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执行蒙特利尔议定书
多边基金执行委员会
第九十二次会议
2023 年 5 月 29 日至 6 月 2 日，蒙特利尔
临时议程[10] 项目 7(a)

# 情况报告和关于具有具体报告要求的项目的报告

1. 本文件由以下各部分组成，载列各份报告以及具有具体报告要求的项目的状况：

一、 实施延期的项目以及对其要求提出特别情况报告的项目

二、 具有具体报告要求的项目：
二.1 概述
二.2 “一揽子”核准
二.3 单独审议

## 一. 拖延执行以及要求对其提出具体情况报告的项目

2. 在第九十一次会议上，执行委员会注意到，各双边和执行机构将在第九十二次会议报告 109 个执行工作出现拖延的项目和建议提交补充情况报告的 37 个[11] 正在执行的多年期协定（MYA）项目或付款（第 91/10 号决定(c)段）。因此，相关双边和执行机构将要求提交的报告提交给第九十二次会议。在审查报告时，秘书处与相关双边和执行机构进行了讨论，指出一些问题已得到圆满解决。表 1 汇总了执行工作出现拖延的项目和建议提交额外情况报告的项目，包括它们的进展情况、秘书处的建议和对本文件附件的引用。

[10] UNEP/OzL.Pro/ExCom/92/1。

[11] 在建议提交补充情况报告的 37 个项目中，有 13 个项目也被列入执行工作出现拖延的项目。对这些项目的审查列入执行工作出现拖延的部分。

**表 1. 执行工作出现拖延和提交额外情况报告的项目汇总**

| 进展情况 | 项目数目 | 决定编号 | 建议 | 附件 |
|---|---|---|---|---|
| 执行拖延 | | | | |
| 取得进展（个别项目和多年期协定） | 70 | 32/4 | 将从未来的报告中删除 | 不适用 |
| 取得一些进展（个别项目和多年期协定） | 29 | 32/4 | 继续监测直至最终完成 | 附件一 |
| 首次未取得进展（多年期协定） | 7 | 84/45 | 继续监测直至最终完成 | 附件二 |
| 连续二次会议未取得进展（多年期协定） | 3 | 84/45 | 发送可能取消的通知 | 附件三 |
| **共计** | **109** | | | |
| 情况报告 | | | | |
| 没有未解决的问题 | 7 | 51/13 | 将从未来的报告中删除 | 不适用 |
| 仍然需要解决的问题 | 17 | 51/13 | 要求提交补充情况报告 | 附件四 |
| **共计*** | **24** | | | |

* 未列入执行工作出现拖延部分的 13 个项目。

## 建议

3. 谨建议执行委员会：

(a) 注意到：

(一) UNEP/OzL.Pro/ExCom/92/9 号文件所载双边机构和执行机构提交的执行拖延报告和情况报告；

(二) 秘书处将就可能取消氟氯烃淘汰管理计划之事致函缅甸政府和作为执行机构的环境规划署：第一阶段，第一次付款(MYA/PHA/68/TAS/14)和第二次付款（MYA/PHA/80/TAS/18）；

(三) 秘书处将就可能取消氟氯烃淘汰管理计划之事致函阿富汗政府和作为执行机构的工发组织：第一阶段，第三次付款 (AFG/PHA/79/INV/22)；

(四) 作为双边和执行机构 2022 年度报告和财务进展报告的一部分，双边和执行机构将向执行委员会第九十三次会议报告本文件附件一、二和三所载的 39 个执行工作出现拖延的项目和本文件附件四所载的建议提交补充情况报告的 17 个项目；以及

(五) 核准对本文件附件四的表内最后一栏所列有具体问题的各个正在进行的项目提出的建议。

## 二. 具有具体报告要求的项目

### 二.1 概述

4. 表 2 列出提交第九十二次会议并建议一揽子核准的具有具体报告要求的项目的报告。

**表 2. 具有具体报告要求并建议供一揽子核准的项目的报告**

| 国家 | 项目名称 | 段次 |
|---|---|---|
| **与氟氯烃淘汰管理计划有关的报告** | | |
| 孟加拉国 | 氟氯烃淘汰管理计划（第二阶段 - 核查报告） | 7 - 13 |
| 巴西 | 氟氯烃淘汰管理计划（第二阶段 - U Tech 暂时使用高全球升温潜能值技术的报告） | 14 - 20 |
| 中国 | 氟氯烃淘汰管理计划（第一阶段 – 根据工业和商用制冷和空调行业计划发放增支经营费用的报告） | 21 – 26 |
| 科特迪瓦 | 氟氯烃淘汰管理计划（第一阶段 - 关于通过部际法令监管消耗臭氧层物质的进口、出口、过境、再出口和贸易以及加强与氟氯烃进出口有关的监测和报告系统的其他措施的报告） | 27 – 30 |
| 埃及 | 氟氯烃淘汰管理计划（第二阶段 – 依照第 79/34 号决定(e)段提出的灵活性请求） | 31 - 36 |
| 埃塞俄比亚 | 氯氟烃淘汰管理计划（第一阶段 - 最后一次付款的工作方案的执行进度报告） | 37 - 46 |
| 伊朗伊斯兰共和国 | 氟氯烃淘汰管理计划（第二阶段 – 改换执行机构） | 47 - 53 |
| 毛利塔尼亚 | 氟氯烃淘汰管理计划（第一阶段 – 审查氟氯烃调查报告的现况和关于修订起点和修订协定的建议） | 54 - 62 |
| 莫桑比克 | 氯氟烃淘汰管理计划（第一阶段 – 第五次和最后一次付款的工作方案执行进度报告和执行核查建议） | 63 - 78 |
| 巴基斯坦 | 氟氯烃淘汰管理计划（第二阶段 - 第三次和第四次付款执行进度报告） | 79 – 94 |
| 巴基斯坦 | 氟氯烃淘汰管理计划（第三阶段 - 关于进口含有 HCFC-141b 的预混多元醇的情况报告和泡沫塑料行业技术援助实施进展报告） | 95 – 100 |
| 太平洋岛屿国家 | 氯氟烃淘汰管理计划（第一阶段 – 第一阶段最后一次付款的工作方案执行进度报告和提交 12 个太平洋岛屿国家的项目完成报告） | 101 – 117 |
| 菲律宾 | 氟氯烃淘汰管理计划（第二阶段 – 最后一次付款的执行进度报告和核查报告） | 118 - 131 |
| 圣卢西亚 | 氯氟烃淘汰管理计划（第一阶段 – 最后一次付款的工作方案的最后执行进度报告和提交项目完成报告） | 132 – 140 |
| 沙特阿拉伯 | 氟氯烃淘汰管理计划（第一阶段 – 剩余活动的执行进度报告） | 141 - 146 |
| **与氢氟碳化物相关的报告** | | |
| 约旦 | 关于 Petra Engineering Industries Co.制造大型 400 千瓦大型商用一体式屋顶空调机组的设施从氢氟碳化物改用丙烷的项目的报告 | 147 - 160 |
| **关于处置消耗臭氧层物质的报告** | | |

| 国家 | 项目名称 | 段次 |
|---|---|---|
| 巴西 | 消耗臭氧层物质废物管理和处置试点示范项目（最后报告） | 161 - 172 |
| **关于低全球升温潜能值项目的报告** | | |
| 沙特阿拉伯 | 在高环境温度下空调行业推广低全球升温潜能值的氢氟烯烃制冷剂的示范项目（最后进度报告） | 173 – 182 |

5. 表 3 列出提交第九十二次会议供单独审议的两份报告和对相关问题的简短解释。

**表 3. 关于具有具体报告要求并供单独审议的项目的报告**

| 国家 | 项目名称 | 问题 | 段次 |
|---|---|---|---|
| **与第 83/41 号决定(e)段有关的报告** | | | |
| 中国 | 执行第 83/41 号决定(e)段所列活动的进度报告 | 第 83/41 号决定(e)段所列各项活动的执行进度报告 | 184 – 190 |
| **与氢氟碳化物相关的报告** | | | |
| 阿根廷 | 控制在生产 HCFC-22 中产生的 HFC-23 的排放量 | 更新项目执行情况，包括不再将副产品 HFC-23 排放到大气和正在整修焚化炉 | 191 - 198 |

## 二.2 “一揽子”核准

6. 本节包括 15 份与氟氯烃淘汰管理计划相关的项目的报告、1 份关于氢氟碳化物项目的报告、1 个消耗臭氧层物质处置项目和 1 个低全球升温潜能值项目。

### A. 与氟氯烃淘汰管理计划有关的报告

**<u>孟加拉国：氟氯烃淘汰管理计划（第二阶段 – 核查报告）</u>（开发计划署和环境规划署）**

**背景**

7. 在第九十次会议上，通过第 90/44 号决定，执行委员会决定：

“(b) 核准孟加拉国氟氯烃淘汰管理计划第二阶段第二次付款和相应的付款执行计划，供资金额 2,142,405 美元，外加给开发计划署的机构支助费用 149,968 美元，但有一项谅解，即：

(一) 只有在秘书处依照第 72/19 号决定(b)段收到和审查核查报告后，财务主任才能将核准的资金发放给开发计划署；

(二) 开发计划署承诺在 2022 年 6 月底之前提交核查报告，且不迟于第九十一次会议举行之前 12 周；

(三) 核查报告提出的各项建议将在执行氟氯烃淘汰管理计划第二阶段第二次付款期间得到处理，并且为此采取的行动将被列入孟加拉国为申请第三次付款提出的氟氯烃淘汰管理计划第二阶段第二次付款的进度报告；以及

(四) 如果核查报告确认孟加拉国没有履行《蒙特利尔议定书》及其与执行委员会签订的协定，则秘书处将通知执行委员会可在第九十一次会议审议相关行动，包括适用惩罚条款。”

8. 在第九十一次会议上，执行委员会注意到开发计划署提交的孟加拉国 2019-2021 年氟氯烃消费量核查报告，该报告将由秘书处在第九十二次会议提交委员会审查，并注意到只有在秘书处根据第 72/19 号决定(b)段和第 90/44 号决定审查核查报告后，才会请财务主任为氟氯烃淘汰管理计划第二阶段第二次付款核准的资金发放给开发计划署（第 91/18 号决定）。

## 核查报告

9. 核查报告确认，该国政府正在对氟氯烃的进出口实施一项许可证颁发和配额制度，并且根据《蒙特利尔议定书》第 7 条报告的 2019 年至 2021 年氟氯烃总消费量正确无误（如下文表 4 所示），不过第 7 条数据与 2019 年核实的 HCFC-142b 消费量略有差异。核查结果表明，孟加拉国政府有效实施了许可证颁发和配额制度，达到了它与执行委员会签订的协定中的各项目标。核查报告还列入以下各项建议：每年向进口商只发放一次配额、一旦 HCFC-22 的货源进一步减少，制定一项满足维修需求的计划、利用 OzonAction GWP-ODP 计算器等可用的工具、采取行动到 2025 年禁止使用含有消耗臭氧层物质的设备并确保海关官员拥有足够的设备和进行识别消耗臭氧层物质的培训。

**表 4： 孟加拉国的氟氯烃消费量（2019-2021 年第 7 条数据）**

| **氟氯烃** | **2019** | **2020** | **2021** | **基准量** |
|---|---|---|---|---|
| **公吨** | | | | |
| HCFC-22 | 875.51 | 844.97 | 852.73 | 825.86 |
| HCFC-123 | 2.50 | 2.60 | 2.00 | 10.50 |
| HCFC-124 | 0.00 | 0.00 | 0.00 | 3.18 |
| HCFC-141b | 0.00 | 0.00 | 0.00 | 193.00 |
| HCFC-142b | 9.77 | 0.00 | 0.00 | 88.04 |
| **（小计/共计）(公吨)** | **887.72** | **847.57** | **854.73** | **1,120.58** |
| 进口的预混多元醇中的 HCFC-141b* | 310 | 360 | 440 | - |
| **ODP 吨** | | | | |
| HCFC-22 | 48.15 | 46.47 | 46.90 | 45.42 |
| HCFC-123 | 0.05 | 0.05 | 0.04 | 0.21 |
| HCFC-124 | 0.00 | 0.00 | 0.00 | 0.07 |
| HCFC-141b | 0.00 | 0.00 | 0.00 | 21.23 |
| HCFC-142b | 0.63 | 0.00 | 0.00 | 5.72 |
| **（小计/共计）（ODP 吨)** | **48.84** | **46.53** | **46.94** | **72.65** |
| 进口的预混多元醇中的 HCFC-141b* | 34.10 | 39.60 | 48.4 | - |

* 国家方案数据

**秘书处的评论**

10. 秘书处审查了核查报告，请开发计划署对一些未提供的信息作出说明，包括说明进口商如何进行注册、如何决定配额和加以发放以及核查报告中的建议如何得到实施。开发计划署提供了要求提供的信息并相应地修改了核查报告，秘书处认为该报告与该国的许可证颁发制度相一致。关于观察到的第 7 条数据与 2019 年核实的 HCFC-142b 消费量之间的微小差异问题，它比报告的消费量少 0.02 公吨，该国政府认识到，这是当年提交报告时的问题，目前这些问题已得到纠正，这将为接下来的几年提供更好的报告。

11. 孟加拉国政府部门已对核查报告作出回应，承诺将执行其中所载的建议，并在申请下一次付款时，向执行委员会报告执行进展情况。

12. 在审查后，秘书处请财务主任将第九十次会议为第二次付款原则上批准的 2,142,405 美元外加机构支助费用 149,968 美元发放给开发计划署。

**建议**

13. 谨建议执行委员会：

(a) 注意到开发计划署提交并载于 UNEP/OzL.Pro/ExCom/92/9 号文件的孟加拉国 2019 年至 2021 年氟氯烃消费量的核查报告；

(b) 进一步注意到，第九十次会议为孟加拉国氟氯烃淘汰管理计划第二阶段第二次付款原则上核准的资金 2,142,405 美元外加机构支助费用 149,968 美元已由财务主任发放给开发计划署；以及

(c) 请开发计划署在提交第三次付款申请时，作为孟加拉国氟氯烃淘汰管理计划第二阶段第二次付款进度报告的一部分，报告核查建议的执行进展情况。

**巴西：氟氯烃淘汰管理计划（第二阶段 - U Tech 暂时使用高全球升温潜能值技术的报告）（开发计划署）**

**背景**

14. 开发计划署在第八十次会议指出，配方厂家 U-Tech 要求在泡沫配方中暂时使用 HFC-134 来代替 HCFC-22，因为氢氟烯烃在该国还没有商业供应。U-Tech 已签署承诺书，保证一旦氢氟烯烃上市供应，并且配方得到开发和优化，就停用氢氟碳化物混合物，而多边基金无需为此承担额外费用。

15. 因此，执行委员会请开发计划署继续协助 U-Tech 取得选用的替代技术所需的供应，但有一项谅解，即在选用的替代技术或另一种低全球升温潜能值技术得到全面采用以及对全面采用原来选用的技术或另一种低全球升温潜能值技术之前的临时技术的使用情况提出报告之前，不会支付增支经营费用（第 80/12 号决定(e)段）。委员会还请开发计划署向每次会议提交供应商在国内市场取得选用的技术包括相关组件的最新进展情况的报告（第 81/9 号决定(b)段）。自此之后，开发计划署在每次会议都报告了临时技术的使用情况。

16. 在第八十八次会议上，开发计划署报告指出，U-Tech 已研发出一种使用气态氢氟烯烃（Solstice GBA）的配方，但这种物质的成本过高，在商业上无利可图，并指出，如果 Solstice GBA 到 2024 年仍不能商用，则 U-Tech 用于淘汰 HCFC-22 剩余的资金将在第二阶段结束时退还多边基金。

17. 在第九十一次会议上，开发计划署指出，U-Tech 在使用 HFC-134a 方面没有取得新进展，并且由于国内市场 HFO-1233zd(E)供货不足，三个已经改用低全球升温潜能值替代品的配方厂家（Amino、Flexível 和 Purcom）请求巴西政府同意暂时向一些客户提供 HFC-365mfc/HFC-227ea。因此，执行委员会请开发计划署继续协助巴西政府向 Amino、Flexível、Purcom 和 U-Tech 四家配方厂家提供低全球升温潜能值的替代技术，并继续依照第 80/12 号决定(e)段和第 81/9 号决定(b)段就此事提出报告（第 91/26 号决定(c)段）。

## 进度报告

18. 依照第 91/26 号决定(c)段的规定，开发计划署报告指出，由于气态氢氟烯烃（Solstice GBA）成本过高，在商业上无利可图，因此 U-Tech 公司暂时使用 HFC-134a 的情况没有进一步发展。关于其他三个暂时使用 HFC-365mfc/HFC-227ea 混合物的配方厂家，Purcom 已经停用并为其所有客户继续提供低全球升温潜能值技术（例如，甲酸甲酯和水基）；尽管与供应商进行了谈判，但由于氢氟烯烃的价格过高，预计到 2023 年 8 月，Amino 和 Flexível 将继续使用该混合物。开发计划署重申，没有为改用制冷剂暂时使用氢氟碳化物支付增支经营费用。

## 秘书处的评论

19. 注意到 Purcom 不再使用氢氟碳化物，但由于选用的替代技术不易取得和成本过高，其余三个配方厂家继续使用它们，秘书处建议开发计划署继续协助 Amino、Flexível 和 U Tech 取得选定的替代技术或另一种低全球升温潜能值技术，并依照第 91/26 号决定(c)段就氢氟碳化物的临时使用情况提出报告。

## 建议

20. 谨建议执行委员会：

(a) 注意到：

(一) UNEP/OzL.Pro/ExCom/92/9 号文件所载开发计划署在巴西氟氯烃淘汰管理计划第二阶段下就 Amino、Flexível、Purcom 和 U tech 配方厂家临时使用具有高全球升温潜能值的替代品提交的报告；

(二) Purcom 配方厂家已停用高全球升温潜能值技术，并为其所有客户提供低全球升温潜能值技术；以及

(b) 请开发计划署继续协助巴西政府向配方厂家 Amino、Flexível 和 U Tech 提供低全球升温潜能值的替代技术，但有一项谅解，即在最初选用的技术或另一种低全球升温潜能值技术得到全面采用之前，不会支付任何可能与改换技术

有关的增支经营费用，并向每次会议提交关于暂时使用高全球升温潜能值替代品的报告，直至最初选用的技术或另一种低全球升温潜能值技术得到全面采用为止，同时还就该国市场上供应商提供选定的技术包括相关部件的最新情况提交报告。

**中国：氟氯烃淘汰管理计划（第一阶段 – 根据工业和商用制冷和空调行业计划发放增支经营费用的报告）（开发计划署）**

**背景**

21. 氟氯烃淘汰管理计划第一阶段的工业和商业制冷和空调（ICR）行业计划在第六十四次会议得到批准，总费用 61,000,000 美元，以期在 2015 年达到削减氟氯烃基准消费量 10%。ICR 行业计划已于 2019 年实施完成，发放承诺的增支经营费用也计划于 2020 年完成。项目完成报告提交给了第八十五次会议。2019 年底爆发的 COVID-19 大流行减缓了经济活动，增支经营费用的发放遭到拖延。在第 86 次会议上，执行委员会允许在 2021 年底之前继续生产和销售转换后的产品并发放增支经营费用。

22. 在第九十次会议上，开发计划署提交了一份关于发放增支经营费用的报告，指出仍有 84%的增支经营费用没有发放。发放增支经营费用缓慢的原因与培训和模型设计使用易燃的 HFC-32 的产品需要额外的努力和时间有关。根据中国政府的请求，执行委员会批准将中国工业和商业制冷和空调（ICR）行业计划第一阶段的财务完成时间延长至 2022 年 12 月 31 日，以便能够发放增支经营费用，但有一项谅解，即不得再要求延长期限。执行委员会还请中国政府和开发计划署在第九十二次会议提交根据工业和商业制冷和空调（ICR）行业计划第一阶段发放增支经营费用的报告（第 90/27 号决定）。

23. 依照第 90/27 号决定(c)段的规定，开发计划署代表中国政府提交了报告。2022 年又向企业发放了增支经营费用 868,300 美元。截至 2022 年 12 月 31 日，增支经营费用余额估计为 1,163,094 美元（占核准的增支经营费用总额的 7%）。具体数额将在进行财务审计后得出，并将在第九十三次会议核准财务审计报告后归还多边基金。

**秘书处的评论**

24. 经询问后，开发计划署指出，发放增支经营费用的依据是改换后的生产线制造的产品证实已在国内市场销售或已出口到第 5 条国家。在发放增支经营费用后，以下 4 家企业共生产了 356,092 台组件：山东格瑞德、海尔、南京天加、宁波奥克斯。这些产品均使用 HFC-32 技术，供国内使用。

25. 开发计划署指出，未发放的增支经营费用都与使用 HFC-32 技术生产商用和工业用水冷空调机、热泵和一体式空调机的五家企业的五条生产线有关。对外环境合作中心（FECO）和中国制冷空调工业协会（CRAA）与企业合作，继续提高对解决易燃性问题的认识、促进市场采用并降低 HFC-32 技术的成本。在 2022 年中国制冷展期间，对外环境合作中心（FECO）和中国制冷空调工业协会（CRAA）组织了一系列研讨会，以分享经验、交流信息、讨论研究和技术问题。使用 HFC-32 的装置的国内销量逐年增加。据行业统计，截至 2022 年底，已经出售了 2,345,010 台使用 HFC-32 的水冷空调机、热泵、一体式空调机和压缩机，较 2021 年底同期销售的 1,469,714 台增长 60%。

**建议**

26. 谨建议执行委员会注意到：

(a) UNEP/OzL.Pro/ExCom/92/9 号文件所载开发计划署依照第 90/27 号决定代表中国政府提交的关于中国氟氯烃淘汰管理计划第一阶段下工业和商业制冷和空调行业计划发放增支经营费用的报告；以及

(b) 在第九十三次会议批准财务审计报告后，增支经营费用余额 1,163,094 美元加上给开发计划署的机构支助费用 81,417 美元将退还给多边基金。

**科特迪瓦：氟氯烃淘汰管理计划（第一阶段 - 关于通过部际法令监管消耗臭氧层物质的进口、出口、过境、再出口和贸易以及加强与氟氯烃进出口有关的监测和报告系统的其他措施的报告）（环境规划署）**

**背景**

27. 在第九十次会议上，执行委员会核准了科特迪瓦氟氯烃淘汰管理计划第一阶段的第五次付款，但有一项谅解，即政府将通过环境规划署在第九十一次会议上提供最新情况，说明通过部际法令监管消耗臭氧层物质的进口、出口、过境、再出口和贸易以及加强与氟氯烃进出口有关的监测和报告系统的其他措施（第 90/32 号决定）。[12]

28. 在第九十一次会议上，依照第 90/32 号决定，科特迪瓦政府通过环境规划署报告说，环境和可持续发展部长已于 2022 年 2 月签署部际法令，他还在 2022 年 10 月 20 日之前采纳了其他三位部长的意见，并将法令交给他们签署。随后，执行委员会请科特迪瓦政府通过环境规划署在第九十二次会议提供关于通过部际法令之事的最新情况（第 91/21 号决定(b)段）。

**进度报告**

29. 应第 91/21 号决定(b)段的要求，科特迪瓦政府通过环境规划署提交了一份报告，确认工商业和中小企业促进部长、预算和国家投资组合部长和环境与可持续发展部长于 2023 年 2 月 14 日签署了管理消耗臭氧层物质进口、出口、过境、再出口和贸易以及加强与氟氯烃进出口有关的监测和报告系统的其他措施的部际法令，这项法令已获通过。

**建议**

30. 谨建议执行委员会注意到：

(a) 环境规划署提交的并载于 UNEP/OzL.Pro/ExCom/92/9 号文件的关于通过部际法令监管科特迪瓦氟氯烃淘汰管理计划第一阶段下消耗臭氧层物质的进口、出口、过境、再出口和贸易以及加强与氟氯烃进出口有关的监测和报告系统的其他措施的报告；以及

[12] 规定载于 UNEP/OzL.Pro/ExCom/90/40 号文件附件八。

(b) 赞赏科特迪瓦政府为通过上文(a)分段提到的部际法令所做的努力。

**埃及：氟氯烃淘汰管理计划（第二阶段 – 依照第 79/34 号决定(e)段提出的灵活性请求）（工发组织、开发计划署、环境规划署和德国政府）**

## 背景

31. 在第七十九次会议上，执行委员会核准了埃及氟氯烃淘汰管理计划第二阶段，其中除其他外，预备将八家制造家用冰箱的企业改为使用环戊烷（第79/34号决定）。作为这项决定的一部分，如果在执行期间认为有此必要，埃及政府可以灵活地将资金分配给聚氨酯泡沫塑料行业中没有申请供资的合格企业（第79/34号决定(e)段）。

## 请求灵活性

32. 依照氟氯烃淘汰管理计划第二阶段，工发组织采购并交付了将八家制造企业之一的Bahgat的生产线从使用HCFC141b改用环戊烷所需的设备。由于COVID-19大流行，转换工作遭到拖延，新的所有人接手该企业，随着大流行后的市场变化，他决定退出这个项目并放弃家用制冷制造行业。[13] 根据第79/34号决定(e)段的规定，工发组织设法寻找另一家可以使用这些设备的企业而不需将其拍卖，虽然没有找到一家没有申请供资的企业，但工发组织还是找到一家符合资格并参加氟氯烃淘汰管理计划第二阶段的企业Tredco，它希望购买Bahgat的现有生产线并使用工发组织为改换生产线而购买的设备，有效地将生产线转移到自己的工厂。该企业将进行必要的土建工程，以便安装设备，并且需要帮助将设备运输到其工厂和进行安装工程。

33. 工发组织代表埃及政府提议向Tredco提供设备，使用聚氨酯泡沫塑料制造项目的结余（截至2023年5月为7,214美元）将设备从Bahgat运送到Tredco，进行任何所需的安装工程，并销毁目前使用HCFC-141b的发泡机。

## 秘书处的评论

34. 工发组织指出，不使用结余款将设备从 Bahgat 运送到 Tredco 可能会使转移工作无法进行，这使工发组织只有设法拍卖设备这一唯一选择，但这不是最好的选择，因为这些设备卖不了多少钱。

35. 秘书处注意到结余款金额有限（7,214 美元），认为要求的灵活性支持项目的目标，包括继续将家用制冷制造行业改用环戊烷。因此，鉴于这种特殊情况，秘书处支持这项请求，指出 (a)否则 Tredco 就需要购买类似的设备；(b) 现有设备的规格符合 Tredco 的需求，因此一旦完成必要的土建工程，该企业就可使用该设备；(c) 结余款不会用于土建工程，任何土建工程费用都将由 Tredco 承担；(d) 结余款仅用于运送设备、用于任何必要的安装工程和销毁目前使用 HCFC-141b 的发泡机。

[13] 该企业已停止生产家用冰箱，但并未破产，并在其他领域保持活跃。

**建议**

36. 谨建议执行委员会作为例外情况，核准工发组织向 Tredco 企业提供援助的请求，以便能在埃及氟氯烃淘汰管理计划第二阶段下，将为转换使用 HCFC-141b 的泡沫塑料生产线购买的设备从 Bahgat 运送到 Tredco。

**埃塞俄比亚：氯氟烃淘汰管理计划（第一阶段 - 最后一次付款的工作方案的执行进度报告）（环境规划署和工发组织）**

**背景**

37. 在第八十五次会议上，鉴于COVID-19大流行可能进一步拖延淘汰活动的实施，执行委员会作为例外情况，核准并注意到在不要求进一步延长项目实施的情况下，延长埃塞俄比亚氟氯烃淘汰管理计划第一阶段的完成日期至2022年12月31日（第85/22号决定(a)段）。

38. 依照这项决定，环境规划署作为牵头执行机构代表埃塞俄比亚政府提交了与氟氯烃淘汰管理计划第一阶段第三次也是最后一次付款相关的工作方案的最终执行进度报告。

**氟氯烃消费量**

39. 埃塞俄比亚只消费专门用于维修行业的 HCFC-22。埃塞俄比亚政府在国家方案执行报告中报告了 2022 年氟氯烃消费量 3.17 ODP 吨，它比氟氯烃履约基准量低 42%。随着氟氯烃淘汰管理计划活动以及许可证颁发和配额制度的实施，消费量继续下降。

40. 埃塞俄比亚政府在 2021 年国家方案执行报告中报告了氟氯烃行业的消费量数据，它与根据《蒙特利尔议定书》第 7 条报告的数据相符。

**第一阶段最后一次付款的执行进度报告**

*法律框架*

41. 该国政府继续有效实施它的氟氯烃进出口许可证颁发和配额制度。国家臭氧机构每年召开两次会议，评估配额制度的效用并设定下一年的配额。埃塞俄比亚政府已经发布 2023 年氟氯烃进口配额为 3.15 ODP 吨，它低于该年《蒙特利尔议定书》的控制目标 3.58 ODP 吨。

42. 为 68 名海关官员举办了三期关于控制和监测消耗臭氧层物质的培训班，其中 22 名是女性，并依照提交给第七十七次会议的核查报告的建议，建立了供进口商在线申请配额的网站。

*制冷维修行业*

43. 2021 年 5 月至 2022 年 12 月执行了以下各项活动：

(a) 为 41 名制冷和空调技术人员举办了两期培训班，其中 3 名是女性，培训内

容涉及良好维修做法、新兴技术以及安全维修和维护使用低全球升温潜能值制冷剂的制冷和空调设备；以及

(b) 为职业培训中心提供培训设备（例如，回收钢瓶、歧管仪表组、气体探测器和碳氢化物教学装置）、为海关和培训中心提供制冷剂识别器以及为维修技术人员提供工具（例如，可调扳手、扩口套件、型锻工具、钎焊焊枪、弯管机、阀门和管件）。

资金发放情况

44. 截至 2023 年 4 月，为第一阶段核准的 315,000 美元均已全数发放（环境规划署 175,000 美元和工发组织 140,000 美元）。

**秘书处的评论**

45. 尽管该国面临 COVID-19 大流行和政治局势带来的挑战，但氟氯烃淘汰管理计划第一阶段已经完成。氟氯烃淘汰管理计划第二阶段的申请在第八十七次会议提交，但随即撤回，预计将于 2024 年再次提交。

**建议**

46. 谨建议执行委员会注意到 UNEP/OzL.Pro/ExCom/92/9 号文件所载环境规划署根据第 85/22 号决定(a)段提交的埃塞俄比亚氟氯烃淘汰管理计划第一阶段最后一次付款相关的工作方案的最终执行进度报告。

**伊朗伊斯兰共和国：氟氯烃淘汰管理计划（第二阶段—更换执行机构）（开发计划署、环境规划署、工发组织和德国）**

47. 开发计划署作为牵头执行机构，代表伊朗伊斯兰共和国政府向第九十二次会议提交了一份申请，请求将德国政府正在执行的氟氯烃淘汰管理计划第二阶段组成部分和氟氯烃淘汰管理计划第三阶段的筹备工作移交给开发计划署[5]。

48. 与德国政府移交开发计划署的项目有关的资金总额为 963,132 美元(外加机构支助费用)，其中包括氟氯烃淘汰管理计划第二阶段第二、第三和第四次付款中的未用余额 836,272 美元，原则上核准用于第二阶段第五次付款的 96,860 美元，以及第三阶段筹备工作中的未用余额 30,000 美元。表 5 列出了为德国政府在氟氯烃淘汰管理计划第二阶段核准的每一次付款和第三阶段筹备工作付款的发放情况和所剩余额。

**表 5. 德国政府向开发计划署移交项目的资金发放情况(美元)**

| 项目详情 | | | 给德国政府的资金 | | |
|---|---|---|---|---|---|
| **供资申请** | **编号** | **行业** | **核准*** | **发放** | **待移交的余额** |
| **氟氯烃淘汰管理计划第二阶段** | | | | | |
| 第一次付款 | IRA/PHA/77/INV/225 | 泡沫塑料 | 645,500 | 645,500 | 0 |
| **小计** | | | **645,500** | **645,500** | **0** |

[5] 根据 2023 年 3 月 19 日伊朗伊斯兰共和国环境部给开发计划署的信。

| | | | | | |
|---|---|---|---|---|---|
| 第二次付款 | IRA/PHA/84/INV/236 | 维修行业 | 962,860 | 869,843 | 93,017 |
| | IRA/PHA/84/INV/242 | 泡沫塑料 | 84,175 | 84,175 | 0 |
| **小计** | | | **1,047,035** | **954,018** | **93,017** |
| 第三次付款 | IRA/PHA/86/INV/244 | 泡沫塑料 | 139,754 | 139,754 | 0 |
| | IRA/PHA/86/INV/250 | 商用制冷剂 | 145,255 | 0 | 145,255 |
| **小计** | | | **285,009** | **139,754** | **145,255** |
| 第四次付款 | IRA/PHA/90/INV/259 | 商用制冷剂 | 502,500 | 0 | 502,500 |
| | IRA/PHA/90/INV/260 | 泡沫塑料 | 95,500 | 0 | 95,500 |
| **小计** | | | **598,000** | **0** | **598,000** |
| **第二阶段小计** | | | **2,575,544** | **1,739,272** | **836,272** |
| **氟氯烃淘汰管理计划第三阶段** | | | | | |
| 筹备工作 | IRA/PHA/87/PRP/251 | 总括 | 15,000 | 10,000 | 5,000 |
| 供资 | IRA/PHA/87/PRP/252 | 工业制冷剂 | 25,000 | 0 | 25,000 |
| **第三阶段小计** | | | **40,000** | **10,000** | **30,000** |
| **总计** | | | **2,615,544** | **1,749,272** | **866,272** |

* 如基金秘书处的项目清单所示

49. 更换机构的申请包括一份关于在氟氯烃淘汰管理计划第二阶段头四个付款项下已在德国政府援助下开展活动情况的进度报告，以及在移交完成后通过开发计划署继续开展这些活动的行动计划。这些活动是：

(a) 在聚氨酯泡沫塑料行业，与一个配方厂家完成了水发泡配方的开发；最后一家制造整皮泡沫塑料的企业完成转换；继续就采用的低全球升温潜能值(GWP)技术向受援中小企业提供技术援助和培训（95,500 美元）；

(b) 在商业制冷行业，进一步向受援企业提供技术援助，包括低 GWP 技术培训；发布处理二氧化碳的培训材料和基于丙烷(R-290)和二氧化碳技术的新虚拟培训模块；将欧洲联盟培训标准纳入技术和职业培训组织的培训材料和标准；发布可再充装钢瓶的使用指南，禁止使用不可再充装钢瓶；推广基于二氧化碳的技术，作为中央制冷系统的替代办法；示范操作采用高科技控制的碳氢化物制冷机组；展示冷藏卡车内的低 GWP 技术；推动使用电子膨胀阀的能力建设(647,755 美元)；以及

(c) 在制冷维修行业，制定技术人员认证计划；继续与技术和职业组织联合提供培训；完成了一项关于采用 R-290 建筑规范所遇障碍的研究；向经销商和分销商提供能力建设和气瓶；完成制冷剂分配系统的最后安装(93,017 美元)。

## 秘书处的评论

50. 秘书处注意到，伊朗伊斯兰共和国政府、德国政府和开发计划署就移交正在氟氯烃淘汰管理计划下开展的活动进行了磋商。作为牵头机构，开发计划署确认，它们将能够有效地将移交的活动纳入其目前在氟氯烃淘汰管理计划下开展的活动。开发计划署还承诺确保在 2025 年 12 月既定日期前完成第二阶段的所有活动，并确认将与有关当局讨论实施细节。将在定于 2023 年第二次会议上提交的第五次付款申请中纳入关于这些活动情况的进度报告。

51. 秘书处更新了本文件附件五所载的伊朗伊斯兰共和国政府与执行委员会之间的《协定》，以在附录 2 A 中反映德国政府将第二、第三和第四次付款的未用余额转入开发计划署第四次付款部分，以及德国政府将原则上核准的全部第五次付款转入开发计划署第五次付款部分。对《协定》第 17 段进行了调整，以表明经修订的最新《协定》取代第九十次会议上达成的协定。

52. 关于结余和可用资源的报告 [6] 讨论了德国政府退还余额和将第二阶段第二、第三和第四次付款以及氟氯烃淘汰管理计划第三阶段筹备工作的资金转给开发计划署的的事项。

## 建议

53. 谨建议执行委员会：

(a) 注意到伊朗伊斯兰共和国政府请求将氟氯烃淘汰管理计划第二阶段的所有剩余活动以及德国政府获核准的氟氯烃淘汰管理计划第三阶段的筹备工作移交给开发计划署；

(b) 关于氟氯烃淘汰管理计划第二阶段:

(一) 注意到关于德国政府返还第二、第三和第四次付款余额以及将相应资金总额转交开发计划署用于执行第四次付款的第 92/XX 号决定；

(二) 核准：

a. 向开发计划署转拨 836,272 美元，外加 58,539 美元的机构支助费用，以便纳入正在落实的氟氯烃淘汰管理计划第二阶段第四次付款;

b. 德国政府向开发计划署转移原则上核准的96,860美元的供资，外加 6,780 美元的机构支助费用，用于氟氯烃淘汰管理计划第二阶段第五次付款；

(三) 又注意到基金秘书处更新了伊朗伊斯兰共和国政府与执行委员会之间关于氟氯烃淘汰管理计划第二阶段的《协定》，见本文件附件五，特

[6] UNEP/OzL.Pro/ExCom/92/4。

别是根据德国政府向开发计划署移交各构成部分而编制的附录 2-A，并对第 17 段进行了修改，以表明经修订的最新《协定》取代第九十次会议上达成的协定；以及

(c) 关于氟氯烃淘汰管理计划第三阶段的筹备工作，注意到关于德国政府返还余额并将资金转给开发计划署用于编制总体战略和筹备工业制冷和空调行业投资活动的第 92/XX 号决定。

**毛里塔尼亚：氟氯烃淘汰管理计划（第一阶段—氟氯烃调查报告的审查情况、关于订正起点的建议和订正协定）（环境规划署）**

## 背景

54. 第八十次会议核准了毛里塔尼亚氟氯烃淘汰管理计划第一阶段，其依据是氟氯烃消费总量削减起点估计为 6.60 ODP 吨(120.00 公吨)，并基于一项谅解，即在提交和核准第二次供资付款之前，将开展一项全面调查，以确定该国的实际消费量并进行独立核查；可以根据调查结果修改起点(第 80/57 号决定)。

55. 在第九十一次会议上，环境规划署申请为第二次付款提供资金，包括氟氯烃调查 [7] 和一份独立核查报告 [8]，以支持请求将起点修订为 20.50 ODP 吨(372 公吨)。秘书处和环境规划署讨论了与调查结果有关的若干事项，包括毛里塔尼亚比邻国相对较高的人均氟氯烃消费量、不同分行业用于确定总消费量的方法、异常高的泄漏率，以及渔业部门消费量的更多详情。秘书处注意到环境规划署需要更多时间来提供所有信息，同意环境规划署根据调查结果完成关于修订起点的讨论，并向第九十二次会议提交一份分析报告。

56. 因此，执行委员会注意到 [9]，秘书处将在第九十二次会议上介绍对毛里塔尼亚氟氯烃调查报告的审查、关于氟氯烃消费总量削减的修订起点的建议，以及在与环境规划署就提交第九十一次会议的氟氯烃调查的进一步协商基础上修订的政府与执行委员会之间的《协定》。

## 情况报告

57. 为筹备第九十二次会议，秘书处与环境规划署就提交给第九十一次会议的氟氯烃调查报告的细节进行了进一步协商。

58. 环境规划署为制冷和空调分行业的消费量提供了更多的理由，解释说这是基于采矿（黄金和铁）和渔业的工业发展造成的。环境规划署补充说，超过一半的毛里塔尼亚人生活在城市地区，与其他非洲国家相比，该国较高的环境温度导致每个家庭拥有多个空调。此外，环境规划署解释说，冷室、中央空调和工业应用中的氟氯烃泄漏率约为 40%，原因

[7] 该调查收集了 2021 年氟氯烃消费数据、设备详情和使用年限，特别是在大型空调应用中，并将这些信息与核实的进口数据进行了交叉核对。

[8] 毛里塔尼亚的核查报告显示，2017 年氟氯烃消费量为 15.80 ODP 吨；2018 年为 15.05ODP 吨；2019 年为 ODP13.91；2020 年为 ODP13.19；2021 年为 ODP13.12，与调查结果一致。

[9] UNEP/OzL.Pro/ExCom/91/72 号文件附件十六中的规定。

是电力供应不稳定、设备老化和维护不足，以及运行中的许多设备都是二手货。环境规划署证实，国际渔船的制冷维修属于调查的一部分。

59. 在本文件发布时，秘书处和环境规划署仍在讨论每个分行业的设备数量及其与该国经济结构的相关性，以跟踪氟氯烃进口和维修需求。环境规划署正根据这些讨论结果编制每个制冷和空调分行业的最新消费量。

**秘书处的评论**

60. 秘书处指出，为了对起点作进一步评估，需要有更多信息来了解调查所涉年份每个分行业使用氟氯烃的设备数量。秘书处同意环境规划署的意见，即毛里塔尼亚政府将在区域履约协助方案小组的支持下，继续处理社会经济数据，以证明该国使用氟氯烃的合理性。

61. 鉴于上述情况，秘书处将在第九十三次会议上提交对调查报告的最终审查、关于氟氯烃消费总量削减订正起点的建议，以及政府与执行委员会之间的订正《协定》。

**建议**

62. 谨建议执行委员会：

(a) 注意到UNEP/OzL.Pro/ExCom/92/9号文件所载氟氯烃调查报告的审查情况、关于订正起点的建议和氟氯烃淘汰管理计划第一阶段订正《协定》；

(b) 请环境规划署提供关于调查所涉年份每个分行业的设备数量和氟氯烃使用情况的补充资料；以及

(c) 注意到秘书处将在第九十三次会议上提交对调查报告的审查结果，其中包括上文第(b)分段提及的补充资料、关于氟氯烃消费总量削减订正起点的建议，以及毛里塔尼亚政府和执行委员会根据第 91/41 号决定签署的氟氯烃淘汰管理计划第一阶段订正《协定》。

**莫桑比克：氟氯烃淘汰管理计划（第一阶段—关于第五次也是最后一次付款相关的工作方案执行情况和核查建议执行情况的进度报告）（环境规划署和工发组织）**

**背景**

63. 莫桑比克氟氯烃淘汰管理计划第一阶段最初在第六十六次会议上核准，并在第八十三次会议上进行了修订，目的是到 2020 年将氟氯烃消费从基准量削减 35%，金额为332,500美元，外加36,825美元的机构支助费用。

64. 第九十次会议核准了第一阶段第五次也是最后一次付款，但有一项谅解，即环境规划署、工发组织和政府将加紧努力实施第一阶段的剩余活动；环境规划署将向 2023 年第一次会议提交一份关于活动执行情况，包括核查建议执行进展的进度报告；并且只有在秘书处收到确认工发组织部分的设备已分发给受益者并进行了相关培训之后，才会审议第二

阶段（第 90/32(a)号决定）[10]。

65. 在同一次会议上，考虑到 COVID-19 大流行造成执行工作的延误，氟氯烃淘汰管理计划第一阶段的期限作为例外延长至 2023 年 6 月 30 日，但有一项谅解，即不得要求进一步延长。

**进度报告**

66. 根据第 90/32 号决定，环境规划署作为牵头执行机构，代表莫桑比克政府提交了关于氟氯烃淘汰管理计划第一阶段剩余活动和核查建议执行情况的进度报告。

67. 在执行第五次付款过程中，该国于 2023 年 2 月与环境规划署签署了相关协议(SSFA[11])，并于 2023 年 2 月支付了第一笔款项。导致延误的原因是主管部行政变动。尽管 SSFA 签署晚了，该国仍能够实施项目活动。

68. 国家臭氧机构于 2023 年 2 月为海关官员组织了一次能力建设讲习班，来自不同边境点的 15 名海关官员包括 4 名女性参加了讲习班。为 40 名海关官员组织了另一期讲习班，他们将接受消耗臭氧层物质贸易控制和监测的培训。国家臭氧机构还举办了关于氟氯烃淘汰和即将实现的相关目标的讲习班，参加讲习班的有制冷和空调技术人员、标准局官员、市政警察、巡逻管制机构、环境和经济活动检查员以及私营部门技术人员。为确保所有讲习班都有女性参加做出了特别努力。

69. 将于 2023 年 5 月举办关于安全处理易燃制冷剂的讲习班，将向 60 名技术人员提供良好维修的基本工具包。正在通过技术援助向制冷空调协会提供支持，以制定认证计划。国家臭氧机构多次组织对公共机构和私营公司的环境访问，目的是确定制冷空调行业的所有设备，即使用消耗臭氧层物质或替代制冷剂的设备总数。这些访问还检查了市场上制冷剂的质量，并帮助发现了一些贴错标签的制冷剂。

70. 国家臭氧机构组织了提高公众认识讲习班，莫桑比克电台和国家公共电视台参加了讲习班。这两家媒体都在各省用不同的地方语言提高对氟氯烃淘汰管理计划和《基加里修正案》的认识。

71. 在监测和报告部分下，举行了两次国家指导委员会会议和三次区域指导委员会会议，每次会议有 20 名成员参加，包括妇女。委员会成员包括各行各业的利益攸关方。征聘一名顾问的工作即将完成，以协助开展相关工作。

72. 将在工发组织组成部分下升级现有的制冷剂再生中心和建立第二个中心，包括为再生中心采购两个再生装置，国家臭氧机构告知，再生不是当前的优先事项，并请工发组织增加技术人员处理制冷剂和进行维护的工具。因此，工发组织向国家臭氧机构提交了一份制冷空调工具和设备拟议清单。国家臭氧机构核可了拟议的工具和设备清单，工发组织正在采购设备，计划于 2023 年 6 月分发。

[10] UNEP/OzL.Pro/ExCom/90/40 号文件附件八中的规定。

[11] 小规模供资协议。

73. 关于核查报告建议的执行情况，起草并经过各种核可程序通过了一项新条例，其中修订了配额制度，以确保向注册的进口商分配年度进口配额，而不是以先到先得的方式核准配额。预计部长会议将在 2023 年 7 月之前批准新条例。政府还在实施一项建议，即每年的氟氯烃配额一经国家指导委员会商定，就应在纸媒或电子媒体上公布，要求潜在的注册进口商视自身需求并根据该国在《蒙特利尔议定书》和多年期协定下所作承诺，申请配额。每年 12 月公布氟氯烃配额，以便在下一年 2 月处理所有申请，以确保所有分配配额的进口都在同一年完成。国家臭氧机构还在建立一个网上申请系统，将于 2023 年 12 月投入使用，作为改进整个系统的一种方式。它将包括《蒙特利尔议定书》下受控物质的在线登记。目前正在开展宣传活动，为网上系统做准备。

