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执行蒙特利尔议定书
多边基金执行委员会
第五十四次会议
2008 年 4 月 7 日至 11 日，蒙特利尔

提供关于对氟氯烃淘汰供资方面的所有有关费用因素进行的分析的初步讨论文件（第 53/37(i)号决定）

执行摘要

1. 当前，HCFC-141b、HCFC-142b 和 HCFC-22 在第 5 条国家占其所有类氟氯烃消费总量的 99%以上。这些氟氯烃主要用于制造泡沫塑料产品和制冷设备以及用于制冷维修次级行业。尽管目前无法准确确定拥有使用氟氯烃的制造企业的国家数目或维修行业所使用氟氯烃的数量，但很显然，拥有使用氟氯烃的制造企业的第 5 条国家不到 50 个。相反，有可能所有第 5 条国家都用 HCFC-22 作为维修制冷设备的制冷剂， 主要是用于空调和商业制冷。因此，制冷维修行业将在实现 2013 年的冻结和 2015 年的减少方面发挥重要作用，特别是在没有使用氟氯烃的制造企业的国家。

2. 根据第 53/37 号决定，现已查明淘汰各类氟氯烃的可靠替代技术，并对相应的增支成本和业务费用进行了估算。成本的计算不是要用作计算增支成本的模板，而是为了说明增支资本和经营费用或结余的相对数量及其对于项目的影响，从而更好地为执行委员会当前的讨论提供信息。在泡沫塑料行业，特别是对于 HCFC-141b，几种技术（即水性体系和烃，计有：正戊烷、环戊烷、异戊烷及其混合物）在第 5 条国家都得到证明并广为使用。更新的技术（即 HFC-245fa、HFC365mfc/HFC-227ea）尚未在第 5 条国家作商业用途，这些技术的效果在非第 5 条国家已得到证明。同样，甲酸甲酯技术看来在以较低成本满足第 5 条国家泡沫塑料生产需要方面前景很好。制冷行业的 HCFC-22 的情况十分类似，有氢氟碳化物和烃的替代品。这些技术都在多边基金的项目中使用过。因此，各执行机构和几个国家完全能够将这些技术用于淘汰各类氟氯烃。仍存在的问题是，通常使用的氢氟碳化物替代品的全球变暖潜值高于其所取代的各类氟氯烃，而全球变暖潜值低的物质，特别是烃，不仅成本费高，而且有安全问题。

3. 维修行业对 HCFC-22 的需求，很大程度上与各国进口 HCFC-22 空调设备有关。为简化维修行业嗣后消费量的减少，各国应尽早考虑可否对 HCFC-22 设备、特别是空调机进口实行管制。这一情况有可能对于向多边基金提出的要求产生影响，这项要求是：尽早为改造 HCFC-22 空调制造设施提供资金，以便向第 5 条国家供应无氟氯烃空调设备。

4. 管理各类氟氯化碳淘汰的各项政策和准则导致了第 5 条国家泡沫塑料企业技术的全面提高。[1]/ 因此，大多数替代技术（即 HFC-245fa、HFC-365mfc/227ea、甲酸甲酯和水性体系）的淘汰都不需要在设备上作更多开支。对于这些替代品来说，增支资本费用主要包括技术援助，这包括泡沫塑料新系统方框的培训和试运行，尽管这样做所需资金高于由氟氯化碳转向氟氯烃（至少在初期阶段），原因是对新技术不甚熟悉，可能需要比 HCFC-141b 更讲求技巧的配方，可能也还需要更全面、花费更昂贵的试运行。但如果选择了含烃技术，就需要大量资本开支，因为需要取代大多数的制造设备，也需要安装设备的其他新部件。

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1 取消了即使使用发泡剂也只能生产隔热性能的泡沫的手搅拌技术，大多数情况下代之以高压发泡器，而低压发泡器也被高压发泡器取代，以便通过使发生反应的泡沫混合液更有效混合改进泡沫的隔热性能。

同样，在某些具体情况下，例如在基准储存罐不再适合处理诸如 HFC-245fa 等替代化学品而出现必须配备新的储存罐的技术要求时，就有需要某种增支资本费用的必要性。

5. 自基金成立以来，对投资项目提案的供资一直根据对增支资本和业务费用的评价进行。由于淘汰项目数目增加，大件设备价格变得固定，资本费用便可以算出，一般都会随着时间的推移而下降。有了这一经验后，制订了行业和国家淘汰计划。在这一框架内，随着时间的推移，对所有组成部分都会了如指掌。但还没有为淘汰氟氯烃建立起这种框架。可能需要作进一步考虑的问题是：

(a) 增支经营费用与支付时间长短成正比。执行委员会有权确定支付增支经营费用的期限。根据为本文件目进行的计算，这些费用在项目总费用中所占的高额比例，便说明了讨论增支经营费用和确定计算这些费用的期限的重要性；

(b) 历史上说，执行委员会都是在制造设备的有用寿命结束前很早便为这些设备的改造提供资金，多数情况下是通过提供新的设备。虽然这种做法显示出及早淘汰的奖励措施方面的很大长处，但这样做也导致过早地撤下和销毁能有效运转的昂贵的基础设施。或许可以考虑，在哪些情况下，多边基金可以在设备达到有用寿命的尽头时提供支助，以避免过早撤销这种基础设施。但需要在每一第 5 条国家的整个履约时间表内对此进行评估。

(c) 硬泡沫塑料次级行业的大多数使用氟氯烃的企业看来是那些氟氯烃消费低于 40 吨（4.4 ODP 吨 HCFC-141b 或 2.2 ODP 吨 HCFC-22）的企业，包括大量的中小型企业，它们中的大多数是“不履约硬泡沫塑料”的生产商。为使所有整皮硬泡沫塑料企业平等地获得现有替代技术，有必要审查适用于淘汰器皿泡沫、非器皿泡沫和整皮泡沫中的氟氯烃的成本效益临界值，并解决成本效益阈值的差异。这样做能够提供奖励，让更多的可能愿意采用烃改造办法的硬泡沫塑料制造企业能够这样做；

(d) 在泡沫塑料行业淘汰氟氯化碳的过程中，为少数一些第 5 条国家的几种系统内的企业提供了资金，生产适当的无氟氯化碳的预先混合的多元醇，同时也为其客户提供技术转让和培训。就氟氯烃淘汰来说，它们的参与可被视为战略的一个重要组成部分，能够提供进程的高效而可持续的做法，因为向新技术过渡所涉大多数技术问题在初期可能在系统一级得到很好的解决；

(e) 虽然有证据显示近来大量的 HCFC-142b 是与 HCFC-22 混合使用，这种用法看来仅限于数目有限的第 5 条国家相对较大型泡沫塑料生产企业。但对于淘汰 HCFC-142b/HCFC-22 混合物而言，在指定淘汰资金之前，需要作更多的调查和研究；

(f) 从制冷行业的信息来看，如果没有若干逐个项目成本评估的经验，特别是在新的次级行业和不多的情况下在现有的次级行业中，显然很难向执行委员会提供与这些次级行业的制造能力改造有关的行业或国家淘汰费用方面适当技术指导。

6. 在编制本文件时，秘书处检查了环境影响指标及其运用有关的问题，为达到或超过这些水平需要提供的奖励措施，以及健康、安全和经济因素。在现阶段，在执行委员会讨论某些政策原则之前，秘书处还无法提供进一步的指导。这尤其涉及到评估替代品的环境影响的最适用的指标，以及这些指标如何应用的问题。

7. 对当前联合供资的奖励措施和机会方面的情况已有所考虑，并得出了如下一些意见：

(a) 由不同的实体核准和落实联合供资项目需时颇长，有可能导致仅对不单单与 2013 年和 2015 年氟氯烃减少目标有关的项目使用联合供资的方法。谨建议执行委员会在今后的某次会议上尽早考虑对与联合供资有关的目标的定义和氟氯烃项目联合供资的初步框架。这将有助于可能的联合供资实体尽早确定其做法，让其在讨论全面预算时能对相关的供资需要作出考虑；

(b) 就多边基金支助下能够产生更多好处的项目提出指导，有可能具有一定的价值，或在今后会具有这种价值，例如符合碳融资的条件。

一. 导言

1. 本份初步讨论文件系根据执行委员会的第 53/37(i)号决定提出，内载关于资助氟氯烃淘汰相关的几个费用问题的分析。

一.1 执行委员会的任务

2. 在 2007 年 11 月的第五十三次会议上，执行委员会审议了基金秘书处编制的关于评估和确定氟氯烃消费和生产淘汰活动中符合资格的增支费用的备选办法的文件。[2]/

3. 除其他外，执行委员会最后要求“秘书处与了解发展程度不同的第 5 条国家和非第 5 条国家的经验的技术专家协商后，在 2008 年 3 月 25 日之前编制完成初步讨论文件，就资助氟氯烃淘汰的所有相关费用问题作出分析，同时顾及执行委员会成员在(l)段所提呈件中表示的意见，并包括：

(a) 关于费用基准/限额以及氟氯烃替代技术的适用性的资料；以及

(b) 根据缔约方第十九次会议通过的第 XIX/6 号决定第 11(b)段审议替代技术、财务奖励措施和共同筹资的机会，这些都与确保氟氯烃的淘汰能够带来好处有关”（第 53/37(i)号决定）。[3]/

一.2 文件的范畴

4. 自 1991 年以来，多边基金编制了大量的成本规范。在单项项目成本计算的检验的基础上，编制了更为复杂的办法，导致产生了诸如成本效益临界值等手段，以及拥有或者少数（25 个以下）或者大量（100 个以上）类似企业的情况的行业和国家成本计算方式。这就导致保证了成本的效益，根据执行委员会的政策确定供资活动的轻重缓急，以及保持第 5 条国家之间的融资平等。

5. 第 53/37(i)号决定的授权表明执行委员会可以期待现有的手段和方式将扩大适用于氟氯烃。因此，作为第一步，需要考虑满足哪些条件后才能将这些手段和方式扩大到能够提供合适的成本计算基准/范围，并能够对这些基准的可靠性进行评估。进行分析时，采用了以下一些基本原则：

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2 UNEP/OzL.Pro/ExCom/53/60。

3 请执行委员会成员在 2008 年 1 月 15 日前就编制氟氯烃淘汰管理计划的准则草案中将要考虑的基本组成部分、秘书处应考虑的费用问题、资金申请资格的截止日期、以及第二阶段改造等问题向秘书处提供意见。

(a) 本文件中对扩展现有政策适用范围的任何假设，都应避免阻止执行委员会关于这一问题的政策讨论；

(b) UNEP/zL.Pro/ExCom/54/54 号文件不含有对执行委员会没有讨论过的政策决定的任何假定；

(c) 资格问题，例如是否资助第二次改造或资助某一截至日期后建立的制造能力的问题，未被视为本文件任务的一部分。同样，对方案管理的手段，例如原拟用于确定项目的轻重缓急的成本效益临界值，未作详细的审查；以及

(d) 应避免在本文件的任务和缔约方会议关于执行蒙特利尔议定书的多边基金2009－2011年资金补充的研究的职权范围的第XIX/10号决定之间产生冲突。

6. 泡沫塑料行业现拥有一部分实践经验，特别是在作为HCFC-141b主要用途的整皮硬泡沫的应用方面。在这一次级行业里，多边基金项目中已使用的技术，可用于氟氯烃的淘汰，而其他更新的技术所具有的技术特性类似于氟氯化碳和氟氯烃的技术特性。与HCFC-22有关的用途的情况不同，既没有关于制冷和空调行业替代品的信息，也没有关于挤塑聚苯乙烯泡沫塑料中使用的氟氯烃的信息。

7. 本文件的主要内容有：

(a) 关于资助氟氯烃淘汰的政策的概览，以及关于第5条国家氟氯烃使用情况的概览。辅助的材料还有附件一：蒙特利尔议定书缔约方和执行委员会所通过的关于氟氯烃淘汰问题的有关政策和决定，以及附件二：关于第5条国家氟氯烃消费情况的概览；

(b) 对泡沫塑料行业淘汰氟氯烃消费的增支成本的分析，辅助文件附件三载有对与泡沫塑料行业相关的技术和成本问题的详细分析；

(c) 对制冷行业淘汰氟氯烃消费的增支成本的分析，辅助文件附件四载有对与制冷行业包括维修行业相关的技术和成本问题的详细分析（此附件将与本文件分开印发）；

(d) 环境问题，特别是在多边基金内落实XIX/6第号决定的必要步骤；

(e) 联合供资的奖励措施和机会；以及

(f) 建议。

8. 编制本文件时考虑了所收到的执行委员会成员根据第53/37(l)号决定所提供的意见。

一.3 可用于资助氟氯烃淘汰的现有政策

9. 对多边基金项目增支成本的评价依据的是蒙特利尔议定书缔约方在其第二次会议上

商定的一般性原则。[4] 在这些原则以及增支成本类别提示性清单的基础上，执行委员会拟订了关于不同行业应用中的增支成本类别的具体政策和准则。

10. 多边基金项目的供资基于对符合资格的增支资本和业务费用评估。资本费用与通过企业所选择以替代技术替代消耗臭氧层物质所需辅助设备、技术转让、培训、试运行和投产有关。增支经营费用或结余（增支经营费用）反映改换成消耗臭氧层物质替代品造成费用的改变，制造流程使用化学品带来的改变，例如推进剂、制冷剂或发泡剂。影响增支经营费用多少的因素是原料价格波动和支付这些费用的期限。根据执行委员会的决定，多边基金项目增支经营费用的期限在各行业中各不相同，从制造压缩机或汽车空调装置的零年（没有增支经营费用）到气雾剂和软质块状泡沫塑料制造企业的 4 年不等（见附件一）。[5]

11. 如果资助消耗臭氧层物质淘汰的现行政策和标准保持不变，淘汰氟氯烃投资项目的符合资格的增支成本将继续以对增支资本和业务费用的评估为基础。本文件所作分析的目的是分析这些成本部分对于多边基金供资义务的影响。

12. 执行委员会为资助拥有制造设施的低消费量国家[6] 项目商定了特殊的供资备选办法，执行委员会的做法是为不适用成本效益阈值[7] 的投资项目确定一种特殊的供资窗口。对于中小型企业淘汰消耗臭氧层物质，准则提供了供资窗口，以便为非低消费量国家气雾剂和泡沫塑料行业的重要小企业群进行改造提供便利。执行委员会是否愿意在氟氯烃问题上继续类似的做法，属于执行委员会需要进一步审议的问题。

13. 由于各类氟氯烃[8] 属于《蒙特利尔议定书》下的管制物质，因此，缔约方自 1993 年 11 月其第五次会议、执行委员会自 1994 年 3 月其第十二次会议以来，均作出了具体决定解决这些消耗臭氧层物质的淘汰。对氟氯烃淘汰尤其重要的是执行委员会作出的要求各执行机构对问什么建议改造使用氟氯烃的技术的原因提供全面的解释，包括对可能采用的非氟氯烃技术进行分析。此外，必须指明，有关企业已同意承担嗣后转换为非氟氯烃技术的费用。根据执行委员会所作这些决定而由执行机构多年来提供的关于替代技术的资料，还为本文件所审议的对可能采取的技术的审查提供了信息。

14. 执行委员会第五十三次会议审议了资助淘汰氟氯烃的框架，并决定，除非另有决定，特别是根据第 XIX/6 号决定作出决定（第 53/37 号决定 d 段），多边基金现行政策和准则

4 第 II/8 号决定附录 1（财务机制）。

5 已选择氟氯烃技术淘汰第 5 条国家所使用氟氯化碳的行业的增支业务费用的期限载于本文件的附件一。

6 低消费量国家是指氟氯化碳基准消费量为 360 ODP 吨的国家。截至 2008 年 3 月，有 102 个第 5 条国家被分类为低消费量国家。

7 执行委员会第十六次会议通过了适用于不同行业的成本效益阈值，作为确定投资项目轻重缓急的途径。成本效益值的计算是根据总的增支资本分业务费用与所淘汰以 ODP 公斤计算的消耗臭氧层物质总量的比。本文件附件一载有关于执行委员会通过的成本效益和阈值的补充资料。

8 本文件附件一按年代顺序载有蒙特利尔缔约方和执行委员会通过的所有关于氟氯烃的决定。

将适用于氟氯烃淘汰的资助。因此，本讨论文件是在上述以及本文件附件一所说明的政策和准则的背景下编制。

一.4 氟氯烃用途概览

15. 第 5 条国家 2006 年氟氯烃 396,100 公吨的总消费量，超出了报告各类氟氯化碳最高数量的 1995 年 189,830 公吨氟氯化碳消费量的两倍多。 然而，氟氯烃对臭氧层的全面消极影响（即总共 35,160 ODP 吨），低于氟氯化碳的影响（187,730 ODP 吨），原因是其消耗臭氧潜能值低。

16. 2006 年第 5 条国家氟氯烃的消费情况分别为：

(a) HCFC-141b、HCFC-142b 和 HCFC-22[9]/ 的消费量占全部氟氯烃消费量的 99％以上；

(b) 71 个国家的氟氯烃消费量低于 360 公吨。29 个其他国家[10]/ 或者报告零消费量，或者没有报告任何消费；

(c) 43 个第 5 条国家[11]/ 使用 HCFC-141b，其中 20 个国家的消费量低于 10 ODP 吨（91 公吨），而只有 21 个[12]/ 第 5 条国家使用 HCFC-142b，其中 18 个国家的消费量低于 10 ODP 吨（154 公吨）；

(d) 在报告了 HCFC-22 消费量的 117 个的 5 条国家[13]/ 中，73 个国家[14]/ 的消费量低于 10 ODP 吨（182 公吨）；以及

(e) 氟氯烃主要是用于旨在泡沫塑料产品（氟氯烃消费总量的 32.5％），及用于制冷制造和维修次级行业（66.2％）。少量的亦用于气雾剂（0.2％）、灭火器（0.1％）和溶剂（1.0％）行业。[15]/

