same three year implementation requirement does not apply to changes to their Annex 6, which covers provisioning. Therefore it was agreed to keep the original 2011 date for implementation of halon alternatives in lavatory waste bin fire protection.

Subsequent to the meeting, ICCAIA, Boeing and Airbus requested that ICAO consider a two year delay in the installation of halon alternative handheld fire extinguishers for new production aircraft. The reason for the delay is to allow for the further development of a “low GWP” unsaturated HBFC, known as 2-bromo,1,1,1-trifluoropropene or 2-BTP. This was the agent mentioned in the fire protection section of the TEAP response to Decision XX/8 that could be commercialized in the short term as a significant part of the required testing had already taken place. In their request to ICAO to consider a two year delay, ICCAIA, Boeing and Airbus agreed that even should 2-BTP prove unsuitable, they would meet the 2016 date to implement non-halon handheld extinguishers using existing alternatives. These are the two high GWP HFCs already approved and the HCFC-123 blend also approved but subject to Montreal Protocol production and consumption phase-out. HTOC was concerned with granting another two year delay. ICAO recommended a compromise to accept the two year delay in exchange for strengthening the requirement from “consider a mandate” to “establish a mandate.” ICCAIA, Airbus and Boeing agreed to the compromise. Attendees of the 1-3 December Meeting are being consulted on the following proposed change to the draft resolution:

- **Requests** that the Council establish a mandate to be applicable in the:
  - 2011 timeframe for the replacement of halon in lavatories for new production aircraft.
  - 2016 timeframe for the replacement of halon in hand-held extinguishers for new production aircraft.
  - 2014 timeframe for the replacement of halon in engines and auxiliary power units for aircraft for which a new application for type certification (sometimes referred to as new designs) has been submitted.
Refrigeration, Air-conditioning and Heat Pumps Technical Options Committee (RTOC) Progress Report

7.1 Progress Reports

In recent years the Refrigeration Technical Options Committee (RTOC) has normally drafted Progress Reports for the annual TEAP Progress Report. In the 2008 TEAP Progress Report one can find an overview of the latest developments in the various sub-sectors of refrigeration and air conditioning; the trends described there are still valid today.

In the year 2009, the TEAP installed a Task Force to address Decision XX/8. The majority of the chapters of this XX/8 report describing the newest developments were contributed by members from the RTOC. The XX/8 Task Force report had chapters on domestic, commercial and industrial refrigeration, unitary and chiller air conditioning and mobile air conditioning, with Chapter Lead Authors that also fulfil this role in the 2010 RTOC Assessment Report. Considering that all relevant material was going to be published in the XX/8 Task Force report, it was the opinion of the RTOC that the drafting of a separate progress report for the TEAP 2009 Progress Report would be redundant.

In the year 2010, something similar happened. The TEAP installed a Task Force to address Decision XXI/9. The Decision requests a description of HCFCs and environmentally sound alternatives, as well as a comparison of low-GWP with high-GWP alternatives, and requests the publishing of a reorganised and restructured version of the XX/8 report. The majority of the chapters of this 2010 XXI/9 Task Force report, describing newest developments, was again contributed by members from the RTOC. As in the case of the XX/8 Task Force report, the XXI/9 Task Force report had chapters on domestic, commercial and industrial refrigeration, unitary and chiller air conditioning and mobile air conditioning, as well as transport refrigeration. The Chapter Lead Authors for the refrigeration and air conditioning chapters were again those that fulfil the same chapter role for the 2010 RTOC Assessment Report. The RTOC therefore took an approach consistent with the one of 2009 and decided that the drafting of a separate progress report for the TEAP 2010 Progress Report would be redundant as all the relevant material is provided in the XXI/9 Task Force report.

A second issue that needs to be mentioned here is the following. In 2009 the RTOC, via a Subcommittee, published a draft report version responding to Decision XIX/8, “HCFC alternatives for high ambient temperatures”. In 2010, this draft report has been made final, has been extended with a section on air conditioning of deep mines, and will be part of the TEAP 2010 Progress Report. The developments described in this RTOC Subcommittee report can also be seen as new material, which, under normal circumstances, could have been part of a progress report.

7.2 RTOC 2010 Assessment Report

In 2008 the RTOC organised a first meeting in Copenhagen to determine the outline and topics for the 2010 Assessment Report, as well as the membership that would be involved. It was decided that a large part of the membership for the 2006 RTOC Assessment would continue; a number of non-Article 5 and Article 5 members were dismissed, and others were taken on board. A second meeting of the RTOC was organised in March 2009 in Montreal at the offices of the Multilateral Fund Secretariat. The RTOC discussed the outline again as well as first conceptual drafts for the chapters. Since the long-standing RTOC co-chair Agarwal (India) had indicated that he wanted to resign, the Committee endorsed RTOC member Roberto Peixoto (Brazil) as its new co-chair.

During the period March-August 2009 drafts for the several chapters were updated and were discussed in a meeting in Sao Paulo in September 2009, hosted by the new RTOC co-chair Peixoto. The major issue in this meeting was the investigation of the consistency of the approaches in the
various chapters. The RTOC agreed on the timelines into the year 2010, particularly when new drafts would be circulated for review.

The current status is that a complete draft report will be circulated to all RTOC members for review and the results will be discussed in the next RTOC meeting, which was originally planned for Bangkok, back to back with the Montreal Protocol OEWG meeting. The move of the OEWG meeting to Geneva has caused a rescheduling of the RTOC meetings for 2010.

The first RTOC meeting after the one in Sao Paulo will now be held in Prague, August 2010, hosted by a RTOC member; this meeting will discuss and amend the semi-final draft that will have to be circulated between May and August 2010. This meeting in Prague will then also agree on the draft that will be sent out for peer review to a large number of experts and expert institutions in the course of September 2010 (with a deadline for submission of comments of mid-November 2010). The RTOC plans to discuss the peer review comments received in a meeting hosted by a RTOC member in Hangzhou, China, in December 2010; it is confident that it can comply with the deadline of 31 December 2010 for the submission of the RTOC 2010 Assessment Report to UNEP.
8 Decision XXI/10 Quarantine and Pre-shipment Report

8.1 Executive Summary

As requested by Decision XXI/10, the availability and market penetration of technically and economically feasible alternatives were estimated for the four largest consuming categories of methyl bromide for QPS: sawn timber and wood packaging material (ISPM-15); grains and similar foodstuffs; pre-plant soils use; and logs. MBTOC-QPS estimated that 1,937 to 2,942 tonnes of methyl bromide that were used in the four main categories of QPS were replaceable globally with currently available technologies, which represented 31% to 47% of global consumption for these four categories.

For sawn timber and wood packaging material, heat is a technically and economically feasible alternative that has a good market penetration in most countries including many Article 5 Parties. For at least 28 countries, methyl bromide is not an option and heat is the main alternative used to meet the phytosanitary requirements of the FAO-IPPC international standard ISPM-15. Not in kind alternatives such as plastic pallets are used in some countries and avoid the need for methyl bromide or heat. In some countries, heat was reported to be less expensive than methyl bromide. Six additional treatments to methyl bromide and heat are under evaluation by the IPPC for possible inclusion as treatment options for wood packaging material in ISPM-15.

For grains and similar foodstuffs, many treatments target non-quarantine pests and are therefore pre-shipment treatments. Phosphine is the most commonly used alternative. Controlled atmospheres were in usage where this technology was available. Where permitted, dichlorvos and sulfuryl fluoride were also used. Several countries specified methyl bromide as the only acceptable treatment which limited the use of alternatives even when available. Heat disinfestation is technically but not economically feasible. For quarantine pests, phosphine is the most widely used treatment.

For pre-plant soils use, the United States was the only country that categorised consumption of methyl bromide for this purpose as QPS. As a category within QPS, it was the second largest consumer of methyl bromide in 2007. Plants for propagation in the US are not eligible for certification if nematodes are detected in a sample of the propagation material, and methyl bromide or an alternative (1,3-D) are applied to the soil in which the plants are grown is used to meet this nematode-free requirement. As the treatment targets nematodes that are not quarantine pests according to the definition used in the Montreal Protocol, TEAP considered this use of methyl bromide in soil inconsistent with this definition. TEAP encourages Parties to require the uses of methyl bromide to be fully consistent with the definitions of QPS agreed by the Parties as this would reduce the amount of methyl bromide used for QPS. Technically and economically feasible alternatives (1,3-D/Pic and methyl iodide/Pic) are available for controlling pests in soils to meet the required standard, and MBTOC estimated that about 50-95% of the methyl bromide used for this purpose was replaceable after consideration of the regulatory and other conditions that limit its use.

TEAP notes that the United States has requested methyl bromide for the same end uses under the Critical Use Exemption and the QPS Exemption. According to the Critical Use Nomination submitted by the United States, the requirement for plant health is similar and specifies that the plants are essentially free from pests and diseases. TEAP notes that use of methyl bromide can be replaced in both exemption categories by technically and economically feasible alternatives that have already been implemented by many Parties.

For logs, methyl bromide is the most widely used fumigant for logs and the largest single commodity treated using methyl bromide. The quantities of methyl bromide used vary according to the requirements of the importing country. In-transit fumigation with phosphine when logs are being shipped from one country to another is a technically feasible alternative and less expensive than methyl bromide for certain pests and between certain countries. In-transit fumigation with phosphine
has partially replaced methyl bromide in some countries, but it currently has a small market penetration globally. The more widespread application of this alternative is limited by the acceptance of bilateral agreements between countries usually due to a lack of efficacy data on specific quarantine pests of concern. Other fumigants and mixtures of them are technically and economically feasible alternatives in some cases and have been registered, but none have been implemented as quarantine treatments for use on logs. Heat applied to logs is a technically and economically feasible alternative in some circumstances where sawn timber is acceptable to the end user, but this treatment may render the logs unsuitable for the end user, which limits its use for the control of quarantine pests. Debarking of logs is expensive and sometimes must be combined with another treatment for acceptance as a quarantine treatment, which limits its application as a quarantine treatment to mainly high value logs in countries where debarked logs are acceptable to the customer.

In accordance with Decision XXI/10 that required further elaboration of the information provided in a previous report, MBTOC-QPS estimated that in Article 5 Parties that more than 60% of the methyl bromide used in sawn timber and wood packaging material could be replaced by heat or alternative fumigants; less than 10% of the methyl bromide used as a quarantine treatment in grains and similar foodstuffs could be replaced by alternative fumigants and controlled atmospheres, and 30-70% for pre-shipment treatments in grains and similar foodstuffs could be replaced by fumigants, protectants, controlled atmospheres and integrated systems; and 10-20% of the methyl bromide used in logs could be replaced by alternative fumigants, conversion to sawn timber (lumber), immersion, debarking and heat. There was no categorisation of methyl bromide as QPS used on soil in Article 5 Parties.

MBTOC-QPS estimated that in non-Article 5 Parties that more than 60-80% of the methyl bromide used in sawn timber and wood packaging material could be replaced by heat or non-wooden pallets; less than 10% of the methyl bromide used as a quarantine treatment in grains and similar foodstuffs could be replaced by alternative fumigants and controlled atmospheres, and more than 80% for pre-shipment treatments in grains and similar foodstuffs could be replaced by fumigants, protectants, controlled atmospheres and integrated systems; about 50-95% of the methyl bromide used in soil could be replaced by alternative fumigants, provided the alternatives meet certification standards and a key alternative (methyl iodide/Pic) was available; and 10-20% of the methyl bromide used in logs could be replaced by alternative fumigants, conversion to sawn timber (lumber), immersion, debarking and heat.

The technical and economic feasibility of alternatives to methyl bromide used for QPS in all countries depended mainly on the efficacy against quarantine pests of concern, the infrastructural capacity of the country, end-use customer requirements, phytosanitary agreements where relevant, and logistical requirements and regulatory approval for the use of the alternative.

Decision XXI/10 also asked TEAP to describe methodology for the assessment of the impact of restricting the quantities of methyl bromide production and consumption for quarantine and pre-shipment uses. Methyl bromide is important to many countries for facilitating trade while at the same time protecting forestry, food production, human health and the indigenous environment from exotic pest incursions. The use of methyl bromide or an alternative treatment for quarantine pests before departure or on arrival in a country are much less expensive strategies than containment or eradication (where possible) which generally involve significant costs.

MBTOC-QPS suggested that the methodology should focus on the quantities of methyl bromide used to facilitate trade for the major QPS categories of methyl bromide use (by quantity) that were reported by Parties for QPS, and in particular methyl bromide that was used for QPS on entry to facilitate trade by one Party with many different countries. The consumption by category and use in Asian countries in future could be examined further since this was the only region where methyl bromide for QPS was increasing significantly, according to the 2008 consumption data, which was the most complete dataset.
In the case where an exporting country bans the use of methyl bromide for QPS, and the importing country had not changed its requirement to allow an alternative to methyl bromide to be used by the exporting country, the importing country may require fumigation with methyl bromide in another country en route, or on arrival. The ability of governments to detect such uses of methyl bromide depends on fumigators maintaining good fumigation records, and in governments collecting and analysing the records to determine uses for which alternatives are available and could be used.

Using MBTOC-QPS’s working definition of an available alternative for QPS, which required it to be registered and operating to an appropriate level of protection, TEAP in the future could examine the constraints and opportunities for methyl bromide replacement in key categories where methyl bromide is currently used. Countries that had phased out methyl bromide for QPS could be examined in order to understand more completely the necessary timeframe to phase out, the usefulness of policies and measures that encouraged alternatives, and the extent and funding of research on alternatives that collectively contributed to the successful substitution of the use of methyl bromide for QPS. Equally important, areas where substitution was not successful could also be examined. The uses of methyl bromide for pre-shipment could also be quantified as much as possible, since it appears from the latest information provided by Parties that most of the pre-shipment use in the past has been replaced by alternatives.

The methodology that could be used to assess an alternative as economically feasible could include the requirement that its net returns are determined relative to a methyl bromide treatment. An alternative should be implemented without significant market disruption and the sectors that benefit as a result of the adoption of the alternative should be identifiable.

The design of any QPS restriction could have an impact on the feasibility of the transition from methyl bromide to alternatives for QPS, and the methodology that TEAP could put in place to assess the impact of restricting the quantities of methyl bromide production and consumption for quarantine and pre-shipment uses. In regard to the design, and without any presumption of such a restriction being put in place, TEAP considers a number of factors as important which the Parties may wish consider, among them being: the timeframe for Party compliance, the flexibility of Party choice in how to maintain compliance, the usefulness of an appropriate exemption pathway that was administratively feasible and expedient to take account of trade flow decisions, and whether or not pre-shipment or pre-plant soil uses should be included in the methodology. Feedback from the Parties on their views of these factors would assist TEAP in the design of appropriate methodology to meet the requirements of the Parties.

TEAP would be pleased to receive any comments from the Parties that they may wish to make that would contribute to the further development of this methodology on data accumulation, analysis and reporting that could assist the Parties with the assessment of the impact of restricting the quantities of methyl bromide production and consumption for quarantine and pre-shipment uses.

8.2 Introduction

8.2.1 Mandate and scope

Decision XXI/10 requests the Technology and Economic Assessment Panel (TEAP) and its Methyl Bromide Technical Options Committee (MBTOC), in consultation with other relevant experts and the International Plant Protection Convention (IPPC) Secretariat, to provide a report to be considered by the 30th Meeting of the Open-Ended Working Group covering the following:

A review of available information on the technical and economical feasibility of alternatives, and the estimated availability, for the following categories of quarantine and pre-shipment uses:

a. Sawn timber and wood packaging material (ISPM-15);
b. Grains and similar foodstuffs;

c. Pre-plant soils use;

d. Logs;

The current availability and market penetration rate of quarantine and pre-shipment alternatives to the uses listed in paragraph (1) above, and their relation with regulatory requirements and other drivers for the implementation of alternatives;

An update of Table 9-1 of the 2009 Task Force report to include economic aspects, and to take account of the information compiled under this paragraph, distinguishing between Article 5 and non-Article 5 Parties and between quarantine and pre-shipment uses separately;

A description of a draft methodology, including assumptions, limitations, objective parameters, the variations within and between countries and how to take account of them, that the Technology and Economic Assessment Panel would use, if requested by the Parties, for the assessment of the technical and economical feasibility of alternatives, of the impact of their implementation and of the impacts of restricting the quantities of methyl bromide production and consumption for quarantine and pre-shipment uses.

The full text of Decision XXI/10 is shown in Annex 1.

8.2.2 Origin and intent of the QPS exemption

At the 1992 Meeting of the Parties in Copenhagen that established methyl bromide as a controlled Ozone Depleting Substance, Article 2H of the Protocol specifically excluded QPS from control measures when it stated, inter alia:

‘The calculated levels of consumption and production …shall not include the amounts used by the Party for quarantine and pre-shipment applications’. This was the first time that QPS was mentioned in the Protocol documentation. It is notable that in the report of this Meeting of the Parties at that time offered no definition of ‘quarantine’ or ‘pre-shipment’ (UNEP/OzL.Pro.4/15), and the terms were defined two years later (UNEP.OzL.Pro.6).

At the time that Article 2H was documented in Copenhagen in 1992, the Parties were aware that there were no alternatives to methyl bromide for a diverse range of treatments carried out with methyl bromide. The Parties recognised that although QPS consumption was about 10% of global methyl bromide consumption at that time, this relatively small volume was nevertheless sufficiently important to merit a specific exemption in the absence of alternatives. Later in 1997, many Parties expressed support for retaining the exemption for methyl bromide used for quarantine and pre-shipment applications, but some expressed concern that exemptions should not overly weaken controls on methyl bromide1. Therefore, unlike other ozone-depleting substances where a process was established for essential uses, quarantine and pre-shipment uses of methyl bromide were excluded from control.

Methyl bromide used for QPS performs a dual role of facilitating trade as well as protecting the environment against the accidental import of exotic pests that can incur substantial costs for control and if possible eradication. The importance of excluding such pests, and the costs of their control and eradication if exclusion is unsuccessful, are discussed in Section 8.5.5.2.

1 UNEP. 1997. Report of the Meeting of the Parties. UNEP/OzL.Pro.9/12; page 16
8.2.3 Quarantine and pre-shipment definitions and application

8.2.3.1 Definitions of quarantine and pre-shipment

The scope of the QPS exemption set out in paragraph 6 of Article 2H has been clarified in Decisions VII/5 and XI/12 of the Protocol relating to the terms 'Quarantine' and 'Pre-shipment'. The definitions of QPS that follow these Decisions, and that are used in this report, are contained in Annex 2.

TEAP (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 (TEAP, 1999) and (UNEP/IPPC, 2008) publication ‘Methyl Bromide: Quarantine and Pre-shipment Uses’.

TEAP and its QPS Task Force have provided (TEAP, 2009) an in-depth analysis of the definitions of QPS and Decisions of the Montreal Protocol dealing with methyl bromide uses for QPS purposes.

In response to Decision XX/6(7), TEAP listed methyl bromide uses that had been classified as QPS by some Parties but not by others. Parties with use listed by TEAP provided explanatory responses that were annexed to the TEAP 2009 report (TEAP, 2009). TEAP notes that the use of methyl bromide as a QPS treatment for soil fumigation against endemic pests and diseases for production of propagation material of high plant health status is not consistent with the definition of ‘quarantine’ agreed by the Parties. This is further discussed in the context of alternatives to methyl bromide for soil uses (Section 8.3.4.1) and the methodology that could be used by TEAP to assess the impact of restricting the quantities of methyl bromide production and consumption on QPS (in Section 8.5.2.2).

8.2.3.2 Alternatives for quarantine and pre-shipment

The Sixteenth Meeting of the Parties to the Montreal Protocol resulted in the definition of an “alternative” to methyl bromide as “any practice or treatment that can be used in place of methyl bromide”. In the assessment of the US critical use nomination submissions reviewed annually by MBTOC since 2003, a technically feasible alternative to methyl bromide has been defined for many years as “an alternative that provides sufficient pest and/or weed control for continued production of that crop to existing market standards” (TEAP, 2007).

These definitions focused on non-QPS treatments and did not consider other elements that would be required in the definition of an alternative to methyl bromide for QPS. Therefore, for the purposes of this report, a working definition of an alternative to methyl bromide for QPS is shown within the context of the discussions in Chapter 8.5, which describes draft methodology for assessing the technical and economic feasibility of an alternative to methyl bromide for QPS (see Section 8.5.2.3).

8.2.3.3 Market penetration

The Sixteenth Meeting of the Parties also resulted in the definition of “market penetration” as “the case-by-case determination of the extent to which an alternative is distributed in the market to users, according to information supplied by the supplier, distributor or manufacturer”. The extent of the market penetration of an alternative is dependent on the number of enterprises that need to transition,

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the estimated training time for the alternative assuming full effort, the opportunities for importing alternative equipment, and the cost”.

In view of the limited time available to provide information in response to the request from the Parties, the market penetration of an alternative to methyl bromide for QPS was based mainly on the experiences of the members of the MBTOC-QPS sub-committee.

8.2.4 **Summary of response to Decision XX/6**

TEAP responded to technical aspects of Decision XX/6 in its report of October 2009. This report responds to Decision XXI/10 and builds on this previous report submitted to the Parties by TEAP in 2009 in response to Decision XX/6. The report in 2009 by the QPS Task Force in response to Decision XX/6 considered the:

- Volumes of methyl bromide used for QPS, by major uses and target pests;
- Technical and economic availability of alternatives for the main methyl bromide uses, by volume, and of methyl bromide 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;
- Regulations that directly affect the use of methyl bromide for QPS treatment, using illustrative examples;
- Barriers preventing the adoption of alternatives to methyl bromide;
- Opportunities for reducing methyl bromide use or emissions for QPS, including technologies for recapture and destruction of methyl bromide from QPS applications.

The report in response to Decision XX/6 also provided:

- An analysis of the information available and an indication of areas where the information was insufficient (and the reasons for this insufficiency), together with a proposal on how best to obtain the information as a basis for a satisfactory analysis;
- A list of categories of use that had been classified as QPS by some Parties but not by others. The Parties mentioned in this classification submitted a rationale for their use of methyl bromide for QPS, and their responses were included in the Final Report.

The Final Report of the TEAP QPS Task Force can be found at:

8.2.5 **Organisation of work**

8.2.5.1 **Membership of MBTOC-QPS**

In response to Decision XXI/10 on QPS uses of methyl bromide, TEAP requested a newly formed QPS subcommittee within MBTOC to prepare a report on those parts of Decision XXI/10 requiring a response by TEAP.

The QPS sub-committee was comprised of nine members: Six from non-Article 5 Parties and three from Article 5 Parties. Members came from diverse regions: Africa, Australasia, Europe, North America, South America and Asia. In accordance with the Decision, TEAP and the MBTOC QPS sub-committee consulted with the IPPC Secretariat and other relevant experts in the collation and assessment of information in support of this report. Further details on the members of the MBTOC QPS sub-committee that contributed to this report, together with their disclosures of interest, are
8.2.5.2 Communications and meeting

MBTOC-QPS work was conducted initially by electronic communication. The website created by the Ozone Secretariat was used for storing documents and making them available to for the work of the MBTOC-QPS subcommittee in this report. MBTOC-QPS conducted extensive reviews of published literature, conference proceedings, QPS regulations from different countries, and undertook consultation with experts, and reviewed other relevant information to the best extent possible. MBTOC economists assisted with economic aspects of this report.

MBTOC-QPS met the IFAPA Research and Education Centre in Chipiona, Spain, from 12 through 16 April 2010 to finalise the report to be submitted to and presented at the 30th OEWG. This meeting was held concurrently with committee meetings of MBTOC-Soils and MBTOC-Structures.

As with other MBTOC reports from MBTOC-Soils and MBTOC-Structures, MBTOC-QPS had limited time at the meeting to share reports that would allow comment and comprehensive input and review. The reports from the three sub-committees in MBTOC were not finalised at the meeting in Chipiona. A plenary meeting was held on the last day of the MBTOC meeting in Chipiona to present summaries of each of the MBTOC sub-committee reports to the MBTOC for discussion and comment. In addition, all reports were circulated to members electronically for their comment and review after the Chipiona meeting and during the TEAP meeting in Madrid, April 2010.

8.2.5.3 Structure of the report

The responses by MBTOC-QPS to the tasks assigned by the Parties to TEAP and its MBTOC in Decision XXI/10 are contained in the following four chapters:

Chapter 2 – Provides a summary of the QPS exemption, background information on uses of methyl bromide for QPS purposes and a summary of the reports written in response to Decision XX/6;

Chapter 3 – Describes the main alternatives for major uses of methyl bromide for QPS purposes and addresses their registration status, technical and economic feasibility plus their estimated market penetration. The relation with regulatory requirements and other drivers for the implementation of alternatives is also discussed;

Chapter 4 – Describes a feasible scenario for replacing some QPS uses of methyl bromide globally, distinguishing between non-Article 5 and Article 5 Parties and between quarantine and pre-shipment uses;

Chapter 5 – Presents a draft methodology for the assessment of the feasibility of alternatives, and of the impact of their implementation and of restricting methyl bromide use for QPS purposes.

Two Annexes are included:

Annex 1: Decision XXI/10 Quarantine and pre-shipment uses of methyl bromide
Annex 2: Definitions of Quarantine and Pre-shipment
8.3 Feasibility, Availability And Market Penetration Of Alternatives To Methyl Bromide For Quarantine And Pre-Shipment

8.3.1 Introduction and mandate

Paragraph 3(1) of Decision XXI/10 requests:

A review of available information on the technical and economical feasibility of alternatives, and the estimated availability, for the following categories of quarantine and pre-shipment uses:

a. Sawn timber and wood packaging material (ISPM-15);
b. Grains and similar foodstuffs;
c. Pre-plant soils use;
d. Logs;

The current availability and market penetration rate of quarantine and pre-shipment alternatives to the uses listed in paragraph (1) above, and their relation with regulatory requirements and other drivers for the implementation of alternatives.

Previous MBTOC and TEAP reports have provided details of existing alternatives for various QPS uses (e.g. MBTOC 1995, 1998 2002 2007; TEAP 1999, 2006, 2009ab). The 2002 MBTOC Assessment (MBTOC 2002) provided detailed discussion of alternatives to QPS methyl bromide use on commodities in specific circumstances. A 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). More information can be found in the QPSTF interim and final reports (TEAP, 2009).

8.3.2 Alternatives for sawn timber and wood packaging material

This section excludes logs and covers only quarantine treatments of wood that has been sawn into lumber and wooden packaging material derived from sawn timber. This material is free of bark, but may include sapwood as well as heartwood. Sapwood is often present in lumber and can contain insects even in logs that have been debarked. For exports of lumber from New Zealand, some countries such as China and Korea do not require fumigation but inspect on arrival and fumigate if pests are detected; and other countries such as India require fumigation of lumber containing sapwood; and in Japan sapwood is categorised as logs and it is inspected and treated in import quarantine.

Sawn timber may be in trade or made into pallets, dunnage and other packing material associated with either international or domestic trade.

8.3.2.1 Technical feasibility

8.3.2.1.1 Heat treatment

The only alternative treatment to methyl bromide treatment approved and accepted internationally under ISPM-15 for treatment of wood packaging materials (wood packaging material) is heat treatment, including kiln drying. A temperature of at least 56°C, core temperature, must be maintained for at least 30 minutes (IPPC, 2006). The current (2009) version of the ISPM-15 standard (IPPC, 2009) specifically encourages the use of heat where feasible in preference to methyl bromide, because of the ozone-depleting properties of methyl bromide.
There is substantial use of the heat treatment in many countries to meet ISPM-15. Many countries use heat exclusively to meet ISPM-15. Canada does not include methyl bromide as an alternative to heat in ISPM-15 treatments carried out in Canada. In general, heat treatment requires a somewhat higher level of infrastructural support compared with methyl bromide fumigation, but has the advantage that a toxic gas is not used.

ISPM-15 requires that the wood packaging material be treated to the required standard before it is stamped with the logo as evidence of the pallet having complied with the ISPM-15 standard. Where packing material such as pallets have not yet been certified, they may be treated to ISPM-15 standard in a heated enclosure of some kind. However, some countries may stamp pallets prior to treatment, which does not comply with the requirements of ISPM-15. Pre-treatment stamping of pallets was understood to have occurred in situations where it may be expedient to treat the packing material and the goods on the pallets together, such as in a loaded shipping container. This may preclude the use of heat, where heat-sensitive and dense goods are present, leaving methyl bromide as the only available alternative.

Kiln drying of sawn timber (lumber) exceeds the temperature thresholds and duration criteria defined in ISPM-15, thereby providing an alternative quarantine treatment to methyl bromide where insect and nematodes are pests of quarantine concern. Higher temperatures are required for control of fungi, but some timber (especially hardwoods) can be damaged by the high temperature treatment.

Canada (CFIA, 2007) describes procedures for measuring and achieving ISPM-15 heat conditions with both green and dried wood. The Australian (AQIS) standard for heat treatment (AQIS, 2009) provides procedures for measuring heat dosages to meet ISPM-15 and for the treatment of other commodities too.

8.3.2.1.2 Chemical alternatives

A chemical treatment is preferred when goods on wood packaging material need to be disinfested to meet the requirements of ISPM-15, and the goods are likely to be damaged by heat. The only officially-recognised chemical option at present is methyl bromide. Alternative chemicals are being evaluated (Section 8.3.2) and non-timber pallets are being used (Section 8.3.2.1.3).

A new ISPM is being drafted for the international movement of wood that will include two categories of treatments. The first category plans to include those that are already in use in bilateral trade and that have proven efficacy against specific pests. The second category will be for classes of wood (round wood, sawn wood and mechanically processed wood) and will be based on the draft criteria for future ISPM-15 treatment submissions and that will use the same decision-tree approach.

8.3.2.1.3 Not in-kind alternatives for wood packaging material

Not-in-kind alternatives exist for wood pallets and other wooden packaging materials. These avoid the need for methyl bromide fumigation or heat treatment. Plastic pallets (often made from recycled plastic) are commercially available and are used by many companies in the EC, the US and many other regions of the world. Cardboard pallets can be suitable for loads of about 3,000 kg, for example, and are available commercially in Australia, the EC, Kenya, New Zealand, the US and others. A detailed description of the environmental and economic benefits of using pallets manufactured from different materials is not a topic for inclusion in this report.

Plastic, cardboard, plywood and particle board can also be used, instead of wood packing materials, for boxes, containers and staves which prevent goods moving within packed shipping containers. These materials are exempt from the requirements for methyl bromide or heat treatments under the ISPM-15, which refers only to solid wood packaging materials. ISPM-15 excludes non-wood
packaging (plastic, cardboard) and plywood, particle board, oriented strand board and similar processed wood that have been glued or pressed during processing (IPPC, 2009).

As a side benefit, a reduction in the volume of new timber used for wood pallets would benefit countries where forest resources are under pressure. Kenya, for example, is estimated to use about 250,000 to 300,000 wood pallets per annum for tea exports alone. This volume of pallets comprises about 5,500-6,600 tonnes of cut timber, which require the felling or importation of about 8,330 - 10,000 tonnes of raw timber per annum (Rodwell, 2007). This demand for timber causes problems in Kenya where the tree cover is rapidly dwindling due to other pressures such as the need for firewood (Rodwell 2007). However, in many Parties especially those that are Article 5 Parties, the added expense of using alternative materials to wood as well as in some cases lack of raw materials with which to make such pallets, places constraints on access to pallets that are not made of wood.

8.3.2.2 Economic feasibility

APHIS (APHIS, 2003) suggests that in the US the use of heat treatment for meeting ISPM-15 is more cost effective than methyl bromide fumigation. The cost of treatments in the United States using methyl bromide without gas recapture was estimated to range between US$1.82 (2003) and US$2.34 per pallet (including cost of chemical and construction of fixed fumigation structure). The cost to fumigate using a tarpaulin structure ranged from US$1.79 and US$2.70 per pallet. Gas recapture is required in some parts of California and Texas where fumigation facilities are sited near schools and other vulnerable facilities. In those places, the cost of a methyl bromide treatment with recapture was reported to be 2-3 times more expensive than in other locations were recapture was not required, when the cost of disposal of the contaminated carbon was also taken into consideration (Ken Vick, pers. comm., 2010). By comparison heat treatment was estimated to add $2.00 per pallet (Jabara et al., 2008). Estimates of the cost of plastic pallets vary widely from 3 to 6% more than wooden pallets (Mokhlesi and Lohrabesi, 2009) to double the cost.

The economic impact in the US of using heat treatment to meet ISPM-15 have been assessed, using the economic model from the Global Trade Analysis Project (GTAP) (Jabara et al., 2007) for the case of two heat treatments. The authors found that ISPM-15 would have only a minor impact on US imports, and generally less than 1% change in import value.

Methyl iodide is registered in some countries. It is also under consideration as a potential alternative to methyl bromide in ISPM-15. Methyl iodide is more costly than methyl bromide on a weight-for-weight basis, plus the preferred delivery for space fumigation is to mix with CO₂, which is likely to add further cost. It can be expected that materials cost for the MI/CO₂ system will be more expensive than methyl bromide. However, as the cost of chemical applied is usually less than 20-30% of the cost of fumigation, a significant increase in chemical cost does not translate directly to the same level of increase for the whole fumigation.

As sulfuryl fluoride has not been approved as a treatment under ISPM-15 there is no information on the economics of this specific use on wood packaging material.

8.3.2.3 Market penetration of heat treatments compared to methyl bromide

There is a trend of compliance with ISPM-15 to entirely using heat rather than methyl bromide.

A variety of facilities are in use to achieve the specified heat dosage for ISPM-15. They include timber kilns (present in many countries), hot water dipping e.g. Bangladesh (Kabir, 2005), modified freight containers or similar enclosures with either hot water heating (China) or electrical or gas heating (Australia, Jamaica). Heat has been used in many Article 5 countries for many years (e.g.
Morocco, Costa Rica, Colombia and Ecuador) and is made easier due to the fact that it can be integrated with kiln drying.

Heat treatment of wood packaging material to comply with ISPM-15 is well-established in Article 5 countries. In Colombia for example, 156 heat treatment companies around the country are presently certified to provide this treatment and can treat on the average four million pallets per year. The technique has become widely available in just five years since the inception of ISPM-15 in the country. Even though the Colombian Institute of Agriculture certified two fumigation chambers for complying with ISPM-15 with methyl bromide treatment in 2009, these have not been used so far (Arévalo and Cárdenas, 2010).

Of the 626 companies registered in Mexico for treating wood packaging material for compliance with ISPM-15, 578 (92.3%) provide heat treatment and only 48 (7.7%) treat with methyl bromide. These are located throughout the country but 50% (309) are located in states that border the US and in combination can treat 4.8 million packaging units per month, the national total being 9.9 million units (Garcia, 2007).

Of the 183 companies registered in New Zealand for ISPM-15 only 19 (10.4%) of them continue to treat with methyl bromide (Ken Glassey pers. comm. 2010). As of March 2010, almost 300 companies in Japan conduct ISPM-15 treatments. Ninety-one percent of them use heat and 9% use methyl bromide to meet ISPM-15 requirements (Takashi Misumi, pers. comm., 2010).

In Argentina, only one facility is registered and authorised for methyl bromide treatment, but it has not been used for the past five years since costs and difficulty of operation do not make it a feasible option. Heat treatment is the preferred method of complying with ISPM-15, and at least 200 companies throughout the country are now authorised for heat treatment. Since an important consideration is transferring packaging materials to and from the treatment site at least cost, the availability in different regions of heat treatment facilities is most important. Owners of such facilities quoted costs, health and environmental hazards and others as factors that discourage them from using methyl bromide instead of heat.

Because methyl bromide for QPS was restricted in the past in the EU, and to encourage the use of as many alternatives to methyl bromide as possible for the treatment of wood packaging material, the EU published a Manual of options and alternatives to achieve the objectives of ISPM-15 without using methyl bromide (Vermeulen and Kool, 2006). The Manual includes a description of the use of controlled atmospheres and sulfuryl fluoride as two possible alternatives to the use of methyl bromide.

8.3.2.4 Regulatory requirements and other drivers

If sulfuryl fluoride is approved by the IPPC for use in ISPM-15 in 2011, a revised draft standard would go to all countries for consultation in 2012 and could be promulgated in 2013 providing it is agreed by the Parties to the IPPC. This would allow those countries where sulfuryl fluoride is registered such as Europe, Australia and the USA to use sulfuryl fluoride for the disinfection of wood packaging material. A government could also approve sulfuryl fluoride for domestic quarantine prior to this if they so wish.

Many countries have not registered sulfuryl fluoride for any use. The high global warming potential may prevent further registrations of sulfuryl fluoride in some countries. Companies are under pressure to reduce their carbon footprint.
8.3.3 Alternatives for grains and similar foodstuffs

8.3.3.1 Technical feasibility

Methyl bromide fumigation continues to be used for pre-shipment treatment of cereal grains where logistical constraints at point of export, or importing country specifications, preclude the use of phosphine. Phosphine is the principal accepted fumigant alternative to methyl bromide. Methyl bromide is also applied when it is specified by regulation, and/or for treatments against certain specific regulated quarantine pests. Methyl bromide fumigation may be the treatment of choice or the only approved and available treatment for the situations where a quarantine treatment is required.

There are different alternative treatments of choice for grains to meet appropriate QPS standards, depending on whether the treatment is officially required by national authorities for common and cosmopolitan insects that attack or are associated with grain in storage and transport (i.e., pre-shipment), or they are for control and elimination of specific regulated quarantine pests.

Export cereal grains, such as rice and wheat, are prone to infestation by a number of cosmopolitan grain pests that cause damage when in storage and are unacceptable to modern market standards. Most of the methyl bromide fumigations are pre-shipment treatments that target non-quarantine pests. These pre-shipment treatments are officially required by official regulations of some exporting countries or by official requirements of some importing countries. Examples of pre-shipment treatments have been reported previously (TEAP, 1999, 2002; MBTOC, 2002). Export cereal grains, similar products and associated packaging from some locations may also be subject to quarantine treatments against specific insect pests, notably Khapra beetle (*Trogoderma granarium*), *Prostephanus* species or contaminants such as specific snails (e.g. *Cochlicella* spp.) or seed-borne diseases such as Karnal bunt (*Tilletia indica*).

Many countries have strict quarantine regulations on grain and other durables originating from countries where Khapra beetle occurs. Typically, only methyl bromide treatment is specified against this quarantine pest, using double normal dosages for stored product disinfestation often with extended exposure period. For instance, cereal products from Khapra beetle areas for import into Australia require 80 gm⁻³ of methyl bromide for 48 hours at 21°C with an end point concentration at 48 hours of 20 gm⁻³ (ICON, 2009).

8.3.3.1.1 Alternatives for pre-shipment treatments

There are well-known, standard processes for protection and disinfestation of stored grain in storage and transport. Grain and similar dry foodstuffs, either bagged or in bulk, can be delivered to an export point in a ‘pest-free’ condition without recourse to methyl bromide fumigation (e.g. see MBTOC, 2007). The choice of alternative is dependent on the commodity or structure to be treated, the situation in which the treatment is required, the accepted level of efficacy and the cost and the time available for treatment. Some alternatives (e.g. some fumigants, heat treatment) may be implemented as ‘stand alone’ treatments to replace methyl bromide in certain situations. Others may be used in combination to achieve an acceptable level of control.

These processes, theoretically, can avoid the need for any further treatment against infestation at the export port. In practice, consignments may be brought to the export point in infested condition. Also, particularly in humid, tropical situations, there is often a high invasion pressure from pests at the export point. As a result, an insecticidal process (usually fumigation) must be used to ensure the grain meets the exporter’s or importer’s official regulations for lack of infestation.

In some cases, the pre-shipment treatment is used to disinfest ship holds or other conveyances before placing grain or similar commodities in the ship hold, in order to prevent infestation from contaminated holds during shipment. Alternatives to methyl bromide for pre-shipment fumigation of
shipholds using phosphine were proposed on the basis of work undertaken in Canada (Field and Jones, 1999).

Pre-shipment treatments in general are aimed at a lower standard of pest control than quarantine. While quarantine treatments lead to a commodity free of regulated quarantine pests, pre-shipment only requires the consignment to be “practically free” of pests. This lower level of security gives some wider choice of alternatives, with reduced requirements for efficacy testing.

Alternatives to methyl bromide fumigation for pre-shipment of cereal grains, including rice, vary with situation, particularly the required speed of action. In some export situations, there is sufficient capacity at the port, to allow slower acting alternative treatments to be used easily, with treatment times of 7 days or more for full effectiveness. Phosphine fumigation is in widespread use for this purpose, for both bagged and bulk consignments. Controlled atmosphere technologies have some usage at present (e.g. Clamp and Moore, 2000), but have potential for much more widespread adoption. Direct application of pesticide to the grain will also give pest-free grain to inspection standards, sometimes with a holding period before inspection to allow for action of the pesticide on the pests. Rapid acting pesticides for direct application include dichlorvos and cypermethrin. The use as methyl bromide alternatives is limited by various registration issues and also by market and end user requirements, some of which require ‘residue-free’ grain.

In many export situations, a high throughput is required, where there is limited space at the port for treatments and as demurrage costs on waiting vessels is high. Typical turnaround times for methyl bromide for a shipment can be 24-48 hours, a time that has to be accommodated in the organisation of the export consignment under pre-shipment treatment.

Sulfuryl fluoride fumigation was restricted by the availability and registration of the fumigant to only a few countries at this time. However, it is now used routinely as an alternative to methyl bromide for pre-shipment treatment of grain e.g., in Australia.

Irradiation has been used as a pre-shipment disinfestation of grain (Zakladnoi et al., 1982) and heat treatments have been demonstrated at moderate rates of throughput (150 tonnes per hour (Thorpe et al., 1984)). Both systems require very substantial infrastructure if they are to match treatment speeds provided by fumigants, including methyl bromide.

Some importing countries may specify fumigation at point of export as a pre-shipment treatment, with indications as to what treatments are acceptable. In cases where methyl bromide is specified as one treatment, phosphine fumigation may be specified as an alternative. However, several countries specify use of methyl bromide as the only acceptable QPS treatment of imported grain from specified exporters.

Treatment of bulk or bagged grain in ships with phosphine after loading may potentially replace some current pre-shipment uses of methyl bromide. However, this may be interpreted as falling outside ‘pre-shipment’ and may not meet regulatory requirements of some exporters and importers who require grain to be practically pest-free before loading. Phosphine treatments may be conducted at the dockside, in lighters or barges prior to loading a ship, or in the ship after loading and before sailing. In suitable ships, in-transit phosphine treatment gives an effective post-export treatment.

The International Maritime Organisation recommendations on safe use of pesticides in ships and shipping containers describe the safe use of both phosphine and methyl bromide at port and in-transit (IMO, 2008ab). The Organisation specifically recommended that cargoes should not be fumigated in ships with methyl bromide prior to sailing due to the risks resulting from the difficulty in ventilating the cargo effectively (IMO, 1996). As an alternative to methyl bromide, for safety and efficacy reasons, in-transit treatment with phosphine is restricted to specially-designed bulk carriers, tanker-type vessels and other ships where the holds are gastight or can be made so (Semple and Kirenga, 1997). In addition, equipment must be installed to circulate the phosphine through the cargo mass
The circulation equipment ensures that the gas penetrates throughout the load and can be aired from the load prior to unloading.

In-transit treatment of bulk grain is in widespread use, potentially avoiding the need for methyl bromide treatment prior to shipment where import and export regulations permit. USDA APHIS estimates that of the 95 million tonnes of wheat and corn that the U.S. exported in 2009, 66.9 million tonnes were transported under in-transit fumigation with phosphine.

8.3.3.1.2 Alternatives for quarantine treatments

The USDA PPQ Treatment Manual (USDA, 2009) contains many treatment schedules specific to Khapra beetle and most involve fumigation with methyl bromide. Schedule T307a refers to various treatment schedules for commodities and transport vehicles found infested with Khapra beetle for post-entry quarantine treatment. Heat treatment at a high temperature and prolonged exposure (7 minutes at 65.5°C) is given as the only approved alternative to methyl bromide and can only to be used when specifically authorised by the APHIS.

Heat treatment is a good alternative to methyl bromide for controlling many stored product pests, including Khapra beetle. Despite its tolerance to temperatures of about 41°C, Khapra beetle is quite susceptible at higher temperatures, more so than some common storage pests such as Rhizophoxia dominica. There are old but good quality data to substantiate heat susceptibility of stored product pests in general. For instance, (Husain, 1923) studied heat disinestation of wheat from Khapra larvae. Pupae of *T. granarium* were found to be the most heat tolerant stage, requiring 16 hours at 50°C or 2 hours at 55°C for ‘100%’ kill, while other stages were eliminated in less than 2 hours (Mookherjee et al., 1968). *R. dominica* requires in excess of 24 hours for complete kill at 50°C, 5 hours at 51°C and 10 minutes at 55°C. Battu (Battu et al., 1975) found LT95 for diapausing and non-diapausing larvae to be 7.4h and 3h respectively at 50°C. Lindgren (Lindgren et al., 1955) noted a slight dependence of time to complete kill at an ambient relative humidity. Treatment at high humidities extended the time. At 55°C, 75% RH, 95% mortality was obtained after 8 and 15 minutes with 4th instar larvae and pupae respectively. Wright (Wright et al., 2007) investigated heat treatment of *Trogoderma variabile*, showing it to have similar response to heat as *T. granarium*. The economic feasibility of heat treatments for grain and similar foodstuffs are discussed further in Section 8.3.3.2.

In the past, *T. granarium* was quite susceptible to phosphine (e.g. (Hole et al., 1976), which made phosphine a potential alternative to methyl bromide against this pest. However, with the development of high levels of phosphine resistance by *T. granarium* in the Indian subcontinent, phosphine is not currently an option for controlling this pest.

Some winter wheat fields in Texas were infected with Karnal bunt disease, *Tilletia indica*, in 2001. Karnal bunt was detected in Arizona in March 1996 and in Texas in 1997. The 2001 detection in Texas was significant because it occurred outside the quarantine area in Texas (J. Schaub pers. comm., 2010). When infected grain was harvested and transferred to storage bins, the bins and grain handling equipment became infected. Methyl bromide fumigation of emptied contaminated storage bins requires a high dosage (240 gm⁻³) for 96 hours to meet quarantine standards. Steam heating to a point of runoff in bins also is an effective alternative to methyl bromide providing surface temperatures reach 77°C (Dowdy, 2002).

Japan imports about 30 million tonnes of grain including wheat, maize and soybean. Methyl bromide is the fumigant of preference for treatment of these imports. There is no approved treatment schedule other than methyl bromide where granary weevil (*Sitophilus granarius*) is detected in the grain. This flightless pest, widespread in most countries, is a listed object of quarantine in Japan. The quantity of methyl bromide used for grains in Japan is larger than for any other category except whole logs (PPS 2007). Phosphine fumigation using aluminum phosphide tablets has been included in the plant quarantine treatment schedule in Japan (MAFF, 1971). The treatment with phosphine takes many
days and is thus unsuitable where there is insufficient capacity at import ports to allow long holding periods. Methyl bromide treatments typically take less than 48h.

8.3.3.2 Economic feasibility

Methyl bromide fumigation was used widely in the past to fulfill requirements for pre-shipment treatment of grain. In general, other processes are cheaper and more convenient and methyl bromide use for this purpose has decreased to the stage where it is typically used only in situations where the rapid action of methyl bromide confers technical and economic benefits.

Use in 1992 for QPS treatment of grains and similar foodstuffs was estimated to be about 7,000 metric tonnes (TEAP, 1997). In 2005, this annual consumption for this purpose was estimated to be about 1,700 tonnes (TEAP, 2009). This significant reduction, brought about largely by the replacement of methyl bromide by phosphine, is indicative of cost competitive nature of phosphine compared with methyl bromide.

Although heat is technically feasible, its use is limited by the high cost of heat treatment facilities that are able to heat grain moving at fast handling speeds, such as when loading or discharging, compared to the costs of facilities to implement other alternatives. Small-scale heat disinfection facilities for bulk grain, operating at a relatively slow speed of tens of tonnes per hour throughput, are commercially available.

8.3.3.3 Market penetration

See Section 8.3.3.2.

8.3.3.4 Regulatory requirements and other drivers

Transition to phosphine for the pre-shipment of grains has been driven largely by economic consideration. Increasing health regulations associated with avoiding worker exposure to methyl bromide are likely to further encourage use of alternatives.