第一阶段完成

74. 环境规划署和工发组织都确认，根据第 90/32 号决定(a)段，第一阶段活动将于 2023 年 6 月 30 日前完成。

**秘书处的评论**

75. 秘书处注意到第一阶段的执行情况，以及莫桑比克政府、工发组织和环境规划署为执行该阶段剩余活动加强了努力，各执行机构由此确认按照执行委员会所作的例外延期决定完成了第一阶段的活动。

76. 秘书处赞赏地注意到为确保所有讲习班都有妇女参加而做出的努力；国家臭氧机构核可了工发组织提议的工具和设备清单，其相关采购程序正在进行，预计将于 2023 年 6 月分发设备，随后将进行相关培训。根据第 90/32 号决定(a)段，一旦秘书处收到确认工发组织部分的设备已分发给受益者并进行了相关培训之后，就将审议第二阶段。

77. 关于核查报告建议的执行情况，秘书处注意到取得的进展表明，国家氟氯烃进口许可证和配额制度已全面运作，能够确保该国遵守《蒙特利尔议定书》的氟氯烃淘汰时间表。

**建议**

78. 谨建议执行委员会注意到由环境规划署提交载于 UNEP/OzL.Pro/ExCom/92/9 号文件的关于莫桑比克氟氯烃淘汰管理计划第一阶段第五次也是最后一次付款的工作方案执行情况和关于核查建议执行情况的进度报告。

**巴基斯坦：氟氯烃淘汰管理计划(第二阶段—第三和第四次付款执行进度报告（工发组织和环境规划署）**

**背景**

79. 在第九十次会议上， 执行委员会核准了空调制造企业 Dawlance 从 R 290 转换到 HFC-32 的技术改变，核准了巴基斯坦氟氯烃淘汰管理计划第二阶段相关的第四次也是最后一次付款，并请巴基斯坦政府和工发组织通过项目的完成每年提交关于氟氯烃淘汰管理计划第二阶段第三和第四次付款相关工作方案执行进度报告，并向 2025 年第一次会议提

交项目完成报告(第 90/47 号决定)。 工发组织根据第 90/47 号决定向本次会议提交了进度报告。

## 关于氟氯烃消费量的报告

80. 巴基斯坦政府报告 2022 年的氟氯烃消费量为 119.09 ODP 吨，比氟氯烃履约基准低 52%，比与执行委员会达成的《协定》中设定的 124.06 ODP 吨的目标低 4%。2018-2022 年氟氯烃消费量见表 6。

**表 6. 巴基斯坦氟氯烃消费量(2018-2022 年第 7 条数据)**

| **HCFC** | **2018 年** | **2019 年** | **2020 年** | **2021 年** | **2022 年** | **基准** |
|---|---|---|---|---|---|---|
| **公吨** | | | | | | |
| HCFC-22 | 2,806.38 | 2,752.41 | 2,021.71 | 2,045.99 | 2,032.85 | 1,908.25 |
| HCFC-123 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 |
| HCFC-141b | 298.67 | 495.50 | 73.00 | 73.25 | 66.00 | 1,259.10 |
| HCFC-142b | 46.00 | 44.00 | 46.00 | 0.00 | 0.00 | 71.55 |
| **共计 (公吨)** | **3,151.05** | **3,291.91** | **2,140.71** | **2,119.24** | **2,099.85** | **3,238.90** |
| 进口预混多元醇中的 HCFC-141b * | 0.00 | 0.00 | 690.00 | 0.00 | 119.00 | 暂缺 |
| **ODP 吨** | | | | | | |
| HCFC-22 | 154.35 | 151.38 | 111.19 | 112.53 | 111.81 | 104.95 |
| HCFC-123 | 0.00 | 0.00 | 0.00 | 0.00 | 0.020 | 0.00 |
| HCFC-141b | 32.85 | 54.51 | 8.03 | 8.06 | 7.26 | 138.50 |
| HCFC-142b | 2.99 | 2.86 | 2.99 | 0 | 0.00 | 4.65 |
| **共计 (ODP 吨)** | **190.19** | **208.75** | **122.21** | **120.59** | **119.09** | **248.11** |
| 进口预混多元醇中的 HCFC-141b * | 0.00 | 0.00 | 75.90 | 0.00 | 13.09 | 暂缺 |

* 国家方案数据

国家方案执行报告

81. 巴基斯坦政府在 2022 年国家方案执行报告中报告了氟氯烃行业消费量数据，与《蒙特利尔议定书》第 7 条下报告的数据一致。

## 进度报告

82. 2021 年 12 月至 2023 年 4 月期间开展了以下活动。

聚氨酯泡沫塑料行业进行转换的最新进展情况

83. 在第八十八次会议 [12] 上，报告了七家生产聚氨酯热水器企业(即 Shoaibee Industries、Asif Zubair and Co .、Delight Plastic、Full Bright Industries、Tropical Plastic 和 Unique Plastic)和其他小企业的转换工作已经完成，淘汰了 31.21ODP 吨(283.75 公吨)HCFC-141b，因为所有企业都已经安装和调试了设备；然而，工发组织报告称，一些受益企业尚未开始使用替代发泡机，由于聚氨酯反应中产生的粘度、压力和热量，它们在采购水发泡聚氨酯泡沫塑料配方时遇到困难。为解决这些问题，工发组织联系了三个主要配方厂家，对使用全水

[12] UNEP/OzL.Pro/ExCom/88/59 号文件。

发泡、减量氢氟烯烃/水发泡和 Ecomate 泡沫塑料配方的化学品进行测试，并正在与这些企业合作测试这些配方。

84. 第二阶段还包括生产聚氨酯泡沫塑料不连续面板的四家企业(即 Koldkraft 制冷公司(Koldkraft)、巴基斯坦空调工程有限公司(PAECO)、巴基斯坦隔热保温公司和 Foster 冰箱公司(Foster))以及其他小企业向环戊烷的转换，HCFC-141b 总消费量为 26.64 ODP 吨(224.02 公吨)。截至 2022 年 11 月，Foster 和 Koldkraft 的转换工作已经完成并得到核查，旧设备已经退役；这导致淘汰了 9.60 ODP 吨(82.37 公吨)的 HCFC-141b。PAECO 和 Pakistan 隔热保温公司的设备已经收到，并于 2023 年 1 月开始在企业安装；预计这两个项目将于 2023 年 6 月完成。Foster 和 Koldkraft 将作为小企业的实际样板，这些小企业在其生产业务中可能选择转用环戊烷作为泡沫塑料发泡剂。尚未安排与相关利益攸关方就其他零 ODP 和低 GWP 技术进行信息交流和协商，预计将于 2023 年完成安排。

85. 挤塑聚苯乙烯泡沫塑料企业(Symbol Industry)向二甲醚/二氧化碳/氢氟烯烃的转换已经完成并得到核实；定于 2023 年 5 月对旧设备进行销毁。由此产生的淘汰量为 1.69 ODP 吨(30.73 公吨)HCFC-22 和 2.99 ODP 吨(46 公吨)HCFC-142b

空调制造行业转换的最新进展

86. 自核准 Dawlance 企业制造进行从 R-290 转换到 HFC-32 的技术改革以来，完成了以下相关活动：进行了基于 HFC-32 的空调的研究和产品开发；采购了 1,000 套基于 HFC-32 的设备的完整拆卸套件；组装和制造了 995 台使用 HFC-32 的设备；编制了培训议程，为技术人员提供了安装、维修和维护基于 HFC-32 的分体式空调的技术支持。根据需求与 Dawlance 商定了一份待采购设备清单，预计设备将于 2023 年上半年交付，转换工作可望于 2023 年 12 月底完成。

维修行业活动

87. 本应由环境规划署在第二和第三次付款中执行的维修行业活动被推迟，主要是受到 COVID-19 大流行的挑战、国家臭氧机构人事变动和缺乏技术专家。第三次付款小规模供资协议(SSFA)的签署被推迟，直到 2022 年 8 月才完成。国家臭氧机构工作人员问题在 2023 年 2 月任命了一名新的国家项目经理后得到解决，随后重新开始实施各项活动。在寻找和任命技术专家为制冷空调维修行业提供培训和政策支持方面遇到挑战。第二次付款下的所有制冷空调培训活动已经完成，第三次付款的相关活动正在进行中，计划在年底前完成。同样，正在规划实施其余的海关和执法培训；培训活动将于年底完成。

88. 国家臭氧机构将参加 2023 年 6 月在卡拉奇举行的供暖、通风、空调和制冷博览会，向与会者提供更多关于低 GWP 技术和替代品的信息；制冷维修中安全使用易燃替代品指南将于 2023 年下半年分发。

资金发放数额

89. 第三和第四次付款的核准供资总额为 264,340 美元，已发放 42,940 美元(16%)；剩余的 221,400 美元将在今后六个月内执行剩余活动后，在年底发放。

## 秘书处的评论

关于氟氯烃淘汰管理计划第二阶段第三和第四次付款的执行报告

聚氨酯泡沫塑料行业转换进展情况

90. 秘书处请求进一步澄清热水器企业的项目能否在 2023 年 12 月底之前完成。工发组织解释说，由于在寻找替代品方面遇到困难，这些企业目前正在使用进口预混多元醇中所含的 HCFC-141b；他们需要额外的技术支持来开发和测试使用水吹技术和其他低 GWP 技术的配方；在三个配方厂家的支持下，这些问题有望得到解决，只要问题成功解决，企业就可转用低 GWP 技术。

空调制造行业(Dawlance)的转换进展情况

91. 关于 Dawlance 的制造设施转换为使用 HFC-32 的空调系统，工发组织告知，各项活动正在进行中，并依据了到 2023 年 12 月将其 80%的生产转换为使用 HFC-32 的空调系统并在 2024 年 12 月完成转换的决定。

维修行业活动

92. 关于维修行业活动执行延误的问题，环境规划署解释说，他们正在与国家臭氧机构密切合作，以确保快速执行培训活动，特别是征聘技术专家以支持落实培训和其他政策工作。随着国家臭氧机构工作人员问题得到解决，预计培训相关活动将在今后六个月内完成。

性别平等政策执行情况 [13]

93. 根据多边基金的性别主流化政策，通过更好地传播关于性别政策的信息和对妇女进行宣传，促进了妇女参加培训、会议和讲习班。国际和国内专家的性别均等程度有所提高。此外，要求本国征聘的专家完成性别平等意识课程，国家臭氧机构工作人员接受了提高对性别平等问题认识的培训。

## 建议

94. 谨建议执行委员会:

(a) 注意到工发组织提交并载于 UNEP/OzL.Pro/ExCom/92/9 号文件的氟氯烃淘汰管理计划第二阶段第三和第四次付款执行进展报告；以及

(b) 请巴基斯坦政府通过工发组织继续通过项目的完成每年提交关于氟氯烃淘汰管理计划第二阶段第三和第四次付款相关工作方案执行进度报告，并向 2025 年第一次会议提交项目完成报告。

[13] 根据第 84/92 号决定(d)段，第 90/48 号决定(c)段顾及 UNEP/OzL.Pro/ExCom/90/37 号文件表 2 所载具体活动，鼓励双边和执行机构继续确保将性别观点主流化的业务政策适用于所有项目。

**巴基斯坦：氟氯烃淘汰管理计划（第三阶段—关于含 HCFC-141b 的预混多元醇的进口情况和泡沫塑料行业技术援助执行进展的报告）（工发组织和环境规划署）**

## 背景

95. 在第九十次会议上，执行委员会核准了巴基斯坦氟氯烃淘汰管理计划第三阶段，并请巴基斯坦政府和工发组织继续监测和每年报告关于含 HCFC-141b 的预混多元醇的进口情况，直至禁止此类进口，并报告泡沫塑料行业技术援助的执行进展情况(第 90/43 号决定(a)段和(g)(二)分段)。

96. 根据第 90/43(a)和(g)㈡号决定，工发组织向本次会议提交了进度报告。

## 进度报告

含 HCFC-141b 的预混多元醇的进口情况

97. 2022 年预混多元醇中所含 HCFC-141b 的进口总量为 13.9 ODP 吨(119 公吨)，2021 年没有报告此类进口。国家臭氧机构正致力于正式禁止进口含 HCFC-141b 的预混多元醇，并计划根据第 90/43 号决定(b)(三)分段，通过商务部收入委员会的一项法定监管令予以实施，自 2024 年 1 月 1 日起生效。

第三阶段泡沫塑料行业技术援助的执行情况

98. 关于第三阶段泡沫塑料行业技术援助执行情况的报告，工发组织告知，一名国际泡沫塑料专家、国家项目协调员和国家臭氧机构对受益者进行了一次联合实地访问，以提高对替代技术的认识(例如，水发泡、甲缩醛、甲酸甲酯、使用氢氟烯烃的配方)；2023 年 4 月采购了替代化学品，并提供给其中一家喷雾泡沫塑料企业进行测试；2023 年 5 月制定了泡沫塑料测试流程和喷雾泡沫塑料认证方案，以测试替代品的性能；起草了商用制冷泡沫塑料和聚氨酯管道保温泡沫塑料的发泡设备技术规范。

## 秘书处的评论

99. 秘书处注意到，政府正计划实施禁止进口含 HCFC-141b 的预混多元醇的条例，并采取了几项措施，对转换项目涵盖的泡沫塑料应用中的 HCFC-141b 替代品进行性能评估和测试，这将有助于及时和系统地实施 HCFC-141b 转换项目。

## 建议

100. 谨建议执行委员会：

(a) 注意到由工发组织提交并载于 UNEP/OzL.Pro/ExCom/92/9 号文件的关于含 HCFC-141b 的预混多元醇进口情况和氟氯烃淘汰管理计划第三阶段下泡沫塑料行业技术援助执行进展的报告；

(b) 注意到对进口预混多元醇中所含 HCFC-141b 的进口禁令将于 2024 年 1 月 1 日生效；以及

(c) 请巴基斯坦政府通过工发组织继续每年报告含 HCFC-141b 的预混多元醇的进口情况，直至禁止此类进口，并报告泡沫塑料行业技术援助的执行进展情况。

**太平洋岛屿国家：氟氯烃淘汰管理计划（第一阶段——与第一阶段最后一次付款相关的工作方案执行情况的进度报告和 12 个太平洋岛屿国家的项目完成情况报告的提交）（环境规划署）**

**背景**

101. 第六十三次会议核准了库克群岛、基里巴斯、马绍尔群岛、密克罗尼西亚联邦、瑙鲁、纽埃、帕劳、萨摩亚、所罗门群岛、汤加、图瓦卢和瓦努阿图（以下简称太平洋岛屿国家）政府的氟氯烃淘汰管理计划第一阶[14]，以实现 2020 年前削减 35%的目标，总费用为 1,696,000 美元，外加机构支助费用。第一阶段包括以下内容：

(a) 区域部分：所有 12 个太平洋岛屿国家的标准化活动，如提供政策咨询和制定立法/法规、海关官员及制冷和空调高级培训师的能力建设以及氟氯烃淘汰认识和外联活动；以及

(b) 国家部分：每个太平洋岛屿国家开展具体活动，用以管制氟氯烃的供应和需求，为氟氯烃淘汰和替代品的引入创造有利环境，并管理、协调和监测氟氯烃淘汰管理计划的执行工作。

102. 在第八十七次会议上，鉴于 COVID-19 大流行导致淘汰活动开展工作出现延迟，作为例外，执行委员会核准将太平洋岛屿国家氟氯烃淘汰管理计划第一阶段的完成日期延期至 2022 年 12 月 31 日，并请太平洋岛屿国家政府和环境规划署向执行委员会 2023 年的第一次会议提交关于与最后一次付款相关的工作方案执行情况的进度报告和项目完成情况报告（第 87/18 号决定）。

103. 环境规划署作为指定执行机构，代表太平洋岛屿国家根据第 87/18 号决定提交了进度报告。

**氟氯烃消费量报告**

104. 太平洋岛屿国家政府[15]根据国家方案执行情况报告称，2022 年的氟氯烃总消费量为 0.17 ODP 吨，比氟氯烃基准量低 95%，比与执行委员会达成协定中的最高允许消费量 10.32 公吨（0.57 ODP 吨）低 70%。2018-2022 年氟氯烃消费量情况见表 7。

[14] UNEP/OzL.Pro/ExCom/63/46 和 UNEP/OzL.Pro/ExCom/63/60 号文件附件二十一。

[15] 瑙鲁和纽埃除外，这两个国家尚未提交其 2022 年国家方案执行报告，但属于消费量非常低的国家。

**表 7. 太平洋岛屿国家的氟氯烃消费量情况（2018-2022 年第 7 条数据）**

| HCFC-22 | 2018 年 | 2019 年 | 2020 年 | 2021 年 | 2022 年 [b] | 基准量 |
|---|---|---|---|---|---|---|
| 库克群岛 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.86 |
| 基里巴斯 | 0.22 | 0.45 | 0.07 | 0.01 | 0.00 | 0.97 |
| 马绍尔群岛 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.99 |
| 密克罗尼西亚联邦 | 0.00 | 1.82 | 0.00 | 0.24 | 1.11 | 2.55 |
| 瑙鲁 | 0.00 | 0.00 | 0.00 | 0.00 | [c] | 0.18 |
| 纽埃 | 0.00 | 0.00 | 0.00 | 0.00 | [c] | 0.15 |
| 帕劳 | 1.20 | 0.13 | 0.34 | 0.00 | 0.07 | 2.97[d] |
| 萨摩亚 | 0.23 | 0.19 | 0.78 | 0.12 | 0.29 | 4.60 |
| 所罗门群岛 | 3.63 | 1.49 | 1.47 | 1.41 | 1.68 | 35.05[d] |
| 汤加 | 0.09 | 0.02 | 0.02 | 0.15 | 0.00 | 2.55[d] |
| 图瓦卢 | 0.03 | 0.00 | 0.00 | 0.03 | 0.00 | 1.64 |
| 瓦努阿图 | 0.29 | 0.22[a] | 0.00 | 0.15 | 0.00 | 5.11[d] |
| **总计（公吨）** | **5.68** | **4.32** | **2.68** | **2.11** | **3.15** | **60.62** |
| 库克群岛 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.1 |
| 基里巴斯 | 0.01 | 0.02 | 0.00 | 0.00 | 0.00 | 0.1 |
| 马绍尔群岛 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.2 |
| 密克罗尼西亚联邦 | 0.00 | 0.10 | 0.00 | 0.01 | 0.06 | 0.2 |
| 瑙鲁 | 0.00 | 0.00 | 0.00 | 0.00 | [c] | 0.00[e] |
| 纽埃 | 0.00 | 0.00 | 0.00 | 0.00 | [c] | 0.00[e] |
| 帕劳 | 0.07 | 0.01 | 0.02 | 0.00 | 0.00 | 0.20[d] |
| 萨摩亚 | 0.01 | 0.01 | 0.04 | 0.01 | 0.02 | 0.3 |
| 所罗门群岛 | 0.20 | 0.08 | 0.08 | 0.08 | 0.09 | 2.00[d] |
| 汤加 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.10[d] |
| 图瓦卢 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.1 |
| 瓦努阿图 | 0.02 | 0.01[a] | 0.00 | 0.01 | 0.00 | 0.30[d] |
| **总计（ODP 吨）** | **0.31** | **0.23** | **0.14** | **0.12** | **0.17** | **3.6** |

[a] 包括 0.002 公吨（0.0001 ODP 吨）的 HCFC-142b 和 0.003 公吨（0.0001 ODP 吨）的 HCFC-124。
[b] 国家方案数据。
[c] 未收到国家方案数据。
[d] 根据缔约方会议第 XXIII/29 号决定修订的 2009 年氟氯烃消费量。
[e] 消费量非常低；将数字四舍五入到两位数，显示消费量为零。

## 进度报告

区域部分

105. 环境规划署支持氟氯烃淘汰管理计划第一阶段的区域部分，为加强与氟氯烃控制有关的立法、法规和执行机制提供指导。在第三次付款期间，四个国家保持氟氯烃消费量为零，四个国家禁止使用氟氯烃的设备的进出口，两个国家简化了配额分配程序以加强监测，还有两个国家发布了禁止以批量散装方式进口氟氯烃的规定。表 8 总结了第一阶段的立法成就。

**表 8. 12 个太平洋岛屿国家的氟氯烃立法和监管措施情况**

| 太平洋岛屿国家 | 立法措施（情况） |
|---|---|
| **许可证制度和配额制度** | |
| 所有国家 | 设立并运行所有氟氯烃进出口的许可证制度和配额制度 |
| 库克群岛、马绍尔群岛、瑙鲁和纽埃 | 在执行第三次付款期间保持消费量为零 |
| 汤加和密克罗尼西亚联邦 | 加强许可证制度和配额分配要求，使配额分配过程更加简化和透明 |
| **批量散装氟氯烃的进口禁令** | |
| 库克群岛和密克罗尼西亚联邦 | 库克群岛，从 2021 年 12 月 7 日开始<br>密克罗尼西亚联邦，从 2021 年 2 月 12 日开始 |
| **采用氟氯烃海关协调代码** | |
| 所有国家 | 采用 2022 年版《太平洋商品名称及编码协调制度》（PACHS22） |
| **控制/禁止使用氟氯烃的设备的进出口** | |
| 库克群岛、密克罗尼西亚联邦、纽埃、帕劳、汤加、瓦努阿图 | 这些国家均禁止。在第三次付款期间，库克群岛、密克罗尼西亚联邦、纽埃和瓦努阿图实施了禁令。帕劳和汤加在之前的付款期间实施了禁令。 |
| 基里巴斯、萨摩亚、所罗门群岛、图瓦卢 | 正在制定禁止使用氟氯烃的设备进口的法规 |
| 瑙鲁 | 自2016年起禁止无英文标签的空调设备 |
| **处理、储存和销售氟氯烃的许可/执照要求** | |
| 库克群岛、基里巴斯、马绍尔群岛、密克罗尼西亚联邦、帕劳、萨摩亚、所罗门群岛、汤加和瓦努阿图 | 已制定要求 |
| 瑙鲁、纽埃和图瓦卢 | 正在制定一项法规，要求对氟氯烃的处理、储存和销售执行许可/执照要求 |
| **预混多元醇所含 HCFC-141b 的进口禁令** | |
| 所有国家 | 禁止预混多元醇所含氟氯烃的进口 |

106. 由于与 COVID-19 大流行有关的限制，无法为海关当局组织关于开发消耗臭氧层物质风险评估系统和制定标准作业程序的区域培训班。相反，环境规划署与大洋洲海关组织（OCO）进行了合作，以加强对氟氯烃供应的控制：

(a) 太平洋岛屿国家政府、大洋洲海关组织和环境规划署共同根据 2022 年版《太平洋商品名称及编码协调制度》为《蒙特利尔议定书》下的受控物质指定了具体的海关协调代码；[16]

(b) 环境规划署为大洋洲海关组织官员制定了一份简化培训材料，为海关经纪人提供培训，作为大洋洲海关组织加强许可证制度，特别是准确报关机制活动

[16] 2022 年版《太平洋商品名称及编码协调制度》是一个多用途货物命名原则，是关税和国际商品贸易统计的基础，旨在帮助大洋洲海关组织中非世界海关组织成员采用 2022 年海关协调代码。

的一部分；以及

(c) 大洋洲海关组织与环境规划署合作制定标准作业程序，该程序描述了指导太平洋岛屿国家海关当局执行许可证制度的程序。

107. 2021年1月，环境规划署聘用了一名国际制冷和空调培训师，负责制定处理易燃制冷剂的标准作业准则（SOG），该准则将分发给太平洋岛屿国家供其采用。

国家部分

108. 第三次付款期间，9 个太平洋岛屿国家（不包括基里巴斯、瑙鲁和纽埃）为共计412 名海关和执法官员举行了关于防止消耗臭氧层物质和使用消耗臭氧层物质的设备的非法贸易、制冷剂引发的火灾和安全危害以及消耗臭氧层物质贸易执法工具使用的培训；所涉新主题包括风险评估和海关经纪人对氟氯烃的误报。[17] 第一阶段第一次付款期间，环境规划署采购并向太平洋岛屿国家交付 16 台制冷剂识别仪，第三次付款期间，制造商在环境规划署的支持下对其中许多设备进行了维修，目前有15台处于工作状态。9个太平洋岛屿国家（不包括基里巴斯、瑙鲁和纽埃）都举行了与进口商和海关经纪人的会议和咨询。

109. 8 个太平洋岛屿国家（不包括基里巴斯、马绍尔群岛、瑙鲁和纽埃）举办了关于良好维修做法的培训班，在第三次付款期间共有 402 名制冷和空调技术员接受了培训。从第三次付款开始即追踪了太平洋岛屿国家氟氯烃淘汰管理计划活动的性别参与情况，结果显示，66 名妇女参加了海关和执法培训，21 名妇女参加了制冷和空调技术员培训。由于大流行和培训师/顾问，基里巴斯、马绍尔群岛（针对制冷和空调培训）、瑙鲁和纽埃无法组织第三次付款期间的培训和会议。下表 9 显示了第一阶段对海关官员和制冷和空调技术员的培训。

**表 9.第一阶段为海关官员和制冷和空调技术员举办的培训班总结**

| 太平洋岛屿国家 | 海关相关培训 | | 制冷相关培训 | |
|---|---|---|---|---|
| | 培训班数量 | 参与人数 | 培训班数量 | 参与人数 |
| 库克群岛 | 7 | 83 | 10 | 138 |
| 基里巴斯 | 8 | 119 | 6 | 181 |
| 马绍尔群岛 | 6 | 72 | 4 | 58 |
| 密克罗尼西亚联邦 | 13 | 187 | 12 | 263 |
| 瑙鲁 | 4 | 45 | 4 | 49 |
| 纽埃 | 7 | 74 | 6 | 41 |
| 帕劳 | 9 | 143 | 6 | 141 |
| 萨摩亚 | 9 | 230 | 7 | 279 |
| 所罗门群岛 | 11 | 165 | 10 | 311 |
| 汤加 | 13 | 716 | 11 | 370 |
| 图瓦卢 | 7 | 136 | 5 | 126 |
| 瓦努阿图 | 12 | 122 | 13 | 228 |
| **总计** | **106** | **2,092** | **94** | **2,185** |

[17] 实施氟氯烃淘汰管理计划第一阶段期间，由于误报，国家臭氧机构记录和海关统计数据之间存在差异，各国政府一直在解决这一问题。

110. 在执行第三次付款期间，国家臭氧机构对第一次付款期间采购的制冷和空调维修设备/工具采取了后续行动，进行定期检查以监测设备状况。太平洋岛屿国家臭氧机构与技术研究所的主要有关利益方合作，建立/加强制冷和空调协会的运作。在 10 个太平洋岛屿国家以及马绍尔群岛和纽埃成立了制冷和空调协会，由于组建制冷和空调协会的制冷和空调技术员数量有限，国家臭氧机构决定对制冷和空调技术员进行外联访问，向他们提供有关氟氯烃淘汰的信息。

111. 6 个国家（库克群岛、密克罗尼西亚联邦、萨摩亚、所罗门群岛、汤加和瓦努阿图）探讨了建立能力认证制度的方案，共举行了 15 次协商会议。所有 6 个国家都报告了有关利益方对建立能力认证制度以提高工作标准的兴趣。在第三次付款期间，在所有 12 个太平洋岛屿国家开展了交流和外联活动，包括《蒙特利尔议定书》相关的协商会议、新闻报道和新闻发布会、关于氟氯烃淘汰的纸质宣传材料，以及推动海关使用 WhatGAS 应用程序的宣传活动。

项目实施和监测

112. 国家臭氧机构负责实施、协调和监测氟氯烃淘汰管理计划，提供的预算用于支付与氟氯烃淘汰管理计划第一阶段相关的研讨会、培训、会议和咨询的差旅费用。

性别平等政策的实施[18]

113. 根据多边基金的性别平等主流化政策，鼓励妇女参与氟氯烃淘汰管理计划的规划、决策、监测和评估；在各项活动中跟踪性别参与情况；将性别平等主流化观点纳入网络会议的议程。

资金发放量

114. 截至 2023 年 4 月，在核准的 1,696,000 美元中，已发放 1,576,290 美元（93%），如表 10 所示。环境规划署正在努力确保项目在 2023 年 12 月底前完成财务工作。项目结束后剩余的任何资金将退还给后续的会议。

**表 10.太平洋岛屿国家氟氯烃淘汰管理计划第一阶段的财务报告（美元）**

| 部分 | 第一次付款 | | 第二次付款 | | 第三次付款 | | 总计 | | |
|---|---|---|---|---|---|---|---|---|---|
| | 已核准 | 已发放 | 已核准 | 已发放 | 已核准 | 已发放 | 已核准 | 已发放 | 结余 |
| 国家 | 739,375 | 739,375 | 530,525 | 463,716 | 141,100 | 91,031 | 1,411,000 | 1,294,122 | 116,878 |
| 区域 | 134,000 | 134,000 | 106,000 | 106,000 | 45,000 | 42,168 | 285,000 | 282,168 | 2,832 |
| **总计** | 873,375 | 873,375 | 636,525 | 569,716 | 186,100 | 133,199 | 1,696,000 | 1,576,290 | 119,710 |
| **发放率（%）** | **100** | | **90** | | **69** | | **93** | | |

## 秘书处评论

115. 秘书处注意到，环境规划署和太平洋岛屿国家政府已圆满完成了氟氯烃淘汰管理计划第一阶段相关所有活动的实施，各个国家和区域部分的项目完成情况报告已于 2023 年

[18] 根据第 84/92 号决定(d)段，第 90/48 号决定(c)段鼓励双边和执行机构继续确保将性别平等主流化业务政策适用于所有项目，同时考虑到 UNEP/OzL.Pro/ExCom/90/37 号文件表 2 所列的具体活动。

4 月提交。

116. 秘书处还赞赏地注意到，太平洋岛屿国家承诺确保及时实施第一阶段的活动，并在实施方面取得了实质性进展，同时注意到了通过与大洋洲海关组织密切合作，其在监测该区域氟氯烃进口方面取得的成就。这将有助于太平洋岛屿国家帮助其海关当局在执法链的各个步骤中实施程序，以跟踪该区域消耗臭氧层物质的转移。

**建议**

117. 谨建议执行委员会赞赏地注意到：

(a) 环境规划署提交的、UNEP/OzL.Pro/ExCom/92/9 号文件中所载太平洋岛屿国家氟氯烃淘汰管理计划第三次也是最后一次付款相关的工作方案执行情况的最后进度报告；以及

(b) 库克群岛、基里巴斯、马绍尔群岛、密克罗尼西亚联邦、瑙鲁、纽埃、帕劳、萨摩亚、所罗门群岛、汤加、图瓦卢和瓦努阿图政府提交了氟氯烃淘汰管理计划第一阶段项目完成情况报告。

**菲律宾：氟氯烃淘汰管理计划（第二阶段——关于最后一次付款执行情况的进度报告和核查报告）（工发组织）**

**背景**

118. 在第九十次会议上，执行委员会决定：

“(b) 由于 COVID-19 大流行造成的延误，作为例外，将菲律宾氟氯烃淘汰管理计划第二阶段的完成日期延长至 2023 年 12 月 31 日，并指出不得请求进一步延期；

(c) 请菲律宾政府通过工发组织提交：

(一) 向第九十一次会议提交的 2021 年氟氯烃消费量核查报告；以及

(二) 每年提交与最后一次付款相关的工作方案执行情况进度报告（直至项目完成）、核查报告（直至第三阶段得到核准），以及项目完成情况报告（提交至 2024 年第一次会议）”（第 90/17 号决定(b)和(c)段）。

119. 核查报告是由工发组织在第九十一次会议审议截止日期之后提交的，因此无法审查；执行委员会注意到了这份报告，但了解到秘书处将在第九十二次会议上审查并提交该报告。此外，根据第 90/17 号决定(c)(二)分段，菲律宾政府通过工发组织向本次会议提交了进度报告。

**氟氯烃消费量报告**

120. 菲律宾政府报告2022年的氟氯烃消费量为69.66 ODP吨，比氟氯烃基准量低57%，比与执行委员会达成协定中设定的 82.56 ODP 吨的目标低 15%。2018-2022 年氟氯烃消费量情况见表 11。

**表 11. 菲律宾的氟氯烃消费量情况（2018-2022 年第 7 条数据）**

| 氟氯烃 | 2018 年 | 2019 年 | 2020 年 | 2021 年 | 2022 年 | 基准量 |
|---|---|---|---|---|---|---|
| **公吨** | | | | | | |
| HCFC-22 | 1,615.6 | 1,643.2 | 843.7 | 1,039.6 | 1043.55 | 1,959.45 |
| HCFC-141b | 144.5 | 111.0 | 18.9 | 18.9 | 101.10 | 475.05 |
| HCFC-142b | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 3.99 |
| HCFC-123 | 57.4 | 57.1 | 106.7 | 57.1 | 57.10 | 84.38 |
| HCFC-225ca | 0.2 | 0.4 | 0.0 | 0.0 | 0 | 0.17 |
| HCFC-225cb | 0.2 | 0.4 | 0.0 | 0.0 | 0 | 0.17 |
| **总计** | **1,817.5** | **1,811.4** | **969.3** | **1,115.7** | **1,201.8** | **2,523.2** |
| **ODP 吨** | | | | | | |
| HCFC-22 | 88.86 | 90.38 | 46.40 | 57.18 | 57.40 | 107.77 |
| HCFC-141b | 15.90 | 12.21 | 2.08 | 2.08 | 11.12 | 52.26 |
| HCFC-142b | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.26 |
| HCFC-123 | 1.15 | 1.14 | 2.13 | 1.14 | 1.14 | 1.69 |
| HCFC-225ca | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| HCFC-225cb | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| **总计** | **105.90** | **103.73** | **50.62** | **60.40** | **69.66** | **161.98** |

国家方案执行情况报告

121. 菲律宾政府在 2022 年国家方案执行情况报告中报告的氟氯烃行业消费数据为 44.41 ODP吨。这一数据与根据《蒙特利尔议定书》第7条报告的数据之间存在差异，原因是，国家方案数据基于使用量，而第 7 条数据基于进口量，就 2022 年的数据而言，进口量还包括库存。

核查报告

122. 核查报告确认，菲律宾政府正在实施氟氯烃进出口的许可证制度和配额制度，2021 年根据《蒙特利尔议定书》第 7 条报告的氟氯烃总消费量数据是正确的（如上文表 11 所示）。核查得出结论认为，菲律宾政府正在实施有效的许可证制度和配额制度，并已达到其与执行委员会达成协定中的目标。核查报告还提供了以下建议：鼓励环境管理局（EMB）继续与进口商和其他有关利益方合作执行其数据管理和监督任务、最终确定环境管理局和海关局（BOC）之间的谅解备忘录以及关于进口和许可证制度的国家法规手册。

**进度报告**

123. 自第九十次会议提交上次进度报告以来，开展了以下活动：

(a) 对政策/执法和海关当局的技术援助：

(一) 举办了一次关于促进臭氧和气候保护替代技术的技术论坛，来自政府、空调制造商和维修企业、进口商和终端用户的 100 多名参与者出席了论坛。在论坛上，菲律宾能源部（DOE）介绍了制冷和空调设备的最新能源标签方案；

(二) 为 40 名培训师进行了有关监测消耗臭氧层物质进口、多制冷剂识别仪的使用和安全处理制冷剂的培训，并为 30 名海关和执法官员举办了关于使用最新海关协调代码的培训。向海关局提供了五台多制冷剂识别仪；

(三) 2021 年 7 月发布了一份通知，要求所有从事维修使用消耗臭氧层物质任何制冷能力的移动和固定制冷和空调设备的人员，通过在线许可系统向环境管理局登记；为 30 多家氟氯烃和使用氟氯烃的设备的经销商和供应商举行了两次会议，讨论登记和数据报告的要求。

(b) 向维修行业提供技术援助，以促进良好制冷做法，并展示和鼓励使用低全球升温潜能值（GWP）替代品：

(一) 为 20 名制冷和空调培训师开展了一次培训师培训方案，内容是尽量减少设备制冷剂泄漏的良好制冷做法并提高对易燃制冷剂的安全考虑。对 8 个区域氟氯烃收集中心进行了实地考察，以评估这些中心如何收集这些物质；在与指定中央收集设施的协调会议上讨论了这一问题，以审查处置这些无用物质的方案和所需的技术援助；

(二) 正在评估技术员业务守则，以确保在其中纳入处理易燃制冷剂的安全做法，评估预计将于 2023 年 8 月完成；

(三) 确定了消防应用潜在替代品的初步清单，并与消防局进行了初步讨论，以支持对消防用 HCFC-123 的潜在替代品的研究。

(c) 为空调制造推广低全球升温潜能值替代品的技术援助：

(一) 与技术教育和技能发展局（TESDA）及冷链创新（CCI）中心合作，举办了为期两天的培训，来自学术界和制冷和空调行业的 25 名参与者参加了培训，内容涉及制冷和空调中的消耗臭氧层物质替代品以及易燃制冷剂的安全处理。在技术教育和技能发展局的冷链创新中心为培训师举办了两期关于替代技术的课程，并聘请了一名氨基技术专家授课；

(二) 就针对制造企业、技术员、终端用户和进口商关于安全处理易燃、有

毒和高压制冷剂的试点在线培训方案的筹备工作进行了初步讨论，以期将其纳入整体维修技术员培训方案；以及

(d) 项目管理股活动的实施和监测，包括聘用一名国家协调员；组织活动、宣传活动和有关利益方协商；编写报告；信息传播；以及性别平等主流化考虑因素。

资金发放量

124. 截至 2023 年 3 月，在第二阶段核准的 811,750 美元中，已发放 357,217 美元（44%）。剩余 454,533 美元将在 2023 年 12 月 31 日之前发放完成。

2023 年执行计划

125. 以下活动将开展至 2023 年 12 月：

(a) 发布通知，告知空调市场供应商，任何含有 HCFC-22 的空调型号都不得在菲律宾市场注册和销售；面向有关利益方开展政策认识提高活动，以促进向节能空调设备的转型；开展两场关于有效执行许可证制度和配额制度的培训（5,500 美元）；

(b) 为 100 名海关和执法官员举办三次关于监测消耗臭氧层物质进口以及氟氯烃控制的海关培训班；为海关经纪人举办一次情况介绍会和一次培训班，探讨消耗臭氧层物质进口政策，并避免使用错误的海关协调代码；更新有关国家进口和许可证制度法规的国家手册（88,410 美元）；

(c) 为 30 名政府参与者及氟氯烃和使用氟氯烃的设备的供应商举办培训班，介绍更新后的在线许可证系统；与氟氯烃的进口商和经销商以及预混多元醇的供应商举行两场协调会议，探讨包括数据报告和提交在内的登记要求（13,500 美元）；

(d) 核查 2022 年的氟氯烃消费量以及氟氯烃淘汰管理计划的执行情况；

(e) 为技术教育和技能发展局及其认可机构的学院提供培训方案；至少对 25 名制冷和空调技术员培训师举办一次培训班，内容涉及修订后的制冷和空调设备操作守则以及 HCFC-141b 的替代品；为 60 名制冷和空调技术员举办三次培训，内容涉及 HCFC-22、HFC-32 及其他替代品的新修订操作守则和新维修程序（68,000 美元）；

(f) 审查中央回收中心的业务模式；收集氟氯烃和其他制冷剂并管理区域收集中心的库存，采购工具和设备[19]；审查国家处置方案；为 100 名制冷和空调技术员举办两场培训，介绍最大限度减少制冷和空调设备中 HCFC-22 泄漏的良好做法（103,021 美元）；

[19] 小型回收机、真空泵、气体识别仪、储罐和气瓶。

(g) 完成关于清洗用 HCFC-225ca 和 HCFC-225cb 以及消防用 HCFC-123 的可用、高性价比替代品的研究；提供培训，教育消防当局使用有关替代品；查明 HCFC-141b 的使用者以及将其作为溶剂的用途；完成关于潜在清洗用替代品的研究并提出建议，并举办培训班，面向来自相关企业的 60 名学员介绍研究成果（72,700 美元）；

(h) 提供技术援助，为制冷和空调行业推广低全球升温潜能值替代品：与技术教育和技能发展局和冷链创新中心合作，为 100 名制冷和空调技术员开展三次关于低全球升温潜能值替代品的安全培训和认识提高方案；采购并交付其他培训课和工具[20]；参观一处采用低全球升温潜能值替代品的空调制造设施（拟议新活动）；针对 800 家制造企业、技术员、终端用户和进口商，进行一次关于安全处理易燃、有毒和高压制冷剂的在线培训（73,902 美元）；以及

(i) 项目管理股（29,500 美元）：聘请一名国家协调员和多名专家、对各项活动进行监测、与有关利益方协商以及差旅费用（14,500 美元）；就相关主题组织信息传播和认识提高活动（8,000 美元）；聘请一名专家，负责审议和监测性别平等成果与指标，以及培训和认识提高活动的发展情况（7,000 美元）。

**秘书处的评论**

进度报告

126. 秘书处注意到，2021 年，菲律宾的消费量增长了 19%，2022 年又增长了 15%；工发组织解释称，这是 COVID-19 相关限制解除后市场复苏的结果，并强调道，2019-2020 年期间消费量急剧下降，且该国消费量过去一直低于《蒙特利尔议定书》的消费量限量以及该国与执行委员会达成协定中的最高允许消费量。

127. 工发组织解释称，该期间内完成的活动表明，项目执行进展顺利。虽然仍有几项培训及其他活动有待完成，但工发组织重申道，菲律宾政府承诺会如所提供的工作计划所述，确保如期完成这些培训和活动。

128. 在与能源部密切协调，制定制冷和空调设备最低能源性能标准，并发布《菲律宾空调能源标签方案实施指引》的方面，与能源部的讨论仍在继续，以确保将使用 HCFC-22 的制冷剂纳入管制产品清单中，并将之适用于制造产品和进口产品。

核查报告

129. 秘书处询问了签发进口前装运证书（PSIC）后，收到进口货物时的工作流程，包括负责监测、检查和放行进口货物的主管当局，并要求制定确定配额及其最终分配的工作流程。工发组织澄清道，海关局目前未提供签发进口前装运证书后放行货物的流程，这可

[20] 真空泵、钳子、软管和易燃制冷剂处理工具。

能是一项供明年核查的成果。工发组织还阐述了配额分配的流程，并说明氟氯烃进口量是基准年单个进口商进口量的百分比，该基准百分比构成随后几年配额分配的基础。

130. 工发组织还提供了一份修订报告，其中包含的建议尤其侧重于确保海关局和环境管理局之间最终确定和签署谅解备忘录，从而更有效地监测消耗臭氧层物质进口；并确保最终确定关于消耗臭氧层物质淘汰的进口和许可证制度的国家法规手册。

**建议**

131. 谨建议执行委员会：

(a) 注意到由工发组织提交的、UNEP/OzL.Pro/ExCom/92/9 号文件中所载 2021 年菲律宾氟氯烃消费量核查报告，以及关于菲律宾氟氯烃淘汰管理计划第二阶段相关的工作方案执行情况的进展报告；以及

(b) 请菲律宾政府通过工发组织继续提交关于最后一次付款相关的工作方案执行情况的年度进度报告（直至项目完成）、核查报告（直至第三阶段得到核准），以及项目完成报告（提交至 2024 年第一次会议）。

**圣卢西亚：氟氯烃淘汰管理计划（第一阶段——关于最后一次付款相关的工作方案执行情况的最后进度报告以及项目完成情况报告的提交）（环境规划署和工发组织）**

**背景**

132. 在第八十七会议上，执行委员会核准了圣卢西亚氟氯烃淘汰管理计划第一阶段第五次也是最后一次付款，并请该国政府、环境规划署和工发组织在执行委员会 2023 年第一次会议上提交一份关于最后一次付款相关的工作方案执行情况的进度报告以及项目完成情况报告（第 87/28 号决定(a)段）。[21]

133. 根据第 87/28 号决定(a)段，环境规划署作为牵头执行机构提交了上述进度报告。

**氟氯烃消费量**

134. 圣卢西亚政府报告 2021 年的氟氯烃消费量为 0.24 ODP 吨，比 1.09 ODP 吨的氟氯烃基准量低 78%，比与执行委员会达成的协定中的最高允许消费量（该年为 0.71 ODP 吨）低 66%。

135. 圣卢西亚的氟氯烃消费量自 2016 年起呈下降趋势；由于 COVID-19 大流行相关限制措施对旅游业造成影响，并降低了制冷和空调设备的维修需求，2020 年的消费量减少至 0.03 ODP 吨。随后，2021 年的消费量增长至 0.24 ODP 吨，这主要是由于该国制冷和空调应用的维修活动得到恢复。

[21] UNEP/OzL.Pro/ExCom/87/58 号文件附件十一所载规定。

**第一阶段最后一次付款的执行情况进度报告**

136. 开展了以下活动：

(a) 就氟氯烃许可证制度和配额制度以及消耗臭氧层物质、制冷剂及其产品的适当分类，为 20 名海关及其他执法官员提供了培训，包括两名妇女学员。培训师中有三名来自国家臭氧机构和海关部门的女培训师。

(b) 就保养和维修制冷和空调设备的良好做法，为 32 名技术员（包括一名妇女）提供了培训；以及

(c) 开展了公众认识和外联活动，包括制作与分发关于氟氯烃及其替代品的最新教育产品及认识提高产品，关于淘汰氟氯烃（包括氟氯烃淘汰管理计划第二阶段）相关主要活动的新闻发布会和媒体信息。

137. 截至 2022 年 12 月 31 日，在核准的 210,000 美元中，已发放 205,419 美元（环境规划署 82,650 美元，工发组织 122,769 美元）；工发组织已退还 4,581 美元。[22]

138. 截至 2022 年 12 月 31 日，与氟氯烃淘汰管理计划第一阶段相关的活动已完成；项目完成情况报告正在编制中，将在 2023 年 6 月底之前提交。

**秘书处评论**

139. 秘书处请求提供信息，说明为何在实施最后一次付款期间只培训了 20 名海关官员（目标为 40 名）。环境规划署解释称，由于海关部门各项优先事项相互冲突，而且存在一定的内部行政问题，该部门难以放出更多的官员接受培训。

**建议**

140. 谨建议执行委员会注意到由环境规划署提交的、UNEP/OzL.Pro/ExCom/92/9 号文件所载关于第五次也是最后一次付款相关的工作方案执行情况的最后进度报告，以及圣卢西亚氟氯烃淘汰管理计划的项目完成情况报告。