17. 数据显示了拥有氟氯烃消费量高的少数国家及第 5 条国家有大量中小型企业。根据对受资助各单项泡沫塑料项目的分析，氟氯化碳转氟氯烃技术所有泡沫塑料企业中超过 80％的企业是位于不超过 12 个第 5 条国家里，这一情况便证明了上述结论。同样，据估计，第 5 条国家所有泡沫塑料企业中 70％以上每年氟氯化碳的消费量低于 40 ODP 吨。

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9 HCFC-141b 的 ODP 值是 0.11，HCFC-142b 的 ODP 值是 0.065，HCFC-22 的 ODP 值是 0.055。

10 29 个国家中有 27 个现被分类为低消费量国家。

11 包括大韩民国、新加坡和阿拉伯联合酋长国消费的 1,028.7 ODP 吨（9,352 公吨）。

12 包括大韩民国和新加坡消费的 126.7 ODP 吨（1,949 公吨）。

13 另有 16 个第 5 条国家报告了 2005 年 HCFC-22 的消费量。分析不包括大韩民国、新加坡和阿拉伯联合酋长国。

14 包括大韩民国、新加坡和阿拉伯联合酋长国消费的 1,213.9 ODP 吨（22,071 公吨）。

15 开发计划署进行的 12 个经挑选的第 5 条国家的氟氯烃调查（UNEP/OzL.Pro/ExCom/51/Inf. 2）。

二. 淘汰泡沫塑料行业氟氯烃消费的增支成本

18. 在多边基金的帮助下，第 5 条国家淘汰了超过 89,370 ODP 吨用作泡沫塑料发泡剂的各类氟氯化碳。这其中包括软硬聚氨酯泡沫塑料中使用的 CFC-11 以及挤塑聚乙烯和聚苯乙烯泡沫塑料中使用的 CFC-12。第 5 条国家选择了永久性技术淘汰整皮硬泡沫塑料次级行业中使用的 CFC-11，包括水性体系、为能够利用易燃物质安全操作发泡机器的企业选择了碳氢化合物（戊烷），以及氟氯烃作为过渡技术。用作替代发泡剂的氟氯烃约占所有被淘汰氟氯烃的 40％。利用永久性改造技术[16]/ 淘汰了其他泡沫塑料次级行业所使用的 CFC-11 和 CFC-12。

19. 在大多数非第 5 条国家，发展了使用各类氢氟碳化物（主要是 HFC-245fa、HFC-365mfc 及其混合物 HFC-365mfc/HFC227ea）、甲酸甲酯的泡沫发泡技术和其他较少使用的技术，以替代与第 5 条国家一样最初作为过渡性氟氯化碳淘汰技术的各类氟氯烃。虽然由于没有需求这些技术仅限于第 5 条国家，但也可在第 5 条国家利用这些技术淘汰作为发泡剂的各类氟氯烃。

二.1 淘汰各类氟氯烃的费用范围

20. 同淘汰泡沫塑料用途中的各类氟氯化碳类似，由氟氯烃转变为无消耗臭氧层物质技术的增值资本费用 取决于企业的现有基准设备；所制造泡沫塑料产品的类型和生产数量；所选择替代发泡剂；以及企业的所在地，在几种情况下，企业所在地可能对决定是否选择使用易燃性物质的重要啊因素。

<u>增支资本费用的范围</u>

21. 根据第 53/37(i)号决定的要求，对于相对于氟氯烃替代品在泡沫塑料用途的成本基准/范围进行了两次平行的增支资本费用估算。一次估算根据的是对现有设备的改造，另一次估算根据的是取代现有而设备采用以下替代技术：碳氢化合物（既有戊烷也有环戊烷）、HFC-245fa 以及甲酸甲酯。以下说明解释了进行两次平行估算的原因。

22. 由氟氯烃转为氢氟碳化物、水性体系或甲酸甲酯技术：

(a) 根据现有政策，所有为在多边基金协助下更新生产设备以便临时使用氟氯烃发泡剂的硬质聚氨酯整皮泡沫塑料企业，都不需要额外的资本费用，除非替代发泡剂的具体性能产生与某些基准设备不相符的问题。[17]/ 例如，在基准储

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16 用于生产挤塑聚乙烯和聚苯乙烯泡沫塑料薄膜的 CFC-12 主要是被丁烷和液化石油气淘汰。软质块状聚氨酯泡沫塑料次级企业中的 CFC-11 被二氯甲烷和液化二氧化碳淘汰，而用于模塑聚氨酯泡沫塑料的 CFC-11 被水性体系淘汰。

17 作为资助多边基金项目的一项要求，转用氟氯烃技术的企业必须与其政府一道作出在多边基金不再给

存罐不适用于安全处理 HFC-245fa 时，新罐的费用将符合增支资本费用的定义。改造或替代任何现有设备或安装由氟氯烃转变为无消耗臭氧层物质替代品的额外设备的必要性，都必须具备技术性理由并作出充分的示范。与技术转让、培训、试运行和投产有关的费用需要确保替代技术适合当地的条件；

(b) 上文(a)小段的同样条件，将适用于那些通过用高压分送器取代低压分送器或在多边基金没有提供援助的情况下已改造高压分送器将其设备进行了改造以便使用氟氯烃的企业，因为这些企业同得到多边基金帮助的企业一样有着相同的基准。同样，相同的条件将适用于建立了高压分送器的新设备的那些企业。将需要技术转让、培训、试运行和投产方面的援助；以及

(c) 只有仍在用手搅拌设备加工 HCFC-141b 泡沫塑料以及 1995 年 7 月 25 日现有符合资格截至日期之后可能安装、或者在实施多边基金措施期间不符合供资资格的低压分送器，才可能需要改造和替代现有基准设备以及技术转让、培训、试运行和投产的资本费用。但供资的模式将取决于执行委员会可能决定的关于资格的规则。因此，对设备取代备选办法的费用基准作出了估计，以便考虑到此种最终情况。

23. 整皮聚氨酯硬泡沫塑料企业向戊烷的转换技术与其他现有技术相比，将涉及很大的资本费用。这些技术将需适合使用碳氢化合物发泡剂、新型多元醇预混合器、碳氢化合物储存系统的高压分送器以及处理易燃物质的安全设备。还需要让当地工人适应碳氢化合物储存系统和车间的改造。某些情况下还需要搬迁工厂。

24. 下文表二.1 是各种泡沫塑料应用的增支资本费用范围的概览。计算费用所参考的企业，只有一台基准泡沫塑料分送器和辅助设备，生产硬塑料的氟氯烃消费量为 5、25 或 75 公吨（或 0.6、2.8 或 8.3 ODP 吨），或生产整皮泡沫的氟氯烃为 10 或 30 公吨（或 1.1 或 3.3 ODP 吨）。这些消费量代表着典型的小型、中型和大型的作业。这一范围内的最低费用的计算，依据的是对所有需要的设备项目的改装，而最高费用的计算依据的是以新设备替换老设备的费用，并且代表的是绝对数额。由于预计要使泡沫塑料配方产生最好效果需要开展更多活动，因此试运行的费用有可能高于转向 HCFC-141b 的情况，作为资本费用组成部分的技术转让、培训和试运行的费用便估计得高于由氟氯化碳向氟氯烃的过渡。

25. 通过计算显示，除了向碳氢化合物技术的转换外，在所有情况下，改造费用大大低于替换备选办法的费用。就向碳氢化合物技术的转换所提看法是，改造的费用和替换现有分送器的费用之间差别为最小。HFC-365mfc 和甲酸甲酯的增支资本费用类似 HFC-245fa 的增支资本费用，但取得储存罐可能例外。

与援助的情况下淘汰剩余的 ODP 的承诺。多边基金几乎所有关于使用 HCFC-141b 的理由都确认，最后的转变不需要对设备进行新的投资。

表二.1：泡沫塑料应用中的增支资本费用范围概览（美元）

泡沫塑料应用	HFC-245fa/HFC-365mfc/甲酸甲酯		水基体系		戊烷	
	低	高	低	高	低	高
仪表、套管、管中管、注塑机、家用以及商业制冷						
改造	20,000	60,000	15,000	55,000	375,000	710,000
替换	135,000	250,000	130,000	245,000	405,000	780,000
喷涂泡沫塑料 (*)						
改造	15,000	55,000	15,000	55,000		
替换	50,000	110,000	60,000	110,000		
不再继续的隔热用（垫箱用）泡沫塑料 (**)						
改造	15,000	55,000	15,000	40,000		
替换	85,000	140,000	65,000	95,000		
整皮泡沫塑料						
改造	40,000	70,000	75,000	125,000	265,000	405,000

(*) 戊烷的易燃性令其现场的应用无法让人接受。
(**) 垫箱操作使戊烷用途十分危险。

增支经营费用范围

26. 氟氯烃转型无消耗臭氧层物质技术的增支经营费用数量主要取决于新配方的性质以及这些配方所使用化学品的相对价格。相关情况下与泡沫密度增加相关的费用，以及水发整皮泡沫中使用的模内涂覆化学品，都可能增加经营费用的数量。对于碳氢化合物技术来说，由于安装其他新设备而造成的辅助保养和能源使用费，以及由于使用易燃物质造成的附加保险费，也会增加增支经营费用。

27. 泡沫塑料配方中发泡剂、多元醇和异氰酸酯（二苯基甲烷二异氰酸酯）等主要化学品成分的比例和价格，是决定增支经营费用数量的主要因素。这些成分的价格在第 5 条国家里差别很大，下文表二.2 进一步显示了这些差别。根据淘汰各类氟氯化碳的经验，这种情况可能会导致某一企业增支经营费用大幅增加，但根据某些或全部成分的价格以及改造前后的差别，这种情况会给同一类型的另一企业生产同样数量的泡沫塑料带来结余。

表二.2： 泡沫塑料配方所使用化学品的时价

化学品	价格：美元/公斤	
	低	高
HCFC-141b	1.40	3.50
二苯基甲烷二异氰酸酯	1.50	3.50
戊烷	0.50	2.50
环戊烷	0.80	3.30
HFC-245fa	10.40	12.00
甲酸甲酯	2.20	3.20

28. 泡沫塑料密度增加，因额外泡沫塑料材料成分而造成费用增加。泡沫塑料密度增加对增支经营费用有重大影响，某些情况下使增支经营总费用增加 50％甚至更多。[18]/ 利用泡沫塑料密度增加程度计算增支经营费用，是基于由使用 CFC-11 转变为使用 HCFC-141b，需要对之进行重新检查以了解 HCFC-141b 淘汰的情况。但现有的资料看来显示，泡沫塑料密度的增加在由氟氯烃转向氢氟碳化物和甲酸甲酯替代品方面不会是一个问题。

29. 计算了以下替代技术的增支经营费用的范围：水性体系、碳氢化合物（戊烷和环戊烷）、HFC-245fa 和甲酸甲酯。这一计算依据的是：泡沫塑料配方中主要化学品成分的比例、其价格 [19]/，以及相关的影响已知增支经营费用数量的因素。为确保连续性和准确性，根据核准项目对计算进行了核对。

表二.3：泡沫塑料用途淘汰每公吨 HCFC-141b 的年度增支经营费用范围概览（美元/公斤）[20]/

发泡剂	硬泡沫塑料		整皮泡沫塑料	
	低	高	低	高
HFC-245fa	2.50	6.40	2.50	6.40
甲酸甲酯	(0.30)	(1.90)	(0.30)	(1.90)
水性体系	0.85	1.75	3.55	12.78
戊烷	0.50	1.60	1.59	3.55
环戊烷	0.65	2.00		

18 与不同泡沫塑料用途相关的泡沫塑料密度增加的程度已经执行委员会第三十一次会议核准（第 31/44 号决定），以便今后再次审议这一问题和视必要作修订。

19 HCFC-141b、戊烷和二苯基甲烷二异氰酸酯的价格是基于 2000 至 2006 年项目完成情况报告的价格范围与某些第 5 条国家通过双边和执行机构提供的最新价格的比较。HFC-245fa 和甲酸甲酯价格基于制造商所提供价格。全球散装货箱（罐箱）加工表报告显示 HFC-245fa 的价格较低，而估计小包装价格稍高，相差在 5％。

20 因 HCFC-22 通常较 HCFC-141b 便宜，淘汰 HCFC-22 的相关增支经营费用可能较表中估计数高。

30. 为显示企业一级增支经营费用的范围，对两年内 HCFC-141b 的消费量为 5 公吨（0.6 ODP 吨）、25 公吨（2.8 ODP 吨）和 75 公吨（8.3 ODP 吨）的硬泡沫塑料企业运用了上表所示平均增支费用，两年是硬泡沫塑料行业经营成本的现时计算期。下文的表二.4 列出了带来的指示性增支经营费用：

表二.4： 企业一级两年内计算的增支经营总费用（美元）

技术	企业消费量（吨）					
	5.0 公（0.6 ODP）		25.0 公（2.8 ODP）		75.0 公（8.3 ODP）	
	低	高	低	高	低	高
HFC-245fa (50%)	21,750	33,060	108,750	165,300	326,250	495,900
HFC-245fa (75%)	47,850	55,680	239,250	278,400	717,750	835,200
水性体系	7,395	15,225	36,975	76,125	110,925	228,375
甲酸甲酯	(2,610)	(16,530)	(13,050)	(82,650)	(39,150)	(247,950)
戊烷	4,350	13,920	21,750	69,600	65,250	208,800
环戊烷	5,655	17,400	28,275	87,000	84,825	261,000

31. 分析增支经营费用时，提出了以下看法：

(a) 泡沫塑料配方中用水取代某些数量的 HFC-245fa，可较大较低增支经营费用。但这取决于如何在节省成本和泡沫塑料制造商所要求的泡沫塑料隔热性能之间作出权衡；

(b) 甲酸甲酯的使用导致整皮和硬泡沫塑料企业增支经营的结余，原因是相对价格低和使用的少[21]/；

(c) 对于转用戊烷技术的硬泡沫塑料用途，尽管发泡剂较其他发泡剂的价格低和由其所取代的大约一半的 HCFC-141b 的使用率较低，但整个转变仍导致增支经营费用增加很多。原因是泡沫塑料密度的增加，以及根据多边基金项目的增支经营费用的计算办法，还需要额外的保养、保险和能源费用；以及

(d) HFC-245fa 和水性体系、特别是为提高泡沫塑料质量满足市场要求使用模内涂覆的整皮泡沫塑料中的 HFC-245fa 和水性体系，造成的增支经营费用最多。

32. 由于增支经营费用是淘汰氟氯烃整个费用中的一部分，应重点解决与其计算相关的问题（即期限、化学品价格和加强结构、泡沫塑料的密度以及其他因素）。在淘汰氟氯烃的过程中，配方的性质，特别是氢氟碳化物和甲酸甲酯，将在决定企业的增支经营费用的适当水平方面发挥重要作用。因此，项目编制的处理方式可能需要有所不同，并在初期就应让系统的供应者尽早参与。

21 价格在戊烷的同一范围内，一份 HCFC-141b 被 0.5 份的甲酸甲脂取代。

二.2 对器皿和非器皿泡沫塑料用途的特殊考虑

33. 根据多边基金的做法，为淘汰作发泡剂用途的 CFC-11 的供资传统上是在泡沫塑料行业下进行，这是针对其成本效益临界值为 7.83 美元/公斤的制造硬聚氨酯泡沫塑料（即所说的非器皿泡沫塑料）的企业来说的。但对于制造家用和商业制冷设备的企业（即所说的器皿泡沫塑料）来说，供资是在制冷行业内处理，家用制冷的次级行业成本效益临界值为 13.76 美元/公斤，商业制冷为 15.21 美元/公斤。

34. 家用和商业制冷行业内的大量多边基金项目已将泡沫塑料隔热转向 HCFC-141b 技术，而制冷剂部分转向了无氟氯烃替代品。因此，应在泡沫塑料行业下处理目前由 HCFC-141b 转向采用无消耗臭氧层物质替代品的下一阶段。执行委员会似需要考虑是否以类似的方式为器皿泡沫塑料和非器皿泡沫塑料用途提供资金。

二.3 第 5 条国家转向使用 HCFC-142b

35. 1990 年代初以来，HCFC-142b 和 HCFC-22 在非第 5 条国家广泛用作氟氯化碳发泡剂的替代品，特别是在挤塑聚苯乙烯泡沫塑料保温板以及建筑行业。这些大多数国家已淘汰此种氟氯烃[22]/。

36. 目前，多边基金淘汰 HCFC-142b/HCFC-22 的现有经验十分有限，而且只是在挤塑聚苯乙烯泡沫塑料薄膜和网方面有此种经验。但过去的几年里，中国隔热材料市场的大力发展和稍小程度上少数第 5 条国家的发展，正在推动挤塑聚苯乙烯企业迅速采用氟氯烃技术[23]/。需要对有关的第 5 条国家泡沫塑料这一较小的部门作进一步的研究以便澄清有关的技术和费用问题。

二.4 系统内的企业积极参与氟氯烃的淘汰

37. 在整皮硬泡沫塑料企业生产中，大多数企业依赖与发泡剂作商业用途预先混合的多元醇以及各公司提供的所谓的系统内的企业的其他重要成分（预混多元醇）。在氟氯化碳淘汰的第一阶段，系统内的企业在 HCFC-141b 向第 5 条国家的市场渗透方面发挥重要的作用。[24]/ 为生产适合的无氟氯化碳预混多元醇的和为其客户（即下游泡沫塑料企业）提供技

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22 所选择主要技术是：HFC-134a、HFC-152a、二氧化碳（或二氧化碳/酒精）以及异丁烷。但加拿大和美国的淘汰较困难，原因是具体产品的要求，特别是家居行业。因此，预期这两个国家 2010 年后还会继续使用 HCFC-142b 和 HCFC-22。

23 2001 年评估（硬质泡沫塑料和软质塑料泡沫技术选择委员会 2006 年评估报告）以来，仅这一行业每年就有 20,000 公吨的新消费量。

24 包括 4 个国家的 290 家侧重于当地土著系统内的企业的中小型企业的 11 个集体项目获得核准，费用总额为 720 万美元。将系统内的企业例如其中的直接影响是淘汰超过 1,300 ODP 吨的 CFC-11。