Methyl bromide treatment of grains for quarantine purposes continues to be often the only accepted and convenient treatment in many cases. There appears to be no drivers away from this situation, in the absence of measures to curtail methyl bromide use for QPS purposes.

8.3.4 Alternatives for pre-plant soils use for propagative material and nursery uses

8.3.4.1 Technical feasibility

A very large amount of research has been conducted by some Parties to develop and adopt alternatives to methyl bromide for pre-plant soil fumigation, including research for the production of propagation material (MBTOC, 1994, 1998, 2002, 2007; TEAP, 2008, 2009ab). Commercial adoption of alternatives has been achieved using outreach, market approaches, and MLF projects. The development and widespread adoption of floating tray and similar systems for production of tobacco seedlings had been an outstanding success, removing a dominant methyl bromide use in many countries.

A statistical analysis undertaken by MBTOC for expert assistance with CUNs was conducted to evaluate alternatives to methyl bromide for pre-plant fumigation (Porter et al., 2006). It mainly concentrated on production of strawberry fruit and tomatoes. However, it identified alternatives which are technically and economically feasible to replace methyl bromide and the relative effectiveness for many pathogens which affect the nursery sectors. Analyses from strawberry fruit
trials showed that a large number of alternatives used alone or in various combinations had mean estimated yields which were within 5% of the estimated yield of the standard methyl bromide with chloropicrin (Pic) treatment (methyl bromide/Pic 67:33). Of these, a number of alternatives led to results that were statistically indistinguishable from those with methyl bromide/Pic treatments. These included chloropicrin alone, 1,3-dichloropropene (1,3-D) + Pic, 1,3-D/Pic + metham sodium. methyl iodide + Pic, which was registered in the majority of US States in 2008 (excluding California), is currently undergoing review for registration in several countries.

Efficacy standards for alternatives to methyl bromide used as a certified nursery treatment require a higher standard of pest control than for alternatives used for annual crop production in a fruiting field. The objective of the treatment for certified nursery treatment is not to optimize yield of fruit for a single year, but rather to produce a high quality root system that is free of damaging pests and pathogens and will perform well when transplanted to the production (fruiting) fields. As shown below, a number of these alternatives have been adopted as effective alternatives for nursery uses in many Non-Article 5 countries that once used methyl bromide for nursery uses (MBTOC 2007; TEAP 2008, 2009ab; EC, 2008). Alternatively, substrates using soilless mixes are proving very effective in replacing methyl bromide for many nursery uses.

As mentioned previously, the use of methyl bromide for pre-plant soil treatment under the QPS exemption amounts to an estimated 2,850 tonnes (see Table 8-5). In 2003, 1,491 tonnes were sought for Critical Use Exemptions by 7 Parties, ie. Australia, Canada, 4 member states of the EC, Israel, Japan, New Zealand and the US of which approximately 1,050 tonnes have been replaced with alternatives. These include predominantly 1,3-D/Pic mixtures, chloropicrin used alone or increased use of soilless substrates for many nursery uses (strawberry runners, fruit and ornamental plant nurseries, forest nurseries, bulb nurseries and others) and methyl iodide/Pic. The above chemical alternatives, together with dazomet, have effectively phased out methyl bromide use for turf in Australia (M. Mitchell R and R Fumigation, pers. comm., 2009). Methyl iodide/Pic mixtures, whilst not yet registered in many regions of the world, is being accepted as a direct replacement for methyl bromide in most pre-plant nursery uses, although concern for the potential for phytotoxicity has also been noted (CDFA, 2009). Steam and solarisation are also approved alternatives in California in containerised production systems.

The production of propagation materials is subject to strict health standards and often certification requirements, which frequently require the use of methyl bromide or a suitable alternative. In many cases, inspection or prevalence thresholds do not exist for endemic pests and often there are limited studies on the levels of pests carried on the propagation material due to the difficulties in potential litigation if reported. Many soil-borne pathogens (especially fungi) can be isolated from and spread on propagation material (DeCal et al., 2004 and 2005), but their levels are often insignificant to those found in the soils where the source material is planted. In the past, MBTOC undertook a survey under which showed that methyl bromide does not control all pathogens in soil. Other studies have also shown that plants grown in soils treated with methyl bromide contain pathogens, which are known to occur in the regions to which they are exported (De Cal et al., 2004 and 2005). To overcome this deficiency, there is potential for many alternatives to be used for propagation material without increased risk of disease in the final production field.

In the case of strawberry runners for example, methyl bromide is used to meet the certification standards for strawberry runner stock. Since a single strawberry runner grown in year one can expand to several million runners over three generations in soil, the reduction of pests in an early generation of the multiplication process is of particular importance in preventing the accumulation of large pest and disease populations later. The same is true for stock plants used for producing cuttings of many ornamental plants.

The certification typically specifies a low tolerance of particular pests and diseases, but rarely would report a level of detection for pathogens, except nematodes. In most of the multiplication stages, certification is only achieved by visual inspection of above ground plants and not by direct
measurement of diseases i.e., lesions on roots. In the US the nursery stock certification standard states that “All nursery stock shall be kept 'commercially’ clean with respect to established pests of general distribution. Commercially clean shall mean that pests are under effective control, are present only to a light degree, and that only a few of the plants in any lot or block of nursery stock or on the premises show any infestation or infection, and of these none show more than a few individuals of any insect, animal or weed pests, or more than a few individual infestations of any plant disease”. Additionally, the nematode free certification standard states that “Any sample in which nematode is detected shall be considered infested and not eligible for certification under the provisions of this article” (3 CCR § 3055.5).

8.3.4.1.1 Alternatives to methyl bromide for strawberry runners

There are several accepted alternatives to methyl bromide for the production of propagative material. Methyl iodide and 1,3-D, either alone or in combination with chloropicrin, are proving extremely effective in several countries and for several US nursery sectors (see e.g. (Kabir et al., 2005). A recent version of Californian Nursery Inspection Procedures Manual: Item #7 “Approved treatment and handling procedures to ensure against nematode pest infestation”, lists 1,3-D and methyl iodide as alternative treatments to achieve certification requirements related to nematode control, although the potential for phytotoxicity with methyl iodide in sandy soils is noted (CDFA, 2009), and methyl iodide is not currently registered in California. Steam and substrates are also considered suitable options for treating soil that will be used in containerized nursery production systems and for achieving the high health status involved.

Strawberry production from transplants fumigated with methyl bromide alternatives was evaluated in Spain (López-Medina et al., 2007); results indicated that treatment with 1,3-D alone or 1,3-D/Pic are efficient alternatives to methyl bromide for high elevation strawberry nurseries. As a result, 1,3-D/Pic and Pic alone have totally replaced the use of methyl bromide in the Spanish strawberry runner industry (García-Méndez et al., 2008; López-Medina et al., 2007; De Cal et al., 2004), and are used as the key alternatives to replace methyl bromide in many other countries which have phased out methyl bromide e.g., Italy, Belgium, UK. (Runia et al., 2008) published a review of the various combinations of chemical and cultural practices used in northern Europe for the control of nematodes and the major diseases attacking strawberry runners.

These alternative fumigants are registered and available in regions producing strawberry runners in the US, but are not approved as a certified nursery treatment with the exception of 1,3-D under specific soil texture, temperature, and moisture conditions. Local regulations may also limit the use of some of the alternatives for health reasons. Pre-plant soil treatments with MI/Pic, Pic followed by dazomet and 1,3-D/Pic followed by dazomet were shown to be potential alternatives to methyl bromide for strawberry runner production in California (Kabir et al., 2005). MI/Pic is now being adopted by the strawberry runner industry in the south-east United States (USA 2009 CUN for strawberry runners). Nursery yields and subsequent fruit yields in California were found to be similar to those obtained with methyl bromide when treated with MI/Pic, or 1,3-D followed by dazomet and chloropicrin followed by dazomet, although economic considerations may influence adoption (Fennimore et al., 2008). In Australia, 1,3-D/Pic is being used in the northern warmer regions. Although it gave excellent control of pathogens, it has not been adopted in the cool, high elevation nurseries due to phytotoxicity (Porter et al., 2009). Methyl iodide has been very effective and is likely to be adopted in Australia when it is registered.

8.3.4.1.2 Non-chemical alternatives - substrates

An alternate approach to chemical soil treatments is the production of nursery stock in bags or containers of different types, using soilless substrates (MBTOC 2007). Substrates are becoming increasingly adopted in many countries as they avoid the need for methyl bromide (Walters et al., 2008).
Strawberry plug plants were found to be a viable alternative to soil fumigation, as long as specific requirements associated to this technology are met (Durner et al., 2002; Sances, 2005). Maintaining good hygiene levels for plug plants is essential to their further expansion. Contamination can produce outbreaks of diseases, especially some airborne diseases, which can proliferate under the controlled conditions of plug production.

Economically feasible production systems that produce high quality propagation material have been identified. In Japan for example, a simple, economically feasible system using trays filled with substrate proved particularly useful for the production of strawberry runners. Various materials were used as substrates (e.g. rockwool, peat moss, rice hulls, coconuts husk and bark) and they can be reused after sterilising with solar heat treatment or hot water (Nishi and Tateya, 2006). Increased profits and earlier fruit yield have been shown when using plug plants in north Florida fruit production fields where early harvests are critical for competing with fruit grown in south Florida (Hochmuth et al., 2006) and Brazil (Giménez et al., 2009). Plugs have not been shown to be cost effective in fruiting fields in the main production area in south Florida.

Soil-less propagation systems are also well developed for ornamental plants, for example roses, where a technique known as rose “stenting” involves multiplication of grafted cuttings on different substrates. Cutting and grafting are performed as a single action, which greatly speeds up the propagation process. In only three weeks the resulting “miniplant” measuring 15-18 cm and with fully functional roots can be transplanted to the production field for roses grown for cut-flowers. The system has proven cost effective in California (Joshel and Melincoe, 2004). Originally developed in the Netherlands, this technique is now in wide use in many countries around the world where production of rose propagation material is important, for example France, Ecuador, Colombia and Uganda. A robot has been recently developed in the Netherlands (http://www.rooting-hormones.com/Video_Robot.htm) to reduce the need for hand labour and to speed up the process of plant propagation. For rose nurseries producing propagative material for garden roses, the mini-plants would still have to be transplanted to field nurseries, which much be treated to meet certification standards, so the need for methyl bromide or an approved alternative would remain.

Cuttings and slips of a wide variety of propagation materials including ornamental plants, fruit trees, forest trees and others, which are subjected to certification requirements are also produced in substrates in many countries around the world that export such materials internationally.

8.3.4.1.3 Non-chemical alternatives - steam

Steam is in wide use for treating used substrates recycled for use for the production of propagation materials in Europe (EC Management Strategy, 2008) as well as in other countries around the world, including Article 5 Parties producing propagation materials which are subjected to certification requirements, for example The Netherlands, Costa Rica and Colombia. (Runia et al., 2008) published a review of the various combinations of chemical and cultural practices used in northern Europe for the control of nematodes and the major diseases attacking strawberry runners.

8.3.4.2 Economic feasibility

Trials conducted in California using different steam application with or without solarisation (Gilbert et al., 2009) have shown that pest control is equal or better than that achieved with methyl bromide/Pic, particularly in the case of weeds. The cost of disinfesting soils with different methods presently available have been evaluated by (Fennimore and Goodhue, 2009) with encouraging results. Such methods could be adapted to nursery production for relatively low acreage production crops and are in fact recognized in certification standards.
Research with strawberry plug plant production in Florida showed an increased net income when using this method, through higher and earlier fruit yield and reduced water and energy consumption (Hochmuth et al., 2006). Early fruit yield was also confirmed by (Giménez et al., 2009) in Brazil.

8.3.4.3 Market penetration

Presently, there is widespread adoption of alternatives for pre-plant soil use in many countries, and their market penetration has been 100% in sectors and areas which have phased out methyl bromide previously sought under the ‘Critical Use Exemption’ process in the Montreal Protocol. For instance in Spain, Italy, UK, Belgium and Poland 1,3-D/Pic or Pic alone have been widely adopted in the strawberry runner and other plant nursery industries, previously reliant on methyl bromide. Registration prevents some alternatives, such as methyl iodide and some mixtures (eg 1,3-D/Pic) from being available for all uses of methyl bromide presently classified under QPS exemptions (MBTOC, 2007; TEAP, 2008; 2009; EC, 2008). The key issue to assist their use is to give consideration of alternatives for inclusion under regulations or certification rules, which may affect their use for production of propagative material. It is noted that efficacy requirements for certification programmes for propagative materials are more rigorous than efficacy requirements for plants in fruiting fields.

Commercial adoption of methyl iodide for example, is taking place at a very fast rate in US states such as Florida where it has recently become registered for a wide range of crops including ornamentals, forest nurseries and turf (US CUN Ornamentals 2009).

Steam is in widespread use for treating used substrates that have been recycled for use in the production of propagation materials in Europe (EC Management Strategy, 2008) as well as in other countries around the world, including Article 5 Parties that produce propagation materials which are subjected to certification requirements, such as Costa Rica and Colombia.

8.3.4.4 Regulatory requirements and other drivers

8.3.4.4.1 Strawberry runners, turf and other propagative material

The United States used methyl bromide for treatment of soil used to produce strawberry runners under the QPS exemption. Although Chile classified this same use as QPS at one point, in 2009 it notified the Ozone Secretariat that they did not consider this use to qualify for the QPS exemption and it is thus included within the controlled uses of methyl bromide.

The United States is now the only Party to the Montreal Protocol that classifies pre-plant fumigation of soil where propagation materials subjected to strict health requirements are produced as a QPS treatment (Federal Register USEPA, 2003).

The Final Rule (Federal Register - 68 FR 2138) that exempts methyl bromide for QPS in the United States states that the exemption applies “for use with plants for planting that are to be transported (complete with rootstock) from one distinct locality to another, and that requires that methyl bromide is used to meet official quarantine requirements specifying that the underground portions of the propagative material are to be free from quarantine pests”. Further, the document states that the exemption is only “to meet official quarantine requirements of the destination to which such material will be transported”. The document further specifies a process to rectify compliance if sent to a place without official quarantine requirements. The interpretation of the rule appears broader than just for quarantine pests (see Section 8.3.4.1).

Pre-plant fumigation of soils with methyl bromide to produce plants for propagation or turf is distinct from treatments of soil to eliminate recognised quarantine pests either in soil transported as a substrate or treated in situ. The key difference is that pre-plant soil use is often applied many months prior to
harvest of the plants and treatment is used to minimise spread of common endemic pests (for example, many soil-borne fungal pathogens and nematodes). In contrast, treatment of soil or substrate that is either imported or exported as a commodity (to grow plants in) is sometimes fumigated with methyl bromide as a quarantine measure to ensure freedom from a pest not found in the region to which it is exported. Also, equipment moving between countries or between quarantine jurisdictions and which may be contaminated with soil that is difficult to remove, is often fumigated with methyl bromide as a precaution against introducing a quarantined pest into a new area.

There has been an assumption that methyl bromide provides disease free material when used as a pre-plant treatment, when in reality low levels of pathogens are often found. If certification is used as a requirement, these generally specify a pathogen threshold and these can help with assessment of the suitability of an alternative.

Pre-plant soil use of methyl bromide for nursery material which is under certification is mostly used for regulation of non-quarantine pests, and this should not be confused with use of methyl bromide for treatment of incursions or outbreaks of quarantine pests which fall under the QPS exemption (ie the potato cyst nematode in the USA). The former is performed to comply with a high health requirement usually involving pests (nematodes, fungi and weeds) which are widespread or have been reported and are known to occur within the region.

The responses provided by Parties to the 2009 QPS Taskforce report identified that Parties are interpreting the definitions for pre-plant soil use under QPS differently (Table 8-1). As shown in Table 8-5 there are further sectors where this definition applies in the United States.

Table 8-1: Parties that may and may not categorise pre-plant fumigation of soil during production of propagation material of high plant health status to be QPS

<table>
<thead>
<tr>
<th>Pre-plant fumigation with methyl bromide</th>
<th>Parties that have classified this use as QPS</th>
<th>Parties that have NOT classified this use as QPS and classify it as a controlled use¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulb propagation</td>
<td>USA</td>
<td>Australia, EC</td>
</tr>
<tr>
<td>Deciduous nurseries</td>
<td>USA</td>
<td>EC (Belgium, France, UK), Israel, New Zealand</td>
</tr>
<tr>
<td>Rose nurseries</td>
<td>USA</td>
<td>Australia</td>
</tr>
<tr>
<td>Forest nurseries</td>
<td>USA</td>
<td>EC (France)</td>
</tr>
<tr>
<td>Strawberry nurseries</td>
<td>USA</td>
<td>Argentina, Australia, Canada, EC (Belgium, Spain, France, Italy), Israel, Lebanon, New Zealand</td>
</tr>
<tr>
<td>Raspberry nurseries</td>
<td>USA</td>
<td>EC (UK, France)</td>
</tr>
<tr>
<td>Turfgrass (sod)</td>
<td>USA</td>
<td>Australia</td>
</tr>
</tbody>
</table>

¹Parties that have used methyl bromide for this use but have phased out its use or are phasing out its use under the ‘Critical Use’ Process or MLF projects

MBTOC considers that nearly all pre-plant soil use of methyl bromide for nursery stock and turf use is for treatment of endemic pests, except methyl bromide used for containment of pest incursions e.g., about 400 tonnes of methyl bromide annually for potato cyst nematode in two States. The pre-plant uses of methyl bromide for QPS are not consistent with the definition of quarantine as defined by the Parties because the treatments target endemic pests and not quarantine pests. Many Parties have applied for ‘Critical Use’ exemptions for these uses under the Montreal Protocol. As mentioned, the United States has provided information for its use under QPS in the QPS Task Force reports in 2009 (TEAP, 2009ab).
8.3.4.4.2 Forest plants

Regulations in the US appear to be a driver for the increased use of methyl bromide under the QPS rather than the Critical Uses Exemption (CUE). Recently the States of Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas and Virginia have updated their phytosanitary regulations to enable their forest nurseries to qualify for methyl bromide under the QPS exemption. These States use QPS-MB in accordance with an:

- EPA 2003 ruling that tree seedlings that are shipped across state boundaries (interstate) qualify for QPS-MB use;
- EPA 2004 ruling that tree seedlings that are shipped within the state would not qualify for QPS-MB use unless the state’s requirements included language that specifically prohibited movement between local jurisdictions “… unless the commodities are free of pests”; and
- Amendment to Section 19 of the Plant Protection Act that requires the Secretary of Agriculture to determine whether a methyl bromide treatment should be authorized as an official control to prevent the introduction or spread of plant pests or weeds either across state boundaries or across localities within a State.

The allocation of QPS-MB for forest nursery users will lead to a reduction by the US for the same users that have also qualified for CUE-MB, thereby avoiding over-allocation of methyl bromide to users that are present in both programmes.

8.3.5 Alternatives for logs

8.3.5.1 Technical feasibility

Methyl bromide is the most widely used fumigant for logs and the largest single commodity treated using methyl bromide. It does have some limitations i.e., limited penetration, particularly across the grain and into wet timber. Most arthropods associated with timber are quite susceptible to methyl bromide but much higher dosages are required to kill fungi e.g. see (Rhatigan et al., 1998). Green logs are problematic to treat due to the high moisture content (80%), presence of bark (very adsorbent), size and large volumes. Overall, methyl bromide is currently the best log fumigant that is registered and available.

Treatments of logs may need to be rapid, such as at point of export or import, to avoid charges and congestion at ports associated with occupying restricted port area for the treatment. Where quarantine treatments can be applied outside port areas, such as prior to export or in-transit, alternatives to methyl bromide that take a longer time can be used. Many pests of quarantine significance, which attack green wood, do not re-infest dry and debarked wood.

Kiln-drying of lumber kills insect pests some of which also may be of quarantine concern (see the section on Heat treatment). Specific QPS alternatives for logs are discussed below, followed by discussion of some processes under development.

8.3.5.1.1 Reduction in methyl bromide dosage

Treatment specifications for logs have not been harmonised worldwide and schedules vary with country of import and target pest. This is because the quarantine security requirements are set by the importing country in accordance with their unique quarantine requirements—a right guaranteed by the World Trade Organization. Korea requires 25 gm⁻³ for 24h at 12-15°C (Yu et al., 1984), China 120 gm⁻³ for 16h at 5-15°C, and Malaysia requires 128 gm⁻³ for 24 hour exposure at the higher temperature of 21°C.
Significant savings of methyl bromide could be achieved by reducing the fumigation rate in situations where the use can be shown to be excessive. Using New Zealand as an example, the consumption of methyl bromide by New Zealand could be reduced by 53 tonnes per annum by reducing the methyl bromide fumigation rate from 120 to 80 gm$^{-3}$ (Ken Glassey, pers. comm., 2010). Examination of the data generated in New Zealand show that the lower dosage of methyl bromide is effective for controlling the target pests. However, permission to use the lower dose in commercial practice is determined by the importing country in according to the level of quarantine security demanded by that country to satisfy its unique quarantine requirements.

A new ISPM is being drafted for the international movement of wood, although its acceptance by the Parties to the IPPC will not necessarily result in a reduction in methyl bromide used for wood packaging treatments. This will include two categories of treatments, firstly those already in use in bilateral trade and with efficacy against specific pests. The second category will be for classes of wood (round wood, sawn wood and mechanically processed wood) and will be based on the draft criteria for future ISPM-15 treatment submissions and use the same decision-tree approach. A call by the IPPC for potential treatments of wood moving in international trade was issued in 2009.

8.3.5.1.2 Alternatives for logs - fumigants

Phosphine

New Zealand has pioneered the use of phosphine for the in-transit fumigation of Pinus radiata logs destined for China. It is now routinely used as a quarantine and pre-shipment measure and has partially replaced methyl bromide for this purpose. However, phosphine in-transit can only be used to treat logs shipped below deck in the holds, which is about two-thirds of each shipment.

One of the major disadvantages of phosphine when compared to methyl bromide is the long exposure time (up to 10 days) required, but this is overcome by applying the phosphine in transit. Considerable efficacy data has been developed in support of this methyl bromide alternative (Hosking and Goss, 2005; Zhang, 2003; Zhang and van Epenhuijsen, 2005). However, efficacy data for the wood wasp Sirex noctilio, a quarantine pest of concern for India, has yet to be obtained to the level required for approval for trade with India.

The current dosage specification requires at least 200 ppm phosphine (v/v, 0.28 gm$^{-3}$) to be maintained for 10 days. 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. In-transit tests have shown an even gas distribution throughout the loaded ship holds. High concentrations of CO$_2$ also occur within the ship holds during the fumigation period that may increase the insecticidal action of the fumigant. The current dosage specification is based on the Australian experience with stored grain pests (insects) and is likely to be significantly higher than required where no insect resistance is involved (Frontline Biosecurity, 2005).

Phosphine is typically produced in the reaction of aluminium or magnesium phosphide with water. There are some formulations of phosphine available in cylinders as technical grade, pure compressed gas or diluted with CO$_2$. The gas is highly toxic to insects and has remarkable penetration ability (Spiers, 2003). Because the egg and pupal stages of insects respire slowly, they are generally more tolerant than the larval and adult stages which respire relatively quickly. Phosphine is generally ineffective against fungi infesting timber.

Phosphine has long been used for the treatment of grain insects but repeated treatment of grain silos and poorly conducted fumigations has led to high levels of phosphine resistance in stored grain pests in some countries (Zettler, 1997, Collinson, 1999). Such resistance is not an issue for one way commodities such as forest produce and extrapolation of data on dosage requirements from grain insects may not be relevant for forest produce.
Sulfuryl fluoride

Sulfuryl fluoride is a similar fumigant to methyl bromide except that the fumigation temperature usually needs to be higher to achieve the same level of pest mortality for all stages including the egg stage. Sulfuryl fluoride penetrates wood significantly better than methyl bromide (Scheffrahn and Thoms, 1993). Sulfuryl fluoride is reported to have a large global warming potential (Papadimitriou et al., 2008).

Methyl isothiocyanate/ Sulfuryl fluoride mixture

The mixed gas of MITC and SF was registered in Japan in 2004 for logs infested with forest insect pests. MITC does have high sorption characteristics and an odour (UNEP 2001). MITC used in mixture with CO2 is effective against wood borers, bark beetles, and ambrosia beetles at 40-60 gm\(^{-3}\) for 24hrs at 15°C (Naito et al., 1998); and it was found to be particularly effective against pinewood nematode (Soma et al., 2001).

Pine wood nematode were killed in a large scale test using 97,400, 59,500 and 22,700 individuals with SF 27 gm\(^{-3}\) + MITC 27 gm\(^{-3}\) at 10°C, SF 21 g m\(^{-3}\) + MITC 21 gm\(^{-3}\) at 15°C and SF 15 gm\(^{-3}\) + MITC 15 gm\(^{-3}\) at 25°C, respectively (Soma et al. 2006). The sulfuryl fluoride/methyl isothiocyanate mixture is under evaluation for inclusion in the quarantine schedule in Japan.

Methyl iodide

In Japan, the developments of alternative chemicals to methyl bromide for imported logs has been carried out by the Ministry of Agriculture, Forestry and Fisheries, manufacturers and other bodies concerned with methyl bromide use. Methyl bromide use for logs is the largest use of this fumigant for plant quarantine in Japan. Methyl iodide is not used for the disinfestation of quarantine pests in logs as it is currently registered for logs or other post-harvest uses in only a few countries in the world.

Complete mortality of the pinewood nematode and the longhorn beetles, Monochamus alternatus and Arhopalus rusticus, were achieved at 84 gm\(^{-3}\) at 10°C, 60 gm\(^{-3}\) at 15°C, 64 gm\(^{-3}\) at 20°C, 48 gm\(^{-3}\) at 25°C respectively using methyl iodide 50% and carbon dioxide 50% (Kawakami et al. 2004). This mixture is now registered in Japan for timber treatment and is in the process of being included in the quarantine schedule. The limited amount of research that has been undertaken suggests it is no better than methyl bromide in controlling pathogens in wood and may be inferior (Schmidt and Amburgey, 1997).

Cyanogen

Cyanogen, sometimes referred to as ethanedinitrile, shows promise but is yet to be registered or used commercially. Its registration is pending in Australia. More data are needed, however, in order to realise the considerable potential for cyanogen as a methyl bromide alternative for logs (Wright et al. 2002).

8.3.5.1.3 Alternatives for logs – non fumigants

Heat treatments

Heat treatment has been accepted as a quarantine treatment for logs and timber to be shipped to the USA and many other countries for many years (e.g. USDA, 1996). The general specification requires the wood to reach a core temperature of 71°C for 60 minutes. Kiln drying of timber to a moisture content of less than 20% using temperatures over 70°C is often a commercial requirement but also has
long been accepted as a quarantine treatment by most importing countries. Currently, 56°C core temperature for 30 minutes is required under ISPM-15 for wood packaging material.

Heat treatment of unprocessed logs is an approved risk mitigation measure for importation into the USA (Morrell, 1995). Steam heat is a more effective quarantine measure than dry heat (USDA, 1994; Dwinell, 2001). Moist heat treatment is an integral part of log conditioning prior to peeling and has the additional benefit of eliminating quarantine pests.

Moist heat treatment can be, if done to a level necessary for pest kill, an integral part of log conditioning prior to peeling veneers and has the additional benefit of killing any quarantine pests that might be present in the wood.

A considerable volume of literature addresses thermal mortality of insects and has been reviewed by (Hosking, 2002a). (Jamieson et al., 2003) provides a good general summary of the literature on heat mortality of insects and fungi. A better summary of heat treatment applications for forestry produce is that of (Dwinell, 2001).

Irradiation

Gamma irradiation is currently approved for the disinfestation of logs into Australia at a rate of 10 kGy (1.0 Mrad). However, its practical application must overcome a number of hurdles, not the least being the construction of large irradiators to handle logs and bulk wood products.

Irradiation is also limited by poor penetration into freshly cut logs, potential damage and dose-dependent degradation of wood products such as fibre board and paper, variation in effect on different insect groups, and very high dosages required to eliminate fungi (Morrell, 1995).

Water soaking or immersion

Water soaking or immersion provides a way to control pests on imported logs. Immersion of some logs destined for plywood manufacture is a useful process as it improves the quality of the products. The storage of logs in water or under water spray has long been accepted as an effective treatment for terrestrial insects and fungi. Salt water immersion of logs for 30 days is an approved treatment for logs into Japan but contamination of waterways with bark is an issue. The upper surface of the logs above the water level is sprayed with an insecticide mixture such as dichlorvos as part of the pest management strategy (Reichmuth, 2002).

The potential for use of water soaking for quarantine treatment of imported logs is limited by the large area of water required and the undesirable side effects of ponding large volumes of logs, making its application on a large scale unlikely.

Sawn Timber

Conversion to timber frequently avoids the need to fumigate for many markets that require fumigation of logs. Due to a lack of infrastructure, cost, tariffs and customer requirements (e.g., veneer) this may not be a viable option in most cases.

Debarking

Bark removal has long been a key strategy in reducing contamination of logs and a way to reduce the risk of logs and sawn timber carrying certain insects and fungi of quarantine concern.

While debarking removes surface contamination and also bark and cambium, which are areas particularly prone to pest attack, it does not affect insects and fungi already in the wood (USDA, 1992). Many countries require debarking of all imported logs. Because of the high cost, and the
requirement by customers in major Asian markets that bark remain on logs, its application as a quarantine treatment is limited and frequently only carried out on high value logs.

Microwaves

Microwaves are essentially a heat treatment using electromagnetic energy in the 10 – 30,000 MHz range. It seems unlikely, however, that microwave irradiation has application in the treatment of logs because of the large quantities exported. Scaling up microwave technology to mitigate against quarantine risk in wood packaging faces significant challenges.

8.3.5.2 Economic feasibility

Treatments of logs may need to be rapid, such as at point of export or import, to avoid charges and congestion at ports associated with occupying restricted port area for the treatment. Where quarantine treatments can be applied outside port areas, such as prior to export or in-transit, alternatives to methyl bromide that take a longer time can be used. Many pests of quarantine significance, which attack green wood, do not re-infest dry and debarked wood.

Some types of logs that are primarily coniferous that are shipped in high volume, they have comparatively low value and they are shipped long distances. This trade is very price sensitive to changes in freight costs, exchange rates and treatment costs. In contrast, there is also a large trade in hardwood logs that has significant value to some countries of over US$ 1billion and each log is valued at several thousand dollars when used for making veneer, for example. Therefore, the economic value that a new treatment brings to the log trade depends mainly on the type of log, its market destination and intended use.

Phosphine is less expensive than methyl bromide for the treatment of logs when it is applied at the point of export as an in-transit treatment: US$ 0.93 per m³ for logs exports from New Zealand to Japan, compared with US$ 3.50 per m³ for methyl bromide (Self and Turner, 2008). The cost effectiveness of in-transit use of phosphine is dependent on the length of transit. Its use on shorter transit shipments would add significant costs (approximately $1,000 per hour (Self and Turner, 2008)) to shipping due to delays. On longer transits phosphine can be more cost effective than methyl bromide. This is because, compared to methyl bromide, the dosage rate is lower, and it is faster to apply which reduces costly moorage time in the port. The sailing time is sooner as the ship avoids having to stay in port for at least 36 hours while the hold is fumigated and then vented. A fumigation technician is required for the voyage to add more fumigant, monitor for leaks and vent the holds. This method can only be used for logs stowed in the holds, which is normally about two-thirds of the cargo, and the balance of the cargo on deck must be fumigated with methyl bromide under tarpaulin on the wharf prior to export.

Sulfuryl fluoride is about 50% more expensive in the United States than methyl bromide due to sulfuryl fluoride’s higher cost per unit of volume and the larger amount needed for the treatment (John Sansone, pers. comm., 2010). Most treatments of logs occur in temperate climates that have temperatures less than 25°C for much of the year, which would make the treatment uneconomic in comparison with methyl bromide treatment. The recommended minimum temperature is 15°C.

Methyl iodide or methyl iodide / CO₂ have similar application rates to methyl bromide but require premixing with CO₂ which adds cost on top of the more expensive price of the chemical. Both treatments are under evaluation in Japan for the control of log pests. While the chemical cost is not the major component of the fumigation cost it will add to the overall cost of treatment. No commercial sized applications have been undertaken to verify the economics of log fumigation with methyl iodide.

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The cost of cyanogen is unknown. Both heat treatment and irradiation of large volumes of logs are uneconomic.

Heat is a technically feasible alternative but because of the energy required and the large amount of the unprocessed logs being shipped, it is rarely an economic alternative to fumigation.

The use of irradiation for decontaminating logs in export trade does not appear to be economically feasible at this time, but may be useful in managing pests on high-value forest products that cannot normally be heat treated or fumigated.

Due to a lack of infrastructure, increased cost, tariffs and customer requirements, conversion to sawn timber may not be viable option in most cases. Conversion of logs to sawn timber that carry a lower quarantine risk is a technically feasible alternative, but would have significant trade implications. Some particular timbers and end uses may be unsuitable for conversion to lumber for technical and end use reasons. The current log trade in many cases relies on conversion to lumber and more highly processed products at the importing country. This provides employment in the importing country, as well as greater control over what the timber is converted to, but at the cost of greater quarantine risk.

Moving the point of conversion of logs from importing country to the exporter would have substantial economic implications. The trade from some countries with high labour costs and limited milling infrastructure may be lost to those that can provide lower cost conversion.

8.3.5.3 Market penetration of alternatives

Phosphine in-transit on those parts of the shipment carried under deck is the only commercially used alternative currently for under bark pests. China has approved a specific treatment schedule for sulfuryl fluoride on logs for fumigation in Germany and other countries prior to export. Data on the use of sulfuryl fluoride under this treatment schedule are not available and the extent of the market penetration of sulfuryl fluoride for this use is unknown.

The alternative must be effective against the pests of concern for the particular importing country and for the treatment to be economic. For instance, efficacy has yet to be proven to a quarantine level for wood wasps and pine wood nematode using phosphine, which holds up the market penetration of the use of in-transit phosphine.

The current market penetration for alternatives for logs is very small. Of the 58 million m³ of logs imported into China, India, Japan and Korea in 2007, only 800,000 m³ (1.3%) was treated with phosphine. This volume could be increased to 8.9 million m³ if all four countries receiving logs from the USA, Canada and New Zealand accepted phosphine fumigation of below-deck logs. Acceptance of phosphine as an alternative would potentially save about 1,200 tonnes of methyl bromide per year, even though it is still only about 15% of the global log trade.

Based on the 2008 trade statistics for logs imported by Japan, MBTOC estimated that Japan could replace about 500 tonnes of methyl bromide with methyl iodide, methyl iodide/CO₂ and/or methyl isothiocyanate/sulfuryl fluoride mixture if those chemicals are approved in Japan by the Japanese government for the treatment of imported logs.

8.3.5.4 Regulatory requirements and other drivers

All countries have a chemical registration process that over time has become more rigorous and expensive making it difficult to register new chemicals or new uses for existing ones. While it is easier to gain approval for the treatment of non-edible products such as logs and timber, it can still take between five to ten years for final approval of a new treatment. There is also a high probability of not being successful at the end of the process, after investing much time and money.
Acceptance of an alternative is also based on time and cost. As exported product may be competing with domestic or another country, and therefore any additional treatment costs or delay may make the trade unviable.

A high level of efficacy is required for treatments to ensure that pests of quarantine concern do not establish in the importing country. History has shown that incursions of forest pests can cause billions of dollars worth of damage (e.g., the Asian longhorn beetle, the emerald ash borer) or even drive species to extinction (Chestnut blight and American elm blight).

Acceptance of alternatives requires negotiation between officials of the importing and exporting countries. Science and research finding play an important part in this process. However, due to a lack of technical personnel, funding, expertise or other resources the negotiations can take years to obtain market access for an alternative treatment. If a treatment is approved at the international level, an included in a standard such as heat for ISPM-15, the negotiation time can be reduced significantly.

Japan attributed several technical and regulatory reasons (Akio Tateya pers. comm., 2010) for its approximately 50% reduction in the consumption of methyl bromide for QPS in 2009 (542 tonnes) compared to 2006 (1,039 tonnes):

- A concerted programme by MAFF to improve gas retention in fumigation chambers;
- Reduction in dosage when the treatment can be carried out at higher temperatures, recirculation equipment is present and other criteria;
- On board fumigation using phosphine of non-food commodities, such as bamboo from Taiwan;
- Import of genetically modified crops that are less susceptible to pest infestation than crops that have not been genetically modified;
- A reduction in products that are subject to plant quarantine e.g. imported timber is subject to plant quarantine but not processed wood;
- On the basis of pest risk analyses following ISPM-2 criteria, a reduction in the number of pests classified in Japan as regulated quarantine pests;
- Reductions of imports to Japan due to tariffs imposed on raw wood exports by the exporting country e.g. Russia;
- Greater use of heat treatment for wood packaging material as heat treatment is less costly than methyl bromide;
- Alternatives to methyl bromide have been registered e.g., for timber sulfuryl fluoride, methyl isothiocyanate, carbon dioxide and sulfuryl fluoride, and methyl iodide but they are not yet in use as quarantine treatments on processed timber.

8.3.6 Alternatives being investigated and under development

8.3.6.1 Sawn timber and wood packaging material

The 2009 revision of ISPM-15 (IPPC, 2009) did not recognise any alternative to methyl bromide except heat, but several potential alternatives to heat and methyl bromide are under evaluation. The Technical Panel on Phytosanitary Measures that advises the Standards Committee of the IPPC on
technical evaluations on alternatives, reports that several potential alternatives have been submitted and are under evaluation (Table 8-2).

The evaluation panels have requested additional efficacy data for the potential alternatives to methyl bromide shown in Table 8-2. Species of Agrilus planipennis (Emerald Ash Borer), Anoplophora glabripennis (Asian longhorned beetle), Bursaphelenchus xylophilus (Pinewood nematode), various bark beetles, sawflies and many other forest pests are key pests that must be controlled to a very high level of quarantine security by any alternative.

**Table 8-2: List of potential treatments for ISPM-15 under IPPC evaluation**

<table>
<thead>
<tr>
<th>Treatment</th>
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<tbody>
<tr>
<td>Sulfuryl fluoride</td>
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<tr>
<td>Sulfuryl fluoride and MITC mixture</td>
</tr>
<tr>
<td>Hydrogen cyanide</td>
</tr>
<tr>
<td>Microwave heating</td>
</tr>
<tr>
<td>Phosphine</td>
</tr>
<tr>
<td>Methyl iodide</td>
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</table>

Of the alternatives for ISPM-15 being considered, the data submitted for sulfuryl fluoride are sufficient to support Probit-9 efficacy for sulfuryl fluoride fumigation against Anoplophora glabripennis in wood packaging material, but not for pinewood nematode. The Technical Panel on Phytosanitary Measures has sufficient information to support the 99.99683% (Probit-9) efficacy of a methyl iodide schedule against pinewood nematode with but not for Anoplophora. Phosphine data submitted are not yet sufficient to demonstrate efficacy against either of the two key pests. Although only two of many quarantine pests that have to be controlled by alternative treatments, effectiveness against these two pests would indicate potential as a quarantine treatment and worthy of additional effort.

The requirement for mortality data showing a high level of efficacy for wide range of pests is a major barrier to development and approval of additional treatments for ISPM-15. The standard also needs approval from all member parties. Details of current requirements for submission of potential alternatives are given in ISPM-28. Criteria for future ISPM-15 treatment submissions are being considered by the IPPC’s Technical Panel on Phytosanitary Measures.

Some National Plant Protection Organisations recognise other treatments for wood packaging material and similar products, instead of methyl bromide or heat treatments undertaken according to the treatment criteria contained in ISPM-15. These treatments may be post entry or prior to export and are generally based on bi-lateral agreements between countries interested in a specific trade. Australia, for example, requires off shore treatments of timber packaging and dunnage that have not been treated in accordance with ISPM-15 to be treated at specified dosages of several alternatives, including fumigation with sulfuryl fluoride, or ethylene oxide or treatment with heat, gamma irradiation or some timber preservatives (ICON, 2009).

8.3.6.2 Grains and similar foodstuffs

8.3.6.2.1 Pre-shipment treatments

Alternatives that act at least as fast as methyl bromide would be welcomed in many export situations, as these would minimise delays handling the export consignment with associated costs and grain handling limitations.
At this time there are no agreed, widely available and approved pre-shipment treatments that will match the treatment speeds of large consignments that can be achieved with methyl bromide fumigation, though there are some in the regulatory approval process in a few countries. The fumigants sulfuryl fluoride, cyanogen and carbonyl sulphide, and synergised ethyl formate all have potential to give similar treatment times and throughputs to methyl bromide (MBTOC, 2007), although these are not registered in most countries.

8.3.6.2.2 Quarantine treatments

Microwave technology used in laboratory tests was reported as effective in controlling Karnal bunt (Tilletia indica) teliospores in 10 seconds compared to 96 hours using methyl bromide (Ingemanson, 1997). Scale up to large quantities of grain is problematic.

Alternative treatments to methyl bromide are needed for various snails of quarantine significance (e.g. Achitina fulica, Cernuella spp, Theba pisana). Methyl bromide fumigation is usually the only approved quarantine measure for these pests when associated with grain shipments. Other processes, including HCN and CO₂ fumigations, may be more effective (e.g. Cassells et al., 1994), but are not approved and not registered.

Phosphine is not accepted for controlling Sitophilus species because the pupal stage of Sitophilus granarius (a regulated quarantine pest for Japan) could not be killed completely at the dosage rates and fumigation conditions used in commercial quarantine fumigation (Mori and Kawamoto, 1966). On the other hand, sulfuryl fluoride has higher efficacy against pupal stages of several stored product insects, although the egg stage is the most tolerant (Furuki et al., 2005; Bell et al., 2003). Fumigating with a mixture of phosphine and sulfuryl fluoride gas kills all stages of Sitophilus species, using the good properties of both fumigants. Tests with mixtures of phosphine and sulfuryl fluoride are in progress in Japan.

8.3.6.3 Pre-plant soils use

8.3.6.3.1 Alternatives for forest nurseries

Research on forest nurseries reported that chloropicrin alone, or in combination with herbicides (when weeds pose problems) or 1,3D/Pic (when nematodes are a problem), were as effective alternatives for methyl bromide used as a QPS treatment (South 2008). Alternatives providing effective include chloropicrin (Pic) alone (South 2007; 2008); 1,3-D/Pic (South 2008), 1,3-D/Pic/metham sodium (South 2008); metham sodium + Pic (Cram et al., 2007); dazomet (Enebak et al., 2006); and methyl iodide (Enebak et al., 2006; Quicke et al., 2009). Pic and metham, when used in conjunction with low-permeability barrier film (LPBF), may provide an effective technical alternative. (Enebak, 2007) found that the application rate of methyl bromide was significantly reduced with LPBF.

More recently, research results from the Area-wide Pest Management project for methyl bromide alternatives in the south Atlantic region of the US showed that methyl iodide/Pic (50:50) and dimethyl disulfide (DMDS) / Pic were equally effective to methyl bromide for controlling weeds and nematodes in forest nurseries (Quicke et al., 2009). Further, populations of Trichoderma spp, which are essential for adequate development of the seedlings, were preserved at the same level as when methyl bromide was used (Quicke et al., 2009). Methyl iodide is now registered and available in the region where the trials were conducted. Registration of DMDS in the US is pending approval by the registration authorities.
8.3.6.3.2 Alternatives for other kinds of propagation materials

Further successful trials have been reported on rose nurseries (Hanson et al., 2006; 2009). MI/Pic, 1,3-D and 1,3-D/ Pic with high-density polyethylene film (HDPE) plus 1,3-D/Pic with Virtually Impermeable Film appear to provide weed control similar to methyl bromide in perennial tree nurseries (Shrestha et al. 2008, Schneider et al. 2009).

Recent research to determine soil treatments that are effective to eliminate the quarantine pathogen Phytophthora ramorum from ornamental nursery beds in California (Yakabe et al., 2010), showed that treatments with Pic, metham sodium and methyl iodide were effective in eliminating the pathogen to undetectable levels. Dazomet was also effective as long as it was fully incorporated into the soil and then tarped.

Steam proved effective for eliminating P. ramorum from ornamental nursery beds in California as long as soil was heated to temperatures above 40 °C (Yakabe et al., 2010). Steaming systems and application methods are being evaluated in California, in an effort to identify the most feasible approach to this technique (Gilbert et al., 2009).

DMDS + chloropicrin produced promising results in the forest nursery sector, although the former is not yet registered in the United States (Weiland et al., 2008; Quicke et al., 2007, 2008, 2009).

8.3.6.4 Logs

There is active research in progress to develop alternatives for logs but gaining the required efficacy data is very difficult as laboratory rearing has not yet been achieved to the numbers required, most insects are seasonal, and the commodity is large and variable.

8.3.6.4.1 Phosphine

Research in China and Japan has demonstrated that phosphine killed 10 species of forest insects of quarantine concern including cerambycids, scolytids and platypodids. Oogita et al. (1997) fumigated the cerambycids (Semanotus japonica, S. japonicus, Callidiellum rufipenne, 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 gm⁻³ for 24 and 48h at 15°C and 25°C. S. japonica and P. perlatus eggs were killed at 2.0 gm⁻³ for 24 hours at 15°C, but larvae and pupae of all species were not killed at 2.0 gm⁻³ for 48h at 15°C. At 2.0 gm⁻³ for 48h at 25°C, all stages of C. fulvus and X. pfeili, except larvae of C. fulvus, were killed. The work concluded that more than 48h was required for complete mortality.

In New Zealand, two phosphine log fumigation trials were completed in 2009 (Wang W. et al. unpublished), using sea containers loaded with commercial export logs and field collected insect-infested logs. The initial dosage of aluminium phosphide in the treatment container was equivalent to 2 gm⁻³ of phosphine gas. Phosphine concentration was maintained at over 200 ppm v/v (0.28 g m⁻³) during the 10-day fumigation period with one to three additional applications of aluminium phosphide pellets. Penetration of the phosphine into export logs at an average moisture content of 59% and 79% to a depth of 80mm achieved an average exposure of 183 ppm.hr (0.25 g h m⁻³) and 265 ppm.hr (0.37 g h m⁻³) respectively in the two trials.

A total of 680 insects extracted from infested logs in the treatment chambers were dead after phosphine fumigation and the mortality rate was 100%. All the 561 insects extracted from the controls were alive. Insects included Cerambycidae; Arhopalus ferus (Mulsant) larvae, Prionopolus reticulatris (White) larvae, Ichneumonidae; Rhysines larvae (Sirex noctilio parasite) and Scolytidae; Pachycotes pergrinus (Chapuis) adults, Hylastes ater (Paykull) adults, Hylastes eggs, Hylurgus ligniperda (Fabricus) larvae, Hylurgus adults, and Hexatricha pulverulenta (Westwood) larvae.
This work confirmed laboratory trials carried out by (Zhang, 2004b) that included four replicates of 94-102 eggs of *A. ferus*, which were successfully killed by 0.28 g m\(^{-3}\) phosphine for 10 days. In another later trial, a further four replicates of 100-253 *A. ferus* eggs were killed at a mean of 0.34 g m\(^{-3}\) phosphine over seven days. The length of time required to complete treatments restricts its commercial acceptability.

The “Florani” experiment showed that phosphine could be successfully used as an in-transit fumigant for eliminating the pinewood nematode from pine chips (Leesch *et al.*, 1989; Dwinell, 2001).

Data are being collected on the efficacy of phosphine controlling wood pests in both New Zealand and Canada, in order to improve the usefulness of this alternative.

8.3.6.4.2 Sulfuryl fluoride

Data are being collected on the efficacy of sulfuryl fluoride for controlling wood pests in the USA and China, in order to assess the usefulness of this alternative for the disinestation of logs.

8.3.6.4.3 Methyl isothocyanate/ Sulfuryl fluoride mixture

Research on alternatives for logs evaluating the efficacy of MI and MITC/SF/ mixtures has been completed in Japan and both treatments are under the process of inclusion under the relevant regulations. However, instructions or procedures for conducting gas measurements and safety devices to protect fumigators from gas exposure still need further work.

8.3.6.4.4 Methyl iodide

Data are being collected on the efficacy of methyl iodide for controlling wood pests in the New Zealand, France and the USA, in order to assess the usefulness of this alternative for the disinestation of logs.

Methyl iodide successfully killed oak wilt fungus at rates similar to methyl bromide (Tubajika 2006).