**沙特阿拉伯：氟氯烃淘汰管理计划（第一阶段——关于剩余活动进行情况的进度报告）（环境规划署）**

**背景**

141. 在第八十六次会议上，执行委员会特别请环境规划署向执行委员会每年的最后一次会议提交年度进度报告，说明制冷维修行业剩余活动、海关培训，以及对氟氯烃淘汰管理计划第一阶段的监测情况，直至这些工作完成（第 86/16 号决定(f)(二)分段）。

142. 根据第 86/16 号决定(f)(二)分段，环境规划署代表沙特阿拉伯政府提交了进度报告。

[22] 第一次和第二次付款的结余。

**进度报告**

143. 自第八十八次会议以来开展了以下活动：

(a) 为 60 名海关官员举办了一次关于氟氯烃消费量监测与报告的虚拟进修培训班，并继续举办关于消耗臭氧层物质政策和法规的国家臭氧委员会会议，同时持续制定关于一次性气瓶的禁令；

(b) 实行了电子许可证系统，使进出口商能够以电子形式提交申请。借助政府资源，对该系统进行了进一步改进，包括将许可证与企业和相关政府机构挂钩，改进工作预计将于 2024 年完成；

(c) 编制了国家制冷和空调技术员良好做法守则，包括安全处理易燃制冷剂的良好做法。根据该良好做法守则，还通过了技术和职业培训公司的最新培训课程；以及

(d) 重新激活了与技术和职业培训公司的谅解备忘录，以便与沙特工程师协会合作，就制冷和空调技术员培训与认证方案开展合作。迄今共有 9,903 名制冷和空调技术员通过认证。

**秘书处评论**

144. 针对执行委员会和沙特阿拉伯政府间达成协定的附录 8-A 中规定的维修行业的四种相关情况，秘书处注意到：

(a) 一次性气瓶禁令的制定工作还在进行中；禁令的预计执行时间尚不明确；

(b) 虽然有法规要求工程专业人员必须持证上岗，但该国似乎仅有一小批技术员通过了认证；

(c) 关于实施一项制度，规定只有认证技术员在开展和监督制冷和空调系统维修工作的实体才能获得制冷剂，环境规划署澄清道，虽然没有规定只允许向认证技术员出售制冷剂，但新通过的法规要求所有实体都须具备认证技术员，否则违规实体将面临触发。执行该项法规、对大量技术员进行培训和认证，以及执行良好做法守则，三者相结合，便等于实施了该项制度；以及

(d) 关于制定一项策略，鼓励制冷和空调设备的终端用户实施泄漏检测和维修措施，环境规划署澄清道，所有控制措施和消耗臭氧层物质相关规定都将在新条例的法规过程中引入。

145. 沙特阿拉伯政府与环境规划署之间的小规模融资协定的终止日期为 2021 年 12 月 31 日。在第八十八次会议上，环境规划署报告了 129,400 美元的结余。自此之后，向已开展的活动发放了 121,900 美元，结余 7,500 美元。秘书处回顾，根据第 86/16 号决定(f)(三)分段，只有在提交了氟氯烃淘汰管理计划第一阶段项目完成情况报告，完成了氟氯烃淘汰管

理计划第一阶段的财务工作，而且所有资金结余均已退还多边基金后，才会审议沙特阿拉伯氟氯烃淘汰管理计划第二阶段。

## 建议

146. 谨建议执行委员会注意到环境规划署所提交UNEP/OzL.Pro/ExCom/92/9号文件中所载关于沙特阿拉伯氟氯烃淘汰管理计划第一阶段剩余活动进行情况的年度进度报告（第86/16号决定(f)(二)分段）。

## B. 跟氢氟碳化物有关的报告

**约旦：关于 Petra Engineering Industries Co.生产 400 千瓦以下大型商用单体屋顶空调设备的设施由使用氢氟碳化物改造为丙烷的项目报告（工发组织）**

## 背景

147. 执行委员会第八十一次会议核准约旦佩特拉工程工业公司（Petra Engineering Industries Co.）的一个项目，对制造 400 千瓦以下大型商用单体屋顶空调设备的设施进行从氢氟碳化物（HFC-134a、R-407C、R-410A）到丙烷（R-290）的改造，金额为1,637,610美元，外加工发组织的机构支助费用（第81/62号决定）。

148. Petra 公司是该国最大的空调设备制造商和唯一的单体屋顶空调设备制造商。该项目旨在模拟、设计、测试和改造使用 R290 的单体屋顶空调设备的生产流程，以取代商业和工业用途的 400 千瓦（114 吨制冷量）以下的使用氢氟碳化物的空调设备，并实现比美国暖气、制冷及空调工程师协会（ASHRAE）标准 90.1 中的最低能效比高 10%至 15%的数值。该公司共有八条装配线和八个注入区，其中两个将被改造为生产 R-290 空调。两台原型机的容量分别为 80 千瓦和 185 千瓦，涵盖在佩特拉生产的所有单体空调设备，并包括两种不同的设计和所有相关的安全措施。

149. 在第九十次会议之前，两条生产线进行了技术改造，并设计、制造和测试了两台容量分别为80千瓦和185千瓦的R-290原型机，此外还有第三台基于HFC-32的原型机。这些原型机都超过了基准机的制冷量（2-9%）和能效比（2-11%）。不过，该企业仍未制造任何基于新技术的大型商用单体屋顶空调设备。

150. 核准的总成本为 1,637,610 美元，包括 889,800 美元的增支资本成本（ICC）和747,810美元的增支经营成本（IOC）。在第九十次会议上，工发组织报告的增支资本成本为1,521,120美元，增支经营成本为零，因为除原型机之外，未生产任何使用R290的单体屋顶空调设备。

151. 该项目应在 2020 年 7 月前完成，并在项目完成后六个月内提交一份全面的完成报告；在第九十次会议上，完成日期被延长至2025年7月31日，以便针对市场需求变化和销售量减少的情况引入新技术。

152. 此外，在其第九十次会议上，执行委员会决定，除其他外，注意到 113,089 美元的余额将专门发放，用于与制造使用 R-290 的大型商用单体屋顶空调设备有关的增支经营成本；在整个项目期间，该企业将通过工发组织，报告使用 R290 的大型商用单体屋顶空调

设备的每年销售情况，第 5 条国家和非第 5 条国家的销售情况将分别进行报告；并且只根据第 5 条国家的使用 R290 的大型商用单体屋顶空调设备的销售情况，提供增支经营成本（第 90/25 号决定）。

153. 工发组织代表约旦政府提交了一份关于项目执行情况的进度报告，包括一份关于使用 R290 的大型商用单体屋顶空调设备的年度销售情况的报告，第 5 条国家和非第 5 条国家分别报告，一份待发放的剩余款项的最新情况报告，以及一份培训和提高认识活动的最新情况报告。

**进度报告**

154. 自第九十次会议以来，该企业未曾销售使用 R290 的大型商用单体屋顶空调设备；但是，为一个第 5 条国家提供的两个订单正在等待最后确认。

155. 该企业继续努力将这一技术引入市场并提高市场接受度，包括通过对其技术人员和安装人员进行培训和资格认定，使其了解针对使用易燃制冷剂的空调系统的良好、安全的安装及维护方法，并通过对潜在客户进行宣传，使其了解易燃制冷剂在空调系统中具备的优势和风险；此外，正在为使用易燃制冷剂的空调系统制定新的安全标准。

156. 剩余的 113,089 美元将专门作为增支经营成本发放，但由于自第九十次会议以来未产生任何销售，因此未发放任何款项。

**秘书处的评论**

157. 秘书处理解 Petra 公司一直面临严峻的商业环境：该企业使用氢氟碳化物的设备生产能力继续降低，2022 年使用氢氟碳化物的设备销售量比 2021 年下降 75%。预计到 2024 年，使用氢氟碳化物的设备的销售才会实现恢复。该企业将销售的大幅下降归因于 COVID-19 大流行病带来的影响，其中包括对商用空调设备的投资普遍减少；一些国家政治局势对该地区的经济形势可能造成影响；以及市场需求出现变化，包括对冷冻水系统的需求增加。工发组织还指出，鉴于大流行期间优先事项的转变，欧洲联盟（欧盟）在 2022 年才开始引进使用 R290 的小型设备，预计这将有助于克服将使用 R290 的设备引入市场的障碍。

158. 在第九十次会议上，工发组织已确认，该企业仍然致力于制造使用 R-290 的大型商用单体屋顶空调设备，并已获准进行延期，以便有更多时间进行政策和监管方面的改革，并建立对该技术的信心。欧盟氟化气体条例的预期修改虽然已被推迟，但这一修改可能会使得使用 R-290 的大型商用单体屋顶空调设备在欧盟国家得到采用[23]。同样，美国加利福尼亚州法规的预期修改可能会促进当地市场采用该技术[24]。此外，该地区第 5 条国家（约

[23] 2022 年 4 月 5 日，欧盟委员会发布了一项更新欧盟氟气体条例的提案，以采取措施，进一步减少氢氟碳化物在欧盟的使用，包括于 2027 年 1 月 1 日禁止使用全球升温潜能值（GWP）为 750 或更高，使用氟气体的某些空调设备；以及增加有资质处理 R-290 的工程师和技术人员数量的措施。

[24] 现有法规规定，新的固定式制冷和空调设备的制冷剂灌装量超过 22.7 公斤时，必须使用全球升温潜能值低于 150 的制冷剂。2022 年 2 月提交的法规修正案将 2030 年后在加州销售的氢氟碳化物的全球升温潜能值限制在 750 或以下，并要求加州空气资源委员会制定期限，以采用使用全球升温潜能值为 150 或以下的制冷剂的空调设备。

旦、沙特阿拉伯和阿拉伯联合酋长国）的建筑法规在进行预期的修改后，将允许安装和采用使用 R-290 的大型商业单体屋顶空调设备。

159. 秘书处要求提供以上条例和建筑法规的最新情况。工发组织就此说明，欧洲议会于 2023 年 3 月 30 日通过了欧盟委员会关于修订氟气体条例的提案；欧盟理事会、欧洲议会和欧盟委员会之间的磋商正在进行，预计修订后的条例将于 2023 年 9 月通过，于 2024 年 1 月 1 日生效。此外，2020 年 12 月，加州空气资源委员会（CARB）通过了一项监管提案，对高全球升温潜能值制冷剂的使用，以及氢氟碳化物及其混合物的销售和分销进行进一步限制。该法规于 2022 年开始实施，目前正在分阶段进行，计划于 2035 年全面过渡到低或无全球升温潜能值的替代技术。工发组织指出，美国、加拿大和日本等其他非第 5 条国家的法规也可能促进这些技术在市场上的应用。上文提及的约旦、沙特阿拉伯和阿拉伯联合酋长国的建筑法规的修订工作正在进行。

**建议**

160. 谨建议执行委员会注意 UNEP/OzL.Pro/ExCom/92/9 号文件所载由工发组织提交的进度报告，其内容涉及对 Petra Engineering Industries Co.公司生产 400 千瓦以下大型商用单体屋顶空调设备的设施由氢氟碳化物改造为丙烷（R-290）项目的执行。

## C. 关于消耗臭氧层物质处置的报告

### 巴西： 消耗臭氧层物质废物管理和处置试点示范项目（最终报告）（开发计划署）

**背景**

161. 执行委员会第七十二次会议核准了巴西的消耗臭氧层物质废物管理和处置试点示范项目，金额为 1,490,600 美元，外加开发计划署的 104,342 美元的机构支助费用（第 72/28 号决定）。执行委员会第七十九次会议核准将该项目延长至 2022 年 12 月，并要求开发计划署向 2023 年的第一次会议提交最后报告，并最迟于 2023 年 7 月提交项目完成报告，并最迟于 2023 年 12 月退还基金余额，但前提是执行委员会不考虑进一步延长该项目完成日期（第 79/18(c)号决定(一)段）。

162. 开发计划署代表巴西政府，根据第 79/18(c)号决定(一)段提交了 UNEP/OzL.Pro/ExCom/92/9 号文件所载关于消耗臭氧层物质废物管理和处置试点示范项目的最后报告。

**报告摘要**

163. 试点项目的目标是通过建立国家消耗臭氧层物质废物管理系统，以环境上适当、高效和经济上可行的解决方案，展示消耗臭氧层物质的管理和最终处置，并探索将消耗臭氧层物质废物管理和报废销毁纳入该国更广泛的国家废物管理和能源效率方案的机会。核准的项目包括 120 公吨消耗臭氧层物质废物的处置，这些废物先前已被收集并指定用于销毁。

164. 该项目通过四个部分实施：处理和运输消耗臭氧层物质废物的能力建设以及废物储存能力的提升；通过在两个选定的焚烧设施中进行燃烧试验和对物流和成本的分析，使国

家标准处置消耗臭氧层物质废物的能力得到认可；为消耗臭氧层物质废物管理和最终处置的程序和标准的评价和标准化提供技术援助；以及项目管理和监督。

165. 该项目销毁了 24.74 公吨的消耗臭氧层物质废物，并使 Essencis 环境解决方案公司（Essencis Soluções Ambientais）的设施通过资格认证，成为受益的销毁设施。该设施获得了进行燃烧试验的必要设备，使工厂销毁消耗臭氧层物质的焚烧炉达到《蒙特利尔议定书》的标准，并进行了气体供应系统安装以及其他改造。此外，还确定了四个再生中心[25]并给予其设备支持，以增加其储存能力[26]，其中三个还收到了设备[27]以改进再生作业。在整个项目期间，对四个中心、环保机构、废物管理人员和其他有关利益方进行了关于消耗臭氧层物质的管理和环境可接受的最终处置的培训。这些再生中心将构成聚集和收集消耗臭氧层物质废物的网络，并由 Essencis 进行最终销毁。为支持该项目，制定了技术标准，如制冷剂液体的收集、复原和再生的规格；同时起草了关于消耗臭氧层物质环境管理的条例，并提交环境部审议。

166. 项目实施过程曾遇到一些挑战，并导致项目延迟完成。这些挑战包括由于设备和运输成本的波动而导致设备采购过程复杂而漫长，以及 COVID-19 大流行病对再生中心和焚烧设施运行的影响。此外还注意到，批准时设想的最初项目执行期（即 24 个月）不足以全面实施所有活动，从而造成了延误。

167. 该项目在巴西这样的大国的消耗臭氧层物质废物管理和处置系统的可持续性方面有许多经验教训，其中包括：需要清晰确定和强化每个有关利益方在整个过程中的作用和责任；定期监测经济、政治和社会风险；提高认识的重要性，以改变市场对再生物质质量的看法，鼓励将其用于维修；以及环境部、巴西环境和可再生资源研究所、圣保罗州环境公司和开发计划署之间密切合作的重要性，这对项目的整体成功至关重要。

168. 该项目销毁了 24,744 公斤（24.74 公吨），报告的支出为核准的 1,490,600 美元的 100%，外加机构支助费用，最终成本效益为 60 美元/公斤销毁的消耗臭氧层物质废物。

**秘书处的评论**

169. 秘书处指出，最后报告包括第 58/19 号决定的下列方面：

(a) 项目最终销毁的消耗臭氧层物质的估计数量；

(b) 关于收集系统的说明，特别是在多边基金项目与其他项目有协同作用的情况下；

(c) 整个流程的详细步骤；以及

(d) 遇到的主要挑战以及如何应对这些挑战，以及迄今为止在开展试点项目中获

[25] Ecosuporte Soluções em Gestão Ambiental、Frigelar、Northeast Regeneration and Recycling Center (CRN) 以及 Recigases.]

[26] 提供了额外的大容量钢瓶（1000 磅）。

[27] 制冷剂识别器、收集器、检漏器和其他设备和工具。

得的经验教训。

170. 开发计划署指出，预期的销毁消耗臭氧层物质废物的目标未能实现，主要是由于大流行病对再生中心的收集工作产生了负面影响。此外，Essencis 公司在燃烧试验排放物超过二恶英和呋喃的上限后，出于安全原因被要求降低销毁消耗臭氧层物质的进料限度，这一问题在调整后得到解决。

171. 由此得出的成本效益为 60 美元/公斤销毁的消耗臭氧层物质废物，高于第七十二次会议上为该项目核准的 12.42 美元/公斤的预期目标。[28]

## 建议

172. 谨建议执行委员会注意开发计划署提交的关于巴西消耗臭氧层物质废物管理和处置试点示范项目的最后报告，该报告附于 UNEP/OzL.Pro/ExCom/92/9 号文件。

## D. 关于低全球升温潜能值项目的报告

### 沙特阿拉伯：关于在高环境温度下为空调行业推广使用氢氟烯烃的低全球升温潜能值制冷剂的示范项目（最后进度报告）（工发组织）

## 背景

173. 示范项目在第七十六次会议上获得核准，以制造、测试和优化使用全球升温潜能值低的氢氟烯烃/氢氟碳化物混合物以及 R-290 的试验型空调设备，进行示范性生产并对一条生产线进行改造，金额为 1,300,000 美元，外加工发组织的机构支助费用 91,000 美元。

174. 该项目最初预计在 2018 年 5 月之前完成。在第八十次和第八十八次会议期间，[29] 鉴于 COVID-19 大流行病带来的限制、成果在多个第 5 条国家的潜在可复制性以及取得的进展，执行委员会四次决定延长该项目，其中包括交付制造设备、移动生产线和安装制造设备和质量控制系统、升级实验室和测试室、完成土建工程以及测试和优化 R-290 装置等方面。[30]

175. 在第九十次会议上，据报告，虽然生产线的调试和实验室安全部件的交付已经完成，R-290 压缩机也已交付，但 R-290 空调设备的资格认定尚未最后完成，因为该企业正在继续优化设备设计，以确保灌装量保持在 500 克/台，同时实现能效比至少比最低能源性能标准高 5%。一名国际专家将访问该企业，为模型设计和验证提供技术援助，之后便可以完成 R-290 空调设备的资格认定和维修手册；此外，将对 R-290 空调设备进行第三方安全测试，并计划进行 R-290 空调设备的推广和举办传播讲习班。因此，鉴于所取得的进展，

[28] 第 72/28 号决定。

[29] UNEP/OzL.Pro/ExCom/88/18 和 UNEP/OzL.Pro/ExCom/90/9 号文件中作了进一步详细说明。

[30] 在第八十三次会议上，据报告，根据该企业的测试以及促进高环境温度国家制冷剂替代物的示范项目（PRAHA-II）的结果，该企业决定将其生产集中在使用 R-290 的设备上，尽管不排除未来使用氢氟烯烃及其混合物。

执行委员会决定将项目的完成日期延长至 2022 年 9 月 30 日，并要求工发组织在第九十二次会议之前提交项目的最后报告并退还所有余额（第 90/20 号决定）。

176. 工发组织根据第 90/20 号决定(c)段，并代表沙特阿拉伯政府，向第九十二次会议提交了关于在高环境温度下为空调行业推广使用氢氟烯烃的低全球升温潜能值制冷剂的示范项目的最后进度报告。最后报告附在本文件之后。

**进度报告**

177. R-290 设备的测试和优化继续进行：测试了更多的原型；制造商的实验室测试得到了升级，并得到了沙特标准、计量和质量组织（SASO）技术条例的认证，从而提高了测试的准确性；建立了两个具有可变条件的房间，对设备进行实际测试。最终开发出的产品是一个迷你分体式 R-290 空调设备，最佳制冷剂灌装量为 500 克；此外，该设备的能效比为 12.2，制冷量为 17.60 BTU/小时，与高全球升温潜能值的基本型设备相比，能效比有所提高，但制冷量降低了 5%。鉴于实验室获得了 SASO 认证，并且设备符合 SASO 标准，不再需要对 R-290 空调设备进行第三方安全测试。该设备获得了生产和进入市场所需的资格认定。

178. 生产线和热交换器测试设施进行了大规模生产所需的改造，包括安全评估，并进行了注入、测试和生产过程的改造。该企业估计每年的生产能力为 300,000 台。

179. 编写并最终确定了维修手册和培训材料；企业的培训人员、管理人员和技术人员接受了关于制造新设备以及处理 R-290 时的良好、安全操作的培训。测试室也被用作培训的一部分，以推广 R-290 空调设备并传播关于项目成果的信息。

180. 在核准的 1,300,000 美元中，已发放了 1,188,813 美元。工发组织确认已启动财务结算程序，但未能在第九十二次会议前及时完成。因此，111,187 美元的余额，加上 7,783 美元的机构支助费用，将退还给第九十三次会议。

**秘书处的评论**

181. 尽管由于 COVID-19 大流行病的影响，项目的实施面临挑战，而且出现了多次延误，但该项目仍能顺利完成。秘书处尤其注意到，该项目示范了一条空调生产线从 HCFC-22 到 R-290 的成功改造，包括协助企业建立必要材料和部件的供应链，包括 5 毫米内槽铜管和适合在高环境温度条件下使用的 60 赫兹[31] 压缩机，以及测试和优化 1.5 吨制冷（TR）分离式空调，这是沙特阿拉伯市场上最常见的设备。相对于使用 R-410A 的设备，使用 R-290 的设备能效比更佳，尽管制冷量略低，但能够更好地实现测试室的设定温度，包括当外部温度高于 30°C时。

**建议**

[31] 沙特阿拉伯的电源是 220 伏交流电/60 赫兹。

182. 谨建议执行委员会注意到UNEP/OzL.Pro/ExCom/92/9号文件所载，由工发组织根据第 90/20(c)段提交，关于在沙特阿拉伯高环境温度下为空调部门推广采用使用氢氟烯烃的低全号决定球升温潜能值制冷剂的示范项目的最后进度报告。

## 二.3 单独审议

183. 本节内容包括两份供单独审议的报告。

### A. 关于第 83/41 罕见的(e)段的报告

**中国： 关于第 83/41 号决定(e)段决定所列活动执行进展的报告**

介绍

184. 执行委员会第八十三次会议审议了以下两份文件：

(a) 根据中国政府与执行委员会之间的氟氯烃消费和生产淘汰管理计划协定，由开发计划署根据第 82/65 号和第 82/71 号决定(a)段，代表中国政府提交对当前的监测、报告、核查和执行制度的审查；以及

(b) 世界银行根据第 82/67 号决定(c)段，代表中国政府提交的关于在氟氯烃淘汰管理计划第一阶段下接受援助的企业的现行泡沫塑料发泡剂消费监测制度和核查方法的案头研究。

185. 在审议中，委员会欢迎了中国政府将采取的一些监管和执法行动；赞赏地注意到了中国政府将采取更多行动支持其执法行动；并进一步赞赏地注意到了中国政府将考虑一整套建议，以补充和加强其监管和执法行动。执行委员会还注意到，中国政府将向第八十四次会议，并再次向第八十六次会议提交报告，说明其执行第 83/41 号决定(a)至(d)段所述活动的进展情况。

186. 执行委员会第八十四次会议审议了中国政府根据第 83/41 罕见的(e)段提交的进度报告[32]，随后注意到中国政府代表提供的关于第 83/41 号决定所列活动执行情况的资料。根据第 83/41 号决定，中国政府随后向第八十六次会议提交了一份进度报告，对该报告的审议被推迟到随后的每次会议，直至第九十一次会议。[33]

187. 执行委员会第九十一次会议审议了有具体报告要求的与中国有关的项目报告，[34]包括关于第 83/41 号决定(e)段所列活动执行进展情况的报告，关于确定可能导致非法生产和使用 CFC-11 和 CFC-12 的监管、执法、政策或市场情况的研究（第 83/41 号决定(d)段），以及关于中国四氯化碳生产及其原料用途的最新报告（第 84/41 号决定(b)和(c)段）。在全体会议上进行交流后，执行委员会同意在一个非正式小组中进一步讨论该文件。

[32] UNEP/OzL.Pro/ExCom/84/22/Add.1

[33] 在第八十七、第八十八和第九十次会议上，根据这些会议的商定程序，以及在第九十次会议上，由于一个成员国代表团的主要代表在线参与，这一审议被推迟。

[34] UNEP/OzL.Pro/ExCom/84/22/Add.1

188. 随后，据报告，该非正式小组进行了有益的信息交流。中国代表指出，该国在执行第 83/41 号决定所列活动方面继续取得进展，包括正在建立一个大气监测站网络，并确认将与国际科学界分享收集的数据。中国还表示，由于生产商对生产过程进行了很好的管理，四氯化碳原料使用的增加并没有导致排放量的大幅增加。中国表示愿意在第九十二次会议上继续讨论与执行第 83/41 号决定所述活动有关的事项。

189. 执行委员会同意在第九十二次会议上继续讨论关于第 83/41 号决定(e)段所列活动执行进展情况的报告，以及中国政府可能希望就其执行第 83/41 号决定所述活动的进展情况提供的任何最新情况。

190. 进度报告全文附于本文件，未经编辑或进一步审查。

## B. 有关氢氟碳化物的报告

### 阿根廷：HCFC-22 生产中产生的 HFC-23 的排放控制（工发组织）

### 背景

191. 执行委员会第八十七次会议核准了对 Frio Industrias Argentina 公司（FIASA）生产 HCFC-22 时产生的 HFC-23 排放进行控制的项目（第 87/52 号决定(b)段），随后的第八十八次会议核准了协定草案（第 88/77 号决定(c)段）和 2021-2022 年度执行计划（第 87/52 号决定(f)段和帝 88/77 号决定(b)段）。

192. 2021-2022 年年度执行计划预计，2022 年 1 月 1 日之后和焚烧炉整修完成之前产生的任何 HFC-23 副产品都将储存在现场低温罐中，直到达到低温罐的最大容量。工发组织指出，如果出现如 COVID-19 大流行病等不可抗力造成的不可预见的延误，FIASA 公司、阿根廷政府和工发组织将立即通知执行委员会，并提出减少 HFC-23 排放的措施。[35]

193. 在第九十次会议上，工发组织报告说，在最后完成焚烧炉整修的合同方面出现了延误。在 FIASA 公司进行焚烧炉整修时，低温储罐本来可用于储存 HFC-23 副产品；然而，由于阿根廷政府担心低温储罐在整修完成前就达到最大容量，FIASA 公司没有连接低温储罐，在 2022 年 1 月至 2022 年 3 月或 4 月重新连接时，HFC-23 被排放到了大气中。2022 年 3 月，由于供应链中断，FIASA 公司在购买原材料方面存在困难，暂时停止了 HCFC-22 的生产。经商定，一旦该企业重新开始生产 HCFC-22，产生的 HFC-23 副产品将储存在低温罐中，直到完成焚烧炉的整修或按原计划达到低温罐的最大容量。

194. 在第九十一次会议上，工发组织报告说，低温罐已连接并储存了产生的 HFC-23 副产品，除向第九十次会议报告的情况外，没有进一步向大气排放 HFC-23。FIASA 公司在 2022 年 6 月恢复了 HCFC-22 的生产。从那时起到 2022 年 9 月，由于供应链中断造成无水氟化氢供应的延误，该企业的 HCFC-22 一直处于间歇生产状态。在该间歇性生产期间产生的 HFC-23 副产品被储存在低温罐中。翻新焚烧炉所需的许多部件已经交付，但并非全部：FIASA 公司直接购买的天然气流量控制和阻断阀预计将于 2022 年 11 月到达，焚烧炉的技术供应商德国迈廷根的西格里碳素集团（SGL）的一些部件被推迟，因为启动外交特

[35] 文件 UNEP/OzL.Pro/ExCom/88/77 第 5 段。

许权程序所需的文件要到 2022 年 10 月才能提供；预计这些部件的交付将需要最多三个月。在交付天然气流量控制和阻断阀后，FIASA 公司计划在等待 SGL 的部件送达的同时，用当地的零件启动焚烧炉，并预计在 2022 年 12 月之前焚烧炉能投入使用。

**提交给第九十二次会议的进度报告**

195. 根据第 90/24 号决定，阿根廷政府通过工发组织向第九十二次会议提交了一份进度报告。报告证实，低温罐正在储存产生的 HFC-23 副产品，除了向第九十次会议报告的情况外，没有进一步向大气排放 HFC-23；但是，焚烧炉还没有投入使用。虽然天然气流量控制和阻断阀已经交付，但 SGL 公司的部件尚未交付，而且对当地零件的测试表明，这些零件不适用于焚烧炉。外交特许权所需的文件已于 2023 年 1 月 19 日发出，并由阿根廷政府处理；预计这些部件将于 2023 年 6 月中旬交付，之后将安装可编程逻辑控制器（PLC）传感器并进行试运行（无火焰和有火焰点火）。因此，预计该焚烧炉将在 2023 年 6 月底前投入使用。

196. 该企业在 11 月至 2023 年 1 月增加了 HCFC-22 的产量，这与阿根廷的夏季和需求增加相一致；在 2023 年 2 月以较低的速度生产 HCFC-22；并在 2023 年 3 月暂时停止了生产。鉴于该企业自低温罐重新连接以来生产了 964.93 公吨的 HCFC-22，储存罐的最大容量尚未达到。截至 2023 年 3 月，估计还有 2.08 公吨的容量，同时有 29.87 公吨的 HFC-23 副产品储存在低温罐中。

**秘书处的评论**

197. 尽管在项目实施过程中面临挑战，但没有更多的 HFC-23 副产品被排放到大气中。注意到 SGL 公司的货物预计将于 2023 年 6 月中旬抵达；SGL 公司的部件抵达后，完成焚烧炉整修的最后一个步骤是安装 PLC 传感器和进行试运行；鉴于焚烧炉预计将于 2023 年 6 月底投入使用，秘书处要求 FIASA 公司向阿根廷政府提供一份书面承诺，确认如果焚烧炉的整修工作进一步延迟，该企业将不会向大气排放 HFC-23 副产品，而且如果达到低温罐的最大容量，该企业将暂时停止生产 HCFC-22，直到焚烧炉投入使用。[36]

**建议**

198. 谨建议执行委员会：

(a) 注意到 UNEP/OzL.Pro/ExCom/92/9 号文件所载、由工发组织提交的关于 FIASA 公司在生产 HCFC-22 过程中产生的 HFC-23 排放控制项目执行情况的进度报告；以及

(b) 请工发组织代表阿根廷政府，向 2023 年第二次会议提供一份关于上文(a)分段所述项目执行情况的报告，其中包括产生、储存和排入大气的 HFC-23 副产品的数量。

[36] 根据 2023 年 4 月 20 日 FIASA 公司给工发组织的信函。

# 附件一

## 被归类为“取得一些进展”并建议继续监测的项目

| 国家 | 编号 | 项目名称 | 机构 |
|---|---|---|---|
| 阿尔及利亚 | ALG/PHA/66/INV/76 | 氟氯烃淘汰管理计划（第一阶段，第一次付款）（Condor 公司停用 HCFC-22 制造室内空调机） | 工发组织 |
| 阿尔及利亚 | ALG/PHA/66/INV/77 | 氟氯烃淘汰管理计划(第一阶段，第一次付款）（制冷维修行业的活动，包括淘汰用于冲洗的 HCFC-141b 和项目监测） | 工发组织 |
| 孟加拉国 | BGD/PHA/81/TAS/50 | 氟氯烃淘汰管理计划(第二阶段，第一次付款）（制冷维修行业） | 环境规划署 |
| 波斯尼亚和黑塞哥维那 | BHE/PHA/82/INV/36 | 氟氯烃淘汰管理计划(第一阶段，第四次付款）（制冷维修行业的活动，包括政策行动） | 工发组织 |
| 波斯尼亚和黑塞哥维那 | BHE/PHA/72/INV/29 | 氟氯烃淘汰管理计划(第一阶段，第二次付款）（制冷维修行业的活动，包括政策行动） | 工发组织 |
| 波斯尼亚和黑塞哥维那 | BHE/PHA/76/INV/33 | 氟氯烃淘汰管理计划(第一阶段，第三次付款）（制冷维修行业的活动，包括政策行动） | 工发组织 |
| 博茨瓦纳 | BOT/PHA/75/INV/18 | 氟氯烃淘汰管理计划（第一阶段，第一次付款） | 工发组织 |
| 博茨瓦纳 | BOT/PHA/82/INV/21 | 氟氯烃淘汰管理计划（第一阶段，第二次付款） | 工发组织 |
| 柬埔寨 | KAM/PHA/83/INV/36 | 氟氯烃淘汰管理计划（第四次付款） | 开发计划署 |
| 喀麦隆 | CMR/PHA/82/INV/45 | 氟氯烃淘汰管理计划(第二阶段，第一次付款） | 工发组织 |
| 智利 | CHI/PHA/76/TAS/191 | 氟氯烃淘汰管理计划(第二阶段，第一次付款）（制冷维修行业） | 环境规划署 |
| 智利 | CHI/PHA/81/TAS/196 | 氟氯烃淘汰管理计划(第二阶段，第二次付款）（制冷维修行业） | 工发组织 |
| 中国 | CPR/PHA/77/INV/574 | 氟氯烃淘汰管理计划（第二阶段，第一次付款）（室内空调制造行业计划） | 意大利 |
| 中国 | CPR/PHA/77/INV/576 | 氟氯烃淘汰管理计划（第二阶段，第一次付款）（室内空调制造行业计划） | 工发组织 |
| 中国 | CPR/PHA/81/INV/588 | 氟氯烃淘汰管理计划（第二阶段，第二次付款）（室内空调制造行业计划） | 工发组织 |
| 多米尼克 | DMI/PHA/62/TAS/19 | 氟氯烃淘汰管理计划（第一阶段，第一次付款） | 环境规划署 |
| 多米尼克 | DMI/SEV/80/TAS/01+ | 逐步减少氢氟碳化物的扶持活动 | 环境规划署 |
| 科威特 | KUW/PHA/74/INV/24 | 氟氯烃淘汰管理计划(第一阶段，第二部分）（聚氨酯泡沫塑料行业淘汰：科威特聚氨酯公司；Kirby 建筑公司，为喷射泡沫塑料用户和其他小规模用户提供技术援助） | 工发组织 |

| 国家 | 编号 | 项目名称 | 机构 |
|---|---|---|---|
| 科威特 | KUW/PHA/74/INV/25 | 氟氯烃淘汰管理计划(第一阶段，第二部分）（挤塑聚苯乙烯泡沫塑料行业淘汰：海湾绝缘材料制造和贸易公司；Isofoam 绝缘材料厂；Al Masaha 公司） | 工发组织 |
| 科威特 | KUW/PHA/83/INV/36 | 氟氯烃淘汰管理计划(第一阶段，第三次付款）（聚氨酯泡沫塑料行业的淘汰） | 工发组织 |
| 莫桑比克 | MOZ/PHA/83/INV/31 | 氟氯烃淘汰管理计划（第一阶段，第三次和第四次付款） | 工发组织 |
| 瑙鲁 | NAU/PHA/74/TAS/10 | 通过区域办法落实太平洋岛屿国家的氟氯烃淘汰管理计划（第一阶段，第二次付款，瑙鲁） | 环境规划署 |
| 菲律宾 | PHI/PHA/83/INV/104 | 氟氯烃淘汰管理计划(第二阶段，第一次付款）（空调行业） | 工发组织 |
| 菲律宾 | PHI/PHA/83/TAS/105 | 氟氯烃淘汰管理计划(第二阶段，第一次付款）（制冷维修行业） | 工发组织 |
| 圣基茨和尼维斯 | STK/PHA/74/TAS/20 | 氟氯烃淘汰管理计划（第一阶段，第二次付款） | 环境规划署 |
| 圣文森特和格林纳丁斯 | STV/SEV/80/TAS/01+ | 逐步减少氢氟碳化物的扶持活动 | 环境规划署 |
| 苏里南 | SUR/SEV/80/TAS/01+ | 逐步减少氢氟碳化物的扶持活动 | 环境规划署 |
| 土耳其 | TUR/PHA/75/INV/107 | 氟氯烃淘汰管理计划(第一阶段，第二次付款）（制冷维修和监测） | 工发组织 |
| 土耳其 | TUR/PHA/84/INV/111 | 氟氯烃淘汰管理计划(第一阶段，第三次付款）（制冷维修和监测） | 工发组织 |

# 附件二

## 被归类为“未取得进展”并建议继续监测的项目

| 国家 | 编号 | 项目名称 | 机构 |
|---|---|---|---|
| 博茨瓦纳 | BOT/PHA/82/TAS/22 | 氟氯烃淘汰管理计划（第一阶段，第二次付款） | 环境规划署 |
| 文莱达鲁萨兰国 | BRU/PHA/82/TAS/24 | 氟氯烃淘汰管理计划（第一阶段，第三次付款） | 环境规划署 |
| 智利 | CHI/PHA/81/TAS/195 | 氟氯烃淘汰管理计划(第二阶段，第二次付款）（制冷维修行业） | 环境规划署 |
| 多米尼克 | DMI/PHA/84/TAS/25 | 氟氯烃淘汰管理计划（第一阶段，第二次付款） | 环境规划署 |
| 缅甸 | MYA/PHA/80/INV/19 | 氟氯烃淘汰管理计划（第一阶段，第二次付款） | 工发组织 |
| 沙特阿拉伯 | SAU/PHA/77/INV/31 | 氟氯烃淘汰管理计划(第一阶段，第四部分）（聚氨酯泡沫塑料行业计划） | 工发组织 |
| 圣文森特和格林纳丁斯 | STV/PHA/75/TAS/23 | 氟氯烃淘汰管理计划（第一阶段，第二次付款） | 环境规划署 |

# 附件三

## 被归类为“未取得进展”并建议发可能取消信函的项目

| 国家 | 编号 | 项目名称 | 机构 |
|---|---|---|---|
| 阿富汗 | AFG/PHA/79/INV/22 | 氟氯烃淘汰管理计划（第一阶段，第三次付款） | 工发组织 |
| 缅甸 | MYA/PHA/68/TAS/14 | 氟氯烃淘汰管理计划（第一阶段，第一次付款） | 环境规划署 |
| 缅甸 | MYA/PHA/80/TAS/18 | 氟氯烃淘汰管理计划（第一阶段，第二次付款） | 环境规划署 |

# 附件四

## 要求提交补充情况报告的项目

| 国家 | 编号 | 项目名称 | 机构 | 建议 |
|---|---|---|---|---|
| 阿富汗 | AFG/PHA/85/TAS/27 | 氟氯烃淘汰管理计划（第一阶段，第四次付款） | 环境规划署 | 请环境规划署向第九十三次会议提交执行进展报告，包括恢复活动的最新情况 |
| 阿富汗 | AFG/PHA/85/TAS/29 | 氟氯烃淘汰管理计划(第二阶段，第一次付款） | 环境规划署 | 请环境规划署向第九十三次会议提交执行进展报告，包括恢复活动的最新情况 |
| 阿富汗 | AFG/PHA/85/INV/28 | 氟氯烃淘汰管理计划（第一阶段，第四次付款） | 工发组织 | 请工发组织向第九十三次会议提交执行进展报告，包括恢复活动的最新情况 |
| 阿富汗 | AFG/PHA/85/INV/30 | 氟氯烃淘汰管理计划(第二阶段，第一次付款） | 工发组织 | 请工发组织向第九十三次会议提交执行进展报告，包括恢复活动的最新情况 |
| 阿富汗 | AFG/SEV/87/INS/31 | 延长体制强化项目（第十阶段：1/2022-12/2023) | 环境规划署 | 请环境规划署向第九十三次会议提交执行进展报告，包括恢复活动的最新情况 |
| 安提瓜和巴布达 | ANT/PHA/73/PRP/17 | 编制氟氯烃淘汰管理计划（第二阶段） | 环境规划署 | 请环境规划署向第九十三次会议提交编制氟氯烃淘汰管理计划第二阶段的进展报告 |
| 安提瓜和巴布达 | ANT/SEV/73/INS/16 | 延长体制强化项目（第五阶段：1/2015-12/2016) | 环境规划署 | 请环境规划署向第九十三次会议提交报告，说明提交进展报告和财务报告的状况 |
| 中非共和国 | CAF/SEV/68/INS/23 | 延长体制强化项目（第六阶段：1/2013-12/2014) | 环境规划署 | 请环境规划署向第九十三次会议提交报告，说明提交进展报告和财务报告和项目完成的状况 |
| 多米尼克 | DMI/PHA/86/TAS/26 | 实施氟氯烃淘汰管理计划第一阶段的核查报告 | 环境规划署 | 请环境规划署向第九十三次会议提交报告，说明编制核查报告的情况 |
| 多米尼克 | DMI/SEV/81/INS/24 | 延长体制强化项目（第七阶段：6/2018-5/2020) | 环境规划署 | 请环境规划署向第九十三次会议提交报告，说明提交进展报告和财务报告的状况 |
| 马里 | MLI/PHA/84/PRP/42 | 编制氟氯烃淘汰管理计划（第二阶段） | 环境规划署 | 请环境规划署向第九十三次会议提交编制氟氯烃淘汰管理计划第二阶段的进展报告 |
| 缅甸 | MYA/PHA/83/PRP/21 | 编制氟氯烃淘汰管理计划（第二阶段） | 环境规划署 | 请环境规划署向第九十三次会议提交执行进展报告，包括恢复活动的最新情况 |

| 国家 | 编号 | 项目名称 | 机构 | 建议 |
|---|---|---|---|---|
| 缅甸 | MYA/PHA/86/TAS/23 | 氟氯烃淘汰管理计划（第一阶段，第三次付款） | 环境规划署 | 请环境规划署向第九十三次会议提交执行进展报告，包括恢复活动的最新情况 |
| 缅甸 | MYA/PHA/86/TAS/24 | 实施氟氯烃淘汰管理计划的核查报告 | 环境规划署 | 请环境规划署向第九十三次会议提交执行进展报告，包括恢复活动的最新情况 |
| 缅甸 | MYA/SEV/84/INS/22 | 延长体制强化项目（第五阶段：7/2020-6/2022) | 环境规划署 | 请环境规划署向第九十三次会议提交执行进展报告，包括恢复活动的最新情况 |
| 缅甸 | MYA/PHA/83/PRP/20 | 编制氟氯烃淘汰管理计划（第二阶段） | 工发组织 | 请工发组织向第九十三次会议提交执行进展报告，包括恢复活动的最新情况 |
| 南苏丹 | SSD/SEV/76/INS/03 | 体制强化项目（第一阶段： 5/2016-4/2018) | 环境规划署 | 请环境规划署向第九十三次会议提交报告，说明签署小规模供资协定和第一次发放资金的情况 |

# 附件五

## 将纳入伊朗伊斯兰共和国政府与多边基金执行委员会关于根据氟氯烃淘汰管理计划第二阶段减少氯氟烃消费量的更新协定的案文

17. 这份更新后的协定取代伊朗伊斯兰共和国政府和执行委员会在执行委员会第九十次会议上达成的协定。

**附录 2-A：目标和供资**

| 行数 | 项目详情 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 共计 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.1 | 蒙特利尔议定书附件 C 第一类物质的减少时间表 (ODP 吨) | 342.4 | 342.4 | 342.4 | 342.4 | 247.33 | 247.33 | 247.33 | 247.33 | 247.33 | n/a |
| 1.2 | 附件 C 第一类物质的最高允许消费总量（ODP 吨） | 342.45 | 342.45 | 266.35 | 266.35 | 247.33 | 247.33 | 247.33 | 95.13 | 95.13 | n/a |
| 2.1 | 牵头执行机构（开发计划署）商定的供资（美元） | 1,298,170 | 0 | 1,593,980 | 0 | 1,307,980 | 0 | **1,300,503** | **337,860** | 0 | **5,838,493** |
| 2.2 | 牵头执行机构支助费用（美元） | 90,872 | 0 | 111,579 | 0 | 91,559 | 0 | **91,035** | **23,650** | 0 | **408,695** |
| 2.3 | 合作执行机构（工发组织）商定的供资（美元） | 473,567 | 0 | 584,000 | 0 | 524,000 | 0 | 0 | 521,638 | 0 | 2,103,205 |
| 2.4 | 合作执行机构支助费用（美元） | 33,150 | 0 | 40,880 | 0 | 36,680 | 0 | 0 | 36,515 | 0 | 147,224 |
| 2.5 | 合作执行机构(环境规划署) 商定的供资(美元) | 200,000 | 0 | 190,000 | 0 | 170,000 | 0 | 0 | 140,000 | 0 | 700,000 |
| 2.6 | 合作执行机构支助费用（美元） | 24,857 | 0 | 23,614 | 0 | 21,129 | 0 | 0 | 17,400 | 0 | 87,000 |
| 2.7 | 合作执行机构（德国）*商定的供资 (美元) | 645,500 | 0 | **954,018** | 0 | **139,754** | 0 | **0** | **0** | 0 | **1,739,272** |
| 2.8 | 合作执行机构支助费用（美元） | 73,420 | 0 | **111,723** | 0 | **16,176** | 0 | **0** | **0** | 0 | **201,320** |
| 2.9 | 合作执行机构（意大利）商定的供资（美元） | 403,203 | 0 | 504,004 | 0 | 0 | 0 | 0 | 0 | 0 | 907,207 |
| 2.1 | 合作执行机构支助费用（美元） | 48,797 | 0 | 60,996 | 0 | 0 | 0 | 0 | 0 | 0 | 109,793 |
| 3.1 | 商定供资总额（美元） | 3,020,440 | 0 | **3,826,002** | 0 | **2,141,734** | 0 | **1,300,503** | **999,498** | 0 | 11,288,177 |

| 行数 | 项目详情 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 共计 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.2 | 总支助费用（美元） | 271,096 | 0 | **348,792** | 0 | **165,544** | 0 | **91,035** | **77,565** | 0 | **954,032** |
| 3.3 | 商定经费总额（美元） | 3,291,536 | 0 | **4,174,794** | 0 | **2,307,278** | 0 | **1,391,538** | **1,077,063** | 0 | **12,242,209** |
| 4.1.1 | 本协定下商定要完成的 HCFC-22 淘汰总量（ODP 吨） | | | | | | | | | | 71.27 |
| 4.1.2 | 前一阶段要完成的 HCFC-22 淘汰量（ODP 吨） | | | | | | | | | | 38.6 |
| 4.1.3 | 剩余的符合资助条件的 HCFC-22 消费量（ODP 吨） | | | | | | | | | | 53.73 |
| 4.2.1 | 本协定下商定要完成的 HCFC-141b 淘汰总量（ODP 吨） | | | | | | | | | | 91.1 |
| 4.2.2 | 前一阶段要完成的 HCFC-141b 淘汰量（ODP 吨） | | | | | | | | | | 125.8 |
| 4.2.3 | 剩余的符合资助条件的 HCFC-141b 消费量(ODP 吨) | | | | | | | | | | 0.0 |

*** 德国政府在第九十二次会议不再是氟氯烃淘汰管理计划第二阶段的合作机构。第二次、第三次和第四次付款的未用余额以及第五次付款原则上核准的全部资金都转交给了开发计划署。**

BRAZIL

# DEMONSTRATION PROJECT FOR THE MANAGEMENT AND FINAL DISPOSAL OF ODS WASTE IN BRAZIL

## FINAL PROGRESS REPORT

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prepared by

MINISTRY OF THE ENVIRONMENT AND CLIMATE CHANGE

supported by

UNITED NATIONS DEVELOPMENT PROGRAM (UNDP)

APRIL 2023

## Abbreviations

ABNT - Brazilian Association of Technical Standards

CADRI - Certificate of Movement of Waste of Environmental Interest

CETESB - Environmental Company of São Paulo State

CFC - Chlorofluorocarbon

COVID-19 – Coronavirus Disease 2019

RC- Reclaim Center

CRN - Northeast Regeneration and Recycling Center

CTC - Carbon Tetrachloride

CPE - Collective Protection Equipment

PPE - Personal Protective Equipment

ExCom - Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol

MLF - Multilateral Fund for the Implementation of the Montreal Protocol

GWP - Global Warming Potential

HCFC - Hydrochlorofluorocarbons

HFC – Hydrofluorocarbon

HPMP – HCFC Phase-out Management Plan

Ibama - Brazilian Institute of Environment and Renewable Resources

EOI- Expression of Interest

MMA - Ministry of the Environment

MoU - Memorandum of Understanding

ODP - Ozone Depletion Potential

NPP – National CFC Phase-out Management Plan

UNDP - United Nations Development Program

PU - Polyurethane Foams

RAC - Refrigeration and Air Conditioning

EPR - Extended Producer Responsibility

ODS – Ozone Depleting Substance

TEAP - Technical and Economic Assessment Panel

DRU - Decentralized Recycling Unit

NOU - National Ozone Unit

## CONTENTS

## LIST OF TABLES



## LIST OF FIGURES

# 1 INTRODUCTION

This document presents the results of the Demonstration Project for the Management and Final Disposal of Ozone Depleting Substances (ODS) Waste in Brazil, which was approved by the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol at its 72nd meeting in May 2014. Through this project, Brazil sought to strengthen, at the national level, an appropriate system for the management and environmentally sound final destination of ODS waste.