术转让和培训的少数系统内的企业核准了资金。

38. 由于现有的氢氟碳化物有限，并由于某些区域使用 HFC-245fa 等较新技术时可能遇到的处理和加工问题，第 5 条国家由氟氯烃转向无消耗臭氧层物质技术可能是一种挑战。为了环节这种问题，似可鼓励或支持第 5 条国家的系统内的企业在项目编制之前，探讨为当地市场以及可能的话氟氯烃消费量不会影响系统内的企业运作的邻国制订或完善适合的配方。

39. 通过与当地系统内的企业和泡沫塑料工业合作解决的其他重要流域有：

(a) 较低依靠昂贵发泡剂（即 HFC-245fa 或 HCF-356mfc）的泡沫塑料配方的费用，为非常计较成本因素的用途提供一种有竞争力的隔热产品（例如使用与碳氢化合物的混合物或与发泡时同时使用水）；

(b) 研发并引进使用碳氢化合物的预混多元醇，从而可以让第 5 条国家尽快摆脱氟氯烃；以及

(c) 向选择使用氢氟碳化物技术的企业提供培训和技术援助，确保这些企业从事生产活动的方式给全球环境带来最小的风险，例如在泡沫塑料生产期间限制氢氟碳化物的排放。

40. 与有关系统内的企业相关的示范项目，有可能是促进优化系统和向当地工业引进淘汰技术的办法之一。

三. 淘汰制冷行业氟氯烃消费的增支费用

41. 目前，HCFC-22 是第 5 条国家制冷和空调行业使用的最主要物质。2006 年，123 个第 5 条国家报告称，制冷和空调行业制造新设备（主要是空调机和少量商用冰箱）和维修现有设备消费了 12,375 ODP 吨（225,000 公吨）的 HCFC-22。[25]/ 制冷行业还有一些其他氟氯烃，特别是冷风机使用的 HCFC-123，以及作为无须改造设备的 CFC-12 替代制冷剂的 HCFC-124 和 HCFC-142b。由于看来第 5 条国家没有这些制冷剂产品方面的专门制造能力，同时由于与 HCFC-22 相比所使用的数量很小，本文件未对这些氟氯烃作进一步的研究。

三.1 行业和次级行业

42. 在空调方面，60 多年来 HCFC-22 一直是最主要的制冷剂，是小型、中型和大型空调系统首选的制冷剂，大型空调系统不包括中央冷风机。看来，几乎全世界的小型家居空

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25 据估计，在生产聚苯乙烯泡沫塑料方面，与 HCFC-142b 一道作为发泡剂使用的 HCFC-22 的额外消费量为 300 ODP 吨（5,500 公吨）。

调系统的制造能力都集中在少数第 5 条国家（不到 15 个）。为了本文件的目的，秘书处确定了以下各次级行业：室内和分体式空调，其中包括家居产品；中型管道和整体式商用空调，例如大型商业建筑屋顶使用的空气空气式系统；以及用于工业空调和若干加工降温用途的功能在 500 千瓦以下的 HCFC-22 冷风机。空调行业内主要的式拥有集中制造能力的大型工业。

43. 商业企业使用的最多样的产品范围和所有各类的制冷设备，都属于商用制冷商用制冷这一次级行业里，上述产品和设备都不明确地属于另外的次级行业。产品大多数、但并非全部用于制冷和冰冻货物的零售、展览和销售。其他用途包括水冷却机和肉类和乳制品的储藏室。由于用途广泛和需要满足各种具体需要，导致工业界出现很少大型、但中小型却很多的定制程度高的产品的企业。在这方面，商用制冷行业和维修行业的某些部分的区分变得模糊了。商用制冷系统有可能是各个大型消费国家、也可能式在大多数消费消费国家中制造。行业使用 HCFC-22 主要是受 CFC-12 淘汰的驱使，其次是由于维修承包商和小型公司拥有进行空调维修的的 HCFC-22 基础设施。如果它们在安装商用制冷和进行灌充以及维修时使用相同的制冷剂，它们便可将操作大为简化。

三.2 替代品

44. 不同的行业都拥有一些替代的制冷剂。从技术上说，制冷中的降温有很多可能性。本文件所侧重的是那些现时的发展水平和应用的领域显示，在中期内它们有可能成为第 5 条国家取代 HCFC-22 的替代品。这些替代品主要是氢氟碳化物制冷剂、碳氢化合物和氨。关于替代技术的详细说明载于附件四。

45. 氢氟碳化物是一般特性类似于氟氯化碳和氟氯烃的制冷剂；从淘汰 CFC-12 时使用 HFC-134a 的过程中，人们了解了这些技术的一些重要方面。第 5 条国家最广泛使用的 HCFC-22 替代品都较 HCFC-22 具有更高的全球暖化影响（全球变暖潜值）。只有 HFC-134a 的全球变暖潜值低于 HCFC-22，可用于某些、特别是较小功能的用途。对第 5 条国家来说，看来这些用途涵盖了有可能符合供资条件的很大一部分设备。HFC-134a 迄今未被用于替代 HCFC-22，因此，没有费用方面的数据。研究了用若干氢氟碳化物取代具体用途中的 HCFC-22，非第 5 条国家和第 5 条国家都成功而广泛地予以使用。有些氢氟碳化物，特别是 HFC-410A 所拥有的特性，由于作用压力的要求高，需要对设备的设计、部件的制造和维修设备做很大的改动。对于现有的一些氢氟碳化物和碳氢化合物的混合物来说，很多情况下可以让 HCFC-22 设备转向使用无消耗臭氧层物质的替代品而无须对设备进行改造。

46. 碳氢化合物和氨是全球变暖潜值低的制冷剂，多年来一直在使用。它们都有安全方面的挑战。碳氢化合物的易燃性很高，氨易燃有毒。虽然人们很了解安全处理这些制冷剂的必要技术，但上述特点导致改装过程中的增支资本费用较高，同时对相关设备的使用带来限制：

(a) 碳氢化合物，特别是异丁烷、丙烷和丙烷，同氨一样都是极好的制冷剂。其

易燃性需要在制造和维修的过程中进行安全处理，也限制了对每一设备灌充碳氢化合物的数量，对生产设施的所在地（必须在居民区以外）和所安装设备（完全通风、大量灌充时必须断绝公众的接近）作出了限制规定。 碳氢化合物已成功地用于制冷器中，已成为得到成分肯定和广泛使用的技术，同时也成功地用于小型空调和小型商用制冷中；以及

(b) 氨技术过去用于大型的制冷车间，特别是与食品加工和化学工业相关的制冷车间，也用于大型的冷风机。安装和维修氨制冷设备所需专门技术有别于氟氯化碳/氟氯烃/氢氟碳化物技术。氨现用于一些第 5 条国家，主要是因为历史的原因，但在以往没有用过的国家难以推行。

47. 现有能源效益资料显示，大多数有关用途都有氢氟碳化物和全球变暖潜值低的制冷剂，它们都能导致 HCFC-22 设备所提供的同样或更好的能源效益。在某些情况下，这种情况可能需要重新设计压缩机或使用优化的压缩机，两种情况都会导致费用有所增加，因此，在不久的将来，只能在逐案的基础上才可实施。

48. 很可能在氟氯烃淘汰的初期，上述替代品成为所有的可能选择。据报道，不易燃和低毒的全球变暖潜值低的制冷剂方面已出现新的发展，但目前还不清楚何时能够上市以及是否能够最终商业化。过去 20 年一直在研发能够将二氧化碳用作替代制冷剂，目前已用于示范性试运行。还不清楚是否以及在何种情况下二氧化碳能够大规模使用，原因是二氧化碳具有与其他制冷剂根本不同的设计、部件以及特别是维修特点。

三.3 维修行业的具体挑战

49. 维修行业为在所有或几乎所有第 5 条国家都是 HCFC-22 的消费者。凡使用空调设备的，都利用 HCFC-22 对设备进行维修。尽管很多空调装置不需要很多修理，但其数量很多而且越来越多，将带来对维修很大的整体寻求。商用制冷使用 HCFC-22 也进一步增加了维修需求。CFC-12 的淘汰让人们了解了维修行业的结构。在淘汰氟氯化碳的努力中，这一行业的活动被分为一组，特别是作为制冷剂管理计划和最终淘汰管理计划的一部分，与立法和执行许可证和配额制度相关的活动分在一组。因此，本章也提供了关于这方面的概览。

50. 大量第 5 条国家的氟氯烃的消费量很可能全部是在维修行业（这一行业包括商用制冷设备的安装和灌充次级行业)。对于氟氯化碳的淘汰而言，大多数国家里至少某些制造（例如软泡沫塑料）是使用氟氯化碳技术，问题解决后可借以支持有关国家履行其团体义务。就氟氯烃而言，与上述情况正相反，很多第 5 条国家可能就没有这种备选办法。出于几个原因，无法在逐个企业的基础上解决和监测维修行业。因此，多边基金的氟氯化碳淘汰一直主要依靠通过许可证和配额制度对供应实行限制，与此同时，并确保维修行业能够通过良好做法的培训和提供工具和设备，应付日益减少的氟氯化碳供应。与此同时，多边基金对维修行业的支助让各国政府能够相信，供应方面的条例不会导致给制冷设备的维修带来大的问题。迄今，这种做法的结果一般地说是好低。氟氯烃淘汰的新挑战是，供应方面的

管理必须在淘汰时间表的早期开始，并持续进行一个较长的时间。

51. 维修行业对 HCFC-22 的寻求与第 5 条国家空调设备进口 HCFC-22 有关联。为了便利维修行业今后消费的减少，看来应该在国家一级考虑是否可以在初期就限制 HCFC-22 设备、特别是空调机的进口。这样做将对提出资助改造特别是 HCFC-22 空调机制造设备的时机产生影响。需要在一开始就改造这些设备，使之能够为其他第 5 条国家供应无氟氯烃的空调设备。

52. 为使低消费量国家能够就进口管制作出决定，对这些国家的维修行业应给与足够的支持，以便尽量减少氟氯烃消费，确保适当处理替代品。因此，或许应该考虑在 2010 年甚至更早便资助主要消费量在维修行业的国家的维修次级行业和相关行业（安装、灌充和最终用户）的氟氯烃淘汰活动，以便为遵守 2015 年 10%削减步骤提供便利。对这些措施的确切性质和数量仍需根据制冷剂管理计划和最终淘汰管理计划的经验进行讨论。然而，看来最终淘汰管理计划的某些主要组成部分，即：立法和执法支助，技术员设备和教育的更新以及对执行情况的监测，都将继续发挥重要的作用。这些组成部分通常与为最终淘汰管理计划申请的资金的大头有关。

三.4 费用因素

53. 为了树立对与制冷行业氟氯烃淘汰有关的可能费用的了解，征询了拥有第 5 条国家经验的专家对于掌握对各行业和次级行业的结构的意见。作为下一步，已作出努力为每一次级行业确定一两个典型的寻求改造的使用氟氯烃的企业。借助淘汰氟氯化碳的经验以及专家的服务、价格表和其他现有数据，已经能够对各种替代品的增支资本费用和增支经营费用的范围作出估计。这一做法是建筑在对期待或更新有用寿命期间的现有设备的假设和氟氯化碳淘汰项目期间的做法之上。由于几个次级行业没有确定增支经营费用的支付期限的准则，所有增支经营费用的期限都标准地定为一年，以便于迅速估算增支经营费用各长短期限的影响。附件四载有不同次级行业的替代技术、这些次级行业的说明以及计算指示性费用范围造成的增支费用的条件和结果。

54. 使用“典型”企业确定增支资本费用的方式限制了估算每一企业改造费用的不确定性，这是因为，资本费用项目仅在不同规模的作业之间呈现差异。但由于一直不知道某一行业内企业的数目和确切的产品范围，在可见的将来，仍无法用推算法赖确定全部行业的改造费用。应该指出的是，就氟氯化碳的淘汰而言，资本费用，而且甚至是与增支经营费用有关项目（压缩机、油、制冷剂）的费用，都会随着时间的推移而减少，并显示不同市场的重大的差别。

55. 不同模式企业的费用计算导致出现表三.1 所示结果。经营费用作为年度费用列出。如果执行委员会作出例如 4 年期限的决定，表中所示增支经营费用的值将相应增加。已就某些次级行业的氟氯化碳淘汰作出有关的决定，但特别是在制冷和空调行业，迄今都还没有作出这种决定。

56. 对增支经营费用所作计算显示，增支经营费在增支费用中所占比例常常大于通常氟氯化碳淘汰项目所占比例。应该指出的是，由于增支经营费用是多边基金下唯一现金形式的支助，因而提供了重要的奖励。例如，如果一个改造项目能够在集中不同的技术中间作出选择，那么，经济上最无法持续的技术，即单位费用增加最高的备选办法，就有可能有与之相关的最高增支经营费用。

表三.1 制冷行业有选择的项目表格的增支资本费用和增支经营费用预测

行业/次级行业和设备类型	年度生产（装置/年）	增支资本费用（美元）		增支经营费用（美元）	增支资本费用（美元）		增支经营费用（美元）	增支资本费用（美元）		增支经营费用（美元）
		最高	最低	年度	最高	最低	年度	最高	最低	年度
空调		R410A			R407C			R290		
室内和分体式空调	250,000	275,000	950,000	2,660,000	190,000	250,000	4,250,000	545,000	670,000	4,512,000
商用管道和整体式空	1,000	245,000	145,000	36,600	120,000	80,000	28,500	暂缺	暂缺	暂缺
调**	100									
冷风机	200	300,000	85,000	待定	暂缺	暂缺	暂缺	暂缺	暂缺	暂缺
商用制冷		R404A			R134a			R290		
单独项目：商用冰柜	1,000	35,000	35,000	15,000	35,000	35,000	11,000			
单独项目:自动售货机	10,000							500,000	800,000	150,000
冷凝装置	1,000	25,000	30,000	26,000	35,000	35,000	20,000			

四. 环境问题

四.1 环境影响指标

57. 第 XIX/6 号决定呼吁各缔约方“促进选择能将环境影响较低到最低点和照顾到各项健康、安全和经济因素的氟氯烃的替代品。”这就提出了评价一系列相应环境影响的迫在眉睫的挑战，将通过使用不同的环境指标对其中大多数挑战进行评估和以不同的术语加以衡量。

58. 可用于氟氯烃淘汰的指标包括：

(a) 多边基金作为指标使用的消耗臭氧潜能值；

(b) 所选择替代化学品的全球变暖潜值[26]；

(c) 替代品排放对气候的影响；能源消费造成的与使用替代品的设备的性能有关

26 全球升温潜能值是用以估算温室气体造成多大程度的全球升温的一种办法。这种相对比例是将有关气体与同样数量的、其全球升温潜能值根据定义等于 1 的二氧化碳加以比较。

的影响；以及/或其他环境影响，例如健康和安全相关问题，以及易分解有机化合物的排放；以及

(d) 以上一项或几项的结合。采取这种做法的实例有变暖影响总当量（TEWI[27]/）以及最近的寿命周期气候性能（LCCP[28]）。

59. 选择适当指标及其值的进程，如果假定属于多边基金的通常程序的话，那么，将由受益者和执行机构共同进行。这就有可能给落实工作带来挑战，因此，需要在执行委员会有此意愿时做进一步的研究。

四.2 指标的应用

60. 一旦确定了适合的指标，执行委员会可能需要解决如何运用指标的问题。蒙特利尔议定书参照某一临界值，利用消耗臭氧潜能值的指标对多边基金的项目加以优化，高于这一临界值的项目得到较低的供资优先考虑。（即首先淘汰消耗臭氧潜能值最高的消耗臭氧层物质）。

61. 指标的应用需要灵活，以便顾及几乎所有使用全球变暖潜值高于其打算取代的氟氯烃的氟化气体（氢氟碳化物）的现有替代技术。第 XIX/6 号决定的授权似可解释为作为最低限度，必须避免由于氟氯烃的淘汰而造成的气候影响。与此同时，还需承认，第 5 条国家氟氯烃用户的最普遍情况是，某些氟化替代品完全适合其情况和/或用途，而全球变暖潜值较低的其他替代品则不然。但除了碳氢化合物和甲酸甲酯外，几乎所有替代品物质的全球变暖潜值都是已知的，在政府间气候变化问题小组或科学评估小组作出决定前，短期内碳氢化合物和甲酸甲酯可被视为 25 的缺省(现时被理解为碳氢化合物备选办法中的首选)。

62. 可通过根据所资助的产品组合为每一项目确定的功能单元计算法，计算能源效益的惠益和不利的因素。但要运用这种做法，就必须对个别企业的产品组合作出明确的说明，并相对稳定。计算也须考虑所使用能源的碳密度，而各个国家的碳密度都会有所不同。可在氟氯烃淘汰管理计划范畴内对这些变数进行评价，作为有关国家不同备选办法之间的比较。嗣后的计算有可能为不同的费用设想提供理由。一种可能是，所作技术选择的能源效益以及对气候惠益的更全面的计算十分复杂，范围非常广泛，无法进行评估与核实。

63. 在计算多边基金项目的增支费用时，考虑了健康和安全的问题，并提供了资金。例如，将为那些用二氯甲烷替代 CFC-11 的软质泡沫塑料企业提供改进的通风系统。还向选择了碳氢化合物技术替代各类氟氯化碳的企业提供碳氢化合物感应器、防爆机器、紧急通风和警报系统方面的资金。淘汰氟氯烃时可继续使用这种做法。

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27 寿命周期气候性能是全球暖化效应以及驱动为空调系统所生成能源的二氧化碳排放的总值。

28 寿命周期评估说明某一产品由最初到最终其与环境之间的相互作用。寿命周期评估包括两个主要步骤，即：说明产品寿命期内将有哪种排放以及使用了哪种原材料；评估这些排放和原材料耗损的影响。

四.3 奖励措施

64. 对某些用途而言，为实现环境惠益而不是为着保护臭氧层，可能需要多受益者提供奖励措施。多边基金的一项原则一直是，为淘汰消耗臭氧层物质和让使用者能够在公认的成本效益阈值内决定其技术选择而对增支费用提供资助。