Methyl iodide is expected to be adopted by Japan as a quarantine treatment in the near future. Lack of registration in other countries for post-harvest uses severely limits its availability for quarantine treatment of forest pests in other countries.

8.3.6.4.5 Cyanogen

It is not known if work is continuing with cyanogen for the treatment of logs as it appears to penetrate high moisture content timber well but may have a high sorption rate (Barak and Ducom pers. comm., 2010).

8.3.6.4.6 Heat

This literature suggests few if any insects can survive even short exposure (less than 24h) to temperatures above 50°C, but some fungi are more tolerant. Direct exposure of gypsy moth eggs (Hosking, 2001) resulted in 100% mortality at the lowest temperature (55°C) and shortest exposure time (5 minutes) tested. Fungi were more variable in their response to temperature and exposure time. Some fungi required exposures of up to 6 hours at 57°C (Morrell, 1995) while others were killed by exposure to 60°C for 10 minutes (Ridley and Crabtree, 2001).

Heat treatment by steam has been shown to eradicate all tested fungi when 66°C is held at the centre of wood for 1.25 hour (Mirc and Willeitner, 1990; Newbill and Morrell, 1991), but (Dwinell, 2001).
reported that neither the APHIS-approved methyl bromide treatment for timber nor heat treatment up to 81°C killed all saprophytic fungal pathogens in imported hardwood pallets. Many fungal pathogens are also very tolerant of methyl bromide (e.g. see Rhatigan et al., 1998). Trials with heat treatment using steam are proposed in the USA (Ken Vick pers. comm., 2010).

8.3.6.4.7 Irradiation

No continuing work on irradiation treatment of logs is known to MBTOC.

8.3.6.4.8 Microwaves

No continuing work on microwave treatment of logs is known to MBTOC.

8.3.7 Summary of technical and economic feasibility and market penetration

Chapter 8.3 showed that there were many potential alternatives to methyl bromide used for QPS in the four sectors that consume more than 75% of global methyl bromide: sawn timber and wood packaging material, grains and similar foodstuffs, soils and logs.

Some alternatives were registered and potentially available for use, but they needed to be added to approved treatment schedules. In some cases, alternatives that were registered and included in treatment schedules still depend on international negotiations for them to put into practice according to the appropriate level of quarantine security agreed between the trading partners. Standards developed by the IPPC have a potentially valuable role to play in this regard as they can be accepted multilaterally, since the treatment conditions have been agreed by the Parties in that convention, which reduces and in some cases eliminates the need for significant bilateral discussions.

The economic feasibility of the treatments depends mainly on the circumstances where the alternative is to be used, the cost of specific equipment, and the cost of training staff in its operation. In the case of heat treatments for wood packaging material, Parties are reporting its widespread use and that in some cases it was more economical than methyl bromide fumigation. Parties also reported that heat was safer and more convenient to use than methyl bromide. Although it is not possible to generalise to all alternatives and indicate that they will be equally affordable for convenient to use, it is possible to say that as the technology becomes more widespread the cost reduces and the experience in the technology increases, which reduce the barriers to its more widespread acceptance.

The market penetration was known reasonably well for the four commodities in this review, according to the knowledge and experience of the members of the MBTOC-QPS sub-committee. The market penetration for a new alternative such as in-transit phosphine treatment of logs was relatively low, compared to phosphine for the treatment of grain and foodstuffs which had a very high market penetration globally. The market penetration of an alternative depended largely on the supply-demand for the commodity, which was often unpredictable and subject to significant increases or decreases in volume. In this regard, the potential use of an alternative could also be constrained by the requirements of the end user e.g. logs for veneer were exported as logs and not as sawn lumber.

Where technology is not currently available, subchapter 3 documents some of the research that is being undertaken to find alternatives. Many examples of such research have been provided in previous reports by TEAP and MBTOC, and an update of these will be provided in the 2010 Assessment Report which is due in December 2010.
8.4 Feasible Scenario for the Global Replacement of Methyl Bromide Used for Quarantine and Pre-Shipment

8.4.1 Introduction and mandate

Paragraph 3(3) of Decision XXI/10 requests:

“An update of Table 9.1 of the 2009 Task Force report to include economic aspects, and to take account of the information compiled under this paragraph, distinguishing between Article 5 and non Article 5 parties and between quarantine and pre-shipment uses separately;”

Table 9.1 from the TEAP 2009 Task Force report estimated a feasible scenario for technically replaceable use of QPS methyl bromide globally, based on technically feasible alternatives discussed in the report. The Table constituted an initial attempt at such estimation, recognising that there were many limitations for estimation at the time.

This Chapter takes estimations further by considering economic aspects and distinguishing between quarantine and pre-shipment uses of methyl bromide, with a separate scenario for Article 5 and non-Article 5 Parties according to mandate in Decision XXI/10.

8.4.2 Feasible scenarios for quantities of methyl bromide

Consumption of methyl bromide per category of use was estimated in response to Decision XX/6. For this, several sources of information were used, including direct response from about 24 Parties, surveys conducted previously (including the UNEP/ROAP survey of QPS uses in Asia and the Pacific and the 2004 QPS survey), previous QPS reports and others. Because all countries did not report consumption of QPS methyl bromide in response to XX/6 and other surveys, including some major QPS methyl bromide consuming countries, the consumption estimates gained for each sector are lower estimates. Actual consumption is likely to be higher.

It was apparent that the breakdown of use by categories was different in Article 5 and non-Article 5 Parties and that it is necessary to account for specific circumstances in the different regions involved when considering possible replacements of methyl bromide with alternatives. For example, logistical issues, use of alternatives already in place, and availability of technologies or infrastructure were important considerations when estimating replaceable amounts.

The proposed scenarios for Article 5 and non-Article 5 Parties are described in the following Sections and Tables.

8.4.2.1 Article 5 Parties

The principal categories of use of methyl bromide for QPS purposes in Article 5 Parties were logs (25%), wood packaging material for compliance with ISPM 15 (19%) and grains (16%). A large proportion of the consumption on grain is estimated to be used for pre-shipment. No pre-plant soils uses were classified as QPS in Article 5 Parties. As stated above in this report Asia is the major consuming region (TEAP, 2009). A suggested best-case scenario for the replacement of methyl bromide for the main uses recorded by Article 5 Parties is presented in Table 8-3

8.4.2.2 Non-Article 5 Parties

The main categories of use in non-Article 5 Parties were soils in situ (30%), logs (17%), grain (7%), and wood packaging material for compliance with ISPM-15 (5%) (TEAP 2009). A suggested best-case scenario for the replacement of methyl bromide for these uses in non-Article 5 Parties is
presented in Table 8-4. Due to specific considerations, pre-plant soils uses are discussed separately in the section below and presented in Table 8-4.

8.4.2.3 Estimated amount of methyl bromide that could be replaced for QPS soil uses

In the absence of official data that had been requested from the party, MBTOC-QPS estimated the quantity of methyl bromide that had been categorised by the Party as QPS on soil according to data provided in the Critical Use Nominations by the United States for use in a range of sectors. Based on these data MBTOC made best estimates of the quantity of methyl bromide being consumed for soil uses, the alternatives that were available to replace methyl bromide, and the amount of methyl bromide that could be replaced (Table 8-5).

Nearly all the estimated 1,476 tonnes of the remaining methyl bromide would have a technically feasible alternative if MI/Pic was registered in all States at a high enough application rate to meet certification standards for these relevant sectors in the USA. MI/Pic is considered a one-to-one replacement for methyl bromide for all soil uses, except where phytotoxicity issues and low label rates limit its use. The amount of methyl bromide that could be replaced may be none, partial or all depending on the extent of restrictions on the use of some alternatives, for example regulatory constraints, practical limitations or economic issues.

For some sectors, in particular caladiums, sweet potatoes, golf and sod turf grass uses of methyl bromide cited in Table 8-5, the estimated quantities may need further examination pending submission of official information by the Party. MBTOC found that the use of methyl bromide that had been categorized as QPS by the Party for turf grass fumigation is likely to have declined due to the economic recession, whilst the use for caladiums appears to have more than doubled. Currently there is no consumption of methyl bromide for sweet potatoes that has been categorised as QPS by the Party. Uneconomic uses of methyl bromide may become economic again in the future, and therefore it seemed reasonable in these cases to show alternative estimates of methyl bromide consumption using square bracket notation. MBTOC-QPS reiterates its request for information from the Party on the consumption of methyl bromide that it has categorised as QPS.

Under the Technology and Economic Assessment Panel (TEAP) Terms of Reference, reports are developed by consensus and must reflect any minority views appropriately. In all reports by TEAP and its TOCs and TSBs (Task Forces etc.), there have been less than five minority statements in the more than 20 years TEAP has operated. Three of these previous minority statements involved issues related to methyl bromide.

This TEAP report includes an indication that the fourth such minority statement related to methyl bromide may be forthcoming. The potential minority statement concerns methyl bromide uses for pre-plant soil fumigation that have been classified as QPS, by one Party, in particular, as given in Table 8-5 below. Quantities of methyl bromide have been approved by the Parties for many of these same uses under the Critical Use Exemption. The possible minority view relates to the data presented in such table and the conclusions that are drawn from it. The definite minority viewpoint from the MBTOC-QPS member who initiated this action has so far not been submitted. The text will be inserted in the report as soon as it is available and at that time it will be possible for TEAP to make additional changes to the report, if necessary.

8.4.2.4 Estimated replaceable quantities – summary

Quantities of QPS methyl bromide given for the four major categories of QPS consumption in Tables 8-3 and 8-4 represent 6,225 tonnes in total from a reported annual consumption in 2007 of 10,614 tonnes. As noted in TEAP (2009), there is a substantial discrepancy between that reported under Article 7 by Parties and that estimated from various data sets that have the consumption (use)
specified by category of use. Part of the discrepancy is attributable to incomplete data with data absent from several larger consumers of QPS methyl bromide. The total use in Tables 8-3 and 8-4 represent 73% of the 8486 tonnes identified QPS uses for 2007.

Data from 2007 in Tables 8-3 and 8-4 allow estimates of total replaceable methyl bromide by currently available technologies of at least 902 and 1,035 tonnes in Article 5 and Non-Article 5 countries respectively, being at least 1,937 tonnes in total. This is 31% of total methyl bromide consumption by the four main categories of QPS use. The upper estimate of replaceable methyl bromide by currently available technologies in Article 5 and non-Article 5 countries is at least 2,942 tonnes or 47% of the global QPS for these four categories.
Table 8-3: Estimated replaceable fractions for various QPS uses using presently available technologies for Article 5 Parties

<table>
<thead>
<tr>
<th>QPS category</th>
<th>Principal alternative technologies</th>
<th>Economic feasibility</th>
<th>Estimated methyl bromide use (tonnes) for 2007 a</th>
<th>Fraction of use replaceable by alternatives immediately available</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood packaging material (ISPM-15)</td>
<td>Heat treatment, alternative fumigants</td>
<td>Some countries use either heat or methyl bromide, establishing heat is feasible in these circumstances. Some countries use heat almost exclusively.</td>
<td>893</td>
<td>&gt;60%</td>
<td>Alternative fumigants under consideration</td>
</tr>
<tr>
<td>Grains and similar Foodstuffs – quarantine</td>
<td>Alternative fumigants and controlled atmospheres</td>
<td>Rapid acting alternatives need development and proving. Current alternatives require construction of additional storage at point of entry if throughput is to be maintained.</td>
<td>329</td>
<td>&lt;10%</td>
<td>Alternative rapid fumigants not available</td>
</tr>
<tr>
<td>Grain and similar foodstuffs – pre-shipment</td>
<td>Fumigants, protectants, CA, integrated systems</td>
<td>Alternatives may require change in export procedures and some infrastructure changes.</td>
<td>765</td>
<td>30-70%</td>
<td>Rapid acting fumigants may not be registered or market acceptable. Many exporting countries do not have an official pre-shipment requirement.</td>
</tr>
<tr>
<td>QPS category</td>
<td>Principal alternative technologies</td>
<td>Economic feasibility</td>
<td>Estimated methyl bromide use (tonnes) for 2007</td>
<td>Fraction of use replaceable by alternatives immediately available</td>
<td>Comments</td>
</tr>
<tr>
<td>------------------</td>
<td>--------------------------------------------------------------------------------------------------------</td>
<td>-----------------------</td>
<td>-----------------------------------------------</td>
<td>------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Soils, <em>in situ</em></td>
<td>Alternative soil fumigants</td>
<td>0</td>
<td></td>
<td>Not applicable</td>
<td></td>
</tr>
<tr>
<td>Logs</td>
<td>Alternative fumigants, conversion to sawn timber (lumber), immersion, debarking, heat and drying</td>
<td>Conversion to sawn timber (lumber) at point of export only where there is a price insensitive demand for higher value products without alternative sources of supply</td>
<td>1371</td>
<td>10-20%</td>
<td>Alternative fumigant processes under development and consideration for specific trades. Infrastructure may not be available. A possible alternative, conversion to debarked, sawn timber, prior to shipment, might have substantial influence on particular trades through economic effects. Debarking used as a possible component of an alternative system.</td>
</tr>
</tbody>
</table>

Data (2007) were supplied by the Parties to the Ozone Secretariat in response to Decision XX/6. Data (2005) from the Regional Office for Asia and the Pacific (UNEP/ ROAP, 2008; ROAP) were used when 2007 data were not available.
Table 8-4: Estimated replaceable fractions for various QPS uses using presently available technologies for non-Article 5 Parties

<table>
<thead>
<tr>
<th>QPS category</th>
<th>Principal alternative technologies</th>
<th>Economic feasibility</th>
<th>Estimated methyl bromide use (tonnes) for 2007 *</th>
<th>Fraction of use replaceable by alternatives immediately available</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood packaging material (ISPM-15)</td>
<td>Heat treatment, non-wood pallets</td>
<td>Some countries use either heat or methyl bromide, establishing heat is feasible in these circumstances. Some countries use heat almost exclusively.</td>
<td>263</td>
<td>60-80%</td>
<td>Alternative fumigants under consideration</td>
</tr>
<tr>
<td>Grains and similar foodstuffs – quarantine</td>
<td>Alternative fumigants and controlled atmospheres</td>
<td>Rapid acting alternatives need development and proving. Current alternatives require construction of additional storage at point of entry if throughput is to be maintained.</td>
<td>251</td>
<td>&lt;10%</td>
<td>Alternative rapid fumigants not available</td>
</tr>
<tr>
<td>Grain and similar foodstuffs – pre-shipment</td>
<td>Fumigants, protectants, CA, integrated systems</td>
<td>Alternatives may require change in export procedures and some infrastructure</td>
<td>73</td>
<td>&gt;80%</td>
<td>Not applicable where MB is only fumigant specified by importer and rapid treatment is required</td>
</tr>
<tr>
<td>QPS category</td>
<td>Principal alternative technologies</td>
<td>Economic feasibility</td>
<td>Estimated methyl bromide use (tonnes) for 2007</td>
<td>Fraction of use replaceable by alternatives immediately available</td>
<td>Comments</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------------</td>
<td>----------------------</td>
<td>-----------------------------------------------</td>
<td>------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Soils, <em>in situ</em></td>
<td>Alternative soil fumigants, sometimes with inspection, substrate, steam</td>
<td>Telone/pic can be used in California but at risk of failed certification through inspection. MB assumed to be effective</td>
<td>1476</td>
<td>About 50%, provided the alternatives not only meet certification standards but are accepted by regulatory authorities</td>
<td>Used for propagation material. Methyl iodide is not registered in California. See Table below that shows the derivation of the 50% estimate in the adjacent column</td>
</tr>
<tr>
<td>Logs</td>
<td>Alternative fumigants, conversion to sawn timber (lumber), immersion, debarking, heat and drying</td>
<td>Conversion to sawn timber (lumber) at point of export only where there is a price insensitive demand for higher value products without alternative sources of supply</td>
<td>804</td>
<td>10-20%</td>
<td>Alternative fumigant processes under development and consideration for specific trades. Infrastructure may not be available. A possible alternative, conversion to debarked, sawn timber, prior to shipment, might have substantial influence on particular trades through economic effects. Debarking used as a possible component of an alternative system.</td>
</tr>
</tbody>
</table>

Data (2007) were supplied by the Parties to the Ozone Secretariat in response to Decision XX/6. Data (2005) from the Regional Office for Asia and the Pacific (ROAP) were used when 2007 data were not available.
Table 8-5: Estimated consumption in 2010 of the methyl bromide that has been categorised by the Party for preplant soil use and the proportion of methyl bromide that was estimated to be replaceable with alternatives

<table>
<thead>
<tr>
<th>Sector</th>
<th>Best Estimate</th>
<th>Minus reduction for uptake of alternatives (CUNs)¹</th>
<th>Amount of use requiring methyl bromide</th>
<th>Possible Alternatives²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulbs</td>
<td>261</td>
<td>78</td>
<td>183</td>
<td>30% uptake of 1,3-D/Pic</td>
</tr>
<tr>
<td>Forest nursery seedlings - Southern US</td>
<td>310</td>
<td>310</td>
<td>0</td>
<td>MI/Pic</td>
</tr>
<tr>
<td>Forest nursery seedlings – Western US</td>
<td>100</td>
<td>100</td>
<td>0</td>
<td>MI/Pic</td>
</tr>
<tr>
<td>Forest nursery seedlings – northern US</td>
<td>45</td>
<td>45</td>
<td>0</td>
<td>MI/Pic</td>
</tr>
<tr>
<td>Ornamentals - Chrysanthemum</td>
<td>32</td>
<td>16</td>
<td>16</td>
<td>3-Way, MI/Pic</td>
</tr>
<tr>
<td>Ornamentals – Caladium⁵</td>
<td>[193] [450]</td>
<td>193</td>
<td>0</td>
<td>3-Way, MI/Pic</td>
</tr>
<tr>
<td>Nursery – Fruit &amp; Nut Deciduous</td>
<td>207</td>
<td>62</td>
<td>145</td>
<td>30% uptake of 1,3-D/Pic</td>
</tr>
<tr>
<td>Nursery - Raspberries</td>
<td>25</td>
<td>7</td>
<td>18</td>
<td>30% uptake of 1,3-D/Pic</td>
</tr>
<tr>
<td>Nursery – Roses</td>
<td>208</td>
<td>61</td>
<td>147</td>
<td>30% uptake of 1,3-D/Pic</td>
</tr>
<tr>
<td>Strawberry runners</td>
<td>460</td>
<td>0</td>
<td>460</td>
<td></td>
</tr>
<tr>
<td>Turfgrass – Sod⁴</td>
<td>680</td>
<td>340</td>
<td>340</td>
<td>50% uptake of 1,3-D/Pic, dazomet, MI/Pic</td>
</tr>
<tr>
<td>Turfgrass – Golf⁴</td>
<td>[110] [0]</td>
<td>55</td>
<td>55</td>
<td>50% uptake of 1,3-D/Pic, dazomet, MI/Pic</td>
</tr>
<tr>
<td>Sweet potato⁵</td>
<td>[224] [0]</td>
<td>112</td>
<td>112</td>
<td>50% uptake of 1,3-D/Pic, herbicides</td>
</tr>
<tr>
<td><strong>Total (tonnes)</strong></td>
<td>[2855] [2778]</td>
<td></td>
<td>1476</td>
<td></td>
</tr>
</tbody>
</table>

¹ Reductions for uptake of alternatives only considered alternatives that were registered at the time of this report. If technical feasibility only was considered then 95% of uses have an alternative, as methyl iodide/chloropicrin is considered a one-to-one replacement for methyl bromide for nearly all uses.

² 3-Way consists of three soil fumigations in each successive year, beginning with a 1,3-D + Pic application, followed by a Pic application, followed by a metham-sodium or metham-potassium application.

³,⁴ Possibly overestimated as turf grass for golf is recently not economic for transport across State boundaries because of the economic recession. The amount that can be replaced could be zero because of EPA restrictions on the use of some alternatives, practical limitations (coverage, dose insufficient) and off-target environmental damage caused by alternatives to local water resources.

⁵ Consumption may be larger at 450 tonnes. ⁶ Previously reported consumption may be currently zero.
8.4.3  **Summary**

MBTOC-QPS found that there is opportunity to replace varying amounts of methyl bromide presently used for QPS purposes, depending on category of use and whether the use is carried out in Article 5 or Non-Article 5 Parties.

It was estimated that in Article 5 Parties more than 60% of the methyl bromide used in sawn timber and wood packaging material could be replaced by heat or alternative fumigants; less than 10% of the methyl bromide used as a quarantine treatment in grains and similar foodstuffs could be replaced by alternative fumigants and controlled atmospheres, and 30-70% for pre-shipment treatments in grains and similar foodstuffs could be replaced by fumigants, protectants, controlled atmospheres and integrated systems; and 10-20% of the methyl bromide used in logs could be replaced by alternative fumigants, conversion to sawn timber (lumber), immersion, debarking and heat. There was no categorisation of methyl bromide as QPS used on soil in Article 5 Parties countries.

MBTOC-QPS estimated that in Non-Article 5 Parties that more than 60-80% of the methyl bromide used in sawn timber and wood packaging material could be replaced by heat or non-wooden pallets; less than 10% of the methyl bromide used as a quarantine treatment in grains and similar foodstuffs could be replaced by alternative fumigants and controlled atmospheres, and more than 80% for pre-shipment treatments in grains and similar foodstuffs could be replaced by fumigants, protectants, controlled atmospheres and integrated systems; about 50-95% of the methyl bromide used in soil could be replaced by alternative fumigants, provided the alternatives meet certification standards and a key alternative, methyl iodide/Pic was available; and 10-20% of the methyl bromide used in logs could be replaced by alternative fumigants, conversion to sawn timber (lumber), immersion, debarking and heat.

The technical and economic feasibility of alternatives to methyl bromide used for QPS in all countries depended mainly on the efficacy against quarantine pests of concern, the infrastructural capacity of the country, end-use customer requirements, phytosanitary agreements where relevant, and logistical requirements and regulatory approval for the use of the alternative.

8.5  **Draft Methodology for Assessing the Feasibility of Alternatives, the Impact of their Implementation and of Restricting Methyl Bromide for Quarantine and Pre-Shipment**

8.5.1  **Mandate and scope**

Paragraph 3(4) of Decision XXI/10 requests:

“A description of a draft methodology, including assumptions, limitations, objective parameters, the variations within and between countries and how to take account of them, that the Technology and Economic Assessment Panel would use, if requested by the Parties, for the assessment of the technical and economical feasibility of alternatives, of the impact of their implementation and of the impacts of restricting the quantities of methyl bromide production and consumption for quarantine and pre-shipment uses;”

For the purpose of completing this task, paragraph 3(4) was interpreted as consisting of three sections:

1. A description of a draft methodology ... for the assessment of the technical and economical feasibility of alternatives;

2. A description of a draft methodology ... for the assessment of the impact of the implementation of alternatives to methyl bromide for QPS;
3. A description of a draft methodology … for the assessment of the impact of restricting the quantities of methyl bromide production and consumption for quarantine and pre-shipment uses.

Paragraph 3(4) was interpreted to require consideration of specific criteria including any assumptions, limitations, objective parameters, the variations within and between countries and how to take account of them. Therefore, in each of these sections these criteria have been considered and elaborated, where appropriate.

It was acknowledged that the draft or similar methodologies described in this report might be used in the future by TEAP to provide information on QPS for the consideration of the Parties, if such information were to be requested by the Parties.

8.5.2 Description of the methodology that could be used to assess technically and economically feasible alternatives to methyl bromide for quarantine and pre-shipment uses

8.5.2.1 Introduction

The protection of agriculture, forests and ecosystems from damaging exotic pests that can be accidentally imported during the course of trade is a priority for most countries. Although biological invasions from new pest species can be difficult to quantify financially, they have been estimated to cost more than $100 billion per year in the United States (TEAP, 2009; Table in this report).

Along with other control methods, methyl bromide as a broad spectrum fumigant is one of the most important procedures that is currently used on a diverse range of products to avoid the accidental shipment of unwanted pests. It can be applied prior to export or on arrival to control pests of quarantine concern.

The three QPS categories of methyl bromide use – QPS in trade and transport of goods between countries, domestic (intra-country) quarantines and pre-shipment use – are distinct in some aspect. However the main point of similarity, all involve control of pests to some level of biological security, allow a common concept of what is an alternative to methyl bromide to be defined.

A significant proportion of the methyl bromide for QPS is used domestically in some countries to prevent the spread of pests of quarantine concern within a country. This includes an “incursion response” that aims to prevent the establishment and/or spread of quarantine pests.

In addition to the use for official phytosanitary measures, there is also some use of methyl bromide to control pests of quarantine concern associated with human health, animal health and indigenous environment e.g., mosquitoes, fire ants. Some treatments applied prior to export may not be officially required, but methyl bromide is sometimes used to kill quarantine pests in order to reduce the risk of rejection of the consignment in the importing if country quarantine pests are intercepted.

Despite its usefulness in protecting the environment of many countries and in facilitating trade, methyl bromide’s ozone-depleting properties, its toxicity and its detrimental impact on products have resulted in the search for equivalent alternatives procedures and technologies that provide an appropriate level of phytosanitary protection.

8.5.2.2 Uses of methyl bromide for soil that were categorised as QPS

The United States reported the use of methyl bromide for some soil treatments (Anon 2009) for the production of propagation material, such as nursery stock, strawberry runners. The Party categorised these methyl bromide fumigations as qualifying for the QPS exemption as they were carried out to
comply with the requirements of various US States for certification of high plant health status for propagation materials, including lack of nematode infestation. Plants for propagation in the US are not eligible for certification if nematodes are detected in a sample of the propagation material. Methyl bromide and some alternatives (1,3-D) are applied to the soil in which the plants are grown to meet this nematode-free requirement. In the case of nematodes, the detection of a single nematode of economic importance is sufficient to make all plants grown in the area represented by that sample ineligible for certification. In practice, inspection of propagation material for nematodes is not part of the certification process when the field has been fumigated with methyl bromide. Therefore, growers producing propagation material prefer to use methyl bromide as, unlike the approved alternative (1,3D-Pic), there is no subsequent test that would make any plants grown in the fumigated area ineligible for certification. Plants grown in methyl bromide fumigated fields are deemed to have passed the certification process and can be marketed without further inspection. Plants grown in non-methyl bromide fields must be inspected at the end of the growing season and presence of nematodes causes the field to fail the certification process and plants grown in that field are not eligible to be marketed as certified plants. Growers therefore prefer to fumigate the field with methyl bromide without a test and have no risk of failure, rather than apply the alternative with the test and risk failure of the field.

The use on soil for production of propagation materials with certified high plant health status was listed by TEAP in its May 2009 report in response to Decision XX/6(7) under “categories of use it has identified that have been classified as quarantine and pre-shipment use by some Parties but not by others”. An explanation of why this use was considered to be QPS was provided by the US and included in (TEAP, 2009b). The use of alternatives to methyl bromide for this use is discussed further on in the Section: Alternatives to methyl bromide for strawberry runners.

This use for soil was the second largest global use of methyl bromide under the QPS exemption. The reported consumption of methyl bromide for QPS was 1,483 tonnes in 2005. Consumption for this use occurred only in the United States. A more detailed analysis by MBTOC of information recently provided by the Party since 2003, according to information provided to MBTOC as a result of the re-classification by the United States of soil uses from CUE to QPS, indicated that the consumption of methyl bromide for soils for this use had almost doubled in 2010 to 2,850 tonnes, compared to amounts consumed 3-5 years earlier (see also Table 8-5). MBTOC made best assessments of the information available and seeks further information from the Party that would further define consumption of methyl bromide for soil uses under the QPS exemption for many different propagation materials.

The pests and diseases involved in certification in the United States are widely distributed in both the source and receiving areas of the propagation material. Its use for this purpose is therefore inconsistent with the requirements and intent of the definitions of quarantine in the Montreal Protocol (TEAP, 2009a; see Annex 2 for the definition of a quarantine pest in this report). Fumigation of soil with methyl bromide, or the use of several alternatives (1,3-D/Pic and methyl iodide/Pic), applied to the soil several months before up-rooting the propagation material, are reported to be extremely effective treatments that prevent the spread of nematodes and other pests (fungi and weeds) from the single production field to the numerous fruiting fields. Complete eradication of pests is not guaranteed. A past review in response to paragraph 8 of Decision XVII/9 by MBTOC showed that nematodes and fungal pathogens can survive methyl bromide treatment and that plants grown in treated soils can have levels of diseases which may or may not meet specified levels of tolerance (MBTOC, 2006). MBTOC believes that methyl bromide fumigation of soil may be sufficient to reduce nematode levels to the standard required by the US, but in this case it is unlikely to meet the rigorous standard required of a quarantine treatment. The treatment has not been shown to prevent the transfer of nematodes from one region to another to the Probit-9 standard of security, which is typically applied in quarantine treatments.

TEAP notes that the United States has requested methyl bromide for the same end users under both the Critical Use Exemption process and the QPS Exemption. In these cases and according to the
United States submission, the requirement for plant health is similar and specifies that the plants are essentially free from pests and diseases. TEAP notes that use of methyl bromide can be replaced under both categories by the implementation of alternatives, which have been adopted by other Parties in these sectors (see Section 8.3.4.1 and Table 8-5). The treatment of endemic nematodes, weeds and fungi, which are not under official quarantine and are not quarantine pests according to the definition used in the Montreal Protocol, may not qualify for a QPS exemption. Parties may wish to consider action for solving this problem.

8.5.2.3 Definitions

Methyl bromide is used by Parties to the Montreal Protocol to prevent the introduction, establishment and/or spread of quarantine and non-quarantine pests. In proposing methodology that could be used to assess technically and economically feasible alternatives to methyl bromide for QPS uses, and to indicate the range of treatments that are permitted by the Montreal Protocol, it is assumed that the definitions of quarantine applications remain as defined by the Parties in Decision VII/5; and as defined for pre-shipment treatments applied to control non-quarantine pests in Decision XI/12. For clarity, these definitions are also shown in Annex 1 of this report.

In the remainder of this chapter, it is assumed that a QPS treatment is:

Any official procedure for the killing, inactivation or removal of pests, or for rendering pests infertile or for devitalisation.

In the Montreal Protocol, ‘official control’ applicable to a quarantine treatment is one that:

... is performed by, or authorised by, a national plant, animal or environmental protection or health authority.

For pre-shipment applications, official requirements are:

... those which are performed by, or authorized by, a national plant, animal, environmental, health or stored product authority.

8.5.3 Technical feasibility of an alternative

In accordance with the request in paragraph 3(4) of Decision XXI/10, the methodology that could be used to assess feasible alternatives to methyl bromide for QPS uses is discussed firstly from a technical perspective and secondly from an economic perspective.

The methodology that could be used to assess an alternative as technically feasible could include the requirement that it has been “authorised by, a national plant, animal or environmental protection or health authority on the basis of its proven efficacy for killing, inactivating or removing pests, or rendering pests infertile or for devitalisation”. Where an alternative is also used to facilitate international trade, it must also “achieve a contracting Party’s appropriate level of protection” or quarantine security.

Therefore, as a working definition for the purpose of addressing the request by the Parties in paragraph 3(4) of Decision XXI/10, a technically feasible alternative to methyl bromide that is used as a phytosanitary treatment against quarantine and non-quarantine pests is:

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2 ISPM No.5 (IPPC).
“An officially-required treatment that has been authorised by, a national plant, animal or environmental protection or health authority which achieves an appropriate level of phytosanitary protection”.

Conversely, an alternative that had not been authorised by, a national plant, animal or environmental protection or health authority as a phytosanitary treatment would not be considered as a technically feasible alternative to methyl bromide at the time of assessment.

Because the treatment has been officially authorised, the alternative is supported by data that have been generated using appropriate scientific procedures, including where relevant an appropriate experimental design; and the data are verifiable, reproducible, and based on statistical methods and/or on established and accepted international practice.

Additional to authorisation, an alternative must also be logistically feasible so that it can be used in commercial practice. A treatment may need to be applied at the point of entry to kill pests incepted on import, under conditions when both space and time are limited. For some countries that have stringent phytosanitary requirements, treatment on arrival is an important element of maintaining national bio-security.

The alternative should not significantly reduce the marketability of the regulated article being treated. In some cases, such as when military equipment is fumigated to control arthropods and other contaminants, the treatment must not affect the functionality of the equipment.

The customer requirements may preclude the use of some officially authorised options e.g., sawn / kiln-dried lumber that has been treated in a way that eliminates pest risk, but the product is not acceptable to the customer as only whole logs are acceptable for the manufacture of wood veneer.

Registation of the alternative by pesticide and other regulatory authorities would typically include consideration of any adverse effects on the environment, off-target organisms, human and animal health. Conversely an alternative available in one country may not be available in another due to not meeting the needs of the regulatory authority. These effects would thus not need to be specifically considered in any methodology for assessment of alternatives as they are covered by the approval process. The chemical alternatives should be applied in a way that does not increase the risk of the target organism developing biological resistance to the treatment.

Obtaining the data to support technical negotiations that result in a bilateral agreement for an international phytosanitary treatment can take many years depending on the target pest, the proposed treatment and the importance policy officials in each country assign to the process. Once agreed, the treatment is applicable to the specific pest/commodity combination and treatment conditions that have been agreed and cannot be applied to a wider range of pests and commodities.

8.5.4 Economic feasibility of alternatives

The methodology that could be used to assess an alternative as a QPS measure as economically feasible could include the requirement that its net returns are determined relative to a methyl bromide treatment.

Net return is a preferred measurement in any proposed methodology since the cost of an alternative can increase or decrease significantly, and its impact on the value of the product may change and is
dependent mainly on what the market is willing to pay. In the case of increased costs, they can sometimes be offset by increases in price in the market at per unit costs that may or may not be significant to the end client.

Determining the economic feasibility of the development of an alternative to methyl bromide for ‘pest incursions’ is not the focus of this draft methodology since the economics of this are less restrictive than those that are under consideration for other areas where QPS alternatives are required. For a destructive pest, the costs of failing to manage or eliminate the pest can be very high (see Table), so the cost differential between methyl bromide and the alternative may not be important, provided it is at least as effective as methyl bromide treatment.

An alternative should be implemented without significant market disruption and the sectors that benefit as a result of the adoption of the alternative should be identifiable.

8.5.5 Description of the methodology for the assessment of the impact of the implementation of alternatives to methyl bromide for quarantine and pre-shipment uses

TEAP assumed that this task required a description of the methodology for the assessment of the impact on the environment, as paragraph 3(4) of Decision XXI/10 provided an unspecific statement in relation to impact. In this regard, the methodology for the assessment of the impact of alternatives, firstly on the atmospheric environment and secondly the impact of an invasive pest on agriculture, forestry and ecosystems (the environment protected in many countries by official phytosanitary measures).

8.5.5.1 Impact of an alternative on the atmosphere

If required by the Parties, TEAP and the Scientific Assessment Panel could assess the impact of the implementation of an alternative to methyl bromide for QPS uses on the atmosphere using internationally-accepted methods for calculating changes to ozone depletion and global warming, which are the two impacts that are most commonly measured.

The Equivalent Effective Stratospheric Chlorine (EESC) could be used to measure the contribution of the substance in the atmosphere as this is directly related to ozone depletion. The EESC was used in the WMO 2002 Scientific Assessment to gauge the effectiveness of the control measures in the Montreal Protocol. It is assumed that the EESC would decrease since methyl bromide would be eliminated as a result of its replacement with a substance that was not ozone-depleting.

The global warming potential (GWP) of a substance is its global warming impact relative to the impact of the same quantity of carbon dioxide over a 100 year period. If the alternative to methyl bromide has been assigned a GWP, the radiative forcing of the alternative could be measured according to the quantity of the substance emitted to the atmosphere.

An alternative to methyl bromide may have other detrimental effects on agriculture, forests and ecosystems that would need to be measured and reported, such as residual pesticides that contaminate water and soils, and pesticide dips that are used for the disinfestation of cut-flowers in some countries. Determining the environmental impact of various components involved in a systems approach that achieves the required level of phytosanitary security can be particularly challenging and time-consuming.

If the Parties considered it important, TEAP could also report on the impact of the implementation of alternatives to methyl bromide for QPS uses on the health of humans and animals as a result of a review of officially-published documents developed as part of the regulatory assessment of the impact of an alternative on water, food and air quality. TEAP would pay particular attention to the likely
impact of an alternative on worker safety since this is a serious health concern for portside workers may be exposed to methyl bromide when opening shipping containers that were fumigated prior to export. There may also be health concerns associated with the exposure of nearby communities to methyl bromide or an alternative.

8.5.5.2 Impact of the invasive pest on agriculture, forests and ecosystems

Methyl bromide fumigations are one of a number of measures used to prevent or restrict introduction of pests and diseases into new areas. In many cases, methyl bromide treatment is the sole available quarantine measure that is available for particular goods that will allow the trade between specific countries to proceed. There are numerous examples of situations where assessments have been made of the cost of restriction of trade and impact of incursions that might have been prevented through effective quarantine measures, including methyl bromide use.

If the alternative is officially authorised as described in Section 8.5.2.2 and the treatment applied as intended, the risk of inadequate disinfestation should be minimal as the treatment would have been approved on the basis of supportive data that had been generated as a result of the use of appropriate scientific procedures.

Without the availability of alternatives to methyl bromide for QPS, there was a strong likelihood of disruption to international trade if the exemption for QPS were not available, resulting in a reduction in the benefits from trade (Margolis et al., 2005). Importing countries may have to forego foreign products and raw materials (Roberts et al., 1999, Mumford, 2002), while exporting countries may lose access to markets (Li et al., 2008, Turner et al., 2007). Just as important was the environmental damage done by introduced quarantine pests and the reality of the critical role played by methyl bromide in preventing the spread of these pests to new locations.

(Li et al., 2008) used an economic model of the global forest sector to estimate the economic impact of a gradual ban on the global trade of roundwood. They predicted that such a ban would lead to a significant reduction in producer revenues (quantity produced times price received) for major log exporters, e.g. 16% reduction for Russia and 10% for New Zealand. For some Article 5 and non-Article 5 Parties that rely to a large extent on export receipts from methyl bromide-treated commodities, the exemption was considered very important as it specifically avoided the equivalent of a ‘…new non-tariff barriers to trade…’ (Decision VI/11), if such an exemption were not in place.

Studies of insect interceptions and establishment however, confirm the role of increased trade as potential pathways for introduction of non-indigenous species (Work et al., 2005, McCullough et al., 2006). Biological invasions by new pest species into a country can have serious adverse effects economically and environmentally e.g., lost recreational opportunities, damage to important food and industrial crops, extinction of indigenous species, and direct costs of pest containment or eradication (Holmes et al., 2009). An objective of quarantine treatments is to prevent establishment of these new pest species in areas that have been free of them.

The combined economic costs of new pests may be significant, with implications for environmental policy and resource management. Estimates of the economic impact of invasive pests (see citations in Turner et al., 2004, Holmes et al., 2009 and Brockerhoff et al., 2010) vary widely (Table 8-6) because of differences in the costs and benefits included, and how an economic value is placed on these. However, full economic impact assessments have rarely been undertaken at a national level, with the exception of (Presetemon et al., 2006) for logs and lumber and (Jabara et al., 2008) for wood packing material. (Presetemon et al., 2006) also included the additional impact of increased stringency of phytosanitary regulations placed on log exports to avoid pest spread to export markets. In addition, it is not usually possible to put a monetary value on environmental changes that new pests cause when introduced into a new habitat.
In addition, the most significant impact of pest establishment and spread may be a reduction of environmental services, which have a non-market value (Holmes et al., 2009). Placing a monetary value on changes in environmental services that new pests cause when introduced into a new habitat can be complicated, though not impossible (citations in Holmes, 2010). The economic costs of the reduction in environmental services associated with the effect of exotic forest pests include the value of lost enjoyment of recreation and natural beauty (Marler & McCrea, 1977), and lost property value (Tyrväinen, 1999).
Table 8-6: Estimates of economic costs of exotic forest pests (for sources of information see Turner et al. 2004)

<table>
<thead>
<tr>
<th>Cost</th>
<th>Cost estimate ($ 10^6)</th>
<th>Pest</th>
<th>Country/ Region</th>
<th>Year/ Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eradication</td>
<td>NZ$10</td>
<td>Orgyia thyellina</td>
<td>New Zealand</td>
<td>1997</td>
</tr>
<tr>
<td></td>
<td>NZ$100</td>
<td>Teia anatoides</td>
<td>New Zealand</td>
<td>2003-</td>
</tr>
<tr>
<td></td>
<td>NZ$3.98</td>
<td>Ophiostoma novo-ulmi</td>
<td>New Zealand</td>
<td>1989-2004</td>
</tr>
<tr>
<td>Reduced harvest value</td>
<td>US$4.2</td>
<td>Lymantria dispar</td>
<td>USA</td>
<td>1933-1952</td>
</tr>
<tr>
<td></td>
<td>NZ$97.9</td>
<td>Orgyia thyellina</td>
<td>New Zealand</td>
<td>1997</td>
</tr>
<tr>
<td></td>
<td>US$35-US$5841</td>
<td>Defoliator insects</td>
<td>Western USA</td>
<td>1990</td>
</tr>
<tr>
<td></td>
<td>US$33.35-US$1670</td>
<td>Bursaphelenchus spp.</td>
<td>Western USA</td>
<td>1990</td>
</tr>
<tr>
<td></td>
<td>US$24.9-US$240.6</td>
<td>Lachnellula willkommii</td>
<td>Western US</td>
<td>1990</td>
</tr>
<tr>
<td></td>
<td>US$201-US$1500</td>
<td>Ips typographus</td>
<td>Western USA</td>
<td>1990</td>
</tr>
<tr>
<td></td>
<td>US$81.1-US$331.4</td>
<td>Annosus root disease</td>
<td>Western USA</td>
<td>1989</td>
</tr>
<tr>
<td></td>
<td>US$4.34</td>
<td>Orgyia pseudotsugata</td>
<td>USA</td>
<td>1983</td>
</tr>
<tr>
<td></td>
<td>US$2100</td>
<td>Plant pathogens</td>
<td>USA</td>
<td>2000</td>
</tr>
<tr>
<td></td>
<td>US$2100</td>
<td>Insect pests</td>
<td>USA</td>
<td>2000</td>
</tr>
<tr>
<td></td>
<td>NZ$6.1</td>
<td>Dothistroma pini</td>
<td>New Zealand</td>
<td>1989</td>
</tr>
<tr>
<td></td>
<td>NZ$22.5</td>
<td>Dothistroma pini</td>
<td>New Zealand</td>
<td>2004</td>
</tr>
<tr>
<td></td>
<td>NZ$5.4</td>
<td>Diplodia pinea</td>
<td>New Zealand</td>
<td>1961-1989</td>
</tr>
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<td></td>
<td>NZ$13.8</td>
<td>Cyclaneusma minus</td>
<td>New Zealand</td>
<td>1989</td>
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<td>NZ$50.9</td>
<td>Cyclaneusma minus</td>
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<td>Cyclaneusma minus</td>
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<td>Armillaria spp.</td>
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<td>NZ$37</td>
<td>Armillaria spp.</td>
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<td>US$108-US$999</td>
<td>Cronartium fusiforme</td>
<td>USA</td>
<td>1992</td>
</tr>
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<td></td>
<td>C$12.7 – C$33.1 billion</td>
<td>Numerous</td>
<td>Canada</td>
<td>2006</td>
</tr>
<tr>
<td>Control</td>
<td>NZ$1.2 yr¹</td>
<td>Dothistroma pini</td>
<td>New Zealand</td>
<td>1989</td>
</tr>
<tr>
<td></td>
<td>NZ$1.6 yr¹</td>
<td>Dothistroma pini</td>
<td>New Zealand</td>
<td>2004</td>
</tr>
<tr>
<td></td>
<td>US$0.66</td>
<td>Orgyia pseudotsugata</td>
<td>Northwest USA</td>
<td>1983</td>
</tr>
<tr>
<td></td>
<td>US$49</td>
<td>Cronartium fusiforme</td>
<td>Southern USA</td>
<td>1992</td>
</tr>
<tr>
<td></td>
<td>NZ$34.7</td>
<td>Orgyia thyellina</td>
<td>New Zealand</td>
<td>1997</td>
</tr>
<tr>
<td>Urban forest loss</td>
<td>NZ$1.5</td>
<td>Ophiostoma novo-ulmi</td>
<td>New Zealand</td>
<td>1993</td>
</tr>
<tr>
<td></td>
<td>NZ$10 100</td>
<td>Ophiostoma novo-ulmi</td>
<td>New Zealand</td>
<td>1999</td>
</tr>
<tr>
<td></td>
<td>NZ$116.7</td>
<td>Forest pathogens</td>
<td>New Zealand</td>
<td>2003</td>
</tr>
<tr>
<td></td>
<td>NZ$290.5</td>
<td>Lymantria dispar</td>
<td>New Zealand</td>
<td>Undated</td>
</tr>
<tr>
<td></td>
<td>NZ$1.5</td>
<td>Orgyia thyellina</td>
<td>New Zealand</td>
<td>1997</td>
</tr>
<tr>
<td></td>
<td>NZ$19,450</td>
<td>Agrilus planipennis</td>
<td>United States</td>
<td>2009-2019</td>
</tr>
</tbody>
</table>

Estimates are not directly comparable due to differences in methodology, year of valuation, area of pest impact, etc. Cost estimates are nominal, varying in their base year, and are in different currencies.
The eradication of a newly discovered pest is generally difficult, often highly controversial, and frequently requires substantial resources costing millions of dollars and commitment of those in charge of an operation and the many stakeholders (e.g., Myers and Hosking, 2002; Simberloff, 2002 2003). It is therefore better to prevent incursions of new pests by providing adequate exclusion of products presenting a pest risk and to provide disinfestation treatments for those permitted entry under specific conditions, than to attempt eradication after an incursion.

However, as (Brockerhoff et al., 2010) found there are ample examples of successful eradication campaigns. These include several recent successful eradication campaigns against tree-defoliating Lepidoptera in New Zealand (at a cost of $NZ 94 million) and North America (e.g., Myers and Hosking, 2002, Suckling et al., 2007)). A number of other pest insects and diseases have been successfully eradicated, including the Mediterranean fruit fly (Ceratitis capitata) in Mexico, parts of Central America, Chile, Australia and California (several times) (Hendrichs et al., 2002); and the red imported fire ant (Solenopsis invicta) in New Zealand (Sarty 2007).

Although there have been some successes in eradicating certain important exotic pests after inadvertent introduction to a new area, in most cases where quarantine pests have been introduced, eradication was either impossible or not feasible for many reasons, including inadequate eradication tools for the species in question, extensive spread before detection, and cost or regulatory concern about the methods that would have to be employed to effect eradication. For these reasons, countries involved in trade have relied on effective quarantine measures to prevent the accidental import and establishment of new pest species. Along with other pest control methods, methyl bromide has been a key tool for this for over 70 years.

8.5.6 Description of the methodology for the assessment of the impact of restricting the quantities of methyl bromide production and consumption for quarantine and pre-shipment uses

8.5.6.1 Consumption of methyl bromide for quarantine and pre-shipment

TEAP (2009) reported global methyl bromide consumption for QPS of approximately 10,000 tonnes in 2007. Non-Article 5 Parties have in general decreased their consumption of QPS and some have phased out, whereas Article 5 Parties have increased their consumption significantly.

Article 5 Parties used about 6,235 tonnes for QPS in 2007, which exceeded the use in Non-Article 5 Parties (5,997 tonnes) for the first time. China, India, Indonesia, Malaysia, Republic of Korea, Singapore, Thailand and Vietnam were the dominant users in Asia (Figure 8-1). Latin American and African countries on the other hand used relatively little.

It appears that Parties that consume methyl bromide for QPS are now in the minority. About 22% of all Parties globally reported consumption of methyl bromide for QPS, compared to 49% that once consumed methyl bromide and have now stopped using it, or 29% that never used it at all for QPS. Parties that do not use methyl bromide for QPS, or once consumed it but no longer do so, may have replaced it with alternatives or may simply have stopped using it. However, it is possible that some exporting Parties that did not report consumption of methyl bromide for QPS relied on methyl bromide applied by the importing country for market access in the event that methyl bromide was applied for a pest of quarantine concern detected on entry. As the reporting by Parties does not provide information to this level of detail, further analysis of imports by some countries would be required to determine the extent to which some countries rely on the methyl bromide of others for market access.
In the case where an exporting country bans the use of methyl bromide for QPS, and the importing country has not changed its requirement to allow an alternative to methyl bromide to be used by the exporting country, the importing country may require fumigation with methyl bromide in another country en route, or on arrival. The ability of governments to detect such uses of methyl bromide depend on fumigators maintaining good fumigation records and in governments collecting and analysing the records in order to determine the uses for which alternatives are available and could be used.