The implementation of this project was coordinated by the Ministry of the Environment (MMA), which operates in Brazil as the National Ozone Unit (NOU) and implemented by the United Nations Development Program (UNDP). This ODS destruction project is one of twelve projects in Article 5 countries funded by the Multilateral Fund for the Implementation of the Montreal Protocol (MLF).

The approach adopted for the structure and content of the report provide a summary description of the historical background and context of the Project, including the scope, general objectives, components, activities and results achieved. Specific activities for strengthening the management system, as well as demonstrating the country's domestic capacity for ODS destruction, are described.

## 1.1 Historical background

The Montreal Protocol on Substances that Deplete the Ozone Layer is an international environmental treaty established in 1987 and ratified by 198 Parties. The Protocol aims to protect the ozone layer by eliminating the production and consumption of Ozone Depleting Substances (ODS).

Brazil has been developing measures to protect and recover the ozone layer for more than three decades since 1988. It adhered to the Vienna Convention and the Montreal Protocol by committing to completely eliminate the consumption of ODS through Decree No. 99,280 on June 6, 1990.

Since 1992, and with financial support from the Multilateral Fund for the Implementation of the Montreal Protocol (MLF), Brazil has carried out and continues to carry out various sectoral projects and activities, in groups or individually, for technological conversion in the Polyurethane Foam (PU), Refrigeration and Air Conditioning (RAC) sectors, Solvents, Agriculture and Chemical and Pharmaceutical Industry. Among the projects, the National CFC Phase-out Management Plan (NPP) and the Brazilian HCFC Phase-out Management Plan (Brazilian- HPMP) deserve to be highlighted.

These projects allowed for the elimination of consumption of Chlorofluorocarbons (CFC), Halon, Carbon Tetrachloride (CTC) and Methyl Bromide (except for quarantine and pre-shipment uses) and the partial elimination of consumption of Hydrochlorofluorocarbons (HCFC), whose actions and control measures for total elimination are in progress. In 2007, the country had achieved 95% elimination of CFC consumption, having reached the targets for total CFC elimination in 2010, according to the established timetable for developing countries.

Despite the elimination of the consumption of CFC, these substances remained present in old equipment in operation and constituted banks of substances to be properly managed. Within the

scope of the NPP, Brazil established the bases for the creation of a system for the management of CFC liabilities, with support for the emergence of five (5) Reclaim Centers (RC) and about one hundred and twenty (120) Decentralized Recycling Units (DRUs), which would allow collection, recycling and regeneration of refrigerant fluids in different parts of the country. To ensure the application of good practices regarding the proper disposal of these fluids, training was provided for around 25,000 technicians who worked in the domestic and commercial refrigeration sectors in all federative units in Brazil.

In 2012, Brazil began implementing actions aimed at eliminating HCFC, through the Brazilian HCFC Phase-out Management Plan (HPMP). To date, the country has eliminated 63% consumption of HCFC, having achieved complete elimination of HCFC-141b consumption in the foam sector by 2020.

## 1.2 Project context

Although Brazil, like other Parties to the Montreal Protocol, has carried out several successful initiatives to eliminate the consumption of ODS, such substances remain present as a refrigerant in RAC equipment or as a blowing agent polyurethane foam in previously produced. As a result, the Parties to the Montreal Protocol understood that part of these substances, at some point or at the end of their life cycle, could be released into the atmosphere. Thus, the remaining ODS banks, formed by substances with a high Ozone Depletion Potential (ODP), would constitute a "dangerous" environmental liability for the Ozone Layer and would jeopardize all the efforts that had been undertaken by the different Parties to the Montreal Protocol. Therefore, such a liability would require special care and should be properly managed and eliminated.

The existence of the problem, as well as the need to seek a solution, was formally recognized by the Parties to the Montreal Protocol at their 20th meeting, held in 2008. The importance of obtaining more detailed information regarding the destruction of ODS banks available at the end of its useful life is reflected in Decision XX/7 **(Annex I)**. The States Parties requested the Executive Committee of the MLF (ExCom) to assess the possibility of providing technical and financial support to demonstrative projects for the management and disposal of ODS with high Global Warming Potential (GWP) in Article 5 countries. Approved projects aimed at collection (without MLF funding), transport, storage and destruction of ODS, with the results providing lessons learned, generation of experience on management and financing modalities, climate benefits. The Technical and Economic Assessment Panel (TEAP) was also requested to carry out ongoing reviews of ODS banks and to update guidance on environmentally sound management and disposal of ODS waste for adoption by Parties.

At the 22nd Meeting of the Parties in 2010, Decision XXII/10 **(Annex II)** further requested the updating of available destruction technologies and the development of criteria applicable to verifying the destruction of ODS at their end-of-life cycle (EOL ODS - End of Life ODS). Recently, Parties, in Decision XXIX/4 **(Annex III)**, requested a further update of the list of approved destruction technologies and their assessment as to their applicability to the destruction of HFC, now included as controlled substances by the adoption of the Kigali Amendment.

As a result of these consultations, ExCom Decision 58/19 (Annex IV) approved a set of guidelines for the financing of demonstration projects aimed at the environmentally sound management and final disposal of ODS waste in A5 countries. In total, twelve demonstrative projects of environmentally sound management and final disposal of ODS waste were financed by the MLF, in different regions of the world, among which is the project implemented in Brazil.

The Brazilian project was approved at the 57th ExCom Meeting, through Decision 57/19 (Annex V) in 2014, with resources of US$ 1,490,600.00 (one million, four hundred and ninety thousand, six hundred American dollars), considering the ODS waste stock mapped in 2014 and the improvement of destruction facilities by high temperature heat treatment, following international standards for this type of activity. The refrigerants considered in this project were CFC-12, CFC-11 and mixtures that contained traces of these substances.

# 2 PROJECT SCOPE

The proposed project aimed to demonstrate, through an environmentally appropriate, efficient and economically viable solution, the management and final disposal of ODS, through the establishment of a National ODS Waste Management System in Brazil.

The project also sought to establish opportunities to integrate ODS waste management and end-of-life destruction into broader national hazardous waste management and energy efficiency programs. To this end, these efforts would be complemented by activities initiated during the implementation of the NPP that promoted the creation of a structure for the collection of CFC from old equipment. The NPP established five reclaim centers and 120 decentralized recycling units, supported by the distribution of recovery machines to companies and technicians in the country.

The project also envisaged finding synergies with HCFC disposal activities, in particular, recovery operations for the maintenance of existing refrigeration equipment. Additionally, the proposed project found legal support in the National Solid Waste Policy, created by Law No. 12,305, of August 2, 2010. This law provides for the application of Extended Producer Responsibility (EPR), an approach that focuses on the treatment of end of life of consumer products and aims to increase the amount and degree of product recovery and minimize the environmental impact of waste materials.

## 2.1 Project Components

The project design established four components, namely:

- Component 1: Establish a comprehensive ODS Waste Management System, including capacity building in ODS waste handling, transport and characterization, as well as improving ODS waste storage capacity,
- Component 2: Carry out burn trials at two incineration facilities to qualify national capacities for disposal of ODS waste according to standards, analyzing its logistics and cost,
- Component 3: Technical assistance associated with the evaluation and standardization of procedures and criteria for the management and final disposal of ODS waste,
- Component 4: Project management associated with project implementation and supervision.

The project objectives, as well as the details of these components, estimated costs, indicative schedule, are presented in Annex VI of this document.

# 3 PROJECT IMPLEMENTATION

Carrying out this Demonstration Project constituted a relevant initiative for Brazil by confirming the feasibility of the experience initiated within the scope of the National CFC Phase-out Management Plan, of a management system, with emphasis on the operability of the final destination of ODS waste. Waste that constituted liabilities of relevant changes in the national policy of prohibition / restriction of the importation and use of ODS in the last decades, in agreement with the international commitments assumed by the Brazilian Government in the scope of the Montreal Protocol.

This Demonstration Project also made it possible to identify the challenges of ODS management in the country, as well as the challenges to promote the sustainability of the Management System with the companies that will operate in this market and the environmental agencies that will control and supervise these liabilities.

In the initial stage of the project (June 2015 to June 2017), activities were carried out with the objective of consolidating the ODS Management System in the country, through the strengthening of the Reclaim Centers, whether by increasing the capacity of storage, whether in improving conditions for regeneration and analysis of regenerated refrigerants; validate the inventory of liabilities of existing ODS; improve the quality of leak monitoring of stored ODS liabilities and define the heat treatment plant with the potential for adapting and subsequently destroying the identified ODS tons.

However, during the implementation it was identified that the period of validity was not adequate to carry out all the activities necessary for its implementation, especially due to the complexity of the adjustments in the incinerator and the defined schedule for the incineration of the identified ODS. Thus, in 2017, the Ministry of the Environment, together with the UNDP, submitted to the ExCom a request to extend the project's validity until December 2022, which was approved within the scope of the 79$^{th}$ ExCom Meeting. The request was based on a detailed work plan prepared by the MMA, CETESB, Essencis and UNDP, which demonstrated all the necessary steps to guarantee the adequacy of the incineration equipment, issuing of environmental licenses and carrying out burning tests, burning schedule of the tons identified after the validation of the national inventory and the issuance of the Certificates of Destruction of the ODS.

From March 2020 until the end of 2021, the Project faced a reduction in the pace of execution due to the COVID 19 pandemic. The pandemic negatively affected all the Project beneficiary companies at different times, many had their production stopped and employees were sick, while others operated with restrictions and reduced staff. Activities could only return to a faster pace after vaccination and its reinforcement, which allowed the contagion and mortality rates to decrease. Given this scenario, the project sought to adapt to the needs and deadlines of the beneficiaries, always making the planning of activities compatible with the real execution capacity of the partners and beneficiaries.

In April 2022, the Project was informed that the Essencis enterprise's incinerator had the plant undergoing maintenance to make adjustments to the operation and, subsequently, carry out a new burning test. This is because, in the previous test, the emission limits for dioxins and furans were exceeded. As a result of this incident, the operation was interrupted to better investigate the causes and make the necessary adjustments. By decision of the enterprise, the feeding limits of chlorinated substances were reduced in relation to the initial license (initially 8.87 kgCl/h, currently 2.14 kgCl/h), negatively impacting the incineration period of the ODS, however, offering greater safety for the

process and the surrounding population, since dioxins and furans are substances derived from the burning of chlorinated compounds (such as ODS) and are potentially carcinogenic when emitted in unlicensed quantities.

This new operating limit, together with all the pandemic issues and an extensive schedule for burning substances in stock (Project ODS plus waste from incinerator customers from sectors such as chemical, agribusiness, health service), made it unfeasible to incinerate the 32,404 kg of ODS waste identified within the scope of the Project by the end of 2022, as planned. Thus, by December 2022, it was possible to incinerate 24,744 kg of ODS waste, leaving 7,660 kg of ODS waste that could not be incinerated under the project. The Brazilian Government, together with UNDP, is evaluating alternatives to carry out the destruction of this remaining quantity.

It is worth highlighting the fundamental importance of the dialogue established within the scope of the Project with the Brazilian Institute for the Environment and Renewable Resources (Ibama) and the Environmental Company of São Paulo State (CETESB). An agreement was established for a partnership in the execution and alignment of environmental licensing actions between MMA and CETESB, the environmental licensing and inspection body of the State of São Paulo responsible for monitoring the activities of the enterprise Essencis.

The project showed a high degree of relevance for Brazilian environmental policy, for the fulfillment of Brazil's international commitments in relation to the Montreal Protocol and for the Sustainable Development Goals. This relevance was ensured by the strengthening of the ODS Waste Final Disposal Management System in the country, which should remain operational in the coming years, as well as by the destruction of a significant percentage of the ODS environmental liabilities identified in the national territory, with adequate technology, contributing transport safety conditions and environmentally sound thermal destruction.

## 3.1 ODS Waste Management System - results achieved

In order to define the companies that would be able to receive technical and financial support from the project to strengthen its Reclaim Center, Expression of Interest (EOI) 32016 of 2017 **(Annex VII)** was carried out in the country. EOI 32016/20017 defined criteria related to compliance with national legislation (environmental and commercial) and the demonstration of technical capacity, in addition to the eligibility criteria of the Montreal Protocol, which should be met by interested companies.

The EOI also clarified the contribution to be made available to the companies: a) increase in the storage capacity of refrigerant fluids; and b) adequacy of chemical analysis laboratories aiming at the correct identification and handling of ODS by the RC.

Its purpose was to assess the enterprises' ability to maintain the sustainability of the ODS regeneration and storage business, once the technical and financial contribution by the project has ended. Four enterprises were qualified, three of which had received support under the NPP:

- Northeast Regeneration and Recycling Center (CRN), located in the state of Pernambuco,
- Frigelar, an enterprise located in the state of São Paulo,
- Ecosuporte Soluções em Gestão Ambiental, located in the state of São Paulo,
- Recigases, located in the state of Rio de Janeiro.

**Figure 1, Appendix I** of this document, shows the geographic location of qualified RC.

Two RC previously supported by the NPP, Regentech and Gresocol, were not qualified by EOI 32016/2017 to receive financial support from the project. However, as the companies had stocks of waste dating back to the NPP, the Project opted to support the companies for the destruction of these stocks, which will be detailed later in this report.

In return for the technical and financial support that would be provided by the project, the RC signed a Memorandum of Understanding (MoU) with UNDP in which they assumed, among others, the following commitments:

- Indicate two professional interlocutors (main and alternate), one of whom must be the Technical Responsible for the laboratory to monitor all activities and all stages of the work,
- Provide adequate space and conditions for the operation of the laboratory, according to the guidelines contained in the Laboratory Infrastructure Guide prepared by a UNDP consultant within the scope of the project,
- After the complete installation of the laboratory equipment and due training, submit a quarterly report with the purity analyzes carried out in the period,
- Provide all PPE (individual protective equipment), CPE (collective protective equipment), other work safety items and documents related to the operation of the laboratory, in compliance with the legislation and standards relevant to the activity,
- Present the Risk and Safety Certificate signed by the enterprise 's legal representative,
- Present an updated inventory of containers stored in the RC: type of cylinders, tanks and drums; quantities and capacities of different containers where ODS waste is stored,
- Submit a descriptive and photographic technical report quarterly containing information on the current conditions of temporary storage of ODS waste (perform visual inspection and with a leak detector and report any observed leakage or loss, indicating the enterprise's measures),
- Transfer ODS waste to standardized 1,000-pound cylinders provided by the project, for final disposal in the incinerator,
- Apply for a Certificate of Handling Waste of Environmental Interest (CADRI) or CETESB Technical Opinion, to carry out the final disposal of ODS waste inventoried by the project and pay the document fee.

The main activities carried out with the objective of consolidating the ODS Waste Management System in the country are detailed below:

### 3.1.1 Increased ODS storage capacity

To increase the storage capacity of ODS, 1,000-pound and 100-pound cylinders were purchased, which were distributed as follows: Six 1,000-pound cylinders and 20 100-pound cylinders delivered to the four RC qualified by the Public Consultation, Frigelar (Osasco/SP), CRN (Recife/PE), Ecosuporte (Americana/SP) and Recigases (Rio de Janeiro/RJ), and nine 1,000-pound cylinders for Revert Soluções Ambientais Ltda., in Careaçu/MG, the enterprise that performs the reverse logistics of domestic refrigeration equipment in Brazil. Figure 2, Appendix I of this document, presents a photographic record of the cylinders purchased and distributed to the RC within the scope of the project.

### 3.1.2 Improvements to the regeneration operation by RC

Refrigerant identifiers, collectors, leak detectors were purchased, in addition to other equipment and tools that were passed on to three RC qualified by Public Consultation, CRN (Recife/PE), Ecosuporte (Americana/SP) and Recigases (Rio de Janeiro /RJ). **Figure 3, Appendix I** of this document, presents a photographic record of the equipment and tools acquired and distributed to the RC within the scope of the project.

### 3.1.3 Availability of digital information for free access by the interested public

The general content produced is available on two websites: http://protocolodemontreal.org.br and http://www.mma.gov.br. The main materials developed within the scope of the project are listed below:

- 2016: Production and dissemination of the Folder "Management and Final Disposal of ODS". The Folder brings information about the project, the importance of carrying out the correct disposal of ODS waste, among other information on the subject for the general public. (Available at: http://protocolodemontreal.org.br/site/imagens/publicacoes).

- 2017: Elaboration of the Laboratory Infrastructure Guide individualized by RC (Ecosuporte, Recigases, Frigelar and CRN). After the initial visit by a consultant hired under the project to assess the conditions of the laboratory facilities of the RC qualified by EOI 32016/2017, Individualized Guides were prepared by RC with guidance on the structural laboratory conditions suitable for the installation and operation of analytical equipment in the sense of guaranteeing the service life. **Figure 4, Appendix I** of this document, presents a photographic record of the technical visits to the RC' facilities prior to the elaboration of the Laboratory Infrastructure Guide.

- 2019: Elaboration of the Technical Training Workbook: Laboratory Operation for Execution of Chemical Tests according to the AHRI 700 standard in refrigerant gases. The booklet provides information on regulatory matters, chemical product labeling, laboratory waste management, tests on refrigerant gases according to AHRI 700 and principles in chromatography. The material was used to carry out individualized courses by RC (Available at: http://protocolodemontreal.org.br/site/imagens/publicacaes).

- 2020: Production of the video on the safe destruction of substances that harm the ozone layer. The video features statements by CETESB and Essencis representatives on the environmental licensing process for the heat treatment plant (Available at: (188) Safe destruction of substances that harm the ozone layer - YouTube).

- 2022: Elaboration of the Guidance Guide: Management and Environmentally Appropriate Final Disposal of ODS – the informative guide seeks to clarify the procedures for the adequate environmental management that should be applied to the liability of ODS and other fluorinated substances, such as HFCs. The material was produced with the support of the working group formed by members of the UNDP, MMA, Ibama and CETESB (Available at: http://protocolodemontreal.org.br/site/imagens/publicacoes) .

- 2022: Production of a draw my life video on environmentally sound management of ODS. The video was produced based on information from the Guidance Guide "Management and

Environmentally Appropriate Final Disposal of ODS Waste" (Available at: https://www.protocolodemontreal.org.br/site/todas-as-notícias).

- 2022: Production of the video and teaser about the Demonstration Project for the Management and Final Disposal of ODS Waste. The institutional video presents the main results of the Demonstrative Project and has the participation of beneficiaries and those involved (Available at: https://www.protocolodemontreal.org.br/site/todas-as-noticias).

### 3.1.4 Conducting training for the waste management sector and training for environmental inspection bodies carried out

Throughout the implementation of the project, training was carried out for RC qualified by EOI 32016/2017, as well as for the general public.

- 2017: Availability of the Laboratory Infrastructure Guide individualized by RC (Ecosuporte, Recigases, Frigelar and CRN). Once the Individualized Guides were made available, the RC received technical assistance from a consultant hired under the project to monitor the necessary infrastructure works and subsequent validation of compliance with the adjustments specified in each guide.

- 2019: Availability of the Technical Training Workbook: Laboratory Operation for Execution of Chemical Tests according to the AHRI 700 standard in refrigerant gases. The booklet provides information on regulatory affairs, chemical product labeling, laboratory waste management, testing on refrigerant gases according to AHRI 700, and principles in chromatography. (Available at: http://protocolodemontreal.org.br/site/imagens/publicacoes).

- 2019: Individual training was carried out on tests of the AHRI 700 standard and good laboratory practices for the four RC: Ecosuporte, Recigases, Frigelar and CRN. **Figure 5, Appendix I** of this document, presents a photographic record of training on AHRI 700 tests and good laboratory practices carried out within the scope of the project.

- 2022: Workshop 'Management and Environmentally Appropriate Final Disposal of ODS'.

Date: 11/17 and 18/2022.

Target Audience: Environmental agencies, RC, DRUs, Waste Managers, Final destination companies and those interested in the topic.

Objective of the event: to present to the target audience the context in which the "Demonstrative Project for the Management and Final Disposal of ODS Waste" was implemented, clarify the procedures for the proper environmental management of ODS liabilities and the control and inspection instruments of ODS. The event was held virtually and the recordings of the two days of the event, as well as the presentations made, can be accessed at: http://protocolodemontreal.org.br/site/imagens/todas_as_noticias.

### 3.1.5 Strengthening / Consolidation of the Integrated ODS Waste Management System

- 2017 to 2019: The project made the quarterly payment, through an approved report demonstrating the provision of temporary storage environmental services for three RC (Ecosuporte, CRN and Recigases) until the beginning of the incineration process of the ODS.

- 2017: Availability of the Laboratory Infrastructure Guide individualized by RC (Ecosuporte, Recigases, Frigelar and CRN). Once the Individualized Guides were made available, the RC received technical assistance from a consultant hired under the project to monitor the necessary infrastructure works and subsequent validation of compliance with the adjustments specified in each guide.

- 2017 to 2019: Equipment, materials, accessories, reagents and laboratory glassware were purchased to adapt and improve the conditions for analyzing the purity of regenerated fluids, in accordance with AHRI 700 and ABNT 16667 for the four RC: Ecosuporte, Recigases, Frigelar and CRN. Figure 6, Appendix I of this document, presents a photographic record of the equipment, accessories and glassware acquired under the project.

- 2019: Individualized training on AHRI 700 tests and good laboratory practices was carried out for the four RC: Ecosuporte, Recigases, Frigelar and CRN.

- 2019: Availability of the Technical Training Handout: Laboratory Operation for Execution of Chemical Tests according to AHRI 700 in refrigerant gases. The booklet provides information on regulatory matters, chemical product labeling, laboratory waste management, tests on refrigerant gases according to AHRI 700 and principles in chromatography. The material was used to carry out individualized courses by RC. (Available at: http://protocolodemontreal.org.br/site/imagens/publicacoes).

- 2019 to 2021: Installations and training for the operation of Gas Chromatographs with the supplier Nova Analítica in four RC: Ecosuporte, Recigases, Frigelar and CRN. Figure 7, Appendix I of this document, presents a photographic record of the installation and training for the operation of the chromatographs within the scope of the project.

One of the challenges faced by the project refers to the processes for purchasing inputs and equipment for the RC' laboratories, which were complex and lengthy due to the costs involved and the specific nature of the bidding process (highly rigorous with regard to the qualifications of the items listed in the bidding).

## 3.2 Destruction of ODS - results achieved

In order to define the enterprises that would be able to receive the project's technical and financial support for adapting thermal treatment facilities (incineration, plasma, or other technologies) for the destruction of ODS, an Expression of Interest (EOI) 30431 of 2017 (Annex VIII) was carried out in the country. EOI 30431/2017 defined criteria related to compliance with national legislation (environmental and commercial) and demonstration of technical capacity, in addition to the eligibility criteria of the Montreal Protocol, which should be met by interested enterprises.

The EOI also clarified the contribution to be made available to the enterprises: the adaptation of a line for feeding gaseous substances into the oven, with all the necessary equipment and materials, as well as the burn test of the substances and all the costs involved in this operation of burning, in accordance with procedures and norms established by the Montreal Protocol. The substances that need to be incinerated basically include Chlorofluorocarbons (CFCs), Hydrochlorofluorocarbons (HCFCs), and other substances that destroy the ozone layer and/or alternatives with high global warming potential (Hydrofluorocarbons - HFCs, for example).

Its objective was to assess the enterprises' ability to maintain the sustainability of the ODS destruction business, once the technical and financial contribution of the project ended. The enterprise Essencis Soluções Ambientais S/A was qualified. Figure 1, Appendix I of this document shows the geographic location of the qualified thermal destruction plant.

In return for the technical and financial support that would be provided by the project, the thermal destruction enterprise signed a Memorandum of Understanding (MoU) with UNDP in which it assumed, among others, the following commitments:

- Indicate two professional interlocutors (main and alternate), one of whom must be the person in charge of the incineration unit to monitor all activities and stages of the incineration work of the ODS liabilities.
- Allow access to the UNDP and MMA team to monitor the incineration activities of ODS liabilities, providing the data available for the proper conduct of the work.
- Provide and present the Environmental Licenses for the destruction of ODS that must be forwarded to UNDP.
- Request Technical Advice from enterprises outside the state of São Paulo: Recigases (RJ), CRN (PE), and Regentech (RS).
- Incinerate the environmental liabilities foreseen in the project stored in the CRs - up to 75 tons, according to the planning previously presented.
- Submit the ODS Waste Destruction Certificate quarterly, until the completion of the burning of the CRs' environmental liabilities.

Therefore, the technology selected for the destruction of ODS in the demonstration project in Brazil was incineration. This is one of the destruction and disposal technologies approved by the Parties to the Montreal Protocol (Decision XIV/6: Approved destruction procedures, Annex IX).

Essencis has a rotary kiln waste incinerator with post-combustion, with a capacity of 800 kg/hour (in total, for solid and liquid waste). The enterprise works in a continuous process, with three shifts of operation.

The main hazardous waste incinerated by Essencis comes from the chemical, pharmaceutical, petrochemical, agrochemical, and universities, among other activities. It is noteworthy that, of the

waste received by the enterprise, a relevant part has chlorine in its chemical structure. Operational data from the Essencis incinerator Operating License at the time of qualification by Expression of Interest:

- Rotary kiln temperature: 916 °C,
- Post combustion chamber temperature: 1,200 °C (for 3 seconds),
- Chlorine feeding limit: 25.0 kg/hour, and
- Fluoride feeding limit: 2.0 kg/hour.

The incinerator has a very efficient and well-controlled system for treating atmospheric emissions, with frequent burn tests carried out, in accordance with the requirements of its Operating License. The enterprise, which has experience in the incineration of solid waste and chlorinated and fluorinated liquids, at the time, had no experience with gaseous waste.

After the completion of Expression of Interest 34041/2017, the project's technical team, made up of representatives from MMA, Ibama and UNDP, carried out a technical visit to the Essencis plant. Figure 8, Appendix I of this document, presents a photographic record of the technical visit carried out at Essencis facilities by the technical teams of MMA, Ibama and UNDP.

The main activities carried out to destroy the ODS identified within the scope of the project are detailed below:

### 3.2.1 Installation License for adjustments to the incinerator

For the Issuance of the Installation License by CETESB so that the enterprise Essencis could install the necessary equipment so that the burn test could be carried out later, initially, the Incinerator Adaptation Plan for burning ODS was drawn up. Once approved by CETESB, Essencis began the process of adapting the incinerator plant.

### 3.2.2 Incinerator adjustments

Operational adjustments for burning ODS in the incineration process and operational tests included:

a) Installation of gas supply system,

b) Installation of a cyclone with greater efficiency in the abatement of particulate matter,

c) Modification of the position of the bag filter and exchange of bags for others made of more resistant material, and

d) Installation of a hot gas generation system to reheat the gases after the washing and neutralization system.

*a) Installation of the gas supply system*

The installation of the gas supply system (Skid), independent of the supply of solids and liquids, with pressure, flow and weight control, aimed to carry out the controlled burning of CFC gases R11 and R12 in a safe manner and in compliance with the burn limits authorized in the License after carrying out the burn

test. The incineration system was prepared to receive CFC consisting of CCl3F and CCl2F2, pure or mixed with each other or with other substances, under the following conditions:

- Pressurized vessels with a capacity of up to 1000 pounds containing pure or mixed CFC whose vapor pressures at 30° C are greater than 1.0 bar absolute, and
- Drums with a capacity of up to 200 liters containing CFC or mixtures whose vapor pressure is less than 1.0 bar absolute.

The Skid was developed anticipating that no type of civil adaptation is necessary, in a metallic structure module that includes the scale, control panel, pump and piping. In operation, the cylinder will remain on the scale for control. Figure 9, Appendix I of this document, presents a photographic record of the gas supply system (Skid) with pressure controller, flow rate and supply weight.

*b) Installation of a cyclone with greater efficiency in the abatement of particulate matter*

The cyclone removes the heaviest particulate matter (ash) and larger particles present in the incineration gases that are decelerated after colliding with the equipment walls, due to its geometry, reducing the particulate material load that will be removed by the bag filter. The installed cyclone was designed for high efficiency (97.5% for particles larger than 20 microns) and low head loss (70 mmCA – operating flow / 102 mmCA – design flow), in order to ensure the maximum abatement of dry powders at a minimum cost. Figure 10, Appendix I of this document, presents a photographic record of the cyclone before and after installation.

*c) Modification of the position of the bag filter and exchange of bags for others made of more resistant material*

This equipment has the function of eliminating the particulate material present in the combustion gases. The sleeves are made of special material, which withstands temperatures of up to 250 °C. The filter operates continuously, having an automatic unloading system, which identifies the saturation of the filter, cleans it and collects the ashes generated, accommodating them in a big bag. The ash removed from the gaseous stream is collected in bags and sent to a class 1 landfill. Chemically, the ash has similar characteristics to the slag generated by the furnace.

The purpose of changing the position of the bag filter in the system was to increase its lifetime and efficiency in the temperature controls of the equipment. Previously, the equipment was located in the process after the cyclones. In this arrangement, the bag filter received the gas stream which was still very acidic due to chlorine, fluorine and sulfur. In the new arrangement, the gases that pass through the equipment will already be washed and neutralized, thus minimizing the corrosive process of the equipment.

The project also considered the thermal insulation of the filter, minimizing condensation in the “dead” spots in case of cooling or power outage. Regarding temperature, the gain was in the conservation and integrity of the bags, as a controlled system for heating the gases was installed before the filter. Changing the location of the equipment allowed working in a range of 90 °C to 130 °C, reducing the probability of damage to the bag. The filter did not change the number of bags, head loss, coal and lime feed system. The only alteration made was in terms of the type of sleeve, as with the change in location, the characteristics of the gas were altered, thus making the previous sleeve inefficient at the new installation point (post washing). Figure 11, Appendix I of this document, presents a photographic record of the bag filter before and after installation.

*d)* Installation of a hot gas generation system to reheat the gases after the washing and neutralization system

The hot gas generation system coupled to the process before the bag filter reheats the gases after the washing and neutralization system (venture and washing tower) at a temperature of 120 °C, above the dew point to avoid gas condensation in the bag filter.

To ensure that the process gas has the proper temperature, the system provides a maximum temperature of 700 °C and an operating/design flow rate of 750 kg/h (970 Nm3/h.). The hot gas generation system was coupled to the process line, before the bag filter. Right after the output of the generator there is an automatic damper, butterfly type, controlled by a system in the way that the pressure in the generator is maintained in depression. The thermal work capacity provided for the generator is 200,000 to 300,000 kcal/h for burning diesel oil / residual liquid fuel.

The generator's internal firing chamber is lined with refractory concrete and insulating ceramic fiber plates, and its passage chamber is also made of carbon steel, internally insulated with ceramic fiber blocks/blanket. The admission of the necessary ambient air to be reheated in the generator is carried out radially in the intake/mixing chamber, through four inlets provided with a manual butterfly valve, and the pressure/depression and flow adjustments must be made through this valve. Figure 12, Appendix I of this document, presents a photographic record of the hot gas generation system before and after installation.

### 3.2.3 Burn Test

Once the adaptations made to the incinerator were approved, it moved on to the burn test stage. This step included the following logistics: a) preparation and approval of the Burn Test Plan; b) issuance of a Precarious License from CETESB to carry out the burn test; c) issue of environmental authorization for transport and incineration; d) carrying out the sample transport, and e) carrying out the burn test.

The Burn test Plan was prepared by Essencis and submitted for approval by CETESB, the environmental agency responsible for licensing the plant. This Plan contains information on the process conditions for carrying out the burn test and efficiency test, as well as the emission parameter monitored during the test.

After approving the plan, CETESB issued the Precarious License to carry out the burn test, moving on to the stage of issuing the environmental license for the transport and incineration of waste.

In Brazil, the transport of ODS waste from the place of use or temporary storage to the place of final destination must always be carried out with an environmental authorization for transport and final disposal of waste, which must be requested from the environmental agency the first time the transfer has been carried out and renewed when it is 120 days from its expiration date. To carry out the burn test at Essencis, part of the ODS waste stored at the Ecosuporte enterprise was used, due to the proximity of the Essencis incinerator. Therefore, it was necessary to issue the Certificate of Handling of Waste of Environmental Interest for transport and incineration, issued by CETESB. The transport was carried out in a closed truck, with safety ties and locks for good fixation of the cylinders, safety plates referring to the type of load, documentation, and mandatory PPE, as well as all licenses and documents referring to the transport of the type of load and of the places/municipalities where it would travel between origin and destination and on return.

The Burn Test was carried out with the assistance of the CETESB team. CFC-11 was used as the “Main Hazardous Organic Compound” (PCOP) for this burn test. The Destruction and Removal Efficiency (DRE) was verified through the mass balance of the CFC-11, considering the difference between the mass fed into the rotary kiln and the mass emitted into the chimney. The removal and destruction efficiency were calculated

according to the ABNT NBR 11,175 standard. The limits to be observed are established by CONAMA Resolution 316 and ABNT NBR 11,175.

Essencis carried out the Burn Test on its industrial waste incinerator in two stages:

- the first stage, to test the efficiency of destruction of ODS, using for this purpose pure CFC-11 (Trichlorofluoromethane), collected and stored in gaseous form in metallic cylinders, also using the feed of CFC-11 for the analysis of chlorine/ hydrochloric acid, total fluorides and dioxins and furans in off-gas, ash and slag; and
- the second stage, for granting the plant's Operating License (LO). The test was carried out as proposed in the Burn Test Plan presented by the enterprise and approved by CETESB (Technical Advice No. 025/19/IPA - Annex X of this document)

The residues used during the Burn test were composed of material of known origin and with substances in predetermined quantities in the previously presented Burn test Plan, in order to subsidize the establishment of feeding rates that can be carried out during normal operation from the incinerator.

The Interlock Test, to automatically interrupt the feeding of waste, was carried out on September 23, 2019, under the conditions established in the Burn test Plan and within the parameters mentioned in CONAMA Resolution 316/02, satisfactorily meeting all the items. It is worth remembering that the minimum interlocking temperatures for the primary and secondary chambers were 900 °C and 1160 °C, respectively. In order to verify the performance of the continuous monitor, standard gas for carbon monoxide (CO) between 100 and 500 ppm was used for a period of 10 minutes.

The residues used to feed the incinerator during the Burn test were characterized and the results obtained can be found in Annex XI of this document. Table 1 presents a summary of the feed rates, by parameter, performed during the Burn Test.

*Table 1 – Feed rate by parameter*

| Parameter | Feed Rate |
|---|---|
| Ashes | 199.28 kg/h |
| Sand | 612 kg/h |
| Chlorine | 14.8 kg/h |
| Nitrogen | 7.24 kg/h |
| Sulfur | 11.65 kg/h |
| Fluorine | 1.22 kg/h |
| Cadmium | 99 g/h |
| Cobalt | 104.7 g/h |
| Arsenic | 105.1 g/h |
| Nickel | 118.1 g/h |
| Selenium | 106.6 g/h |
| Lead | 557.5 g/h |
| Chrome | 1043.7 g/h |
| Cyanide | 106.7 g/h |
| Copper | 191 g/h |
| Manganese | 462.5 g/h |
| Tin | 582.9 g/h |
| Antimony | 104.1 g/h |
| Vanadium | 98.2 g/h |
| CFC | 8.87 kg/h |

Regarding ashes and slag generated in the incineration system, the provisions of article 43, paragraph 1 of CONAMA Resolution No. 316 of 10/29/2002, considers these residues as Class I – Hazardou and must be complied with. Therefore, they must be sent to treatment/final disposal systems for Class I waste.

As for the elements mercury, thallium, tellurium, palladium, platinum, and rhodium, they were not fed during the tests and the limits suggested by ABNT NBR 11.175/1990 were adopted.

The gaseous effluent collections were carried out in the chimney of the incinerator exhaust system, after the set of equipment for controlling atmospheric pollutants, being performed with the test methods accepted by CETESB according to the target pollutants and carried out by Prameq Indústria e Comércio Ltda. technical team. The calculation sheets presented were checked and are in accordance with the methodologies accepted by CETESB.

The results of this Burn Test are presented in **Annex XI** of this document.. Tables 2 and 3 show the results of the collection of atmospheric pollutant emissions obtained in this Burn test, as well as the emission limits established in Operation License No. 33007244.

*Table 2 – Results obtained for the licensing of CFC incineration and the respective emission limits (first step)*

| Parameters | Date of collections | 1st Collection | 2nd Collection | 3rd Collection | Emission limits |
|---|---|---|---|---|---|
| Particulate Matter ($mg/Nm^3$) | 09/24/19 | **63.3** | **96.8** | **165.2** | **50.0** |
| | 09/24/19 and 09/25/19 | **90.8** | **63.3** | **91.2** | |
| | 12/09/19 | 12.8 | 5.6 | 5.5 | |
| Sulfur Oxides ($mg/Nm^3$) | 09/24/19 | 2.7 | 2.7 | 2.8 | **250** |
| | 12/09/19 | 3.3 | 3.2 | 3.3 | |
| Nitrogen Oxides ($mg/Nm^3$) | 03/27/17 | 352.5 | 418.4 | 425.1 | **400** |
| | 12/09/19 | 225.5 | 203.3 | 157.3 | |
| Hydrochloric Acid ($mg/Nm^3$) | 09/24/19 and 09/25/19 | 0.08 | 0.07 | 0.11 | **80** |
| Hydrochloric Acid (kg/h) | | 0.0004 | 0.0004 | 0.0004 | **1.8** |
| Dioxins and Furans ($ng/Nm^3$) | 09/25/19 and 09/26/19 | 0.008 | 0.008 | 0.010 | **0.14** |
| Hydrofluoric Acid ($mg/Nm^3$) | 09/27/19 | 10.26 | 0.16 | 0.18 | **5.0** |
| Destruction and Removal Efficiency - DRE (%) | 09/30/19 | 99.9999 | 99.9999 | 99.9999 | **99.99** |

Note: The concentration values in the table are under normal conditions (1 atm. and 0 °C), dry basis and corrected to 7% oxygen.

*Table 3 - Results obtained for compliance with the operating license and the respective emission limits (second stage).*

| Parameters | | Date of collections | 1st Collection | 2nd Collection | 3rd Collection | Emission limits |
|---|---|---|---|---|---|---|
| Particulate Matter (mg/Nm3) | | 01/30/19 and 10/01/19 | 40.3 | 18.9 | 18.3 | 50.0 |
| | | 10/02/19 | 7.1 | 12.8 | 8.9 | |
| Hydrochloric acid (mg/Nm$^3$) | | 01/30/19 and 10/01/19 | 0.53 | 0.23 | 0.38 | 80 |
| Hydrochloric acid (kg/h) | | | 0.003 | 0.001 | 0.002 | 1.8 |
| Inorganic Substances (mg/Nm$^3$) | Class I [(a)] | 10/02/19 | 0.10 | 0.15 | 0.13 | 0,28 |
| | Class II [(b)] | | 0.30 | 0.37 | 0.24 | 1,4 |
| | Class III [(c)] | | 0.76 | 1.67 | 0.81 | 7,0 |
| Dioxins and Furans (ng/Nm$^3$) | | 10/03/19 and 10/04/19 | 0.01 | 0.01 | 0.01 | 0.14 |

Note: The concentration values in the table are under normal conditions (1 atm. and 0 °C), dry basis and corrected to 7% oxygen.

(a) Only Cd emissions were considered, as the elements mercury (Hg) and thallium (Tl) were disregarded from the sum because they were not fed into the incinerator.
(b) Sum of Ni, As, Co, and Se emissions, the element Tellurium (Te) being disregarded in the analysis because it was not fed into the incinerator.
(c) Sum of total Pb, Sb, Cu, Cr, Mn, V, Sn, Fluorides, and Cyanides emissions, with the elements platinum (Pt), palladium (Pd) and rhodium (Rh) disregarded in the analysis because they were not fed into the incinerator.

According to the tables containing the summaries of the results, it is observed that, in the first stage of the Burn test, the MP and NOx parameters were above the established limits. This occurred because the bag filter had problems in its operation during that first week. These problems were resolved for the second week of the test and, due to this intervention, improvements in the control of pollutants were demonstrated, proven by the satisfactory results of the samplings. So that there were no doubts as to the efficiency of the filter, new collections of PM, SOx and NOx were carried out after the Burn Test period, and the control of these parameters was once again satisfactory.

For the purpose of evaluating the source's Dioxin and Furan (D&F) emissions, considering the worst-case situation, among the congeners considered in the results obtained in which they present values below the quantification limit of the laboratory analysis, these limits were considered as they are adopted the most critical situation for the assessment of emissions.

The values obtained from the continuous monitors installed in the chimney and verified during the collection periods of the gaseous effluents are shown in the tables of operational conditions presented in Annex XI of this document, being verified for the parameters MP, SOx, and NOx, the discrepancy between the values observed in the monitors and the results obtained in the sampling. Therefore, Essencis carried out the proper calibration of continuous monitors, emphasizing that Board Resolution No. 326/14/I of 11/05/2014 established calibration criteria for continuous monitors to verify compliance with emission limits.

It should be noted that mercury emissions in the gaseous effluent from the incinerator were not determined, as well as emissions of thallium, tellurium, platinum, palladium and rhodium, as they were not fed during the tests.

Samplings were carried out by Prameq Indústria e Comércio Ltda., which has accreditation certificate CRL nº 0507 from the National Institute of Metrology, Quality and Technology (INMETRO). The laboratory analyses, in addition to being carried out by Prameq itself, were also carried out by other laboratories that are also accredited by the same institute.

For the collection and analysis of gaseous effluents, the laboratories used the following methodologies:

- L9.210 - Analysis of Combustion Gases Using the Orsat Apparatus - Test Method (October/1990) – CETESB.
- L9.221 - Ducts and Chimneys from Stationary Sources - Determination of Sampling Points - Procedure (July/1990) – CETESB.
- L9.222 - Ducts and Chimneys from Stationary Sources - Determination of the Velocity and Flow of Gases - Test Method (May/1992) – CETESB.
- L9.223 - Ducts and Chimneys from Stationary Sources - Determination of Dry Molecular Mass and Excess Air in the Gas Flow - Test Method (June/1992) – CETESB.
- L9.224 - Ducts and Chimneys from Stationary Sources - Determination of Effluent Humidity - Test Method (June/1993) – CETESB.
- L9.225 - Ducts and Chimneys from Stationary Sources - Determination of Particulate Matter - Test Method (March/1995) – CETESB.
- L9.213 - Ducts and chimneys of stationary sources fluoride determination by the specific ion electrode method - Test Method (September/1995) – CETESB.
- L9.228 - Ducts and chimneys from stationary sources - determination of sulfur dioxide and sulfuric acid and sulfur trioxide mists: test method (June/1992) – CETESB.
- L9.229 - Ducts and Chimneys from Stationary Sources - Determination of Nitrogen Oxides - Test Method (October/92) – CETESB.
- L9.232 - Ducts and Chimneys from Stationary Sources - Determination of Semi-Volatile Organic Compounds - Test Method (August/90) – CETESB.
- E16.030 - Ducts and Chimneys from Stationary Sources - Calibration of Equipment Used in Sampling Effluents - Test Method (July/2009) – CETESB.
- Method 23 - Determination of Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans from Stationary Sources – USEPA.
- Method 26 A - Determination of Hydrogen Halide and Halogen Emission from Stationary Sources – USEPA.
- Method 29 - Determination of Metals Emission from Stationary Sources – USEPA.
- Method 29 OTM - Sampling and Analysis for Hydrogen Cyanide Emissions from Stationary Sources – USEPA.
- Method 40 – Sampling of principal organic hazardous constituents from combustion sources using TEDLAR® bags.

The results obtained in the Burn Test in question showed that the gaseous emissions of the Essencis hazardous waste incinerator meet the emission limits established in the Operating License No. 33007244 of 01/14/2019, with the observed waste feeding rate.