65. 过去，执行委员会确定了若干概念以确保这项原则得到遵守，与此同时，向使用者提供奖励以决定具体的行动方式。例如，就制冷制造次级行业来说，选择碳氢化合物作为氟氯化碳替代技术的项目，将其成本效益阈值提高了 30%。对于打算采用碳氢化合物技术取代氟氯烃的大量中小型企业，可考虑采取类似的奖励做法。如果对满足了某些条件的项目专门订有不同数额的资金，则可探讨供资窗口的概念。

66. 一种可能是，某些情况下，选择一种比较复杂、因而更昂贵的淘汰氟氯烃的技术，可能会比其他技术给气候带来更多的好处。例如，对改造空调系统的氟氯烃压缩机进行技术更新，可能导致研究出能够让最终用户大幅降低能源消耗的高效压缩机。这些额外的好处有可能较有关资金的增加带来的好处更大。

67. 谨提议执行委员会首先就全球变暖潜值等直接衡量环境惠益的规范考虑气候惠益，然后在整体的氟氯烃淘汰管理计划范围内考虑各项能源效益措施。

四.4 其他因素

68. 多边基金资助的项目有可能带来不仅与臭氧层有关、而且与气候变化有关的环境惠益。特别是通过碳融资，可利用其中一些惠益产生与减少排放相关的可转让许可证。由于这样做会造成重复供资，因此，谨提议执行委员会考虑可行办法对此加以限制。

五. 奖励措施和联合筹资的机会

69. 在编制这一初步讨论文件时，秘书长被要求对财政奖励措施和联合供资的机会加以考虑，而根据议定书缔约方第 XIX/6 号决定第 11(b)段，财政奖励措施和联合供资可能与确保氟氯烃的淘汰带来好处有关。

70. 多边基金所有项目都是作为对第 5 条国家受益企业和机构的赠款获得核准，如冷风机的情况一样，少数项目需要联合供资。赠款数额的确定，依据的是对符合资格的增支费用所作的分析。与项目有关的其他不符合资格的增支开支或非增支开支，很多情况下由受益企业支付。由企业支付的非增支费用的实例有：与超出基准水平的车间改造、能力提高或技术更新有关的建筑费用。这些都是可被视为多边基金项目的受益者联合供资的实例[29]/。

29 根据其他供资机制，这些费用被视为“对应供资”或“联合供资”。

秘书处未对这些非增支费用进行评估和记录，因此，由于需要汇编，目前还无法提供有份量的资料。

71. 在制冷维修行业，作为制冷剂管理计划、最终淘汰管理计划和国家淘汰计划的一部分，制订了各项奖励方案，特别是对最终用户行业，在这方面，向受益最终用户提供了部分资金，使其将使用消耗臭氧层物质的制冷系统改造为使用替代制冷剂。

72. 执行委员会第四十五次会议决定设立中央冷风机替换用途供资窗口。嗣后，秘书处在 46/37、47/20 和 47/21 号文件中对主要问题和相关经验作了分析。有关的一些结论也与本文件的任务有关。替换冷风机用途供资窗口的设立是建筑在这样的谅解之上，即：用使用替代技术的冷风机替换老的使用氟氯化碳的冷风机会带来多重的好处。

73. 第四十七和第四十八次会议核准了冷风机项目，但有一项谅解，即：只有落实了联合供资后才发放资金。根据联合供资，冷风机项目将分成三组：设备所有者的联合供资；环境基金的联合供资；以及或者通过碳市场或者通过试图减少其电耗负荷的电力公司的联合供资。联合供资来自所有者的项目在执行委员会核准项目后的几个月内便首先得到了实施。项目核准大约 18 个月起，全球环境基金（全环基金）或其他环境基金提供的较多数目的资金便开始到位，但还没有完全确立。国际金融机制的资金尽管取得了很大进展，但迄今仍然没有到位。国际金融机制需要建立和接受受益模式以及复杂的筹资机制。电力公司的资金的情况相同。

74. 对实现 2013 年和 2015 年履约目标所需取得的进展进行评估表明，心态在 2009 至 2014 年之间编制和执行项目，以便实现必要的消费量的减少。经验表明，如果项目是与所有者以外的来源的联合供资挂钩，项目的执行就有可能发上重大的拖延。在审议那些旨在支持各国实现 2013 年和 2015 年履约目标的项目的联合供资时，需要考虑这一时限。

75. 因此，动员联合供资所需的漫长筹备时间将意味着，执行委员会在不久的将来需要对一些相关问题进行审议，最好是在今后大约 12 个月内。这就涉及到有必要确定执行委员会在吸引联合供资时所要追求的目标，并确定联合供资项目的初步框架。之所以需要这两个方面，是让潜在的联合供资实体能对合作的可能性有所了解，并让这些实体能够针对多边基金资助的实现氟氯烃淘汰的项目的可能资金需要，及时调整自己的现金流动规划。

六. 建议

76. 本文件认为，对以下一些主要问题需要给与优先的考虑，这些问题是确定淘汰氟氯烃供资数额以及为持续淘汰氟氯烃奠定基础的前提条件。谨提议执行委员会将这些项目列为其初步讨论中所审议的优先问题的一部分：

(a) 增支经营费用和影响决定增支经营费用的各项因素，包括支付增支经营费用的期限、化学品价格以及以可靠的方式确定其数额的方法；

(b) 替换制造设备以便在其有用寿命结束之前早早适应替代技术；

(c) 环境指标和潜在奖励措施以促进能够降低环境影响、特别是对气候的影响的氟氯烃替代品的选择。短期内可优先考虑淘汰消耗臭氧潜能值对高的氟氯烃的活动，以及可行时采用全球变暖潜值低、或具有能源效益等其他环境好处的替代品的活动；

(d) 其他问题：

（一） 第 XIX/6 号决定的未决问题，特别是新建立制造企业的停产日期和第二次改造的资格问题；以及

（二） 与联合供资有关的问题。

ANNEX I

POLICIES FOR FUNDING HCFC PHASE-OUT

1. The evaluation of the incremental costs of all Multilateral Fund project has been based on the general principles agreed by the Parties to the Montreal Protocol at their 2nd Meeting[1], namely:

- (a) The most cost-effective and efficient option should be chosen, taking into account the national industrial strategy of the recipient Party. It should be considered carefully to what extent the infrastructure at present used for production of the controlled substances could be put to alternative uses, thus resulting in decreased capital abandonment, and how to avoid deindustrialization and loss of export revenues;

- (b) Consideration of project proposals for funding should involve the careful scrutiny of cost items listed in an effort to ensure that there is no double-counting;

- (c) Savings or benefits that will be gained at both the strategic and project levels during the transition process should be taken into account on a case-by-case basis, according to criteria decided by the Parties and as elaborated in the guidelines of the Executive Committee; and

- (d) The funding of incremental costs is intended as an incentive for early adoption of ozone protecting technologies. In this respect the Executive Committee shall agree which time scales for payment of incremental costs are appropriate in each sector.

I.1 Categories of incremental costs

2. On the basis of these principles, the Executive Committee has developed specific policies and guidelines of categories of incremental costs in different industrial applications. The two main categories of incremental costs are capital costs and operating costs:

- (a) Capital costs are typically related to the additional equipment that would be needed to replace ODSs with the alternative technology selected by the enterprise, technology transfer, technical assistance, training, trials and commissioning. They also include safety equipment and modifications to the enterprise when the technology selected is based on flammable substances. The size of the capital costs depends on the installed production capacity of the enterprise, the equipment available before the conversion, the alternative technology selected, and the location of the enterprise. Throughout the years, as the number of investment projects increased, the actual prices of major pieces of equipment required for the conversion were well established and used in the majority of the projects.

- (b) Incremental operating costs reflect changes in costs attributable to the conversion

[1] Appendix 1 of decision II/8 (Financial Mechanism).

to CFC alternatives and arising from changes in starting materials and chemicals used in the production process such as additives, propellants and blowing agents. Fluctuations in raw material prices leading to changes in incremental operating costs occur frequently[2], and vary widely at the local and regional levels[3]. Typically enterprises respond to these changes by passing the increases to their customers in an orderly manner and as market conditions allow;

(c) The level of incremental operating costs is associated with their duration. According to decisions adopted by the Executive Committee, the duration for the application of incremental operating costs varies among sectors and sub-sectors[4], as follows:

(i) No operating costs for compressors;

(ii) For domestic refrigeration, ten per cent of incremental cost to be paid up-front, or six months of incremental operating costs calculated at current prices and paid up-front, or incremental operating costs for a duration of one year adjusted according to prevailing costs at the time of disbursement, when the modified plant was operating, which ever is greater;

(iii) Two years for commercial refrigerator, rigid and integral skin foam manufacturing plants; and

(iv) Four years for aerosol and flexible slabstock manufacturing plants.

I.2 Cost-effectiveness thresholds

3. In order to prioritize the approvals of investment projects, at its 16th Meeting in March 1995, the Executive Committee established cost-effectiveness threshold[5] values for different sectors and sub-sectors, as shown in Table I.1 below. The values were established on the basis of project proposals that were fully prepared and submitted by implementing agencies, as well as proposals that were partially developed where costs and amounts of ODS to be phased out were roughly estimated.

[2] For example, the price of HCFC-141b dropped from US $5.45/kg in 1993 to US $3.40/kg in 1998, a reduction that is typical of pricing trends once a product is introduced, production is optimised, economies of scale increase and competition becomes established in the marketplace. Enterprises that received funding in 1993 when the price of HCFC-141b was at US $5.45/kg were overcompensated for the incremental operating costs that they actually incurred (UNEP/OzL.Pro/ExCom/36/34).
[3] According to the progress report on the implementation of the 2007 country programme submitted to the Fund Secretariat by Article 5 countries the 2006 price of HCFC-22 ranged from less than US $1.00 to US $30.00 per kilogram.
[4] These are the sectors where HCFC technologies were chosen for phasing-out the use of CFCs in Article 5 countries.
[5] The cost-effectiveness value is calculated as the ratio between the sum of the total incremental capital and operating costs and the total amount of ODS to be phased in kilograms ODP.

Table I.1. Sectoral cost-effectiveness threshold values established by the Executive Committee

Sector	Subsector	CE (US$/kg ODP)
Aerosol	Hydrocarbon	4.40
Foam	General	9.53
	Flexible polyurethane	6.23
	Integral skin	16.86
	Polystyrene/polyethylene	8.22
	Rigid polyurethane	7.83
Halon	General	1.48
Refrigeration	Domestic	13.76
	Commercial	15.21
Solvent	CFC-113	19.73
	TCA	38.50

4. While adopting the threshold values, the Executive Committee recognized that the conversion from CFCs to hydrocarbon technology of domestic refrigerators manufacturing enterprises would require additional funding for the provision of safety equipment and agreed that when calculating the cost of domestic refrigeration projects the safety related costs be discounted in a way that ensures parity with other options[6].

5. The Committee also recognized the special situation of low-volume consuming (LVC) countries and decided to reserve US $6,630,000 for allocation to projects from these countries in addition to any funds received as a result of approval of projects from LVC countries that qualified under the cost effectiveness threshold values.

I.3 Small and medium-sized enterprises (SMEs)

6. Special consideration has been given by the Executive Committee to the phase-out of ODSs by small and medium-sized enterprises SMEs since its 22nd Meeting in May 1997, when it constituted a contact group to address issues related to SMEs.

7. Subsequently, at its 25th Meeting, the Executive Committee allocated US $10 million from the resource allocation for 1999 for a funding window designed to facilitate pilot conversions of significant groups of small firms in the aerosol and foam sectors from non-LVC countries. The maximum allowable levels of consumption per enterprise were 25 ODP tonnes/year for flexible and extruded polyethylene/polystyrene foams and 10 ODP tonnes/year for flexible integral skin and rigid polyurethane foams. It was also decided that group projects should: be at a level of US $1 million or less; have an overall cost-effectiveness of no more than 150 per cent of the level of the current cost-effectiveness threshold values; use the most cost-effective technologies reasonably available; and consider the possible use of centralized use of equipment and industrial rationalization. These projects should be submitted with a Government

[6] The cost effectiveness threshold value for domestic refrigeration projects was adjusted at the 20th Meeting by discounting the numerator by 35 per cent which was sufficient to maintain parity between HCFC 141b/HFC 134a and cyclopentane/HFC 134a technology options in the domestic refrigeration sector (decision 20/45).

plan including policies and regulations designed to ensure that the specific level of agreed reduction to be achieved was sustained (decision 25/56).

I.4 Policies on HCFCs

8. As HCFCs are controlled substances under the Montreal Protocol, specific decisions addressing the phase-out of these ODSs have been taken by the Parties since their 5th Meeting in November 1993, and the Executive Committee since its 12th Meeting in March 1994. As reference, all relevant decisions adopted by the Parties to the Montreal Protocol and the Executive Committee regarding HCFCs are presented below in chronological order of adoption.

<u>Fifth Meeting of the Parties (November 1993)</u>

9. The Fifth Meeting of the Parties decided (decision V/8) that each Party is requested, as far as possible and as appropriate, to give consideration in selecting alternatives and substitutes, bearing in mind, *inter alia*, Article 2F, paragraph 7, of the Copenhagen Amendment regarding hydrochlorofluorocarbons, to:

(a) Environmental aspects;

(b) Human health and safety aspects;

(c) The technical feasibility, the commercial availability and performance;

(d) Economic aspects, including cost comparisons among different technology options taking into account:

(i) All interim steps leading to final ODS elimination;

(ii) Social costs;

(iii) Dislocation costs; and

(e) Country-specific circumstances and due local expertise.

<u>Twelfth Meeting of the Executive Committee (March 1994)</u>

10. The Twelfth Meeting of the Executive Committee adopted the following recommendations on the use of transitional substances as substitutes for ozone depleting substances:

(a) In view of the ongoing review requested of the Technology and Economic Assessment Panel by the Parties to the Montreal Protocol, the paper on The Use of Transitional Substances as Substitutes for Ozone Depleting Substances (UNEP/OzL.Pro/ExCom/12/34) may not be considered as a policy guideline but as a possible input to the work of the Open-ended Working Group of the Parties to the Montreal Protocol.

(b) Meanwhile, consideration of the use of HCFC in the Multilateral Fund projects should be sector-specific and approved for use only in areas where more environment-friendly and viable alternative technologies are not available.

Fifteenth Meeting of the Executive Committee (December 1994)

11. The Fifteenth Meeting of the Executive Committee stated that, whenever possible, HCFCs should not be used. It further requested that the applicability of HCFCs in commercial refrigeration projects should be examined by an expert group, possibly the OORG, which should prepare a report for submission to the Executive Committee.

12. The Executive Committee also requested Implementing Agencies to take the following issue into consideration when preparing projects for domestic refrigerator insulation foam conversion:

(a) As HCFCs were not controlled substances for Article 5 countries, incremental costs for conversion of HCFC-141b plants were not eligible for funding;

(b) Implementing Agencies should note a presumption against HCFCs when preparing projects; and

(c) Where HCFC projects were proposed, the choice of this technology should be fully justified and include an estimate of the potential future costs of second-stage conversion.

Nineteenth Meeting of the Executive Committee (May 1996)

13. The Executive Committee, noting the recommendation of the Sub-Committee (UNEP/OzL.Pro/ExCom/19/5, para. 12), decided (decision 19/2):

(a) To take note of decision VII/3 of the Seventh Meeting of the Parties to control HCFCs and to note further that projects involving conversion to HCFCs should be considered in the light of that decision, as well as other relevant factors;

(b) That in the future, in cases where conversion to HCFCs was recommended, the Implementing Agencies should be requested to provide a full explanation of the reasons why such conversion was recommended, together with supporting documentation that the criteria laid down by the Executive Committee for transitional substances had been met, and should make it clear that the enterprises concerned had agreed to bear the cost of subsequent conversion to non-HCFC substances; and

(c) To request the Secretariat to prepare for examination by the Executive Committee at its Twentieth Meeting a paper on:

(i) The historical background to HCFC conversion projects;

(ii) What information on alternatives to HCFCs had been provided by the

Implementing Agencies to the applicant countries, and how that information had been received and acted upon; and

(iii) The justifications given for the choice of one technology over another.

Twentieth Meeting of the Executive Committee (October 1996)

14. The Twentieth Meeting of the Executive Committee, decided (decision 20/48 (b, c)):

(a) To request the Implementing Agencies to ensure that adequate information on all alternative technologies was provided to enterprises converting from CFCs;

(b) To reaffirm paragraph (b) of its decision 19/2 which stated that, in cases where conversion to HCFCs was recommended, the Implementing Agencies should be requested to provide a full explanation of the reasons why such conversion was recommended, together with supporting documentation that the criteria laid down by the Executive Committee for transitional substances had been met, and should make it clear that the enterprises concerned had agreed to bear the cost of subsequent conversion to non-HCFC substances.

Eighth Meeting of the Parties (November 1996)

15. The Eighth Meeting of the Parties decided (decision VIII/13):

(a) That UNEP distribute to the Parties of the Montreal Protocol a list containing the HCFCs applications which have been identified by the Technology and Economic Assessment Panel, after having taken into account the following:

(i) The heading should read "Possible Applications of HCFCs";

(ii) The list should include a chapeau stating that the list is intended to facilitate collection of data on HCFC consumption, and does not imply that HCFCs are needed for the listed applications;

(iii) The use as fire extinguishers should be added to the list;

(iv) The use as aerosols, as propellant, solvent or main component, should be included, following the same structure as for other applications;

(b) That the Technology and Economic Assessment Panel and its Technical Options Committee be requested to prepare, for the Ninth Meeting of the Parties, a list of available alternatives to each of the HCFC applications which are mentioned in the now available list.

Twenty-third Meeting of the Executive Committee (November 1997)

16. The Twenty-third Meeting of the Executive Committee decided (decision 23/2):

(a) To request the Fund Secretariat to produce a paper containing figures on an analysis of what projects were being submitted for funding using HCFC technologies, to see whether there existed any trend towards or away from HCFC use in specific sectors, particularly the foam sector;

(b) To request the Secretariat to incorporate the following elements in the project evaluation sheets and, in the case of (i) below, in the list of projects and activities presented to the Committee for approval:

(i) Information on the conversion technology to be used;

(ii) A comprehensive outline of the reasons for selection of the HCFC technology, if used; and, where possible,

(iii) An indication of how long an enterprise intended to use a transitional HCFC technology.