For countries or regions that have phased out their uses of methyl bromide for QPS, such as the European Union, it would be useful if such Parties removed from their legislation the requirement for the exporting country to use methyl bromide, in circumstances where an alternative that provides the appropriate level of quarantine security is available. For example, in the EU legislation methyl bromide is only required in one case which is for export of oak logs to control oak wilt. However, when fumigation is specified in Directive 2000/29/EC as an option, the fumigant itself is generally not specified. This means that the EC does not specify that plants or plant products are required to be fumigated with methyl bromide. To be accepted by the EC, however, the fumigation treatment must be carried out to the specified requirements that have been approved by the EC Standing Committee on Plant Health.

Directive 2000/29/EC specifies the use of methyl bromide in only two cases: 1) Treatment of oak logs (Quercus L.) with bark attached that are exported from the United States of America to Europe; and 2) Treatment of wood-packaging material. Methyl bromide fumigation for oak logs with bark attached and for wood packaging material is not required under specific conditions when alternative treatments or procedures are used. Methyl bromide fumigation is not required by the EC if the oak wood meets one of the following conditions: (a) all round surfaces are removed, or (b) bark-free and dried to <20% moisture, or (c) bark-free and treated with hot-air or hot water treatment, or (d) sawn and kiln-dried to <20% moisture (Council Directive 2000/29/EC as amended, Annex IV, Part A, Section 1.3). These conditions may result in the imported material not be acceptable to the end user e.g., logs used for veneer, resulting in the use of methyl bromide to fumigate whole logs.

These and other objective parameters that show variations in methyl bromide consumption for QPS within and between countries and regions would be important to elucidate further when proposing methodology for the assessment of the impact of restricting the quantities of methyl bromide production and consumption for QPS uses. In proposing this methodology, the work undertaken to supply information to the Parties would benefit from any guidance that the Parties may wish to provide that would focus the TEAP’s work on particular groupings of countries or scenarios that would be of most benefit to the Parties.
(TEAP, 2009) described the main categories of use that could be used for data collection. Data are needed from the Parties by:

1. Category of use;
2. Quantity of use in latest year for which data are available;
3. Target pests and level of biosecurity required for the QPS measure;
4. Economic value of the QPS measure using methyl bromide;
5. Effectiveness and availability of potential alternatives for the particular use.

They are discussed below in relation to QPS consumption data, the experiences of Parties that have phased out methyl bromide for QPS, and the design of the any restriction on methyl bromide for QPS that might be agreed in the future by the Parties.

8.5.6.2 Domestic use of methyl bromide for QPS treatments

Apart from methyl bromide that is used on import to control pests of quarantine concern, or on exports under bilateral arrangements, it is also used domestically to prevent the spread of pests of quarantine concern within a country.

For some countries such as Argentina, domestic use consumes more methyl bromide for QPS than any other use, whereas in others such as Australia the consumption is about 10% of total methyl bromide use. Japan does not use any methyl bromide for QPS to prevent the spread of pests of quarantine concern within Japan.

Some countries use methyl bromide domestically for QPS to eradicate a pest (an ‘incursion response’) that has been introduced but has not established. These treatments may need to be undertaken annually or even several times in the same year. Methyl bromide is considered essential in many cases by quarantine authorities for controlling pest incursions and preventing pests from becoming established.

Determining the financial value of the ecosystem (forestry, food production, recreational and other resources) being protected in each country would be the prerogative of each Party and not work that TEAP could easily undertake. However, TEAP would include in its methodology any estimates of the likely cost of a alternative in relation to methyl bromide, and the influence that the implementation of an alternative might have on the trade flows of the major commodities identified in this report as being most commonly fumigated with methyl bromide.

These examples of the domestic consumption of methyl bromide for QPS are generally not under federal or national control but may be under the control of competent or regulatory authorities that do not necessarily report the quantity used at the national or federal level. As the quantities of methyl bromide are not known for domestic uses in some countries, and in order to assess the impact of restricting the quantities of methyl bromide for this purpose, TEAP would request Parties to obtain information on the amount of methyl bromide consumed for QPS domestically, the categories of use and the prospects of alternatives being used for this purpose.

8.5.6.3 Methyl bromide reported as QPS consumption

In the methodology for the assessment of the impact of restricting the quantities of methyl bromide production and consumption for QPS uses, TEAP would suggest obtaining the most recent reports on
QPS consumption that have been submitted annually by Parties to the Ozone Secretariat pursuant to Article 7 of the Montreal Protocol.

The limitations of these reports are that some Parties have not reported or that they report inconsistently from one year to the next. Some Parties do not yet have a mechanism in place for determining the quantity of methyl bromide used on exports for QPS. TEAP proposes to take account of these limitations by extrapolating the information for missing years from existing information where this is feasible, and/or by contacting the Party / National Ozone Unit in the country concerned to determine if any further information can be made available.

Once the information is contained in a database, TEAP would suggest analysing the information for trends in the consumption of methyl bromide for QPS in the relevant Parties. For example, TEAP (2009) reported that there were nine non-Article 5 Parties in 2007 that reported QPS consumption pursuant to Article 7, and of these two Parties accounted for 82% of the methyl bromide consumption for QPS.

Treatment on arrival is common in some countries that have stringent quarantine standards. Treatment on import of products from many countries allows these products to be placed on the domestic market of the importing country. Treatment on arrival is therefore important for trade with many countries. These data would indicate that the TEAP methodology should examine the disinfection treatments carried out by relatively few Parties in the Montreal Protocol, with the understanding that these uses facilitate the trade with many Parties that themselves may not use methyl bromide for QPS. TEAP would request data from countries on the amount of methyl bromide used for treatment on import, the types of commodities treated and the countries that shipped them.

On the basis of reports submitted by Parties in 2009 to the Ozone Secretariat on uses of methyl bromide for QPS, TEAP would include in the methodology an assessment of the quantity of methyl bromide that was reported to be used for specific categories of use. (TEAP, 2009) reported that just over half the methyl bromide used for QPS in 2007 was used on commodities prior to export, whereas only about 15% was used on commodities when a pest was detected on import. Less methyl bromide on import could be expected since most National Plant authorities prefer to have disinfection treatments at the point of origin since there is typically sufficient time for the treatment at that location and the phytosanitary risk is less when the treatment is carried out in the exporting country.

(TEAP, 2009) also reported that about 75% of the methyl bromide consumed for QPS was applied to products in four major categories: sawn timber and wooden packaging material; grains or similar foodstuffs; pre-plant soil use; and logs. This indicated that the alternatives that had been applied in many countries for these uses could provide a useful lead in determining their suitability in countries using methyl bromide for QPS.

The relatively large consumption of methyl bromide for QPS by relatively few countries does not mean that TEAP would focus its methodology only on these countries. In many cases, a relatively small volume of methyl bromide is very important for trade from low volume consuming (LVC) Parties. Therefore understanding the trade flows and methyl bromide consumption in LVC Parties would be incorporated into the TEAP methodology.

In general for all Parties that use methyl bromide for QPS, TEAP would put in place methodology that would measure the change from the baseline (methyl bromide for QPS) as a result of the loss of methyl bromide or its replacement with an alternative. This could be tested under the assumption that demand for the product remains the same but the conditions for market access change. What are the regulatory barriers? What is the impact if the alternative is less costly than methyl bromide? Some of the impacts would be difficult to measure since there is no single economic construct that can be used to assess changes in the markets, most markets are price sensitive according to supply and demand, the extent of the inventory varies according to the market and the commodity, and the options for diverting trade may be limited in the event that methyl bromide is not replaced with an alternative.
TEAP would also propose including in the methodology an examination of any data that is held by competent or regulatory authorities on the uses of methyl bromide for QPS. Decision XI/13 in 2001 encouraged Parties to monitor the use of QPS-MB by commodity and quantity as a way of targeting the efficient use of resources when developing and implementing technically and economically feasible alternatives.

TEAP proposes to request Parties to provide information on methyl bromide consumed for QPS in specific categories, the quarantine pests involved, the amounts used for regulated non-quarantine pests, the reasons why a substitute for methyl bromide for a particular use had or had not been possible, and the costs of the alternative. This information will contribute toward an assessment of the potential impact of restricting the quantities of methyl bromide production and consumption for QPS uses.

8.5.6.4 International Plant Protection Convention

In 2008, the International Plant Protection Convention that is responsible for phytosanitary (quarantine) issues adopted a Recommendation on Replacement or Reduction of the Use of Methyl Bromide as a Phytosanitary Measure. It noted that, to reduce the risk of introduction of some quarantine pests, the need for methyl bromide remained until a range of equivalent alternatives had been developed. Inter alia, it encouraged Parties ‘to put in place a strategy that will help them to reduce the use of methyl bromide for phytosanitary measures and/or reduce emissions of methyl bromide’. The strategy included actions to replace methyl bromide, such as reducing use, physically reducing emissions, accurately recording methyl bromide use, and guidelines for appropriate use of methyl bromide as a phytosanitary measure.

As part of the methodology for the assessment of the impact of restricting the quantities of methyl bromide production and consumption for QPS uses, TEAP proposes close collaboration with the IPPC on issues related to the use of methyl bromide, and on the use of alternatives to methyl bromide for phytosanitary treatments.

The collaboration between TEAP and the IPPC could include, inter alia, gaining a better understanding of the role and impact of IPPC standards that facilitate trade; the likely impact on the consumption of methyl bromide of any new treatments added to ISPM-15 for the treatment of wood packaging material; and how regulatory and other issues impede or support the adoption of methyl bromide alternatives for QPS uses.

8.5.6.5 Trade that depends on the use of methyl bromide for QPS

There are some commodities that are traded between countries that are dependent on methyl bromide fumigation for the disinfestation of pests of quarantine concern for this trade to occur. The most useful example to illustrate this is the trade in logs from countries such as the USA and New Zealand to South Korea, China and India. This trade is characterised by unpredictable demand which can increase significantly within a short time period. For example, the log trade from New Zealand in the first quarter of 2009 was equivalent to the entire trade the year previously. Although in-transit phosphine has been approved as an alternative to methyl bromide as a result of a bilateral agreement, the bulk of the trade is still dependent on methyl bromide.

Apart from this international trade where quarantine pests are controlled, there is also trade in commodities such as grain that undergoes a pre-shipment fumigation with methyl bromide prior to shipment. These treatments are authorised by the authorities described in Section 8.5.2.3 above, and

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1 IPPC (2008) IPPC Recommendation on Replacement or Reduction of the Use of Methyl Bromide as a Phytosanitary Measure. Recommendation for the Implementation of the IPPC.
are carried out to reduce the population of non-quarantine pests that can, if left unchecked, reduce the quality of the commodity.

In order to assess the impact of restricting the quantities of methyl bromide production and consumption for quarantine and pre-shipment uses, TEAP proposes including methodology to better understand the value of the trade that depends on methyl bromide, the trends that are taking place particularly at a time of improvement in the global economy, the impact on this trade of not having access to methyl bromide in the event that a technically and economically feasible alternative is not available, and the quantities of methyl bromide that are required to facilitate this trade.

As part of this methodology, TEAP also proposes obtaining information on the likely time that would be required to negotiate a bilateral trade agreement for an alternative; the impact of tariffs on trade, the domestic infrastructure (e.g. saw mills) and legislation that enhance or reduce the prospects for the implementation of technically and economically feasible alternatives; and the types of alternatives that might be available that meet customer specifications for logs.

Some exporting countries are required to use methyl bromide for QPS prior to shipment to meet the regulatory or similar requirements in the importing country for the trade in a particular commodity. In this case, the exporting country is not able to eliminate its use of methyl bromide for this use and still maintain trade.

The importing country may be willing to accept an alternative treatment to methyl bromide for an equivalent level of quarantine security, but has not yet reviewed its regulatory requirements to make a change to eliminate the need for methyl bromide. Decision XI/13 in 2001 encouraged Parties to review their national plant, animal, health and stored product regulations with a view to removing the requirement for the use of methyl bromide for QPS where technically and economically feasible alternatives exist. TEAP would propose including methodology that would quantify the amount of methyl bromide that is used for this purpose, the name of the regulation that requires this use, the commodity involved, and alternatives that may or may not be available to substitute for this use.

For bilateral treatments, many countries do not specify the treatment that is to be applied in the exporting country to control pests of quarantine concern that could be present on commodities imported. Instead, the level of quarantine security that is required to be achieved is specified. The exporting country then must prove with research that the treatment and conditions it proposes to achieve the importing country’s desired level of quarantine security.

TEAP would apply the same methodology used for the logs to other sectors where there is significant international trade flows in order to construct a more complete picture of the global trade that depends on methyl bromide.

8.5.6.6 Experiences of the phase out of methyl bromide for QPS in some countries

(TEAP, 2009) reported that some countries have either not reported methyl bromide consumption for QPS, or reported this consumption in the past but no longer use methyl bromide for QPS. This would imply that alternatives to methyl bromide for QPS have been adopted, or that trade in products that depended on methyl bromide for export or import no longer takes place. The extent of the restriction to phase out methyl bromide for QPS is dependent on the extent to which methyl bromide can be replaced by alternatives or not. The phase out of methyl bromide for QPS in these countries can therefore provide some important quantitative and qualitative information on the impact of restricting or eliminating quantities of methyl bromide for this use.

In proposing methodology for the assessment of the impact of restricting the quantities of methyl bromide production and consumption for QPS uses, TEAP proposes to obtain information to understand the procedures, planning process, regulatory environment, cost, logistics, research & development and other details that resulted in the phase out of methyl bromide for QPS in some countries.
countries. TEAP would document areas where trade continued or increased as a result of the adoption of an alternative, and situations where trade was reduced or halted as a result of having no recourse to methyl bromide. The environmental impact of introduced pest species would be compared between countries that have and have not phased out the use of methyl bromide for QPS use. In situations where there is a loss of trade, it can take many years for the trade to re-establish to similar volumes.

The adoption rate of an alternative is often highly dependent on its cost. For example, in some countries, such as Argentina, heat treatments of solid wood packaging to ISPM-15 standard now account for all of the ISPM-15 disinfestation treatments despite methyl bromide also being available for this purpose. Although no detailed investigation has been carried out, it is likely that the users selected heat because it was less expensive and not hazardous to human health compared to methyl bromide (Eduardo Willink MBTOC pers. comm., 2010).

For the major categories that consume methyl bromide for QPS and for the relevant countries, TEAP proposes to include methodology that assesses the cost threshold for when alternatives become economic to adopt, the cost of the research for those alternatives and government subsidies that were potentially available to support the change. TEAP would document uses of methyl bromide and quantities that were unlikely to be replaceable because of the lack of finance to support the transition away from methyl bromide.

TEAP proposes requesting this information from relevant Parties and commercial interests, and by using its membership and that of MBTOC to follow up with Parties and commercial interests in the relevant countries.

8.5.6.7 Other methods to reduce emissions of methyl bromide

Another method to reduce some emissions of methyl bromide is to attach equipment that recovers/destroys or recovers-recycles-destroys any methyl bromide used for QPS. Methyl bromide fumigations for QPS except for soil fumigations normally occur in well-sealed fixed facilities or shipping containers, which facilitates the attachment of equipment for recovery, recycling and destruction. Recapture may, depending on the absorption by the commodity being fumigated, result in 40 – 90% reduction in methyl bromide emissions.

Experience with recapture and recycling equipment in conserving methyl bromide continues to accumulate (see (TEAP, 2009) for details). One country has dual chambers that vents used methyl bromide from one chamber and recycles it to an adjacent chamber using about 30% less methyl bromide than would otherwise be used. However, some countries do not allow re-use of methyl bromide on food or other products, whereas others allow this use. Some countries or states have recapture and destruction facilities working and a significant amount of gas is being destroyed, resulting in the possibility of the Party deducting the destroyed amount from their consumption data submitted under Article 7. The cost of capturing and destroying methyl bromide is reported to be approximately double the cost of the fumigation treatment.

TEAP proposes to include a determination of the usefulness and financial significance of such equipment within its methodology for assessing the impact of restricting the quantities of methyl bromide production and consumption for QPS uses.

8.5.6.8 Design of the restriction influences TEAP’s proposed methodology

The design of any QPS restriction will have an impact on the feasibility of the transition from methyl bromide to alternatives for QPS, and the methodology that TEAP could put in place to assess the impact of restricting the quantities of methyl bromide production and consumption for quarantine and pre-shipment uses.
8.5.6.8.1 Timeframe for any proposed restriction

As a result of TEAP’s collection and analysis of consumption data supplied by the Parties and described above, TEAP may be in a position to improve on estimates of the quantity of methyl bromide for QPS that could and could not be replaced by alternatives over different time scenarios. Allowing a Party sufficient time to replace methyl bromide used for QPS with an alternative will improve the prospects for compliance with any proposed restriction that the Parties might agree in the future. It would also allow importing countries sufficient time to amend any requirements to permit the use of an alternative in the exporting country, rather than methyl bromide, which might otherwise be the case.

8.5.6.8.2 Flexibility of choice

The Parties may also see other factors as important, such as allowing a Party flexibility in the choice of methyl bromide uses that are replaced with alternatives. Flexibility has been an important cornerstone of the phase out of other ODS in the Montreal Protocol.

8.5.6.8.3 Exemption pathway

An exemption pathway may also be seen as useful whereby a Party would be able to gain access to methyl bromide for QPS and exceed the national restriction, in the event that a technically and economically feasible alternative for this use was not available. This may be important for maintaining trade that depends on methyl bromide, in the light of unpredictable and relatively quick changes in trade volume that are known to occur (see Section 8.5.6.5 above).

The procedures that have been developed for the assessment of nominations for Critical Uses of non-QPS methyl bromide may provide guidance to the Parties on the options for the evaluation of any recourse to a similar exemption that may be considered by the Parties for QPS. Unpredictable and relatively quick changes in trade volume and trade partners, sudden changes in bilateral phytosanitary requirements following pest outbreaks, and the need for a rapid response to enable pest eradication suggest that any exemption pathway should be efficient and speedy.

8.5.6.8.4 Pre-shipment

(TM, 2009) reported that, according to a data recently submitted by the Parties in 2009, the use of methyl bromide for pre-shipment appeared to be small compared to its use in the past. Because these data were relatively limited, TEAP would propose including methodology to specifically assess where methyl bromide was still being used for pre-shipment, the applications by category, and the quantities of methyl bromide being consumed for this purpose. Further data on pre-shipment and alternatives for this use would determine the importance of this use for Parties.

Pre-shipment targets unregulated non-quarantine pests that usually affect storage and end-use quality. Pre-shipment applications are not within the scope and mandate of the IPPC, as that Convention is concerned with regulated quarantine and non-quarantine pests in international trade. Removing pre-shipment would also remove the inconsistency in the classification of uses as pre-shipment or quarantine by the Parties due to differences in interpretation of quarantine and pre-shipment that have been defined by the Parties to the Montreal Protocol.

8.5.6.8.5 Timing and impact of any restriction on the funding of alternatives

The MLF provides financial assistance to Parties in accordance with Article 10 of the Montreal Protocol. Significant financial assistance to Article 5 Parties is not usually provided until the Parties agree a control measure for the reduction and phase out of a specific ODS use. Currently, methyl
bromide for QPS is exempted from phaseout under the agreed control measures and therefore and therefore there has been little expenditure by the MLF to date on projects in Article 5 Parties on alternatives to methyl bromide for QPS.

Section 8.5.6.1 showed that while some Parties were decreasing and even eliminating their consumption of methyl bromide for QPS, some Parties and in particular those in Asia had increased their consumption of methyl bromide for QPS significantly in 2007.

(TEAP, 2009) reported that consumption for QPS in Article 5 countries exceeded that of non-Article 5 Parties for the first time in 2007. This may reflect a combination of the trend towards increased treatment at country of origin prior to shipment, increased trade from Article 5 countries at risk of infestation by quarantine pests (requiring QPS fumigation), and adoption of alternatives in non-Article 5 countries. TEAP would put in place methodology to determine the most likely reason for this increased consumption. Continuing increase in methyl bromide consumption for QPS may increase the cost to the MLF of eliminating methyl bromide used for QPS in Article 5 Parties.

\section*{8.5.7 \quad Discussion and conclusions}

For many Parties, the use of methyl bromide for QPS is synonymous with its use in facilitating market access under conditions that reduce the risk of accidentally introducing exotic pests that have the ability to cause significant damage agriculture, forests and ecosystems. However, its positive attributes have been offset by its ability to deplete ozone and therefore the Parties through Decision XXI/10 have requested information on the methodology that could be used to assess the impact of restricting the quantities of methyl bromide for QPS uses.

TEAP has described methodology that could be used to provide information for the consideration of the Parties should they wish to restrict the use of methyl bromide for QPS in the future. The informational needs are challenging since the routine reporting by the Parties under Article 7 does not sufficiently describe the role that methyl bromide has in facilitating trade flows for some commodities, and the importance of treatment on arrival that is carried out in some countries that allow trade in a wide range of commodities from many more countries than are reflected in the methyl bromide consumption data.

Apart from the statistics on methyl bromide consumption, TEAP has also suggested how insights can be gained from Parties that have phased out their use of methyl bromide for QPS, some as long as 15 years ago. Much can be learnt from their success, as well as understanding where difficulties occurred and where trade for some commodities is pending the implementation of an alternative.

On the basis of the MBTOC’s review in 2009 and in 2010, there appear to be some uses of methyl bromide that are not consistent with the definitions of QPS under the Montreal Protocol. Paragraph 3(4) of Decision XXI/10 requested TEAP to propose methodology that considered the variations in the use of methyl bromide for QPS within and between countries. TEAP therefore notes that there are such variations in the use of methyl bromide for QPS, particularly in its use as a soil fumigant (see Section 8.5.4 above; and (TEAP 2009)). Soil uses accounted for approximately 15-20\% of the reported global consumption of methyl bromide for QPS that was categorised by a Party as QPS in 2007. In Table 8-5 above, TEAP estimated that about 50\% of the soil uses of methyl bromide that had been so categorised were replaceable. TEAP urges Parties to require the uses of methyl bromide to be fully consistent with the definitions of QPS agreed by the Parties, as consistency with the definitions would significantly reduce the amount of methyl bromide used for QPS. Uses that were agreed by the Parties to not be consistent with the agreed definitions could then be identified and excluded from any proposed methodology that could be used to assess technically and economically feasible alternatives to methyl bromide for QPS.

The design of the restriction also significantly influences that methodology that TEAP could use to assess the impact of any restriction that the Parties may wish to place on QPS in the future. For
example, compared with other ozone-depleting substances that have been phased out, some QPS alternatives require significant time to develop them and to negotiate internationally agreeable levels of quarantine security and conditions of use. Trade flows can be fickle, depending on market opportunities that require many elements to be in place for the trade to be successful, including an effective disinfection treatment where this became necessary.

This chapter has therefore highlighted in the methodology description a range of activities that would be important for data accumulation, analysis and reporting. TEAP would therefore be pleased to receive any comments from the Parties that may wish to contribute to the further development of this methodology.

8.6 References


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8.7 Annexes to chapter 8

8.7.1 Annex 1: Decision XXI/10 Quarantine and pre-shipment uses of methyl bromide

Recognizing that methyl bromide use for quarantine and pre-shipment purposes is identified in the 2006 assessment report of the Scientific Assessment Panel as a remaining uncontrolled use of ozone-depleting substances of which the emissions may delay recovery of the ozone layer;

Mindful of the Scientific Assessment report scenarios which calculated that the integrated total chlorine and bromine in the atmosphere from 2007 to 2050 (equivalent effective stratospheric chlorine, EESC) would be reduced by 3.2% if all quarantine and pre-shipment emissions were eliminated by 2015;

Mindful that the use of methyl bromide for quarantine and pre-shipment purposes is still increasing in some regions,

Acknowledging the efforts made by Parties to phase-out or reduce the use and emissions of methyl bromide for quarantine and pre-shipment purposes,

Noting that 22 non-Article 5 Parties and 54 Article 5 Parties have reported data on current quarantine and pre-shipment consumption, that 31 other Parties which used quarantine and pre-shipment in the past have reduced their quarantine and pre-shipment consumption to zero, and that 14 additional Parties will cease next year and that a further 27 Parties are scheduled to cease consumption by 1 January 2010;

Noting that the Technology and Economic Assessment Panel’s Task Force concluded that there are technically feasible alternatives which may replace a large proportion of the quarantine and pre-shipment uses of methyl bromide, especially in sawn timber, wood packaging material (ISPM-15), grains and similar foodstuffs, pre-plant soils use and logs;

Aware that, particularly for compliance with ISPM-15, there are more than 6,000 certified heat treatment facilities deployed in many countries, and that not-in-kind alternatives (such as plastic pallets or cardboard pallets) are available worldwide, including in many Article 5 countries, and do not require any treatment under ISPM-15; also noting that the ISPM-15 standard encourages national plant protection organisations (NPPOs) to promote the use of alternative treatments approved in that standard;

Further noting that under the International Plant Protection Convention alternative treatments are currently under review;

Noting the importance of monitoring quarantine and pre-shipment uses of methyl bromide and their reporting under Article 7 in order to assess the contribution of quarantine and pre-shipment uses to methyl bromide emissions into the atmosphere;

Aware that several Parties have succeeded in reducing quarantine and pre-shipment consumption by adopting policy measures such as promoting the adoption of alternatives, reviewing regulatory requirements, allowing alternative options, adopting ‘polluter pays’ taxes on methyl bromide imports, and/or limiting quarantine and pre-shipment consumption;

Noting that methyl bromide use and emissions can also be reduced by technical improvements in fumigation practices, such as using gas-tight structures, determining minimum effective methyl bromide doses, monitoring during fumigation to minimise re-dosing, using recovery
equipment, and treating wood packing materials prior to loading containers rather than treating entire loaded containers;

1. *To remind* Parties of their obligations to report annual data on the consumption of methyl bromide for quarantine and pre-shipment under Article 7 and to establish and implement a system for licensing trade in methyl bromide, including quarantine and pre-shipment, under Article 4B;

2. *To invite* Parties to collect data on quarantine and pre-shipment according to Decision XI/13, and to consider using the format provided in the Technology and Economic Assessment Panel’s report of April 1999;

3. *To request* the Technology and Economic Assessment Panel and its Methyl Bromide Technical Options Committee, in consultation with other relevant experts and the IPPC Secretariat to provide a report to be considered by the 30th meeting of the Open-ended Working Group covering the following:

   (1) A review of available information on the technical and economical feasibility of alternatives, and the estimated availability, for the following categories of quarantine and pre-shipment uses:
   - Sawn timber and wood packaging material (ISPM-15);
   - Grains and similar foodstuffs;
   - Pre-plant soils use;
   - Logs;

   (2) The current availability and market penetration rate of quarantine and pre-shipment alternatives to the uses listed in paragraph 3(1) above, and their relation with regulatory requirements and other drivers for the implementation of alternatives;

   (3) An update of Table 9.1 of the 2009 Task Force report to include economic aspects, and to take account of the information compiled under this paragraph, distinguishing between Article 5 and non Article 5 parties and between quarantine and pre-shipment uses separately;

   (4) A description of a draft methodology, including assumptions, limitations, objective parameters, the variations within and between countries and how to take account of them, that the Technology and Economic Assessment Panel would use, if requested by the Parties, for the assessment of the technical and economical feasibility of alternatives, of the impact of their implementation and of the impacts of restricting the quantities of methyl bromide production and consumption for quarantine and pre-shipment uses;

4. *To encourage* Parties to apply best-practice measures to reduce methyl bromide quarantine and pre-shipment use and emissions, that may include the review of required use dosages, gas tightness controls, monitoring during fumigation and other measures to minimize methyl bromide dosages, and, in applications where alternatives are not yet available, the recovery and possible reuse of methyl bromide, and to review the methyl bromide quarantine and pre-shipment requirements for possibilities of introducing alternative mitigation measures whenever possible;
5. To encourage Parties to consider adopting, where possible within their national policy framework, incentives to promote the transition to alternatives such as deposit/rebate schemes or other financial measures;

6. To encourage Parties or regions to use the October 2009 Technology and Economic Assessment Panel quarantine and pre-shipment task force report to develop documents that summarise information on technical options to reduce emissions, and on adopted technologies that have replaced methyl bromide quarantine and pre-shipment applications, the reductions achieved, the investments needed, the operating costs, and the funding strategies;

7. To encourage Parties to implement the recommendations of the third meeting of the Commission of the Phytosanitary Measures under the IPPC, also referred to in Decision XX/6.

8.7.2 Annex 2: Definitions of Quarantine and Pre-shipment

Decision VI/11: Clarification of “quarantine” and “pre-shipment” applications for control of methyl bromide

The Sixth Meeting of the Parties decided in Dec. VI/11:

1. Recognizing the need for non-Article 5 Parties to have, before 1 January 1995, common definitions of “quarantine” and “pre-shipment” applications for methyl bromide, for purposes of implementing Article 2H of the Montreal Protocol, and that non-Article 5 Parties have agreed on the following:

   (a) Quarantine applications, with respect to methyl bromide, are applications 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 authorized 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.

Decision XI/12: Definition of pre-shipment applications of methyl bromide

The Eleventh Meeting of the Parties decided in Dec. 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. Official requirements are those which are performed by, or authorized by, a national plant, animal, environmental, health or stored product authority.
9 Methyl Bromide Technical Options Committee (MBTOC) Progress Report

This chapter updates trends in methyl bromide (MB) production and consumption for controlled and exempted uses, 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).

9.1 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 April 2010. 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, three Article 5 Parties had not submitted data for 2008. The database for MB is however much more complete than in the past.

9.1.1 Controlled uses

9.1.1.1 Production of MB for controlled uses

Trends in the reported production of MB for all controlled uses (excluding QPS and feedstock) in all non Article 5 and Article 5 countries are shown in Figure 9-1 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 Article 5 and non-Article 5 countries decreased from the preceding year (details can be found in section 9.1.2). Production in 2008 continued the downward trend, totalling 10,784 tonnes or 17% of the baseline.
Non-Article 5 countries reduced their MB production for controlled uses from about 66,000 tonnes in 1991 (non-Article 5 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, and to 10,146 in 2008, 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) in 2003 to 39% of baseline in 2004. For 2008 the production amount is 638 tonnes, which represents 49% 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.

9.1.1.2 Global consumption for controlled uses

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 9,902 tonnes in 2008 as illustrated by Fig 9-2 below.
Figure 9-2: Baselines and trends in MB consumption in Non-Article 5 and Article 5 regions, 1991 – 2008 (metric tonnes)

Source: MBTOC estimates calculated from Ozone Secretariat data of April 2010.

9.1.1.3 Consumption trends in Non-Article 5 countries

Figure 9-2 shows the trends in MB consumption in Non-Article 5 countries for the period between 1991 and 2008. The official baseline for Non-Article 5 countries was 56,050 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 2008 the estimated consumption based on quantities approved or licensed amounted to 6,996 tonnes or about 12% of the baseline (however, reported use to the Ozone Secretariat was only 4,507). For 2009 about 5,870 tonnes were approved or licensed which is a further reduction to 10% 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 2009, permitted levels amounted to 17%, 0%, 17% and 5%, in the same order, whilst for 2010 these figures came down to 11%, 0%, 8% and 4% 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.
- Of the eleven Parties applying for MB for CUEs in 2007 only five have sought CUEs in 2010. Israel has announced that it will not seek further exemptions as of 2012 and Japan, in accordance with its phase-out plan, will stop CUN requests for soil uses by 2013. A phase out plan for postharvest uses is expected from the Party.

9.1.1.4 Consumption trends in Article 5 and CEIT countries

Figure 9-2 shows the trend in MB consumption in Article 5 countries in the period between 1991 and 2008. 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. Article 5 consumption was reduced to 67% of baseline in 2004 (10,512 tonnes) and 34% in 2008 (5,395 tonnes).

• Most Article 5 Parties have continued to make substantial progress in achieving reductions in MB consumption at a national level.

Trends at national level can be described as follows:

• At the time of preparing this report, three Article 5 Parties had not reported MB consumption for 2008: Ethiopia, Nauru and Timor-Leste. One Party, El Salvador, reported export of MB, which was imported previously into the country (i.e. negative consumption)

• In 2008, 87% of Article 5 Parties (128 Parties) reported national consumption of less than 50% of the national baseline. Only fifteen Article 5 Parties consumed more than 50% of their national baseline.

• 75% of Article 5 Parties (110 Parties) reported zero MB consumption in 2008. This shows continued progress since 2002 when 50% of Article 5 Parties reported zero MB consumption.

• According to latest reported consumption data (for 2008) only one Article 5 country (Iraq) was in non-compliance with the 20% reduction step of 2005.

• 87% of Article 5 parties (128 parties) reduced their national MB consumption to less than 50% of national baseline in 2008.

At regional level, the decrease in consumption has been greatest in Countries with Economy in Transition (CEIT) (now reporting zero consumption), 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. 9-3). 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, but progress in reduction has been made in these countries in 2008 as compared to 2007.

The status of MB phase-out in Article 5 regions in 2008, compared to the regional baselines (1995-98 average) is as follows:

• Latin America has phased-out 51% of its regional baseline

• Africa has phased-out 75% of its regional baseline

• Asia has phased-out 72% of its regional baseline

• CEIT region has phased-out 100% of its regional baseline
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. The top 15 countries reduced MB consumption by 68% from 2001 to 2008 (from 14,932 tonnes in 2001 to 4,830 tonnes in 2007). An increase is noted in South Africa, increased consumption from 100 tonnes in 2007 to 376.5 in 2008.

- In the last 4 years alone, the top 15 countries have reduced MB by 49% (from 9,399 tonnes in 2004 to 4,830 tonnes in 2007).
- In 2008, MB consumption in the top 15 countries was only 38% of the baseline on average
- By 2008 these large consumers have phased out 76% of their historical peak use of MB.

Many Article 5 countries are finishing or have finished implementing MLF projects to reduce or totally phase-out MB. This includes 14 of the 15 largest MB consuming countries (i.e. countries that consumed more than 470 metric tonnes, which together accounted for 80% of the Article 5 baseline consumption). The exception is South Africa, which is currently preparing a Global Environment Fund (GEF) project for MB phase-out. Two Parties in this group, Brazil and Turkey, which reported consumption larger than 500 tonnes in the past, phased out completely and reported zero consumption in 2007. In 2008, Lebanon has joined this group.

### 9.1.2 Exempted uses

#### 9.1.2.1 Production for QPS purposes (exempted uses)

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, followed by a significant decrease in 2008 (Fig. 9-4). 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 9-4: Reported or estimated QPS production 1990 - 2008**

![Graph showing reported or estimated QPS production 1990-2008](image)

Source: MBTOC, 1994, 1998; MBTOC estimates; Ozone Secretariat data, April 2010

### 9.1.2.2 Consumption for QPS purposes (exempted uses)

Figure 9-5 below shows the reported QPS consumption in Article 5 Parties and non-Article 5 Parties from 1999 to 2008. When consumption is considered in the light of regional groupings of Article 5 and non-Article 5 countries, the following trends are evident:

- In 2007 reported consumption for QPS in Article 5 countries exceeded that in non-Article 5 for the first time. This trend continued in 2008.

- 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 and 3,136 in 2008.

- In contrast, reported consumption for QPS uses in Article 5 countries has grown in an approximately linear fashion since 2000, from 3,990 tonnes to 5,803 tonnes in 2007 and 5,906 in 2008.

- It may be speculated that the reasons for the increases in QPS consumption in Article 5 countries with corresponding decrease in non-Article 5 countries results from a combination of the trend towards increased treatment at country of origin prior to shipment, much increased trade from Article 5 countries that are at risk of infestation by quarantine pests and requiring QPS fumigation, and concurrent adoption of non-methyl bromide alternatives in non-Article 5 countries (TEAP, 2009)

Evolution of reported consumption for Article 5 and non-Article 5 Parties is illustrated in Fig 9-5 below.
Fig 9-5: MB consumption for QPS uses in Article 5 and non-Article 5 Parties 2000 - 2008

Source: Ozone Secretariat Database, April 2010

9.2 Alternatives for Soil Treatments

9.2.1 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, 2009a). The recent registration of methyl iodide in the US (in all states except California, New York and Washington) of methyl iodide and the adoption of a 3 way fumigant system (1,3-D/Pic/metham sodium) (Culpepper et al., 2008) have offered further options for many of the remaining uses proving difficult to control with other alternatives. Nevertheless concerns on the toxicity of methyl iodide on ornamentals and vegetables still need further clarification (Rosskopf et al., 2009; Spadafora, 2009). Dimethyl disulfide (DMDS), a new fumigant (Ajwa et al., 2010) is also being tested in various countries and was found to be effective against a wide range of galling and non-galling nematodes. It is less effective against fungi and weeds (Owens et al., 2009).

Several Parties previously applying for CUNs particularly for 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 practices, i.e. slightly longer plant back times and a greater awareness of soil conditions which improve the efficiency of alternatives; modifications 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, various combinations of fumigants, pesticides (i.e. strobilurines), resistant varieties and grafting onto resistant/tolerant rootstocks adopted alone or in combinations with fumigant and not fumigant nematicides (Porter et al., 2007; Louws, 2009; Kokalis-Burelle 2008).

Methods which avoid the need for methyl bromide, such as cropping in substrates, grafting plants onto resistant/tolerant rootstocks (Louws, 2009) and using resistant varieties, continue to expand in the ornamental and vegetable industries (TEAP, 2009a).

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) (Porter et al., 2007).

Low permeability barrier films, LPBF, (e.g. VIF or equivalent such as TIF) 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 (Gilreath et al., 2008; Santos et al., 2007, 2008). 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 (Ou et al., 2007, TEAP, 2009a). 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 (Ou et al., 2007; Chow, 2009; Ajwa, 2009; Fennimore, 2009; Freeman, 2009; Villahoz, 2009).

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.

An important issue, which should be carefully considered, is the induced accelerated degradation of fumigants as a result of their repeated application. It was shown under field conditions that MITC is rapidly dissipated following repeated application of metham sodium leading to insufficient control of soilborne diseases (Triky Dotan et al., 2009). Similar results were shown for 1,3-D in Israel (Alon et al., 2009). With the limited available fumigants, accelerated degradation is an issue of major concern: an integrated approach would limit negative effects, but clearly, the combination of several components (chemical and non chemical) is needed as a strategy for soil disinfestation.

9.2.2 Update on registration of chemical alternatives:

9.2.2.1 United States

Methyl iodide (MI) now holds a permanent registration in the US in all states except California, New York and Washington. A registration decision for use of MI in California (a
major methyl bromide using state) is expected in 2010. 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).

A registration decision on DMDS is also expected in 2010 for use on tomatoes, peppers, eggplants, cucumbers, squash, melons, onions, field grown ornamentals and forestry nursery crops. A decision on furfural for use on golf courses and sod farms should also come by later in the year.

Due to the global economic slowdown and the concomitant reduction in market demand for epoxy resins from which 1,3-D is produced, the supply of 1,3-D, which is a key methyl bromide alternative, was significantly reduced in the USA for part of 2009. However, Dow Agro Science conducted efforts to secure a substantial increase in the supply of 1,3-D for the USA beginning in late 2009 and continuing in 2010. The projected supply of 1,3-D for 2010 is thus comparable to levels provided in 2006, 2007 and 2008.

9.2.2.2 Japan

1,3-D is registered for the control of MNSV of melon, however it can cause phytotoxicity, 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 9-5 below lists alternatives already registered and in the process of evaluation or registration in Japan.

<table>
<thead>
<tr>
<th>Use category</th>
<th>Alternatives available</th>
<th>Status of registration</th>
<th>Alternatives under development</th>
<th>Possible date of registration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chestnut (Commodity)</td>
<td>Methyl iodide</td>
<td>Registered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cucumber (Soil)</td>
<td>None</td>
<td></td>
<td>Attenuated virus</td>
<td>Unknown</td>
</tr>
<tr>
<td>Ginger (field &amp; protected, soil)</td>
<td>Chloropicrin</td>
<td>Registered</td>
<td>Methyl iodide</td>
<td>Unknown</td>
</tr>
<tr>
<td></td>
<td>Dazomet</td>
<td>Registered</td>
<td>Amisulbrom</td>
<td>Unknown</td>
</tr>
<tr>
<td></td>
<td>Metham sodium</td>
<td>Registered</td>
<td>Mixture of azoxystrobin + metalaxyl-M</td>
<td>Unknown</td>
</tr>
<tr>
<td></td>
<td>1,3-D/ Pic</td>
<td>Registered</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mixture of 1,3-D + MITC</td>
<td>Registered</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Metalaxyl</td>
<td>Registered</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Propamocarb</td>
<td>Registered</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cyazofamid</td>
<td>Registered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green &amp; hot pepper (Soil)</td>
<td>None</td>
<td></td>
<td>Attenuated virus</td>
<td>Unknown</td>
</tr>
<tr>
<td>Melon (Soil)</td>
<td>Mixture of 1,3-D/ Pic</td>
<td>Registered</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Methyl iodide</td>
<td>Registered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Watermelon soil</td>
<td>None</td>
<td></td>
<td>Attenuated virus</td>
<td>Unknown</td>
</tr>
</tbody>
</table>
9.2.2.3 Australia

The main alternatives registered in Australia for the remaining MB use - the strawberry nursery industry - appear in Table 9-6 below.

Table 9-6: Registration status of chemical alternatives to MB in Australia

<table>
<thead>
<tr>
<th>Use category</th>
<th>Alternatives available</th>
<th>Status of registration</th>
<th>Alternatives under development</th>
<th>Possible registration date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strawberry Nurseries</td>
<td>Chloropicrin</td>
<td>Registered</td>
<td>Methyl iodide</td>
<td>2011</td>
</tr>
<tr>
<td></td>
<td>1,3- D</td>
<td>Registered</td>
<td>EDN</td>
<td>unknown</td>
</tr>
<tr>
<td></td>
<td>Metham Sodium</td>
<td>Registered</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dazomet</td>
<td>Registered</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Methyl iodide and ethanedinitrile both have pending registration applications with the APVMA (Australian Pesticides and Veterinary Medicines Authority) for use on strawberry runners. The registrant for methyl iodide is completing a flux study requested by APVMA in order to evaluate bystander exposure. This study will be submitted this year, and a registration decision is anticipated in 2011. The registration status of ethanedinitrile is unknown at this time.

In addition, since the only currently registered application rate of MB (25g/m²) exceeds MBTOC’s standard of 20g/m², the Party undertook a 2 year study in 2008 using reduced rates (MB:PIC (50:50) @ 375 kg/ha); however, the second year’s results indicated that the lower rate did not adequately control root and crown rot on certain varieties of runners. Another 2-year study has been initiated, but the Party estimates that it will be 2013 before lower MB rates could be used.

9.2.2.4 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.

9.2.2.5 Israel

In general, there is no change in the status of registration for fumigants since the last progress report. Details are presented in Table 9-7 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, MBTOC has not been informed of any efforts conducted at present to extend this registration to other crops.

Chloropicrin is not registered, however initial registration procedures are under way for cucurbits (Pic in pure form and combined with DMDS).

DMDS has been granted a temporary permit for tomato, melon and cucumber against nematodes. An extended registration package is expected to be submitted by the end of 2010 including additional crops.

1,3- D is registered for cucurbits, carrots, tomato, potato, sweet potato, annual and perennial flowers (including gerberas), herbs and strawberries.
1,3-D/Pic has restricted availability in Israel. It is registered for potato, tomato eggplant, pepper, strawberry and some cucurbits (watermelon and melon).

Dazomet is only registered for melon, watermelon and tomato.

Methyl iodide is currently under registration experiments; however, a registration package is not expected to be submitted before 2011.

9.2.2.6 Europe

As of 18 March 2010, methyl bromide is no longer registered or authorized in the EC for any use, including QPS. Authorisations for use of 1,3-D have expired as of 20 March 2009, but an application for reconsideration of 1,3-D registration is under review. Authorisations for use of (1) metham sodium / potassium, (2) chloropicrin and (3) dazomet will expire on (1) 13 January 2011 and (2+3) 31 December 2011 respectively. Applications for reconsideration of all three have been submitted.

9.2.3 Alternatives to methyl bromide for crops where a CUN is sought

This section provides an overview of the main alternatives to MB adopted for those crops presently applying for critical use exemption of MB (CUNs).

9.2.3.1 Vegetables

(a) Tomatoes

Effective alternatives adopted in the tomato sector include chemicals such as 1,3-D/Pic, metham sodium and metham potassium, dazomet and methyl iodide. Non-chemical options such as substrates, soilless cultivation, grafting, resistant varieties, biofumigation, solarisation and steam are also in use (Besri, 2007a, 2007b, Fennimore et al, 2008). These alternatives are applied alone or in combination, and are intended mostly to limit the damages of root knot nematodes (Besri 2007a, 2007b, Runia, 2006, Culpepper et al., 2008).

MB use for tomatoes has been entirely phased out from all European countries, as well as Australia and Israel (except for the control of broomrape in Israel, Orobanche spp).

Grafting continues to be adopted as an effective alternative in many countries and is now in wide use in Europe, Northern Africa, Central America, and North America. In the USA, this technique is still largely limited to greenhouse production and small organic producers, but new research is underway to help establish this technology on a wider scale (Louws, 2008; Kubota, 2008; Rivard et al., 2009; Bausher, 2009; Freeman, 2009). The introduction of this technology to open fields has potential efficacy particularly in melon sector, as part of IPM programmes aimed at reducing the use of soil fumigants in vegetable production, although 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. Recently, a grafting robot fitted with an automatic seedling feeder system has been developed. It reduces labour and increases the efficiency and accuracy of the grafting technique. Commercial availability of this device is expected soon (Kobayashi 2008). The robot has been introduced in the US for the production of grafted vegetables (Kokalis-Burelle, 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), halosulfuron 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 at various dosages applied under metalized mulch controlled nutsedge to the same level as MB, 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., 2009).

Welker *et al* (2008) reported that fumigation with DMDS /Pic 80:20 kills inoculum to a depth sufficient to produce an economical harvest.

(b) Eggplant

Adoption of grafting also continues to expand in the eggplant sector as new and more suitable rootstocks become available. In this regard *Solanum torvum* and other *Solanum* species seem to be particularly efficient to limit the effects of root knot nematodes. In Turkey, 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, particularly when grown on previously solarised soil treated with alternative fumigants (Yilmaz *et al*., 2009).

(c) Peppers

Different 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, olives, brassicas, and garden residues. The effect of pepper residues on *Meloidogyne incognita* populations was also evaluated (Piedra-Buena *et al*., 2007).

Solarisation 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 solarisation 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 solarisation 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 as well as in Central America. When combined with other treatments, grafted plants can be grown successfully without MB (Beltrán *et al*., 2008). Rootstocks resistant or tolerant to soilborne pests and pathogens such as *Fusarium oxysporum* are available for melon, watermelon and
cucumber; for *Monosporascus cannonballus* and *Didymella bryoniae* for melon; and for *Phomopsis sclerotiodes* for cucumber (Blestos, 2005; Crinò et al., 2007).

In Israel, grafting is also showing promising results, particularly when this system is carefully adapted to the particular growing conditions of each region (Cohen et al., 2007). Grafting is commercially adopted for watermelons and is successful for melon cultivars, however some incompatibility constraints remain for trellised cultivars.

In Italy, where melon production is a significant component of the vegetable industry, major rootstocks are *Cucurbita* spp. (‘Shintosa’, ‘RS841’) as well as *Cucumis melo* (‘Dinero’), which are used depending on the season, the growing area and the disease pressure. Nevertheless, since 2006 sudden and heavy melon collapses have been observed and consistently correlated both to the scion/rootstock combination and the use of exogenous auxins basically adopted to increase the yield (Minuto et al., 2009). These results are in coincidence with other studies carried out in Israel; the paper further describes growing procedures that can encourage the collapse of grafted melons under commercial field conditions (Aloni et al., 2008).

In Morocco, cucurbit grafting enjoys wide adoption at the commercial level. Many rootstocks with resistance to most of the soil borne pathogens (except *Meloidogyne*) are now available. Grafting is used as a component of IPM programmes (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*, *Pythium irregulare*, *Rhizoctonia solani* and *Cyperus esculentus* in squash crops (Desaeger et al., 2008).