Therefore, the following items were included as a technical requirement of the enterprise license, in addition to other existing ones:

*1. It is prohibited to feed waste, materials, or substances, as well as their mixtures, into the incinerator, whose feed mass is greater than:*

*Chlorine: 14.8 kg Cl/h; Sulfur: 11.7 kg S/h; Nitrogen: 7.24 kg N/h; Fluorine: 1.22 kg F-/h; Ash: 199.3 kg ash/h; Sand/Soil for decontamination: 612 kg/h.*

*2. It is prohibited to feed waste, with substances, as well as their mixtures, whose feed mass is greater than:*

*Cadmium: 99 g/h; Cobalt: 104.7 g/h; Arsenic: 105.1 g/h; Nickel: 118.1 g/h; Selenium: 106.6 g/h; Lead: 557.5 g/h; Chromium: 1043.7 g/h; Cyanide: 106.7 g/h; Copper: 191 g/h; Manganese: 462.5 g/h; Tin: 582.9 g/h; Antimony: 104.1 g/h; Vanadium: 98.2 g/hr.*

*Note: Based on the ABNT NBR 11.175/1990 Standard, items 4.1.4.2.1 to 4.1.4.2.3, in the case of metals that were not fed during the Burn Test, a feed rate of up to:*

*Mercury (Hg): 0.33 g/h; Thallium (Tl): 0.33 g/h; Tellurium (Te): 1.0 g/h; Palladium (Pd): 2.0 g/h; Platinum (Pt): 2.0 g/h; Rhodium (Rh): 2.0 g/h.*

*3. The incinerator will be able to incinerate CFC 11 (Trichlorofluoromethane - $CCl_3F$), CFC 12 (Dichlorodifluoromethane - $CCl_2F_2$), and other ODS residues containing Chlorine and Fluorine, as well as mixtures of ODS, packed mainly in pressurized cylinders with a feed rate not exceeding 8.87 kg/h, not exceeding the chlorine feed mass load of 14.8 kg Cl/h and Fluorine: 1.22 kg F-/h*

*4. The incinerator is licensed to operate with diesel oil as fuel, and changes in this fuel imply carrying out a new Burn Test.*

*5. Carry out Burn Test every two years.*

*6. Carry out a sampling of gaseous emissions every six months for particulate matter, NOx, and SOx parameters, under normal incinerator conditions, with CETESB having to be communicated in advance.*

*7. The temperature in the rotary kiln should not be less than 900 °C.*

*8. The temperature in the post-combustion chamber cannot be less than 1160 °C.*

*9. Provide a monitoring system to verify the rotation of the kiln in order to control the residence time of solid waste, which must be included in the data system of the incineration plant operation software.*

*10. Activated carbon consumption must be greater than or equal to 6.4 kg/h*

*11. The incinerator shall continuously monitor and record at least the following operational parameters of the process and continuous monitors:*

*I - Waste feeding rate in each chamber,*

*II - Temperature of the combustion chamber and post-combustion chamber,*

*III - Oxygen concentration in the gaseous effluent at the representative point,*

*IV – Outflow of the gaseous effluent in the chimney,*

*V - Pressure in the chambers,*

*VI - Furnace rotation; and*

*VII – The concentrations of CO, NOx, Sox, and Temperature in the gaseous effluent.*

*12. Emissions of air pollutants must meet the maximum limits determined below, all expressed on a dry basis at 7% oxygen:*

*I - total particulate matter (PM): 50 mg/Nm³ (fifty milligrams per normal cubic meter);*

*II - inorganic substances in particulate form, grouped together as:*

- *Class 1: 0.28 mg/Nm³ (twenty-eight hundredths of a milligram per normal cubic meter): sum of cadmium emissions and its compounds, measured as cadmium (Cd); mercury and its compounds, measured as mercury (Hg); thallium and its compounds, measured as thallium (Tl),*
- *Class 2: 1.4 mg/Nm³ (one milligram and four tenths per normal cubic meter): sum of emissions of arsenic and its compounds, measured as arsenic (As); cobalt and its compounds measured as nickel cobalt and its compounds measured as nickel (Ni); tellurium and its compounds, measured as tellurium (Te); selenium and its compounds, measured as selenium (Se),*
- *Class 3: 7.0 mg/Nm³ (seven milligrams per normal cubic meter): sum of emissions of antimony and its compounds, measured as antimony (Sb); lead and its compounds, measured as lead (Pb); chromium and its compounds, measured as chromium (Cr); easily soluble cyanides, measured as Cyanides (CN); copper and its compounds, measured as copper (Cu); tin and its compounds measured as tin (Sn); easily soluble fluorides, measured as fluorine (F); manganese and its compounds, measured as manganese (Mn); platinum and its compounds, measured as platinum (Pt); palladium and its compounds, measured as palladium (Pd); rhodium and its compounds measured as rhodium (Rh); vanadium and its compounds, measured as vanadium (V).*

*III. Gases:*

- *Sulfur oxides (SOX): 250.0 mg/Nm³ (two hundred and fifty milligrams per normal cubic meter), measured as sulfur dioxide,*
- *Nitrogen oxides (NOX): 400.0 mg/Nm³ (four hundred milligrams per normal cubic meter), measured as nitrogen dioxide,*
- *Carbon monoxide (CO): 100.0 ppm (one hundred parts per million),*
- *Hydrochloric acid (HCl): 70.0 mg/Nm³ (seventy milligrams per normal cubic meter), up to 1.8 kg/h, measured as hydrogen chloride,*
- *Hydrofluoric acid (HF) 5.0 mg/Nm³ (five milligrams per normal cubic meter), measured as hydrogen fluoride; and*
- *Dioxins and Furans (D&F) dibenzo-p-dioxins and dibenzo-p-furans, expressed in TEQ (total toxicity equivalent) of 2,3,7,8 TCDD (Tetrachlorodibenzo-p-dioxin): 0.14 ng/Nm3. The toxicity equivalence factors (FTEQ) considered are those contained in Annex I of CONAMA Resolution No. 316 of 10/29/2002.*

*13. The ash and slag from the heat treatment process are classified as Class I – Hazardous waste and must be sent to treatment/final disposal systems for Class I – Hazardous waste.*

*14. Adapt to the calibration criteria for continuous monitors established in Board Resolution No. 326/14/I of 11/05/2014, which deals with criteria for using continuous monitoring data to verify compliance with emission limits.*

### 3.2.4 CETESB Operating License for thermal destruction of ODS

After approval of the burn test, the Operating License was issued with the conditions for the destruction of ODS, with the feeding limits of chlorinated substances defined as 14.8 kg Cl/h, of which 8.87 kg Cl/h dedicated to the destruction of ODS.

In September 2021, the Burn Test was repeated, in accordance with the periodicity provided for in the operating license, and the results obtained in this Burn Test are presented in **Annex XII** of this document.

According to Table 4, the MP and D&F parameters were above the established limits. This was most likely due to the fact that the bag filter had malfunctioned during the first week of the test. These problems were resolved for the second week and, due to this intervention, improvements in PM control were demonstrated, as shown by the results of the collections carried out on 09/22/2021. So that there were no doubts about the efficiency of the filter, new collections of PM were carried out after the Burn test period, and the control for this parameter proved to be satisfactory.

*Table 4 - Results obtained for compliance with the operating license and the respective emission limits.*

| Parameters | | Date of collections | 1st Collection | 2nd Collection | 3rd Collection | Emission limits |
|---|---|---|---|---|---|---|
| Particulate Matter (mg/Nm$^3$) | | 09/14/21 | 107.3 | 39.8 | 224.0 | 50.0 |
| | | 09/22/21 | 89.4 | 58.1 | 35.1 | |
| | | | 41.8 | 22.3 | 23.1 | |
| | | 12/10/21 | 44.6 | 46.6 | 36.0 | |
| Sulfur Oxides (mg/Nm$^3$) | | 09/14/21 | 13.4 | 10.7 | 9.5 | 250 |
| | | 09/22/21 | 14.0 | 11.0 | 10.5 | |
| Nitrogen Oxides (mg/Nm$^3$) | | 09/14/21 | 126.8 | 48.8 | 46.5 | 400 |
| | | | 62.8 | 49.3 | 46.1 | |
| | | | 127.9 | 47.2 | 320.1 | |
| | | 09/22/21 | 343.6 | 303.7 | 151.5 | |
| | | | 401.2 | 420.9 | 354.3 | |
| | | | 362.0 | 307.9 | 186.2 | |
| Hydrochloric acid (mg/Nm$^3$) | | 09/20/21 | 0.5 | 0.8 | 0.7 | 80 |
| Hydrochloric acid (kg/h) | | | 0.0021 | 0.0029 | 0.0026 | 1.8 |
| Inorganic Substances (mg/Nm$^3$) | Class I [(a)] | 09/22/21 | 0.13 | 0.03 | 0.03 | 0,28 |
| | Class II [(b)] | | 0.17 | 0.13 | 0.29 | 1,4 |
| | Class III [(c)] | | 3.9 | 2.8 | 2.1 | 7,0 |
| Dioxins and Furans (ng/Nm$^3$) | | 09/15/21 and 09/16/21 | 0.22 | 0.17 | 0.31 | 0.14 |
| | | 12/14/21 and 12/15/21 | 0.32 | 0.91 | 0.07 | |
| Hydrofluoric acid (mg/Nm$^3$) | | 09/14/21 | 3.4 | 2.5 | 1.7 | 5.0 |
| Destruction and Removal Efficiency - DRE (%) | | 09/20/21 | 99.9999 | 99.9999 | 99.9999 | 99.99 |

Note: The concentration values in the table are under normal conditions (1 atm. and 0 °C), dry basis and corrected to 7% oxygen.

(d) Considering only Cd emissions, as the elements mercury (Hg) and thallium (Tl) were disregarded from the sum because they were not fed into the incinerator.
(e) Sum of Ni, As, Co, and Se emissions, the element Tellurium (Te) being disregarded in the analysis because it was not fed into the incinerator.
(f) Sum of total Pb, Sb, Cu, Cr, Mn, V, Sn, Fluorides, and Cyanides emissions, with the elements platinum (Pt), palladium (Pd), and rhodium (Rh) disregarded in the analysis because they were not fed into the incinerator.

For the D&F parameter, the control system proved to be unsatisfactory both in the collections carried out in September and in those carried out in December 2021.

During the analysis of the results of the D&F samplings, which were carried out on 12/14/2021 and 12/15/2021, it was observed that the SGS laboratory exceeded the maximum recommended time for sample extraction by USEPA method 23, of 30 days from your collection date. In analyzing the reports presented and observing the results obtained in the blank test for these parameters, no inconsistencies were verified that would justify the cancellation of these collections, therefore, the D&F results were validated, both those obtained in September and those obtained in December.

For the purpose of evaluating the D&F emissions from the source, considering the worst case situation, among the congeners considered in the results obtained in which they present values below the quantification limit of the laboratory analysis, these limits were considered, as we understand them to be the most critical situation for the assessment of emissions.

In order to improve the conditions of the incineration system, and consequently, atmospheric emissions, the following measures were implemented:

- kiln feed system interlock is limited to 20 kg of material for each kiln feed cycle. The objective of this implantation is to maintain the homogeneous feeding of the rotary kiln, and the control will be carried out by a scale coupled to the system of mats that are controlled by the supervisory SDCD. In the event of weight exceeding 20 kg, the conveyor belts are automatically stopped, and the door remains closed until the operator corrects the weight,
- Decrease in the chlorine content in the material to be incinerated, limited to 10.3 kg/h of chlorine, 2.17 of which dedicated to the incineration of CFC, and
- Maintenance of constant flow of gaseous waste feed (CFC and similar), the flow is being regulated at the beginning of the sampling until the end of the sampling without intervention in cases of drop in the gas flow, or its alteration.

For the Burn Test, a BLEND of waste, with sand, silt and sawdust, was used with the following composition and the respective feeding rates:

- 3 kg/h of CFC-11 providing 2.3 kg/h of elemental chlorine and 16 kg/h of PVC providing 8 kg/h of elemental chlorine, totaling 10.3 kg of elemental chlorine.
- 400 g of PVC per bag will be fed (one bag per cycle of the furnace feeding system) to maintain uniformity in the chlorine supply, totaling 16 kg of PVC in one hour.
- For this rate of 10.3 kg/h of chlorine, 6.4 kg/h of activated carbon will be added to the bag filter.
- For the supply of the CFC, the flow adjustment will be performed at the beginning of the sampling and the same adjustment will remain until the end of the sampling without intervention in cases of drop in the gas flow.

The results of this Burn Test are presented in Annex XIII of this document. The waste fed into the incinerator during the Test is shown in Table 5.

*Table 5 - Feed rate by parameter*

| Parameter | Feed Rate |
|---|---|
| Ashes | *178.40 kg/h (*)* |
| Sand | 762 kg/h |
| Chlorine | *9.78 kg/h (*)* |
| Nitrogen | 7.9 kg/h |
| Sulfur | 12.6 kg/h |
| Fluorine | 1.23 kg/h |
| Cadmium | 99.4 g/h |
| Cobalt | 107.8 g/h |
| Arsenic | 108.2 g/h |
| Nickel | 107.6 g/h |
| Selenium | 113.2 g/h |
| Lead | 592.4 g/h |
| Chrome | 1109.1 g/h |
| Copper | 202.9 g/h |
| Manganese | 491.4 g/h |
| Tin | 309.7 g/h |
| Antimony | 110.6 g/h |
| Vanadium | 104.3 g/h |
| CFC | *2.14 kg/h (*)* |

*(*)* New feed rates.

Table 6 presents the results of the collection of atmospheric pollutant emissions obtained in this Burn test (Annex XIII), as well as the emission limits established in Operation License No. 33007991.

*Table 6 - Results obtained for compliance with the operating license and the respective emission limits.*

| Parameters | Date of collections | 1st Collection | 2nd Collection | 3rd Collection | Emission limits |
|---|---|---|---|---|---|
| Particulate Matter (mg/Nm$^3$) | 04/04/22 | 33.9 | 19.8 | 12.3 | **50.0** |
| Hydrochloric Acid (mg/Nm$^3$) | 04/04/22 | <0.78 | <0.59 | <0.62 | **70.0** |
| Hydrochloric Acid (kg/h) | | <0.024 | <0.023 | <0.023 | **1.8** |
| Dioxins and Furans (ng/Nm$^3$) | 04/05/22 and 04/06/22 | 0.12 | 0.09 | 0.12 | **0.14** |

Note: The concentration values in the table are under normal conditions (1 atm. and 0 ºC), dry basis and corrected to 7% oxygen.

Observing the presented results of the Burn Test in question, with the reduction of the chlorine feed rate, it can be concluded that the gaseous emissions of the industrial waste incinerator of Solví Essencis meet the emission limits established in the Operating License n. 33007991. Thus, the chlorine and ash feed rates contained in the license were changed, with the rates observed in the test in question being valid. The feeding limits of chlorinated substances defined 10.3 kg Cl/h, of which 2.17 kg Cl/h dedicated to the destruction of ODS.

### 3.2.5 Destruction of ODS identified by the project

After the issuance of the Operating License by CETESB for the thermal destruction of ODS, it moved on to the incineration stage. This step included the following logistics: a) transfer of ODS to standard cylinders; b) issuance of environmental permits for transportation; c) transportation of ODS; d) incineration of ODS; e) transport of empty cylinders; and f) Issuance of the Certificate of Waste Destruction (CDR).

As previously mentioned, transferring the ODS stored in the CRs to the standardized 1,000-pound cylinders provided by the project, for the final destination to the incinerator, was the responsibility of the CRs themselves. However, the Project supported the CRs with the issuance of environmental authorizations, namely: CADRI for the enterprise Frigelar and Technical Advice for the enterprises: Recigases, CRN, Regentech (former Refrigeração Capital), Gresocol (former Bandeirantes Refrigeração). Regentech and Gresocol are two CRs previously supported by the PNC that were not qualified by EOI 32016/2017 to receive financial support from the project. However, as the enterprises had stocks of waste dating back to the PNC, the Project opted to make the transport of waste available for destruction, with subsequent return of the empty cylinders to the enterprises.

Transporting ODS from the destination to the incinerator was one of the biggest challenges faced by the project. This is because the geographical location of the CRs, combined with the increase/variation in fuel prices in Brazil in the years 2019 to 2022 made the hiring processes of transport enterprises quite complex, in addition to the fact that substances would be transported classified as hazardous waste according to national legislation. However, the project was committed to transporting the CR Frigelar, CRN Ecosuporte, Recigases and Gresocol (Bandeirantes) to the incinerated for transporting the cylinders containing ODS and, after destruction, transporting the empty cylinders from the incinerator to the CRs.

Transport was carried out in trucks (closed or open), with safety ties and locks to secure the cylinders, safety plates referring to the type of cargo, documentation, and mandatory PPE. Additionally, carriers should have all the licenses and documents referring to the transport of the type of cargo and the places/municipalities through which it would transit between origin and destination and on return. Figure 13, Appendix I of this document, presents a photographic record of the transport of cylinders.

Another important challenge faced by the project was the interruption in the operation of the incinerator in early 2022, due to plant maintenance needs to adjust the operation and, subsequently, carry out a new burn test. This is because, in a scheduled burn test according to CETESB requirements, the emission limits of dioxins and furans had been exceeded. Due to this occurrence, the initiator operation was interrupted to better investigate the causes and make the necessary adjustments. This process led to a reduction in the feeding limits of chlorinated substances in relation to the license from 8.87 kgCl/h to 2.14 kgCl/h, negatively impacting the ODS incineration period, however, offering greater security to the process and to the surrounding population.

This new operating limit, together with all the pandemic issues and an extensive schedule for burning substances in stock (project ODS plus waste from incinerator customers), made it unfeasible to incinerate the 32,404 kg of ODS identified within the scope of the project until the end of 2022, as planned. Therefore, approximately 24% of identified waste could not be incinerated with project support. Table 7 presents information on the quantities of ODS destroyed.

*Table 7– Data on the ODS identified within the scope of the project*

| CR | Quantity identified | Quantity incinerated | Quantity not incinerated |
|---|---|---|---|
| ECOSUPORTE (SP) | 7,250 | 5,465 | 1,785 |
| FRIGELAR (SP) | 979 | 979 | 0 |
| BANDEIRANTES (SP) | 9,094 | 5,767 | 3,327 |
| RECIGASES (RJ) | 6,359 | 6,359 | 548 |
| CRN (PE) | 6,174 | 6,174 | 0 |
| REGENTECH (RS) | 2,000 | 0 | 2,000 |
| **TOTAL** | **32,404** | **24,744** | **7,660** |

The Certificate of Waste Destruction of all quantities listed above was presented by Essencis to the respective CR and is presented in **Annex XIV** of this document.

## 3.3 Standardization of procedures and criteria for the management and final disposal of ODS waste - results achieved

In addition to technical support to the Brazilian Association of Technical Standards (ABNT) with the Standards ABNT NBR 16667:2018 – Specifications for refrigerant fluids and ABNT NBR 15960:2011 – Refrigerant fluids – Collection, recycling and regeneration (3R) – Procedure, the project also enabled the production of a draft rule on the environmental management of ODS, with the support of the Working Group formed by the UNDP, MMA, Ibama and CETESB, and forwarded to the MMA to assess the pertinence of official submission to ABNT.

## 3.4 Counterpart

As previously mentioned, the Memorandum of Understanding signed between UNDP and the project beneficiary companies (RC and Incinerator) established some commitments for the companies, which resulted in the counterparts shown in Tables 8 and 9.

*Table 8 – Counterpart of the Reclaim Centers*

| Item | Estimated value (USD) | | | | |
|---|---|---|---|---|---|
| | CRN | Ecosuporte | Frigelar | Recigases | Total |
| Adequacy of laboratory facilities following the recommendations of the Laboratory Infrastructure Guide. | 6,202.51 | 16,976.16 | 6,363.35 | 8,912.66 | **38,454.68** |
| Responsible Chemist Fees (Annual amount) | 25,928.71 | 64,683.43 | 34,750.87 | 15,507.89 | **140,870.91** |
| Records in control bodies (Federal Police and Ministry of Defense) | 4,510.27 | 0.00 | 5,294.30 | 1,291.99 | **11,096.55** |
| Other items you consider relevant (detail)[1] | 12,599.82 | 36,400.66 | 25,038.75 | 125.93 | **74,165.16** |
| **Total** | **49,241.31** | **118,060.26** | **71,447.26** | **25,838.47** | **264,587.29** |

*Table 9 – Counterpart of the enterprise Essencis*

| Item | Estimated value (USD) |
|---|---|
| Hours/man worked by the two professionals appointed to dialogue with the UNDP (item 2.3.1 – Memorandum of Understanding – attached document) | 75,710.62 |
| Estimated value of incineration of 24,744 kg of ODS waste, including estimated man-hours worked (item 2.3.6 - Memorandum of Understanding - attached document) | 28,600.79 |
| Completion of the burn test that took place in early 2022 | 15,920.40 |
| Adequacy of the incinerator facilities not covered by the service contract BRA10-32190, which occurred after the burn test was carried out in early 2022 (e.g., the adjustments carried out in early 2022 after the burn test was carried out - no break, etc.) | 109,452.74 |
| Operating License after completion of the burn test that took place in early 2022 | 8,651.61 |
| Other items you consider relevant (detail) | - |
| **Total** | **238,336.15** |

[1] Federal Police, Civil Police, Ministry of Defense and Professional Council.

## 3.5 Financial Execution

Throughout the implementation of the project, there was a need to reallocate resources between results, especially to achieve the results related to Component 1. Table 10 presents information on the financial execution of the Project.

*Table 10 – Financial Execution of the Project*

| Item according to the approved proposal | Budget according to the approved proposal (USD) | Budget according to Substantive Review (USD) | Current Disbursement (USD) | Remaining obligations (USD) | Balance (USD) |
|---|---|---|---|---|---|
| Integrated ODS Waste Management System established, including technical assistance for collection, training, storage, consolidation and transport. | 482,600 | 643,978.56 | 823,340.24 | 3,887.78 | -183,249.46 |
| Incineration of ODS waste demonstrated | 703,000 | 634,155.25 | 384,640.95 | 0.00 | 249,514.30 |
| Technical assistance associated with the evaluation and standardization of procedures and criteria for the management and final disposal of ODS waste carried out | 100,000 | 98,658.36 | 41,747.04 | 0.00 | 56,911.43 |
| Project Management associated with the implementation, supervision, monitoring and evaluation of the planned activities carried out | 205,000 | 113,807.72 | 221,717.78 | 15,266.21 | -123,176.27 |
| **Total** | **1,490,600** | **1,490,600** | **1,471,446.01** | **19,153.99** | **0.00** |

# 4 LESSONS LEARNED

## 4.1 Challenges

Throughout its implementation, the Project faced several challenges, which forced the team to adopt different measures. Such situations and their solutions are listed below; the problems are categorized according to the related aspect:

1. Purchasing: The procurement processes for the inputs and equipment for the RC' laboratories to produce Component 1 results were complex and lengthy due to the costs involved and the specific nature of the tender (highly rigorous with regard to the qualifications of the items listed in the bidding).
   Action: such rigor was necessary to reduce product quality and delivery risks.
2. Country: the increase or variation in fuel prices in recent years in Brazil negatively impacted the development of the project. This factor made the hiring processes of transport companies quite complex, in addition to the fact that substances classified as hazardous waste by national legislation would be transported.
   Action: to mitigate the situation, contracts with suppliers were managed to ensure the transfer of ODS waste from the RC to the incinerator.
3. External problems: the pandemic negatively affected all the Project beneficiary companies at different times; many had their production stopped and employees removed, while others operated with restrictions and reduced staff.
   Action: use of virtual communication tools to maintain dialogue with all beneficiaries and compatibility between planning activities and the actual execution capacity of partners and beneficiaries.
4. Elaboration x Implementation of the Project: throughout the implementation of the project, it was identified that: i) the term of validity of the demonstrative project was not adequate for carrying out all the activities necessary for its implementation; ii) there was a need to reallocate resources between results, especially to achieve results related to Result 1.
   Action: request for an extension of the project's validity upon presentation of a detailed work schedule and readjustment of the project in order to adjust the resources initially proposed to achieve the results.
5. Others: interruption in the operation of the incinerator at the beginning of 2022 due to plant maintenance needs to adjust the operation and, subsequently, carry out a new burning test. This process led to a reduction in the feeding limits of chlorinated substances in relation to the initial license (initially 8.87 kgCl/h, currently 2.14 kgCl/h), negatively impacting the ODS incineration period, however, offering greater safety to the process and the surrounding population.
   Action: monitoring of the process with CETESB and Essencis to define impacts on project results and decision-making.

## 4.2 Lessons Learned

The implementation of this project made it possible to identify several lessons learned regarding the challenges for the management and final disposal of ODS waste in countries with a continental dimension such as Brazil, as listed below:

1. Awareness and determination of responsibilities in the correct final destination of substances are decisive factors for the sustainability of the management system.
2. Strengthening, expanding and consolidating the actions of the actors involved are decisive factors for the sustainability of the management system.
3. The constant monitoring and management of economic, political and social risks and adaptive management are essential to guarantee the sustainability of the management system.
4. Need to strengthen mechanisms for used ODS and their packaging to reach RC. Currently, only 0.2% of the refrigerants that Brazil consumes reach the RC.
5. Need to change the market's view of the quality of the regenerated fluid, which creates obstacles to the product's credibility.
6. RC analysis laboratories are essential to guarantee the quality of the regenerated fluid.
7. The RC will tend to carry out other activities, such as the sale of imported fluid analysis services, the sale of process performance analysis services based on the gaseous substances used (ODS, substances with high global warming potential and gaseous substances in general), in addition to environmental management services for ODS, in pursuit of the enterprise's commercial sustainability.
8. There is a criticality in the control and inspection of ODS due to the fact that the residues of these substances can be easily released into the atmosphere without anyone noticing or identifying their leakage. Most ODS are in gaseous form, have no color or odor and are not directly toxic to humans.
9. Currently, destruction of ODS waste is limited to heat treatment processes, such as incineration, which comply with licensed environmental limits for the destruction of chlorinated substances. This type of treatment has a high cost and is highly demanded by other sectors (chemicals, agribusiness, health services), as it uses refined equipment to control the formation of secondary substances in the process and to control the resulting atmospheric emissions, which must remain within the standards of environmental legislation.
10. It is important that other initiatives support the development of thermal treatment companies and alternative technologies for the final disposal of ODS waste, which should result in greater agility and lower cost for the destruction of this liability.
11. The use of virtual communication tools was of fundamental importance to maintain dialogue with all beneficiaries, especially in the years 2020 and 2021, during the COVID-19 pandemic.
12. The close collaboration established between MMA, Ibama, CETESB and UNDP was fundamental for the security in making decisions of great importance for the implementation of the project, as well as for the success achieved.

# 5 APPENDIX I

# 6 ANNEXES

6.1 Annex I - 20th Meeting of the Parties, Decision XX/7

6.2 Annex II - 22nd Meeting of the Parties, Decision XXII/10

6.3 Annex III - 29th Meeting of the Parties, Decision XXIX/4

6.4 Annex IV - Decision ExCom 58/19

6.5 Annex V - Decision ExCom 57/19

6.6 Annex VI - Approved Project

6.7 Annex VII - Expression of Interest 32016 of 2017

6.8 Annex VIII - Expression of Interest 30431 of 2017

6.9 Annex IX - 14th Meeting of the Parties, Decision XIV/6

6.10 Annex X - Technical Opinion No. 025/19/IPA

6.11 Annex XI - Results of the 2019 Burning Tests

6.12 Annex XII - Results of the 2021 Burning Tests

6.13 Annex XIII - Results of the 2022 Burning Tests

6.14 Annex X - Waste Destruction Certificate

*Figure 1 - Location of the Reclaim Centers and the Incinerator.*

*Figure 2 – Cylinders acquired and distributed to the RC within the scope of the project.*

*Figure 3 - Equipment and tools purchased and distributed to the RC within the scope of the project.*

*Figure 4 – Technical visit to the RC facilities prior to the preparation of the Laboratory Infrastructure Guide: a) CRN, b) Ecosuporte, c) Frigelar, d) Recigases.*

*Figure 5 – Record of training on tests of the AHRI 700 standard and good laboratory practices carried out within the scope of the Project.*

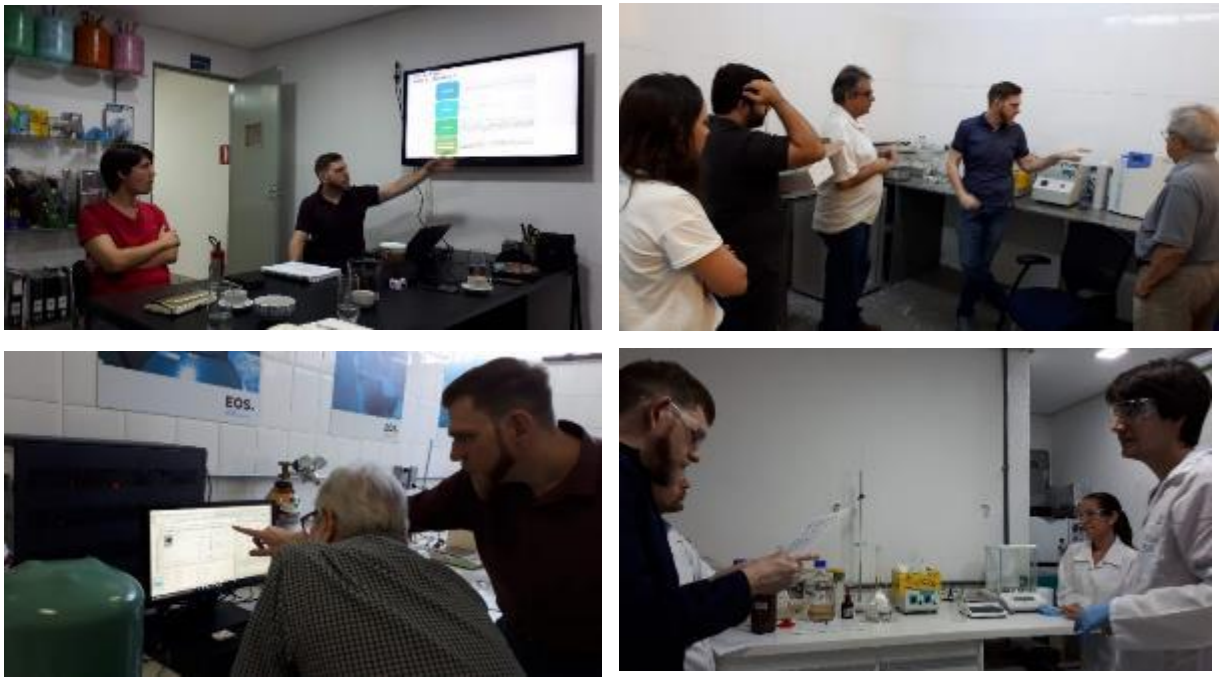



*Figure 6 – Equipment, accessories and glassware acquired under the Project.*

*Figure 7 – Installation and training for the operation of gas chromatographs.*

*Figure 8 – Technical teams from MMA, Ibama, Essencis and UNDP visiting the incinerator facilities..*

*Figure 9 – Skid: Gas supply system with pressure, flow and feed weight controller.*

*Figure 10 – Cyclone: before and after installation.*

*Figure 11 – Bag filter: before and after installation.*

*Figure 12 – Hot gas generation system before and after installation.*

*Figure 13 – Transport of cylinders.*

# Report

# Demonstration Project on Promoting HFO-based Low GWP Refrigerants for Air-conditioning Sector in High Ambient Temperatures

## SAU/REF/76/DEM/28

## Final report Dec 2022

# Table of content

# 1. Introduction

To facilitate a smooth transition to ODS alternatives with low global warming potential (GWP), the Executive Committee in decision 72/40 agreed to consider proposals for demonstration projects for additional low-GWP alternatives and invited bilateral and implementing agencies to submit demonstration project proposals for the conversion of HCFCs to low-GWP technologies in order to identify all the steps required and to assess their associated costs.

In particular, Para (b)(i)a of Decision 72/40 indicates that project proposals should propose options to increase significantly in current know-how in terms of a low-GWP alternative technology, concept or approach or its application and practice in an Article 5 country, representing a significant technological step forward.

Alessa participated in the PRAHA project, where they developed prototype window and split units with different low GWP refrigerants for testing. The tested units showed promising results and potential for further optimization in order to reach commercialization.

Under the Kingdom of Saudi Arabia (KSA)'s HPMP, UNIDO has proposed to work with Alessa on a conversion project which will substantially contribute to the HCFC phase-out plan in the manufacture of window and split unit air conditioners in KSA and neighbouring countries as planned under the agreement between KSA and the MLF. Following the completion of testing and demonstration, the company will evaluate the complete conversion from HCFC-22 to lower GWP and zero ODP R290 (HC-290). This evaluation shall consider KSA's commitments to the Montreal Protocol (MP), safety considerations, current building codes, existing Minimum Energy Performance Standards (MEPS), market trends, and cost and availability of refrigerants and components. The complete phase-out is encouraged by UNIDO, but the ultimate decision will remain with the beneficiary.

In this conversion project, UNIDO worked with Alessa to convert one of their mini-split Room AC (RAC) manufacturing line to low GWP, zero ODP replacement to HCFC-22. This effort involves:

- Manufacturing facility safety evaluation,
- Manufacturing line safety upgrades,
- Refrigerant lines upgrades,
- Technical assistance for safety compliance,
- Technical assistance for equipment redesign,
- Demo production setup and validation of the procedures,

- Laboratory testing,
- Field testing,
- Real-life testing in the factory of Alessa,
- Environmental and energy impact study,
- Production of units and testing at customers,
- Training of service technicians and setting up curricula as well as documentation, and
- Final reporting and workshop.

A report on production line installation and commissioning, real-life testing rooms setup, and laboratories upgrades was submitted in 2021. In UNIDO provided additional capacity building and support through several missions of experts for finalisation of the product. With the final achievement of the G-mark certification which grants the possibility for placing the units on the market.

The real-life test rooms were extensively used to compare the performance of the developed prototyped against the baseline equipment. This setup has also provided a testbed for servicing training opportunities besides the testing as on a customer site.

This demonstration project has successfully met its goals in proving the possibility of using the low-GWP zero-ODP HC-290 as a refrigerant for RAC applications in High Ambient Temperature (HAT) environments. However, the ultimate decision for product commercialization is a commercial decision by the beneficiary that has to account for many issues – chief amongst them are the supply chain/logistics issues, local legislations, safety regulations, and market acceptance.

## 2. Research and Development

Alessa worked with UNIDO to evaluate different low GWP technologies and solutions available on the global market. The intention of visits to factories in China unfortunately due to the Covid-19 situation was impossible. This study revealed that HC-290 is the preferred refrigerant of choice, HFO's and R32 were discarded by Alessa at the start. Furthermore, Alessa and UNIDO reviewed the local market to identify the product development priority. The market survey indicated that window air conditioning units are losing market share to the mini-split technology. As such, it was decided to work on the development of a 5 kW (1.5 TR or 18 kBtu/h) HC-290 split cooling capacity unit to satisfy the local market in KSA – which is the prevalent size of RAC.
The research and development supported by UNIDO experts was tiered as follows:

- Develop a unit based on existing Alessa outdoor unit platform coupled with an OEM indoor unit (from Chinese or Indian suppliers working with HC-290 technology) and using either Indian or Chinese indoor units
- Optimize the refrigerant charge to comply with safety limits of 500 g by keeping the performance
- Use an HC-290 prototype compressor developed specially for T3 applications at 60 Hz
- Improve outdoor coil design to minimize refrigerant charge
- Improve outdoor coil design to maximize energy efficiency
- Properly size the capillary tube

The research focused on complying with the current SASO energy efficiency requirements of ISO 5151[1] and SASO 2663/2018. During the course of the project, the local MEPS were upgraded to SASO 2663/2021 adding SEER test requirements, T3 cooling conditions, and H1 heating conditions. Table 1 provides the test conditions and MEPS as per SASO 2663/2021.

*Table 1. Testing Conditions and MEPS according to SASO 2663/2021*

| Testing condition | Indoor section | | Outdoor section | | MEPS[2] $EER_{min}$ (Btu/h.W) |
|---|---|---|---|---|---|
| | Dry bulb, °C | Wet bulb, °C | Dry bulb, °C | Wet bulb, °C | |
| T1 | 27.0 | 19.0 | 35.0 | 24.0 | 11.8 |
| T3 | 29.0 | 19.0 | 46.0 | 24.0 | 8.3 |
| H1 | 20.0 | 15.0 | 7.0 | 6.0 | - |

UNIDO experts worked with Alessa and different compressor OEMs were contacted to develop prototype compressors suitable for the KSA market. One of the main challenges is that the power supply in Saudi Arabia is 220 VAC / 60 Hz; which is not a typical electricity configuration. Furthermore, the compressors needed to be certified to operate at T3 conditions for the refrigerant of choice – HC-290.

As for heat exchanger, Alessa has both 7 mm and 5 mm heat exchanger production lines. However, they did not have 5 mm copper tubing commercially available at the beginning of the project. They were able to establish contacts with their suppliers and secure the required amount of 5 mm inner grooved tubes for the development of the outdoor coils. Furthermore, Alessa R&D department established the required procedure for charge optimization in order to maximize energy efficiency.

[1] https://www.iso.org/standard/63409.html

[2] For Split type ducted and non-ducted using air cooled condensers, heat pumps using air cooled condensers

## Compressor development

UNIDO, the international expert, Alessa and the Chinese compressor supplier provided the required compressor specifications for HAT[3] countries as well as for the Saudi 60 Hz power supply.

The team started by using a 50 Hz T1 HC-290 compressor to initiate equipment performance evaluation achieving promising results. Next, a prototype 60 Hz T3 compressor was supplied for integration in the outdoor unit. Alessa tested with the prototype compressor and achieved acceptable results, as shown in the results section.

In the future, Alessa may consider using an inverter compressor model to further improve the performance. A second round of improvements was taken with the compressor supplier after evaluation of the results of the prototype testing.

One of the discussion points will be availability of inverter compressors for 18 and 24 kBTU/hr models as they aren't available at the moment.

## Split unit Development

The product development team started with the experimental evaluation of the first prototype HC-290 unit in July 2018. The testing was performed according to SASO 2663/2018 (which are similar to ISO 5151). The test conditions and MEPS are listed in Table 1. The primary target was to meet the MEPS at T1 and T3 as well as providing adequate performance for H1 test conditions.

The first tests conducted in July 2018 identified the need for improved condenser and compressor. The unit achieved acceptable efficiency but fell short of meeting the capacity target due to using a 50 Hz model; furthermore, the charge was not optimized. Therefore, the project team worked on:

- Reducing the charge through condenser redesign
- Procuring appropriate compressors
- Improving the system efficiency through
    - Condenser optimization
    - Selection of indoor unit meeting the targeted performance
    - Capillary tube sizing and charge optimization

[3] HAT High Ambient Temperature

One of the main OEM suppliers to the beneficiary provided a 60-Hz prototype HC-290 compressor rated at T3 conditions. This compressor increased the cooling capacity and maintained the EER. Further improvements were investigated by modifying the condenser to be made of 5 mm OD inner-grooved copper tubing (IGT) as shown in Figure 1.

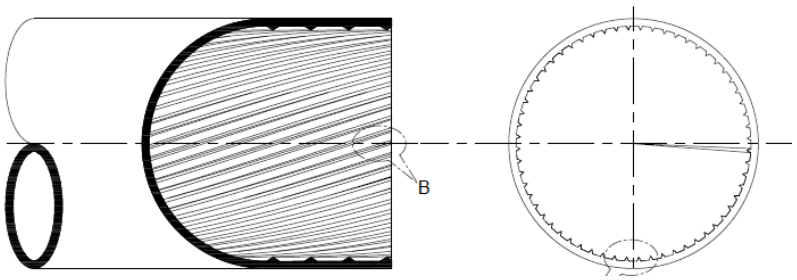



*Figure 1. Inner grooved copper tubing*

The 5 mm IGT had been widely commercially since 2016 but was rarely used. It negatively effecting the cost despite "less material" used. For the optimization of the condenser, with HC-290, we were able to move away from the 7- or 9-mm tubing used for HCFC and HFC's. IGT have helical internal fins that promote heat transfer and extend the inner heat transfer area. Alessa had already developed the required manufacturing line upgrades to enable manufacturing with 5 mm IGT heat exchangers so from the moment we procured the 5 mm IGT the first models of heat exchangers were made. Fin-and-tube heat exchangers offer an occupational advantage over microchannel heat exchangers for Alessa as all the heat exchangers for all the units can be made in-house. Furthermore, modelling and analysis of 5 mm IGT heat exchanger proved to provide good performance as detailed in the appendix.

The improvements from the initial tests in 2018 showed an increase in cooling capacity of 12 % and with the last improvements on the condenser 13.5% reaching 18,300 BTU/h. At the T3 conditions, relevant for HAT country like KSA, the optimized condenser showed an improvement of 16%. Compared with the local MEPS, the prototype achieved EER of 12.5 at T1 (compared with 11.8 for MEPS) and 9.4 at T3 (compared with 8.3 for MEPS). This allowed for a good margin from the moment these requirements are raised and allow production margins due to manufacturing tolerances.

Development work involved numerous interchanges with UNIDO experts who provided know-how and heat exchanger design. Trial work of Alessa and their longstanding experience had absolutely an important contribution. The recognition of what has to be done based on lab testing is a valuable asset combined with good refrigeration knowledge.

The model developed was finalised and ready for production. As mentioned, the new batch of compressors we ordered, 48 compressors, had been improved with respect to the prototype model. Once they arrived a verification of the performance was made. At the same time, Alessa had ordered indoor units so that they could be matched with the compressors and trial batch field-ready units could be manufactured. This would provide them with the required experience on the production line.

In more detail, 6 sets of tests were made under different conditions depending on the development stages. Measurements for the results were all made at T1 and T3 conditions for comparison reasons. Our development concentrated on the 18,000 BTU/hr since this is the most common unit sold on the market in KSA.

| | | |
|---|---|---|
| Date | 23 July 2018 – unit supplied by UNIDO 18 K | **1** |
| Model | GSC 18 FG 6 BOG | |
| Compressor | DSF340V1UFT | |
| Comments | 50 Hz ODU 170700052SA00027/ IDU 170700052SA00023 | |

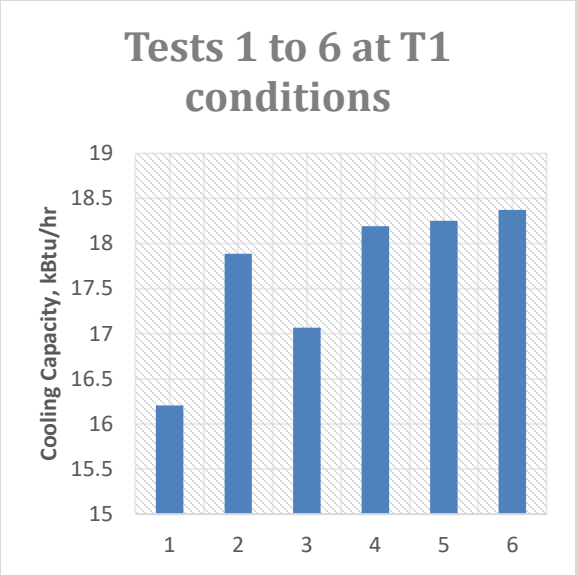
| | | |
|---|---|---|
| Date | 06 October 2019 | **2** |
| Model | DS18CE7HY7HC-290 / DSA120FE7HY7CL (TCL) | |
| Compressor | DSG280N1VKT S# 906000002K (GMCC) | |
| Comments | 60 Hz – changed indoor unit | |

| | | |
|---|---|---|
| Date | 06 October 2019 | **3** |
| Model | DS18CE7HY7HC-290 / GSC18FG6BOG (GODREJ) | |
| Compressor | DSG280N1VKT S# 906000002K (GMCC) | |
| Comments | 60HZ – change indoor unit and charge | |

| | | |
|---|---|---|
| Date | December 2019 | **4** |
| Model | GSC 18 FG 6 BOG | |
| Compressor | DSG280N1VKT S# 906000002K (GMCC) | |
| Comments | 60 Hz with new 5 mm condenser | |

| | | |
|---|---|---|
| Date | February 2020 | **5** |
| Model | GSC 18 FG 6 BOG | |
| Compressor | DSG280N1VKT S# 906000002K (GMCC) | |
| Comments | 60 Hz with new 5 mm without subcooler | |

| | | |
|---|---|---|
| Date | February 2020 | **6** |
| Model | GSC 18 FG 6 BOG | |
| Compressor | DSG280N1VKT S# 906000002K (GMCC) | |
| Comments | 60 Hz with new 5 mm without subcooler - optimised | |



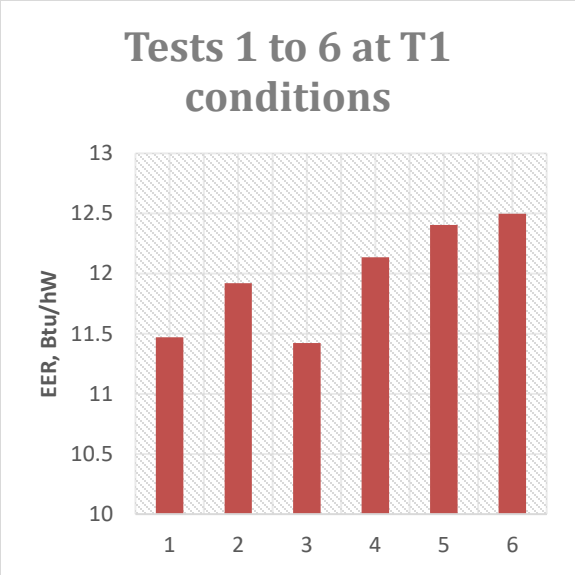
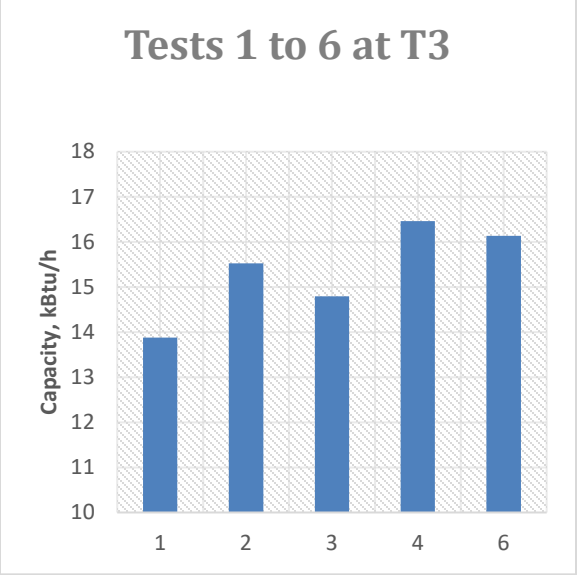




*Figure 2. Cooling capacity (Left) and EER (Right) for the different tests at T1 conditions*

Several indoor units, condensers and compressors were used to find an optimal configuration. We were able to increase the cooling capacity and at the same time the energy efficiency (EER) as shown in Figure 2. A comparison had to be made also at T3 conditions where we see that for the same unit the cooling capacity drops by 14% and EER up to 29%, as shown in Figure 3.