Twenty-sixth Meeting of the Executive Committee (November 1998)

17. The Twenty-sixth Meeting of the Executive Committee decided (decision 26/26):

(a) That the full information provided in the project document should be included in the project evaluation sheet;

(b) That where, upon review by the Fund Secretariat, a project proposal requesting HCFC technology was considered to provide inadequate information justifying the choice of that technology, the project should be submitted for individual consideration by the Sub-Committee on Project Review.

Twenty-seventh Meeting of the Executive Committee(March 1999)

18. The Executive Committee at its Twenty-seventh Meeting (decision 27/13) expressed its appreciation for the increased information/justification provided for the selection of HCFCs and noted that that was the level of information originally expected, and that at least that level was expected in the future; stressed to the Implementing Agencies that it considered this to be more than a paper exercise, and urged the Agencies to take seriously the obligations related to providing information on alternatives available; and decided, in recognition of Article 2F of the Montreal Protocol, to request that Implementing Agencies provide, for all future projects or groups of projects for HCFCs from any country, a letter from the Government concerned. In the letter, the country should:

(a) Verify that it had reviewed the specific situations involved with the project(s) as well as its HCFC commitments under Article 2F;

(b) State if it had nonetheless determined that, at the present time, the projects needed to use HCFCs for an interim period;

(c) State that it understood that no funding would be available for the future conversion from HCFCs for these companies.

Twenty-eighth Meeting of the Executive Committee (July 1999)

19. The Twenty-eighth Meeting of the Executive Committee decided (decision 28/28) that information on a possible study comparing costs of alternative technologies and the impact on their choice of support from the Multilateral Fund should be the subject of a separate agenda item for its Twenty-ninth Meeting, for consideration by the Executive Committee itself.

Eleventh Meeting of the Parties (December 1999)

20. The Eleventh Meeting of the Parties decided (decision XI/28) to request the Technology and Economic Assessment Panel to study and report by 30 April 2003 at the latest on the problems and options of Article 5 Parties in obtaining HCFCs in the light of the freeze on the production of HCFCs in non-Article 5 Parties in the year 2004. This report should analyze whether HCFCs are available to Article 5 Parties in sufficient quantity and quality and at affordable prices, taking into account the 15 per cent allowance to meet the basic domestic needs of the Article 5 Parties and the surplus quantities available from the consumption limit allowed to the non-Article 5 Parties. The Parties, at their Fifteenth Meeting in the year 2003, shall consider this report for the purpose of addressing problems, if any, brought out by the report of the Technology and Economic Assessment Panel.

Thirtieth Meeting of the Executive Committee (March 2000)

21. The Thirtieth Meeting of the Executive Committee decided (decision 30/1) to establish an open-ended contact group, with Sweden as convener, in order to consider the question of policy on HCFC use as an interim technology and that the outcome of the group's work would be discussed under "Other matters".

Thirty-fourth Meeting of the Executive Committee (July 2001)

22. The Thirty-fourth Meeting of the Executive Committee decided (decision 34/51) to request the Secretariat, in relation to all future projects which involved conversion to HCFC-141b, to include in the meeting documentation the letter from the Government concerned, explaining the reasons for the choice of the technology, as per Decisions 23/20 and 27/13.

Thirty-sixth Meeting of the Executive Committee (March 2002)

23. The Thirty-sixth Meeting of the Executive Committee decided (decision 36/56):

(a) To take note with appreciation of the paper submitted by France;

(b) To request the Multilateral Fund Secretariat to update document UNEP/OzL.Pro/ExCom/36/34 with new costs for various options and to investigate the availability of non-ODS pre-blended polyol, and to submit the updated document and its findings for the consideration of the 39th Meeting;

(c) To request Implementing Agencies to amplify the relevant enterprise information pursuant to Decision 20/48 with data concerning import restrictions into non-Article 5 countries and the cost situation for alternatives, and to inform the enterprises that they should acknowledge having received that information. The corresponding documentation should accompany the project proposal;

(d) To request the Secretariat to send to the National Ozone Unit of the recipient country, a letter recalling that HCFC-141b projects would be excluded from funding in the future (no second conversion), with copies to the Ministries of the Environment and Foreign Affairs;

(e) That the annual Executive Committee report to the Meeting of the Parties should state by country the amount of HCFC-141b consumption phased in through projects using HCFC as replacements, a consumption which would - in application of Decision 27/13 - be excluded from funding at future stages.

Thirty-eighth Meeting of the Executive Committee (November 2002)

24. The Thirty-eighth Meeting of the Executive Committee decided (decision 38/38) for projects to phase-out CFCs by conversion to HCFC technologies, Governments had officially endorsed the choice of technology and it had been clearly explained to them that no further resources could be requested from the Multilateral Fund for funding any future replacement for the transitional HCFC technology that had been selected.

Fourteenth Meeting of the Parties (November 2002)

25. The Fourteenth Meeting of the Parties (decision XIV/10), noting that the Intergovernmental Panel on Climate Change and the Technology and Economic Assessment Panel are invited by the Convention on Climate Change to develop a balanced scientific, technical and policy-relevant special report as outlined in their responses to a request by the Subsidiary Body for Scientific and Technological Advice of the Convention on Climate Change (UNFCCC/SBSTA/2002/MISC.23), decided to request the Technology and Economic Assessment Panel to work with the Intergovernmental Panel on Climate Change in preparing the report mentioned above and to address all areas in one single integrated report to be finalized by early 2005. The report should be completed in time to be submitted to the Open-ended Working Group for consideration in so far as it relates to actions to address ozone depletion and the Subsidiary Body for Scientific and Technological Advice of the Convention on Climate Change simultaneously.

Fifteenth Meeting of the Parties (November 2003)

26. The Fifteenth Meeting of the Parties decided:

(a) That the Parties to the Beijing Amendment will determine their obligations to ban the import and export of controlled substances in group I of Annex C (hydrochlorofluorocarbons) with respect to States and regional economic organizations that are not parties to the Beijing Amendment by January 1 2004 in accordance with the following:

(i) The term “State not party to this Protocol” in Article 4, paragraph 9 does not apply to those States operating under Article 5, paragraph 1, of the Protocol until January 1, 2016 when, in accordance with the Copenhagen and Beijing Amendments, hydrochlorofluorocarbon production and consumption control measures will be in effect for States that operate under Article 5, paragraph 1, of the Protocol;

(ii) The term “State not party to this Protocol” includes all other States and regional economic integration organizations that have not agreed to be bound by the Copenhagen and Beijing Amendments;

(iii) Recognizing, however, the practical difficulties imposed by the timing associated with the adoption of the foregoing interpretation of the term “State not party to this Protocol,” paragraph 1 (b) shall apply unless such a State has by 31 March 2004:

(i) notified the Secretariat that it intends to ratify, accede or accept the Beijing Amendment as soon as possible;
(ii) certified that it is in full compliance with Articles 2, 2A to 2G and Article 4 of the Protocol, as amended by the Copenhagen Amendment;
(iii) submitted data on (i) and (ii) above to the Secretariat, to be updated on 31 March 2005, in which case that State shall fall outside the definition of “State not party to this Protocol” until the conclusion of the Seventeenth Meeting of the Parties;

(b) That the Secretariat shall transmit data received under paragraph 1 (c) above to the Implementation Committee and the Parties;

(c) That the Parties shall consider the implementation and operation of the foregoing decision at the Sixteenth Meeting of the Parties, in particular taking into account any comments on the data submitted by States by 31 March 2004 under paragraph 1 (c) above that the Implementation Committee may make.

Forty-second Meeting of the Executive Committee (April 2004)

27. The Forty-second Meeting of the Executive Committee decided (decision 42/7):

(a) To request the Government of Germany to take into account the views expressed on the eligibility of funding HCFC phase-out management studies by the Multilateral Fund at the 42nd Meeting of the Executive Committee, in the informal group meeting and, in addition, further submissions of additional ideas and opinions sent by e-mail to GTZ-Proklima, as the German bilateral Implementing Agency, provided that they were received 10 weeks prior to the 43rd Meeting of the Executive Committee; and

(b) Also to request the Government of Germany to circulate to the Executive Committee, through the United Kingdom delegation, a policy paper on the issues of the responsibility of the Multilateral Fund and potential eligibility requirements for such a study and to reformulate the project proposal for submission and consideration at the 43rd Meeting of the Executive Committee on that basis.

Forty-third Meeting of the Executive Committee (July 2004)

28. The Forty-third Meeting of the Executive Committee decided (decision 43/19):

(a) To note that:

(i) The May 2003 Technology and Economic Assessment Panel's HCFC Task Force Report predicted a dramatic increase in HCFC consumption in China in the foreseeable future;

(ii) The intent of the proposed project was also to allow utilization of its results for all Article 5 countries; and

(iii) Established Executive Committee policies did not support conversion of capacity installed after July 1995 nor a second conversion and the study was therefore not aiming at preparing or initiating any conversion projects;

(b) To approve the project "Development of a suitable strategy for the long-term management of HCFCs, in particular HCFC-22, in China", addressed in documents UNEP/Ozl.Pro/ExCom/43/21 and UNEP/OzL.Pro/ExCom/43/51, at the level of funding of US $300,300 plus support costs for the Government of Germany of US $39,039 on an exceptional basis on the condition that, as one of the outcomes, a study would look into the effects of management of HCFCs in China and in other Article 5 countries; and

(c) To further note that:

(i) A schedule for the study, indicating a project duration of 21 months, had been submitted to the Fund Secretariat. Both the Government of Germany and the Government of China would strive to adhere to that schedule;

(ii) The Government of China intended to use relevant outcomes of the study as a basis for subsequent national action by the Government and expected that such action would take place within three years after finalization of the study; and

(iii) Interested Executive Committee members and Implementing Agencies would be invited to participate in an informal advisory group, which might discuss survey methodologies, the evaluation of information gathered, and policies.

<u>Nineteenth Meeting of the Parties (September 2007)</u>

29. The Nineteenth Meeting of the Parties agree (decision XIX/6) to accelerate the phase out of production and consumption of hydrochlorofluorocarbons (HCFCs), by way of an adjustment in accordance with paragraph 9 of Article 2 of the Montreal Protocol and as contained in annex III to the report of the Nineteenth Meeting of the Parties, on the basis of the following:

(a) For Parties operating under paragraph 1 of Article 5 of the Protocol (Article 5 Parties), to choose as the baseline the average of the 2009 and 2010 levels of, respectively, consumption and production; and

(b) To freeze, at that baseline level, consumption and production in 2013;

(i) For Parties operating under Article 2 of the Protocol (Article 2 Parties) to have completed the accelerated phase out of production and consumption in 2020, on the basis of the following reduction steps:

(ii) By 2010 of 75 per cent;

(iii) By 2015 of 90 per cent;

(iv) While allowing 0.5 per cent for servicing the period 2020–2030;

(c) For Article 5 Parties to have completed the accelerated phase out of production and consumption in 2030, on the basis of the following reduction steps:

(i) By 2015 of 10 per cent;

(ii) By 2020 of 35 per cent;

(iii) By 2025 of 67.5 per cent;

(iv) While allowing for servicing an annual average of 2.5per cent during the period 2030–2040;

(d) To agree that the funding available through the Multilateral Fund for the Implementation of the Montreal Protocol in the upcoming replenishments shall be stable and sufficient to meet all agreed incremental costs to enable Article 5 Parties to comply with the accelerated phase out schedule both for production and consumption sectors as set out above, and based on that understanding, to also direct the Executive Committee of the Multilateral Fund to make the necessary changes to the eligibility criteria related to the post-1995 facilities and second conversions;

(e) To direct the Executive Committee, in providing technical and financial assistance, to pay particular attention to Article 5 Parties with low volume and very low volume consumption of HCFCs;

(f) To direct the Executive Committee to assist Parties in preparing their phase-out management plans for an accelerated HCFC phase-out;

(g) To direct the Executive Committee, as a matter of priority, to assist Article 5 Parties in conducting surveys to improve reliability in establishing their baseline data on HCFCs;

(h) To encourage Parties to promote the selection of alternatives to HCFCs that minimize environmental impacts, in particular impacts on climate, as well as meeting other health, safety and economic considerations;

(i) To request Parties to report regularly on their implementation of paragraph 7 of Article 2F of the Protocol;

(j) To agree that the Executive Committee, when developing and applying funding criteria for projects and programmes, and taking into account paragraph 6, give priority to cost-effective projects and programmes which focus on, inter alia:

(i) Phasing-out first those HCFCs with higher ozone-depleting potential, taking into account national circumstances;

(ii) Substitutes and alternatives that minimize other impacts on the environment, including on the climate, taking into account global-warming potential, energy use and other relevant factors;

(iii) Small and medium size enterprises;

(k) To agree to address the possibilities or need for essential use exemptions, no later than 2015 where this relates to Article 2 Parties, and no later than 2020 where this relates to Article 5 Parties;

(l) To agree to review in 2015 the need for the 0.5 per cent for servicing provided for in paragraph 3, and to review in 2025 the need for the annual average of 2.5 per cent for servicing provided for in paragraph 4 (d);

(m) In order to satisfy basic domestic needs, to agree to allow for up to 10% of baseline levels until 2020, and, for the period after that, to consider no later than 2015 further reductions of production for basic domestic needs;

(n) In accelerating the HCFC phase out, to agree that Parties are to take every practicable step consistent with Multilateral Fund programmes, to ensure that the best available and environmentally-safe substitutes and related technologies are transferred from Article 2 Parties to Article 5 Parties under fair and most favourable conditions.

30. The Nineteenth Meeting of the Parties also decided (decision XIX/8):

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

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

<u>Fifty-third Meeting of the Executive Committee (November 2007)</u>

31. The Fifty-third Meeting of the Executive Committee decided (decision 53/37):

(a) That ratification of or accession to the Copenhagen Amendment was the prerequisite for an Article 5 Party to access Multilateral Fund funding for phasing out the consumption of HCFCs;

(b) That ratification of or accession to the Beijing Amendment was the prerequisite for an Article 5 Party to access Multilateral Fund funding for phasing out the production of HCFCs;

(c) That, in the case of a non-signatory country, the Executive Committee might consider providing funding for conducting an HCFC survey and the preparation of an accelerated HCFC phase-out management plan, with the commitment of the government to ratify or accede to the necessary Amendment and on the understanding that no further funding would be available until the Ozone Secretariat had confirmed that the government had ratified or acceded to that Amendment, through the deposit of its instrument in the Office of the United Nations Headquarters in New York;

(d) That the existing policies and guidelines of the Multilateral Fund for funding the phase-out of ODS other than HCFCs would be applicable to the funding of HCFC phase-out unless otherwise decided by the Executive Committee in light of, in particular, decision XIX/6 of the Nineteenth Meeting of the Parties;

(e) That institutions and capacities in Article 5 countries developed through Multilateral Fund assistance for the phase-out of ODS other than HCFCs should be used to economize the phase-out of HCFCs, as appropriate;

(f) That stable and sufficient assistance from the Multilateral Fund would be provided to guarantee the sustainability of such institutions and capacities when deemed necessary for the phase-out of HCFCs;

(g) That the production sector sub-group would be reconvened at the 55th Meeting to consider issues pertaining to the phase-out of HCFC production, taking into account decision XIX/6 of the Nineteenth Meeting of the Parties and the following issues, as well as further elaboration and analysis of those issues to be prepared by the Secretariat in consultation with technical experts:

(i) The continued applicability of the current approach to funding HCFC production phase-out being based on the assumption of plant closures;

(ii) The timing of funding HCFC production phase-out in view of the long duration between the HCFC freeze in 2013 and the final phase-out in 2030, taking into consideration that production and consumption phase-out could take place simultaneously;

(iii) The eligibility of the CFC/HCFC-22 swing plants in view of the commitment in the CFC production phase-out agreement not to seek funding again from the Multilateral Fund for closing down HCFC facilities that use the existing CFC infrastructure;

(iv) The cut-off date for funding eligibility of HCFC production phase-out;

(v) Other measures that could facilitate management of HCFC production phase-out; and

(vi) Other issues related to the HCFC production sector, taking in account subparagraph (g)(ii) above.

(h) That the Secretariat would work with the implementing agencies to examine the existing guidelines for country programmes and sector plans (decision taken at the 3rd Meeting of the Executive Committee and decision 38/65), and propose draft guidelines to the 54th Meeting for the preparation of HCFC phase-out management plans incorporating HCFC surveys, taking into consideration comments and views relating to such guidelines expressed by Executive Committee members at the 53rd Meeting and the submissions to the 54th Meeting referred to in paragraph (l) below, and that the Executive Committee would do its utmost to approve the guidelines at its 54th Meeting;

(i) That the Secretariat, in consultation with technical experts with knowledge of experiences in Article 5 countries with different levels of development and non-Article 5 countries, would prepare by 25 March 2008 a preliminary discussion document providing analysis on all relevant cost considerations surrounding the financing of HCFC phase-out, taking into account the views expressed by Executive Committee Members in the submissions referred to in paragraph (l) below, and including:

(i) Information on the cost benchmarks/ranges and applicability of HCFC substitute technologies; and

(ii) Consideration of substitute technologies, financial incentives and opportunities for co-financing which could be relevant for ensuring that the HCFC phase-out resulted in benefits in accordance with paragraph 11(b) of decision XIX/6 of the Nineteenth Meeting of the Parties;

(j) That the current classifications of low-volume-consuming (LVC) countries and small and medium-sized enterprises (SMEs) should be maintained until the cost-effectiveness thresholds of HCFC phase-out had been developed and the potential impact of those thresholds on LVC countries and SMEs had become better known. It would then be possible to review those classifications including a classification for very low-volume consuming countries, and current policies and funding arrangements targeting those countries and enterprises;

(k) To note that the following cut-off dates for funding HCFC phase-out had been proposed:

(i) 2000 (Cap of HCFC production/consumption in one major country);

(ii) 2003 (Clean Development Mechanism);

(iii) 2005 (proposal for accelerated phase-out of HCFCs);

(iv) 2007 (Nineteenth Meeting of the Parties);

(v) 2010 (end of the baseline for HCFCs);

(vi) Availability of substitutes;

(l) As a matter of priority, and taking into account paragraphs 5 and 8 of decision XIX/6 of the Nineteenth Meeting of the Parties, to invite Executive Committee Members to submit their views on the following issues to the Secretariat, by 15 January 2008, with the understanding that the Secretariat would make the submissions available to the 54th Meeting:

(i) Elements the Secretariat should consider in the draft guidelines for the preparation of national HCFC phase-out management plans;

(ii) Cost considerations to be taken into account by the Secretariat in preparing the discussion document referred to in paragraph (i) above;

(iii) Cut-off date for funding eligibility; and

(iv) Second-stage conversions;

(m) To approve 2008 expenditure of up to US $150,000 to cover the costs of consultations with technical experts and other stakeholders required for the preparation of the documents referred to in the present decision.