However, non-chemical alternatives 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 and Mullinix, 2007). Further, Kokalis-Burelle et al., (2008) evaluated the combination of grafting plus fumigants under metallized 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).

9.2.3.2 Ornamental crops

Floriculture is a complex industry with many flower types, production cycles and cropping systems involved. Alternatives such as fumigants, soilless culture (substrates) steam and resistant/tolerant cultivars have been widely adopted.

Constraints to adoption of chemical alternatives in the ornamental sector include regulatory issues (e.g. township caps, buffer zones) and lack of registration. Insufficient R&D for minor ornamental crops is also reported in some countries. However registration of some chemical alternatives such as metham sodium, 1,3-D and Pic has been expanded in some countries e.g. Israel and Italy and now include additional flower types.
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 (Borrero et al., 2009; Termorshuizen et al., 2006). Steam use is often under discussion because the cost of fossil fuels (Fennimore and Goodhue, 2009) but recent research shows that depending on the steaming equipment used and other considerations, this option can be economically feasible. Trials conducted in California using different steam application with or without solarisation (Gilbert et al. 2009) have shown that pest control is equal or better than that achieved with methyl bromide/Pic, particularly in the case of weeds. The cost of disinfesting soils with different methods presently available have been evaluated by Fennimore and Goodhue (2009) with encouraging results. Solarisation has proven to be an efficient alternative for some flower types (McSorley et al., 2008; Yilmaz et al., 2009) and is being successfully used in combination with fumigants at reduced rates (Gamliel, 2009). Roses, carnations, chrysanthemum, 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.

Chemical alternatives include dazomet, metham sodium, metham potassium, 1,3-D, chloropicrin, methyl iodide and DMDS applied alone or in specific combinations or sequences (Gerik et al., 2009; Rosskopf and Kokalis-Burelle, 2009; Yakabe and MacDonald, 2010). Application of fumigants with barrier films such as VIF, allows the use of reduced rates of chemicals without affecting control levels, 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).

9.2.3.3 Strawberry fruit

(a) General

Formulations of 1,3-D/Pic, Pic alone and metham sodium combined with other fumigants have been adopted widely throughout industries applying for CUNs, and have replaced the majority of the production area previously treated with MB/Pic mixtures. Of the Parties previously applying for CUNs, 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). Since 2009, the USA and Israel are the only Parties seeking exemptions for this sector.

Non-chemical alternatives include soilless systems, crop rotation, solarisation, biofumigation and use soil mulches.

(b) California

The California strawberry fruit industry is the largest remaining critical use for MB worldwide, requesting around 750 tonnes of MB for 2012. To further evaluate progress in uptake of alternatives, MBTOC continued to monitor historical MB use data in strawberry fruit in California. Looking at the MB use areas in California strawberry fruit over time, there has been a growth in the state-wide strawberry fruit sector in terms of total production area since 2003, whilst during this period there is a reduced reliance on MB. However, this overall trend is not representative for the individual strawberry fruit growing districts in California, where MB use has increased between 2007 and 2008 to a level of 159 tonnes above the 2008 CUE.
9.2.3.4 Nurseries and propagation material for strawberries and 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.

In some cases, growers have transitioned 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 the 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 methyl iodide, if and when it is registered for use in California (CDFA, 2009) as a certified nursery stock soil treatment. Recent research trials indicate some materials (such as methyl iodide) and some combinations (such as 1,3-D /Pic) show promise as MB alternatives for specific circumstances, although effective rates may be higher than those needed in annual crops and use of an effective barrier film is necessary (Schneider et. al, 2008; Schneider et. al, 2009a; Schneider et. al, 2009b; Walters et. al, 2009). Other materials (such as metham sodium and Pic) were not adequate for certified nursery standards (Schneider et al., 2009b).

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.

The requirement for broadacre treatment of nursery soil (to avoid recolonisation 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 on this issue is being made in trials in California (Fennimore and Weber, 2008), while trials in Alabama illustrate the logistical problems yet to be solved (Quicke et. al, 2009)

Cuttings and slips of a wide variety of propagation materials including ornamental plants, fruit trees, forest trees and others, which are subjected to certification requirements are also produced in substrates in many countries around the world that export such materials internationally.

9.2.3.5 Sweet potatoes

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. Stoddard (2008) tested a number of alternatives to MB for sweet potato slips including Pic, PicChlor 60, solarisation, 1,3-D combined with dazomet, plus additional treatments (napropamide, dicloran, thiabendazole and flumioxazin). Solarisation 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.

9.2.3.6 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).

*Ralstonia solanacearum, Meloidogyne incognita* and *Pythium* sp. are important soil pests in China. Pic has been widely used to control bacteria and fungi and showed very good results. Phytotoxicity can occur when Pic is applied in the spring and low temperatures are present. This problem can be avoided by applying the Pic in the autumn immediately after ginger harvest.

Trials with ginger showed that 1,3-D/Pic capsules applied in the autumn or 1,3-D/Pic, DMDS/Pic, MI/Pic, sulfuryl fluoride applied in the spring can control nematodes, bacteria and fungi as effective as MB, but these promising alternatives are not presently registered (Cao, 2000, pers. comm).

9.2.3.7 Replant disease

Replant disease poses a serious economic threat to certain orchards of perennial fruit trees and grapevines. The economic implications are exacerbated by the long production life of orchards and vineyards. Producers are reluctant to adapt to alternatives unless proven to be effective over a reasonable time span. A number of medium to long term scientific studies such as the USDA Pacific Area-wide Pest Management Program are now coming to some preliminary conclusions resulting in a pronounced shift to alternatives by producers.

Since 2006, MI has been registered in several key regions of the world and MI/Pic (50:50) has been shown to be equally as effective as methyl bromide for controlling replant disease. In states where MI has not been registered, the most appropriate chemical alternatives include 1,3-D used singly or with Pic, or Pic alone (Brown et al., 2009). These can be used successfully where the required dosage rates are allowed under prevailing local regulations.

Amounts of MB requested under the CUE have however been very significantly reduced (US Orchard Replant CUN, 2010), which could indicate successful adoption of alternatives.

9.2.3.8 Weeds

(a) Broomrape

Broomrapes (*Orobanche spp.*) are root parasites of higher plants that depend entirely on their hosts for nutrients. They parasitise a wide range of economically important hosts, such as tomato (greenhouses and 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 this parasite, which makes an integrated approach combining various techniques necessary. The main challenge with broomrape control 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* attacking narbon bean in 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*.

An integrated approach, including the application of herbicides to the soil and foliar application of systemic herbicides, has been tested over the last 10 years in many field experiments. Control of *O. aegyptica* in processing tomatoes has been effective, and was achieved by applying sulfosulfuron as a soil solution and imazapic on tomato foliage. These experiments demonstrated that the efficacy of *O. aegyptica* control is highly correlated with the rate and timing of herbicide application. In order to ensure precise timing of application, a decision support system (DSS) termed PICKIT for *O. aegyptica* control in processing tomato was developed. PICKIT is based on risk assessment and the following submodels: (i) growing degree days and (ii) herbicide rate optimisation. Both models were validated under field conditions using a minirhizotron camera (Hershnehorn et al., 2009, Eizenberg et al., 2009).

(b) Nutsedge

Yellow and purple nutsedge (*Cyperus* spp) are a key target for critical use of MB that still requires effective alternatives in some circumstances. In the past year, trials involving combinations of herbicides and combinations of fumigants have shown these 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 tomato field study showed that yellow nutsedge was controlled with acrolein combined with other herbicides and metham sodium. The successful combinations included acrolein with Eptam, halosulfuron or metham sodium. (Belcher, et al., 2007). In Florida, Gilreath and Santos (2008) have used combined fumigant programs with either Pic and fosthiazate or 1,3-D/Pic + metham sodium applied together with herbicides (napropamide+ trifluralin) in pre-emergence and post-directed trifloxysulfuron, showing improved control of nutsedge. In a separate study, Santos (2009) showed that combinations of 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 with MB/Pic (67/33), methyl iodide/Pic (50/50) and the 3 way approach (consisting of the application of 1,3-D followed by chloropicrin, and then by metham sodium) were evaluated on peppers. Nutsedge was controlled at similar levels 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).

In California, Wang et al., (2009) compared rotations of spring cantaloupe with winter broccoli (with a summer fallow period) in fields infested with yellow and purple nutsedge, with alternative rotations that included hand hoeing, a crop of wheat and Sudan grass, wheat followed by solarisation, and sweet corn with a halosulfuron application followed by Sudan grass. Solarisation was the most effective treatment for purple nutsedge but economic returns were negative. All methods controlled yellow nutsedge effectively especially when a summer fallow period was observed, but economic returns varied significantly. Currently, selective
preplant herbicides followed by a metham sodium application is also in use in Florida vegetable production (Santos, 2009).

9.2.3.9  **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 peppers worldwide. Seeds, grafted seedlings, soil, plant sap and cuscuta (*Cuscuta subinclusa, C. lupuliformis, C. campestris*) are the main means of transmission for these viruses.

The only country requesting a critical use to control these viruses is Japan, which will nevertheless be phasing out this application by 2013 (Tsuda 2008; Tateya 2009). Japan has made significant efforts in developing transitional measures to help achieve the phase-out, which are expected to be in place by 2012. Such measures include IPM programmes involving crop rotation, resistant varieties, amending the soil with cellulose and wrapping roots with paper, all of which reduce the severity of the virus attacks (Nishi et al., 2008; Fukaya, 2008; Ooizumi et al., 2008). Soilless culture using different kinds of substrates (paddy rice, peat moss, bark tip, vermiculite and others) is under development (Fukaya, 2008). Preimmunisation with an attenuated virus is also reported as a promising means of protection against aggressive strains (Nishi et al., 2008; Fukaya, 2008; Kubota, 2008).

9.3  **Structures and Commodities**

The Progress Report for MBTOC Structures and Commodities (SC) contains the following sections:

- Regulatory Update
- Environmental Concerns in Conflict with the Use of MB Alternatives
- Personnel Issues
- Update on Pest Control Methods in Mills and Food Processing in the United Kingdom
- Special Report on Pest Control Issues of Fresh Dates
- Research Update – Efficacy of Alternatives
- References

9.3.1  **Regulatory Update**

Regulatory approval of MB alternatives has in most cases stalled, and in some cases been revoked. As noted in the introduction to the CUN report for structures and commodities, unless there are additional regulatory approvals, and an increased commitment to use alternatives that are approved or which do not require approval, CUNs for structures and commodities seem set to continue for several years and likely at the current levels.

9.3.1.1  **Sulfuryl fluoride (SF)**

In Australia, Canada, the US and Europe, there has been no change for approximately two years in the extent of approvals required for the use of sulfuryl fluoride (SF), a key alternative for uses in food processing structures and commodities. In France, approval of the use of SF...
on fresh chestnuts has been withdrawn. The SF treatment resulted in a fluoride residue in chestnuts which exceeded the European Union 25 ppm MRL.

In two instances (Australia and US) CUN applicants report regulatory interpretations concerning the use of SF which they believe prevents its use; in both those cases, MBTOC believes the registration and the label should permit the use of SF.

Specifically, the applicant for Australian rice reports that although SF has been registered, the registration does not include packaged rice. MBTOC has reviewed the SF label in Australia finding, SF is registered for rice, polished rice and wild rice against all stages of stored product pests in silos, food handling and processing facilities, mills, warehouses, temporary and permanent fumigation chambers (Dow Profume Label Australia, 2008).

Additionally, in the US, the California applicant for dates reported that SF is approved only for dried dates. However, the dates harvested in the US are considered by MBTOC to have already been dried on the tree prior to harvest in that their moisture content is approx 17-23% (John Davies pers comm to MBTOC). This moisture content does not conform to the definition of high moisture dates in other date growing regions of the world. In the US dates at the time of harvest are referred to as ‘fresh’, but this is a marketing term. The concept of ‘fresh’ is not pertinent or informative to this discussion. MBTOC believes it is reasonable to interpret the regulation as allowing the use of SF on these dates in the US.

In Canada, although registration for SF was achieved for structures several years ago, maximum residue levels for the fluoride residue in food resulting from the SF treatment of the food processing structure has not been set; this is a contributing factor to the ongoing CUN for flour milling and pasta facilities. The reason for this is that food products and ingredients are commonly found in silos, in warehouses and finished product stores in mills and pasta processing facilities.

In France, SF has been registered for logs, but there remain practical use which affect adoption for this purpose. For Europe, there is no MRL for fluoride residues resulting from SF treatment of dried fruit. Similarly to Canada, in the EU there is no food contact registration for SF in flour mills. Large mills containing integral flour bins are experiencing very difficult practical implementation problems with SF fumigation. Other than in the UK, the SF supplier is not advocating the combined use of SF and elevated temperatures, although MBTOC recommends this combined treatment. Heat treatment alone is not feasible for these large mills.

In the United States SF is a major methyl bromide alternative for post harvest uses. In 2004 and 2005 the US EPA established tolerances for SF use on dried fruits, tree nuts, pistachios, cereals, small grains, coffee, coconut, cottonseed, legume vegetables as well as on processed foods such as pasta, cake mixes, cookies, crackers, powered milk and eggs where fluoride residues may result from the use of SF to fumigate the space and equipment where these foods are processed. The Fluoride Action Network (FAN) objected to these tolerances arguing that adverse effects and precursor effects can occur at lower doses which should have precluded EPA from making the “reasonable certainty of no harm” safety finding required to establish tolerances. To assess the safety of fluoride levels to humans from all routes of exposure (drinking water, toothpaste, pesticide residues, etc.) EPA’s Office of Water requested the National Academy of Sciences (NAS) to review the current drinking water standards for fluoride. A March 2006 NAS report recommended that the current drinking water standard (MCLG of 4 mg/L) should be reduced. EPA’s Office of Water is evaluating the NAS report and working on a revised risk assessment. Any changes to the drinking water standard will be taken into account when EPA responds to FAN’s objections.
In the US, although there is registration for the use of SF in structures and tolerances for many food products, the list of foods on the SF label is not as inclusive as is the list of foods on the methyl bromide label. This is the main reason for the ongoing CUN for pet food facilities and for the requested use of MB in food processing facilities. Food products and ingredients are commonly found in silos, in warehouses and finished product stores in mills, processed food facilities and pet food facilities. MBTOC has suggested that changes be made such as moving foods out of the fumigation area, sectioning off the fumigation areas or tarping the foods. Applicants report that moving food commodities out of the facility before a fumigation would cost too much, that sometimes sectioning off the food stores can not be done, and that tarping off foods during SF fumigation would not meet regulatory requirements.

MBTOC notes that these regulatory issues are separate from issues surrounding the now intensified question of SF environmental issues, which are discussed separately below.

9.3.1.2 Methyl Bromide

Regulatory problems associated with MB alternatives have to be viewed in context of possible upcoming regulatory events with MB as well. Currently, the US EPA is in re-registration process for MB, and it has published the intention to reduce worker exposure limits. Currently the re-registration eligibility decision calls for worker exposure limits of 1ppm for an 8 hr time-weighted average, but since there were concerns about that limit it is under review. Currently, the clearance level is 5ppm. (The term clearance level refers to that level after a facility fumigation aeration which allows re-entry of personnel). Industry users of MB in the US have supplied the worker exposure data for facilities but now the worker exposure data for QPS use is being generated. All MB users are trying to work out if it will be possible to mitigate worker exposure rates through new labor practices.

9.3.1.3 Methyl Iodide

There have been two regulatory changes that are more positive. Methyl iodide was registered for fresh chestnuts in Japan in 2009. However, Government of Japan says that supplies will not be present in Japan until 2011. Since chestnut fumigation takes place on farms, farmer training in the safe use of the fumigant is also needed.

9.3.1.4 Phosphine

Several years ago MBTOC was given regulatory interpretations that phosphine was approved for dried beans in California, but there was a difference of opinion about the regulatory interpretation and treatment logistical problems which then resulted in CUNs for dried beans for a few years. This year, however, there was no CUN for dried beans; we assume that both the regulatory interpretation and the logistical problems have been solved.

In May of 2008, the International Maritime Organization issued Circular 1264 Recommendations on the safe Use of Pesticides in Ships applicable to the Fumigation of Cargo Holds. This Circular has allowed “In-Transit Fumigation” of plant and animal products. This Circular formalizes the practice of fumigation on board vessels using PHOSPHINE Fumigants only. This circular re-enforces the advantage of using Phosphine as an alternative to Methyl Bromide as a fumigant for disinfesting plant and animal products.

At this time there are now many bulk carries of plant and animal products that are using Phosphine fumigants as Phytosanitary requirements for the control of insect and mite pests of plant and animal products that may be carried into the cargo holds with goods (introduced infestation).
9.3.1.5 Heat treatment

MBTOC notes that heat treatment to disinfest structures does not require regulatory approval. Heat is effective and in use in many of the other companies included in the industry sectors which generate CUNs for MB. Problems achieving technical efficacy with heat have been reported, but it is also reported that with effort technical efficacy can be achieved with no damage to the structure. Also noteworthy is the increasing adoption of spot heat treatment for equipment reported in many structural applications. We note that full site heat treatment can cause problems for facilities where food products and ingredients are commonly present; heat treatment of commodities is usually not recommended due to food quality restraints. Food commodities could be removed before heat treatment; this however, would increase the workload and requires time and effort which would vary depending on facility.

9.3.2 Environmental Concerns in Conflict with the Use of MB alternatives

Transition away from methyl bromide use for treatment of food processing facilities and structures in non Article 5 countries has come to rely heavily on availability of SF. MBTOC advises the Parties that environmental concerns about using sulfuryl fluoride amongst milling and food processing companies should not be underestimated as an obstacle to adoption of this MB alternative. All flour milling and food processing CUNs in 2010 noted environmental concern with using SF, either in the context of regulatory uncertainty or milling and food processing customer demand for companies to reduce their carbon footprint.

MBTOC notes the following statement from MOP 21, Decision XXI/9 (Hydrochlorofluorocarbons and Environmentally Sound Alternatives) (para 8): “To encourage Parties to consider reviewing and amending as appropriate, policies and standards which constitute barriers to or limit the use and application of products with low- or zero-GWP alternatives to ozone-depleting substances, particularly when phasing out HCFCs.” Parties may wish to consider the potential similarity (or not) in its concerns for HCFCs and SF.

According to the US pet food industry, use of SF could easily eviscerate any reductions in carbon emissions that pet food makers are able to realize. Pet food sector companies reported that use of SF could potentially expand a company’s carbon footprint and that such a situation is likely to be viewed by retailers and consumers with much disapproval.

The rice milling sector reports that their industry is currently being driven by international and some national customers that are designing sustainability plans for their own needs and sending the plans down the food supply chain. One of the most basic requirements is to reduce the carbon footprint in every step of the chain. Rice producing fields are currently at a severe disadvantage for their inability to mass-utilize no-till practices. Adding a climate change contributor (SF) to the same supply chain is counterintuitive and contrary to customer requirements of reducing the carbon footprint and controlling global warming.

Of note, Walmart, the largest retailer in the United States, announced on February 25, 2010, that it wants its suppliers to eliminate “20 million metric tons of greenhouse gas emissions by the end of 2015.” Millers and food processors point to this as an example of the reasons they must continue to use MB and not switch to SF fumigation.

As background to this issues, in 2009, research was published indicating that SF has a much higher global warming potential than previously considered (Millet et al., 2009). Its atmospheric life-time is estimated as 36 years, about 8 times greater than previously thought, with the oceans as the dominant sink. These new reports indicate SF may be 4,800 times more effective at trapping heat in the atmosphere than carbon dioxide (St. John, 2009). The GWP of SF is comparable to that of CFC 11 (Muhle et al., 2009). By comparison GWP of R-134a is only 1410 and venting is prohibited under the Clean Air Act. California is currently using...
50% of all SF produced. According to Anderson in 2009 the current SF use in California is equal to the CO2 emissions of 1 million vehicles over 1 year (Anderson, 2009).

Dow AgroSciences, the main supplier of SF in North America and Europe, has successfully obtained the necessary registrations for use of SF, but further information on MRLs is being requested by various authorities for extensions of registration to cover the wide range of commodities on the methyl bromide label. Dow is aware of the global warming challenge and is monitoring developments.

9.3.3 Personnel Issues

In January 2010, TEAP co-chairs decided to reorganize MBTOC to form a subcommittee for quarantine and pre-shipment issues (QPS). As a result, six of the members of the MBTOC subcommittee formerly known as Quarantine, Structures and Commodities (QSC) were transferred to QPS subcommittee. The resulting MBTOC Structures and Commodities (SC) subcommittee now includes 12 members from 9 countries, 2 of which are from Article 5 countries. All members of MBTOC SC also have considerable expertise and experience in quarantine and pre-shipment issues.

MBTOC SC may be unable to operate if the EU members are not funded to attend MBTOC meetings. Human resources in the field of control of stored product pests is exceptionally thin worldwide due to most countries having closed or considerably decreased stored product research institutes; for this reason, MBTOC cannot easily replace its current members.

Additionally, in December 2010, the MBTOC SC member from Belize resigned due to change in her employment. We appreciated her contribution and wished her well in her new work.

9.3.4 Update on Pest Control Methods in Mills and Food Processing in the United Kingdom

In the UK, methyl bromide was formerly used by most flour mills on an annual basis as a full site treatment. Food production premises were occasionally MB treated. Now all mills and food production premises have adopted a more intensive IPM program which includes intensive monitoring of infestation levels and regular precisely documented cleaning and pesticide applications. The IPM program is designed to minimize the possibility of needing a full site treatment.

If the localized infestation is detected by the intensive monitoring, perhaps in a machine or a room of the building, then it is treated with spot heat treatment. One advantage of spot heat over fumigation is that, unlike fumigation, heat treatment does not require that production be stopped. The affected area is normally isolated with thermal sheeting or another type of suitable enclosure. The floor and the other immediately adjacent areas to the equipment or room are treated with insecticidal dust or spray in case of insect escape from the heated equipment. Heat is applied from portable equipment to raise the internal temperature in all parts of the treated area to a minimum of 52°C for a minimum of 1 hr. This spot treatment normally takes between 5-12 hours.

Using these procedures MB has been successfully replaced in all flour mills and food processing facilities in the UK where it was formerly used as a full site treatment. The overall cost of fumigation to the UK flour milling and food processing sectors has been reduced. The reason is that formerly 50-60 full site MB were conducted each year, but for the past three years, the number of full site treatments has been reduced to an average of 10 per year. Admittedly, each full site treatment now costs approximately 3x more than the MB treatments.
used to cost. IPM costs have also increased, but the need to phase out MB was not the only driver to improve IMP in flour mills and food processing facilities. The need to reduce worker dust inhalation and to improve food quality and safety were also contributing factors requiring IMP improvements.

9.3.5 Special Report on Pest Control Issues of Fresh 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 disinfect dates and prevent fermentation. In 2003, MBTOC noted that technically and economically effective alternatives were 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. A MBTOC SC group of experts carried out an extensive preliminary investigation of potential pest control techniques for this sector. Five alternatives were tested. As a result of this study, considerable information about potential alternatives was identified and discussed at a UNIDO workshop in Vienna in 2009 on the replacement of methyl bromide for disinfection of high moisture dates.

As a result of the study and discussions during the workshop, one of the key technical problems to be addressed was the lack of information on the moisture content of dates in various producing countries. MBTOC members considered moisture content to be a key determinant for the selection of an effective disinfectant. 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 accepted and approved:

“Dates at high water content”, so called “fresh dates”, are dates of the Deglet-Nour variety with a moisture content from 30 to 40% (compared to the net 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. In contrast, dates with moisture content between 17-23 % may be considered as dried fruit.”

In 2009, UNIDO decided not to conduct the research, which had been recommended to further this investigation.

In 2009, two MBTOC SC members (Ducom, France and Reichmuth, Germany) and the USDA scientist currently conducting date research (Walse), visited the date growing area in the Coachella Valley of California. This valley is the primary date production site in the United States. The visit included packing and storage areas and infrastructure. Deglet Noor and Medjoul varieties are grown in this area. However, the moisture content of the dates at harvest is region specific; it is 17-23% in California compared to 35-40% in North Africa. Thus, MBTOC considers US dates as "dried fruit" and the dates in North Africa as "high moisture fruit", leading to different regulatory considerations. The SF label in the US includes dried dates; MBTOC interprets this to mean that these California dates can be subject to treatment with SF under the US label. USG is requested to investigate this regulatory interpretation.
All dates require post harvest disinfestations of field insect pests. In California, chamber fumigations with MB are presently used for disinfestation of freshly harvested dates. The exposure is 24 g/m² methyl bromide for 12 hours. At present, tarpaulin fumigations with phosphine, typically lasting 3-30 days, are utilized for stored-dates disinfestations.

Given the infrastructural, logistic, food quality, and pest-control scenarios facing the California date industry, phosphine treatment may be an alternative for those dates that can be stored for two weeks. If a regulatory interpretation is made that California dates can be SF treated, it could be an alternative for a quick disinfestation of these dates, provided that the temperature during treatment is higher than 25°C.

Researchers with Dow AgroSciences, a supplier of SF, reported the investigation of the efficacy and economics of using SF on dates in California. Previous work showed that 2.1x more SF was required than MB, and this resulted in an increased cost. Improved painting and door sealing reduced half-loss time to 12-15 hours. Adding a small fan further improved treatment efficacy. These changes resulted in the efficiency of only needing the same volume of SF as was formerly used with MB, with resulting cost savings. In California about 70% of dates are fumigated in stacks of bins under tarps on yards when time is not critical. Dates might be stored, under fumigation, for weeks or even months. The tarp stacks are fairly gas tight; SF fumigation of these tarp stacks could be conducted with lower dosage and longer fumigation times (Williams, MBAO, 2009).

Chemical fumigation is not the only alternative for dates; controlled atmosphere (CA) is both effective and in commercial use. In Tunisia, one of the biggest dates producers (in Kebili) built a CA Terminal. The facility has a capacity of 1300 tonnes per year and performs 70 treatment shifts per year. Treatment time (including pull down and ventilation) is 5 days from products coming in until products coming out for further processing. The insect that is the target of the process is *Ectomyelois Ceratoniae*, and the type of dates that is treated is the "Deglet Nour" (high and low moisture) (Vroom, 2010).

### 9.3.6 Research Update – Efficacy of Alternatives.

Of the recent research papers on control of pests of stored products and in mills and food processing structures, the following are most closely pertinent to the CUNs.

Difficulties remain in achieving sufficient pest kill efficacy for pests infesting dry-cure pork (also referred to as ham) and cheese in storages in the US. Shilling of Mississippi State University is leading a multi-state research project in this field. He reported that tests of carbon dioxide and ozone show lack of efficacy and lack of practicality against mites. Initial work on phosphine showed efficacy but also showed changes in odor of the pork. Earlier work by this group using SF indicated lack of efficacy. (Shilling, 2009a, 2009 b). MBTOC notes that mites are one of the key pests of cured pork and that mites will not be controlled by the phosphine treatment. Additionally, phosphine is not registered for this purpose in the US. The results of this ongoing study have reduced MB use in this traditional food processing sector by improving IPM processes, facility sanitation and by an improved understanding of the pest-food process complex. This research is ongoing.

Walse of USDA-ARS is leading a study to develop methods to control of pests of fresh dates using SF. Since problems with dates are a concern in several countries we have prepared a separate section on issues surrounding control of pests in dates, below.

Research continues to test the effectiveness of SF in other foods as well. Reichmuth reported on a collaborative project with Barakat of Cairo University on rice moth (*Corcyra cephalonica*) to SF. This moth is a pest of cocoa, rice, peanuts, chocolate and biscuits and dried fruit in Africa, India, China and Mediterranean. They researched effectiveness at 27°C
because that is closer to ambient temperature in Africa. Age of eggs was a factor in tolerance; younger eggs more resistant. CT of about 500 (4.19mg/l) was needed for an effective 5-day treatment. Reducing the fumigation time to 3 days requires an increased fumigant concentration. In Germany, it is more common to use longer fumigation times and lower fumigant concentrations because allowable residue levels are lower. For other countries, the Dow AgroSciences Fumiguide® indicates a CT of 1500.

Also in Germany, the same research team reported on 1-4-day-old eggs, larvae and pupae of the warehouse moth, *Ephestia elutella* (Hcobner) (*Lepidoptera*) were investigated for their susceptibility to SF under different conditions. Each life stage was exposed for 18 h, 24 h or 48 h, to 11.6 g/m³ or 21.3 g/m³ at 15°C, 20°C or 25°C and 65% relative humidity. Within 18 h of exposure, all larvae and pupae of *E.elutella* died at 11.6 g/m³ at all three temperatures. The 1 and 2- day-old eggs were generally more susceptible, whereas the 3 and 4-day-old eggs were more tolerant to the SF treatment. All eggs of all ages were controlled within 48 h of exposure to the concentration of 21.3 pl 1.3 g/m³ at temperatures of 20°C and 25°C (Baltaci et al., 2009).

Ciesla and co-workers in Bordeaux, France investigated the influence on CT and temp on Red Flour Beetle (RFB) and Confused Flour Beetle (CFB) eggs. They investigated the use of low dosages of SF, at elevated temperatures and longer fumigation times in mills of 5000 – 7500 m³. The intent was to provide treatment guidance in view of the relatively low fluoride residue tolerances in the EU following mill fumigation with SF. Temperature was found to be the most important factor leading to good ovicide kill with RFB eggs; at 30°C there was 100% mortality. Eggs of CFB are easily killed. Increasing the mill temperature to 30°C or higher allowed the use of 25% less SF. (Ciesla et al, 2009)

Muhareb evaluated combining SF, propylene oxide (PPO) and carbon dioxide (CO₂) as a treatment for dried fruit and nut commodities infested with stored product insects. Mixing SF and PPO created no new chemicals. The chamber was first put under vacuum, then PPO was added, then normal air pressure was established and SF added. They used 10% CO₂, which was a safety factor and also allowed a 36% decrease in fumigant required. They observed a 72% reduction in the fumigant requirement when the combination of PPO, SF and CO₂ was used and there was 100% mortality of RFB eggs. Cost comparison of the fumigants alone showed the mix was about 25% of the cost of SF fumigation alone when you want LC95% for CFB eggs.

Also investigating combination of fumigants, in this case, for control of pests in rice were Naito and co-workers in Japan. Fumigation tests using sulfuryl fluoride (SF) and phosphine (PH) were conducted to develop an alternative to methyl bromide fumigation. Egg, larval, and pupal stages of *Sitophilus granarius* and *S. zeamais* were tested. SF fumigation showed high efficacy toward larval and pupal stages of both weevils: The stages were killed completely at 10 mg/l for 24 hours at 15°C. However, the mortalities of the egg stage of each weevil were 26.4 and 3.6%, respectively, with SF showing the least efficacy toward the egg stage. Mixture gas fumigation of SF 30 mg/l and PH 2 mg/l for 24 or 48 hours at 15°C was conducted to cover the weak point of SF. The mixture gas fumigation showed high efficacy toward all stages: however, 100% mortality was not obtained in the pupal stage of *S. zeamais* by the mixture gas for 48 hours. This result was not in accord with the result of SF fumigation. Then, mixture gas fumigations taking account of the order of the injection of both gases and the pace of increase of PH gas concentration were conducted, and this made clear that these factors affected the mortality of larval and pupal stages of both weevils. These results indicated that mixture gas fumigation of SF and PH has promise as an alternative to methyl bromide fumigation, but it is necessary to take into account the method of the PH dosing (Naito, et al., 2007).
In structural research with sulfuryl fluoride, Chayaprasert and co-workers at Kansas State continue to try to characterize the factors that affect efficacy of SF fumigation studying predictive factors of environmental and facility-specific conditions. Past fumigation data as the primary means for evaluating the structural sealing quality of a current fumigation is not adequate. Predictions of fumigant leakage rate and fumigation performance should incorporate quantifiable sealing effectiveness and weather information for the planned fumigation period. Comparisons between SF and MB fumigations indicated that under similar weather conditions and fumigation practices the leakage characteristics of SF and MB do not differ. In practical situations where the dosage requirements for SF and MB are typically not the same, however, the leakage rates of SF and MB fumigations could be different due to the buoyancy effect. Nevertheless, the magnitude of the difference may or may not be significant depending on other factors such as sealing quality, wind speed and direction, and ambient temperature (Chayaprasert, 2009).

Arthur of USDA also looked at the efficacy of combination methods, in this case of pyrethrins plus insect growth regulator in aerosols used to reduce pest populations. There is an additive effect of the two insecticides. CFB is more tolerant species to this treatment, so 3% pyrethrin+1IGR (Dyacon) gave best results. If the pest concern is RFB, a 1% solution will work and it will cost less (Arthur, 2009). Several food processing companies are now reported to use aerosols as part of IPM to reduce the need for full site treatments.

Brijwani and co-workers at Kansas State University looked at heat treatment factors in a cereal plant that has 180 rooms. This facility is now solely heat treated, and heat treatments are done every month. Efficacy improvements now allow for a 17-hr heat treatment, which saves time and money. The study advised to increase the heating rate to kill pests faster and the result will be a shorter heat treatment. Pests will survive in cool spots, below 50°C, and also in flour residues, so it is important to direct heat to otherwise cool spots and remove flour residues (Brijwani, 2009).

Berte worked in the Barilla pasta factory in Italy to study the effect of heat treatment as a disinfestation treatment in the pasta manufacturing structure. In 1994, Barilla decided to stop using MB in favour of alternative techniques. For this reason and for the growing attention that Barilla is paying towards the environment, a mill heat treatment was experimented in 2005, and heat was also applied in a large pasta factory in 2007. Hot-air treatment is based on the principle according to which insects and their eggs, larvae and chrysalids die at temperatures starting from 45°C due to the result of protein coagulation. The gradual heating of the pasta factory (~60,000 m³), needed to eliminate insect pests, was achieved by using the heat produced by production driers, air-treatment plants and thermal convectors. To check whether all the developmental stages (eggs, adults, larvae) of the pests were dead and to evaluate treatment effectiveness, 30 bioindicator kits were provided each containing the following species: Plodia interpunctella (eggs and larvae), Tribolium castaneum (eggs, larvae and adults), a mixed population of Lasioderma serricorne, and a mixed population of Sitophilus oryzae. After having tested heat treatment with success in Barilla mills, it can be confirmed that it is applicable and effective in large pasta factories. The researchers concluded that when the required temperature is maintained for ~40 h, species mortality in all developmental stages could be observed. Treatment with hot air can therefore be used together with other precautionary measures in the fight against pests.

Boina and co-workers at Kansas State University, proposed a model for predicting survival of mature larvae of Tribolium confusum during facility heat treatments. Their model was developed to predict survival of mature larvae, which is the most heat-tolerant stage of the confused flour beetle, Tribolium confusum (Jacquelin du Val), at elevated temperatures between 46°C and 60°C. Their model can be used to predict survival of mature larvae of T. confusum during heat treatments of food-processing facilities based on time-dependent temperature profiles obtained at any given location.
Control of pests of dried fruit is a concern of several countries and the basis for a CUN from the United States. Two recent studies confirmed the effectiveness of phosphine treatment for dried figs. Quality of fruits treated with phosphine (MgPH$_3$), at 600 ppm for 3 or 5 days and at 1000 ppm for 5 days under tarpaulin was monitored. The tested concentrations and exposure periods provided 100% mortality in test insects. Fumigation with phosphine for 3 to 5 days at 600 ppm is recommended for the dried fig sector since no negative effects were detected on fruit quality parameters after 6 months of storage under ambient conditions (Meyvac and Sen, 2007).

Also working in Turkey with dried figs, Aksoy and co-workers examined the effect of magnesium phosphide as a methyl bromide alternative in controlling major pests of dried figs and the effect of fumigation on dried fig quality. Magnesium phosphide treatment of a dried fig stack at 600 and 1000 ppm phosphine for 3 days under tarpaulin provided 100% mortality in test insects and no negative effect on fruit quality for 9 months in storage under ambient conditions (Aksoy, et al., 2008).

Controlled atmosphere methods and technologies have become well established commercially in several countries with little published research. CA’s are based on the establishment of a low-oxygen environment, which kills pests. CA’s are established by means of an oxygen converter system. The best method to use for this system is the use of a pressure swing absorption converter. Low oxygen levels vary between 0.5% and 1.5%. It can be applied in airtight environments ranging from 1 m$^3$ to 1000 m$^3$. Insects in all stages are eliminated (99.996% Lt) because of the lack of oxygen which causes the insects, larvae and eggs to dry out and suffocate. The infected products are exposed to CA in airtight rooms equipped to control temperature, oxygen and humidity, within a specified range of parameters known to be lethal to the pest. The treatment normally requires 1 to 6 days, depending on the type and level of infestation.

In this study, Sen and co-workers in Turkey examined the efficacy of controlled atmosphere methods for sun-dried figs. The research was carried out in a pilot fumigation chamber designed by EcO B.V., AG Numansdorp, The Netherlands (a MBTOC member was an owner of this company.) The objective was to test the effectiveness of controlled atmosphere (CA) (in this case defined at decreased O$_2$ at 1+or-0.5%) at elevated temperature (41˚C) in controlling the major storage pests, fig moth (Ephestia cautella), Indian meal moth (Plodia interpunctella), and dried fruit beetle (Carpophilus spp.). In addition, major quality parameters of dried figs were analyzed soon after the treatments, and after 4 months of storage under ambient conditions, in comparison with MB-treated controls (60 g/m$^3$ for 24 h). The CA treatment can be recommended as a post-harvest MB alternative for dried figs since it provided 100% control of the pest species tested, had neutral or positive effects on dried fruit quality and required comparatively short (~ 26 h) treatment times compared with other MB alternatives (Sen et al., 2010).

Riudavets et al (2009) conducted a study confirming the efficacy of using modified atmosphere packaging (MAP) with a high CO$_2$ content to control pests in final food products during their storage, distribution and marketing. The study included a spectrum of species and all of their developmental stages that could be present in a wide range of processed food products.

Pons et al (2009) confirmed the efficacy of using CO$_2$ in big bags and containers to prevent pests’ development in rice, dried herbs and cocoa. Since rice and other postharvest commodities are often stored in silos, there has been an investigation about the potential to use CA in silos in Switzerland, a Dutch Company, together with Silo Olten A.G. and the Pest Control Company Desinfecta A.G. started to commercialize the idea of silo’s equipped with the CA technique. This lead to a successful implementation of CA based silo’s treatment against a variety of insects. The technique is applied in the following manner: nitrogen is
injected at 6 Bar, which even with a leakage rate of 20% a regime of less than 1% oxygen can be accomplished (and pest control achieved) (Vroom, 2010).

9.4 Quarantine and Preshipment

Decision XXI/10 requested the TEAP and its MBTOC, in consultation with other relevant experts and the IPPC, to provide a report to be considered by the 30th OEWG. The report should cover:

1. A review of available information on the technical and economical feasibility of alternatives, and the estimated availability, for main categories of QPS uses: a. Sawn timber and wood packaging material (ISPM-15); b. grains and similar foodstuffs; c pre-plant soil uses and d; logs

2. A review of the current availability and market penetration rate of QPS alternatives to the uses listed in above, and their relation with regulatory requirements and other drivers for the implementation of alternatives;

3. An updated estimate of amounts of MB presently used for QPS purposes that may be replaced with alternatives including economic aspects, distinguishing between Article 5 and non-Article 5 Parties and between quarantine and pre-shipment uses separately. A preliminary estimate was presented in a previous QPS report submitted to the Parties (TEAP, 2009b).

4. A description of a draft methodology, including assumptions, limitations, objective parameters, the variations within and between countries and how to take account of them, that the TEAP would use, if requested by the Parties, for the assessment of the technical and economical feasibility of alternatives, of the impact of their implementation and of the impacts of restricting the quantities of methyl bromide production and consumption for QPS uses.

In response to this Decision, the MBTOC- QPS sub-committee has prepared a comprehensive report included as Chapter 8 of this TEAP Progress Report. MBTOC-QPS estimated that about 1,995-2,571 tonnes of methyl bromide used for QPS were immediately replaceable globally for the four main categories of QPS, which represents 32-42% of total consumption for these major categories of use.

9.5 Economic Aspects of Methyl Bromide Alternatives

9.5.1 Background

The experience that MBTOC has gained in the economic assessment of CUNs shows that the following points should be considered in deciding on the information required for the assessment of the economic feasibility of alternatives to the use of methyl bromide:

- The economic assessment starts with a financial analysis of the impact of the relevant activity with methyl bromide and with the alternatives on the ‘bottom line’ of individual firms.

- All nominations for a CUE should include a full financial argument whether or not the nomination is based on technical feasibility. This is to provide for situations where MBTOC may differ on the issue of technical feasibility.

- Accounting systems to measure financial performance differ across jurisdictions. However, the basic components for assessing financial feasibility described below,
i.e. revenue and costs, are universal. Accounting systems can also be ignored as they are unlikely to change between the use of methyl bromide and the next best alternative.

- A financial analysis typically provides a snapshot of circumstances given existing prices of inputs and outputs. However, in some cases, it will be necessary to supplement the financial analysis with a more comprehensive economic analysis, if the adoption of alternatives is expected to change the structure of supply and/or demand for inputs and outputs. In this case, the elasticities will change, leading to different budget outcomes. Such partial equilibrium analyses (i.e. analyses of the changes in the input and output markets most directly affected) could be necessary for commodities and structures, soils, or QPS uses.

- Furthermore, it may become necessary to extend the scope of the analysis to take account of the general equilibrium effects of such changes (i.e. the indirect effects of changes in these markets on other markets). General equilibrium analyses typically require considerable resources and will not be used often, but may become necessary in, for example, assessing the impact of the phase-out of QPS uses.

- As a final step, economic tools can also be used to assist in answering questions about the economic impact of environmental implications of the changes proposed in a CUN.

- Nevertheless, it is MBTOC’s considered opinion that a partial budget analysis will suffice in most economic assessments of CUNs.

### 9.5.2 Components of an assessment of financial feasibility

In assessing financial feasibility the calculation of each of the following key components is done for two cases; (i) the firm operating with methyl bromide and (ii) the firm operating with the next best alternative for each use:

- **Gross revenue** measures the earnings of the firm, broadly the quantity of the product sold times the average selling price per unit. Where gross revenue is not expected to change as a result of the adoption of an alternative (e.g. in the case of the fumigation of a mill), it is not necessary to consider gross revenue.

- **Variable costs** are those costs of production that vary with the amount produced, e.g. fumigation costs. They may be thought of as the quantity of the input used times the cost per unit of input. Borrowing costs for capital equipment (see capital costs below) and the remuneration to the owner are conventionally excluded from variable costs.

- **Fixed costs** are those costs of production that do not vary with the amount produced, i.e. they are incurred whether or not there is any production, e.g. salaries. Fixed costs may be difficult to deal with in situations where firms produce more than one product, as they then have to be allocated to different products produced by the firm.

- **Capital costs** are classified as fixed costs; e.g. investment in new machinery. Capital includes a time element as it generates revenues over more than one production cycle and its costs are spread over time through interest on borrowing. Where transition to an alternative involves investment in capital equipment, the costs of such equipment should be spread over the economic life of the asset.
• The **Gross Margin** is what remains from gross revenue after subtracting certain variable costs. The process of calculating the gross margin is conventionally referred to as **partial budgeting** because it does not include fixed and capital costs.

• **Net Revenue (or Net Returns)** is what remains from gross revenue after subtracting variable, fixed and capital costs

### 9.5.3 *Estimating the components for assessing financial feasibility*

• A responsible financial assessment requires sufficient data to construct a partial budget for the current use (in this case production with methyl bromide) as well as for the next best technically feasible alternative practice.

• However, enterprise budgets in farming are difficult to construct because of:
  
  o The diversity of firms in terms of size, age and geographic location, etc.;
  
  o The diversity of conditions that can affect input use as well as gross revenue;
  
  o Changes introduced as a result of the adoption of the next best alternative, such as increased risk of loss in production, increased variability in yields or efficacy, missed market windows, etc.;

• Because of this diversity, it is important that the presentation of the budgets be accompanied by explicit statements of the way in which each figure was calculated.

• In all these cases, it is not always possible to provide proprietary information on individual firms. Hence, data should be provided for either a ‘typical’ or an average enterprise, i.e. one that shares similar physical, economic, etc. characteristics as the firm(s) in question.

• The information regarding financial feasibility must be assessed for internal consistency, completeness, and reasonableness. Because there are virtually no published sources on the financial feasibility of the adoption of methyl bromide alternatives, MBTOC is largely dependent on the Parties to provide objective sources. **To this end, the work of MBTOC will be made easier if the data that is provided has been verified by a third party**, e.g. via banks that serve the clients in question, government agencies such as extension services, and farmer study groups, etc.

• In terms of financial feasibility, the following considerations apply:
  
  o Alternatives that result in negative net revenues are not financially feasible.
  
  o In the unlikely event that the gross revenues are higher and costs are lower, the alternative is financially feasible.
  
  o In the unlikely event that changes in costs and revenues are absolutely equal, the alternative is financially feasible because of the environmental benefits accruing.
  
  o When costs and revenues increase or decrease simultaneously, the result is ambiguous, and there is a need to define default values.

• Default values:
Financial feasibility criteria are needed for those cases where net revenue declines but remains positive. Thus, Parties asserting that methyl bromide alternatives are not financially feasible should explain why projected impacts are of sufficient magnitude to support their claim.

MBTOC has adopted the default assumption that alternatives leading to decreases in net revenues of around 15 to 20 percent or more are not financially feasible.

9.6 References


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Johnson C., Benjamin G and Mullinix J. (2007). Cultural control of yellow nutsedge (Cyperus esculentus) in transplanted cantaloupe (Cucumis melo) by varying application timing and type of thin-film mulches United States Department of Agriculture, Research, Education and Economics, Agricultural Research Service (USDA-ARS), Crop Protection and Management Research Unit, Coastal Plain Experiment Station, November 2007


10 Evaluations of Critical Use Nominations for Methyl Bromide and Related Matters – Interim Report

10.1 Scope of the Report

This 2010 interim report provides evaluations by MBTOC of CUNs submitted for methyl bromide (MB) in 2011 and 2012 by Parties in accordance with Decision IX/6 (Annex I, MOP16). CUNs were submitted to the Ozone Secretariat by the Parties, in accordance with Decision XVI/4 (Annex II of this report). Parties are encouraged to ensure their submissions are in accordance with the timetable set out in Annex I, Decision XVI/4.

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), consideration of national, sub national and local regulations and law on the use of MB alternatives (Decision XX/5) and summaries of emission control, research and appropriate efforts (Decision XXI/11, para 9). 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 increased or fallen within the sector due to a range of circumstances.

Standard presumptions used in the 2010 round were the same as those used in the 2009 round. MBTOC S has updated references to substantiate its standard presumptions for MB dosage rates in previous reports, no further updates have been provided in this report. 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 to be presented to the MOP for notification of the Parties as required in Annex 1, MOP16).

MBTOC Soil has initial responsibility for the pre-plant soil uses and alternatives of MB. MBTOC Structures and Commodities (MBTOC SC) has initial responsibility for issues concerning MB uses and alternatives for structural and commodity treatments. MBTOC QPS has initial responsibility for preparation of a report for the 29th OEWG as required in Decision XXI/10.

Evaluations of CUNs for the two categories are reported separately below. Outcomes from deliberations by the three MBTOC subcommittees were discussed in plenary with the whole committee in Chipiona, and vetted via electronic communication after the meeting. Recommendations made by MBTOC S were circulated to MBTOC SC and vice versa, as part of the process of reaching consensus within the whole committee. The economists attended parts of the three subcommittee meetings which were held at Sanlucar, Spain from 12-16th April, 2010.

10.2 Critical Use Nominations for Methyl Bromide

10.2.1 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 provides 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 of this report for a copy of Decision IX/6.

10.2.2 Fulfilment of Decision IX/6

Decision XVI/2 and Decision XXI/11 directed MBTOC to indicate whether all CUNs fully met the requirements of Decision IX/6. When the requirements of Decision IX/6 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. Several Parties presented action plans to phase out MB and in the absence of full detailed information in nominations this was considered appropriate effort under Decision IX/6. 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.

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 many 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. Parties are encouraged to review the new section in the Progress Report concerning economic analysis as guidance to improving the economic information in the CUNs.

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.

10.2.3 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.1/4(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 10-1 to 10-5 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 10-1: 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.