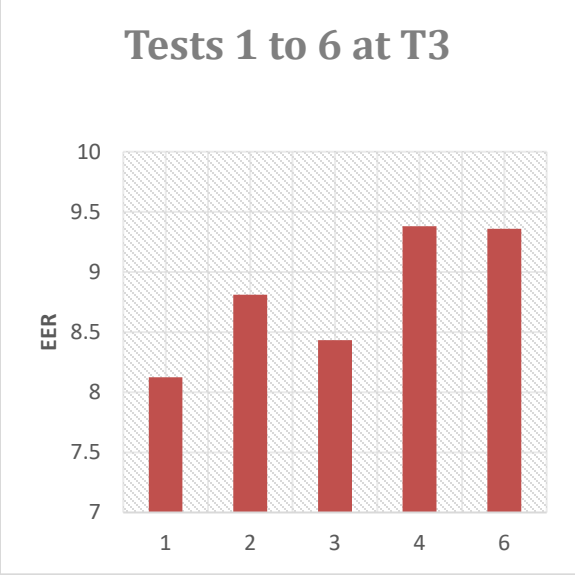




*Figure 3. Cooling capacity (Left) and EER (Right) for the different tests at T3 conditions*

These result shows us the importance of the demonstration project and awareness process for the stakeholders. Figure 4 emphasizes the importance of this project to HAT countries, it

indicates that EER at T3 can be reduced by up to 29% compared with T1 conditions. The progress on equipment optimization resulted in equipment with only 25% loss in efficiency at T3 compared with T1 conditions.

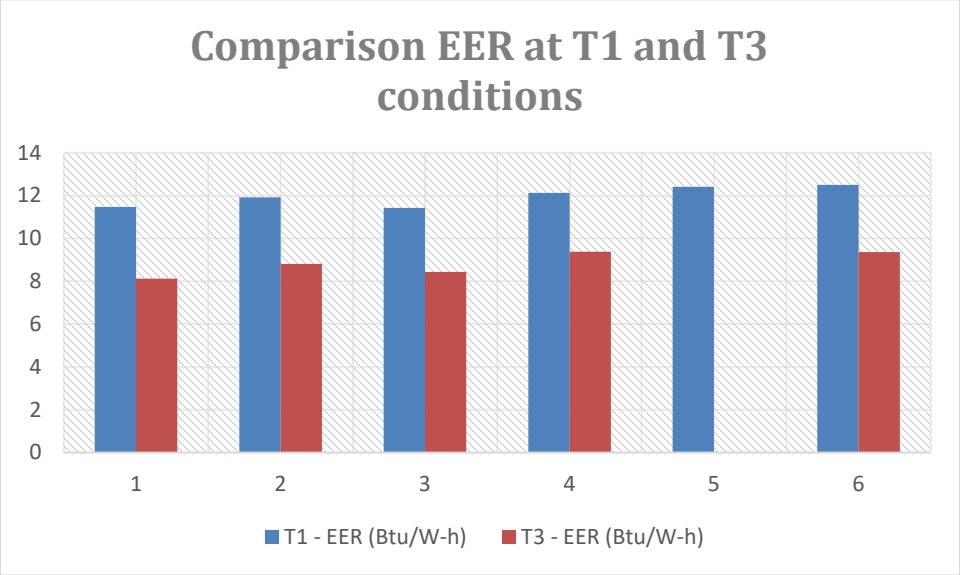



*Figure 4. Comparison between EER at T1 and T3 for the different tests.*

It is clear that the developed prototype is of acceptable performance and can meet the new proposed MEPS requirements set by SASO as shown in Table 1.

The performance of the RAC equipment in HAT countries should be evaluated at both the T1 and T3 conditions in order to ensure its ability to operate and satisfy the cooling need efficiently. Through this project, we have demonstrated that the HC-290 technology is suitable for use in HAT countries and provides an alternative to HCFC, HFC, and HFO refrigerants, or their mixtures.

In order to enter the production phase, Alessa needed the tested units to achieve an EER better than 11.8 to account for production manufacturing tolerances. While the original prototype showed promising results and was set to be the production model as shown in previous report. Alessa was not able to continue with the originally selected indoor unit. Alessa worked with a their new OEM to secure additional indoor units to be matched with their current optimized outdoor unit. Unfortunately, the new prototype test results didn't achieve the target performance. Furthermore, the test laboratories at Alessa has been upgraded and accredited by SASO, resulting in higher measurements accuracy and fidelity. this resulted in the need for additional missions of the experts to finetune the prototype to achieve the target performance. The lab accreditation means that we do not need to submit the splits for testing to a third

party. UNIDO consultants provided additional guidance to Alessa regarding the testing and progress towards the goal. A system model was developed using EGSim[4] and was calibrated against original experimental data showing high accuracy. The model was further used to identify potential issues related to the poor performance realized in recent tests. These were largely due to the use of a poor performance indoor unit with low efficiency fan that resulted in high parasitic power and low air flow rate to the evaporator.

As such, Alessa used the same outdoor unit developed during 2021 which comprised a compressor (GMCC DSG280N1VKT S# 906000002K), and a 3-row condenser made of 5 mm internally grooved tubes and soft-optimized the system using different capillary-tubes and indoor units. During the visit in May 2022 the most promising model was frozen and prepared for G-Mark testing submission.

The final model used for certification purposes has been certified with an EER of 12.2 and cooling capacity of 17.600 BTU/h, for more details please check the certification certificate in the following chapter.

## 3. Laboratory development / G-Mark certification

Alessa has continued in further developing the laboratories to receive the certificate of accreditation. This required internal company restructure to allow the laboratories to be independent from the production and act as third party. This accreditation allows now that there is no need of third parties for performance testing of the unit.



[4] https://github.com/OmarZaki96/EGSim

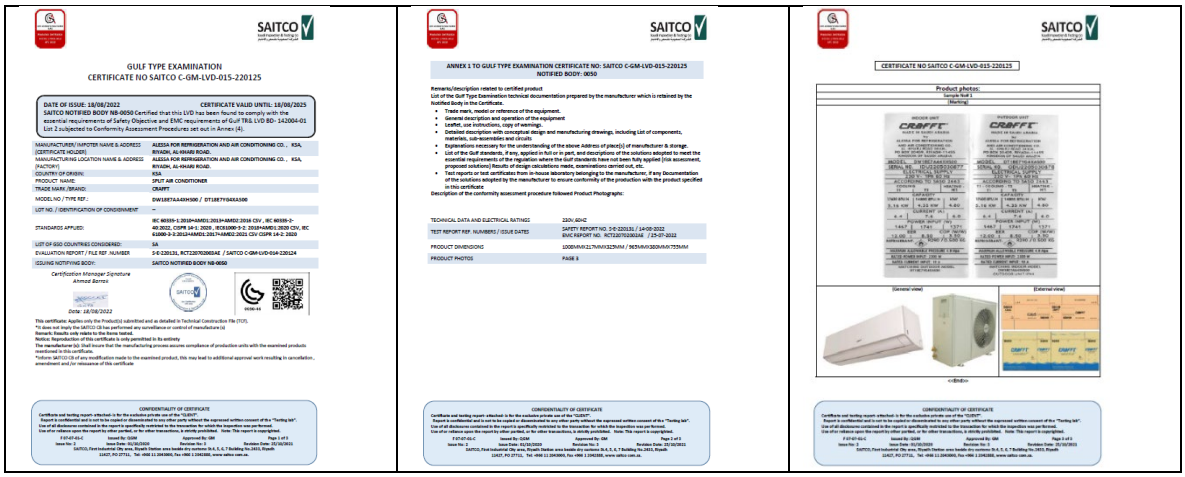
*Figure 5: Alessa laboratory Certificate of Accreditation IAS and SAC*

## G-Mark certification

According to GCC regulations for placement on the market of air conditioners a G-mark certification is required. During the visit of the expert the certification institute has been visited and we are organising the procurement details for having the unit tested. The tests involve electrical EMC testing and issue of a safety report. We envisage that in October we should have the G-mark as Alessa is well acquainted with the procedures for requesting the G-Mark according to international standards.

The specification was finalised and agreed upon with the test laboratory, the local laboratory in Riyadh has been chosen following the procurement process. The G-Mark testing is a requirement but actually is a formality as the unit electrical components are standardized for the different models.

The unit received the G-mark certification and is therefore, allowed to be sold in KSA and other GCC markets. The G-mark was awarded on August 18, 2022 by Saitco notified body NB-0050 with a validity until August 18, 2025 as shown in Table 2.


GULF TYPE EXAMINATION
CERTIFICATE NO SAITCO C-GM-LVD-015-220125

ANNEX 1 TO GULF TYPE EXAMINATION CERTIFICATE NO: SAITCO C-GM-LVD-015-220125
NOTIFIED BODY: 0050

CERTIFICATE NO SAITCO C-GM-LVD-015-220125

*Table 2: G-Mark certification*

## 4. TüV third party testing

The TOR and specification have been finalised and certification institutes, e.g. TüV, identified awaiting the optimisation process and for the unit to be shipped. This testing involves safety testing from a third party. The system is a closed system, and the components are certified with HC-290 as a refrigerant so

we do not expect issues for the certification. This testing is mainly done as standard procedure with projects handling flammable refrigerants.

After the final testing and certification, G-mark see separate paragraph on this topic, 2 units were planned to be shipped to TUV.

Unfortunately, the time required for shipment of prototypes (export and import permits) exceeded the available project duration and could not be any more implemented. Therefore, the tendering has been halted and not fund disbursed for it.

## 5. Production line

UNIDO's international expert worked with Alessa to develop the required specifications for the production line modifications. A detailed project description was developed. An international bidding was conducted in 2017 and the production line upgrade was awarded to an Italian supplier. In March 2018, the supplier visited Alessa to verify the installation conditions and fine tune the requirements for the machines based on the review of:

- Laboratory, safety for testing with HC-290
- Production, adding safety equipment for HC-290 to the production line
- Heat exchanger testing area, verification of the testing enclosure, placement of helium leak test, pressure, and vacuum testing
- Life testing, fine tuning of the software requirements for the test measurements
- Agreement on local works to be performed by Alessa for a smooth installation

The factory layout shown in Figure 6 was revised as shown in Figure 7 due to the need of shifting the production line to a larger workshop area and to concentrate all the refrigeration activities in one manufacturing building. This new line has been financed by Alessa. Furthermore, the new location is better as the original location was next to the heavy metal presses. The new line has been moved to this building and is situated next to the production line for chest freezers.

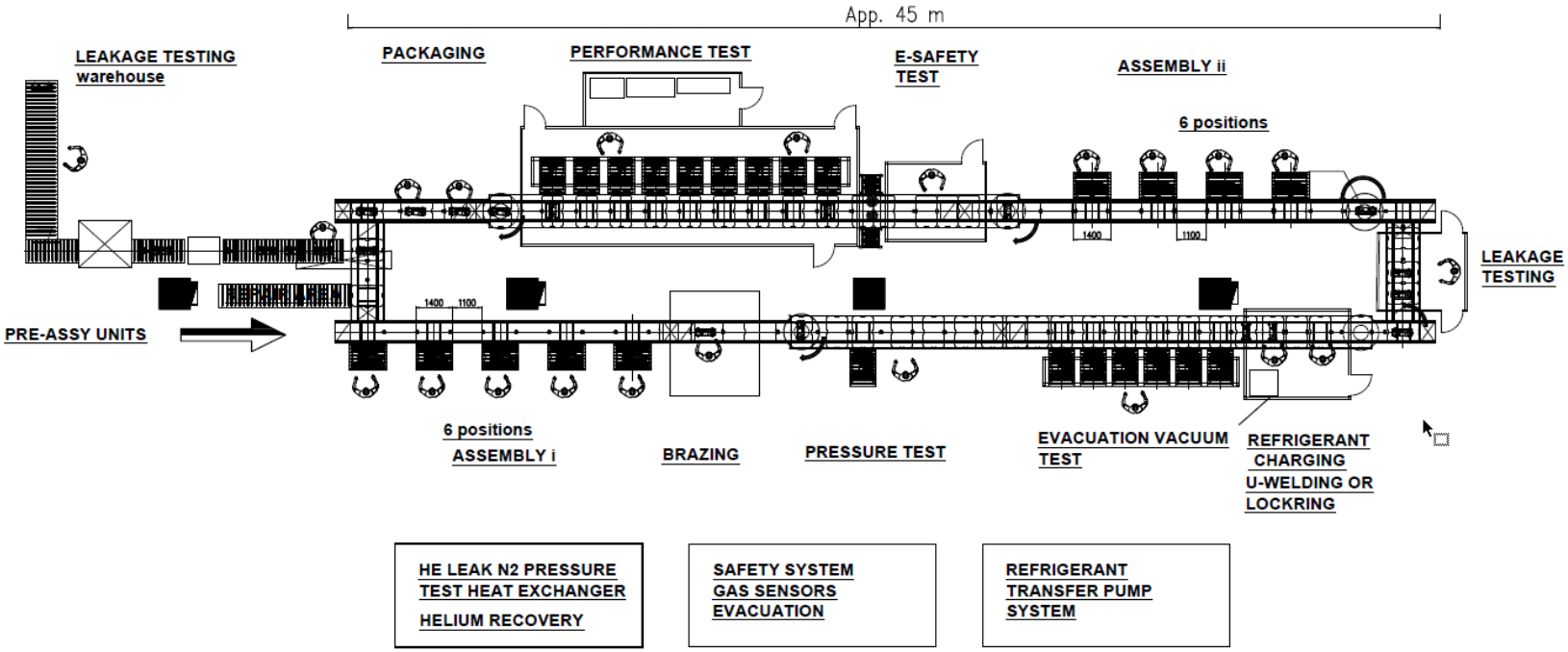



*Figure 6. Original production line layout.*

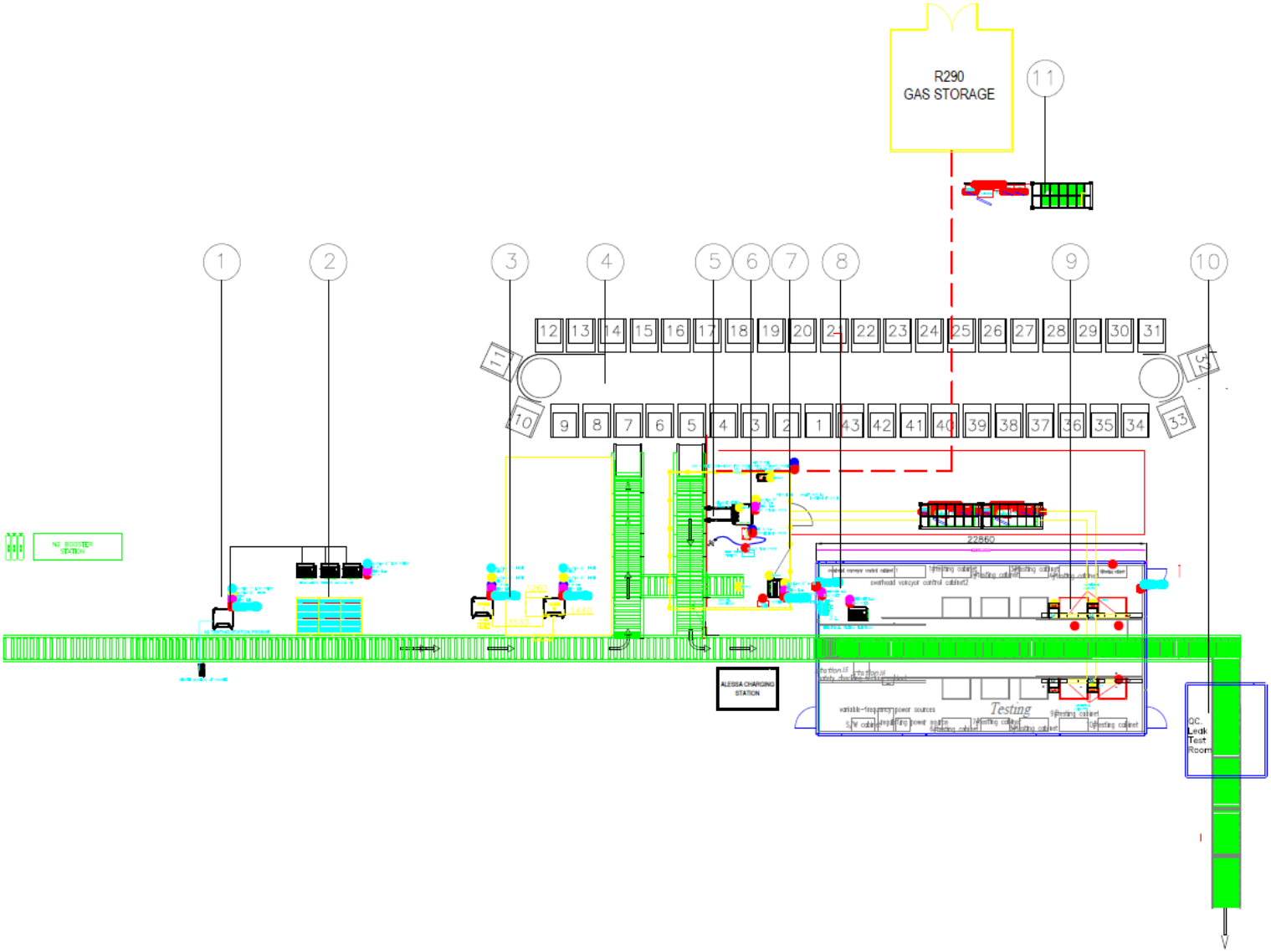



*Figure 7. Installed manufacturing line*

The different stations enumerated on Figure 7 include:

1. Pressure testing with Nitrogen
2. Pre-evacuation
3. Helium leakage testing
4. Pre-charging evacuation
5. Charging
6. Leakage testing
7. Maintenance area rejected units
8. Electrical testing
9. Full performance testing
10. Quality control leakage testing package units
11. Outside of the building refrigerant HC-290 storage and pumping station

The Italian supplier has installed the required testing and charging equipment at the different stations including a complete quality control system. Each station features a bar code reader for reading each unit and monitoring the quality. The heat exchanger manufacturing and testing is not shown in these figures; the figure focuses primarily on the assembly lines. Also, the figures doesn't include the ventilation system for clarity reasons. Figure 8 shows the equipment upgrades effort in the performance room and Figure 9 shows the final installation of the exhaust vents on the roof.

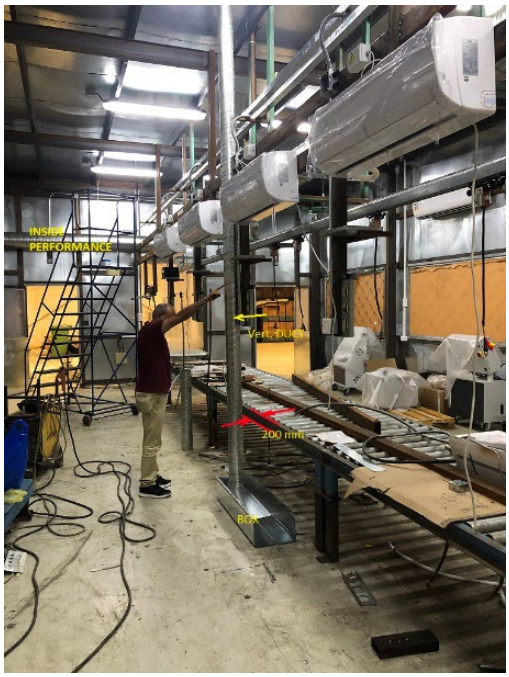



*Figure 8. Equipment upgrades in the performance room.*

*Figure 9. Exhaust vent on the roof of the production line area.*

The installation of the production line, laboratories, and real-life test room have been completed including all piping, electrical, safety system, and ventilation ductwork by the end of 2021. Similarly, the laboratories and real-life testing rooms have been upgraded with all the required equipment and instrumentations. The original plan actually was for the supplier engineer to come in February 2020 but due to the COVID-19 pandemic, all flights had been cancelled. Once, travel was resumed between KSA and Italy, the commissioning was finalised by the end of 2021.

During the visits of the UNIDO Expert reviewed the completed production line upgrades, discussed all operation procedures with the factory team, and provided the required training. The production procedures include the manufacture at component and assembly level.

At component level the focus was on the manufacture of the coils because during the production they are considered a critical element for leakage testing. Due to the large number of brazing joints, it is difficult to evaluate their quality on a production line within the target production cycle time. The following changes were made to ensure product quality and maintain target manufacturing capacity:

- Remove the evaporative oil used for expanding the tubes,
- Increase the pressure testing limit,
- Continue with the current leakage testing practice with the addition of statistical verification using Helium at component level (production line workstation).

For the production line, the UNIDO expert provided capacity building for:

- Level of vacuum,
- Helium testing procedures,
- Charging,
- Additional electrical testing addition that weren't possible with the existing equipment,
- Additional performance tests (functional testing).

All these tests are in accordance with the EN 60335 standards for certification of the unit.

The complete line after the visit in September was reviewed and remaining points were solved in common agreement between Alessa and the supplier on 9 December, 2021 including:

- the layout drawings of the factory were updated according to the installation results,
- Electrical diagrams finalised,
- missing parts solved,
- documentation of test protocols provided,

The complete acceptance report with the list of equipment installed is attached in Annex A. It is important to highlight that the cooperation between Alessa and the supplier was well-coordinated given the challenges imposed by the Covid-19 pandemic.

## 6. Servicing

Alessa has its own servicing/ sales branch in different cities. The company acts under the name of WIFEX and acts as authorised servicing company. Trainers and managers for the different servicing branches were trained. These branches have approximately 100 technicians.

We had first a meeting with service technicians who performed an installation so that we could review the status. The technicians were quite knowledgeable and only minor points was that they flushed instead of evacuating the flexible hoses. The interviewed technicians had no prior experience with HC-290.

During the meeting with the trainers, we went into depth about HC-290 refrigerant and servicing issues. We shared a training manual with them, highlighting the most important aspects related to working with HC-290. Furthermore, a user manual was developed with the R&D department and we finalised the servicing manual adding comments and information required for the service engineers.

An important aspect for the sales is to have tools which promotes the use of environmentally friendly HC-290 units. We visited the real-life test rooms for hands-on experience on R-410A and HC-290 units. During the hands-on training, the R-410A units could not provide sufficient cooling to maintain an indoor set point of 20°C when the outdoor conditions were around 42 to 44°C. This was a positive practical experience to the technicians. The real-life test rooms are available for further testing as well as training of technicians. They can also be used as a testbed to provide consumers with realistic benefits of using the new HC-290 RAC model.

## 7. Real-life Test room for field testing and training

The project team identified two created two rooms at the factory site that are currently used as shown in Figure 10.

Office 1 – app. 16 $m^2$

Office 2 next to office 1 and identical

Building Exterior

Sample Outdoor Unit

*Figure 10. Photos for the site Real-life Testing room.*

The condensing units were placed outside, ground level, instead of on the roof. During the field study, the impact of condensing unit placement was simulated by putting them in direct sun and then

providing appropriate shading. Furthermore, ground-level installation enabled better training environment for the technicians as well as providing the required demonstration.

Once the field-test setup was complete, a meeting with SASO was organised in order to provide them with a detailed hands-on experience on the operation of the HC-290 units in comparison with R-410A.

The setup installation was carried with supplier remote intervention as they weren't able to travel. Alessa under guidance of the supplier installed the units and gained experience in use. Note that the same setup is also used on the production line so that data can be compared. During the expert visit measurement errors were further reduced.

It is interesting to note that at an ambient temperature of +40°C the R-410 A unit was not providing cooling to achieve a room temperature of 20°C. Note that when the tests are performed both units run in parallel for a comparison under the same ambient conditions. What we can say is that in both cases due to the large windows of the rooms the insulation is poor. Which means that the units need to work continuously to cover the heat loss.

*Figure 11: real-life test room, rooms are located where you see the outdoor units on the ground*

A learning point is also the orientation of the outdoor unit. When you look at the roof there is a unit with the condensing unit orientated to the south, the others you see the ventilators. A unit placed like that will have a lower performance as the heat cannot be properly removed due to the direct sun radiation.

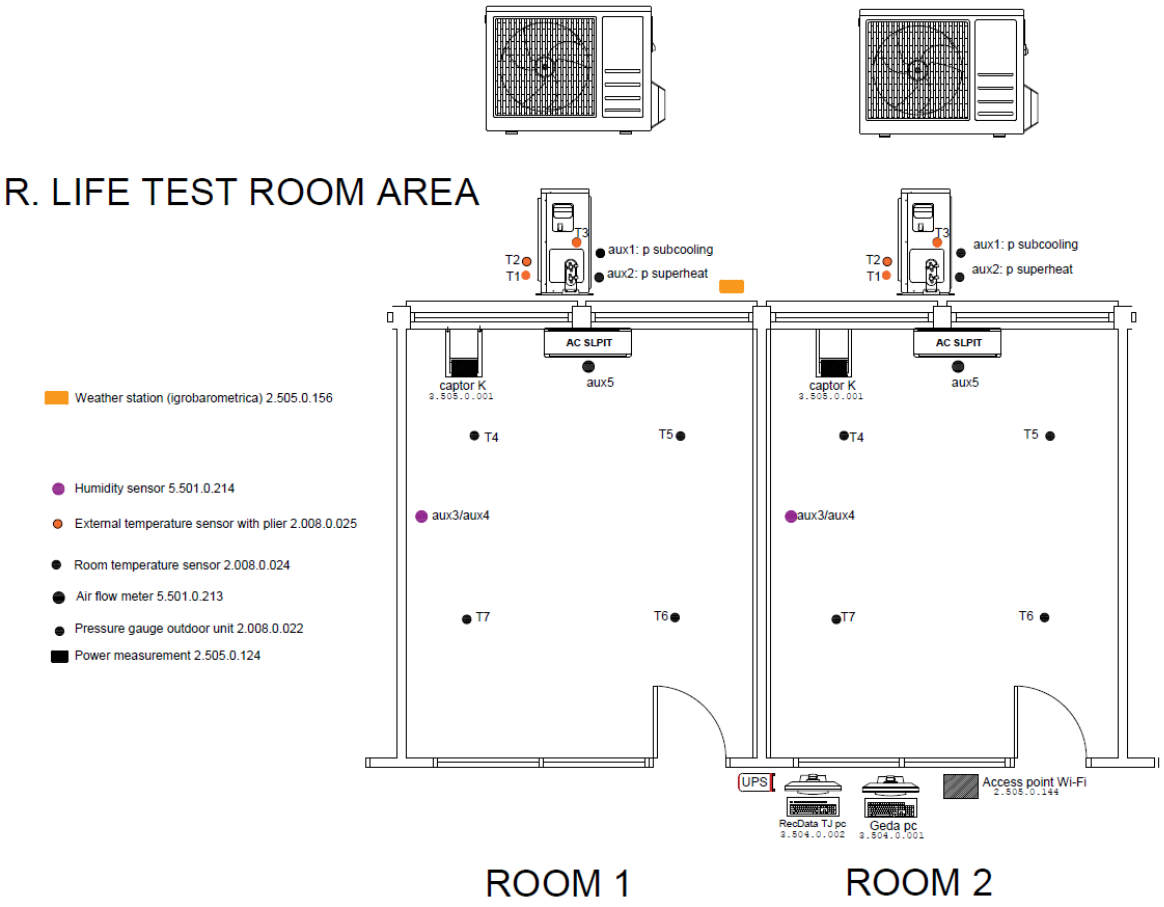



*Figure 12: Layout of the rooms and position of the sensors*

The measurements are done with the same equipment used on the production line assuring accurate measurements. The sensors used in real-life testing are placed as shown in Figure 12 and can be summarised as follows:

- Internal room temperature placed at a height of approximately 1.5 m
- Pressure and temperature measurement of the indoor and outdoor unit
- External and internal measurement of the ambient conditions like pressure, humidity, and temperature
- Weather station, as shown in Figure 13


*Figure 13: weather station*

## Performance of splits under test

Before stating the tests in the real-life test room the units were tested in the laboratory according to SASO 2663/2021 under the conditions listed in Table 1. The laboratory results are summarised in Table 4.

*Table 3: summary of lab testing results for the units under test*

| Unit under test certification | | |
|---|---|---|
| Unit | HC-290 | R410A |
| Refrigerant charge (g) | 500 | 1510 |
| | T1 | T1 |
| EER (BTU/W-Hr) | 12,65 | 12,35 |
| Test unit power (W) | 1408 | 1450,7 |
| Cooling capacity (BTU/Hr) | 17805.2 | 17922.4 |
| | T3 | T3 |
| EER (BTU/W-Hr) | 9,376 | 9,22 |
| Test unit power (W) | 1664 | 1770.1 |
| Cooling capacity (BTU/Hr) | 15601 | 16343.8 |

Briefly the HC-290 units has a better EER but at the same time a slightly lower cooling capacity, more details are in the test reports, see annex.

## Real-life test room results

Both baseline and prototype units were tested simultaneously in side-by-side rooms in order to maintain the same environmental conditions. It is important to note that both rooms were fitted with poorly insulating windows. Both units were tested while running at the high and turbo speeds of the indoor unit with setpoints of 16, 18, and 20°C. And additional test was conducted with insulated windows and split unit set at 20°C. the following criteria were investigated:

A. Can the unit under investigation providing satisfy the cooling requirements and achieve the setpoint?
B. Is there a difference between the electrical power draw in the real-life test and the lab tests?
C. The overall performance of the unit and any operation issues that would arise.

A: Ability to provide adequate cooling and meet setpoint

Both units cooled down the room but the R-410A unit only met the set temperature at turbo speed with an indoor temperature setting of 20°C. This was also the day with the lowest external temperatures, max 39 and min 25°C. the other days the external temperature was always above 40°C.

B: Difference between laboratory and real-life electrical power draw

For all real-life testing conditions, the ambient conditions were between the T1 and T3 conditions used for the laboratory testing; however, the power draw was lower than under T1 conditions as shown in Table 5. The largest deviation in electrical power draw from the laboratory tests were observed when the windows were insulated, and the room temperature was set at 20°C under the "Turbo speed" mode.

*Table 4: Power decrease during real-life testing with respect to T1 MEPS testing conditions*

| Unit | Set temperature room on unit (°C) | Ambient temperature (°C) | % power change T1 test | Did not achieve set temperature | Speed setting |
|---|---|---|---|---|---|
| HC-290 | 16 | 40.8 | 13% | | High speed |
| R410A | 16 | 40.8 | 23% | X | |
| HC-290 | 18 | 38.6 | 18% | | |
| R410A | 18 | 38.6 | 26% | X | |
| HC-290 | 20 | 40.6 | 16% | | |
| R410A | 20 | 39.9 | 28% | X | |

| | | | | | |
|---|---|---|---|---|---|
| HC-290 | 20 | 35.2 | 25% | | High + **Insulated window** |
| R410A | 20 | 35.2 | 43% | X | |
| HC-290 | 16 | 37.3 | 12% | | Turbo speed |
| R410A | 16 | 37.3 | 21% | X | |
| HC-290 | 18 | 38.35 | 18% | | |
| R410A | 18 | 38.35 | 30% | X | |
| HC-290 | 20 | 28.5 | 46% | | |
| R410A | 20 | 28.5 | 48% | | |
| HC-290 | 20 | 31.2 | 58% | | Turbo + **Insulated window** |
| R410A | 20 | 31.2 | 50% | | |

It is important to note that the HC-290 unit was able to meet the room setpoint at all conditions. For the tests were the R-410A unit couldn't meet the conditions – it showed significant variation over the laboratory test data. The difference is quite high between both units with exception for the last test in turbo speed with the units set at 20°C and both meeting the set temperature.

C: Overall performance of the unit and operation issues

The overall HC-290 unit was acceptable, and it operated as predicted. It should be noted though that future installations should consider a minimum ceiling clearance of 200 mm. This would allow for better air distributions. Future tests should consider the impact of supply louvers. While the installation manual provides proper guidance on the height of the unit with respected to the ceiling; it might not always be met depending on the position and design of the windows.

- Inverter technology is advisable to reduce the power output once the temperatures are met and avoid start – stop.
- It is important to perform real-life testing to showcase proper impact on operating cost and comfort. Current testing standards do not capture real-life conditions including lower room set point temperatures and varying outdoor conditions. The HC-290 unit worked well and is working in these conditions since at least 2 years!
- Tests with windows insulations showed that the units performed much better and both the R-410A and the HC-290 units were able to meet the room set point conditions.

R410A room

HC-290 room

*Figure 14: Insulation of windows with EPS foam*

Please note that:

- During operation of the compressor, because the units are w.o inverters, the peak power is constant in relation with the ambient temperature (external environment temperature).

The results showed what we already knew:

- Set temperature was reached,
- The number of stops of the units increased (i.e compressor off),
- Overall power consumption for the test duration decreased,
- The energy reduction consumption achieved is far more what you could achieve by increasing MEPS.

In table 4 we can already see that with the insulated windows we achieve app. a 10% reduction in energy consumption. This is of course not surprising as the balance of heat entering and therefore cooling capacity need is reduced, principle of reducing demand.

We also looked at how often the unit switched off (compressor stop) but ventilation continued.

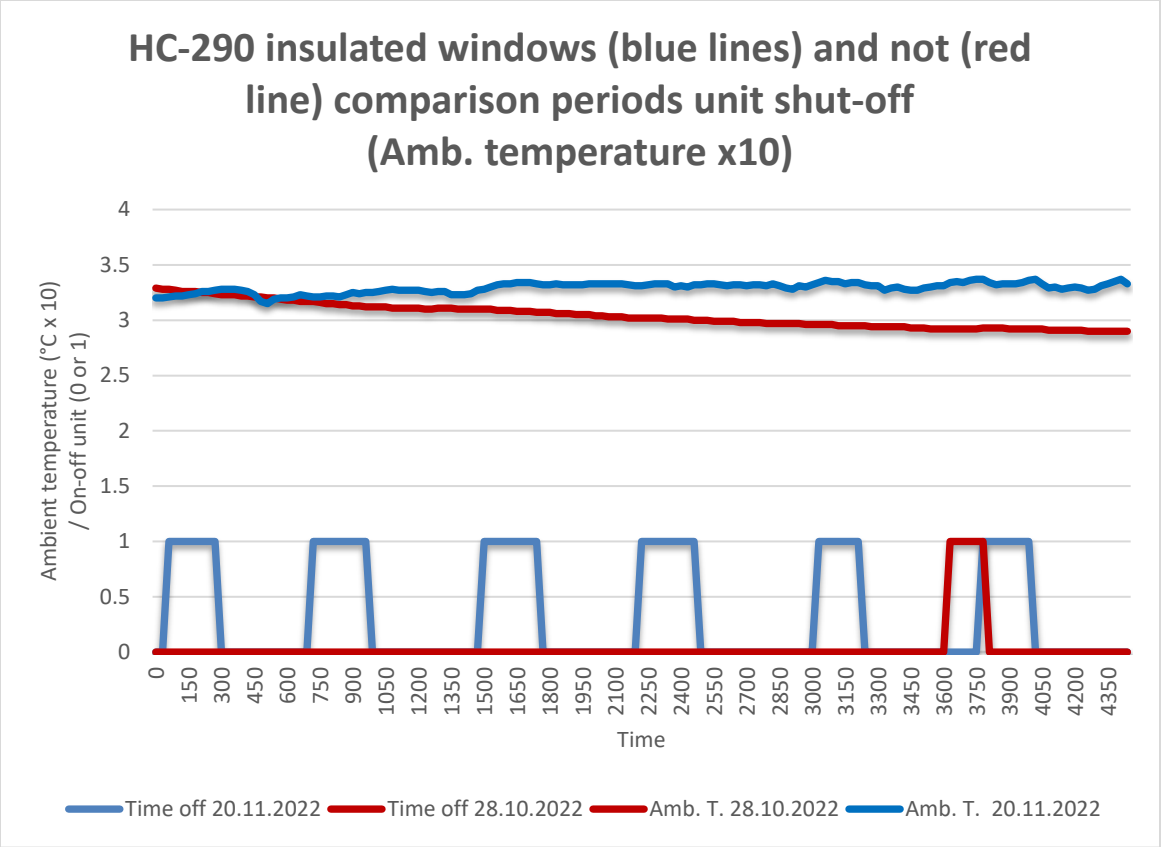



*Figure 15: Graph for HC-290, blue lines with insulated windows and red without insulation.*

The graph shows an interval in which the ambient temperature was equal. On top the ambient temperature (x10) which for both tests was around 30 to 35°C and on the bottom the on-off switching of the unit. We see that the set temperature for the insulated windows is reached more often, the time off sequences for the insulated window setup were 330x30 sec versus 299 for the not insulated situation. Power consumption reduced from 765 Wh to 596 Wh over the time duration of 6 hours test.

For R410A we see a similar situation but the difference in power consumption not insulated versus insulated is less 754 versus 719 Wh and less stops 199 versus 203. Overall power consumption reduction was only 2° although the mean temperature over the complete test period with the not insulated test was 28,5 versus 31,2°C for insulated windows. Overall the R410A unit underperformed under real-life high ambient temperatures conditions. This was also felt during inspection of the rooms in October 2021 and 2022.

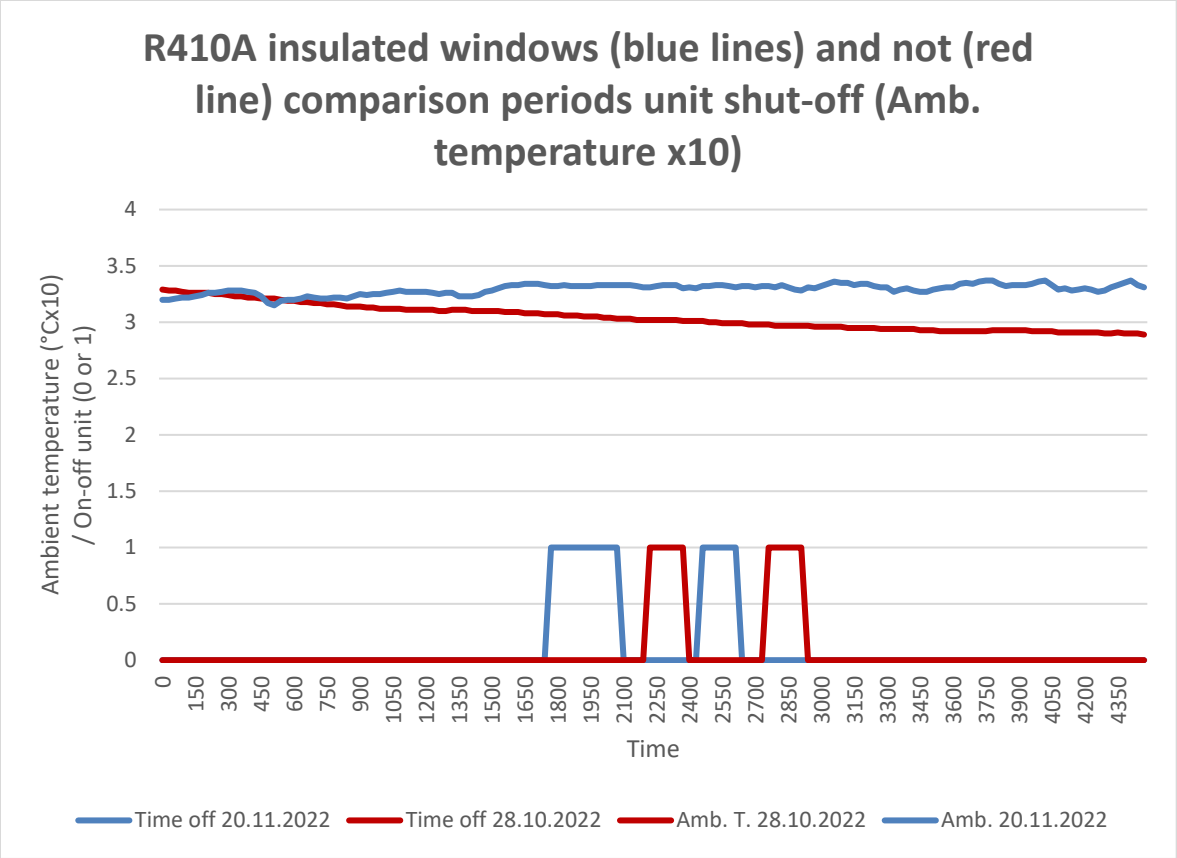



*Figure 16: R410A results comparison for insulated (blue lines) and not insulated test setup (red).*

The applied insulation was simple and the centre window was kept free to simulate an office space. Note also that the units should have been placed in a way that on top there is a free space of about 200-250 mm for a better intake of hot air. We knew this from the beginning but clear that this could be an actual installation in any real situation. The energy consumption for the set temperatures 16, 18 and 20°C reduced with higher room temperatures. This is not always evident compared to laboratory tests where the indoor room side is kept at 27°C so the unit always has to cool down a mass of air at a constant temperature of 27°C instead of a decreasing temperature in the real-life room.

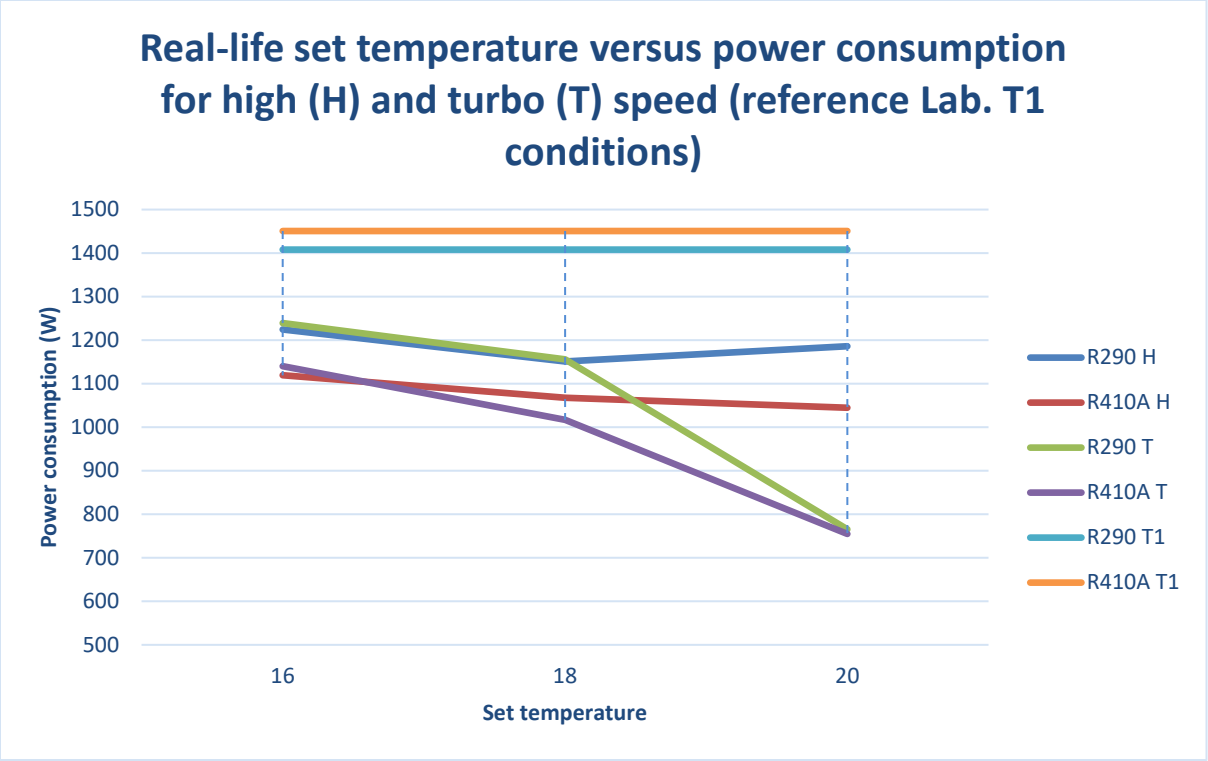



*Figure 17: Power consumption for real-life room set temperatures 16, 18, and 20°C.*

What we see here is the opposite of the graphs presented for the HAT investigation that with the increase of the outside temperature the power consumption increases. In our case with increase of the real-life temperature setting the power consumption decreases. This is also the main reason why in many countries the set temperatures for offices are increased for cooling or decreased in case of heating.

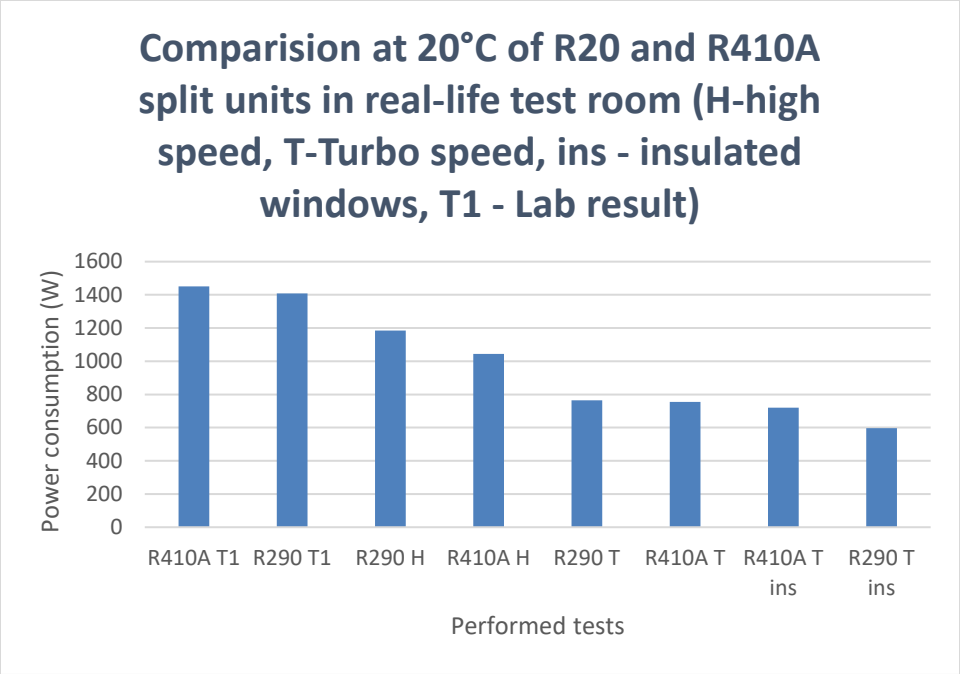



*Figure 18: Comparison real-life test room set temperature of 20°C of energy consumption.*

We see that the T1 lab tests energy consumption is by far higher than the real-life test room measured data. This is due that during the working of the split unit the temperature inside the room is reduced and therefore the heat load of the split unit is reduced. The reason is that the compressor power consumption is related to the heat load.

What we also notice that with operation of the unit in high speed mode (H) the power consumption is higher. The room was so badly insulated that the unit had to work at full power continuously to meet the set temperature.

In turbo mode (T) the units power consumption is lower as the unit regularly met the set temperature and the compressor switched off. Best result was achieved for HC-290 with insulated window whereby in the situation of turbo mode both units nearly performed equally. Although the EER of the HC-290 unit is better than the R410A but the cooling capacity of the R410A is 5% higher as already mentioned earlier.