ANNEX II

OVERVIEW OF HCFCS USES

1. HCFCs have been used as early as 1936 when HCFC-22 was commercialized as a refrigerant. Production and consumption levels of HCFCs were substantially increased as a result of new applications particularly in the air conditioning sector as well as the Montreal Protocol, since several countries selected these substances as interim replacements of CFCs and other controlled substances.

2. As a consequence, global production of HCFCs reached 37,749 ODP tonnes (549,941 metric tonnes) in 2000 while the global consumption reached 38,219 ODP tonnes (546,996 metric tonnes) in the same year of which Article 5 countries accounted for 23 per cent. Since then, HCFC production and consumption levels have been reduced worldwide as a result of their phase-out in non-Article 5 countries.

3. However, against the global reduction trend, a substantial growth in HCFC production and consumption occurred in Article 5 countries[1] resulting in this group of countries accounting for nearly 80 per cent of the global production and over 75 per cent of the global consumption, as shown in Table II.1 below:

Table II.1 Levels of production and consumption of HCFCs (*)

	2000	2001	2002	2003	2004	2005	2006
HCFC production							
In ODP tonnes:							
Non-Article 5 countries	29,981	26,176	25,271	17,095	14,180	11,863	7,075
Article 5 countries	7,768	8,460	10,482	13,629	17,589	20,543	27,003
Total ODP tonnes production	37,749	34,635	35,753	30,724	31,769	32,406	34,078
In metric tonnes:							
Non-Article 5 countries	420,785	359,889	335,577	254,287	221,251	205,779	118,044
Article 5 countries	129,156	140,358	165,778	211,580	276,476	326,518	413,659
Total metric tonnes production	549,941	500,247	501,355	465,867	497,727	532,297	531,703
HCFC consumption							
In ODP tonnes:							
Non-Article 5 countries	25,219	23,360	22,333	14,865	10,975	10,278	7,120
Article 5 countries	13,000	12,435	13,403	15,826	19,783	21,536	28,040
Total ODP tonnes consumption	38,219	35,795	35,736	30,691	30,758	31,814	35,160
In metric tonnes:							
Non-Article 5 countries	347,741	321,823	291,318	225,013	185,019	182,326	122,107
Article 5 countries	199,255	191,854	201,023	230,354	287,407	329,104	396,099
Total metric tonnes consumption	546,996	513,677	492,341	455,367	472,426	511,430	518,206

(*) Data reported under Article 7 of the Montreal Protocol

[1] This category includes data from the Republic of Korea, Singapore and United Arab Emirates, representing countries that have so far not received assistance from the Multilateral Fund.

II.1 HCFCs consumption in Article 5 countries

4. Based on an analysis of HCFC data reported by Article 5 countries under Article 7 of the Montreal Protocol , it was noted that:

(a) HCFC-141b, HCFC-142b and HCFC-22 accounted for more than 99 per cent of the total amounts of HCFCs that were produced or consumed in 2006;

(b) Consumption of HCFC-22 represented 48.5 per cent of the total consumption of HCFCs in 2006, while consumption of HCFC-141b and HCFC-142b represented 43.5 and 7.2 per cent respectively of the total HCFC consumption;

(c) Seventy one countries reported a total HCFC consumption below 360 ODP tonnes in 2006 while 29 other countries either report zero consumption or not reported consumption (27 of these countries are currently classified as LVC countries);

(d) HCFC-142b increased significantly from 106.5 ODP tonnes (1,639 metric tonnes) in 2000 to 2,029.9 ODP tonnes (31,229 metric tonnes) in 2006. Consumption of HCFC-141b increased by 19 per cent while consumption of HCFC-22 increased by 8 per cent over the same period;

(e) In 2006, the total production and consumption of HCFCs by Republic of Korea, Singapore and United Arab Emirates amounted to 146.5 ODP tonnes (6,764 metric tonnes) and 1,016.2 ODP tonnes (33,372 metric tonnes) respectively. These three Article 5 countries have not received any assistance from the Multilateral Fund for phasing out their production and consumption of ODSs;

(f) For the purpose of comparison, the total consumption of CFCs reported by all Article 5 countries under Article 7 amounted to 189,830 metric tonnes in 1995, which represented the maximum amount ever reported. The total 2006 consumption of HCFCs in metric tonnes is more than two times the CFC consumption reported in 1995.

5. Consumption of HCFC-141b and HCFC-142b was reported only in 43 and 21 Article 5 countries respectively in 2006. Twenty[2] of the 43 countries reported consumption of HCFC-141b consumption below 10 ODP tonnes (91 metric tonnes). Similarly, 18[3] of 21 countries reported consumption of HCFC-142b below 10 ODP tonnes (154 metric tonnes). Thus, virtually three countries accounted for the entire HCFC-142b consumption of Article 5 countries in 2006. These levels of HCFC consumption point to a large number of SMEs among Article 5 countries with respect to HCFCs.

[2] Including 1,028.7 ODP tonnes (9,352 metric tonnes) consumed by Republic of Korea, Singapore and United Arab Emirates.
[3] Including 126.7 ODP tonnes (1,949 metric tonnes) consumed by Republic of Korea and Singapore.

6. Seventy three[4] of the 117 Article 5 countries that reported consumption of HCFC-22[5] in 2006 had consumption below 10 ODP tonnes (182 metric tonnes). It appears that the consumption of HCFC-22 in these countries is mainly for servicing refrigeration systems.

7. The number of countries by level of consumption and type of HCFC is presented in Table II.2 below.

Table II.2 Number of countries by level of HCFC consumption in 2006 (ODP tonnes)

HCFC	<10	>10 and <50	>50 <100	>100 < 1,000	>1,000	Total
HCFC-141b**	22	8	6	6	1	43
HCFC-142b**	18		1	1	1	21
HCFC-22(*)	73	20	7	16	1	117

(*) An additional 16 countries had reported HCFC-22 consumption in 2005.

II.3 Sectoral distribution of HCFCs

8. The only information on the sectoral uses of HCFCs in Article 5 countries available at the Fund Secretariat was that contained in the preliminary surveys on HCFCs undertaken by the Government of Germany for China[6] and UNDP for 12 selected Article 5 countries[7]. Some of the results of these surveys were the following:

(a) Excluding HCFC feedstock consumption, about 4,950 ODP tonnes of HCFC-22 were used in China in 2004 as refrigerant and 550 ODP tonnes as foaming agent and in the aerosol sector. The largest share of HCFC-22 consumption in China is for room air-conditioners, with a total production of 67.6 million units in 2005. During the next ten years, the use of HCFC-22 is likely to increase to about 16,500 ODP tonnes for domestic consumption, unless constrained by policy and technology improvements;

(b) The room air-conditioner and the expanded polystyrene foam sub-sectors in China are expected to grow at an annual rate of 7 per cent and 9 per cent, respectively;

(c) According to the surveys conducted by UNDP, the two main industrial sectors where HCFCs are currently consumed in Article 5 countries are the foam sector (32.5 per cent of the total consumption) and the refrigeration sector (66.2 per cent). The remaining consumption is in the aerosol (0.2 per cent), fire extinguisher (0.1 per cent) and solvent (1.0 per cent) sectors; and

(d) The breakdown of HCFC use by manufacturing versus servicing sectors in countries covered by UNDP's surveys are country dependent as shown below:

[4] Including 1,213.9 ODP tonnes (22,071 metric tonnes) consumed by Republic of Korea, Singapore and United Arab Emirates.
[5] An additional 16 countries Article 5 countries had reported HCFC-22 consumption in 2005. Republic of Korea, Singapore and United Arab Emirates are excluded from the analysis.
[6] UNEP/OzL.Pro/ExCom/51/Inf. 3.
[7] UNEP/OzL.Pro/ExCom/51/Inf. 2.

Country	Manufacturing (%)	Servicing (%)
Argentina	38.0	59.0
Brazil	45.0	52.0
Colombia	59.0	31.0
India	79.0	20.0
Indonesia	56.0	44.0
Iran	83.0	17.0
Lebanon	31.0	69.0
Mexico	64.0	35.0
Venezuela	21.0	77.0

II.4 HCFC technology in Multilateral Fund projects

9. Since the inception of the Multilateral Fund in 1991, the Executive Committee has approved 858 stand-alone investment projects in 47 Article 5 countries where HCFCs have been selected as the technology to replace CFC consumption, partially or totally[8]. Additionally, sectoral phase-out plans in the foam and refrigeration sectors and the conversion of CFC-12 compressors to HCFC-22-based systems have also been approved by the Executive Committee in a few Article 5 countries. The sectoral distribution of the stand-alone projects is presented in Table II.3 below:

Table II.3 Sectoral distribution of Multilateral Fund stand-alone projects with HCFC replacement technology

Sector	Projects	Countries
Foam	491	31
Refrigeration(*)	364	44
Solvent	3	2
Total	**858**	

(*) Compressor projects converted to HCFC-22 technology are not included.

10. Over 40,000 ODP tonnes of CFCs have been replaced by HCFC technologies, mainly HCFC-141b in foam applications including foam insulation in domestic refrigerator manufacturing enterprises, and HCFC-22 as a refrigerant and to a lesser extent as a foam blowing agent. The total amount of HCFC-141b and HCFC-22 consumption phased in through projects using HCFCs as a replacement of CFC-11 and CFC-12 amounts to over 3,700 ODP tonnes[9], as shown in Table II.4 below.

[8] Inventory of Approved Projects, including projects approved at the 53rd Meeting of the Executive Committee.

[9] This analysis has not included the amounts phased in from refrigeration manufacturing enterprises and a few foam enterprises covered under multi-year national phase-out plans since composite phase-out data for these plans are not yet available, although it is to be expected that the conversion technologies and their outcomes will be similar to those of the projects implemented as individual, umbrella projects or specific sector plans. It is also expected that these figures are relatively small.

Table II.4 Amounts of HCFC consumption phased-in through approved projects (ODP tonnes)

Country	CFC phased out in projects using HCFC technologies	HCFC phased in
Algeria	54.2	5.4
Argentina	817.4	79.0
Bahrain	15.3	1.5
Bolivia	11.0	1.1
Bosnia and Herzegovina	29.1	2.9
Brazil	4,830.8	476.1
Chile	236.5	20.2
China	14,078.4	1,168.4
Colombia	644.9	63.9
Costa Rica	33.1	3.3
Cuba	0.8	0.1
Dominican Republic	135.3	13.4
Egypt	484.4	37.4
El Salvador	18.3	1.8
Guatemala	45.4	4.5
India	4,463.8	432.6
Indonesia	2,839.7	281.4
Iran	1,045.5	103.6
Jordan	330.3	32.7
Kenya	22.8	2.3
Lebanon	81.0	8.0
Libya	61.5	6.1
Macedonia, FYR	75.1	7.4
Malaysia	1,226.5	118.5
Mauritius	4.2	0.4
Mexico	2,106.3	193.6
Morocco	118.0	11.7
Nicaragua	8.0	0.8
Nigeria	487.5	48.3
Pakistan	781.1	77.4
Panama	14.4	1.4
Paraguay	66.5	6.6
Peru	146.9	14.6
Philippines	518.9	51.4
Romania	192.0	19.0
Serbia	44.2	4.4
Sri Lanka	7.2	0.7
Sudan	4.4	0.4
Syria	628.4	62.3
Thailand	2,015.8	199.3
Tunisia	234.9	20.3
Turkey	372.2	36.9
Uruguay	98.1	9.7

Country	**CFC phased out in projects using HCFC technologies**	**HCFC phased in**
Venezuela	699.1	69.3
Vietnam	44.4	4.4
Yemen	9.7	1.0
Zimbabwe	11.3	1.1
Total	**40,194.6**	**3,706.6**

ANNEX III

INCREMENTAL COSTS FOR PHASING OUT HCFC CONSUMPTION IN THE FOAM SECTOR

1. To date, over 89,370 ODP tonnes of CFCs used by Article 5 foam manufacturing enterprises have been phased out through Multilateral Fund individual and umbrella projects and sectoral phase-out plans, comprising 80,370 ODP tonnes of CFC-11 from the rigid polyurethane foam including domestic and commercial refrigeration, and integral skin foam sectors, and 9,000 ODP tonnes of CFC-12 from the extruded polystyrene and polyethylene foam sector. Out of this amount, some 34,000 ODP tonnes of CFC-11 were replaced by HCFC-141b, 760 ODP tonnes were replaced by HCFC-22[1] and about 280 ODP tonnes by HCFC-22/HCFC-142b[2], with a phase-in of some 3,380 ODP tonnes of HCFC-141b and 42 ODP tonnes of HCFC-22. The latest (2006) HCFC-141b consumption reported by Article 5 countries under Article 7 of the Montreal Protocol is about 12,200 ODP tonnes. The differences in the consumption levels may possibly be attributed to growth in the consumption of HCFC-141b resulting from industrial expansion in the foam sector already supported by the Multilateral Fund and installation of new capacity.

Size of Multilateral Fund projects

2. An analysis of 657 Multilateral Fund foam projects approved as individual projects for 38 Article 5 countries to phase out CFC-11 using HCFC-141b technology showed the following:

(a) About 50 per cent of the enterprises were small scale enterprises with CFC consumption below 20 ODP tonnes, 20 per cent were medium scale with CFC consumption ranging from 20 to 40 ODP tonnes, while 30 per cent had consumption above 40 ODP tonnes. Thus, nearly 70 per cent of all the enterprises were small and medium scale foam producers;

(b) Only 20 per cent of the enterprises had CFC consumption over 60 ODP tonnes and could have cost-effectively used hydrocarbon-based technology;

(c) Nearly 80 per cent of the foam enterprises converting to HCFC-141b technology were located in seven of the 38 Article 5 countries (i.e., Brazil, China, India, Indonesia, Malaysia, Mexico and Thailand). In these countries 80 per cent of the enterprises had consumption below 40 ODP tonnes per year.

3. An additional analysis of 454 Multilateral Fund projects approved for 48 Article 5 countries to phase-out CFC-11 using HCFC-141b technology and CFC-12 using alternative refrigerants in the domestic and commercial refrigeration sector, showed that:

(a) Over 75 per cent of the enterprises were small and medium scale producers with

[1] HCFC-22 was used as a substitute for CFC-11 in rigid and integral skin foam projects only in the early stages of project funding in only one country under a special programme. Over 80 ODP tonnes of CFC-11 funded to be phased out using HCFC-22/HCFC-142b was phased out using HCFC-141b.
[2] These consumption data under the Multilateral Fund are based on baseline data reported in project proposals at the various times of their approval and do not factor in any growth in consumption.

annual CFC consumption below 40 ODP tonnes (over 60 per cent of the enterprises consumed less than 20 ODP tonnes);

(b) Nearly 14,300 ODP tonnes of CFCs used as blowing agent (i.e., over 63 per cent of the total consumption) were replaced by cyclopentane (63.5 per cent of the total) in only 119 enterprises (26 per cent). The other 335 enterprises (74 per cent) selected HCFC-141b technology;

(c) The selection of cyclopentane technology by 26 per cent of the enterprises was mainly related to the production capacity (size) of the enterprises and the products being manufactured.

4. Cyclopentane technology was selected by 26 refrigeration manufacturing enterprises with CFC-11 consumption below 20 ODP tonnes per year. The cyclopentane technology was feasible for these low volume CFC consuming enterprises since the projects were funded under the refrigeration manufacturing sub-sector where foam and refrigerant components were treated as one project, with cost-effectiveness thresholds of US $13.76/kg for domestic refrigeration and US $15.21/kg for commercial refrigeration. However, with a sub-sector cost-effectiveness threshold of US $7.83/kg, among rigid foam enterprises not manufacturing refrigeration equipment, only those with CFC consumption of over 40 ODP tonnes could select hydrocarbon-based technologies as a replacement of CFCs, .

5. From the above analysis and from a review of the baseline equipment described in Multilateral Fund project documents, the foam sector in many Article 5 countries comprises a large number of small scale units which are technically and chemically unsophisticated. Many of the enterprises usually manufacture within the same facility different combinations of foam products. For example, insulated panels for truck bodies could be produced in the same facility as block foam and moulded pipe sections, while at the same time doing spray foam at different sites using the same type of blowing agent. Some enterprises also manufacture both rigid foam and integral skin foam products in the same facility, using the same dispenser and hand mixing and the same type of blowing agent.

Selection of alternative technologies

6. Given the limited technical capabilities of many enterprises, the selection of alternative technology to CFC-11 has been driven by the need to have a technology which would not only resemble CFC-based technology (virtual drop-in) but would also be locally available to ensure readily available technical support from material suppliers (i.e., systems houses). Depending on the products being manufactured, the production volume and the baseline equipment, several alternative technologies were chosen by Article 5 countries. Specifically, methylene chloride and liquid carbon dioxide technologies were selected for polyurethane flexible slabstock foam; water/carbon dioxide technology for flexible moulded polyurethane; hydrocarbons (butane/LPG) for polystyrene and polyethylene foam and pentane/cyclopentane/isopentane for relatively large rigid and some integral skin foam operations.