<table>
<thead>
<tr>
<th>Party</th>
<th>Critical use exemptions authorized by MOP for 2005</th>
<th>Quantity of MB as reported by Parties (metric tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount on hand at start of 2005</td>
<td>Quantity acquired for CUEs in 2005 (production + imports)</td>
</tr>
<tr>
<td>Australia</td>
<td>146.6</td>
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</tr>
<tr>
<td>Canada</td>
<td>61.792</td>
<td>0</td>
</tr>
<tr>
<td>EC</td>
<td>4 392.812</td>
<td>216.198</td>
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<td>1 089.306</td>
<td>16.358</td>
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<td>7 613</td>
</tr>
</tbody>
</table>

(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 10-2: Quantities of MB ‘on hand’ at the beginning and end of 2006, as reported by Parties in 2007/2008 under Decision XVI/6.

<table>
<thead>
<tr>
<th>Party</th>
<th>Critical use exemptions authorized by MOP for 2006</th>
<th>Quantity of MB as reported by Parties (metric tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount on hand at start of 2006</td>
<td>Quantity acquired for CUEs in 2006 (production + imports)</td>
</tr>
<tr>
<td>Australia</td>
<td>75.1</td>
<td>0</td>
</tr>
<tr>
<td>Canada</td>
<td>53.897</td>
<td>3.713</td>
</tr>
<tr>
<td>EC</td>
<td>3 536.755</td>
<td>114.953</td>
</tr>
<tr>
<td>Israel</td>
<td>880.29</td>
<td>0</td>
</tr>
<tr>
<td>Japan</td>
<td>741.4</td>
<td>70.735</td>
</tr>
<tr>
<td>USA(a)</td>
<td>8 081.753</td>
<td>9 974(a)</td>
</tr>
</tbody>
</table>

(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 10-3: Quantities of MB ‘on hand’ at the beginning and end of 2007, as reported by Parties in 2008/2009 under Decision XVI/6.

<table>
<thead>
<tr>
<th>Party</th>
<th>Critical use exemptions authorized by MOP for 2007</th>
<th>Quantity of MB as reported by Parties (metric tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount on hand at start of 2007</td>
<td>Quantity Acquired for CUEs in 2007 (production +imports)</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------------------------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>Australia</td>
<td>48.553</td>
<td>0</td>
</tr>
<tr>
<td>Canada</td>
<td>52.874</td>
<td>0.897</td>
</tr>
<tr>
<td>EC</td>
<td>689.142</td>
<td>31.635</td>
</tr>
<tr>
<td>Israel</td>
<td>966.465</td>
<td>0</td>
</tr>
<tr>
<td>Japan</td>
<td>636.172</td>
<td>23.417</td>
</tr>
<tr>
<td>USA</td>
<td>6 749</td>
<td>7 671(a)</td>
</tr>
</tbody>
</table>

(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 10-4: Quantities of MB ‘on hand’ at the beginning and end of 2008, as reported by Parties in 2009 under Decision XVI/6.

<table>
<thead>
<tr>
<th>Party</th>
<th>Critical use exemptions authorized by MOP for 2008</th>
<th>Quantity of MB as reported by Parties (metric tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount on hand at start of 2008</td>
<td>Quantity Acquired for CUEs in 2008 (production +imports)</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------------------------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>Australia</td>
<td>48.450</td>
<td>0</td>
</tr>
<tr>
<td>Canada</td>
<td>42.19</td>
<td>0.348</td>
</tr>
<tr>
<td>EC</td>
<td>245.146</td>
<td>6.409</td>
</tr>
<tr>
<td>Israel</td>
<td>Reported incomplete information</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>443.775</td>
<td>24.467</td>
</tr>
<tr>
<td>USA</td>
<td>5 336</td>
<td>1 730 6458(a)</td>
</tr>
</tbody>
</table>

(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
Table 10-5: Quantities of MB ‘on hand’ at the beginning and end of 2009, as reported by Parties in 2010 under Decision XVI/6.

<table>
<thead>
<tr>
<th>Party</th>
<th>Critical use exemptions authorized by MOP for 2009</th>
<th>Quantity of MB as reported by Parties (metric tonnes)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount on hand at start of 2009</td>
<td>Quantity Acquired for CUEs in 2009 (production +imports)</td>
<td>Amount available for use in 2009</td>
<td>Quantity used for CUEs in 2009</td>
<td>Amount on hand at the end of 2009</td>
</tr>
<tr>
<td>Australia</td>
<td>37.61</td>
<td>0</td>
<td>33.278</td>
<td>33.278</td>
<td>33.278</td>
</tr>
<tr>
<td>Canada</td>
<td>39.1</td>
<td>1.997</td>
<td>30.276</td>
<td>23.8</td>
<td>6.38</td>
</tr>
<tr>
<td>EC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Israel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>305.380</td>
<td>11.882</td>
<td>278.616</td>
<td>290.498</td>
<td>286.532</td>
</tr>
<tr>
<td>USA</td>
<td>2,276</td>
<td>4,273(a)</td>
<td>2,274</td>
<td>6,547</td>
<td>2,215</td>
</tr>
</tbody>
</table>

(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 year’s production

10.2.3.1 Stocks

TEAP notes that the amount of MB stocks held by the US at the end of 2009 is still 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 could still be 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.

10.2.4 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 III and IV). 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 10-6, Figures 10-1 and 10-2) 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 10-7 and 10-8 in particular shows the amounts nominated and recommended for ‘Critical Use’ in 2011 and 2012 for preplant soil use by Party.
10.2.5  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 10-1 and 10-2 show the trends in the reduction in amounts approved/nominated by Parties for ‘Critical Use’ from 2005 to 2012 for some key uses. The complete trends in phase out of MB by country, as indicated by change in CUE, are shown in Tables 12 and 13, Annexes III and IV.
Figure 10-1: Amounts of MB exempted for CUE uses in preplant soil industries from 2005 to 2011. Solid lines indicate the trend in CUE methyl bromide. Dashed lines indicate quantity of MB nominated by the Parties in either 2011 or 2012.
Figure 10-2: Amounts of MB exempted for CUE uses in mills and food processing facilities from 2005 to 2012. Solid lines indicate trend in CUE methyl bromide. Dashed lines indicate quantity of MB nominated by the Party in either 2011 or 2012.

<table>
<thead>
<tr>
<th>Year</th>
<th>Australia</th>
<th>Canada</th>
<th>European Community</th>
<th>Israel</th>
<th>Japan</th>
<th>New Zealand</th>
<th>Switzerland</th>
<th>USA</th>
<th>TOTALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>206,950</td>
<td>61,992</td>
<td>5754.361</td>
<td>1117.156</td>
<td>748.000</td>
<td>53.085</td>
<td>8.700</td>
<td>10753.997</td>
<td>18704.241</td>
</tr>
<tr>
<td>2006</td>
<td>81,250</td>
<td>53.897</td>
<td>4213.47</td>
<td>1081.506</td>
<td>741.400</td>
<td>53.085</td>
<td>7.000</td>
<td>9386.229</td>
<td>15617.837</td>
</tr>
<tr>
<td>2007</td>
<td>52.145</td>
<td>46.745</td>
<td>1238.873</td>
<td>1236.517</td>
<td>651.700</td>
<td>32.573</td>
<td>0</td>
<td>7417.999</td>
<td>10677.552</td>
</tr>
<tr>
<td>2008</td>
<td>52.900</td>
<td>42.241</td>
<td>245.00</td>
<td>952.845</td>
<td>589.600</td>
<td>0</td>
<td>0</td>
<td>6415.153</td>
<td>10297.739</td>
</tr>
<tr>
<td>2009</td>
<td>38.999</td>
<td>39.115</td>
<td>383.700</td>
<td>699.448</td>
<td>508.900</td>
<td>0</td>
<td>0</td>
<td>4958.034</td>
<td>8297.739</td>
</tr>
<tr>
<td>2010</td>
<td>37.610</td>
<td>35.080</td>
<td>288.500</td>
<td>383.700</td>
<td>288.500</td>
<td>0</td>
<td>0</td>
<td>3299.490</td>
<td>6244.487</td>
</tr>
<tr>
<td>2011</td>
<td>35.450</td>
<td>19.368</td>
<td>249.429</td>
<td>1232.247</td>
<td>249.429</td>
<td>0</td>
<td>0</td>
<td>2388.128</td>
<td>2928.142</td>
</tr>
<tr>
<td>2012</td>
<td>34.600</td>
<td>16.281</td>
<td>221.104</td>
<td>1089.306</td>
<td>221.104</td>
<td>0</td>
<td>0</td>
<td>1181.779</td>
<td>1453.824</td>
</tr>
<tr>
<td>2005 – (1ExMOP and 16MOP)</td>
<td>146,600</td>
<td>61.792</td>
<td>4392.812</td>
<td>1089.306</td>
<td>748.000</td>
<td>50.000</td>
<td>8.700</td>
<td>10753.997</td>
<td>18704.241</td>
</tr>
<tr>
<td>2006 – (1MOP + 16MOP)</td>
<td>75,100</td>
<td>53.897</td>
<td>3536.755</td>
<td>880.286</td>
<td>741.400</td>
<td>42.000</td>
<td>7.000</td>
<td>9386.229</td>
<td>15617.837</td>
</tr>
<tr>
<td>2007 – (17MOP + 18MOP)</td>
<td>48,517</td>
<td>52.874</td>
<td>689.142</td>
<td>966.715</td>
<td>636.172</td>
<td>0</td>
<td>0</td>
<td>6415.153</td>
<td>10677.552</td>
</tr>
<tr>
<td>2008 – (18MOP + 19MOP)</td>
<td>48,450</td>
<td>36.112</td>
<td>245.146</td>
<td>860.580</td>
<td>443.775</td>
<td>0</td>
<td>0</td>
<td>4958.034</td>
<td>8297.739</td>
</tr>
<tr>
<td>2009 – (19MOP)</td>
<td>37.610</td>
<td>39.020</td>
<td>0</td>
<td>610.854</td>
<td>305.380</td>
<td>0</td>
<td>0</td>
<td>3299.490</td>
<td>6244.487</td>
</tr>
<tr>
<td>2010 – (20MOP + 21MOP)</td>
<td>36.440</td>
<td>30.340</td>
<td>0</td>
<td>200.787</td>
<td>267.000</td>
<td>0</td>
<td>0</td>
<td>2388.128</td>
<td>2928.142</td>
</tr>
<tr>
<td>2011 – (21MOP)</td>
<td>5.95</td>
<td>19.368</td>
<td>0</td>
<td>224.497</td>
<td>238.746</td>
<td>0</td>
<td>0</td>
<td>1181.779</td>
<td>1453.824</td>
</tr>
</tbody>
</table>

*Not yet available.
**Members of the European Community which had CUNs/CUEs included:

- Belgium, France, Germany, Greece, Italy, Netherlands, Poland, Portugal, Spain, and the United Kingdom.
- Belgium, France, Germany, Greece, Ireland, Italy, Latvia, Malta, Netherlands, Poland, Portugal, Spain, and the United Kingdom.
- France, Greece, Ireland, Italy, Netherlands, Poland, Spain, and the United Kingdom.
- Poland, Spain
10.2.6 Evaluations of CUNs – 2010 round for 2011 and 2012 exemptions

All three subcommittees of MBTOC met together at the Agricultural Research and Education Center (IFAPA) in Chipiona, Spain from 12 through 16 April 2010 to conduct a review of CUNs as requested by Parties, to update reports, discuss issues of registration of alternatives and other matters. Three MBTOC economists attended the meetings, spending time in each subcommittee. MBTOC welcomed a new economist member from New Zealand who has expertise in economic issues related to MB use for QPS. MBTOC also welcomed one new member for the QPS subcommittee.

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 MBTOC Soils and MBTOC Structures and Commodities subcommittees were discussed in plenary and via electronic communication as part of the process of reaching consensus within the whole committee.

During the meeting MBTOC S held a bilateral meeting with the US delegation and the Californian Strawberry Commission and MBTOC-SC had bilateral meetings with the US delegation.

One Party (Israel) submitted nominations for preplant soil use in the 2011 round and four Parties (Australia, Canada, Japan, and the USA) submitted nominations for both preplant soil use and post harvest use in 2012. Australia also submitted a supplementary CUN for preplant soil use in 2011 for strawberry runner use. Israel did not submit a nomination for dates. Canada nominated amounts for post harvest in one sector for both 2011 and 2012. All these Parties have submitted nominations in previous CUN rounds. The total number of 36 nominations was submitted by five Parties and was the same number as in the last round. In 2008, Japan indicated in correspondence prior to the 28th OEWG that it plans to phase out all preplant soil uses of MB by 2013 and in April 2010, Israel indicated it would not be submitting any further CUN nominations after this round. MBTOC SC has been informed that Japan will submit a phase out plan for its postharvest MB use later this year.

In Structures and Commodities, Parties continue to make progress on CUNs, reducing many MB uses by continuing to resolve the inter-related issues of treatment logistics, costs, trade demands and effectiveness of alternatives. But unfortunately, in the case of the majority of CUNs for structures and commodities, progress in adopting alternatives has stalled. In this interim report, MBTOC has recommended reductions in many of the CUNs as described below. MBTOC informs the Parties that without an increased research focus, regulatory approvals of alternatives and a commitment to requiring the use of the alternatives that are available, CUNs may well persist at current levels for several years or longer.

MBTOC has sometimes recommended quantities of MB for 2011 or 2012 which are different from those nominated. The grounds used for these recommendations are given in detail after the relevant CUNs in Tables 10-12 and 10-13. The adjustments for preplant soils use may in part be to account for presumptions given in Tables 10-9 and 10-10.

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 10-12 and 10-13 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. In structures and commodities CUNs noted considerable
concern about switching from methyl bromide to sulfuryl fluoride given the SF’s high GWP. This situation is discussed further in the Progress Report. 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.

10.2.7 Critical Use Nominations Review

In considering the CUNs submitted in 2010, 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 used the standard presumptions set out in Table 10-9 and 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.

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.

10.2.8 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 2010 CUN process, according to a standardised format developed by TEAP. The Disclosure of Interest declarations can be found on the internet at http://ozone.unep.org/Assessment_Panels/TEAP/index.shtml. 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.

10.3 MBTOC Soils: Final Evaluations of 2010 Critical Use Nominations for Methyl Bromide

10.3.1 Summary of outcomes

In the 2010 round, 27 CUNs were submitted for soil uses, 9 for 2011 and 18 for 2012. A further supplementary CUN was submitted by Australia for the strawberry runner sector in 2011 for 5.95 tonnes. Interim recommendations were made on all nominations, which were for 238.197 tonnes for 2011 and 1271.649 tonnes for 2012. The recommended amounts totalled 230.447 tonnes for 2011 and 1164.452 t for 2012 (Tables 10-7 and 10-8).

MBTOC acknowledged the substantial reductions made by Israel and USA in this round and the action plans to phase out MB in Israel by the end of 2011 and for Japan by the end of 2012.
Table 10-7: Summary of MBTOC S final recommendations for 2011 and 2012 by country for CUNs received in 2010 for preplant soil use of MB (tonnes)

<table>
<thead>
<tr>
<th>Country</th>
<th>CUE approved at 21st MOP</th>
<th>CUN for 2011 and 2012</th>
<th>MBTOC-S Interim Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>23.840</td>
<td>5.950</td>
<td>29.790</td>
</tr>
<tr>
<td>Canada</td>
<td>5.261</td>
<td>5.261</td>
<td>5.261</td>
</tr>
<tr>
<td>Israel</td>
<td>290.878</td>
<td>232.247</td>
<td>224.497</td>
</tr>
<tr>
<td>Japan</td>
<td>224.451</td>
<td>216.120</td>
<td>216.120</td>
</tr>
<tr>
<td>USA</td>
<td>1977.830</td>
<td>1020.478</td>
<td>913.311</td>
</tr>
<tr>
<td>Total</td>
<td>290.878</td>
<td>238.197</td>
<td>1271.649</td>
</tr>
</tbody>
</table>
Table 10-8: Summary of the interim recommendations by MBTOC S (in square brackets) for CUE’s for preplant uses of MB (tonnes) for 2011 and 2012 submitted in the 2010 round.

<table>
<thead>
<tr>
<th>Country and Sector</th>
<th>Years</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <strong>Australia</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Strawberry runners</td>
<td>[5.95]</td>
<td>[29.760]</td>
<td></td>
</tr>
<tr>
<td>2. <strong>Canada</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Strawberry runners</td>
<td></td>
<td>[5.261]</td>
<td></td>
</tr>
<tr>
<td>3. <strong>Israel</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Broomrape protected</td>
<td>[12.500]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Cucumber</td>
<td></td>
<td>[12.500]</td>
<td></td>
</tr>
<tr>
<td>3. Cut flowers open field</td>
<td>[23.292]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Cut flowers&amp; bulbs protected</td>
<td>[52.335]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Melon protected &amp; open field</td>
<td>[35.000]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Strawberry fruit - Sharon and Gaza</td>
<td>[41.875]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Strawberry runners - Sharon and Gaza</td>
<td>[27.000]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Sweet potatoes</td>
<td></td>
<td>[20.000]</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>[224.497]</td>
<td></td>
</tr>
<tr>
<td>4. <strong>Japan</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Cucumber</td>
<td></td>
<td>[26.162]</td>
<td></td>
</tr>
<tr>
<td>2. Ginger open field</td>
<td></td>
<td>[42.235]</td>
<td></td>
</tr>
<tr>
<td>4. Melon</td>
<td></td>
<td>[67.936]</td>
<td></td>
</tr>
<tr>
<td>5. Pepper green &amp; hot</td>
<td></td>
<td>[61.154]</td>
<td></td>
</tr>
<tr>
<td>6. Watermelon</td>
<td></td>
<td>[12.075]</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>[216.120]</td>
<td></td>
</tr>
<tr>
<td>5. <strong>USA</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Cucurbits</td>
<td></td>
<td>[59.500]</td>
<td></td>
</tr>
<tr>
<td>2. Eggplants (field)</td>
<td></td>
<td>[6.904]</td>
<td></td>
</tr>
<tr>
<td>3. Forestry nursery</td>
<td></td>
<td>[34.230]</td>
<td></td>
</tr>
<tr>
<td>5. Orchard replant</td>
<td></td>
<td>[18.324]</td>
<td></td>
</tr>
<tr>
<td>6. Ornamentals</td>
<td></td>
<td>[48.164]</td>
<td></td>
</tr>
<tr>
<td>7. Pepper (field)</td>
<td></td>
<td>[206.234]</td>
<td></td>
</tr>
<tr>
<td>8. Strawberry (field)</td>
<td></td>
<td>[756.515]</td>
<td></td>
</tr>
<tr>
<td>9. Strawberry runners</td>
<td></td>
<td>[3.752]</td>
<td></td>
</tr>
<tr>
<td>10. Sweet potatoes</td>
<td></td>
<td>[8.709]</td>
<td></td>
</tr>
<tr>
<td>11. Tomatoes (field)</td>
<td></td>
<td>[54.423]</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>[1020.478]</td>
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</tbody>
</table>

10.3.2 **Issues related to CUN Assessment for Preplant Soil Use**

Key issues which influenced assessment and the need for MB for preplant use of MB in the 2010 round were:

i) Increased adoption and registration of methyl iodide (MI or iodomethane) with barier films in most states of the USA (not California) in mid 2008 which has led to commercial adoption on large sale areas in the US and substantial reduction in the US nominations in SE and Florida.

ii) Continued and progressive acceptance of a 3 way fumigant strategy (1,3-dichloropropene, metham sodium, Pic) as 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) Introduction of a new formulation of 1,3-D/Pic (Picchlor 60) in the USA which increases the use of 1,3-D in areas affected by township caps.

v) Effect of restrictions on use of high rates of Pic (greater than 200 kg/ha (20 g/m²)) in some counties of California.

vi) Lack of acceptance in specific sectors that alternatives exist, e.g. orchard replant in heavy soils, and nursery industries.

In this round, the US indicated that it had reclassified further quantities into QPS for the forest nursery sector. Israel indicated an intention to no longer seek CUNs beyond this round (ie. from 2011 onwards) and in previous rounds Japan has indicated it will no longer seek any nominations beyond 2012.

In the 2010 round, MBTOC also used actual adoption data of alternatives in specific regions to assist with assessment where it was available, such as the Californian Department of Pesticide Regulation commodity and pesticide data.

MBTOC continues to urge Parties to consider review of regulations covering the registration, use and adoption of alternatives, particularly review of barrier films to reduce dosage rates of MB and the 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. There is a lack of research studies to develop and demonstrate effectiveness of alternatives in these sectors. This lack of research effort leads MBTOC to conclude that several of the CUNs 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 the use of MB and alternatives.

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 regulations prevent use of barrier films which otherwise could have reduced the MB dosage rate. Also regulations on the use of alternatives are preventing their uptake for a substantial proportion of the remaining CUNs for preplant soil use. 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.

10.3.2.1 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”.

Methyl iodide, 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 states). This registration has been expanded in 2009 and includes strawberries, tomatoes, peppers, ornamentals, stone fruits, nut crops, vine crops (including table and wine grapes), turf, conifer trees and nursery crops. 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, 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 and metham sodium are under review. A grace period for the registration of 1,3-D became due on 20 March 2009 and was extended, but its future registration is uncertain.

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.

10.3.2.2 Update on rates of adoption of alternatives for preplant uses - Decision XIX/9

As of the 2010 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 (Porter et al, 2006) 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.

Figures 10-1 in this report shows the apparent reduction rates for preplant soil use of 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 10-12 also provide detail of some of the key alternatives that Parties have and should consider to further replace MB for the remaining uses.

Further guidance from the Parties, particularly Australia, Canada and the US of expected rates of adoption of alternatives following registration, would assist MBTOC in evaluation of CUNs in future.

10.3.2.3 Sustainable alternatives for preplant uses

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. On occasion of this
meeting, MBTOC was able to visit flower growers in Southern Spain who have successfully adopted biodisinfestation as an efficient and sustainable alternative to MB.

10.3.3 Standard presumptions used in assessment of nominated quantities.

The tables below (Tables 10-9 and 10-10) 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 have been provided in previous reports and were revised for some sectors after consideration by the Parties at the 19th MOP. The rates and practices adopted by MBTOC as standard presumptions are based on maximum rates considered acceptable by published literature and actual commercial practice.

As in the evaluations in previous years, MBTOC considered reductions to quantities of MB in particular nominations to a standard rate per treated area where technical evidence supported its use. As a special case, MBTOC continues to accept a maximum rate of 200 kg/ha (20 g/m²) 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/m²) or less 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.
**Table 10-9: Standard presumptions used in assessment of CUNs for the 2009 round – soil treatments.**

<table>
<thead>
<tr>
<th>Comment</th>
<th>CUN adjustment</th>
<th>Exceptions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Dosage rates</strong></td>
<td>Maximum guideline rates for MB:Pic 98:2 are 25 to 35 g/m² with barrier films (VIF or equivalent); for mixtures of MB:Pic are 12.5 to 17.5 g MB/m² for pathogens and nutsedge respectively, under barrier films depending on the sector. All rates are on a ‘per treated hectare’ basis.</td>
<td>Amount adjusted to maximum guideline rates. Maximum rates set dependent on formulation and soil type and film availability.</td>
</tr>
<tr>
<td><strong>2. Barrier films</strong></td>
<td>All treatments to be carried out under low permeability barrier film (e.g. VIF, TIF)</td>
<td>Nomination reduced proportionately to conform to barrier film use.</td>
</tr>
<tr>
<td><strong>3. MB/Pic Formulation: Pathogen control</strong></td>
<td>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.</td>
<td>Nominated amount adjusted for use with MB/Pic 50:50 (or similar).</td>
</tr>
<tr>
<td><strong>4. MB/Pic Formulation: Weeds/nutsedge control</strong></td>
<td>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.</td>
<td>Nominated amount adjusted for use with MB/Pic 67:33 (or similar).</td>
</tr>
<tr>
<td><strong>5. Strip vs. Broadacre</strong></td>
<td>Fumigation with MB and mixtures to be carried out under strip</td>
<td>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.</td>
</tr>
</tbody>
</table>

**Table 10-10. Maximum dosage rates for preplant soil use of MB by sector used in the 2009 round (standard presumptions).**

<table>
<thead>
<tr>
<th>Film Type</th>
<th>Maximum MB Dosage Rate (g/m²) in MB/Pic mixtures (67:33, 50:50) considered effective for:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strawberries and Vegetables</td>
<td>Nurseries*</td>
<td>Orchard Replant</td>
</tr>
<tr>
<td>Barrier films - Pathogens</td>
<td>12.5</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Barrier films - Nutsedge</td>
<td>15.0</td>
<td>17.5</td>
<td>17.5</td>
</tr>
<tr>
<td>No Barrier films – Pathogens</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>No Barrier films - Nutsedge</td>
<td>26</td>
<td>26</td>
<td>26</td>
</tr>
</tbody>
</table>

* Maximum rate unless certification specifies otherwise
10.3.4  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 and 2006; 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). Parties are urged to consider even lower dosage rates of MB for the remaining CUNs. This includes rates as low as 75 kg/ha (7.5 g/m²) with mixtures of 30:70 or 33:67 mixtures (at 250 kg/ha) or 100 kg/ha (10 g/m²) of MB in 250 kg/ha of 50:50 MB/Pic mixtures in conjunction with barrier films (Table 10-11).

Table 10-11: 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.

<table>
<thead>
<tr>
<th>Commercial application rates of formulation</th>
<th>MB/Pic formulation (dose of MB in g/m²)</th>
<th>98:2</th>
<th>67:33</th>
<th>50:50</th>
<th>30:70</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. With Standard Polyethylene Films</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>400</td>
<td></td>
<td>39.2</td>
<td>26.8</td>
<td>20.0</td>
<td>12.0</td>
</tr>
<tr>
<td>350</td>
<td></td>
<td>34.3</td>
<td>23.5</td>
<td>17.5</td>
<td>10.5</td>
</tr>
<tr>
<td>300</td>
<td></td>
<td>29.4</td>
<td>20.1</td>
<td>15.0</td>
<td>9.0</td>
</tr>
<tr>
<td>B. With Low Permeability Barrier Films (LPBF)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>250</td>
<td></td>
<td>24.5</td>
<td>16.8</td>
<td>12.5</td>
<td>7.5</td>
</tr>
<tr>
<td>200</td>
<td></td>
<td>19.6</td>
<td>13.4</td>
<td>10.0*</td>
<td>6.0</td>
</tr>
<tr>
<td>175</td>
<td></td>
<td>17.2</td>
<td>11.8</td>
<td>8.8</td>
<td>5.3</td>
</tr>
</tbody>
</table>

* Note: Trials from 1996 to 2008 (Annex III) show that a dosage of 10g/m² (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/m² using standard PE films

10.3.5  Use/Emission reduction technologies - Low permeability barrier films and dosage reduction

Decision XXI/11 (para 9) requested further reporting on Decision IX/6 to ensure Parties adopted emissions controls where possible. For preplant soil use, this includes the use of barrier films and lowest effective dose of MB with mixtures of chloropicrin. Other methods include deep shanking and use of ammonium thiosulphate and different irrigation technologies (Yates et al 2007). These latter technologies have not been reported or adopted widely by Parties and need to be evaluated more widely for future CUN uses.

In south east USA the reported use of barrier films in vegetable crops has expanded to over 20,000 hectares 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 barrier films 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.
### Table 10-12: Final evaluations of CUNs for preplant soil use submitted in 2010 for 2011 or 2012

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>Strawberry runners</td>
<td>35.750</td>
<td>37.500</td>
<td>35.750</td>
<td>35.750</td>
<td>29.790</td>
<td>29.790</td>
<td>23.840</td>
<td>5.95</td>
<td>29.790</td>
<td>5.95</td>
</tr>
</tbody>
</table>

**MBTOC comments 2010:**

MBTOC recommends the supplementary nomination of 5.95 tonnes of MB for use in 2011. The second year of a 2-year study showed that the reduced rate of 18.75 g/m² did not adequately control root and crown rot on the Festival variety and currently could not be used as it is not registered. Therefore the requested amount from the Party was accepted for the 2011 nomination.

MBTOC recommends a reduced CUE of 29.760 tonnes for use in 2012. The reduction by MBTOC is based on adoption of the soilless production system for the foundation generation. 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 an MB dose of 25 g/m² is required to meet certification standards. The Party's request exceeds MBTOC's standard presumption of 20 g/m², but this rate continues to remain unregistered. The Party's first 2-year effort using a reduced rate of 18.75 g/m² resulted in unsatisfactory results in the second year of testing. The Party has indicated, however, that it is initiating a second 2-year trial using the reduced rate of 20 g/m² which should be completed in September 2011. The Party states that the most promising alternative, MI:Pic has been demonstrated in commercial scale field trials to compare with the efficacy to MB:Pic. The register has indicated that additional data has been requested by the national registration authority (APVMA) which will be submitted this year and should lead to registration in 2011. 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 second 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 suggests the following actions by the Party: (1) Report the first year’s results with reduced rates of 20 g/m² of MB with its next CUN submission and report to MBTOC the tentative second year results by August 2011; (2) Provide a comprehensive update of the registration status of MI and EDN, (3) Provide the results from the new trials using recaptured MB & Pic as well as a comprehensive plan for commercialization, and (4) Since the production of 60,000 foundation generation plants has been found to be economically feasible, the Party needs to provide the economic analysis that supports their assertion that any further expansion in future generations is not economically feasible, (5) consider other methods (new barrier films, potassium thiosulphate, etc.) for emission controls.

**MBTOC comments on economics 2010:**

The nomination states “The second part of a two year trial that evaluated the economic and biological feasibility of production of foundation stock by a soil-less system is now complete. It compared productivity with the status quo system of production in MB:Pic treated soil in insect proof cages. Results confirm the biological and economic feasibility of adopting the soil-less system for production of the foundation generation of runners (A1).” The CUN further states “The economics of the system compare favourably with the current methods of production.”

**Comments requested in Dec. XX1/11 (para 9)**

- **Dec. IX/6 b(i) Emission control:** No, barrier films are not being used and the regulations require higher MB rates of use than the standard presumptions. Standard LDPE films are still used because they are reported to perform the same as barrier films in the cold temperatures and heavy wet soils typical for strawberry runner production and the Party states that barrier films provide no further effectiveness.
|---------|----------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|----------------------------|-------------|--------------------------------|-----------------|

**MBTOC comments 2010:**

MBTOC recommends 5.261 tonnes for this use in 2012. The CUN for 2012 is based on a reduced rate for MB of 20 g/m², and MBTOC acknowledges the Party’s reduction in the absence of formal registration for this dose rate. The Party has attempted to replace MB with 1,3-D, but 1,3-D was banned for use in Prince Edward Island in January 2003 due to ground water contamination. Chloropicrin (PIC 100) has been registered by PMRA, but the PEI authorities have denied a permit for its use until further ground water testing has been conducted. MI registrant has not applied for registration in Canada. The company has also been testing organic production from 2006 - 2009 with different varieties. Reduced yields resulted (yield reductions ranged from 40% - 70%). One variety using the organic production system compare favorably to conventional production. Organic trials continued in 2009. While MB:Pic 67.33 @ 500 kg/ha is the only use rate registered for strawberry runners, which exceeds MBTOC’s standard presumption of 200 kg/ha, the grower petitioned PMRA to use a lower rate under barrier films. PMRA, in the absence of a formal label amendment, granted permission to use a lower rate, but at the grower’s own risk and liability. In 2008 the grower tested two plots totalling 2.4 ha using 25% & 30% lower rates under barrier films and expanded the area tested in 2009. The results were comparable using the reduced rates with barrier films. The CUN for 2012 is based entirely on a reduced rate for MB of 200 kg/ha for the entire area to be fumigated. For future submissions, MBTOC suggests actions for the Party to (1) complete the necessary ground water studies to obtain the PIC 100 permit and (2) test the adoption of soilless cultures for at least part of the production cycle, (3) consider MI.

**MBTOC comments on economics 2010:**

The nomination was not based on economic arguments.

**Comments requested in Dec. XX11/11 (para 9)**

- **Dec. IX/6 b(i) Emission reduction:** Yes, uses barrier films with reduced application rate of MB conforming to MBTOC’s presumptions
- **Dec. IX/6 b(iii) Research program:** Yes, focus has been on organic production testing, but trials with MI not being conducted.
- **Dec. IX/6 b(iii) Appropriate effort:** The Party demonstrates an active research program and is seeking registration of PIC100
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<tbody>
<tr>
<td>Israel</td>
<td>Broomrape</td>
<td>None</td>
<td>None</td>
<td>250.000</td>
<td>250.000</td>
<td>125.000</td>
<td>12.500</td>
<td>-</td>
<td>12.500</td>
<td>12.500</td>
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**MBTOC comments 2010:**

MBTOC recommends 12.500 tonnes for this use in 2011. The nomination is for a specific species of broomrape (A. aegyptica) greenhouse use in tomatoes and pepper and is additional to the outdoor field nominations in previous years. MB use for a national broomrape eradication on outdoor field crops has been approved as a CUN for the years 2007, 2008, 2009 and 2010, however the allocated amounts have not been utilized. It is MBTOC’s understanding is that previous MB approved for broomrape control has not been produced, and therefore is unavailable for this nomination. In the the 2010 nomination, the Party confirms that Telon EC is a very good chemical alternative for the control of O. aegyptica the main species parasitizing tomato however the registration is unclear and use may not be resolved for all species of brommrape. Telon EC as a stand alone application or in sequential application with MS suppresses broomrape when applied under plastic sheets through the drip irrigation system in tunnels or greenhouses. The Party has also identified some alternatives for controlling low infestations of Orobanche (e.g. solarization). In addition to Telone EC alone or with MS, MBTOC has identified other alternatives, such as Sufonylurea, imazapic, and imazomox (Eizenberg et al, 2004). (Abanga et al., 2007; Nadal et al., 2008; Miller et al., 2009). Barrier films are used to reduce rates by 50% and also emissions. The Party discusses an on-going research program in the nominations however no results are reported.

**MBTOC comments on economics 2010:**

The nomination states that since an eradication program is being proposed, the standard format of an economic evaluation is not appropriate. The CUN also states, without supporting evidence, 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. MBTOC takes note of these statements in light of the fact that the nomination is not based on economic arguments.

**Comments requested in Decision XXI/11 (para 9)**

- **Dec. IX/6 b(i)- Emission Reduction:** Yes, the Party is using barrier films and standard rates.
- **Dec. IX/6 b(iii)- Research Program:** No, the research is supposedly on-going, but is not reported in the nomination.
- **Dec. IX/6 b(iii)- Appropriate Effort:** Israel has indicated that it will no longer be applying for CUE’s after 2011.

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</tr>
</thead>
<tbody>
<tr>
<td>Israel</td>
<td>Cut flowers-bulbs-protected</td>
<td>303.000</td>
<td>240.000</td>
<td>220.185</td>
<td>114.450</td>
<td>85.431</td>
<td>63.464</td>
<td>-</td>
<td>52.955</td>
<td>52.330</td>
<td>52.330</td>
<td></td>
</tr>
</tbody>
</table>

**MBTOC comments 2010:**

MBTOC recommends uced amount of 52.330 tonnes for this use in 2011. MBTOC does not approve use for MB on substrates being 0.625 t. MBTOC recognizes that in 2012 the Party will totally phase out MB uses. There is very little change from nominations submitted in previous years, particularly in 2009 and 2010. Phase-out efforts are still based on transitional measures – high 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 additional flower types. More expansion of registration is expected this year. Substrate production protocols are now available for many of the flowers for which they claim they are yet to be developed (“artificial” production is not critically impacted by local conditions and this makes experiences from other countries valid). MBTOC notes the Party has adjusted MB dosages used for carnations grown in Ghaza to 25 g/m². MBTOC is aware that carnation cultivars resistant to fusarium wilt are available and commercially used and accepted by international markets.
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<tr>
<td>Israel</td>
<td>Cut flowers-open field</td>
<td>77,000</td>
<td>67,000</td>
<td>74,540</td>
<td>44,750</td>
<td>34,698</td>
<td>28,554</td>
<td>-</td>
<td>23,292</td>
<td>-</td>
<td>23,292</td>
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**MBTOC comments on economics 2010:**
No economic arguments are provided in the nomination.

**Comments requested in Dec. XX1/11 (para 9)**
- Dec. IX/6 b(i) Emission reduction: Yes, barrier films are currently used in protected flowers and rates conform with MBTOC’s standard presumptions.
- Dec IX/6 b(iii) Research program: No. Poor to no research have been conducted on alternatives. This appears to be an orphan sector in the alternatives to methyl bromide program and is dependent on research from other sectors.
- Dec. IX/6 b(iii) Appropriate effort: Israel has indicated that it will no longer be applying for CUE’s after 2011.

**MBTOC comments 2010:**
MBTOC recommends the nominated amount of 23,292 tonnes for this use in 2011. The nominated amount was an 18% reduction over the approved amount for 2010. MBTOC recognizes that in 2012 the Party will totally phase out MB uses. Overall, due to the MB phase out stated by the Party, there is very little change from nominations submitted in previous years, particularly in 2009 and 2010. Phase-out efforts are still based on transitional measures - barrier films with reduced rates of methyl bromide. 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 in these cropping systems. 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, in spite of successful trials. MB formulations with higher chloropicrin 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 registrations of potential alternatives are expected this year. Solarisation has been proven to be an efficient alternative for some flower types (Choi et al., 2007; Yakabe and MacDonald, 2010) and is being successfully used in combination with alternative chemicals such as metham sodium and 1,3-D.

**MBTOC comments on economics 2010:**
No economic arguments are provided in the nomination.

**Comments requested in Dec. XX1/11 (para 9)**
- Dec. IX/6 b(i) Emission reduction: Yes, barrier films are currently used in open field flowers and rates conform with MBTOC’s standard presumptions.
- Dec IX/6 b(ii) Research program: No. Poor to no research have been conducted on alternatives. This appears to be an orphan sector in the alternatives to methyl bromide program and is dependent on research from other sectors.
- Dec. IX/6 b(iii) Appropriate effort: Israel has indicated that it will no longer be applying for CUE’s after 2011.
Israel

Cucumber

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<tr>
<td>Israel</td>
<td>Cucumber</td>
<td>None</td>
<td>None</td>
<td>25,000</td>
<td>18,750</td>
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<td>15,937</td>
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<td>12,500</td>
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**MBTOC comments 2010:**

MBTOC recommends 12,500 tonnes for this use in 2011. The recommended quantity represents a 21.6% reduction from the 21th MOP approved amount based on uptake of available alternatives, such as grafted plants, improved sanitation and possible uptake of other alternatives (MS and 1,3-D). 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 key pathogen problems were 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 combined with 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 reduce the nomination further.

**MBTOC comments on economics 2010:**

No economic arguments are provided in the nomination.

**Comments requested in Dec. XXI/11 (para 9)**

- Dec. IX/6 b(i) Emission reduction: Yes, barrier films and dosage rates conform to the standard presumptions.
- Dec. IX/6 b(iii) Research program: Limited reporting of any research, but have used information from other sectors.
- Dec. IX/6 b(iii) Appropriate effort: Efforts in IPM technology, promotion of grafted seedlings. Israel has indicated that it will no longer be applying for CUE’s after 2011.

| Israel  | Melon - protected and field | 125,650 | 99,400 | 105,000 | 87,500 | 87,500 | 70,000 | 35,000 | 35,000 | - |

**MBTOC comments 2010:** MBTOC recommends 35,000 tonnes for this use in 2011. The request is reduced to half of last year’s nomination (down to 35 tonnes) due to the adoption of a pesticide through drip systems which uses new application technology, eg. Azoxystrobin. *Monosporascus cannonballus* 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. The requested amount at a rate of 250 kg/ha (25 g/m²) of 98:2 MB under barrier films (LDPF) complies with MBTOC’s standard presumptions. Additionally, MBTOC understands some alternative fungicides show very effective control of *Monosporascus* and are now available to the growers (Pivonia et. al; 2008; Israel melon CUN, Pivonia et al 2009). MBTOC notes that Pic and MB/Pic mixtures and the fungicide, fludioxonil, are effectively used for Monosporascus in other countries under similar conditions, but fludioxonil has not been shown effective in Israel (e.g. Stanghelini et al. 2003; Martyn 2002, Pivonia et al 2009). 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 (Cohen et al, 2007). On melon, however, problems of scion-rootstock compatibility and fruit...
quality require an additional research effort. Furthermore, new diseases, such as crown rot of melons and cucumbers need to be addressed, as the pathogen has already invaded the relevant area. MBTOC suggests the following actions by the Party: (1) to consider further expansion of the adoption of Azoxystrobin and (2) consider formulations with more chloropicrin (MB/Pic 67:33, 50:50) as they are effective and (3) non chemical alternatives, such as grafting.

**MBTOC comments on economics 2010:**

The nomination states that granular Basamid, is similar in mode of action to MS, however is not feasible economically because of a dramatic increase in the prices of Basamid and waiting period constraints. CUN provides the results of a financial comparison between the use of MB and different formulations of Basamid that show significant losses when the alternatives are not used, with the closest comparator being Basamid 60, which shows losses of net revenue in the order of 30-50%. MBTOC is not able to verify the accuracy of these data. MBTOC notes that the nomination is not based on economic arguments.

**Comments requested in Dec. XX1/11 (para 9)**

- Dec. IX/6 b(i) Emission reduction: Yes, barrier films are is used and MB dosage rates conform with standard presumptions
- Dec. IX/6 b(iii): Research program: Yes, current trials have validated previous research.
- Dec. IX/6 b(iii): Appropriate effort: Active research program reviewing pesticide application and fumigant registration. Israel has indicated that it will no longer be applying for CUE’s after 2011.

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<tr>
<td>Israel</td>
<td>Strawberry fruit - protected (Sharon and Ghaza)</td>
<td>196.000</td>
<td>196.000</td>
<td>93.000</td>
<td>105.960</td>
<td>77.750 (42.75 Sharon, 35.00 Ghaza)</td>
<td>57.063 (32.063 Sharon, 25.00 Ghaza)</td>
<td>-</td>
<td>28.500 (Sharon) 20.50 (Ghaza)</td>
<td>21.375 (Sharon) 20.50 (Ghaza)</td>
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**MBTOC comments 2010:**

MBTOC recommends 21.375 tonnes for Sharon for this use in 2011 and 20.500 tonnes for Ghaza making a total of 41.875 t for this use in 2011. In Sharon, the Party reduced the amount by 11% and MBTOC has reduced by a further 14% based on increased uptake of MS followed by Telon EC which has been shown to be effective. 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 Party is concerned particularly about Macrophomina control, although recent trials showed good results with metham sodium formulations. Previous research has also shown that Telon EC followed by MS was effective. Telone EC has a smaller buffer than 1,3-D/Pic shank applied, i.e. 100 m compared to 250 m, however the registration is unclear. Bromopic is registered, but past results with application have prevented further studies until recently when trials are evaluating it under barrier films. MBTOC acknowledges the Party for indicating an intention to not submit CUNs in 2011 for 2012.

**MBTOC comments on economics 2010:**

The nomination shows that the gross and net revenue of all considered alternatives (Telopic, Bazamid and Telodrip) are higher than for MB. However, these are not feasible due to registration and buffer zone issues.
Country Industry CUE for 2005\textsuperscript{1} CUE for 2006\textsuperscript{2} CUE for 2007\textsuperscript{3} CUE for 2008\textsuperscript{4} CUE for 2009\textsuperscript{5} CUE for 2010\textsuperscript{6} CUE for 2011\textsuperscript{7} CUN for 2011 CUN for 2012 MBTOC rec. for 2011 (addtl or new) MBTOC rec. for 2012 (new)

Comments requested in Dec. XX1/11 (para 9)

- Dec. IX/6 b(i) Emission reduction: Yes, however further dosage reduction would be possible if use of Bromopic with barrier films was not prevented because of high buffer zones
- Dec. IX/6 b(iii) Research program: Yes, however trials on key alternatives as shown above do not appear to be being conducted as they are not reported
- Dec. IX/6 b(iii) Appropriate effort: The nomination indicates limited information on progress with alternatives, but that the Party will not be seeking nominations for MB use in 2012.

Israel Strawberry runners (Sharon and Ghaza) None None - 31.900 28.075 15.825 (Sharon) 12.250 (Ghaza) 22.320 - 13.500 (Sharon) 13.500 (Ghaza) 13.500 (Sharon) 13.500 (Ghaza)

MBTOC comments 2010:

MBTOC recommends 13.5 t for Sharon and 13.5 t for Ghaza for this use in 2011. The key pests affecting strawberry runner production are fungi (Rhizoctonia solani, Verticillium dahliae, Fusarium and Phytophthora spp., Sclerotinia sclerotiorum, Macrophomina phaseolina), root knot nematodes and purple nutsedge. The Party stated that MB 98:2 at a rate of 500 kg/ha (50 g/m\textsuperscript{2}) with standard polyethylene films and 250 kg/ha (25 g/m\textsuperscript{2}) with barrier films are necessary to meet certification standards in Ghaza and Sharon respectively. 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 2010:

No economic arguments are provided in the nomination.

Comments requested in Dec. XX1/11 (para 9)

- Dec. IX/6 b(i) Emission reduction: Yes for Sharon and No for Ghaza as MBTOC is unclear on the availability of barrier films. Further dosage reduction would be possible if use of Bromopic with barrier films was not prevented because of high buffer zones
- Dec. IX/6 b(iii) Research program: Yes, however trials on key alternatives as shown above do not appear to be being conducted as they are not reported
- Dec. IX/6 b(iii) Appropriate effort: The nomination indicates limited information on progress with alternatives, but that the Party has indicted an intention to phase out MB by the end of 2011.
---|---|---|---|---|---|---|---|---|---|---|---|---
Israel | Sweet Potatoes | None | None | None | 111.500 | 95.000 | 20.000 | - | 20.000 | 20.000 | MBTOC rec. for 2011 (addtl or new) | MBTOC rec. for 2012 (new)

**MBTOC comments on 2010:**

MBTOC recommends 20,000 tonnes for 2011 (compared to 95 t used in 2009 and 20 t in 2010) for production of sweet potato transplants. The previous nomination in 2009 included use for field grown crops, but now the nomination is only for seedbeds and clean propagation material. MBTOC recognizes the need for clean propagation material. In the light sandy soils root-knot nematodes- *Meloidogyne* spp. the scab pathogen *Streptomyces ipomoea* and *Pythium* spp. are the disease issues on the plants used for propagation purposes. The applicant states that they expect registration of MB alternatives (eg. Telone II) by 2010, but this has not yet been approved. Root knot nematode resistant cultivars are available, but they are not commercially desirable in Israel. No data is presented from trials since 2006, although that data suggested that Telone II + metham sodium (Adochem super) 400 l/ha was an excellent alternative for MB and registration was sought. The Party has not provided further evidence of research conducted from that date. The MB rates stated in the CUN are consistent with MBTOC’s standard presumptions and barrier films are being used. 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 (Reference: [http://mbao.org/2008/027Stoddard.pdf](http://mbao.org/2008/027Stoddard.pdf)). MBTOC expects that if any disease control products are registered prior to 2011 that the quantity of MB nominated will be adjusted downward to reflect the availability of the alternative(s). In the absence of this, MBTOC expects data on the suitability of the use of alternative varieties resistant to nematodes which are used effectively in other countries.

**MBTOC comments on economics 2010:**

The Party states that “the semi-commercial application of Telon on a total area of 100 ha in 2005 led to unsatisfactory results and economic losses”. CUN also shows that application of Telon 200+MS 400 l/ha results in higher gross and net revenue than MB 350 kg/ha.

**Comments requested in Dec. XXI/11 (para 9)**

- Dec. IX/6 (i) Emission reduction: Yes, barrier films and rates comply with MBTOC presumptions are being followed.
- Dec. IX/6 (iii) Research program: No, has not been updated since 2006, but the Party has identified alternatives that are in the registration process.
- Dec. IX/6 (iii) Appropriate effort: The Party has identified an intention to phase out MB by the end of 2011.

---|---|---|---|---|---|---|---|---|---|---|---|
Japan | Cucumber | 88.300 | 88.800 | 72.400 | 51.450 | 34.300 | 30.690 | 27.621 | - | 26.162 | - | 26.162 |

**MBTOC comments on 2010:**

MBTOC recommends 26.162 tonnes for this use in 2012. The recommended amount is based on the reduction that the Party has made on the melon combination which has the same pathogen problems as the cucumber. Japan had made public an action plan to complete phase out of methyl bromide for soil use in 2013 and submitted revised national management strategy for critical use nomination of methyl bromide to the Ozone Secretariat in April 2008. MBTOC acknowledges that the Party will phase out MB by using a number 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 surrounding 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 2010:**

No economic arguments are provided in the nomination prior to testing for technically feasible alternatives.