We can read from the above that the room cooling demand is equal to what the units can provide in high speed mode. In real-life this means that properly dimensioning the unit according to the insulation and size of the room is vital for reducing the energy consumption. Secondly, with simple insulation measures power consumption can be reduced significantly.

Conclusions

- Both units worked well but the R410A unit had issues to meet the set temperatures when the outside temperature was above 30°C.
- Actually the HC-290 unit overperformed as the temperature in the room was up to 3°C lower than the set value.
- Best performance was reached with a room temperature of 20°C and actually for Europeans this is very cold but in KSA quite common.
- Energy reduction should aim at insulation instead of trying to push further MEPS of units.
- What we have also seen is that inverter units are strongly advisable, the on-off requires re-stabilization of temperatures and in the period that the compressor is off warm air is pushed inside the room.
- The laboratory testing for certification of MEPS is not corresponding with the real-life conditions, the indoor temperatures are fixed for T1 and T3 testing and in real-life the temperature is dropping due to the split unit cooling. Overall the energy consumption is considerable lower than T1 conditions.
- Proper dimensioning of the unit for the size and insulation of the room is important to avoid that the set temperatures are not reached or overall high energy consumption.
- Overall the real-life test room is an excellent place for testing, training and compare units.

## 8. Environmental assessment

MEPS provide a comparative behavior if the unit is 20% better in MEPS.

Looking at the unit we identify the following emission sources:

a) Workmanship and energy needed on the assembly lines,
b) Manufacturing of mainly metal parts the outdoor unit housing,
c) Indoor unit plastic housing,
d) Components making up the refrigeration system
    a. Compressor
    b. Condenser
    c. Evaporator
    d. Switch over valve
    e. Piping
e) Electrical components
f) Refrigerant

Ad a) The number of components, piping brazing and tests are the same. We could consider that the amount of refrigerant for a 410A unit is triple the HC-290.

Ad b) the R410A has more steel due to the larger size of the outdoor unit so overall the difference in kg has an impact on emissions for producing steel and transport. Steel can however be recycled to a high extent.

Ad 3) the same is valid for the indoor plastic parts.

Ad 4) for the components the discussion was always that the compressors would be more expensive for HC-290 units. From environmental impact this is secondary as the weight of metal and transport are driving the emissions. We will see differences in the evaporator and condenser as they are larger for the R410A units. In the case of the Alessa model the piping used for the HC-290 condenser is 5 mm wrt to 7 mm for the R410A. Length is shorter so overall a gain is achieved here. Switch over valves are practically the same as well as the piping.

Ad e) electrical components are the same, condenser for starting the compressor, cabling and electronic print plate.

Ad f) the refrigerant plays the major role as the GWP of HC-290 is 3 and R410A 2088 $CO_2$ eq/kg with the charge of 500 gr respectively 1500 grams the difference in $CO_2$ eq is 3130.

What also has to be considered are the emissions for producing the refrigerants and the more complex the molecule the higher the emissions! Secondly, during use a refill is more likely to occur and end of life disposal emissions are considerable higher for 410A. HC-290 can be used to produce thermal power and therefore at the end of the day closely reach net zero.

Overall the HC-290 unit is  lighter, less steel and the impact is considerable:

- Consider as reference an outdoor unit weight of 25 kg,
- Production capacity for Alessa is 300.000 units/year

This equals 7500 t of steel with a HC-290 unit about 10% less steel is used means a cost reduction of 750 t of steel. Emissions (steel low alloyed 2,3 kg $CO_2$ eq/kg) are then reduced by 1.725 T $CO_2$ eq.

A summary is in the following table where we have indicated the additional impact.

| | HC-290 | R410A |
|---|---|---|
| Compressor weight | = | = |
| Condenser difference | | 23% |
| Overall weight outdoor unit | | 10% |
| Overall weight indoor unit | | 13% |
| Charge (gr) | 500 | 1500 |
| GWP | 3 | 2.088,00 |
| GWP difference | | 3130,5 |
| Emissions for production of refrigerant | | higher |
| Workmanship assembly lines | = | = |
| Manufacturing metal parts | | 10% |
| Manufacturing plastic housing | | 13% |
| Electrical components | = | = |
| Transportation steel | | 750 t |
| Transportation indoor units | = | = |

*Tabel 1: summary environmental impact*

## 9. Management and monitoring

The Alessa product development team consisted of

- Procurement personnel,
- R&D engineers,
- Production engineers,
- Quality control, and
- Servicing technicians.

This team was supervised by the General Manager. The supply channels were established for HC-290 parts and the required indoor units with major manufacturers. Contacts with SASO to introduce the required certification of the new technology. The production team prepared the required modifications to the production line and heat exchanger testing facility. First steps in safety assessment were started from day 1 and continued with UNIDO international expert support. Changes in charging, testing and

production process was explained, understood, and implemented. A step-by-step manual of procedure was established.

Overall, the team was enthusiastic and fully supported by the new General Manager and proceeding with the project. With the follow-up visits the team established the required awareness and knowledge related to the HC-290 technology. The team built up the confidence in the technology, and related product development activities. The team is enthusiastic about HC-290 due to its competitive cost and significant improvement in performance compared with the baseline HCFC-22 technology.

Overall Alessa had been hit by the Covid-19 and also the economy overall. The production is only now. Mid of 2022 picking up the rates of before Covid-19.

### Co-financing Alessa

Alessa actively participated in the project with man-power, use of laboratories, plant engineering preparing the site and providing all utilities and installation of a new production line. Alessa did not account factory space costs for the new production line as well as civil works costs.

The project supported the financial costs for the equipment, training, installation and commissioning. Alessa contributed with the support of plant engineering, laboratory testing and personnel further to consumables and utilities outside the scope of the project:

1- human resources allocated: 150,000 $ (est.)
2- labs and facility: 100,000 $ (est.)
3- Consumables and utilities: 50,000 $ (est.)

The plant engineering supported significantly through their engineering department but also internal electricians, mechanical engineers and maintenance crew. Further to all kinds of steel manufacturing activities for support structures and extension of the storage area of the HC-290 tanks.

## 10. Project implementation

Despite delays in the start-up of project implementation due to factory internal reorganisation, difficulties in obtaining visas for the international experts, Covid-19 the project objectives where achieved. The good cooperation with Alessa and (PME) NCEC simplified the work. Project operationally completed.

## 11. Future outlook HC-290 units

The units have been certified and meet the Saudi Arabia MEPS, design is finalised, BOM for procurement is ready and the production line ready to produce. The production capacity of the units has a cycle time of 1 min which means for three shifts of 8 hour and 250 working days and 10% off-time more than 300.000 units/year.

The already build 50 units can be used for the different training centres (TVTO's) which programs are being implemented under the UNEP components. Also the two additional units planned for complementary third party testing by the TüV, unhappily due lack of time we could not proceed, are going to be placed in the training facility in Riyadh.

In February a dedicated master training will be held with these units for flammable refrigerants in addition to the on-going good practices training.

NCEC has clarified with SASO any restrictions for placement on the market and meetings are on-going between NCEC and Alessa refrigeration for promoting the placement on the market of the units.

## 12. Financial status

Project operationally completed.

| Fund approved USD | Disbursed USD | Available USD* |
|---|---|---|
| 1,300,000 | 1,188,813 | 111,187 |

- *Not financially completed.

## 13. Conclusions

The covid-19 had quite an impact and although delays occurred the Alessa team continued and finalised together with UNIDO and PME/ CNEC the project.

UNIDO and its international experts worked with Alessa to develop an optimized fully functional prototype HC-290 mini-split AC unit with a capacity of 18 kBtu (5.37 kW). This units employs an optimized 5 mm IGT condenser; no further condenser optimization are needed. This unit has exceeded the local MEPS requirements and produced EER of 12.5 at T1 conditions and 9.36 at T3 conditions.

The developed mini-split HC-290 unit is fully compliant with SASO requirements and received the G-mark certification and is ready for production and placement on the market.

With the real-life test room we also had the opportunity to verify the units working under real conditions. We saw that the MEPS certifications are a good indicator for the overall energy performance but the reality is quite different once installed. The impact of overall housing insulation could be further investigated as this will be the major contributor to rising energy consumption.

Overall, the environmental impact of a HC-290 unit is considerable lower, not so much with regard to energy consumption as this is completely related to the actual installation, but moreover due to the used refrigerants and materials.

The units are ready for mass production and placement on the market.

# Appendices Detailed Condenser Design Document

**Executive Summary**

Alessa AC manufacturing company is currently working with UNIDO on a refrigerant conversion project to develop a line of 1.5 RT (18,000 Btu/hr) heat pump operating with propane as a working fluid. Alessa was able to develop a working prototype that meets the current Standards in KSA (EER = 11.8 at T1 conditions and EER greater than or equal to 8.3 at T3 conditions). The current prototype has an optimum refrigerant charge of 500 g.

After reviewing the detailed test results of the prototype; it was clear that the condenser has a significant pressure drop, 20.8 psi (143.4 kPa). This pressure drop corresponds to a saturation temperature difference of 8.13°F (4.52°C). Hence, it was important to redesign the condenser and identify potential means to reduce the pressure drop in order to optimize the unit performance.

After careful design and optimization, it was identified that there is no need for a separate subcooling circuit and that a simple circuit design of dividing the coil into 6 identical circuits each with 18 tubes (6 tubes per row) would achieve the required performance and result in less than 1.8°F (1°C) saturation temperature drop. The overall system performance is expected to improve by 1.4%.

**Introduction**

Alessa AC manufacturing company finished working with UNIDO on a refrigerant conversion project to develop a line of 1.5 RT (18,000 Btu/hr) heat pumps operating with propane as a working fluid. This project involves conversion of their production line and performance test facility in order to enable the use of flammable refrigerant. Furthermore, the project includes support for the design and optimization of the vapor compression system operating with propane. One of the main challenges when working with flammable refrigerant is to meet the national and international safety standards related to allowable refrigerant charge. As such, Alessa worked on developing high performance condenser using 5-mm internally grooved tubes. This technology has a great potential to reduce the refrigerant charge and enhance the refrigerant side heat transfer.

The current AC standards in KSA require that the AC equipment achieve EER of 11.9 or greater at T1 conditions and 8.3 or greater at T3 conditions. As such, UNIDO consultants worked on sourcing high performance 60 Hz Propane compressor prototypes that can achieve this level of performance. GMCC provided sample compressors and Alessa built a prototype condenser based on UNIDO's consultant design. The prototype system was able to meet the current minimum efficiency performance standards in KSA.

In this report, we detail the analysis and suggested design modifications to improve the overall system performance by further design optimization of the condenser. Design optimization was done using the

validated CoilDesigner® heat exchanger simulation tool and VapCyc® vapor compression system simulation tool.

**Prototype Performance Analysis**

The current prototype developed by Alessa components are summarized in Table 4 below.

*Table 5: Prototype HC-290 Heat Pump components*

| | |
|---|---|
| Outdoor Chassis | Alessa 18 kBTU, 230 VAC, 60 Hz |
| Compressor | prototype GMCC propane compressor DSG280N1VKT S# 906000002K |
| Condenser | 3 rows (2.5 coil), 5 mm, IGT, 6 ckt., 36 tubes per row, 18 FPI, 1 row (375 mm x 705 mm) & 2 rows (818 mm x 705 mm) L-bend |
| Condenser fan motor | DC, 1000 rpm |
| Capillary | 0.064" x 40" x 2# |
| Indoor Unit | Outsourced |
| Evaporator | 2 rows, 7 mm, IGT, 4 ckt., 18 FPI (gold fins), 760 mm x 340 mm |
| Evaporator fan motor | DC, multi-speed |

The test results for the prototype are summarized in Table 5. It can be shown that the performance is quite repeatable (T1 and T1 repeat have almost similar performance; the indoor air flow rate is a little smaller in T1 repeat which resulted in 5% higher latent capacity – however the total cooling capacity and EER were within less than ±0.5% of the original test).

NIST REFPROP[5] was used to perform careful analysis on the saturated refrigerant temperature, pressure, and enthalpy at the different points within the cycle in order to evaluate the evaporator superheat, suction superheat, condenser subcooling, and the condenser and evaporator saturated temperature pressure drop.

The results show that the condenser and evaporator both resulted in significant refrigerant side pressure drop. Alessa use TCL indoor unit and don't have the facility to manufacture the evaporator. Hence, it is less likely to be able to optimize the evaporator. However, they fabricated the condenser prototype and intend the fabricate the 5 mm IGT condenser at their facility. Hence it would be beneficial to optimize the design of the condenser to minimize the pressure drop while maintaining the capacity. This would result in reduce compressor discharge pressure and overall EER improvement.

[5] Lemmon, E.W., Bell, I.H., Huber, M.L., McLinden, M.O. NIST Standard Reference Database 23: Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology, Standard Reference Data Program, Gaithersburg, 2018.

*Table 6: Performance Results and Analysis Summary*

| Test Condition (ISO 5151) | | T1 | T3 | H1 | Max, 90% | Max 110% | T1 repeat |
|---|---|---|---|---|---|---|---|
| Evaporator inlet T | °C | 13.06 | 16.28 | 35.83 | 20.39 | 20.06 | 12.56 |
| Evaporator outlet T | °C | 13.28 | 11.06 | 44.00 | 19.11 | 18.72 | 13.89 |
| Condenser inlet T | °C | 61.78 | 68.61 | -0.39 | 79.50 | 79.61 | 61.28 |
| Condenser outlet T | °C | 34.61 | 45.22 | 6.61 | 48.72 | 51.33 | 36.00 |
| Compressor discharge T | °C | 61.33 | 68.22 | 47.33 | 79.44 | 79.72 | 63.33 |
| Compressor suction T | °C | 17.11 | 14.17 | -0.89 | 23.50 | 22.67 | 15.78 |
| Compressor bottom T | °C | 57.83 | 66.28 | 45.06 | 76.50 | 76.44 | 59.50 |
| Compressor top T | °C | 63.83 | 70.56 | 50.28 | 81.78 | 81.94 | 62.61 |
| Compressor discharge P | kPa | 1547.15 | 1959.35 | 1386.05 | 2207.08 | 2204.91 | 1530.96 |
| Compressor suction P | kPa | 574.99 | 613.50 | 442.84 | 678.51 | 668.07 | 575.35 |
| Liquid P | kPa | 1403.74 | 1814.56 | 868.25 | 2014.02 | 2015.99 | 1375.83 |
| Indoor air flow | $m^3$/hr | 1000.72 | 1025.18 | 1100.62 | | | 977.27 |
| Sensible capacity | kW | 4.12 | 4.51 | | | | 4.05 |
| Sensible heating | kW | 0.00 | 0.00 | 4.83 | | | 0.00 |
| Latent capacity | kW | 1.21 | 0.31 | | | | 1.28 |
| Cooling capacity | kW | 5.33 | 4.82 | | | | 5.33 |
| Heating capacity | kW | 0.00 | 0.00 | 4.83 | | | 0.00 |
| EER | Btu/W | 12.135 | 9.38 | | | | 12.186 |
| COP | W/W | 3.56 | 2.75 | 3.40 | | | 3.57 |
| test unit power | W | 1499.10 | 1754.80 | 1421.60 | 1926.50 | 1960.00 | 1491.90 |
| test unit current | A | 6.70 | 7.80 | 6.30 | 9.40 | 7.90 | 6.60 |
| test unit power factor | % | 0.98 | 0.98 | 0.98 | 0.99 | 0.98 | 0.98 |
| | | | | | | | |
| Suction saturation T | °C | 6.78 | 9.02 | -1.85 | 12.56 | 12.01 | 6.74 |
| Evaporator superheat | K | 6.50 | 2.03 | 1.46 | 6.55 | 6.71 | 7.15 |
| Suction superheat | K | 10.33 | 5.15 | 0.96 | 10.94 | 10.66 | 9.04 |
| Liquid saturation T | C | 41.25 | 52.81 | | 57.73 | 57.78 | 40.34 |
| Subcooling | K | 6.64 | 7.58 | | 9.00 | 6.44 | 4.34 |
| Condenser ΔP | kPa | 143.41 | 144.79 | | 193.05 | 188.92 | 155.13 |
| Evaporator inlet P (Psat@$T_{evap,\ in}$) | kPa | 693.44 | 757.35 | | 845.06 | 837.68 | 683.89 |
| evaporator ΔP | kPa | 118.46 | 143.86 | | 166.55 | 169.62 | 108.55 |
| | | | | | | | |
| Calculated refrigerant flow rate | kg/h | 63.50 | 65.25 | | | | 64.05 |
| | | | | | | | |
| ΔT sat Condenser | K | 4.30 | 3.62 | | 4.44 | 4.35 | 4.70 |
| ΔT sat Evaporator | K | 6.60 | 7.58 | | 8.12 | 8.34 | 6.08 |

**Analysis**

In order to study the impact of condenser optimization, a condenser model based on the current circuit was developed by expert using specialized software. The condenser model was validated against the performance test data and showed good agreement. Furthermore, a model for the TCL evaporator was also developed in the same programme. Finally, a complete vapor compression system was modeled. The system was made of a generic compressor for both the condenser and the evaporator and the system was solved for a given subcooling and superheat degrees. The lack of compressor details required calibrating the generic compressor in order to identify an equivalent displacement volume, volumetric efficiency, and isentropic efficiency. Finally, the model results were compared with the prototype performance results at T1 and T3. Next, the condenser circuit was modified by eliminating the subcooling section and simplifying the circuit to be 6 identical circuits, and the system was modeled in the programme.

**Results**

The baseline condenser design is shown in Figure 19. The measured performance of the condenser based on the T1 data show that the condenser has a capacity of 6425.5 W, a pressure drop of 143.41 kPa, and a subcooling of 6.64 K. the modeling results from CoilDesigner® showed a capacity of 6400.2 W, a pressure drop of 101.9 kPa, and a subcooling of -7.45 K. These results showed good agreement with the test results except for the refrigerant side pressure drop. This might be due to the inaccurate modeling of pressure drop in U-bends or the connection between the 6 circuits and the subcooler section. Furthermore, Figure 19 indicate that the capacity of the last tube of each circuit and that of the entire subcooler are negligible. The detailed results showed that the pressure drop per circuit is roughly 15.544 kPa and the pressure drop in the subcooler is 82.5 kPa. Hence, it is clear that eliminating the subcooler would greatly improve the performance.

Next, the VapCyc® model was developed as shown in Figure 20. The modeling results showed an EER of 12.155 Btu/W, Cooling capacity of 5.325 kW, and Power of 1494.757 W; these are less than ±0.3% of the measured value. This suggests that the VapCyc® Model is accurate for the evaluation of the modified condenser design.

A new condenser circuit was developed using 36 tubes per row, 3 rows, and 6 circuits. All circuits were identical; 18 tubes per circuit, 6 tubes per row as shown in Figure 21. The modeling results showed a capacity of 6403.3 W, a pressure drop of 17.4 kPa, and a subcooling of -10 K.

This condenser was replaced the original CoilDesigner® coil in VapCyc®. The modeling results showed an EER of 12.322 Btu/W, Cooling capacity of 5.27 kW, and Power of 1459.052 W. This means that by optimizing the condenser circuit, we can improve the EER by 1.4%; however, the system capacity was slightly reduced by 1%.

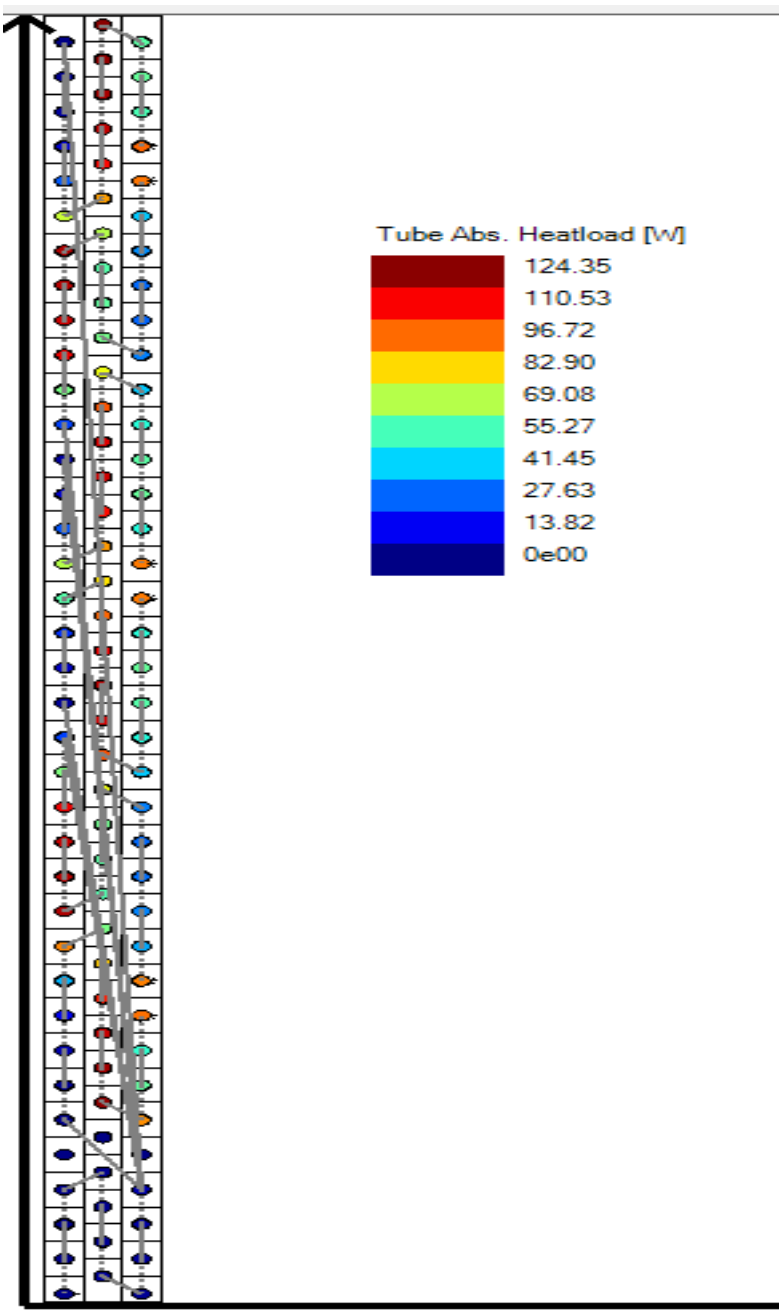



*Figure 19: Baseline condenser circuit, tubes colored by the heat load modeled using CoilDesigner®.*

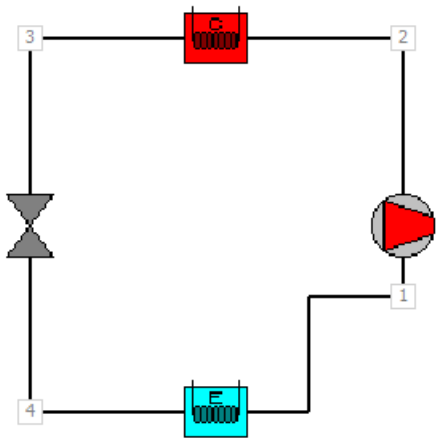
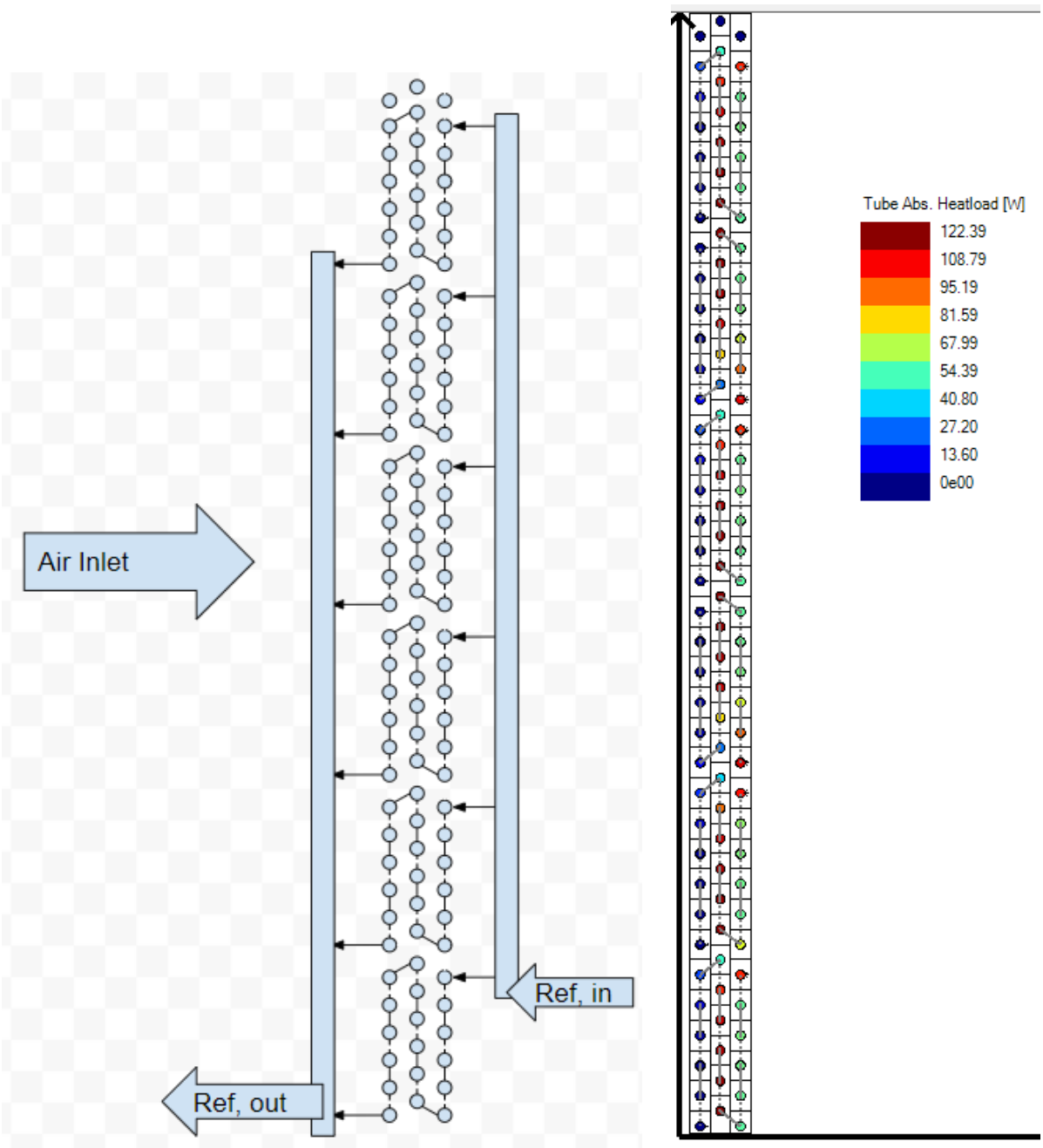



*Figure 20: Baseline vapor compression system model using VapCyc®.*




(a) (b)

*Figure 21: (a) Simplified condenser circuit design, (b) tubes colored by the heat load modeled using CoilDesigner®.*

**Conclusions**

A simplified condenser circuit was proposed and evaluated using validated heat exchanger and system simulation tools. It was found that the proposed 6 circuit condenser with no subcooler can enhance the EER by 1.4% with minimal impact on capacity.

**Prototype Compressor Performance**

Prototype compressors provided by the OEM had the performance as shown below in Table 6 under the test conditions shown in Table 7.

*Table 7. Prototype compressors performance*

| Model | Series No. | Capacity W | Input W | COP | Condition |
|---|---|---|---|---|---|
| DSG280N1VKT | 906000001K | 5810 | 1306.9 | 4.44 | GX/230V/60Hz/40µF |
| | 906000002K | 5796.8 | 1302.1 | 4.45 | |
| | 906000003K | 5817.3 | 1302.5 | 4.46 | |

*Table 8. Test conditions for the prototype compressors*

| Parameter | Value |
|---|---|
| Condensing Temperature, °C | 46 |
| Liquid Temperature, °C | 41 |
| Evaporating Temperature, °C | 10 |
| Suction Temperature, °C | 18 |
| Ambient Temperature, °C | 35 |

**Sample Detailed Report for Experimental Testing add last version**

| | | | |
|---|---|---|---|
| Alessa العيسى | نماذج الجودة<br>مختبر شركة العيسى | الإصدار تاريخ :<br>14/11/2017 | مراجعة :<br>3 |
| | اسم الوثيقة :<br>تقرير اختبار مختبر سيكرومتري | رقم الوثيقة :<br>QFORM-510-01 | صفحة رقم:<br>1من 1 |

**PO BOX 20409, RIYADH-11455, KSA**

ص .ب 20409 الرمز البريدي 11455 الرياض – المملكة العربية السعودية

## PSYCHROMETRIC LABORATORY TEST REPORT تقرير اختبار مختبر سيكرومتري

| | | | | | |
|---|---|---|---|---|---|
| Receipt Date تاريخ الاستلام | : 23-Jul-18 | | Test Request Application Form # نموذج طلب الإحالة | : 5289 | |
| Customer Name اسم العميل | : LEO P. PAREDES | | Test Report # تقرير الاختبار | : 1C0537/18 | |
| Address العنوان | : PO Box 20409, Riyadh - 11455, KSA | | Testing Date تاريخ الاختبار | : 23-Jul-18 | |
| Contact Number رقم الاتصال | : -- | | Test Room # غرفة الاختبار | : TR1 (Lab 1) | |

### NAMEPLATE RATINGS معلومات لوحة البيانات

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Test Standard مواصفة الاختبار | : ISO 5151 / Cooling Capacity @ T3 | Voltage الجهد | : 230 | V فولت | Capacity السعة | : | BTU/Hr وح.ب/ س |
| Brand العلامة التجارية | : GODREJ | Frequency تردد | : 50 | Hz هرتز | EER/COP نسبة كفاءة الطاقة / معامل الأداء | : | BTU/W-Hr وح.ب/واط - س |
| Model الموديل | : GSC 18 FG 6 BOG | Phase الطور | : 1 | | Power القدرة | : | Watts واط |
| Serial Number الرقم التسلسلي | : ODU - 170700052SA00027 / IDU - 170700052SA00023 | Refr. Charge كمية الغاز | : 375 | grams جرامات | Current التيار | : | A أمبير |
| Manufactured By تم التصنيع بواسطة | : Alessa for Refrigeration and Air Conditioning Co. | Refr. Type نوع الغاز | : R290 | | Annual Energy Consumption الاستهلاك السنوي | : | KW-H/Yr ك.واط – س / عام |

### TEST CONDITIONS ظروف الاختبار

| Settings Parameters إعدادات المتغيرات | | Set Point نقطة الضبط | | Actual الفعلي | | Error الخطأ | Tolerance التسامح |
|---|---|---|---|---|---|---|---|
| Indoor Dry Bulb Temperature درجة حرارة الهواء الداخلية الجافة | : | 84.2 | °F ف° | 84.19 | °F ف° | ### °F ف° | +/- 0.5°F ف° |
| Indoor Wet Bulb Temperature درجة حرارة الهواء الداخلية الرطبة | : | 66.2 | °F ف° | 66.19 | °F ف° | ### °F ف° | +/- 0.3°F ف° |
| Outdoor Dry Bulb Temperature درجة حرارة الهواء الخارجية الجافة | : | 114.8 | °F ف° | 114.83 | °F ف° | ### °F ف° | +/- 0.5°F ف° |
| Outdoor Wet Bulb Temperature درجة حرارة الهواء الخارجية الرطبة | : | 75.2 | °F ف° | 75.25 | °F ف° | ### °F ف° | +/- 0.3°F ف° |

### TEST RESULTS نتائج الاختبار

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Test Duration مدة الاختبار | : 3 | Hrs ساعة | | Evaporator Temp In درجة حرارة المبخر الداخلة | : 57.7 | °F ف° |
| Power Supply Frequency تردد المنبع أو مصدر الطاقة | : 50.0 | Hz هرتز | | Evaporator Temp Out درجة حرارة المبخر الخارجة | : 54.8 | °F ف° |
| Test Unit Supply Voltage الجهد المُسلط على الوحدة من المصدر | : 230.4 | Volt فولت | | Condenser Temp. In درجة حرارة المكثف الداخلة | : 164.8 | °F ف° |
| Outdoor Entering Humidity الرطوبة الداخلي بالوحدة الخارجية | : 13.20 | % | | Condenser Temp. Out درجة حرارة المكثف الخارجة | : 124.0 | °F ف° |
| Subcooling التبريد الفرعي | : - | °F ف° | | Compressor Discharge Temp. درجة حرارة تفريغ المناعة | : 164.4 | °F ف° |
| Superheat التسخين الشديد أو الفائق | : - | °F ف° | | Compressor Suction Temp. درجة حرارة سحب المناعة | : 63.9 | °F ف° |
| Indoor Static Pressure الضغط الاستاتيكي الداخلي | : 0.000 | inH2O في H2O | | Compressor Bottom Temp. درجة حرارة المناعة السفلية | : 142.9 | °F ف° |
| Fan Motor Speed ID سرعة الموتور الداخلية | : - | rpm لفه بالدقيقة | | Compressor Top Temp. درجة حرارة المناعة العلوية | : 142.8 | °F ف° |
| Fan Motor Speed OD سرعة الموتور الخارجية | : - | rpm لفه بالدقيقة | | Compr. Discharge Pressure ضغط تفريغ المناعة | : 293.0 | $PSI_g$ |
| Barometric Pressure الضغط البارومتري | : 27.78 | inHg زئبقي | | Compr. Suction pressure ضغط سحب المناعة | : 76.9 | $PSI_g$ |
| Indoor Air Leaving DB الهواء الخارج الجاف | : 58.58 | °F ف° | | Indoor Air Flow سريان الهواء للوحدة الداخلية | : 481.4 | $ft^3/min$ قدم مكعب / د |
| Indoor Air Leaving WB الهواء الخارج الرطب | : 56.65 | °F ف° | | Sensible Capacity السعة المحسوسة | : 12541.0 | BTU/Hr وح ب/س |
| Moisture removal إزالة الرطوبة | : 0.020 | lb/min باوند بالدقيقة | | Latent Capacity السعة الكامنة | : 1336.5 | BTU/Hr وح ب/س |
| Ratio Rated Cooling Capacity معدل سعة التبريد المقنن | : !WERT# | % | | Cooling Capacity سعة التبريد | : 13877.5 | BTU/Hr وح ب/س |
| Ratio Rated Heating Capacity معدل قدرة التدفئة المقنن | : | % | | Heating Capacity قدرة التدفئة | : | W واط |
| Ratio Rated EER نسبة كفاءة استهلاك الطاقة EER | : !WERT# | % | | EER نسبة كفاءة الطاقة EER | : !WERT# | BTU/W-Hr و ح ب/ واط- س |
| Ratio Rated COP معدل معامل الكفاءة المقنن COP | : | % | | COP معامل الأداء COP | : | W/W واط / واط |
| Ratio Rated Power معدل القدرة المقنن | : | % | | Test Unit Power قدرة الاختبار للوحدة | : 1707.9 | Watts واط |
| Ratio Rated Current معدل التيار المقنن | : | % | | Test Unit Current تيار الاختبار للوحدة | : 7.5 | A أمبير |
| Annual Energy Consumption استهلاك الطاقة السنوي | : | KW-H/Yr ك واط / العام | | Test Unit Power Factor معامل القدرة للوحدة المختبرة | : 0.988 | % |

Remarks ملاحظات ☐ PASSED نجحت ☒ FAILED فشلت

Tested @ Turbo Speed

| Tested By تم الاختبار بواسطة: | Reviewed by تمت المراجعة بواسطة: | Approved by تمت الموافقة بواسطة: |
|---|---|---|
| K. Raju Shajil<br>Lab. Operator / Technician<br>مشغل مختبر / تقني | Neil D. Landicho<br>Lab. Test Engineer<br>مهندس الاختبار | Turki Alanzi<br>Lab. Technical Manager<br>المدير الفني للمختبر | Mayeen Ghouri<br>Lab. Manager<br>مدير المختبر |

## Appendices - Installation report ( ALESSA)

# Production line

Pressure strength testing- ProHe I – no comments

| Pressure Strength Testing – ProbHe I | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | 1 machines, with display mounted on the machine<br>GTP: the display should be remoted |
| Machine number: | Code No. : 1.008.1.001<br>Model No. : PROBHE<br>S.N. : 31L0090<br>Rev. Software 3.08 – Rev. Firmware 3.10 – IP: 192.168.0.34 – MAC Address: 64:33:31:4C:00:58 |
| Open points: | Installation COMPLETED – with Testing & Commissioning No open points |
| Machine working: | MACHINE WORKING OK |
| Items to be replaced or repaired: | Replaced /increased length of power Cable by additional 1 mtr. Long. Replaced /increased length of hose for the discharge pipe by 1mtr. Long.<br>Fixed additional clamps & brackets or all pipes line 1 mtr. Distance clamps. |
| Training received: | Training received by Alessa Team – QC. - Production, - PE- Maintenance – 16 ~ 20 Hrs Training |

| | |
|---|---|
| | |
| Documentation: | Documents / Manuals Received ( Hard & Soft Copy) |
| Components missing: | Nothing missing |
| Other comments: | The machine has been programmed to perform the gross leak test with Nitrogen and works correctly; the machine is connected to the Nitrogen booster pump.<br>No comment |

Vacuum NK –

| Vacuum and Vacuum Decay Measurement _ VACUUM NK | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | 3 nos. |
| Machine number: | Code No. : 4.003.0.032 DK VACUUM<br>Model No. :<br>S.N. : 73K0018 / 73K0017 / 73K0019<br>S/N 73K0017 – Rev. Firmware 04 – IP: 192.168.0.37 – MAC Address: 64:37:33:4B:00:11<br>S/N 73K0018 – Rev. Firmware 04 – IP: 192.168.0.36 – MAC Address: 64:37:33:4B:00:12 |

| | |
|---|---|
| | S/N 73K0019 – Rev. Firmware 04 – IP: 192.168.0.38 – MAC Address: 64:37:33:4B:00:13 |
| Open points: | No open points … but we are planning to shift the machine near to main conveyor to reduce the length of vacuum hose. |
| Machine working: | MACHINE WORKING OK |
| Items to be replaced or repaired: | Replaced /increased length of power Cable by additional 1 mtr. Long. Replaced /increased length of hose for the discharge pipe by 1mtr. Long |
| Training received: | Training received by Alessa Team – QC, Production, PE- Maintenance – 16 ~ 20 Hrs Training |
| Documentation: | Documents / Manuals Received |
| Components missing: | Nothing missing |
| Other comments: | Machine installed programmed and tested with some units … No Comment |

Helium Leakage testing- PROBHe – no comments

| Helium Leakage Testing – PROBHe II | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | 2 machines with Display unit |
| Machine number: | Code No. : 4.008.1.001<br>Model No. : PROBHE<br>S.N. : 31L0090 / 31L0089<br>S/N 31L0090 – Rev. Software 3.08 – Rev. Firmware 3.10 – IP: 192.168.0.35 – MAC Address: 64:33:31:4C:00:5A<br>S/N 31L0089 – Rev. Software 3.08 – Rev. Firmware 3.10 – IP: 192.168.0.33 – MAC Address: 64:33:31:4C:00:59 |
| Open points: | Nothing… all OK |
| Machine working: | MACHINE WORKING OK |
| Items to be replaced or repaired: | Replaced /increased length of power Cable by additional 1 mtr. Long. Replaced /increased length of hose for the discharge pipe by 1mtr. Long<br>Fixed additional clamps & brackets or all pipes line 1 mtr. Distance clamps |
| Training received: | Training received by Alessa Team – QC, Production, PE- Maintenance – 16 ~ 20 Hrs Training |
| Documentation: | Documents / Manuals Received |
| Components missing: | Nothing missing |

| | |
|---|---|
| Other comments: | No comment , Machine installed and programmed to perform helium leak test and working OK. Also connected to the recovery system. |

Helium leakage tester – Protec 3000 -

| Helium Leakage Tester – Protec 3000 | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | 2 machines |
| Machine number: | INFICON – 520 – 001 – Protec P3000<br>Serial No. 90001339726 / S/N . 90001339725 . |
| Open points: | Improve the pedestal / stand to avoid falling down … during production this machine need to be powered thru UPS for the safety of the device. ( to be done by Alessa team) |
| Machine working: | MACHINE WORKING OK |
| Items to be replaced or repaired: | Nothing |
| Training received: | Training received by Alessa Team – QC, Production, PE- Maintenance – 16 ~ 20 Hrs Training |
| Documentation: | Documents / Manuals Received |
| Components missing: | Nothing missing |

| | |
|---|---|
| Other comments: | No comment |

Refrigerant charging – Kion M11 – No comments

| Refrigerant Charging – Kion M11 | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | 1 machine |
| Machine number: | Code No. : 4.001.1.005<br>Model No. : KION M 11<br>S.N. : 19L0021<br>S/N 19L0021 - Rev. Software 3.9 – Rev. Firmware 3.10 – IP: 192.168.0.31 – MAC Address: 64:31:39:4C:00:15 |
| Open points: | To provide light indicator in the charging area for the operator to aware if the GAS cylinder tank is empty.<br>( to be done by our team) |
| Machine working: | MACHINE Calibrated and WORKING OK |
| Items to be replaced or repaired: | Nothing |
| Training received: | Training received by Alessa Team – QC, Production, PE- Maintenance – 16 ~ 20 Hrs Training |
| Documentation: | Documents / Manuals Received |

| | |
|---|---|
| Components missing: | Nothing missing |
| Other comments: | Machine run and charge 15 outdoor units with charging time 30~35 sec./ unit by prod. & QC. No Comment .. Machine running OK<br><br>The charging machine is connected to the refrigerant supply system which is composed by nr. 1 transfer pump mod. RP4, one HCDS-02 unit and one SYNC + TAF Atex (tank exchange) system. The machine has performed a few tests by charging in bottle to verify the accuracy and the accuracy is in accordance to the technical specifications. One unit of the customer has been charged correctly |

Ultrasonic welder UWM –

| Ultrasonic Welder - UWM | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | 1 machines |
| Machine number: | Code No. : 3.501.0.259<br>Model No. : UWM EX<br>S.N. : 77L0008 |
| Open points: | Machine Working …. But need to change the Push button switch. As it not working properly<br><br>GTP: we will provide the replacement push buttons under warranty. Our OA will follow asap. |
| Machine working: | Machine Working …. But need to change the Push button switch. As it not working properly. |

| | |
|---|---|
| Items to be replaced or repaired: | To replace the defective push button switch. |
| Training received: | Training received |
| Documentation: | Documents / Manuals Received |
| Components missing: | Nothing |
| Other comments: | waiting instruction from Galileo |

Leak testing after charging – Ecotec E3000

| Leak Testing after charging – Ecotec 3000 | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | 2 machines |
| Machine number: | 530 – 001 – Inficon Ecotec E3000<br>Serial No. 90001341355 / 90001342250 |
| Open points: | Improve the pedestal / stand to avoid falling down … during production this machine to be powered thru UPS for the safety of the device, to be done by Alessa.<br>GTP A new calibrated leak should be sent |

| | |
|---|---|
| | GTP: we will provide under warranty a new calibrated leak with a higher value in order to have a better calibration of the instrument (5 g/y). Our O/A will follow shortly. |
| Machine working: | MACHINE WORKING OK |
| Items to be replaced or repaired: | Replaced /increased length of power Cable by additional 1 mtr. Long. |
| Training received: | Training received by Alessa Team – QC, Production, PE- Maintenance – 16 ~ 20 Hrs Training |
| Documentation: | Documents / Manuals Received |
| Components missing: | Nothing missing |
| Other comments: | The calibrated leak for HC-290 GCL-R (code 30050015 – s/n 30050236) gives the value of 0,99 g/y which is different compared to the one indicated on the label (i.e. 1,66 g/y); GTP will provide a new calibrated leak with a higher value in order to have a better calibration of the instrument (5 g/y). |

Electrical testing - Elektron

| Electrical Testing - ELEKTRON | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | 1 machines |

| | |
|---|---|
| Machine number: | Code No. : 4.501.0.003<br>Model No. : ELEKTRON<br>S.N. : 41L0052<br>S/N 41K0052 – SGP 3.04 rev fw 1.17 - ETEST 004 rev fw 1.06 – IP: 192.168.0.39 – MAC Address: 64:34:31:4C:00:34 |
| Open points: | To change power socket to suit with calibration box ( requirement by Alessa) … TO BE DONE BY OUR TEAM |
| Machine working: | Machine calibrated and working OK |
| Items to be replaced or repaired: | Nothing repaired / replaced. |
| Training received: | Training received by Alessa Team – QC, Production, PE- Maintenance – 16 ~ 20 Hrs Training |
| Documentation: | Documents / Manuals Received |
| Components missing: | Nothing missing |
| Other comments: | Machine run and tested 15 outdoor units by Prod. & QC.<br>Ground Test : Earth continuity test < 200m΄Ω & Di Electric strength test: 10Ma.<br>Insulation Test : 5 Ma<br>No Comment.. Machine running OK |

Performance testing – CAPTOR K

Performance Testing – Captor K

| | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | 4 machines |
| Machine number: | CAPTOR #1 - Serial No. 04260121 – Inside Performance Room<br>CAPTOR #2 - Serial No. 04260090 – Inside Performance Room CAPTOR # 3 - Serial No. 04260126 – Inside Performance Room CAPTOR#4 - Serial No. 04260142— For spare/Backup.<br>Hostname: [1001] IP: 11.0.1.1 MAC Address: 00:40:9D:66:55:BD<br>Hostname: [1002] IP: 11.0.1.2 MAC Address: 00:40:9D:66:18:74<br>Hostname: [1003] IP: 11.0.1.3 MAC Address: 00:40:9D:92:A5:7D |
| Open points: | Nothing |
| Machine working: | Machine configured and working OK |
| Items to be replaced or repaired: | Nothing |
| Training received: | Training received by Alessa Team – QC, Production, PE- Maintenance – 16 ~ 20 Hrs Training |
| Documentation: | Documents / Manuals Received |
| Components missing: | All complete … nothing missing |
| Other comments: | All Data Report been saved in the PC at test room area. |

Final leak test before packaging :

| Final Leak Test before packaging – Ecotec + HLD 6000 | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and | 1 machines |

| | |
|---|---|
| machine number(s): | |
| Machine number: | INFICON - 510 -028 HLD 6000 – Serial No. 90001338933<br>INFICON - 530 – 001 Ecotec E3000 – Serial No. 90001341355 |
| Open points: | Improve the pedestal / stand to avoid falling down … during production this machine to be powered thru UPS for the safety of the device. |
| Machine working: | Machine Calibrated by Galileo and Working OK |
| Items to be replaced or repaired: | Nothing replaced / repaired |
| Training received: | Training received by QC,– 16 ~ 20 Hrs Training |
| Documentation: | Documents / Manuals Received |
| Components missing: | All complete … nothing missing |
| Other comments: | Tested By QC with the 15 Outdoor Units … All are OK … No Comment |