7. For a large number of foam enterprises manufacturing rigid polyurethane and integral skin polyurethane foam enterprises, HCFC-141b met the needs of both small scale and medium

scale enterprises. HCFC-141b-based systems were technically mature and commercially available. They also provided relatively the most acceptable insulation value and energy efficiency, and the lowest investment and operating costs vis-à-vis other options. No major changes in the auxiliary equipment/tooling in the production programme, such as jig or mould redesign, were needed. According to information in approved project documents and enterprise commitment letters submitted with them, enterprises understood the transitional nature of HCFC-141b and expected the final replacement for it to have similar characteristics that would meet their production demands. Accordingly, the use of HCFCs as alternative blowing agent accounted for about 34 per cent of all CFCs phased out. Table III.1 below provides detailed breakdown of alternative blowing agents to CFC-11 used in approved Multilateral Fund rigid and integral skin polyurethane foam projects.

Table III.1. CFC replacement technologies in rigid and integral skin polyurethane foam projects

Replacement	ODP tonnes	% of subtotal
Rigid polyurethane foam		
50% reduced CFC	46.0	0.2%
HFC-134a	57.8	0.3%
HCFC-22	542.2	2.4%
Water/carbon dioxide	904.8	4.1%
Pentane/cyclopentane	4,036.2	18.2%
HCFC-141b	16,630.9	74.9%
Sub-total rigid polyurethane	**22,217.9**	**100.0%**
Rigid polyurethane (insulation refrigeration)		
Water/carbon dioxide	93.0	0.4%
50% reduced CFC	450.0	1.8%
HCFC-141b	9,255.7	36.6%
Pentane/cyclopentane	15,472.0	61.2%
Sub-total rigid (insulation ref.)	**25,270.7**	**100.0%**
Integral skin		
DOP (di-octyl-phtalate)	8.6	0.2%
Methylene chloride	8.8	0.2%
HCFC-22	60.0	1.5%
Pentane/cyclopentane	164.6	4.0%
Hexane	255.0	6.2%
HCFC-141b	837.6	20.4%
Water/carbon dioxide	2,766.6	67.5%
Sub-total integral skin	**4,101.2**	**100.0%**
Multiple-subsectors (*)		
HCFC-22	157	4.6%
Water/carbon dioxide	1,031	30.2%
HCFC-141b	2,231	65.2%
Sub-total multiple-subsectors	**3,419**	**100.0%**
Total	**55,008.8**	

(*) Enterprises producing a mix of several products either within or across foam sub-sectors, e.g., rigid polyurethane pipe sections, panels and flexible polyurethane moulded and integral skin foams.

Baseline equipment upgrades for conversion to HCFC-141b and other alternatives

8. Equipment baseline information provided in project documents showed invariably that existing equipment in many enterprises consisted of low pressure foam dispensers several of them home-made, with simple open top pre-mixers or mechanical drill and bucket for premixing foam chemical components and pouring into moulds and/or cavities by hand. Better equipped enterprises predominantly had low pressure foam dispensers with mechanical mixing heads while relatively small number had high pressure dispensers.

9. After extensive technical review and discussions among the Fund Secretariat, the implementing agencies, experts from the foam industry and representatives of equipment and chemical manufacturers, it was concluded that HCFC-141b-based foam would have poorer quality of insulation (e.g., increased thermal conductivity) than that produced with CFC-11, which was being replaced. It was also concluded that this problem could be mitigated by producing foam of fine cell structure which is achieved by impingement mixing of high pressure dispensers.

10. As a consequence, financial assistance was provided from the Multilateral Fund through approved projects to enterprises manufacturing rigid polyurethane foam for insulation applications as follows:

(a) Low pressure foam dispenser that existed in the baseline was replaced with a new high pressure dispenser of equivalent effective capacity;

(b) High pressure dispensers already existing in the baseline were retrofitted to enable them to accommodate the new formulations and mixing ratios, by changing the pump kits, the parts vulnerable to the solvent action of HCFC-141b and by recalibration;

(c) Where no dispenser existed in the baseline (i.e., manual operation), a high pressure dispenser meeting the product output requirements of the enterprise was provided with 50 per cent contribution from the enterprise towards the cost of the new machine. Where the enterprise could not afford the contribution required to be made for a high pressure machine, a low pressure machine was provided with a much lower agreed contribution from the enterprise (usually between 25 and 35 per cent depending on the size and capacity of the machine). It was understood by recipient enterprises that the equipment provided under such arrangement was sufficient for handling the next stage of phasing out the HCFC;

(d) Additional pieces of equipment were provided, mainly polyol pre-mixers, if they were used with the CFC-based foam production.

11. In the integral skin and flexible moulded foam sub-sector most enterprises had low pressure machines that could process CFC-based formulations. Since the insulation property of the foam is not an issue in these applications, the replacement of the low pressure dispenser with a high pressure dispenser was not justified except when hydrocarbon-based technologies were selected. Partial funding was provided for low pressure dispensers as described above for those

enterprises that did not have a foam dispenser in the baseline (i.e., SMEs with hand-mixing operations). The weaknesses in the baseline dispensers, both low and high pressure, were addressed through several retrofits, including variable drive pump motors to control the ratio of the dispenser; heat exchangers for controlling material temperature; refrigeration unit (chiller) to properly control the reactivity of the water blown foams in a hot environment; barrier coat system to replicate the thick skin of the CFC-11 blown foams as closely as possible; power washer for product finishing operations; mould ovens for preheating of the moulds for the water-blown integral skin foam and for drying the barrier coat; and/or suitable moulds where baseline moulds are of glass fibre.

12. In one country, to cover polyurethane foam production for insulating products using HCFC-22 as a blowing agent in rigid polyurethane foam thermoware products, funding was provided to replace existing low-pressure with high-pressure foaming dispensing units as well as on-site pre-mixers since polyol blends with HCFC-22 were not available. For production of extruded polystyrene foam sheets using HCFC-22/HCFC-142b as a blowing agent, funding was provided for installation of a gas storage facility, replacement of the existing extruder with a new extruder and auxiliary equipment.

Items of incremental operating costs paid for CFC phase-out

13. The level of incremental operating costs or savings of Multilateral Fund foam projects depend on several factors, including the nature of the new formulations that would produce foam of a similar quality as in the baseline, the relative prices of chemicals required for the manufacturing of foams; cost penalty resulting from increase in the density of the foam (applicable mainly to rigid insulation polyurethane foam); the cost of incremental maintenance, incremental insurance (estimated to be 5.5 per cent of net incremental cost of equipment) and incremental energy usage when selecting hydrocarbon-based technologies; and the cost of in-mould coating chemical in integral skin foam products.

14. The incremental operating cost associated with foam density can be as high as 60 per cent of the total incremental operating cost of the project. Since the duration of incremental operating cost for rigid foam projects is two years, calculation of the component of incremental operating cost associated with increase in foam density is based on “initial density increase” for the first year and “mature density increase” for the second year. Incremental operating costs of high density rigid insulation foams (above 45 kg/m^3), such as pipe-in-pipe foam (density: 70-80 kg/m^3) and spray foam for roofs (density: 48-50 kg/m^3) are not affected by foam density increase, all other applications are affected with increases in density ranging from 4-16 per cent for the first year and 3-13 per cent for the second year. Pentane and cyclopentane-based foam for boards and domestic refrigeration have the highest increase respectively of 16 and 13 per cent and 16 and 10 per cent in the first and second years.

15. The Secretariat and the implementing agencies have worked on and agreed the baseline densities and mature densities during conversion from CFC-11 to HCFC-141b technology. These mature densities could consequently become the baseline densities for the second stage conversion from HCFC-141b to non-ODS alternatives. However, information obtained on conversions using the new generation of alternative blowing agents, particularly HFC-245fa and methyl formate indicate that increase in foam density after conversion would not be an issue as

lower foam densities than that obtained with HCFC-141b could be achieved. It is, therefore, necessary to revisit the issue of changes in foam density in order to more accurately account for the required level of incremental operating costs.

Alternative blowing agents to HCFCs

16. The choice of substitute blowing agent and its associated conversion technology had to meet the following criteria which are equally applicable to conversion from HCFC-based technology:

(a) Proven and reasonably mature technology;

(b) Critical properties to be maintained in the end product;

(c) Cost effective conversion and local availability of substitute, at acceptable pricing;

(d) Support from the local systems suppliers; and

(e) Meeting established standards on environment and safety.

17. Information available from project documents and confirmed by project completion reports, the TEAP Foam Technical Options Committee and other sources point to the following technologies as potential alternatives to HCFCs in foam blowing.

Water-based (water/CO_2)

18. Water-based systems, where the blowing agent is carbon dioxide generated during the foaming process, became available in some Article 5 countries during the conversion from CFC-11 in rigid integral skin foams, rigid foams with relatively less critical insulation applications such as in-situ foams, surf boards, low density packaging foams, and thermoware and spray foam, initially with the use of HCFC-141b. Water-based systems, particularly for rigid foams, are up to 50 per cent more expensive than other CFC-free technologies since the technology is associated with reductions in insulation value and lower cell stability. The problem is addressed by adding more material (up to 50 per cent) to increase foam thickness, where feasible, with resulting increase in cost. Thus, the use of water-based technology in pour-in-place for insulation applications, while in principle feasible, would require an increase in thickness, which is not always practical or cost-effective.

19. Rigid integral skin foams have almost universally converted to all-water-based systems. In most of these applications, skin formation is triggered through densification (mould pressure) rather than condensation. Accordingly, subsequent coating may be required and densities can be increased. However, since densities in this application are already relatively high, (e.g. 60 kg/m3) this is not a major issue. This is not the case for flexible and semi-flexible integral skin foams. The related cost penalty arising from significantly increased densities and the poor skin formation associated with water blown systems has made the use of pentane, hexane and HFCs attractive in non-Article 5 countries and has caused almost universal conversion to HCFC-141b

in Article 5 countries. Under the Multilateral Fund also projects have been approved for 23 shoe sole (semi-flexible integral skin) manufacturers, mainly in Brazil, Indonesia, Mexico and Pakistan. About 60 per cent of the enterprises employed water/CO_2 technology while 40 per cent used hexane.

20. In one Article 5 country, with the assistance from the Multilateral Fund some enterprises converted their integral skin foam production to water-blown technology without increase in foam density to achieve a surface finish of the product using water-based cross-linked in-mould coating. This required inexpensive modifications to their manufacturing equipment. However, the incremental operating cost was still higher than that of using HCFC-141b due to the higher cost of the coating. Water-based systems have zero ODP. Water vapour is a major greenhouse gas; however, new emissions do not affect global warming because it is already at a saturation point in the atmosphere. CO_2 has a GWP of 1.

Hydrocarbons

21. Hydrocarbons as foam blowing agents have been proven commercially in both non-Article 5 and Article 5 countries. Pentanes, namely n-, iso-, and cyclopentane or their blends, have emerged as the most favoured blowing agents among the hydrocarbons, because the level of their use needed to achieve the same foam density is substantially lower than that for other blowing agents such as HCFC-141b. They constitute a permanent final technology, and their relatively low prices compared to other blowing agents make them economically attractive. However, in several projects approved under the Multilateral Fund claims for costs associated with increase in foam density or dimensional stability, incremental maintenance, incremental energy usage and incremental insurance have often resulted in substantial incremental operating costs.

22. Hydrocarbons are the preferred conversion technology for large and organized foam producers, where the safety requirements can be complied with and investments can be economically justified. Hydrocarbons have zero ODP and a relatively low GWP (maximum 25).

HFCs

23. HFCs have a higher insulating value than other foam blowing alternatives at operating temperatures for applications such as walk-in coolers and cold storage areas. They are mainly used where end product fire performance is an issue with insurers or where investment costs for hydrocarbon-based technology are prohibitive mainly for SMEs. The three main HFCs currently used in foam applications are HFC-134a, HFC-245fa and HFC-365mfc (and its blend with HFC-227ea).

(a) HFC-245fa (marketed primarily by Honeywell as Enovate 3000) is currently available across most, if not all, non-Article 5 countries although only currently manufactured in the United States and, to a smaller extent, in Japan (Central Glass). It has been used to replace HCFCs in most rigid foam applications, including domestic refrigeration, spray foam, and metal faced sandwich panels. Feedback from users underlines the excellent flow properties of systems containing HFC-245fa, good solubility in polyol, possible foam density reductions and reduced panel waste due to ease of processing. In most cases it can be processed with the same spray foam and pour in place dispensers used for HCFC-141b. HFC-245fa is typically used as co-blowing agent with CO_2/water in order to gain from the thermal performance, while limiting the cost impact. However, HFC-245fa poses some technical challenges to formulators due to its low boiling point and its lower fire-resistance properties relative to HCFC-141b. It currently has limited commercial availability in Article 5 countries due to lack of demand. It has a high price, currently costing over US $10.00/kg for bulk containers. HFC-245fa has zero ODP value and a GWP of 1,020.

(b) HFC-365mfc and its blend HFC-365mfc/HFC227ea (marketed almost exclusively by Solvay Fluor as Solkane-365 and Solkane-365/227, respectively), is currently available in most, if not all, non-Article 5 countries with the exception of the Canada and the United States, where patents prevent its use in foams. HFC-365mfc-blown foams have a fine cell structure with good insulation properties and good compressive strength. These foams are good for insulation purposes, where a non flammable liquid foaming agent with low thermal conductivity is needed, but does have a lower blowing efficiency than some other alternatives. For several applications, HFC-365mfc is blended with HFC-227ea to overcome a minor flammability issue. It has also a high price ranging from US $4.50 to US $5.00/kg. HFC-365mfc has zero ODP and GWP of 610. HFC-227ea has a much higher GWP value (2,900), however, it is used in relatively small proportions;

(c) HFC-134a has been used widely in Multilateral Fund projects as a refrigerant in refrigeration projects. However its use as a foam blowing agent has been very minimal due to processing difficulties, the fact that its pre-blends cannot be made available, and high production costs owing to the need for on-site pre-mixer which would limit its application by SMEs. Therefore it does not appear to have the potential as alternative blowing agent in Article 5 countries. HFC-134a has zero ODP and GWP of 1,300.

<u>Methyl formate</u>

24. Methyl formate (marketed primarily by Foam Supplies/BOC as Ecomate), is an emerging technology that could be of interest in Article 5 countries due to its reported high efficiency and low cost. Information available from the suppliers indicates that methyl formate seems an ideal replacement for HCFC 141b in integral skin foams because it has a desirable combination of boiling point and solubility to mimic those of HCFC-141b. Its boiling point just above ambient, allows good skin formation without expensive cooling. Spray and pour foams made with methyl formate have good physical properties, good fire resistance and good stability. It is reported to be currently supplied to some countries in Asia, Africa, Europe and Latin American. Some concern over dimensional stability has been reported in some applications, presumably arising from high solubility. The price of methyl formate worldwide is reported to be in the same range as of the

price of pentanes but not affected by to the price pressures of crude oil on pentanes. Methyl formate has zero ODP and relatively low GWP[3], likely to be similar to other hydrocarbons.

Range of incremental capital costs for phasing-out HCFCs

25. For purposes of funding the phase-out of HCFCs, the recipient enterprises may be put into the following categories, namely

(a) Enterprises that have converted their foam production from CFC-11 to HCFC-141b with the financial and technical assistance of the Multilateral Fund;

(b) Enterprises that that have converted their foam production from CFC-11 to HCFC-141b through their own resources and/or enterprises that might have established new foam production plants or installed new foaming equipment based on HCFC-141b.

26. The second category of enterprises consists of the following:

(a) Enterprises that established CFC-based foam production facilities after the cut-off date of 25 July 1995 using low pressure machines and have subsequently converted to HCFC-141b-based production by replacing the low pressure machines with high pressure ones and enterprises that established CFC-based foam production facilities after the cut-off date of 25 July 1995 using high pressure machines and have converted to HCFC-141b;

(b) Enterprises that established CFC-based foam production facilities after the cut-off date of 25 July 1995 using low pressure machines and have subsequently converted to HCFC-141b-based production on the same machines or enterprises that established HCFC-141b-based production on low pressure machines and continue to produce on the same machine;

(c) Enterprises that have converted part of their CFC-based foam production to HCFC-141b with the assistance of the Multilateral Fund while the other part on low pressure foaming capacity established after the July 1995 cut-off date did not receive assistance but continues to be used to produce HCFC-141b-based foam without any changes.

27. Against the background of the technical upgrades of enterprises that received assistance from the Multilateral Fund and of the discussion above regarding categories of enterprises that may potentially receive assistance from the Fund, the Secretariat made two parallel incremental capital cost estimates based on retrofit of existing equipment or replacement of existing equipment. The following considerations informed the calculations of the incremental capital cost:

[3] The supplier's claim of zero GWP is based on the US EPA SNAP evaluation which described the GWP of methyl formate as 'likely to be negligible'. However, no actual testing was carried out to support this. Indeed, there is no chemical reason why the value should not be similar to that of other hydrocarbons.

(a) Conversion from HCFC-141b to liquid blowing agents, such as HFC-245fa, HFC-365mfc, HFC-365mfc/HFC-227ea blend, water/CO_2 or methyl formate, should be based on retrofits of the production equipment in the baseline. Replacement of existing production equipment should be fully demonstrated and considered on a case-by-case basis;

(b) Conversion to hydrocarbon technology should be based on retrofit or replacement of existing foam dispenser and pre-mixers as technically required. Additional equipment for storage of hydrocarbon and for safety is included.

28. Thus the incremental capital costs were determined on the basis of the following:

(a) Calculations were based on a unit operation (i.e., one dispenser and associated manufacturing equipment);

(b) The majority of enterprises rely on premixed systems instead of premixing in-house for each application segment. The cost of a new premixer or retrofit of existing premixer was included in the list of equipment for those enterprises that do not rely on premixed systems;

(c) The minimum cost was based on retrofit of all required equipment items except when an item has to be replaced for technical reasons such as the conversion to hydrocarbon-based blowing agent. The maximum cost was based on installation of new equipment or replacement of old equipment with new ones without any deductions for counterpart contribution. Also, the minimum and maximum cost levels represent the absolute levels;

(d) The cost of technology transfer, training and trials were estimated at a higher level than the levels during the transition from CFC to HCFCs due to anticipated need for more activities for finessing foam formulations with potentially higher cost of trials than was the case with transition to HCFC-141b;

(e) The incremental capital costs for integral skin foam sub-sector were calculated based on retrofits only except in the conversion from HCFC-141b to hydrocarbon-based technology where new production equipment is required.