**Comments requested in Dec. XX1/11 (para 9)**

- **Dec. IX/6 b(i) Emission reduction:** Yes, barrier films are used in part of applications and rates in the nomination conform to the standard presumptions.
- **Dec. IX/6 b(iii) Research program:** Yes, a certain trials are now energetically undertaken now to find alternative technology to control KGMMV such as plant debris humus acceleration by input of wheat bran as the material for the microbe reproduction, use of bag culture with fertigation of the mixture of vermiculite, wooden bark manure, peat moss, rice bran and mountain soil and use of bio-decomposition pot for avoiding contact of seedling root with the virus contaminated soil. And seedling dipping in extract of *Lentinus edodes* mycelia just before planting has been tested.
- **Dec. IX/6 b(iii) Appropriate effort:** Party has identified an action plan that will phase out MB by the end of 2012.
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<tr>
<td>Japan</td>
<td>Ginger (Field)</td>
<td>119.400</td>
<td>119.400</td>
<td>109.701</td>
<td>84.075</td>
<td>63.056</td>
<td>53.400</td>
<td>47.450</td>
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<td>42.235</td>
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<td>MBTOC recommends the requested rate of <strong>42.235 t</strong> for 2012 (a reduction of 5.215 t or 11.5% from 2011). This was mostly achieved by reductions of acreage and some reduction in dosage rates. Fields are now fumigated on alternative years rather than yearly. Several regions now use dosage rates as low as 16-20 g/m² under LBPF which are within or lower than MBTOC’s standard presumptive rates. The nomination is for control of <em>Pythium spp.</em> (<em>P. ultimum var. ultimum, P. zingiberium</em>) in open field cultivated ginger fields using MB (98:2) applied from small cans. The party has provided MBTOC with a list of studies that indicate highly promising results for the implementation of alternatives by 2013, the date for complete phase out of MB in Japan.</td>
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<td>The nomination states that hot water treatment can possibly be considered as a technically feasible alternative under specific topographical and soil conditions, but that initial and running costs are high, hence it is not economically feasible. No data are provided to support this argument. CUN provides data that shows that net revenues when using alternatives such as dazomet or Metalaxyl are lower that for MB. MBTOC is not able to verify the accuracy of these data.</td>
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<td>• Dec. IX-6 (i) Emission reduction: Yes, barrier films and rates complying with MBTOC presumptions are being followed except that the products in 98:2 in small cans.</td>
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<td>• Dec. IX-6 (iii) Research program: Yes, the research program has been updated and the party has identified alternatives that are in the registration process.</td>
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<td>• Dec. IX-6 (iii) Appropriate effort: The Party has identified an action plan that will phase out MB by the end of 2012.</td>
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<td>MBTOC recommends the total requested amount of 6.558 tonnes for 2012. This represents a reduction of 6.8% reduction from 2011 year amount approved 2012 under LBPF. The nomination is for control of <em>Pythium spp.</em> (<em>P. ultimum var. ultimum, P. zingiberium</em>) in protected ginger fields using MB (98:2) applied from small cans. Several regions now use dosage rates as low as 16-20 g/m² under LBPF which are within or lower than MBTOC’s standard presumptive rates. MBTOC has now been provided by the Party with the results of numerous studies which have highly promising results for the implementation of alternatives by 2013, the date for complete phase out of MB in Japan.</td>
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<td>• Dec. IX-6 (i) Emission reduction: Yes, barrier films and rates complying with MBTOC presumptions are being followed except that the products in 98:2 in small cans.</td>
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Melon  194.100 203.900 182.200 136.650 91.100 81.720 73.548 67.936 67.936

Japan

MBTOC comments 2010: MBTOC recommends a reduced amount of 67.936 tonnes for this use in 2012. The recommended quantity represents a 12.5 % reduction from the 21th 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 has an action plan to complete phase out of methyl bromide 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 and lead to a reduction of 10 % by adoption of alternatives and low permeable barrier film with the dose rate reduction in 2011. 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 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 2010:

The nomination argues that no alternatives are technically or economically feasible, while the economic (and technical) feasibility of the inoculation of the attenuated virus is being trialed at present. The nomination argues that there is an important market window for melons in Japan, while virus-resistant varieties fetch lower prices in the market. These statements are supported by budget data. MBTOC is not able to verify the accuracy of these data.

Comments requested in Dec. XX1/11 (para 9)

- Dec. IX/6 b(i) Emission reduction: Yes, barrier films and rates conform to the standard presumptions.
- Dec. IX/6 b(iii) Research program: Yes, several control technologies are now checked whether they are adaptable to each specific production region with the complete replacement of methyl bromide. Those are appropriate use of the mixture of chloropicrin and 1,3 D to control MNSV without any phytotoxicity, methyl iodide use, selection of resistant variety in the respective production regions, effectiveness on the rotation by tomato.
- Dec. IX/6 b(iii) Appropriate effort: Party has identified an action plan that will phase out MB by the end of 2012.
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</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>Pepper (green &amp; hot)</td>
<td>187.200</td>
<td>200.700</td>
<td>156.700</td>
<td>121.725</td>
<td>81.149</td>
<td>72.990</td>
<td>65.691</td>
<td>-</td>
<td>61.154</td>
<td>61.154</td>
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<tr>
<td></td>
<td>MBTOC comments 2010: MBTOC recommends 61.154 tonnes for this use in 2012. The Party nominated an amount representing 7% reduction from the amount approved for 2011 (2012: 61.154 t, 2011: 68.260 t) and has indicated it will not apply for further nominations under their action plan. According to the Party, this reduction is due to the introduction and deployment of alternatives, more distribution of low permeable barrier film with the dose rate reduction and reduction of the frequency of MB application to every two years. Five regions applied for MB: Miyazaki: 72.9 ha (20.717 t), Kagoshima: 32.6 ha (6.006 t), Ibaraki: 116.3 ha ha (25.593 t), Kochi 31.9 ha (7.020 t), Wakayama: 4.5 ha (1.818 t). The total area nominated is 258.2 ha, 61.101 t. The average MB rate is 236 kg/ha. However, the MB rates vary from one region to another (184kg/ha to 400 Kg/ha) according to the pest pressure: Japan provided a comprehensive National Action Plan detailing step wise phase out by 2013 using a range of non chemical alternatives:( Bag culture with fertigation, Inoculation of attenuated virus as vaccine, development of the bio-decomposed pot for the seedling, resistant varieties, hydroponics, solarization) and chemical alternatives(dazomet, metam sodium, chloropicrin and chloropicrin capsule). The Party believes that all these alternatives will be widely accepted in the future. The development of resistant varieties is progressing well for the control of some viral strains. 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 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.</td>
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<td></td>
<td>MBTOC comments on economics 2010: No economic arguments are provided in the nomination.</td>
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<td>Comments requested in Dec. XX1/11 (para 9)</td>
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<td></td>
<td>• Dec. IX/6 b(i)- Emission reduction: No, but the use of barrier films varies from region to region with some regions not using barrier films. The Party’s nomination however conforms to MBTOC’s standard presumptions.</td>
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<td>• Dec. IX/6 b(iii)- Research program: Yes, a detailed research program is on-going.</td>
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<td>• Dec. IX/6 b(iii)- Appropriate effort: The Party has presented a detailed research program in place, in accordance with Decision IX/6. MBTOC believes that the Party will be able to phase out MB completely by 2013 in alignment with their National Management Plan.</td>
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<tr>
<td>Japan</td>
<td>Watermelon</td>
<td>129.000</td>
<td>98.900</td>
<td>94.200</td>
<td>32.475</td>
<td>21.650</td>
<td>14.500</td>
<td>13.050</td>
<td>-</td>
<td>12.075</td>
<td>12.075</td>
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</table>
|         | MBTOC comments 2010: MBTOC recommends 12.075 tonnes for this use in 2012. This represents a 9.25% reduction of the approved 13.05 tonnes by the Parties at the 21st MOP. 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 methyl bromide for critical use nomination for soil use in 2013 and submitted revised national management strategy for critical use nomination of methyl bromide to the Ozone Secretariat in April 2008. MBTOC acknowledges that the Party will phase out MB by using variety alternatives in 2013 and lead to a reduction of 10 % by adoption of alternatives and low permeable barrier film with the dose rate reduction in 2011. 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.

**MBTOC comments on economics 2010:**
No economic arguments are provided in the nomination.

**Comments requested in Dec. XX1/11 (para 9)**
- Dec. IX/6 b(i) Emission reduction: No, barrier films are used for part of the nomination, but rates conform to the standard presumptions with barrier films
- Dec. IX/6 b(iii) Research program: Yes, research effort have been conducted on key fumigant and non chemical alternatives.
- Dec. IX/6 b(iii) Appropriate effort: Extensive action plan showing research efforts for phase out by 2013.
|-----------|----------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|-------------------------------|--------------|--------------------------------|------------------|

**MBTOC recommendation for 2010:**
MBTOC recommends 59,500 tonnes for this use in 2012. From this amount, 4,076 t are for Georgia squash, 3,285 t for Georgia cucumber; 12,073 t for Georgia melon; 38,321 t for the Southeast region and 1,739 t for MarDel. MBTOC recognizes the reduction made by the Party of 70% down from 2011 recommendation for transition to a 3 way combination of 1,3 D + chloropicrin, followed by chloropicrin alone, followed by metam-sodium, that shows good results against key cucurbit pests in spring season fumigation.

MBTOC recognizes the for cucurbit growers who can only use either 1,3-D + chloropicrin or metam-sodium+chloropicrin in fall-season fumigations to control nutsedge and nematode pests, the yield loss estimates used in last year’s nomination continue to be applicable. While one study in 2006 showed good efficacy of a combination of 1,3 D + chloropicrin and the herbicides napropamide + halosulfuron or metolachlor + trifloxysulfuron in small plots of Florida tomatoes (Santos et al. 2006), these results are not applicable to cucurbits because neither metolachlor or trifloxysulfuron are registered in the US for cucurbits, and halosulfuron can have phytotoxic effects on cucurbits.

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 2010:**
The nomination 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.

**Comments requested in Dec. XX1/11 (para 9)**
- **Dec. IX/6 b(i) Emission reduction**: Yes, barrier films used in all of the applications.
- **Dec. IX/6 b(iii) Research program**: Yes, studies were conducted in other crops such as tomatoes, which are relevant also to cucurbits. Studies specific to cucurbits (Hausbeck and Cortright (2007), showed that cucurbit plant vigor was measured to determine fumigant/mulch performance under either LPDE or barrier films plastic mulch for the control of Fusarium oxysporum. Of the fumigants used in the study, the MB and MI treatments resulted in cantaloupe plants with the highest vigour. In general, treatments under LPDE had higher plant vigor when compared with plants grown under barrier films. Research continues to also be conducted to identify Fusarium resistant watermelon stock that can be grafted on a commercially feasible basis. Other studies were also given in the CUN for these crops.
- **Dec. IX/6 b(ii) Appropriate effort**: 

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May 2010 TEAP Progress Report
<table>
<thead>
<tr>
<th>Country</th>
<th>Industry</th>
<th>CUE for 2005¹</th>
<th>CUE for 2006²</th>
<th>CUE for 2007³</th>
<th>CUE for 2008⁴</th>
<th>CUE for 2009⁵</th>
<th>CUE for 2010⁶</th>
<th>CUE for 2011⁷</th>
<th>CUN for 2011 (addtl or new)</th>
<th>CUN for 2012</th>
<th>MBTOC rec. for 2011 (addtl or new)</th>
<th>MBTOC rec. for 2012 (new)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>Eggplant</td>
<td>76.721</td>
<td>82.167</td>
<td>85.363</td>
<td>66.018</td>
<td>48.691</td>
<td>32.820</td>
<td>19.725</td>
<td>-</td>
<td>6.904</td>
<td>-</td>
<td>6.904</td>
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**MBTOC comments 2010:**

MBTOC recommends 6.904 tonnes which is the total requested amount by the Party. The Party has made a 65% reduction in MB use from the amount approved by the Party’s for 2011 (19.725 t). MBTOC acknowledges the substantial reduction by the Party for uptake of alternatives, particularly the use of the 3 way system. Of this amount, 3.061 t are for Georgia and 3.843 t are for Florida. 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 125 kg/ha both for pathogens and for nutsedge. 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, 2007) 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. This research is on-going, however specific studies conducted or in progress since the last nomination were not cited in the CUN. 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. 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. MBTOC considers that the Party should develop non chemical alternatives e.g. grafting, biofumigation, soil less culture… 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 Article Scountry on eggplant. There is no indication in the nomination that research in these areas is continuing.

**MBTOC comments on economics 2010:**

The nomination 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.

**Comments requested in Decision XXI/11 (Para 9)**

- Dec. IX/6 b(i) Emission reduction: No, there is no information in the nomination about the use of VIF or equivalent film, however, the rates (125 kg/ha) are consistent with the use of barrier films and MBTOC’s standard presumptions
- Dec. IX/6 b(iii) Research program: Yes, equivalent research is on-going in similar sectors, however specific studies conducted or in progress since the last nomination were not cited in the CUN
- Dec. IX/6 b(iii) Appropriate effort: The Party is increasing uptake based on adoption of alternatives such as the Georgia 3-Way and Methyl iodide. More effort to implement grafting, resistant root stocks, etc. may facilitate the phase out of MB in areas where regulatory constraints prevent the use of some of the chemical alternatives.
Forestry nursery

192.515 157.694 122.032 131.208 122.060 117.826 93.547  - 34.230  - 34.230

**MBTOC comments 2010:**

MBTOC recommends an amount of 34.230 tonnes for this nomination in 2012. MBTOC recognizes a reduction in the nominated amount with respect to last years’ approved amount, but was informed by the Party that some of this amount was moved into QPS MB. Despite requests from the Party it is unclear what proportion of this amount has been moved into QPS. The nomination indicates 100% reduction by three groups and 48% for the remaining three groups (the Southern Forest Nursery Management Cooperative, the Michigan Seedling Growers, and the Northeastern Forest and Conservation Nursery Association. Key pests are nutsedge, nematodes and fungi. MBTOC recognises that propagative material requires a very high level of soilborne pest and pathogen control in order to avoid their wide spread distribution. 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. The nomination is for certified forest seedlings produced in 3 forest nursery regions. 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 which have been shown to be as effective as MB are MI which has been found effective (i.e. Enebak, 2006) and recently registered; chloropicrin alone (South, 2007; 2008); 1,3-D/Pic (South, 2008) 1,3-D /Pic/metham sodium (South, 2008); metham sodium + Pic (Cram et al., 2007); and dazomet (Muckenfuss et al., 2005; Enebak et al., 2006). DMDS + Pic has produced encouraging results (Quicke et al, 2007) although the former is still not registered. Integrated pest management systems have also been shown to be effective (South et al., 2006; Hildebrand et al., 2004). 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 (2007) found that with LPBF, use rates of MB can be significantly reduced. Gluing of LPBF remains a challenge (Quicke et al., 2009; Walters et al., 2009). The 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 and commercially available, however, MBTOC expects that future nominations will be based on its use. 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. Jacob et al. (2009) report effective control of weeds in Iowa Nurseries with different herbicides. MBTOC acknowledges the initiation of large scale, 5-year demonstration trials for this sector by the Party now with promising results (Quicke, 2007; Quicke, 2008; Weiland, 2008). Recent findings confirm the promising results of MI, MI/Pic, DMDS, DMDS/Pic, but no indication of pathogen or weed pressure was given (Quicke, 2009; Weiland, 2009). Limited substrate production of these crops is reported as economical for small niche markets; however MBTOC is aware that International Paper produces over 40 million tree seedlings per year in substrates in their Brazil operation. MBTOC encourages additional effort on use of substrates, better methods for gluing barrier films, and use of MI.

**MBTOC comments on Economics 2010:**

The Party states that estimated costs of fumigation per hectare for northeastern nurseries average $8,300 for iodomethane (98:2), $10,500 for iodomethane (50:50), and $4,820 for methyl bromide (98:2). CUN notes that there are no yield losses with the use of iodomethane, hence if these cost differences are maintained the industry would find iodomethane to be economically infeasible. However, CUN shows losses in net operating revenue of 7% (Southern Forest Nursery Management Cooperative) and 14% (Northeastern Forest and Conservation) respectively.

**Comments requested in Dec. XX1/11 (para 9)**

- Dec. IX/6 b (i) Emission reduction: No. Barrier films are not used, but rates conform to the standard presumptions without barrier films. Inability to glue effectively
and the lack of commercial availability of gluing LPBF have restricted the ability to use barrier films.

- **Dec. IX/6 b (iii) Research program:** Yes. Research effort has been conducted on alternatives.
- **Dec. IX/6 b (iii) Appropriate effort:** The reduction and research indicates appropriate efforts.

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<thead>
<tr>
<th>Country</th>
<th>Industry</th>
<th>CUE for 2005¹</th>
<th>CUE for 2006²</th>
<th>CUE for 2007³</th>
<th>CUE for 2008⁴</th>
<th>CUE for 2009⁵</th>
<th>CUE for 2010⁶</th>
<th>CUE for 2011⁷</th>
<th>CUN for 2011 (addtl or new)</th>
<th>CUN for 2012</th>
<th>MBTOC rec. for 2011 (addtl or new)</th>
<th>MBTOC rec. for 2012 (new)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>Nurseries stock (fruit, nut, flower)</td>
<td>45.800</td>
<td>64.528</td>
<td>28.275</td>
<td>51.102</td>
<td>25.326</td>
<td>17.363</td>
<td>7.955</td>
<td>-</td>
<td>1.591</td>
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<td>1.591</td>
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**MBTOC comments 2010:**
MBTOC recommends a total of 1.591 tonnes for this use in 2012. This comprises 0.191 tonnes for roses, and 1.400 tonnes for the California Assoc. of Nursery and Garden Center. MBTOC notes the large reduction in this nomination, which is 80% less than last year’s approved amount. The rates conform to MBTOC’s standard presumptions. This nomination is for propagation materials that need to be certified as free of pests and diseases (CDFA,2009; USDA-APHIS,2007). The amount of MB is specified in certification requirements, regardless of the formulation (CDFA, 2009). The California Dept of Food and Agriculture has approved the use of 1,3-dichloropropene as a certified nursery stock soil treatment for certain crops under specific conditions and recently added methyl iodide (MI), if and when it is registered for use in California (CDFA, 2009). MBTOC recognises that propagative material requires a very high level of soilborne pest and pathogen control in order to avoid their wide spread distribution. Research trials indicate some materials (such as MI) and some combinations (such as 1,3-D /Pic) show promise as MB alternatives for specific circumstances, although effective rates may be higher than those needed in annual crops and use of an effective barrier film is necessary (Schneider et. al, 2008; Schneider et. al, 2009a; Schneider et. al, 2009b; Walters et. al, 2009). Other materials (such as metham sodium and chloropicrin) were not adequate for certified nursery standards (Schneider et. al, 2009b). Advances using alternatives are being made (Hanson et al., 2007; Hanson et al., 2007; Hanson et al., 2009). Few effective herbicides are available to nursery managers in California (Shrestha et al., 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. MBTOC encourages continued research on chemical and non-chemical alternatives and on high barrier films in hope (anticipation?) of the future approval for use in California.

**MBTOC comments on economics 2010:**
The nomination concludes that 1,3-D+Chloropicrin 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.

**Comments requested in Dec. XX1/11 (para 9)**
- **Dec. IX/6 b(i) Emission reduction:** Yes. Barrier films cannot be used for this nomination in California, but rates conform to the standard presumptions.
- **Dec. IX/6 b(iii) Research program:** Yes, An area wide program is evaluating the key alternatives, including methyl iodide/Pic and spot treatment of Pic.
- **Dec. IX/6 b(iii) Appropriate efforts:** A range of alternatives are being considered and commercialised.
United States

|-----------------|------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|------------------------------|--------------|-----------------------------------|--------------------------|

**MBTOC Comments for 2010:** MBTOC recommends a CUE of 18.324 tonnes be approved for this use in 2012. This includes 12.700 t for stone fruit, 0.626 t for raisins, 1.844 t for walnuts, 1.660 t for almond and 1.494 t for wine grapes. MBTOC acknowledges that the CUN is a 90% reduction from the previously approved amount. The CUN is for orchard/vineyard replant disorder of unknown etiology for a portion of replant sites in California where alternatives are not suitable, either because of regulatory restrictions or physical characteristics such as unacceptable soil type, moisture or topography. The CUN is for heavy soils or soils which cannot be treated to a sufficient depth to kill of old roots and the associated pathogens in deeper soil. Regulatory constraints (maximum labelled rated) prevent the use of 1,3-D at the rates needed for effective. The best alternatives for orchard replant that have been identified are 1,3-D or 1,3-D with chloropicrin, chloropicrin alone, and/or metam-sodium, especially in coarse-textured soils (Caprilie and McKenry, 2006; Wang et al., 2009; Browne et al., 2007; Browne et al., 2008; Beede et al., 2008). Under certain soil and moisture conditions (less than 12% to 1.5 meters) 1,3-D is an effective management tool for replant problems and is currently used to replant the majority of orchard and vineyard sites. 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 rootstocks such as Nemaguard, Viking, Krymsk1, and Floraguard have been reported by McKenry (2006). Additional alternatives proven to be effective include IM or 1,3-D and spot treatments applied through GPS-controlled shanks or through a spot drip application system (Browne et al., 2007; 2008).

**MBTOC comments on economics 2010:**
Walnut and almond orchards: 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/Pic. However the NPV and IRR (close to 14%) of both alternatives are similar. MBTOC notes that there is an error in Table 1 of the CUN. Losses with almonds are expected to be higher because of higher tree mortality rates. 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 methyl bromide alone are approximately $125/hectare. The result is a decrease of 12% in net operating revenue, but both alternatives have a negative NPV although MB provides additional benefits.

**Comments requested in Dec. XX1/11 (para 9)**
- Dec. IX/6 b(i) Emission reduction – Yes. Barrier films cannot be used for this nomination in California, but rates conform to the standard presumptions.
- Dec IX/6 b(iii) Research program - Yes, an area wide program is evaluating the key alternatives, including methyl iodide/Pic, spot treatment of Pic.
- Dec. IX/6 b(iii) Appropriate efforts - A range of alternatives are being considered and commercialised.
**United States**

|----------------|--------------|--------------|--------------|--------------|--------------|--------------|-------------------------------|----------------------------|----------------------------|----------------------------|

**MBTOC comments 2010:**

MBTOC recommends the requested amount of 48.164 tonnes for this use in 2012. This includes 46.950 t for California and 1.214 t for Florida. MBTOC acknowledges the 25% reduction in the nominated amount compared to the previous amount approved, including a significant reduction of 90% in Florida. This rate of adoption would support a 4 year transition to available alternatives. In Florida, methyl iodide (MI) is now registered and other alternatives are available, for example 1,3-D/Pic and solarization alone or in combination with chemicals (McSorley et al, 2006; McSorley 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. Portulaca, Ambrosia and others), and previous crop propagules. The Party has adjusted dosage rates for all regions to 20 g/m², 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). Steaming systems and application methods are being evaluated in California, in an effort to identify the most feasible approach to this technique (Gilbert et al, 2009). MBTOC recognizes the potential for phytotoxicity issues for MI on ornamentals. MBTOC encourages research on non-chemical and chemical alternatives.

**MBTOC comments on Economics 2010:**

A major change in this CUN is the availability of iodomethane in Florida (registered in 2008), but not in California. Its economic impacts as an alternative to methyl bromide are relatively small. The partial budget of Florida lilies resulted in a 4% loss as a percentage of net operating revenue. In California the alternatives to methyl bromide imply a significant negative economic impact on growers; however, the data show that growers incur a loss even when using MB.

**Comments requested in Dec. XX1/11 (para 9)**

- **Dec. IX/6 b(i) Emission reduction:** Yes, for part of the nomination. Barrier films are currently used in Florida. Barrier films cannot be used in California due to regulatory constraints. Rates conform to the standard presumptions with barrier films.
- **Dec. IX/6 b(iii) Research program:** Yes, research efforts have been conducted on alternatives.
- **Dec. IX/6 b(iii) Appropriate efforts:** The nomination indicates significant efforts have been made to switch to alternatives. Substantial reduction indicates appropriate efforts particularly in Florida. In California, efforts have been made within the constraints imposed by regulations.
|------------|-------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|---------------------------------|-------------|---------------------------------|------------------------|

**MBTOC comments 2010:**

MBTOC recommends the total requested amount of 28.366 tonnes for 2012. The Party has made a 86.2 % reduction in MB use from the amount approved by the Party’s for 2011. MBTOC acknowledges the substantial reduction by the Party for uptake of alternatives. Of this amount, 0.947 t is for Georgia, 27.077 t is for Florida and 0.341 t is for the Southeast. The Party did not again submit a CUN for Michigan for 2012. The Party is projecting rates of 125 kg/ha (12.5 g/m²) for both pathogens and 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 Georgia fall crops, this system needs further development for use in areas with moderate to high nutsedge pressure. 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 1,3-D in the fall require longer waiting periods for planting than MB. Delays could result in missed market windows. Midas, mixture of Ml and Pic, 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. The main constraints to the widely use of Ml are : (1) the cost of Ml formulations which is higher than MB, (2) growers and researchers will need time to evaluate Ml 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 Ml application rates and to avoid the corrosion of some metals that can occur with Ml (Summer 2005, Noling et al., 2006). 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, MBTOC considers that the Party should also develop some non chemical alternatives e.g. grafting, biofumigation, soil less etc. 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 non Article 5 countries on pepper. There is no indication in the nomination that research in these areas is continuing.

**MBTOC comments on economics 2010:**

The nomination describes the economic impact of using iodomethane 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 iodomethane 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 iodomethane, losses in net revenue are negligible. One drawback to the Georgia 3-Way is the yield losses are expected in fall plantings, with studies in Georgia’s application show a 50% yield loss. These losses are not expected when iodomethane 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, iodomethane can be.

**Comments requested in Decision XXI/11 (para 9)**

- Dec. IX/6 b(i) Emission Reduction: No, there is no information in the nomination about the use of VIF or equivalent film, however, the rates (125 kg/ha) are consistent with the use of barrier films and MBTOC’s standard presumptions
- Dec. IX/6 b(ii) Research Program: Yes, equivalent research is on-going in similar sectors, however specific studies conducted or in progress since the last nomination were not cited in the CUN
Country Industry CUE for 2005\(^1\) CUE for 2006\(^2\) CUE for 2007\(^3\) CUE for 2008\(^4\) CUE for 2009\(^5\) CUE for 2010\(^6\) CUE for 2011\(^7\) CUN for 2011 (addtl or new) MBTOC rec. for 2011 (addtl or new) MBTOC rec. for 2012 (new)

United States

**Strawberry (field)**

<table>
<thead>
<tr>
<th>Year</th>
<th>CUE</th>
<th>CUE</th>
<th>CUE</th>
<th>CUE</th>
<th>CUE</th>
<th>CUE</th>
<th>CUE</th>
<th>CUN</th>
<th>MBTOC rec. for 2011 (addtl or new)</th>
<th>MBTOC rec. for 2012 (new)</th>
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<tr>
<td>2005</td>
<td>2052.846</td>
<td>1,730.828</td>
<td>1,476.019</td>
<td>1,349.575</td>
<td>1,269.32</td>
<td>1,007.477</td>
<td>812.709</td>
<td>-</td>
<td>649.348</td>
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**Dec. IX/6 b(iii) Appropriate Efforts:** It appears that the Party is making an appropriate effort to replace MB with alternatives such as the Georgia 3-Way and Methyl Iodide. More effort to implement grafting, resistant root stocks, etc. may facilitate the phase out of MB in areas where regulatory constraints prevent the use of some of the chemical alternatives.

MBTOC comments for 2010:

MBTOC recommends a reduced CUE of 649.348 tonnes for this use in 2012. This comprises an overall reduction of 14% of the nomination being 644.429 t for California, 1.647 t for Eastern USA and 3.272 t for Florida. The Party reduced the nomination by 7% over the amount approved at the 21 MOP. At the meeting in Chipiona, The Californian Strawberry Commission presented data that predicted they would only require 667.667 t of MB in 2012 which was less than the 751.000 t nominated by the Party. The request had not been officially reduced by the Party at the time of writing this report. MBTOC acknowledges the excellent information provided by the CSC.

For California, the Party nominated 751.000 t (3927 ha at 170 kg/ha). This is an 11% reduction of the recommended volume for 2011. In California, the three strawberry producing districts for which MB is nominated are Oxnard, Watsonville/Salinas and Santa Maria, with in 2010 respectively almost 5000 ha, 5800 ha and almost 4000 ha of strawberry fruit (predicted). The most recent PUR data (2003-2008) show that alternatives based on 1,3-D, Pic and metham have been widely adopted in these production districts (i.e. excellent adoption in Oxnard and some adoption in Watsonville/Salinas). In California, 1.3-D use has more than doubled from 2,001 ha (2003) to 4,408 ha (2008). PUR data indicate that in Ventura county alone the adoption rate of MB alternatives has been about 800 ha per year (between 2003 and 2007). Notwithstanding this progress, over the period 2003-2008, the Santa Maria strawberry fruit area has more than doubled its MB use, an expansion which is larger than the expansion of the Santa Maria overall size of production area. The approved CUE for strawberry fruit in California was just over 1000 t in 2008, however PUR use data show that over 1200 t was used in the same year. PUR use data for 2008 also show that 98:2 and 67:33 formulations are still being used on 17% of the use area, and that 57:43 is used on 78% of the California strawberry area. 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 enable 50:50 formulations to be used widely. The Party has adopted 170 kg/ha in its CUE-CUN for 2011-2012 respectively. 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). The registration progress of MI/Pic in California is ongoing, however it is not expected to become available before 2012-2013. MBTOC urges Party to deliver, for California, an action plan with stepwise reductions to effectively progress the transition to MB alternatives. In Ventura county, MB alternatives are implemented in the areas with township caps. The California Strawberry Commission has calculated a stepwise transition in Monterey county of in total 44% between 2008 and 2012. A proportionate transition is considered feasible in the other counties, and hence a stepwise transition from 6565 ha in 2008 to 3791 ha in 2012 (42% transition) is deemed realistic. Hence MBTOC recommends a CUE of 644.429 t (3791 ha @ 170 kg/ha).

For the Eastern the Party nominated 1,647 t (11 ha @ 150 kg/ha). This is a transition of 92% from 20 t as per the CUE in 2011. MBTOC commends this progress, which is
realistic given that MI/Pic has been registered in 2008 and is technically feasible for the total nomination area. For Florida, the Party nominated 3,272 t (22 ha @ 150 kg/ha). This is a transition of 92% from 41 t as per the CUE in 2011. Given that technically and economically feasible alternatives are available, MBTOC considers this transition realistic.

Comments requested in Dec. XX1/11 (para 9)

- Dec. IX/6 b(i) Emission reduction: Yes in Florida and Eastern states, with use of VIF; No in California where VIF is not used but the nomination is in accordance with MBTOC standard presumptions;
- Dec. IX/6 b(iii) Research program: Yes, there is an ongoing research program, which the CUN refers to;
- Dec. IX/6 b(iii) Appropriate efforts: Excellent progress in Florida and Eastern states; In California there is varying effort in the different production districts.

### MBTOC comments for 2010:

MBTOC recommends 3.752 tonnes for California in 2012, but does not accept use in the south eastern States as a suitable alternative is available. In the previous round, MBTOC accepted the action plan of the Party for 2010 and 2011 for amounts of 2.018 t and 1.346 t respectively in the south east. MBTOC considers that MI is technically suitable for strawberry fruit production from runners grown in MI treated soil, and accepted that time was required to conduct commercial scale up trials of MI in fruit fields. The submission showed no evidence that these commercial scale up trials were ineffective so MBTOC does not consider further need for MB in these regions.

The CUN does not specify regions for use and applies generally for 3.752 tonnes, however 99% of the hectares are exempted under QPS. The key pests previously stated as affecting strawberry runners are weeds (purple and yellow nusedge), fungi (*Rhizoctonia* and *Pythium spp* in SE, *Phytophthora, Verticillium in California*), nematodes (root-knot, sting in CA). Alternatives that have been evaluated in research trials over the past several years are 1,3-D/chloropicrin, 1,3-D/chloropicrin + metam-sodium, 1,3-D and metam-sodium, and dazomet as a follow-up application to 1,3-D/chloropicrin or chloropicrin (Fennimore et al., 2008b) the latter proving very effective.

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). [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 Party's request is based on MBTOC's standard presumption of 200 kg/ha (20 g/m²) of MB which is considered effective for production of 'high health' strawberry runners using LPBF and other emission control technologies (TEAP 2005). California regulations prohibit the use of LPBF with MB. The Party did not provide further information on commercial scale up trials requested in the 2009 round.

### MBTOC comments on Economics:

The nomination states that iodomethane is under registration review in California; however registration is not expected in the near future. California strawberry nursery growers are expected to see a yield decrease of 10% with 1,3-D + chloropicrin. Net revenue declines from more than $12000/ha to a loss of almost $8000/ha.

Comments requested in Dec. XX1/11 (para 9)

- Dec. IX/6 b(i) Emission control: No, regulations prevent the use of barrier films with MB but barrier films can be used with alternatives. Rates conform to standard presumptions.
### United States

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<tbody>
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<td>Sweet Potatoes slips</td>
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<td>0.000</td>
<td>0.000</td>
<td>180144</td>
<td>18.144</td>
<td>14.515</td>
<td>11.612</td>
<td>-</td>
<td>8.709</td>
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**MBTOC comments for 2010:**

MBTOC recommends 8.709 t for this use in 2012. Two years of trials indicate that Pic combined with herbicides provide transplants that give yields and returns above that of MB. MBTOC recognizes that this is a 25% reduction from the 2011 year application. The pathogens of concern are a complex of Pythium diseases, roots rots, Pox (**Streptomyces ipomeae**); Scurf (**Monilochaetes infuscans**); Fusarium wilt (**Fusarium oxysporum**); Black rot (**Ceratocystis fimbriata**), root knot caused by nematodes, and the infestation of various weed species. The basis of the nomination is that township caps limit the use of 1,3-D and 1,3-D combinations the preferred MB alternative treatments. The industry sector is now carrying out extensive trials for replacing MB. 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. Trials by Stoddard (2008) indicate that pic combined with herbicides is provided transplants that gave yields and returns above that of MB. Second year trials carried out by Stoddard et al. (2009) confirmed result obtained in 2008 that showed that pic is a good alternative to MB. Solarization also significantly increased yield and with more effective herbicides may also become a MB alternative. No VIF is used as it is not permitted in California. The applicant will be conducting the third year of trials in 2010 and in 2011 replicated trial will be done in 6 to 8 locations. If results comparable to 2008-09 are obtained with the alternatives are verified from these tests MBTOC expects complete phase out for this sector by 2013.

**MBTOC comments on economics 2010:**

The nomination shows trial data that reflect that yield increases by 11% with the use of chloropicrin, resulting in a gain in gross and net operating revenue of 7 and 22% respectively.

**Comments requested in Dec. XX1/11 (para 9)**

- **Dec. IX/6 b(i) Emission control:** No, barrier films are not used in California as legislation prohibits this. Rates comply with MBTOC presumptions.
- **Dec. IX/6 b(iii) Research program:** Yes, A very active research program is in place to find alternatives and the party has indentified alternatives that are now being implemented.
- **Dec. IX/6 b(iii) Appropriate Effort:** The Party has identified an action plan that will phase out MB as soon as alternative technologies have been proven effective.

### United States

<table>
<thead>
<tr>
<th>Industry</th>
<th>MBTOC comments 2010:</th>
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<tr>
<td>Tomatoes (field)</td>
<td>MBTOC recommends 54.423 tonnes the total requested amount by the Party. The Party has made a 81.4 % reduction in MB use from the amount approved by the Party’s for 2011 (292.751 tonnes). Of this amount, 0.073 t is for Maryland, 0.646 t for Virginia, 8.164 t for SE, 3.882 t for Georgia, and 41.657 t for Florida. MBTOC acknowledges the substantial reduction by the Party for uptake of alternatives, particularly the use of the “UGA 3-WAY”, consisting of three successive soil fumigations, beginning with 1,3-D +</td>
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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, 2007). 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 tomato pests, including nutsedge, in a number of trials with 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). Lows (2009), Bausher (2009) provides evidence that ‘Big Power’, ‘Beaufort’, and ‘Maxifort’ rootstock can be utilized to manage Soil borne pathogens. .Freeman et al (2009) reported that although grafted plants add significantly to input costs at current prices, the net economic result is often positive when infestations are high. There is no indication in the nomination that research in these areas is continuing. Therefore, MBTOC considers that more research is necessary to demonstrate appropriate effort to replace MB under decision IX/6. It is important to note that MB is not used any more in developed countries on tomato.

MBTOC comments on economics 2010:
CUN concludes that iodomethane 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, chloropicrin, and metam-sodium/potassium) and achieve yields that are comparable to those produced by using methyl bromide for spring crops only.

Comments requested in Decision XXI/11
- Dec. IX/6 b(i)- Emission Reduction: No, there is no information in the nomination about the use of VIF or equivalent film, however, the rates (125 kg/ha) are consistent with the use of barrier films
- Dec. IX/6-b(iii)-Research Program: Yes, the research is on-going, however specific studies conducted or in progress since the last nomination were not cited in the nomination
- Dec. IX/6-b(iii)-Appropriate Efforts: The Party made large reductions recently. Consideration of grafting, resistant root stocks, etc. may facilitate the phase out of MB in areas where regulatory constraints prevent the use of some of the chemical alternatives.

<table>
<thead>
<tr>
<th>Country</th>
<th>Industry</th>
<th>CUE for 2005¹</th>
<th>CUE for 2006²</th>
<th>CUE for 2007³</th>
<th>CUE for 2008⁴</th>
<th>CUE for 2009⁵</th>
<th>CUE for 2010⁶</th>
<th>CUE for 2011⁷</th>
<th>CUN for 2011 (addtl or new)</th>
<th>CUN for 2012</th>
<th>MBTOC rec. for 2011 (addtl or new)</th>
<th>MBTOC rec. for 2012 (new)</th>
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¹ExMOP and 16MOP  
²16MOP+2ExMOP+17MOP  
³MOP17+MOP18  
⁴MOP18+MOP19  
⁵MOP19+MOP20  
⁶MOP20  
⁷MOP21
Interim CUN Report – Issues Specific to MBTOC Structures and Commodities

MBTOC met at the Agricultural Research and Education Center (IFAPA) in Chiponia (Province of Cadiz), Spain. We sincerely appreciated the welcome and hospitality of the IFAPA staff and the Government of Spain. MBTOC Structures and Commodities met concurrently and in the same location as MBTOC Soils and QPS.

Our agenda was to assess the 2010 CUNs, to prepare the Progress Report and begin assignments for the Assessment report. As part of our work a short bilateral meeting was held with USG to discuss questions about the CUNs. Additionally, MBTOC SC conducted a field trip to a rice growing and processing cooperative in Isla Mayor, Spain (Arrozua company). There, with the kind assistance of the management and their fumigation company (Roca Difisan SL), MBTOC reviewed their modern phosphine fumigation, rice processing and storage methods. It was a very instructive learning experience.

Parties continue to make progress on some CUNs, reducing many MB uses by continuing to resolve the inter-related issues of treatment logistics, costs, trade demands and effectiveness of alternatives. But unfortunately, in the case of the majority of CUNs for structures and commodities, progress in adopting alternatives has stalled. MBTOC has questioned Parties about regulatory avenues and possible adaptations of potential alternatives, has encouraged and cajoled. We have provided extensive examinations of the research, have written lengthy correspondence and text boxes with ideas and concerns and held lengthy bilateral discussions. In this interim report MBTOC has recommended reductions in many of the CUNs as described in the table below. MBTOC informs the Parties that without an increased research focus, regulatory approvals of alternatives and a commitment to requiring the use of the alternatives that are available, CUNs may well persist at current levels for several years or longer.

This year the Government of Israel did not submit a critical use nomination for dates. In recent years, researchers in Israel have developed heat treatments, then worked to adapt them to suit the practicalities required by date packing houses in rural areas. MBTOC congratulates the Government of Israel for its ability to achieve phase out of methyl bromide for dates and offers appreciation for the ongoing exchange of information about the technical basis for its accomplishment. Pest infestation of dates continues to be a problem for date producers in several countries as discussed in other parts of this report.

A resolution of treatment logistics and a regulatory interpretation favoring the use of phosphine as an alternative, seems to have contributed to the final phase out of the use of methyl bromide for dried beans in the United States. MBTOC congratulates the Government of the United States and its applicant for resolving this difficult matter and achieving phase out in the use of MB for this commodity.

The use of methyl bromide in Canadian flour milling continues to decrease. In Canada, regulatory approval of sulfuryl fluoride has not been achieved to the extent necessary for full adoption because it is registered only for structures and not for food contact. But the extensive industry-led research program of past years, and the regulation which allows sharing of the MB allotment amongst CUN applicant-industry members, seems effective in reducing use to those in most need of the fumigant.

There was no decrease in the US CUN for flour and rice milling and pet food manufacturing, for 2012 over the amount granted by the Parties for 2011. In the US (and Canada), concerns about costs and the environmental impact of using sulfuryl fluoride, are cited as slowing adoption of that key alternative. This problem is discussed more fully in the Progress Report. Additionally, differences between the extent of regulatory approval for food products between
methyl bromide and sulfuryl fluoride prevent SF’s full adoption in these facilities where food products are commonly present.

MBTOC has suggested research and logistical adaptations to circumvent this problem, but no information has been sent to us to indicate that trials have been conducted. One recent trial in flour mills has been made available to MBTOC. Research in rice mills and pet food facilities has not been submitted, although the applicants say they are making research investments. MBTOC maintains that differences between flour mills, rice mills and pet food establishments are substantive; trials of alternatives in these specific facilities are required and the reports submitted to MBTOC if CUNs are to be substantiated.

Although the use of MB for dried fruit and nuts in the US has very considerably decreased since 2005, there was only a very minimal decrease in the CUN nominated amounts this year (4.907 t). When questioned by MBTOC, the Government of the United States has informed MBTOC that no further adoption of alternatives seems possible for dried fruit and nut sector. MBTOC’s assessment is not in agreement with this viewpoint.

In the US food processing sector, (the CUN titled for the applicant -- the National Pest Management Association NPMA), and the Canadian pasta facility sector have reached an impasse that seems to be caused by both inadequate regulatory approval for sulfuryl fluoride and a lack of commitment to use heat treatments, even though heat is technically effective and does not require regulatory approval. MBTOC notes with dismay, that lack of regulatory progress in adoption of sulfuryl fluoride is used as a reason for these sectors to delay adoption of alternatives, even though heat treatment as an alternative seems technically feasible and does not require registration.

MBTOC is also concerned that there has been no adoption of alternatives at all for packaged rice in Australia. Decreases in use of MB have been achieved because the rice harvest is low so less rice is MB treated. The Australian applicant also began using less MB when standard MB dosage rates were adopted. The Government of Australia reports that the applicant is unable to afford to even begin adopting a technically effective, registered and inexpensive fumigant (phosphine), because severe drought in Australia has resulted in very low harvests. This has prevented the industry from being able to afford the adoption of alternatives. MBTOC and its economists continue to be very concerned about the lack of adoption of alternatives for Australian packaged rice when technically effective alternatives are available and because the company reports it has returned to normal profitability. In former years Government of Australia has indicated that if larger harvests were achieved such that the MB allotment was insufficient, then alternatives would be adopted. In correspondence this year, the applicant indicated that if a larger harvest is achieved, it would either use an alternative or export or store the excess rice (Government of Australia to MBTOC, April 2010).

The lack of effective and registered alternatives for US dry-cured pork, fresh chestnuts, cheese and some date varieties results in the ongoing use of methyl bromide, although at slightly lower levels than in previous years. There is a technically effective alternative for fresh chestnuts in Japan; however, sufficient quantities of the alternative have not yet been obtained, and farmers have not yet been trained in the safe use of the fumigant. MBTOC recommends immediate training of farmers and the beginning of market penetration of this fumigant in 2011.

MBTOC acknowledges that trials to improve the effectiveness of SF as a treatment for dates in the US are rigorous and ongoing.

Unfortunately, there are no alternatives in the pipeline for pork and cheese in storages. Without a technical and regulatory change, this use of MB (currently 5,542 kg for both commodities spread over two CUNs) is likely to continue for many years. The Party and users may wish to adopt improved containment and methyl bromide recapture systems for these uses to mitigate
emissions, as expected under one of the requirements for CUEs set out in Decision IX/6, para b (i).

MBTOC draws the Parties’ attention to two important problems that prevent us from assisting Parties by hampering our ability to provide the best technical assessment of CUNs. CUN applicants are not required to report the results of trials of alternatives to their governments or to MBTOC and some applicants have been unwilling or unable to substantiate claims of technical ineffectiveness or higher costs of alternatives. In the field of postharvest use of MB, where published research is at a low level, much of the important assessments are conducted by MB users and their fumigation companies, who are also the CUN applicants. There is an inherent conflict of interest when the companies requesting the MB are the ones doing the trials and who can withhold the information that would allow MBTOC to assess those trials.

MBTOC has become concerned that some CUN applicants have become complacent and are not as focused on adopting alternatives as they should be. We have noted that some Parties are not submitting nominations that provide adequate substantiation and depth of information to support their CUNs.

We draw the attention of the Parties to the environmental concerns about the use of SF. The high GWP of sulfuryl fluoride as a contributing factor to ongoing MB use should not be underestimated. The Progress Report will discuss this situation further.

10.4.1 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 minimise the critical use and any associated emission of methyl bromide’. Decision Ex.II/1 also mentions emission minimisation techniques, requesting Parties “…to ensure, wherever methyl bromide is authorised for critical-use exemptions, the use of emission minimisation techniques that improve 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 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. Since that time, and with very little delay, all Parties and fumigators have adhered to those practices. The EPPO dosage rates for commodity treatment vary by commodity, sorption rate and environmental conditions. They can be found in annexes to the MBTOC 2006 Assessment Report (MBTOC, 2007). Where possible, the use of lower dosages, combined with longer exposure periods, can reduce MB use while maintaining efficacy. (MBTOC. 2007. 2006 Report of the Methyl Bromide Technical Options Committee. 2006 Assessment Report.)

10.4.2 Details of evaluations

Parties have submitted eight CUNs for the use of MB in structures and commodities in 2010. The total MB volume nominated in 2010 for non-QPS post-harvest uses was 185.704 tonnes.

In the 2010 round, one (Canada Pasta) nomination was for 2011 for a total MB amount of 3.529 tonnes. In the 2010 round, seven were for 2012 for a total MB amount of 182.175 tonnes.
Of nominations for 2011, MBTOC recommended 2.084 tonnes and for 2012, 98.936 tonnes. MBTOC did not recommend 86.768 tonnes.

Table 10-13 provides the MBTOC-SC interim recommendations for the CUNs submitted.
Table 10-13: Final evaluations of CUNs for structures and commodities submitted in 2010 for 2011 or 2012

|---------|----------|--------------|--------------|--------------|--------------|--------------|--------------|-----------------------------|--------------|----------------------------------|-------------------|

**MBTOC comments 2010:**

MBTOC recommends 1,948 kg for rice in Australia in 2012. This is a 60% reduction of the Party’s nominated amount of 4,870 kg for 2012. The Party had nominated the same amount for 2012 as was granted by the Parties for 2011. The Accounting Framework indicated that in 2009, Australia authorized 3,488 kg for rice. Our recommendation for 2012 represents a 44% reduction in the actual use in 2009, for 2012. For the reasons discussed below, MBTOC continues to find that several technically effective and registered alternatives are available in Australia for immediate adoption for the treatment of packaged rice or rice in silos.

In three previous years, MBTOC has recommended a reduction of 15-20% of MB for Australian rice. These reductions should have resulted in some adoption of alternatives. There is no evidence that this has occurred because the Party has based its nominations on harvests formerly achieved when rainfall was greater and water allocations were higher. The usual and feasible adoption rate for alternatives should have allowed a step-up to 30% adoption in the second year, followed by 60% in the third year, however this applicant is behind schedule due to the complete lack of adoption of alternatives.