29. Detailed calculations and breakdown for the various segments are provided in Appendix I.

Range of incremental operating costs

30. The level of incremental operating costs or savings for conversion from HCFCs to non-ODS-based technologies would depend on the nature of the new formulations that would produce foam of a similar quality as in the baseline formulation, the relative prices of chemicals required for the manufacturing of the foam; the expected increase in foam density; potential incremental maintenance, insurance and energy usage costs when using hydrocarbon-based

technologies; and the price and quantities of in-mould coating chemicals when used during production of water-blown integral skin foam.

31. The proportions of the main chemical ingredients in foam formulations (namely blowing agent, the polyol and MDI) and their prices are the key determinants of the level of incremental costs or savings. From an analysis of several Multilateral Fund projects, it was observed that small changes in material ratios and/or price differential could result in substantial incremental operating costs for one enterprise but incremental operating savings for another enterprise for the same type and amount of foam produced. Increase in foam density which translates into the cost of additional foam material also has a significant impact on incremental operating cost and savings, representing in some cases 50 per cent or more of the total operating costs. The levels of increase in foam densities associated with different foam applications were approved at the 31st Meeting of the Executive Committee (decision 31/44) with the view to revisit the issue in future and make modifications where necessary. The increases in foam densities were based on the transition from CFC-11 to HCFC-141b and need to be revisited for the transition from HCFC-141b to other alternative technologies, especially since there are indications that for some of the alternatives increase in foam density following conversion may no longer be the case.

32. Cost ranges of incremental operating costs were calculated for the following alternative technologies: water-based systems, hydrocarbons, both pentane and cyclopentane, HFC-245fa and methyl formate, on the basis of the following assumptions and considerations:

(a) Prices of chemicals for pentane and water-based technologies for which the Secretariat has extensive experience and a large body of information from project completion reports, prices were derived from project completion reports completed between 2000 and 2006. The information was complemented with information on prices provided by some Ozone Units through bilateral and implementing agencies;

(b) Prices of HFC-245fa and methyl formate were obtained from the relevant companies (Honeywell and Foam Supplies Inc.);

(c) Calculations were based on the relationship between HCFC-141b and the replacement chemicals based on ratios of 1:0.50 and 1:0.75 for HFC-245fa and 1:0.50 for methyl formate consistent with information obtained from the suppliers; 1:1.5 for water-based systems; 1:0.5 for pentane and cyclopentane in rigid foam; and 1:0.75 for integral skin foam according to methods used in approved projects;

(d) Given the limited time available for the preparation of this paper, the direct association between increases in foam density from HCFC-141b to other technologies for the various rigid polyurethane insulation foam application segments could not be subject to a thorough review. Therefore, no increase in density was factored into the calculation for HFC-245fa and methyl formate. However, as stated earlier, increase in foam density may not be a factor in reality. Based on observations made upon review of calculations of the incremental operating costs of hydrocarbon-based projects a 10 per cent increase in foam density was factored into the calculations for pentane and cyclopentane-blown foams;

(e) The cost of in-mould coating chemical was included in the calculations for the integral skin foam as it is a component of the foam processing chemicals accounting for up to about 70 per cent of the total incremental operating cost;

(f) Costs associated with incremental maintenance, insurance and energy usage of hydrocarbon-based technologies were also included in the calculation for integral skin foam consistent with the practice in approved projects.

33. The incremental operating costs were calculated for enterprises with HCFC-141b consumptions of 5, 25, and 75 metric tonnes (0.55, 2.75 and 8.25 ODP tonnes) to represent the rigid foam sub-sector and enterprises with consumptions of 10 and 30 metric tonnes (1.1 and 3.3 ODP tonnes) for the integral skin foam sub-sector. Calculation per kg of HCFC-141b eliminated was also made. The calculations were checked against approved projects to ensure consistency and accuracy of the methodology.

34. The detailed calculations as well as its application to typical consumption levels as indicated above for rigid and integral skin foams can be found in Appendix 1.

Strategies for viable and sustainable HCFC conversion in the foam sector

35. In rigid and integral skin polyurethane foam production, most enterprises rely on polyols commercially premixed with the blowing agent and other essential ingredients (premixed polyols)[4] that are provided by companies known as systems houses. While enterprises with pre-mixers on site have the flexibility to vary their foam formulations to meet their customers' end-product requirements, SMEs have to rely on systems houses to meet their customers' requirements. In that regard access to a systems house becomes critical to the competitiveness and/or productivity of a foam producer and above all the sustainability of the conversion programme overall. During the first phase of CFC phase-out, systems houses played a key role in the market penetration of HCFC-141b in Article 5 countries.

36. Eleven group projects involving 290 SMEs centered around local indigenous systems houses were approved in four countries at a total cost of US $7.2 million. The direct impact of involvement of the systems houses was a phase-out of over 1,300 ODP tonnes of CFC-11. Table III.2 provides basic information on the systems houses assisted through the Multilateral Fund.

Table III.2. Systems house activities in the phase-out of CFCs

Country	Systems house	Number of enterprises	Sector/sub-sectors	Project cost (US$)	Impact (ODP tonnes)	Substitute blowing agent
Brazil	JNP	25	Rigid PU, integral skin/ flexible molded PU	636,400	80.3	HCFC-141b

[4] Data on approved CFC-based integral skin and rigid foam projects shows that about 80 to 85 per cent relied on premixed polyol. Also, over 60 per cent of foam enterprises relying on premixed polyol were SMEs consuming between 0.2 and 20.0 ODP tonnes CFC-11 per year.

Country	Systems house	Number of enterprises	Sector/sub-sectors	Project cost (US$)	Impact (ODP tonnes)	Substitute blowing agent
Brazil	Plastquim	50	Rigid PU, integral skin/ flexible molded PU	721,500	153.4	HCFC-141b
Brazil	Polsul	14	Rigid PU	536,892	55.0	HCFC-141b
Colombia	GMP	29	Rigid PU	449,130	56.6	HCFC-141b
India	Polymermann	80	Rigid PU	1,403,921	290.0	HCFC-141b
India	Shevathene Linopack	28	Rigid PU	699,139	105.7	HCFC-141b
Mexico	Comsisa	20	Rigid PU, integral skin	424,055	68.7	HCFC-141b
Mexico	Orca	11	Integral skin shoe sole	1,321,500	190.0	Hexane
Mexico	Productos Eiffel	10	Rigid PU spray foam	345,000	100.0	Water/CO2
Mexico	Pumex	19	Rigid PU spray foam	519,750	167.7	HCFC-141b
Mexico	Valcom	5	Rigid PU spray foam	122,440	44.3	HCFC-141b
Total		291		7,179,727	1,311.7	

37. In collaboration with implementing agencies' experts, systems houses not only provided suitable foam systems to their customers but also they undertook technology transfer and training of the downstream foam enterprises as technology partners.

38. The infrastructure already put in place at some system houses should be utilized, built upon and expanded to enable systems houses in Article 5 countries both indigenous and transnational to continue to facilitate the next stage of ODS phase-out. Through the development and optimization of formulations suited to their local markets and possibly neighboring countries where low levels of HCFC consumption would not make a systems house operation feasible, system houses could contribute to the sustainability of the HCFC phase-out. This includes the critical issue of the development and application of hydrocarbon-based premixed polyols that could accelerate the move away from HFCs in Article 5 countries.

Appendix I

INCREMENTAL CAPITAL AND OPERATING COSTS CALCULATIONS

Incremental capital cost ranges for conversion of panels, pipe in pipe foam, thermoware* domestic refrigerators (US $)

Equipment item	**HFC-245fa**		**Water/CO2**		**Pentane**	
	Min.	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**
Production						
Replacement of low pressure with high pressure dispenser (60 kg/min-100 kg/min)	80,000	120,000	80,000	120,000	90,000	170,000
Retrofit of high pressure dispenser	-	15,000	-	15,000	60,000	100,000
Additional mixing head	15,000	30,000	15,000	30,000	20,000	40,000
Retrofit of pre-mixing unit (where eligible)	-	10,000	-	10,000		
Replacement of pre-mixing unit	20,000	65,000	20,000	65,000	55,000	85,000
Modification of press					15,000	25,000
Hydrocarbon tank and accessories (piping and pumps, ventilation)					30,000	55,000
Buffer tank for polyol					10,000	15,000
Nitrogen supply system					10,000	40,000
Plant safety						
Ventilation and exhaust system (fans, piping, ductworks, grounding, electrical boards/connections)					15,000	85,000
Heating, ventilation and enclosure for cabinet plant (domestic refrigeration)					40,000	50,000
Heating, ventilation and enclosure for door plant (domestic refrigeration)					40,000	50,000
Gas sensors, alarm, monitoring system for entire plant					25,000	50,000
Fire protection/control system for the plant					-	10,000
Lightning protection and grounding					15,000	25,000
Antistatic floor					-	5,000
Safety audit/Safety inspection & certification					10,000	25,000
Stand-by electric generator					-	15,000
General works						
Civil work/plant modifications					20,000	25,000
Technology transfer/training	10,000	20,000	5,000	10,000	20,000	30,000
Trials and commissioning	10,000	15,000	10,000	20,000	10,000	20,000
Total						
Total retrofit	20,000	60,000	15,000	55,000	375,000	710,000
Total replacement	135,000	250,000	130,000	245,000	405,000	780,000

The use of hydrocarbon-based blowing agent might be limited in this application.

Incremental capital cost ranges for conversion of spray foams and discontinuous block foam (US $)

Equipment item	Min.	Max.	Min.	Max.
	Low-output dispenser		High-output dispenser	
Production: Spray foam (*)				
Replacement of low pressure with high pressure spray foam dispenser (7 kg/min) (with standard accessories)	15,000	20,000		
Replacement of low pressure with high pressure spray foam dispenser (12-15 kg/min) (with standard accessories) (***)			25,000	40,000
Retrofit of high pressure spray foam dispenser	-	15,000	-	15,000
Replacement of pre-mixing unit (where eligible)	20,000	40,000	20,000	40,000
Retrofit of pre-mixing unit (where available)	-	10,000	-	10,000
DISCONTINUOUS BLOCKS (**)	**Dispenser option**		**Boxfoam option**	
Production: Discontinuous blocks (**)				
Replacement of box foam (handmix) with large output low pressure dispenser	50,000	70,000		
Replacement of box foam with semi-automatic boxfoam unit			50,000	65,000
Retrofit of low pressure dispenser	-	15,000	-	-
Retrofit of semi-automatic boxfoam unit			-	10,000
Replacement of pre-mixing unit (where eligible)	20,000	40,000		
Retrofit of pre-mixing unit (where available)	-	10,000	-	-
General works				
Technology transfer and training	5,000	10,000	5,000	10,000
Trials and commissioning	10,000	20,000	10,000	20,000
Total				
Total retrofit spray foam	15,000	55,000	15,000	55,000
Total replacement spray foam	50,000	110,000	60,000	110,000
Total retrofit discontinuous blocks foam	15,000	55,000	5,000	40,000
Total replacement discontinuous blocks foam	85,000	140,000	65,000	95,000

* Hydrocarbon technology not included.
** Hydrocarbon technology not included as availability in this segment is uncertain.
*** For SMEs having spray foam and pour-in-place operations.

Incremental capital cost ranges for integral skin foams (US $)

Equipment item	HFC-245fa		Water/CO2		Pentane	
	Min.	Max.	Min.	Max.	Min.	Max.
Production						
Retrofit of dispenser for refrigerated thermal control	10,000	15,000	10,000	15,000		
Retrofit of dispenser for variable ratio control	10,000	15,000	10,000	15,000		
Penta-foam dispenser					90,000	120,000
Premixer with polyol and buffer tank					65,000	85,000
Pentane tank (500-1,000 l) with auxiliaries					25,000	35,000
In mold coating high-volume low-pressure spray system			10,000	15,000		
Mold preheating oven	5,000	10,000	5,000	10,000		
Infrared coating drying system			10,000	15,000		
In mold coating exhaust booth			10,000	15,000		
Plant safety						
Process ventilation					20,000	30,000
Electrical grounding					5,000	10,000
Pentane monitoring/alarm system					20,000	40,000
General works						
Technology transfer/training (foam)	5,000	10,000	5,000	10,000	10,000	30,000
Technology transfer, training (coating)			5,000	10,000		
Trials and commissioning	10,000	20,000	10,000	20,000	5,000	10,000
Safety audits					10,000	20,000
Miscellaneous local works					15,000	25,000
Total						
Retrofit	40,000	70,000	75,000	125,000	265,000	405,000

Incremental operating costs: Rigid polyurethane foam (US $)

Chemical	**Prices US $/kg**		**Ratio (*)**	**Consumption (metric tonnes)**		
	High	**Low**		**Plant 1**	**Plant 2**	**Plant 3**
HCFC-141b	1.40	3.50	1.00	5.00	25.00	75.00
HFC-245fa(**)	10.40	12.00	0.50	2.50	12.50	37.50
HFC-245fa (**)	10.40	12.00	0.75	3.75	18.75	56.25
Methyl formate	2.20	3.20	0.50	2.50	12.50	37.50
Water-based systems	1.50	3.50	1.50	7.50	37.50	112.50
Pentane	0.50	2.50	0.50	2.50	12.50	37.50
Cyclopentane	0.80	3.30	0.50	2.50	12.50	37.50
MDI (pentane)	1.50	3.50	1.10	5.50	27.50	82.50

(*) Ratio between HCFC-141b and the alternative blowing agent
(**) The lower and higher prices represent bulk price and small package price allowing for 15% difference.

Description	**Plant capacity: 5 tonnes**		**Plant capacity: 25 tonnes**		**Plant capacity: 75 tonnes**	
Before conversion						
HCFC-141b	7,000	17,500	35,000	87,500	105,000	262,500
After conversion						
HFC-245fa (50%)	26,000	30,000	130,000	150,000	390,000	450,000
HFC-245fa (75%)	39,000	45,000	195,000	225,000	585,000	675,000
Water-based system	11,250	26,250	56,250	131,250	168,750	393,750
Methyl formate	5,500	8,000	27,500	40,000	82,500	120,000
Pentane	9,500	25,500	47,500	127,500	142,500	382,500
Cyclopentane	10,250	27,500	51,250	137,500	153,750	412,500
One year IOC						
HFC-245fa (50%)	19,000	12,500	95,000	62,500	285,000	187,500
HFC-245fa (75%)	32,000	27,500	160,000	137,500	480,000	412,500
Water-based system	4,250	8,750	21,250	43,750	63,750	131,250
Methyl formate	(1,500)	(9,500)	(7,500)	(47,500)	(22,500)	(142,500)
Pentane	2,500	8,000	12,500	40,000	37,500	120,000
Cyclopentane	3,250	10,000	16,250	50,000	48,750	150,000
Two year IOC						
HFC-245fa (50%)	33,060	21,750	165,300	108,750	495,900	326,250
HFC-245fa (75%)	55,680	47,850	278,400	239,250	835,200	717,750
Water-based system	7,395	15,225	36,975	76,125	110,925	228,375
Methyl formate	(2,610)	(16,530)	(13,050)	(82,650)	(39,150)	(247,950)
Pentane	4,350	13,920	21,750	69,600	65,250	208,800
Cyclopentane	5,655	17,400	28,275	87,000	84,825	261,000

Notes
1. For pentane projects to the incremental operating costs should be added the following costs:
   (a) Incremental maintenance of 5% of net incremental investment
   (b) Incremental insurance of 0.5% of net incremental investment
   (c) Extra power of 5 kW/dispenser, 10 kW for premixer, 10 kW for ventilation for 2,000 hr/year at 0.10/kW
2. The prices of HFC-245fa and methyl formate are global prices as provided by manufacturers

Incremental operating costs: Integral skin foam (US $)

Chemical	Prices US $/kg		Ratio (*)	Consumption (metric tonnes)	
	High	Low		Plant 1	Plant 2
HCFC-141b	1.40	3.50	1.00	10.00	30.00
HFC-245fa(**)	10.40	12.00	0.50	5.00	15.00
HFC-245fa (**)	10.40	12.00	0.75	7.50	22.50
Methyl formate	2.20	3.20	0.50	5.00	15.00
Water-based systems	1.50	3.50	1.50	15.00	45.00
Pentane/Isopentane	0.50	2.50	0.75	7.50	22.50
In-mold coating	1.20	2.10			

(*) Ratio between HCFC-141b and the alternative blowing agent
(**) For water-based systems.

Description	Plant capacity: 10 tonnes		Plant capacity: 30 tonnes	
Before conversion				
HCFC-141b	14,000	35,000	42,000	105,000
After conversion				
HFC-245fa (50%)	52,000	60,000	156,000	180,000
HFC-245fa (75%)	78,000	90,000	234,000	270,000
Water-based system	49,500	162,750	148,500	488,250
Methyl formate	11,000	16,000	33,000	48,000
Pentane	21,139	42,684	28,639	80,184
One year IOC				
HFC-245fa (50%)	38,000	25,000	114,000	75,000
HFC-245fa (75%)	64,000	55,000	192,000	165,000
Water-based system	35,500	127,750	106,500	383,250
Methyl formate	(3,000)	(19,000)	(9,000)	(57,000)
Pentane	7,139	7,684	(13,361)	(24,816)
Two year IOC				
HFC-245fa (50%)	66,120	43,500	198,360	130,500
HFC-245fa (75%)	111,360	95,700	334,080	287,100
Water-based system	61,770	222,285	185,310	666,855
Methyl formate	(5,220)	(33,060)	(15,660)	(99,180)
Pentane	12,421	13,370	(23,249)	(43,180)

Notes;
1. For pentane conversion projects to the IOC should be added the following operating costs:
   Incremental maintenance & insurance (minimum) = 5.5% of 85% of $265,000
   Incremental maintenance & insurance (maximum) = 5.5% of 85% of $405,000
   Incremental energy @ 25kW for 2000hrs/year (US $0.1/kWh)
2. For water-based systems the cost of in-mold coating is 1.2 to 2.1 times the cost of MDI, depending on whether in-mold coating is used before and after conversion or only after conversion with water-blowing. Price of in-mold coating taken as US $10.0/kg.