The applicant has selected phosphine as its preferred alternative. The Party reports that the applicant can not afford to adopt phosphine for two reasons: 1. that to begin to adopt phosphine they would have to build 100 silos and 2. that due to low rice harvests the applicant can not afford to even incrementally adopt alternatives at all.

MBTOC disagrees on the extent of infrastructural and processing changes required if phosphine were to be adopted. Use of phosphine for processed rice prior to packaging would require an increase in the number of sufficiently gastight silos, but the CUN says that packaged rice will be fumigated. Silos are not required for the fumigation of packaged rice. If packaged rice is to be fumigated with phosphine, it could be treated in stacks in sheds, rooms or temporary enclosures which are much less expensive than building new silos. The CUN indicates that the applicant has achieved normal profitability and therefore there should be some opportunity to phase in alternatives. Furthermore, the Party has indicated that in the instance of having an insufficient MB allocation, the applicant will either export the excess rice or stored for future years.

More recently the applicant said it is also considering using SF which would not require extensive new infrastructure. SF treatment time is comparable to MB use. SF is registered for rice, polished rice and wild rice against all stages of stored product pests in silos, food handling and processing facilities, mills, warehouses, temporary and permanent fumigation chambers (Dow Profume Label Australia, 2008).

As in previous years, MBTOC informs the Party that controlled atmosphere technology is effective, does not require registration, is in commercial use in numerous countries and the suppliers of controlled atmosphere storage facilities rent the equipment and facilities to users, reducing the infrastructure investment.

As in previous years, the applicant has said it will only consider phase out if harvests increase, but MBTOC is mandated to expect that the applicant must begin to adopt alternatives for the harvests they actually have, not the harvest they wish to achieve. MBTOC finds that recent history suggests that relatively low harvests are now prevalent for this region in Australia. Supporting this view is that rice farmers have already borrowed against future water allocations and until recently the region continued to experience drought.

**Emission Reduction:** Yes. The applicant now intends to send all MB-fumigated rice through MB recapture equipment. The applicant previously recaptured a majority percentage of the MB used.
Research Program. Unable to assess. A research project in 2009 was interrupted due to the unfortunate death of the scientist in charge. For several years the applicant has indicated that they have chosen phosphine as their alternative; MBTOC does not believe there is a need for further research on phosphine. The applicant is now considering sulfuryl fluoride and so should conduct further research on this fumigant as proposed in recent correspondence.

Appropriate effort. Insufficient. As with all postharvest registration issues, neither the applicant nor the Party mandated with Montreal Protocol nominations has control over pesticide registration. This applicant, however, has not made appropriate efforts to adopt alternatives, since no alternatives have been adopted in spite or registration of technically effective and affordable alternatives being available. Economists need partial budget analysis to allow an economic assessment.

MBTOC comments on economics 2010:

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 November 2007 and SunRice commenced trials in January 2009. The Party notes the need to generate supporting data. Phosphine fumigation is considered by the Party to be the best solution, both technically and economically, although the applicant requires that the introduction of phosphine also include a considerable change to processing methods and a substantial infrastructure investment. The CUN shows projected operating costs with the phosphine system would be 15 times that for methyl bromide. The CUN relates the difficulties faced by the applicant in raising the capital for transition to phosphine. 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 recognizes that the phosphine system contemplated by the applicant is a significant different process than the current MB based process. However, it is unclear that construction of one or more pilot silos, or other fumigation structures and incremental implementation of a phosphine system is unaffordable. The company indicates it has returned to normal profitability.

MBTOC comments 2010:

MBTOC recommends the nominated amount of 11,020 kg for Canada flour mills in 2012. The party’s nomination was a reduction of 22% over the amount of MB granted by the Parties for 2011. In 2012 there will be 19 mills included in the application, one fewer than in 2011. The applicant has reduced its nomination by about half since 2010, due to the results of a multi-year research program and the advent of the new regulation which allows sharing of the MB allocation by companies within the CUN. The amount of MB recommended for 2012 will only fumigate 7-8 mills.

With this and other CUNs MBTOC remarks that heat treatments (in combination with DE) should also be used, when possible. The reason for this is that there may be ongoing problems with achieving the full registration of sulfuryl fluoride. In a recent letter, the Government of Canada explained that availability of heaters is limited during weekends traditionally used to conduct pest control treatments. MBTOC recommends that efforts to overcome this logistical problem be intensified.

Concerning heat treatments for mills, MBTOC notes that research shows practical/logistical challenges and possible insufficient efficacy for heat treatment with mills >40,000 m². MBTOC also notes that in large mills that have concrete basements it might be difficult or economically unfeasible to heat the mill sufficiently to allow the same degree of control of pest control as can be achieved with a gas fumigant (depending on the weather at time of treatment).
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<th>Country</th>
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With a concrete basement acting as a heat sink and refuge for the pests, the pest population rebounds faster. However, there is also evidence that heat treatment can be optimized and effective once it is learned how exactly to conduct the heat treatment in each individual mill. There is a long learning curve to achieve optimization because whole site treatment is usually only done once per year, so it might take several years to really optimize the treatment method for that particular mill. It would be good to have heat treatment experience and therefore a choice of effective treatments.

MBTOC does recognize the need to ensure the optimization of effective heat treatment or fumigation in the context of increasing requirements for food hygiene.

Although this CUN reduces by 18-22% each year, we note, with concern, that this use could be ongoing for several years unless there is regulatory change or greater adoption of heat treatment. The applicants report they are awaiting the full registration for SF which would allow contact of SF on commodities. MBTOC notes that it is possible that the full registration of SF will never occur. Therefore the Party is requested to provide a management plan which will allow for phase out of MB in this sector in the eventuality that full registration of SF is not achieved.

### Emission control

Mills are now not treated annually, which reduces emissions.

**Ongoing research** – Excellent research multi-mill, multi-stakeholder research program in past with several full reports submitted to MBTOC (SF, heat and DE, SF and elevated temperature, phosphine + CO2, etc). Research has not been reported in past two years; MBTOC is not convinced that further research in this field is absolutely necessary. When mills are not MB fumigated, they are being heat treated and all are now in enhanced IPM.

**Appropriate effort in the CUN?** Full registration of SF has not been achieved; there is still no food tolerance for F residues from SF treatment of mills. This action has been delayed for several years and hinders ability to fully adopt SF as an alternative treatment. Neither the millers nor the Party can affect fumigant registration. In spite of delay in achieving full registration, the mills are continuing to make progress.

**MBTOC comments on economics 2010:**

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.

The Party has stated in the past that operating margins in this industry are small. This CUN 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. The competitive conditions faced by flour mills make it unlikely a substantial portion of these added costs could be passed on down the supply chain. Regarding the observation that there are no government 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. The Party has indicated concerns that SF has been shown to have significant global warming potential and this could result in future constraints on its use, which adds another factor which might slow adoption of SF.
|---------|----------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|-------------------------------|--------------|--------------------------------|----------------------|

**MBTOC comments 2010:**

MBTOC recommends 2,084 kg for Canada pasta facilities in 2011. This is a 41% decrease of the amount granted by the Parties for this use in 2010. The Party nominated 3,529 kg for 2011, which is the same amount granted by the Parties for 2010. There are three facilities, each requesting one fumigation per facility. Concerning the nominated amounts, MBTOC notes that given the facility volumes, the MB nominated is only sufficient for partial facility fumigation, in two of the pasta facilities.

All facilities are making IPM improvements. Facility #1 of the CUN reports poor gastightness and we can not recommend the use of MB in a facility of poor gastightness any longer. We note that facility #2 reporting medium gastightness will have to make facility improvements to show good gastightness to be considered for any future CUN.

In the CUN for the 2009 round, MBTOC recommended that one facility conduct a trial with an alternative and report the results to MBTOC and to the other companies in the sector. Although the facilities have said they conducted SF trials in the sections where food products would not be contacted, reports documenting those trials were not submitted to MBTOC. No research reports have been submitted this year.

The applicants report they are awaiting the full registration for SF which would allow contact of SF on commodities. MBTOC notes that it is possible that the full registration of SF will never occur. Therefore the Party is requested to provide a management plan which will allow for phase out of MB in this sector in the eventuality that full registration of SF is not achieved.

It has been reported that other pasta facilities in Canada and the US use heat alone or SF and elevated temperature for pest control. For several years MBTOC has recommended that heat treatments be conducted in Canadian pasta facilities. These applicants however, have not reported to MBTOC the results of any heat treatments in their facilities, or elsewhere. The applicants indicate concerns about using heat, but in spite of repeated requests have not submitted any evidence to support this concern.

Heat treatments are successfully conducted at other pasta manufacturers. Heat and IPM have been used for a number of years in pasta facilities in North America, including large pasta facilities comprising mills, interior silos and processing lines (Gyovai, 2009). Europe has more than 180 pasta facilities; this sector completed the MB phase-out several years ago even in countries that have not registered SF (Buckley 2008). Heat and IPM are used for pasta in cold northern European countries in which SF is not registered (European Community, 2008). There is ample evidence that heat treatment can be optimized and effective once it is learned how exactly to conduct the heat treatment in each individual facility. There is also ample evidence worldwide that the concerns mentioned by the applicant can be addressed by service providers when they conduct heat treatments. Spot heat treatment of infested equipment is also a likely alternative. There is a long learning curve to achieve optimization of full site heat because such treatment is usually only done once per year, so it might take several years to fully optimize the treatment method for that particular facility. There is a much shorter learning curve to conduct spot heat treatments; spot heat treatments of infested equipment are used in several food processing companies. It would be good to have heat treatment experience and therefore a choice of effective treatments, particularly because full registration of SF may not be achieved soon.

SF can be used for empty structures only and not for food products in Canada. There are some rooms in the pasta plants which contain food ingredients and products which must be sealed off at the time of fumigation. Full registration of SF, including establishment of MRLs for cereal grains and milled grain products is taking longer than expected and as of April 2010 it has not occurred. However, MBTOC notes that it is not an adequate phase out plan to continue to request MB while awaiting a registration change that continues to be delayed and considering that other methods are being used in similar
situations. The other methods include heat alone (either full site or spot heat), SF treatment of non-food facility rooms, and avoidance of full site treatments through other means.

**Emissions reduction.** MBTOC has not recommended MB use in the one facility reporting poor gastightness. Another facility reporting medium gastightness is working to improve but will have to achieve good gastightness to even be considered for a CUN in future rounds.

**Research effort.** Insufficient. Full reports of research and trials of alternatives are required in the types of facilities included in the CUN.

**Appropriate effort.** As with all postharvest registration issues, neither the applicant nor the Party mandated with Montreal Protocol nominations has control over pesticide registration. Many similar companies have switched to alternatives. As indicated, inadequate effort has been made to ensure MBTOC receives sufficient information about this sector and to supply actual data, research reports and partial budget analysis.

**MBTOC comments on economics 2010:**

This CUN is not based on economic arguments. The current CUN adds no economic information. It restates earlier assertions that heat treatment remains a costly alternative with technical concerns about damage to building and equipment.

The CUN states that cost data on alternatives for pasta manufacturing facilities will be provided “as it becomes available.” MBTOC cannot conclude there is an economic basis for this CUN absent substantiation of the costs of alternatives.

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<tbody>
<tr>
<td>Japan</td>
<td>Chestnuts</td>
<td>7.100</td>
<td>6.800</td>
<td>6.500</td>
<td>6.300</td>
<td>5.800</td>
<td>5.400</td>
<td>5.35</td>
<td>4.984</td>
<td>-</td>
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**MBTOC comments 2010:**

MBTOC recommends 3,489 kg for 2012 which is a 30% reduction over the Party’s nominated 4,984 kg for Japan fresh chestnuts for 2012. The Party nominated a 7% reduction for this year over the 2011 amount; the reduction was to be achieved by logistical changes in on-farm fumigation.

To date there has been no adoption of alternatives in this commodity, but methyl iodide (MI) was registered for fresh chestnuts in Japan in 2009. The Government of Japan says market supply can not be achieved until 2011. MBTOC notes that since MI has been registered and will be available in 2011, it is therefore expected that Japan will begin adoption of MI as of the September-October harvest in 2011. In 2011, which MBTOC views as the first year of adoption, a 15% market penetration of MI should be achievable, with a resulting reduction in MB use. MBTOC also believes that a further 15% market penetration should be achievable in 2012.

Japan says they must take time to train farmers in safe use of the new fumigant, but this necessary training can and should begin to take place with the 2010 harvest (September – October of 2010). MBTOC sees the need for training in the use of MI. Japan has informed MBTOC that a firm phase out plan for MB use on chestnuts will be submitted later. (Japan NMS has indicated an intention to phase out of soil use of MB by 2013.) There is no need to change fumigation infrastructure in the switch between MB and MI, but in consideration of the need for on-farm training, MBTOC believes that a 30% reduction in 2012 is both responsible and achievable.

The Party notes that the price of MI is currently 4x higher than MB, but MBTOC notes that the cost of fumigation is a very small (and possibly insignificant) percentage of the price of this high value commodity. Therefore, even at current MI price, we do not find the cost of MI fumigation to be significant against the high value of chestnuts. Furthermore, the MI manufacturer is planning to do some research trials to investigate the use of a lower dosage rate (~50%) which will therefore lower costs.

**Emission reduction.** To date regular reductions in MB use through logistical improvements.
**Research program in past 12 months.** Extensive research program has been completed, no further research needed other than to see if reduced dosage of MI can be achieved, and that is optional. There is established efficacy of MI for this purpose in Japan and it has been registered.

**Appropriate effort?** Registration for methyl iodide proceeded as per normal and was registered after appropriate review.

**MBTOC comments on economics 2010:**

CUN states that an economic assessment has not been conducted because methyl iodide, registered in 2009, is scheduled to be sold after two years, in 2011, but that the price of methyl iodide is expected to be four times higher than MB.

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<th>Country</th>
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<th>CUE for 2005¹</th>
<th>CUE for 2006²</th>
<th>CUE for 2007³</th>
<th>CUE for 2008⁴</th>
<th>CUE for 2009⁵</th>
<th>CUE for 2010⁶</th>
<th>CUE for 2011⁷</th>
<th>CUN for 2011 (Addtl or new)</th>
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<th>MBTOC rec. for 2011(addtl or new)</th>
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<td>United States</td>
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<td>87.719</td>
<td>78.983</td>
<td>58.921</td>
<td>45.623</td>
<td>19.242</td>
<td>5.000</td>
<td>4.907</td>
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<td>2.155</td>
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**MBTOC comments 2010:**

MBTOC recommends 2,155 kg for US commodities in 2012. This is a 56% reduction over the amount nominated, based on 75% reduction in the dried fruit nomination (829 kg recommended), 50% reduction in walnuts (263 kg recommended) and 0% reduction in dates (1063 kg recommended). The Party nominated 4907 kg for commodity use in 2012. The commodities included in the CUN are dried fruit (3,317 kg) (dried plums, figs and raisins), walnuts (527 kg) and dates (1,063kg).

The USG reported that until viable options with the registered alternatives are further developed, the dried fruit industry has reached the maximum adoption of alternatives. But MBTOC believes there are several lines of action available with registered alternatives to almost entirely avoid the use of MB for dried fruit and nuts. For example, phosphine, cold storage after heat drying to prevent reinfestation and propylene oxide (when used to reduce bacteria and mold, insect pests will also be killed) are alternatives that could be used for the commodities in this CUN. SF is also registered for some of these commodities. In Germany carbon dioxide under pressure is used to disinfect some dried fruits.

The industry acknowledges that dried plums are free of insects when they come out of the dryer and that re-infestation occurs fairly soon thereafter: the re-infestation is the reason for these stored commodity treatments. MBTOC’s view is that the industry should work to prevent re-infestation and recommends this logistical problem be resolved on a priority basis. The USG said in correspondence that the industry has already transitioned to phosphine where possible, but that MB is needed if treatments need to occur around electronic and electrical equipment. MBTOC does not find this a valid reason. Commodity requiring phosphine fumigation can be moved to an appropriate location for fumigation.

The Party states that the California dried fruit and nut industries continue to financially support research on methyl bromide alternatives for postharvest applications, but full reports of these tests have not been submitted to MBTOC.

The CUN reports that SF is an effective treatment for walnuts. The walnut industry fumigates during 6 months of the year at or below 10°C (50 °F) (supporting temperature data for the San Joaquin and Sacramento Valleys of California was provided). MBTOC notes that small heaters could be used to raise the temperature of stacks of fruit or nuts to allow effective treatment with SF. Such methods are in common use in several commodities in the US and worldwide. Additionally MBTOC questions whether presence of pest eggs is indeed a problem in walnuts at time of harvest. Normally, infesting pests have progressed to larval stage by harvest; larvae are easier to kill at lower temperatures with SF.

The CUN (page 7) says,“Approximately 25 percent of walnuts are sold in the shell. Those that are packed and shipped to European market within a couple of days of the fumigation treatment qualify for quarantine exemptions for Methyl Bromide use. Those that are sold domestically or not immediately shipped may apply for a CUE. The remaining 75 percent of walnuts are processed further to create a variety of packaged shelled products. These walnuts must be
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<th>CUE for 2009⁵</th>
<th>CUE for 2010⁶</th>
<th>CUE for 2011⁷</th>
<th>CUN for 2011 (Addtl or new)</th>
<th>MBTOC rec. for 2011 (addtl or new)</th>
<th>MBTOC rec. for 2012 (new)</th>
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|         |          |               |               |               | me is not crucial. Phosphine can be used for the 75 percent of walnuts that are allocated for packaged shelled products because turnaround time is not crucial. Considering the CUN comments on walnuts, the CUN nominated 527 kg for walnuts and this amount of MB would treat approximately 12,000 m³ of in-shell walnuts or about 2,500 tonnes. Therefore the CUN seems to be requesting MB for the amount of in-shell walnuts sold domestically. MBTOC questions whether this segment might not be needed for immediate domestic sale and if so if logistical improvements might be possible to allow the use of phosphine for most of this segment. Additionally, controlled atmosphere could be used. The controlled atmosphere treatment of walnuts used in Europe against moths is 5 days, in gastight chambers under elevated temperature conditions. Furthermore, propylene oxide treatment is allowed for use on nutmeats to reduce bacteria and mold and this treatment would also kill insect pests. Cold storage is also used by this sector to prevent reinfestation. With dates there is an issue of regulatory interpretation. In the United States, sulfuryl fluoride is currently labeled for use on dried dates only. The dates harvested in the US are considered by MBTOC to have already been dried on the tree prior to harvest in that their moisture content is approx 17-23% (John Davies pers comm to MBTOC). This moisture content does not conform to the definition of high moisture dates in other date growing regions of the world. The concept of ‘fresh’ is not pertinent or informative to this discussion. MBTOC believes it is reasonable to interpret the regulation as allowing the use of SF on these dates in the US. The USDA Agriculture Research Service scientist has submitted an extensive report of ongoing date research (Walse, 2009). The use of sulfuryl fluoride has not yet been shown to be technically effective because ambient temperature at time of harvest is relatively low; studies have shown that eggs survive when SF treated at these low temperatures. Although the low temperature problem was mentioned for all three sectors of this CUN, the problem of low temperature is particularly pertinent to dried fruit and dates at the end of the harvest season. The applicants believe that further research is needed on the ovicidal efficacy of SF at temperatures below 21°C (70 °F), as well as on the ovicidal efficacy of propylene oxide/SF combinations. If there is no immediate demand for dates, phosphine treatment could be used. The California Date Commission reports that it is currently testing the efficacy of sulfuryl fluoride on dates, with preliminary results showing less than adequate egg kill, even when the amount used is twice that needed for a comparable methyl bromide fumigation. MBTOC acknowledges that the US date research program is ongoing and that it has been kept well informed of progress and problems. MBTOC members have been able to visit and confirm conditions at the date processors. Essentially, when ambient temperature was low (<21°C or 70 °F), and at dosages where residues were lower than regulatory maximum limits, eggs survived. This is predictable. The work is now being done combining SF and elevated temperatures. **Emissions reduction.** This sector has very considerably reduced use of MB, and therefore emissions. Fumigation takes place in chambers or suitable enclosures. **Research effort.** Research on dates is excellent thus far but more remains to be done, for example, to optimize SF treatment by elevating temperature. MBTOC needs detailed and complete reports on research conducted on the other commodities included in this CUN. **Appropriate effort.** Several alternatives are already registered. MBTOC notes that regulatory interpretation of use of SF on dates needs to be clarified; MBTOC believes the US dates are dried at time of harvest. **MBTOC comments on economics 2010:** The same economic arguments are provided as in the previous year. CUN is not based on economic (in)feasibility.
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<tr>
<th>Country</th>
<th>Industry</th>
<th>CUE for 2005¹</th>
<th>CUE for 2006²</th>
<th>CUE for 2007³</th>
<th>CUE for 2008⁴</th>
<th>CUE for 2009⁵</th>
<th>CUE for 2010⁶</th>
<th>CUE for 2011⁷ (Addtl or new)</th>
<th>CUN for 2011</th>
<th>CUN for 2012</th>
<th>MBTOC rec. for 2011 (Addtl or new)</th>
<th>MBTOC rec. for 2012 (new)</th>
</tr>
</thead>
<tbody>
<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>17.365</td>
<td>-</td>
<td>17.365</td>
<td>-</td>
<td>NR</td>
</tr>
</tbody>
</table>

**MBTOC comments 2010:**

MBTOC does not recommend this CUN. The Party nominated 17,365 kg, for food processing facilities in 2012, the same amount as granted by the Parties for 2011.

The substantiation for this CUN is unacceptably thin. No studies or reports detailing trials have been submitted that were conducted in the facilities included in this CUN. The applicants indicate that trials are conducted but the information will not be submitted to MBTOC; since these same organizations withholding the results of trials are also the applicant requesting MB, MBTOC finds this situation to be unacceptable.

To MBTOC’s knowledge, no flour mills are included in this CUN, but the only study that was submitted to MBTOC supporting this CUN was one flour mill study by researchers at Kansas State University; no studies in processed food facilities, herb and spice facilities or cheese stores have been submitted. No heat treatment studies have been submitted, although heat treatment is commonly used in this sector in the US and elsewhere.

In response to MBTOC’s questions about the use of spot heat treatment for herb and spice milling equipment, MBTOC was supplied with a paragraph on the inadvisability of treating organic pasta product with heat, which is not relevant to the subject. Spot heat treatment of equipment such as would be found in herb and spice facilities is conducted in other countries.

MBTOC asked many questions trying to obtain information about the use of alternatives directly relevant to the facilities included in this CUN. MBTOC indicated that a review of this CUN required MBTOC to know the numbers and types of facilities included; these questions were not substantively answered and documentation was not received. USG said that it had informed MBTOC of the types of facilities included in this CUN in 2005, but this information is completely out of date for a CUN for 2012.

USG has not supplied any actual use data for this sector, even for MB use in cheese storages where USG has said that MB fumigation only occurs upon the requirement of government inspectors. The USG told MBTOC that records of failed inspections are not available to the public. This is not a sufficient answer because we do not need to know company names we only need to know actual use (if any) of MB for cheese stores.

The applicant’s interpretation of the success of the one Kansas State University flour mill study submitted is not in agreement with the study’s authors. The study authors concluded that, “Both MB treatments killed 100% of all stages in the boxes except for large larvae in a few locations. In these locations, the mortality of large larvae ranged from 96-98%. SF treatments killed 100% of all stages except eggs. In the May treatment with SF, egg mortality ranged from 44-100% with only two boxes showing 100% mortality, because of under-dosing. Under-dosing occurred because the mill temperature was assumed to be greater than 27°C when it was actually below 27°C. In the second SF trial, only three boxes had egg mortalities that were less than 100%. However, data from the two replications showed that the mean mortalities of eggs and large larvae between MB and SF were not significantly different from each other.” (Hartzer et al, Kansas State University, 2010 in press)

**Emissions reduction.** The sector has considerably reduced MB use and therefore reduction but we have not been provided with information about the gastightness in the facilities included in the CUN.
Research effort. Insufficient. Full reports of research and trials of alternatives are required in all the types of facilities included in the CUN.

Appropriate effort. As with all postharvest registration issues, neither the applicant nor the Party mandated with Montreal Protocol nominations has control over pesticide registration. Many of the companies formerly associated with this CUN have switched to alternatives and/or decreased their use of MB to only once every few years. As indicated, inadequate effort has been made to ensure MBTOC receives sufficient information about this sector and to supply actual data, research reports and partial budget analysis.

**MBTOC comments on economics 2010:**
The same economic arguments are provided as in the previous year. CUN is not based on economic (in)feasibility.

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>United States</td>
<td>Mills and processors</td>
<td>483.000</td>
<td>461.758</td>
<td>401.889</td>
<td>348.237</td>
<td>291.418</td>
<td>291.418</td>
<td>173.023</td>
<td>-</td>
<td>135.299</td>
<td>74.510</td>
</tr>
</tbody>
</table>

**MBTOC comments 2010:**
MBTOC recommends 74,510 kg, for US food processing structures in 2012. This represents a 50% decrease in flour milling, a 50% decrease for rice milling and a zero decrease for pet food facilities from the amounts nominated by the Party. The Party has nominated 135,299 kg for the food processing structures included in this CUN. This was the same amount granted by the Parties for 2011. The Party nominated flour milling (107,066 kg), rice processing (14,511 kg), and pet food manufacturing (13,722 kg), but MBTOC recommends for flour milling (53,533 kg), rice processing (7,255 kg) and pet food manufacturing (13,722 kg).

As in previous years, MBTOC comments that substantiation for this CUN is very thin. In fact, although one flour mill study by researchers at Kansas State University was presented, no studies in rice mills or pet food establishments have been submitted. There have been several North American flour mill studies including a heat treatment study by Kansas State University and those by Canadian companies in association with Agriculture and Agri-Food Canada, but these were not included or considered by the applicant.

Furthermore, the applicant’s interpretation of the success of the one Kansas State University flour mill study submitted is not in agreement with the study’s authors. The study authors concluded that, "Both MB treatments killed 100% of all stages in the boxes except for large larvae in a few locations. In these locations, the mortality of large larvae ranged from 96-98%. SF treatments killed 100% of all stages except eggs. In the May treatment with SF, egg mortality ranged from 44-100% with only two boxes showing 100% mortality, because of under-dosing. Under-dosing occurred because the mill temperature was assumed to be greater than 27°C when it was actually below 27°C. In the second SF trial, only three boxes had egg mortalities that were less than 100%. However, data from the two replications showed that the mean mortalities of eggs and large larvae between MB and SF were not significantly different from each other." (Hartzer et al, Kansas State University, 2010 in press)

In response to MBTOC’s request in correspondence, short summary paragraphs were sent in letters from USG about trials in rice mills and pet food facilities. This is insufficient information and does not adequately support the CUN.

According to the USG, there has been much progress in the alternatives of methyl bromide. Alternatives are not only sulfuryl fluoride, but also heat and micro-sanitation. The use of fogging, space, and crack and crevice treatments has greatly decreased the number of times structures are fumigated. However the Party reports that many companies desire to retain the ability to utilize methyl bromide in the event of a difficult infestation. MBTOC notes that MB use on a contingency basis is not a critical use and that an emergency use provision still exists under the Montreal Protocol for such events.

The applicants for US food structures CUN indicate that trials are conducted but the information is proprietary and will not be submitted to MBTOC; since
these same organizations withholding the results of trials are also the applicant requesting MB. MBTOC finds this situation to be an inherent conflict of interest. The applicant is assured that proprietary information would be handled confidentially within MBTOC, in addition, company names need not be sent to MBTOC.

The Party reports that, “a vast majority of pet food facilities have transitioned away from use of methyl bromide as part of their routine pest management program. Companies that have completed the transition away from methyl bromide either view their pest management programs as proprietary or as a competitive advantage, so we are unable to share specifics on those alternative programs. We can suppose that such programs utilize techniques such as microsanitation, spot heat treatment, insect growth inhibitors, and fumigation treatment with Vapona ULV fogging, phosphine and ProFume.”

The CUN indicates that lack of adequate registration negatively impacts the ability of pet food facilities to use sulfuryl fluoride because the SF label does not include pet food and the applicant says that the pet food can not be moved out of the establishment before fumigation with SF.

The pet food facility applicants in particular report they are awaiting label extensions for SF which would allow contact of SF on commodities. MBTOC notes that it is possible that this will never occur. Therefore the Party is requested to provide a management plan which will allow for phase out of MB in this sector in the eventuality that label extensions for SF are not achieved.

In flour and rice milling, a different problem is presented with the use of SF. The GWP of SF has been reported by TEAP and elsewhere to be approximately 4000 times that of carbon dioxide (refer to Progress Report for more details). Furthermore more SF is used to fumigate a facility than MB (the amount varies from 1.5 to 4x more depending on temperature at time of fumigation). No actual evidence in the form of letters or policy positions of retailers or other industrial customers were presented to MBTOC. In response to MBTOC correspondence, USG said that Walmart is pressuring millers to reduce their carbon footprint and the applicants say this is preventing their use of SF.

No new economic data has been presented in this year’s CUN for structures. SF requires elevated temperature in combination and when this is done the combined treatment is technically comparable to MB. The cost of SF treatment is higher (with or without additional heat). However, Parties to the Montreal Protocol have not indicated that a higher cost is a sufficient reason to avoid using an alternative.

MBTOC economists are adopting a standard that a 15-20% decrease in net revenue is still an economically feasible alternative. For pet foods, reviewing Table 5 of CUN, the Party indicates 0.8% loss on gross revenue for the worst case scenario of having to heat a cold manufacturing facility of 4˚C to 54.4˚C. (MBTOC notes that only the most dire and completely unlikely circumstance would see the temperature of an entire pet food establishment fall this low.) This table also indicates that 0.06% loss of gross revenue on an elevated temperature-plus-SF treatment when the treatment is required to raise the temperature from 4.4˚C to 29.4˚C plus SF treatment. (Again it is completely unlikely that an entire pet food establishment temperature would be this low.). In the instance of a SF treatment there would be additional costs of moving the pet food out of the building. Therefore, according to MBTOC’s economic’s standard, both heat treatment alone and elevated temperature plus SF treatment are economically feasible. The comparable data for rice and flour milling were not provided to MBTOC.

For several years, MBTOC has asked for partial budget analysis for all the sectors included in this CUN, including the flour and rice milling sectors, but these have not been received. In the absence of gross revenue data, we assume the fumigation costs for flour and rice milling sectors are a comparable percentage to pet food manufacturing.

**Emission reduction.** There is still work to be done to improve the sealing of mills and facilities. Improved sealing would allow the use of lower dosages which would decrease emissions.

**Research effort:** Insufficient. Full reports of research and trials of alternatives are required in all the types of facilities included in the CUN.
### Appropriate effort.

As with all postharvest registration issues, neither the applicant nor the Party mandated with Montreal Protocol nominations has control over pesticide registration. Many of the companies formerly associated with this CUN have switched to alternatives and/or decreased their use of MB to only once every few years. As indicated, inadequate effort has been made to ensure MBTOC receives sufficient information about this sector and to supply actual data, research reports and partial budget analysis.

### MBTOC comments on economics 2010:

The same economic arguments are provided as in the previous year. CUN is not based on economic (in)feasibility.

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<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>Cured pork</td>
<td>67.907</td>
<td>40.854</td>
<td>18.998</td>
<td>19.669</td>
<td>18.998</td>
<td>4.465</td>
<td>3.73</td>
<td>-</td>
<td>3.730</td>
<td>-</td>
</tr>
</tbody>
</table>

**MBTOC comments 2010:**

MBTOC recommends 3,730 kg for cured pork products in 2012. The Party nominated 3,730 kg for cured pork products in 2012, the same amount nominated for 2011. Some decrease in the MB nomination has been achieved over the years resulting from IPM, emissions controls and treatment improvements. There is no alternative registered for this use. There is a multi-state, multi-university research program ongoing which is testing several alternative treatments, increasing knowledge of pest and dose response to potential alternatives. Initial work on phosphine showed efficacy but also showed changes in odor of the pork. Earlier work by this group using SF indicated lack of efficacy. (Shilling, 2009a, 2009 b). MBTOC notes that mites are one of the key pests of cured pork and that mites will not be controlled by the phosphine treatment. Additionally, phosphine is not registered for this purpose in the US. MBTOC encourages registration of effective fumigants, once identified. Full reports of this research has been sent to MBTOC, and communicated to the industry sector. MBTOC has been able to observe and confirm the conditions and processing of the cured pork at various sites included in this CUN.

**Emissions reduction.**

Over the years the applicants have made facility improvements to improve gastightness, but this is a traditional meat curing process and some of the facilities are older and unusual. The research program continues to work with the applicants to improve gastightness, IPM and other process improvements which reduce the need for fumigation and result in decreased use of MB. This work needs to continue.

**Research effort.**

Excellent research effort to date but more needs to be done. A multi-state, multi-university research program is ongoing and full reports of research have been made available to MBTOC.

**Appropriate effort.**

As with all postharvest registration issues, neither the applicant nor the Party mandated with Montreal Protocol nominations has control over pesticide registration. There are no alternatives registered for the treatment of pests in meat at this time.

**MBTOC comments on economics 2010:**

CUN states that no economic analysis was done due to the lack of technically feasible alternatives.
10.5 References


Hartzer, M., Subramanyam B.,Chayaprasert W., Maier D.E., Savoldelli S., Campbell J.F. and P.W. Flinn. Methyl bromide and sulfuryl fluoride effectiveness against red flour beetle life stages. 2010 (IN PRESS)


John Davies, Manager, Hadley Inc. California. Pers comm..


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 I to Chapter 10: 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 10: Decision XVI/4

Review of the working procedures and terms of reference of the Methyl Bromide Technical Options Committee


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 10 - Part A: Trend in Preplant Soil Applications

List of nominated (2005 – 2012 in part) and exempted (2005 – 2011 in part) amounts of MB granted by Parties under the CUE process for each crop or commodity.

<table>
<thead>
<tr>
<th>Party</th>
<th>Industry</th>
<th>Total CUN MB Quantities</th>
<th>Total CUE Quantities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>Cut Flowers – field</td>
<td>40.000 22.350 18.375 22.350</td>
<td>18.375 22.350</td>
</tr>
<tr>
<td>Australia</td>
<td>Cut flowers – protected</td>
<td>20.000</td>
<td>10.425</td>
</tr>
<tr>
<td>Australia</td>
<td>Cut flowers, bulbs – protected Vic</td>
<td>7.000 7.000 6.170 6.150</td>
<td>7.000 7.000 3.598 3.500</td>
</tr>
<tr>
<td>Australia</td>
<td>Strawberry Fruit</td>
<td>90.000</td>
<td>67.000</td>
</tr>
<tr>
<td>Belgium</td>
<td>Asparagus</td>
<td>0.630 0.225</td>
<td>0.630 0.225</td>
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<tr>
<td>Belgium</td>
<td>Chicory</td>
<td>0.600 0.180</td>
<td>0.180 0.180</td>
</tr>
<tr>
<td>Belgium</td>
<td>Chrysanthemums</td>
<td>1.800 0.720</td>
<td>1.120</td>
</tr>
<tr>
<td>Belgium</td>
<td>Cucumber</td>
<td>0.610 0.545</td>
<td>0.610 0.545</td>
</tr>
<tr>
<td>Belgium</td>
<td>Cut flowers – other</td>
<td>6.110 1.956</td>
<td>4.000 1.956</td>
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<tr>
<td>Belgium</td>
<td>Cut flowers – roses</td>
<td>1.640</td>
<td></td>
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<tr>
<td>Belgium</td>
<td>Endive (sep from lettuce)</td>
<td>1.650</td>
<td>1.650</td>
</tr>
<tr>
<td>Belgium</td>
<td>Leek &amp; onion seeds</td>
<td>1.220 0.135</td>
<td>0.660</td>
</tr>
<tr>
<td>Belgium</td>
<td>Lettuce(&amp; endive)</td>
<td>42.250 22.425</td>
<td>25.190</td>
</tr>
<tr>
<td>Party</td>
<td>Industry</td>
<td>Total CUN MB Quantities</td>
<td>Total CUE Quantities</td>
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</tr>
<tr>
<td>Belgium</td>
<td>Nursery</td>
<td>Not Predictable</td>
<td>0.384</td>
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<td>Belgium</td>
<td>Orchard pome &amp; berry</td>
<td>1.350</td>
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<td>Ornamental plants</td>
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<td>Pepper &amp; egg plant</td>
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<td>Strawberry runners</td>
<td>3.400</td>
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<td>Belgium</td>
<td>Tomato (protected)</td>
<td>17.170</td>
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<td>Belgium</td>
<td>Tree nursery</td>
<td>0.230</td>
<td>0.155</td>
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<td>Strawberry runners (Quebec)</td>
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<td>Strawberry runners (Ontario)</td>
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<tr>
<td>France</td>
<td>Carrots</td>
<td>10.000</td>
<td>8.000</td>
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<td>France</td>
<td>Cucumber</td>
<td>85 revised to 60</td>
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<td>Cut-flowers</td>
<td>75.000</td>
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<tr>
<td>France</td>
<td>Forest tree nursery</td>
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<td>10.000</td>
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<tr>
<td>France</td>
<td>Melon</td>
<td>10.000</td>
<td>10.000</td>
</tr>
<tr>
<td>France</td>
<td>Nursery: orchard, raspberry</td>
<td>5.000</td>
<td>5.000</td>
</tr>
<tr>
<td>Party</td>
<td>Industry</td>
<td>Total CUN MB Quantities</td>
<td>Total CUE Quantities</td>
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<td>---------</td>
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</tr>
<tr>
<td>France</td>
<td>Orchard replant</td>
<td>25.000</td>
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</tr>
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<td>France</td>
<td>Pepper incl in tomatoeun</td>
<td>27.500</td>
<td>6.000</td>
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<tr>
<td>France</td>
<td>Strawberry fruit</td>
<td>90.000</td>
<td>86.000</td>
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<td>France</td>
<td>Strawberry runners</td>
<td>40.000</td>
<td>4.000</td>
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<tr>
<td>France</td>
<td>Tomato (and eggplant for 2005 only)</td>
<td>60.500</td>
<td>33.250</td>
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<tr>
<td>France</td>
<td>Eggplant</td>
<td>27.500</td>
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<tr>
<td>Greece</td>
<td>Cucurbits</td>
<td>30.000</td>
<td>19.200</td>
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<td>Greece</td>
<td>Cut flowers</td>
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<td>Greece</td>
<td>Tomatoes</td>
<td>180.000</td>
<td>73.600</td>
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<tr>
<td>Israel</td>
<td>Broomrape</td>
<td>250.000</td>
<td>250.000</td>
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<tr>
<td>Israel</td>
<td>Cut flowers – open field</td>
<td>77.000</td>
<td>67.000</td>
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<td>Israel</td>
<td>Cut flowers – protected</td>
<td>303.000</td>
<td>303.000</td>
</tr>
<tr>
<td>Israel</td>
<td>Fruit tree nurseries</td>
<td>50.000</td>
<td>45.000</td>
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<tr>
<td>Israel</td>
<td>Melon – protected &amp; field</td>
<td>148.000</td>
<td>142.000</td>
</tr>
<tr>
<td>Party</td>
<td>Industry</td>
<td>Total CUN MB Quantities</td>
<td>Total CUE Quantities</td>
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</tr>
<tr>
<td>Israel</td>
<td>Potato</td>
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<td>Israel</td>
<td>Seed production</td>
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Annex IV to Chapter 10 – Part B: Post-harvest Structural and Commodity Applications

List of nominated (2005 – 2012 in part) and exempted (2005 – 2011 in part) amounts of MB granted by Parties under the CUE process for each crop or commodity.

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11     TEAP and TOC Organisation Issues

11.1     Current TEAP/TOC membership and TEAP nomination of a replacement TEAP Co-Chair

Currently TEAP has 20 members; this number includes the TEAP co-chairs, the TOC-co chairs and Senior Expert members. Of the 20 members, 7 are from Article 5 Parties and 13 are from non-Article 5 Parties. As of April 2010, the total membership of the TEAP and its six TOCs is about 150 members, including about one third from Article 5 Parties and about two thirds from non-Article 5 Parties (which includes a small number of experts from non-Article 5 former CEITs, Eastern Europe and Central Asia). There are an additional 10 consulting (non-voting) members in the Halons and Refrigeration Technical Options Committees.

In 2010, K. Madhava Sarma (TEAP Senior Expert Member) retired from TEAP and Jose Pons Pons (TEAP Co-chair and MTOC Co-chair) retired as TEAP Co-chair, but remains as MTOC Co-chair. The consensus of TEAP is to nominate Marta Pizano (Colombia) as TEAP Co-chair to replace Jose Pons Pons (Venezuela). Marta Pizano has been a member of MBTOC since 1998 and a MBTOC Co-chair since 2005. There are no TEAP nominations for a replacement for K. Madhava Sarma.

11.2     Medical Technical Options Committee (MTOC)

Jose Pons-Pons has retracted his resignation as Co-chair of MTOC and will continue in this role.

11.3     Methyl Bromide Technical Options Committee (MBTOC)

The recent strengthening and adjustment of the MBTOC continues to improve the efficiency of meetings and the consensus process. In response to Decision XXI/10, TEAP co-chairs reorganized MBTOC into three subcommittees: (1) MBTOC-Soils co-chaired by Ian Porter (Australia) and Mohamed Besri (Morocco); (2) MBTOC-Structures and Commodities chaired by Michelle Marcotte (Canada) and (3) MBTOC-QPS (quarantine and pre-shipment) chaired by Marta Pizano (Colombia).

11.4     Refrigeration, AC and Heat Pumps Technical Options Committee (RTOC)

Parties agreed at MOP-21 to replace retiring RTOC Co-chair Dr. Radhey S. Agarwal (India) with Dr. Roberto de Aguiar Peixoto (Brazil), RTOC member since 1996.

11.5     Volcanic ash complicates and inconveniences TEAP and TOC operations

The airborne volcanic ash from the eruption of the Eyjafjallajokull volcano disrupted air travel for some TEAP and MBTOC members attending their respective meetings in Spain in April 2010. The TEAP meeting therefore also included consultations of members not present at the meeting via telephone conferences and submission of material for review by email.
11.6 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 sponsor their own travel, lodging, and other expenses of attending meetings; as a result, TEAP, TOC and Task Force operations are becoming even more difficult to accomplish.

TEAP would like to remind Parties that TEAP and its TOCs are producing reports and technical papers that are technically sound and globally informed at a cost much lower than if consultants would be contracted for the same assignments.

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.

If Parties prefer to not provide additional funding, TEAP and its TOCs will need to take drastic steps to minimise costs; including fewer meetings with smaller committees, fewer experts attending the OEWG and MOP, and rationalising membership, as needed.
12  TEAP TOC Membership List Status April 2010

The disclosure of interest (DOI) of each member can be found on the Ozone Secretariat website at: http://ozone.unep.org/Assessment_Panels/TEAP/toc-members-disclosures.shtml. The disclosures are updated whenever necessary.

Technology and Economic Assessment Panel (TEAP)

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<th>Co-chairs</th>
<th>Affiliation</th>
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<tr>
<td>Stephen O. Andersen</td>
<td>U.S. Environmental Protection Agency</td>
<td>USA</td>
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<tr>
<td>Lambert Kuijpers</td>
<td>Technical University Eindhoven</td>
<td>Netherlands</td>
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<tr>
<td>Jose Pons Pons</td>
<td>Spray Quimica</td>
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<tr>
<td>Thomas Morehouse</td>
<td>Institute for Defense Analyses</td>
<td>USA</td>
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<tr>
<td>Shiqiu Zhang</td>
<td>Center of Environmental Sciences, Peking University</td>
<td>China</td>
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<td>UK</td>
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<td>Mohamed Besri</td>
<td>Institut Agronomique et Vétérinaire Hassan II</td>
<td>Morocco</td>
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<td>Biao Jiang</td>
<td>Shanghai Institute of Organic Chemistry</td>
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<td>David Catchpole</td>
<td>Petrotechnical Resources Alaska</td>
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<td>Sergey Kopylov</td>
<td>All Russian Research Institute for Fire Protection</td>
<td>Russian Federation</td>
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<td>Michelle Marcotte</td>
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<td>Canada</td>
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<td>Roberto de A. Peixoto</td>
<td>Maua Institute (IMT), Sao Paulo</td>
<td>Brazil</td>
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<td>Marta Pizano</td>
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<td>Ian Porter</td>
<td>Department of Primary Industries</td>
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<td>Miguel Quintero</td>
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<td>Ian D. Rae</td>
<td>University of Melbourne</td>
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<td>Masaaki Yamabe</td>
<td>National Inst. Advanced Industrial Science and Technology</td>
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TEAP Chemicals Technical Options Committee (CTOC)

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<tr>
<td>Biao Jiang</td>
<td>Shanghai Institute of Organic Chemistry</td>
<td>China</td>
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<tr>
<td>Ian D. Rae</td>
<td>University of Melbourne</td>
<td>Australia</td>
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<td>National Inst. Advanced Industrial Science and Technology</td>
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<tr>
<td>D. D. Arora</td>
<td>The Energy and Research Institute</td>
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<tr>
<td>Olga Blinova</td>
<td>Russian Scientific Center for Applied Chemistry</td>
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<td>Jianxin Hu</td>
<td>College of Environmental Sciences &amp; Engineering, Peking</td>
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<td>Michael Kishimba</td>
<td>University of Dar-es-Salaam</td>
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<td>Abid Merchant</td>
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<td>Koichi Mizuno</td>
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<td>Keichi Ohnishi</td>
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<tr>
<td>Claudia Paratori</td>
<td>Coordinator Ozone Programme -CONAMA</td>
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<td>Teijin Aramids</td>
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<td>Fatemah Al-Shatti</td>
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## TEAP Flexible and Rigid Foams Technical Options Committee (FTOC)

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<tr>
<td>Paul Ashford</td>
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<tr>
<td>Kyoshi Hara</td>
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<td>Candido Lomba</td>
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## TEAP Halons Technical Options Committee (HTOC)

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<td>Thomas Cortina</td>
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<tr>
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<tr>
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## Medical Technical Options Committee (MTOC)

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<td>Jose Pons Pons</td>
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<td>Emmanuel Addo-Yobo</td>
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<td>Adam Wanner</td>
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<tr>
<td>Kristine Whorlow</td>
<td>National Asthma Council Australia</td>
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<tr>
<td>You Yizhong</td>
<td>Journal of Aerosol Communication</td>
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### TEAP Methyl Bromide Technical Options Committee (MBTOC)

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<tr>
<td>Mohamed Besri</td>
<td>Institut Agronomique et Vétérinaire Hassan II</td>
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<tr>
<td>Michelle Marcotte</td>
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<tr>
<td>Ian Porter</td>
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<tr>
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<td>Patrick Ducom</td>
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<td>Suat Yilmaz</td>
<td>BATEM Horticulture Research Station</td>
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## TEAP Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee (RTOC)

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<tr>
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<tr>
<td>Lambert Kuijpers</td>
<td>Technical University Eindhoven</td>
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<td>Roberto de A. Peixoto</td>
<td>Maua Institute, IMT, Sao Paulo</td>
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<td>Radhey S. Agarwal</td>
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<td>Petter Nekså</td>
<td>SINTEF Energy Research</td>
<td>Norway</td>
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<tr>
<td>Horace Nelson</td>
<td>Manufacturer</td>
<td>Jamaica</td>
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<td>Alexander C. Pachai</td>
<td>Johnson Controls</td>
<td>Denmark</td>
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<tr>
<td>Andy Pearson</td>
<td>Star Refrigeration Glasgow</td>
<td>UK</td>
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<td>Per Henrik Pedersen</td>
<td>Danish Technological Institute</td>
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<tr>
<td>Sulkan Suladze</td>
<td>Consultant</td>
<td>Georgia</td>
</tr>
<tr>
<td>Paulo Vodianitskaia</td>
<td>Consultant</td>
<td>Brazil</td>
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### Consulting Experts

<table>
<thead>
<tr>
<th>Consulting Experts</th>
<th>Affiliation</th>
<th>Country</th>
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<tbody>
<tr>
<td>Takuo Hirahara</td>
<td>Mitsubushi Electric Corp.</td>
<td>Japan</td>
</tr>
<tr>
<td>Lindsey Roke</td>
<td>Fisher and Paykel</td>
<td>New Zealand</td>
</tr>
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