Software and Data Acquisition GEDA-Recdata TJ

| Software and Data Acquisition GEDA – Recdata TJ | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | Software – 2 computers – 8 bar code readers<br>Software (Geda and Recdata TJ) – 2 Computers (1 with Geda sw and 1 with Recdata TJ sw) – 8 (eight) bar code readers (cable version code 2.002.2.424) and 2 Blue Tooth Code 2.002.2.455 - |

| | |
|---|---|
| | |
| Machine number: | S/N RECDATA TJ 91S0031 – DESKTOP -V40M5G2 – REV. 1.08.00 UNIDO - IP: 11.0.0.100 – MAC Address:<br><br>68:05:CA:71:D5:07<br><br>S/N GEDA 90S0087 – DESKTOP -70CBCQ2 – REV. 1.16.01 - IP: 192.168.0.56 - MAC Address: 68:05:CA:7E:10:B0 |
| Open points: | Nothing All OK … but need to re organised the position of the computer table. |
| Machine working: | Maching Working O.K. ... All machine data been recorded and saved in the PC. |
| Items to be replaced or repaired: | Nothing . |
| Training received: | Training received by QC,– 16 ~ 20 Hrs Training |
| Documentation: | Documents / Manuals Received |
| Components missing: | All complete … Nothing missing |
| Other comments: | Test Report done and recorded … Alessa QC to provide pdf copy |

Production line Ancillary equipment

Purging station - VORTEX

| Vortex Purging Station | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | 2 machines |
| Machine number: | VORTEX #1 – Serial No. 52K0047 – at Charging Machine Area. VORTEX #2 – Serial No. 52K0048 - at LAB Area<br><br>S/N 52K0047 – For production Rev. Firmware 04 – IP: 192.168.0.32 – MAC Address: 64:35:32:4B:00:30<br><br>S/N 52K0048 – For laboratory - Rev. Firmware 04 – Not connected to Geda |
| Open points: | Exhaust Pipe line to be modified by Alessa |
| Machine working: | Maching Tested and Working O.K |
| Items to be replaced or repaired: | Nothing |
| Training received: | Training received by QC,, Prodn & PE Maintenance – 16 ~ 20 Hrs Training |
| Documentation: | Documents / Manuals Received |
| Components missing: | All complete … nothing missing |
| Other comments: | The Vortex S/N 52K0048 hasn't got the discharge pipeline and Alessa shall provide it. The pipeline must run from the Vortex machine to the roof Vortex pipe line completed by Alessa |

Helium recovery and distribution HEREC NK HP No comments

| Herec Helium Recovery and Distribution | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | 1 machines |
| Machine number: | Model No. : HEREC NK HP 200<br>S.N. : 87L0013<br>S/N 97L0013 – rev SW V2 RV02 – rev SW V2 RV01 – IP: 192.168.0.40 |
| Open points: | Nothing |
| Machine working: | Maching Tested and Working O.K |
| Items to be replaced or repaired: | Nothing |
| Training received: | Training received by QC,, & PE Maintenance – 16 ~ 20 Hrs Training |
| Documentation: | Documents / Manuals Received |
| Components missing: | All complete … nothing missing |
| Other comments: | The recovery unit was installed and connected to 2 ProbHe units; it works properly.<br>No Comment |

Nitrogen distribution and gas booster – No comment

| Nitrogen Distribution and Gas Booster | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | 2 machines but actually 1 is not being used |
| Machine number: | Model No. : AP05/0189<br>S.N. : 024/18<br>Ref. GTP Code 2.036.0.003 |
| Open points: | All Done … Leak and Functional Test …DONE |
| Machine working: | Maching Tested and Working O.K |
| Items to be replaced or repaired: | Nothing |
| Training received: | Training received by QC, Prodn& PE Maintenance – 16 ~ 20 Hrs Training |
| Documentation: | Documents / Manuals Received |
| Components missing: | All Complete.. nothing Missing |
| Other comments: | To comply with the new required production rate, the customer needs to provide an additional tank and a system to provide Nitrogen or dry air with a proper flow rate to Galileo TP' gas booster. In the future, should Alessa increase its production rate, the second booster pump can be added<br>No Comment |

Gas storage feed station and ancillary – RP4

| Gas Storage Feed Station and Ancillary – RP4 | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | 1 |
| Machine number: | Model No. HCDS02 , Serial No. 78L0008<br>S/N 73L0185 |
| Open points: | |
| Machine working: | Machine Tested and Working O.K |
| Items to be replaced or repaired: | Reduced the length of the GAS hose from 2 mtr to 1 mtr. , Fixed additional hose fittings & 2 nos. Ball valve from the cylinder tank to reduce the volume of GAS release s during tank change. (DONE) |
| Training received: | Training received by QC, Prodn & PE Maintenance – 16 ~ 20 Hrs Training |
| Documentation: | Documents / Manuals Received |
| Components missing: | All Complete.. nothing Missing |
| Other comments: | The refrigerant transfer pump mod. RP4 is part of the storage area which is composed by 1 transfer pump mod. RP4, one HCDS-02 unit and one SYNC + TAF Atex (tank exchange) system. The installation of this area is completed and the refrigerant supply line is connected to the charging machine.<br>No comment |

Real-life testing equipment

| Performance Testing – Captor K - no comments | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | 3 machines (2 installed 1 spare) |
| Machine number: | CAPTOR #1: SN.: 04260108<br>CAPTOR #2: SN.: 04260099<br>CAPTOR #3: SN.: 04260147 For spare/Backup. |
| Open points: | Nothing … this is running long time |
| Machine working: | Machine working |
| Items to be replaced or repaired: | nothing |
| Training received: | Training received R&D |
| Documentation: | Documents / Manuals Received |
| Components missing: | Nothing missing |
| Other comments: | Data Report to be provided by R&D. |

| Software and Data Acquisition GEDA – Recdata TJ – No comment | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | Software – 1 computer |
| Machine number: | S/N 91S0032 |
| Open points: | Nothing |
| Machine working: | Maching Tested and Working O.K |
| Items to be replaced or repaired: | Nothing |
| Training received: | Training received by QC, Prodn& PE Maintenance – 16 ~ 20 Hrs Training |
| Documentation: | Documents / Manuals Received |
| Components missing: | All Complete.. nothing Missing |
| Other comments: | Report all the test being done and recorded – provide a pdf of the printout |

Production line and laboratory Safety equipment

CERBERUS N – gas sesors and ventilation control panel

| Cerberus N – Gas sensors and Ventilation Control Panel | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | Cerberus @ Charging Machine Area – Serial No. 36000467<br>Cerberus @ Performance Room Area – Serial No. 36000469<br>Cerberus @ GAS STORAGE Area – Serial No. 36000468<br>Cerberus @ LAB Area – Serial No. 36000466<br>Ventilation Control Panel - s/n 370328 – at Performance Test Room<br>Ventilation Control Panel - s/n 370327 – at Charging MC Area<br>Ventilation Control Panel - s/n 370326 – at Gas Storage<br><br>1 Cerberus for Laboratory with 3 IR gas sensors<br>3 Cerberus for production with 9 IR gas sensors |
| Machine number: | Cerberus @ Charging Machine Area – Serial No. 36000467<br>Cerberus @ Performance Room Area – Serial No. 36000469<br>Cerberus @ GAS STORAGE Area – Serial No. 36000468<br>Cerberus @ LAB Area – Serial No. 36000466<br>Ventilation Control Panel - s/n 370328 – at Performance Test Room<br>Ventilation Control Panel - s/n 370327 – at Charging MC Area Ventilation Control Panel - s/n 370326 – at Gas Storage<br><br>S/N 36000466 (Laboratory) - SENSOR 1: 6813040ARKJ-1713; SENSOR 2: 6813040ARLA-1372; SENSOR 3: 6813040ARKJ-1722 |

| | |
|---|---|
| | S/N 36000467 (Charging Area) - SENSOR 1: 6813040ARLD-0216; SENSOR 2: 6813040ARLD-0209; SENSOR 3: 6813040ARKJ-2571; SENSOR 4: 6813040ARLA-1375; SENSOR 5: 6813040ARLA-1365.<br><br>S/N 36000468 (Storage) – SENSOR 1 6813040ARKJ-1725; SENSOR 2 6813040ARLD-0200<br><br>S/N 36000469 (Test Room) - SENSOR 1: 6813040ARKJ-171; SENSOR 2 6813040ARLA-1369 |
| Open points: | Laboratory: in case of gas alarm, the power inside this area must be cut. Alessa needs to take the gas alarm contact from the Cerberus to the main power board of the area to cut off it automatically in case of alarm.<br><br>LAB area to cut off it automatically in case of GAS alarm. Wiring installation ongoing. |
| Machine working: | All Machines working. |
| Items to be replaced or repaired: | Fixed indicator lamp outside LAB to aware/Alarm the operator if there is malfunctioning from the system. |
| Training received: | Training received By maintenance and R&D. |
| Documentation: | Received |
| Components missing: | Nothing missing |
| Other comments: | The safety and ventilation systems have been installed and work correctly.<br><br>Laboratory: in case of gas alarm, the power inside this area must be cut. Alessa needs to take the gas alarm contact from the Cerberus to the main power board of the area to cut off it automatically in case of a No comments |
| !!!!! | A schematic layout plan to be provided by Galileo / provided. |
| Testing | GTP: We had already sent the reports of all the testing. We are attaching them again |

DREAGER IR Gas Sensors

| DRAEGER IR Gas Sensors | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | 12 machines |
| Machine number: | Gas Sensors<br><br>-#1 – s/n. ARLD – 0200 -, #2 s/n. ARKI 1725, -( 2 nos. at Gas Storage )<br><br>- #3 s/n ARKJ 2571, #4 s/n ARLA 1365 , #5 s/n ARLD 1375 , #6 s/n ARLD 0209 , #7 s/n ARLD 0216– (5 nos.at<br><br>Charging MC Area) , #8 s/n ARLA 1369 , #9 ARKJ 1717 ( 2 nos. at Performance Test Room) #10 s/n ARKJ 1722 - #11 s/n ARKJ 1713 , #12 s/n ARLA 1372 - (3 nos. at R&D LAB)<br><br>3 IR sensors installed on the Cerberus for Laboratory - SENSOR 1: 6813040ARKJ-1713; SENSOR 2: 6813040ARLA-1372; SENSOR 3: 6813040ARKJ-1722<br><br>5 IR sensors installed on the Cerberus for Charging area - SENSOR 1: 6813040ARLD-0216; SENSOR 2: 6813040ARLD-0209; SENSOR 3: 6813040ARKJ-2571; SENSOR 4: 6813040ARLA-1375; SENSOR 5: 6813040ARLA-1365.<br><br>2 IR sensors installed on the Cerberus for Test Room - SENSOR 1 6813040ARKJ-1725; SENSOR 2 6813040ARLD-0200<br><br>2 IR sensors installed on the Cerberus for Storage - SENSOR 1: 6813040ARKJ-171; SENSOR 2 6813040ARLA-1369 |
| Open points: | Nothing, All OK |
| Machine working: | All Machines working. |

| | |
|---|---|
| Items to be replaced or repaired: | Nothing |
| Training received: | Training received By maintenance, PROD and QC. |
| Documentation: | Received |
| Components missing: | Nothing missing |
| Other comments: | No comments |
| | |
| Testing | Test protocol and the test report to be provided by R&D & Galileo.<br>*GTP: attached to this message .* |

Wind Ventilators

| Wind - Ventilators 1 x WIND I-S & 3 x WIND II-S | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | 4 machines |
| Machine number: | Ventilation Control Panel - s/n 370328 – at Performance Test Room<br>Ventilation Control Panel - s/n 370327 – at Charging MC Area<br>Ventilation Control Panel - s/n 370326 – at Gas Storage<br>Ventilation Control Panel - s/n 370325 – at R&D LAB |

| | |
|---|---|
| | S/N WIND I–S 370325 for laboratory<br>S/N WIND II-S 370326 (for charging area), 370327 (for storage), 370328 (for Test Room) |
| Open points: | Nothing, All OK |
| Machine working: | All Machines working. |
| Items to be replaced or repaired: | Nothing |
| Training received: | Training received By maintenance and QC. |
| Documentation: | Received |
| Components missing: | Nothing missing |
| Other comments: | No comments….  All working OK. |
| !!!!! | A schematic layout plan to be provided by Galileo/ provided.<br>GTP: In the general layout we also indicated the layout of the ventilation |
| Testing | Test protocol and the test report to be provided by R&D & Galileo/ provided<br>*GTP: already provided and attached again* |

Guard House Remote safety alarm

| |
|---|
| Guard House Remote Safety Alarm |

| | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | 1 machines |
| Machine number: | This is called by Galileo as supervisory Area --- Drawing Part no. 3.501.0.289 |
| Open points: | |
| Machine working: | GTP Code 3.501.0.289 |
| Items to be replaced or repaired: | N/A. |
| Training received: | No training required … just to inform awareness by the guard house + safety dept. |
| Documentation: | N/A. |
| Components missing: | N/A. |
| Other comments: | N/A.<br><br>Originally customer had installed it in the charging area but it is of no use as all the local alarms are already present. For this reason it was not connected, but customer may connect it in case he thinks that it could be useful. GTP suggests to install it in a different position/area |
| !!!!! | We will provide the layout once it get installed. |
| Testing | We provide update after get installed. |

Ventilation ducting

| Ventilation Ducting | |
|---|---|
| Date: | 13-Oct-2021 |
| Number of machines and machine number(s): | Dustings Installed at Production Area, Gas Room Area & LAB Area. ( done by local contractor and followed as per Galileo drawing) |
| Machine number: | N/A |
| Open points: | As per Galileo .. we need to fix roof shed for the Wind outside R&D Lab for rain & direct sun protection. |
| Machine working: | All working OK |
| Items to be replaced or repaired: | Increased the height of the wind ducting outside LAB area from 1 mtr. To 2.5 mtr.<br>. Fixed Ladder at the wind structure for maintenance access. ( outside LAB area) Job Done |
| Training received: | No Training Required |
| Documentation: | No document Available … Only Drawings given directly by Galileo to Local Contractor |
| Components missing: | Nothing missing |
| Other comments: | No comment |
| !!!!! | Layout of ducting available from Galileo / provided needs to be checked by Alessa |
| Testing | We need Test Procedure to follow. / to be provided by GTP.<br>*GTP: we already sent the report of the verification of the ventilation (attached again)* |

Spare parts

Please go through it and check if everything is there.

Used spare parts during the installation/commissioning need to be replaced by the supplier

Already parts missing noted during Unido mission

Jaws of the lockring clamping tool

Torque wrench

Maybe you found them otherwise they need to be provided.

General remarks:

- The final approval of the risk assessment of the area is under customer's responsibility.

- The line was commissioned and a pre-series of 20 units was properly produced. No problems were detected. The line is working correctly.

Already parts missing noted during Unido mission

- Jaws of the lockring clamping tool

- Torque wrench

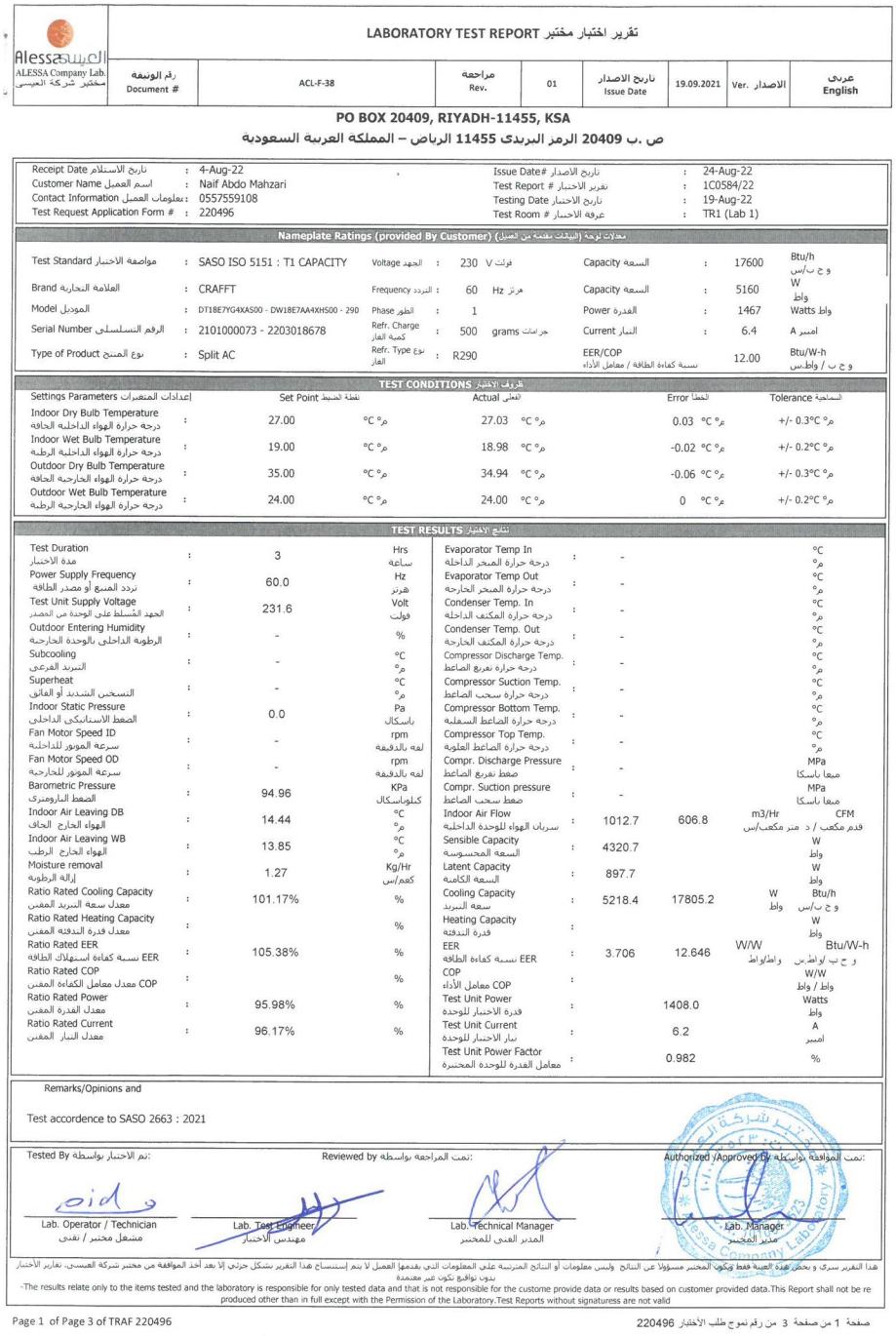
These parts were shipped inside box nr. 19.

"Note : Jaws of the lockring clamping tool - Not Found" to be provided by GTP

GTP: we are sure that they were sent as they were included in the packing list; in any case we will provide them under warranty. Our OA will follow shortly.

# Appendix lab test reports real-life testing room split units HC-290 and R410A

## HC-290 test report



ALESSA Company Lab. مختبر شركة العيسى

**LABORATORY TEST REPORT تقرير اختبار مختبر**

| رقم الوثيقه Document # | ACL-F-38 | مراجعه Rev. | 01 | تاريخ الاصدار Issue Date | 19.09.2021 | Ver. الاصدار | عربى English |
|---|---|---|---|---|---|---|---|

**PO BOX 20409, RIYADH-11455, KSA**

**ص .ب 20409 الرمز البريدى 11455 الرياض – المملكة العربية السعودية**

| | | | |
|---|---|---|---|
| Receipt Date تاريخ الاستلام | : 4-Aug-22 | Issue Date# تاريخ الاصدار | : 24-Aug-22 |
| Customer Name اسم العميل | : Naif Abdo Mahzari | Test Report # تقرير الاختبار | : 1C0584/22 |
| Contact Information معلومات العميل | : 0557559108 | Testing Date تاريخ الاختبار | : 19-Aug-22 |
| Test Request Application Form # | : 220496 | Test Room # غرفة الاختبار | : TR1 (Lab 1) |

**Nameplate Ratings (provided By Customer) معلومات لوحة (البيانات مقدمة من العميل)**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Test Standard مواصفة الاختبار | : SASO ISO 5151 : T1 CAPACITY | Voltage الجهد | : 230 | V فولت | Capacity السعة | : 17600 | Btu/h و ح ب/س |
| Brand العلامة التجارية | : CRAFFT | Frequency التردد | : 60 | Hz هرتز | Capacity السعة | : 5160 | W واط |
| Model الموديل | : DT18E7YG4XAS00 - DW18E7AA4XHS00 - 290 | Phase الطور | : 1 | | Power القدرة | : 1467 | Watts واط |
| Serial Number الرقم التسلسلى | : 2101000073 - 2203018678 | Refr. Charge كمية الغاز | : 500 | grams جرامات | Current التيار | : 6.4 | A امبير |
| Type of Product نوع المنتج | : Split AC | Refr. Type نوع الغاز | : R290 | | EER/COP نسبة كفاءة الطاقة / معامل الأداء | 12.00 | Btu/W-h و ح ب / واط.س |

**TEST CONDITIONS ظروف الإختبار**

| Settings Parameters إعدادات المتغيرات | Set Point نقطة الضبط | | Actual الفعلى | | Error الخطأ | | Tolerance السماحية |
|---|---|---|---|---|---|---|---|
| Indoor Dry Bulb Temperature درجة حرارة الهواء الداخلية الجافة | : 27.00 | °C م° | 27.03 | °C م° | 0.03 | °C م° | +/- 0.3°C م° |
| Indoor Wet Bulb Temperature درجة حرارة الهواء الداخلية الرطبة | : 19.00 | °C م° | 18.98 | °C م° | -0.02 | °C م° | +/- 0.2°C م° |
| Outdoor Dry Bulb Temperature درجة حرارة الهواء الخارجية الجافة | : 35.00 | °C م° | 34.94 | °C م° | -0.06 | °C م° | +/- 0.3°C م° |
| Outdoor Wet Bulb Temperature درجة حرارة الهواء الخارجية الرطبة | : 24.00 | °C م° | 24.00 | °C م° | 0 | °C م° | +/- 0.2°C م° |

**TEST RESULTS نتائج الإختبار**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Test Duration مدة الاختبار | : 3 | Hrs ساعة | Evaporator Temp In درجة حرارة المبخر الداخلة | : - | | | °C م° |
| Power Supply Frequency تردد المنبع أو مصدر الطاقة | : 60.0 | Hz هرتز | Evaporator Temp Out درجة حرارة المبخر الخارجة | : - | | | °C م° |
| Test Unit Supply Voltage الجهد المُسلط على الوحدة من المصدر | : 231.6 | Volt فولت | Condenser Temp. In درجة حرارة المكثف الداخلة | : - | | | °C م° |
| Outdoor Entering Humidity الرطوبة الداخلى بالوحدة الخارجية | : - | % | Condenser Temp. Out درجة حرارة المكثف الخارجة | : - | | | °C م° |
| Subcooling السبريد الفرعى | : - | °C م° | Compressor Discharge Temp. درجة حرارة تفريغ الضاغط | : - | | | °C م° |
| Superheat التسخين الشديد أو الفائق | : - | °C م° | Compressor Suction Temp. درجة حرارة سحب الضاغط | : - | | | °C م° |
| Indoor Static Pressure الضغط الاستاتيكى الداخلى | : 0.0 | Pa باسكال | Compressor Bottom Temp. درجة حرارة الضاغط السفلية | : - | | | °C م° |
| Fan Motor Speed ID سرعة الموتور للداخلية | : - | rpm لفة بالدقيقة | Compressor Top Temp. درجة حرارة الضاغط العلوية | : - | | | °C م° |
| Fan Motor Speed OD سرعة الموتور للخارجية | : - | rpm لفة بالدقيقة | Compr. Discharge Pressure ضغط تفريغ الضاغط | : - | | | MPa ميغا باسكا |
| Barometric Pressure الضغط الباروميترى | : 94.96 | KPa كيلوباسكال | Compr. Suction pressure ضغط سحب الضاغط | : - | | | MPa ميغا باسكا |
| Indoor Air Leaving DB الهواء الخارج الجاف | : 14.44 | °C م° | Indoor Air Flow سريانات الهواء للوحدة الداخلية | : 1012.7 | 606.8 | m3/Hr متر مكعب/س | CFM قدم مكعب / د |
| Indoor Air Leaving WB الهواء الخارج الرطب | : 13.85 | °C م° | Sensible Capacity السعة المحسوسة | : 4320.7 | | | W واط |
| Moisture removal إزالة الرطوبة | : 1.27 | Kg/Hr كغم/س | Latent Capacity السعة الكامنة | : 897.7 | | | W واط |
| Ratio Rated Cooling Capacity معدل سعة التبريد المقنن | : 101.17% | % | Cooling Capacity سعة التبريد | : 5218.4 | 17805.2 | W واط | Btu/h و ح ب/س |
| Ratio Rated Heating Capacity معدل قدرة التدفئة المقنن | : | % | Heating Capacity قدرة التدفئة | : | | | W واط |
| Ratio Rated EER نسبة كفاءة استهلاك الطاقة EER | : 105.38% | % | EER نسبة كفاءة الطاقة EER | : 3.706 | 12.646 | W/W واط/واط | Btu/W-h و ح ب /واط.س |
| Ratio Rated COP معدل معامل الكفاءة المقنن COP | : | % | COP معامل الأداء | : | | | W/W واط / واط |
| Ratio Rated Power معدل القدرة المقنن | : 95.98% | % | Test Unit Power قدرة الاختبار للوحدة | : | 1408.0 | | Watts واط |
| Ratio Rated Current معدل التيار المقنن | : 96.17% | % | Test Unit Current تيار الاختبار للوحدة | : | 6.2 | | A امبير |
| | | | Test Unit Power Factor معامل القدرة للوحدة المختبرة | : | 0.982 | | % |

Remarks/Opinions and

Test accordence to SASO 2663 : 2021

| Tested By تم الاختبار بواسطة: | Reviewed by تمت المراجعة بواسطة: | Authorized /Approved By تمت الموافقة بواسطة: |
|---|---|---|
| Lab. Operator / Technician مشغل مختبر / تقنى | Lab. Test Engineer مهندس الاختبار | Lab. Technical Manager المدير الفنى للمختبر |
| | | Lab. Manager مدير المختبر |

هذا التقرير سرى و يخص عينة المعينة فقط وتكون المختبر مسؤولا عن النتائج المترتبة على المعلومات التي يقدمها العميل لا يتم إستنساخ هذا التقرير بشكل جزئي إلا بعد أخذ الموافقة من مختبر شركة العيسى. تقارير الاختبار بدون توقيع تكون غير معتمدة

-The results relate only to the items tested and the laboratory is responsible for only tested data and that is not responsible for the custome provide data or results based on customer provided data.This Report shall not be re produced other than in full except with the Permission of the Laboratory.Test Reports without signaturess are not valid

Page 1 of Page 3 of TRAF 220496

صفحة 1 من صفحة 3 من رقم نموج طلب الاختبار 220496

R410A test report

| | TCL indoor & Alessa outdoor / DSG280 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Compressor | DSG280N1VKT S# 906000002K (GMCC) | | | | | | | |
| Condenser Coil | 3 rows (2.5 coil), 5 mm, IGT, 6 ckt., 36 tubes per row, 18 FPI, 1 row (375 mm x 705 mm) & 2 rows (818 mm x 705 mm) L-bend.<br>**New condenser coil circuitry without sub-cooler.** | | | | | | | |
| Capillary | 0.064" x 40" x 2# | | | | | | | |
| Cond. FM | DC Motor (1000 rpm) | | | | | | | |
| Evaporator Coil | 2 rows, 7 mm, IGT, 4 ckt., 18 FPI (gold fins), 760 mm x 340 mm | | | | | | | |
| Frequency (Hz) | 60 | | | | | | | |
| R290 charge (g) | 520 | | 490 | | | | | |
| Test Condition | T1 (°F, psi) | T1 (°C, Bar) | T1 (°F, psi) | T1 (°C, Bar) | T3 (°F, psi) | T3 (°C, Bar) | H1 (°F, psi) | H1 (°C, Bar) |
| Cooling Capacity (BTU/Hr) | **18253.6** | | **18373.0** | | **16133.4** | | - | |
| Sensible Capacity (BTU/Hr)/(W) | 14047.6 | | 14153.6 | | 15410.4 | | 4659.4 | |
| SHR (%) | 77.0 | | 77.0 | | 95.5 | | 100.0 | |
| Latent Capacity (BTU/Hr)/(W) | 4206.0 | | 4219.5 | | 723.0 | | 0.0 | |
| Heating Capacity (W) | - | | - | | - | | **4659.4** | |
| Power (W) | 1471.3 | | 1470.1 | | 1723.9 | | 1404.1 | |
| EER (BTU/W-Hr) | **12.406** | | **12.498** | | **9.359** | | - | |
| COP (W/W) | - | | - | | - | | **3.318** | |
| Current (A) | 6.5 | | 6.5 | | 7.6 | | 6.3 | |
| Voltage (V) | 230.1 | | 230.1 | | 229.9 | | 230.0 | |
| CFM ($ft^3$/min) | 579.0 | | 580.7 | | 606.7 | | 620.6 | |
| Evap. Header Inlet Temp. | 60.3 | 15.7 | 60.2 | 15.7 | 65.2 | 18.4 | 96.6 | 35.8 |
| Evap. Header Outlet Temp. | 49.7 | 9.8 | 49.8 | 9.9 | 52.3 | 11.3 | 105.6 | 40.9 |
| Cond. Header Inlet Temp. | 128.5 | 53.6 | 133.8 | 56.2 | 151.3 | 66.3 | 32.0 | 0.0 |
| Cond. Outlet Temp. | 99.9 | 37.7 | 100.4 | 38.0 | 124.0 | 51.1 | 42.3 | 5.7 |
| Suction Temp. | 50.4 | 10.2 | 57.1 | 13.9 | 57.0 | 13.9 | 33.3 | 0.7 |
| Discharge Temp. | 131.4 | 55.2 | 135.8 | 57.7 | 153.9 | 67.7 | 112.9 | 44.9 |
| Compressor Bottom Temp. | 124.7 | 51.5 | 127.8 | 53.2 | 147.1 | 63.9 | 107.0 | 41.7 |
| Compressor Top Temp. | 132.0 | 55.6 | 136.4 | 58.0 | 154.6 | 68.1 | 115.0 | 46.1 |
| Suction Pressure | 71.8 | 4.95 | 71.9 | 5.0 | 75.4 | 5.2 | 53.8 | 3.7 |
| Liquid Pressure (condenser) | 201.0 | 13.9 | 201.0 | 13.9 | 258.9 | 17.8 | 64.2 | 4.4 |
| Discharge Pressure | 209.0 | 14.4 | 209.5 | 14.4 | 264.7 | 18.2 | 186.0 | 12.8 |
| Sub-cooling | 10.6 | 5.6 | 10.1 | 5.3 | 6.1 | 2.9 | | |
| Superheating | 4.5 | 2.7 | 11.2 | 6.4 | 8.6 | 4.8 | | |

**Progress Report Pursuant to Decision 83/41 of the 83rd Meeting of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol**

## I. Background

According to Decision 83/41 of the 83rd Meeting of the Executive Committee (ExCom) of the Multilateral Fund, the Government of China will report to the ExCom, at the 86th meeting, on its latest progress in implementing the activities related to China's ODS monitoring and law enforcement.

## II. Progress of monitoring and law enforcement activities

The Government of China attaches great importance to the unexpected emission increase of trichlorofluoromethane (CFC-11) in the atmosphere. On the one hand, control of CTC supply is strengthened to prevent diversion of CTC to illegal ODS production. On the other hand, China is constantly strengthening monitoring and law enforcement of ODS to prevent illegal sales and use of ODS. Since the beginning of 2020, although the COVID-19 pandemic has posed adverse impacts on monitoring and law enforcement in implementing the Montreal Protocol, the Government of China is still striving to overcome difficulties and take active actions to improve law and regulation system, conduct law enforcement actions, intensify CTC supervision and management, build capacity for implementing the Montreal Protocol, strengthen cooperation with the industry, and establish monitoring network, etc. The progress of relevant work from October 2019 to July 2020 is as follows (see Annex 1):

### (I) Improve law and regulation system

In August 2019, the Ministry of Ecology and Environment (MEE) launched the revision of *the Regulation on the Administration of Ozone Depleting Substances* (hereinafter referred to as the Regulation), conducted an assessment of the implementation of the Regulation, and formulated *the Regulation on the Administration of Ozone Depleting Substances and Hydrofluorocarbons (Draft for Soliciting Opinions*) based on the assessment and new requirements for implementing the Montreal Protocol. The revision mainly includes: 1) Considering the future compliance requirements of the Kigali Amendment, hydrofluorocarbons (HFCs) are incorporated into the scope of control; 2) To further clarify definition and classification of uses, it is stipulated that co-production and by-production are classified as production activities, pre-blended polyols are included in the monitoring scope as mixtures, and pre-blended polyols manufacturing enterprises are strictly supervised as consumption enterprises with controlled use. At the same time, targeted monitoring measures are formulated for supervising controlled use and feedstock use; 3) Work related to monitoring and evaluation is included, a national monitoring network of controlled substances under the Montreal Protocol will be established, and the monitoring and evaluation work will be organized accordingly; 4) The legal responsibilities of both market entities

and supervisors are further elaborated, and the punishment measures on various violations are further reinforced, 5) Supporting policy measures will be improved and the R&D and application of testing and monitoring methods of controlled substances will be encouraged and supported.

As of the end of June 2020, public opinion solicitation has been completed. At present, it is being revised based on opinions and feedback. The Regulation (Revised Draft for Approval) will be submitted to the State Council for review within 2020, and will be issued upon the approval by the State Council in accordance with relevant procedures.

**(II) Carry out law enforcement actions**

**1. Cracking down on illegal use of CFC-11**

From June to August 2019, MEE dispatched law enforcement officers to form joint enforcement groups with local law enforcement personnel to 11 key provinces/municipalities including Shandong, Hebei, Henan, Jiangsu, Zhejiang, and Guangdong to conduct special inspections. In this action, 656 system houses and polyurethane foam enterprises were inspected. Testing through portable instant detectors found that samples from 37 enterprises, including 6 system houses and 31 foam manufacturers, contained CFC-11. After the laboratory retesting, it's confirmed that 16 enterprises have been engaged in illegal use of CFC-11. None of these 16 enterprises received funds from the Multilateral Fund or was registered with the China Plastic Processing Industry Association (CPPIA). The local ecology and environment bureaus (EEBs) have handled these cases in accordance with the law. Through laboratory testing, samples from the 21 enterprises were found to contain no or only trace of CFC-11. Hence, these 21 enterprises could not be confirmed using CFC-11.

Among these cases, one enterprise's legal representative was sentenced to 10 months of imprisonment for the crime of environmental pollution by the local court. The specific circumstance is: Through the sudden unannounced inspection in Huzhou Deqing Minghe Insulation Materials Co., Ltd. (hereinafter referred to as Minghe Company), Zhejiang working group found clues of the company's illegal practice which pointed out the criminal facts of Minghe Company's three-year illegal purchase and use of 849.5 tons of CFC-11 in the production of pre-blended polyols. The sentence of the case was pronounced by the People's Court in Deqing County in March 2020: Minghe Company was fined 700,000 RMB yuan for environmental pollution caused by its illegal production of pre-blended polyols using CFC-11, and illegal gains of more than 1.4 million RMB yuan was recovered; its legal representative Qi was sentenced to 10 months of imprisonment for the crime of environmental pollution and was fined 50,000 RMB yuan. Among the 4 suppliers (all dealers) of CFC-11 raw materials in this case, 2 were held criminally responsible for the crime of environmental pollution (one was sentenced to 8 months of imprisonment, the other was sentenced to 9 months of imprisonment), and the other 2 people are still under investigation. It is the first case that was sentenced to substantial punishment for the illegal use of ODS in the domestic polyurethane foam sector to date, which fully reflects China's

firm zero-tolerance attitude towards illegal activities related to ODS. MEE issued a public report with the theme of *China's First Case of Illegal Use of ODS Sentenced to Criminal Punishment*.

Among the other 15 enterprises which involved violations, including 4 system houses and 11 polyurethane foam enterprises, about 9.4 tons of CFC-11 raw materials, 4.35 tons of pre-blended polyols and 2.2 tons of polyurethane foam products were seized and soundly disposed of, a fine of 2,816,900 RMB yuan was imposed (including the confiscation of illegal gains). Facilities and equipment of one enterprise were dismantled, violation of one enterprise has been transferred to the public security bureau (the case is still under investigation), and another enterprise was shut down.

**2. Additional law enforcement equipment for local EEBs**

As of the end of December 2019, a total of 50 portable ODS instant detectors have been distributed to EEBs of 30 provinces (autonomous regions and municipalities) and law enforcement officers from some key cities and counties, so as to help them conduct on-site inspection.

**3. Strengthen supervision and law enforcement**

In December 2019, MEE formulated *the Guideline on Supervision of Ozone Depleting Substances (Trial)*, including specific requirements for methods and contents of law enforcement inspection and handling of illegal behaviors. The Guideline has been issued and distributed to local EEBs.

MEE has formulated and issued *the 2020 Work Plan for Law Enforcement Inspection on Ozone Depleting Substances* in July 2020 and launched a new round of special ODS law enforcement inspection nationwide at the end of July 2020 mainly targeting at HCFC-141b and HCFC-22 production enterprises and illegal production and use of CFC-11. Outcome of this special law enforcement inspection will be reported to MEE from local EEBs by the end of this year.

In 2021, through the national CTC online monitoring platform and industrial rewards for reporting platform, MEE will further intensify source control, crack down on illegal ODS production, and improve the identifying mechanism, investigation mechanism and disclosure mechanism of illegal ODS production cases in steps.

**(III) Intensify source control**

**1. Establishment of CTC monitoring platform**

MEE has imposed stricter control measures on the chloromethane producers generating CTC as by-product since 2019, requiring every enterprise to install a verifiable and quantitative CTC online production monitoring system. At present, all chloromethane producers have completed the installation

of the online monitoring systems. Meanwhile, MEE is working on establishing a national CTC monitoring platform, which is currently in the stage of system design and development. The online trial operation is expected to be completed by the end of 2020 to realize online monitoring of CTC by-production in all chloromethane enterprises.

With regard to perchloroethylene (PCE) production enterprises, according to the current available information, there is only one enterprise that uses the alkane chlorination process during the PCE production in China. On September 5th 2019, MEE conducted an on-site survey on this enterprise with local EEBs. In light of the survey, during the PCE production process of this enterprise, CTC is only generated as an intermediate conversion product and reactor diluent, which is not separated or purified as by-products in the system. Since CTC does not flow out of the system and the production facility has no outlet pipes for CTC, there is no need to take daily supervision measures targeting at CTC on this enterprise as applied to chloromethane enterprises.

**2. On-site supervision**

From June 2019 to January 2020, MEE dispatched supervisory working groups to 16 chloromethane enterprises with CTC by-production to carry out the on-site inspection on CTC crude output, purification, residue, storage, conversion and sales, and other key processes to ensure legal production and use. By January 2020, 14 rounds of on-site supervision with attendance reaching 577 had been conducted. Each round lasted for two weeks (including holidays), achieving continuous daily on-site supervision. Since February 2020, the on-site inspection of CTC by-production enterprises has been suspended due to the COVID-19 pandemic, however, MEE still requires chloromethane production enterprises to report CTC related data weekly, and local EEBs have taken measures to conduct on-site inspections as needed.

**(IV) Building Capacity for implementing the Montreal Protocol**

**1. Construction of testing laboratories and development of testing standards**

For construction of testing laboratories, by the end of 2019, MEE had completed the construction of 8 ODS testing laboratories for industrial products, and all of them have obtained the expansion of CMA (China Inspection Body and Laboratory Mandatory Approval) certificate to ensure testing reports with legal effect could be provided.

For the formulation of laboratory testing method standards for ODS in industrial products, in October 2019, MEE approved and issued two national environmental protection standards, *Determination of ozone-depleting substances including HCFC-22, CFC-11, and HCFC-141b in pre-blended polyols — Headspace/gas chromatography-mass spectrometry (HJ 1057-2019*) and *Determination of ozone-depleting substances including CFC-12, HCFC-22, CFC-11 and HCFC-141b in rigid polyurethane foam and pre-blended polyols—Portable headspace/gas chromatography-mass*

*spectrometry (HJ 1058-2019)*, to standardize testing of controlled substances under the Montreal Protocol. At present, testing standards for ODS in liquid refrigerants and solvents are being developed and is progressing on schedule, and it is expected to be officially released by the end of 2020.

**2. Hold Supervision and law enforcement training**

In December 2019, MEE held a training workshop on ODS phase-out management, which trained about 120 officers and technical support personnel from the atmospheric environmental management division of local EEBs. In December 2019 and July 2020, MEE held two training workshops for law enforcement personnel, training a total of 400 environmental law enforcement officers at the provincial, city and county levels.

In order to further enhance the capacity of grassroots environmental protection personnel below the provincial level, some provinces and municipalities have also held ODS phase-out management training workshops within their provinces or municipalities. In October and November 2019, Henan, Jiangxi and Shanxi carried out training workshops respectively, a total of 1,130 personnel of atmospheric environmental management departments from provincial, city and county levels received training.

MEE and the General Administration of Customs will continue to jointly organize the training workshop on ODS import and export management for a total of 70 customs officers in this October.

**3. Optimize ODS information management system**

Since October 2019, MEE has launched the construction of the ODS data information management system, which will be comprehensively updated based on the existing HCFCs online information system to realize the online data reporting of enterprises. The online test of the system modules will be completed before the end of 2020.

**(V) Enhance cooperation with industries**

**1. Enhance communication with industries**

Industrial associations have been providing technical support for supervision and management, policy formulation, and law enforcement of the government over the long term. Some technical experts recommended by industrial associations directly participate in special law enforcement operation and on-site inspection, providing technical support for supervision and law enforcement from a professional perspective. During the revision of the Regulation, communications have been conducted actively with industrial associations, experts, scientific research institutions and others, and their suggestions have been fully incorporated during the revision process.

**2. Market analysis of the PU foam sector**

China Plastic Processing Industry Association (CPPIA) cooperated with industry experts to analyze the situation of the polyurethane foam market in 2018 and consumption of various blowing agents by using mass balance analysis. See Annex 2 for details.

**3. Market analysis of refrigeration and air-conditioning sector**

MEE has communicated with industrial associations and experts to discuss the feasibility and methodology of mass balance analysis in the refrigeration and air-conditioning market. The feasibility research on the mass balance analysis of the industrial and commercial refrigeration and air-conditioning (ICR) sector and room air-conditioning (RAC) sector has been completed.

Studies have shown that for the RAC sector, the use of HCFC-22 in the RAC manufacturing sector could be analyzed and calculated by collecting data on the annual output of various product types, charging quantity of various product types, and the proportion of using HCFC-22 as the refrigerant (See Annex 3 for details). However, scattered maintenance of room air-conditioners brings great difficulties on data collection, therefore it is impossible to conduct a mass balance analysis on the HCFC-22 consumption in the servicing sector.

The ICR sector has a wide range of equipment products and applications. The size of various products varies greatly and there are numerous models, which makes it difficult to obtain statistics on product data. A number of equipment in the ICR sector are non-standard or customized products. Considering factors include application occasions, customer needs, technologies and energy efficiency levels, even for similar products with the same cooling capacity, the refrigerant charge amount would vary greatly when different refrigerants are applied. In addition, various products' sales are affected by the domestic and international economic situation, policy changes, and weather, making it difficult to collect data on refrigerant consumption. Therefore, it is impossible to carry out mass balance analysis on refrigerant consumption in the ICR sector.

**(VI) Establishment of monitoring and alerting capacity**

In 2019, the Government of China officially launched the planning of the ODS atmospheric monitoring network to strengthen compliance monitoring and early warning capability and performance evaluation capability. According to the regional characteristics of the distribution of ODS production and consumption in China, through the scientific assessment of the existing atmospheric pollutant monitoring background stations, 6 stations which are suitable for monitoring ODS have been selected preliminarily. The monitoring capability will be progressively improved. National atmospheric ODS

monitoring network will be established in phases and steps, and a unified technical system of monitoring technology and comprehensive evaluation method, quality management, data sharing and information release will be built. At present, the National ODS Monitoring Expert Committee has been established and a joint expert team has been formed. At the same time, MEE is organizing relevant domestic research institutions to develop high-sensitivity ODS atmospheric monitoring equipment. MEE will start construction of ODS monitoring stations in 2021 and conduct ODS monitoring in 2022.

**(VII) Non-governmental study**

In accordance with the decision of the 83rd Meeting of the ExCom, MEE selected an independent non-governmental consulting agency (ESD China Limited) through public bidding to conduct a study to evaluate the ODS phase-out regulations, policies, law enforcement and market circumstances and risks in China. At present, the study report has been completed and will be submitted to the ExCom.

In general, since the unexpected increase in global emissions of CFC-11, the Government of China has promptly taken a series of actions to comprehensively strengthen the capacity of compliance management and supervision and law enforcement, to further provide guarantees to ensure sustainable compliance.

**In terms of improving the laws and regulations**, the Government of China has organized the revision of the Regulation to further clarify management measures and law enforcement basis for all aspects of ODS. For management scope, the life-cycle supervision of production, sales, use, import and export, recycle, reuse and destruction of ODS are to be achieved. For management system, the full process supervision on ODS monitoring and evaluation, directory management, technology research and development, quota approval, supervision and inspection, and violation punishment are to be realized. At the same time, the legal force and deterrence have been further enhanced by reinforcing the intensity of penalties for various cases of violations.

**In terms of source control,** all chloromethane production enterprises have installed a verifiable and quantitative CTC online production monitoring system, realizing real-time monitoring of the entire process of CTC from production to disposal. For the management of the production and consumption of ODS raw materials, through measures including the revision of the Regulation and establishment of the ODS data information management system, targeted supervision and reporting measures have been formulated for implementation. By adopting these measures, the Government of China has carried out more systematic and strict control over ODS from the source of supply to prevent the illegal outflow of ODS.

**In terms of supervision and law enforcement,** through a combination of national special law enforcement and daily supervision and inspection in all provinces and cities, the Chinese government has been severely cracking down on illegal ODS behavior and holding the offenders accountable,

continuously imposing high pressure and deterrence against illegal ODS behavior, which has fully demonstrated China's firm attitude of "zero tolerance" towards illegal ODS behavior. In response to the issue such as inadequate inspection capabilities of ODS law enforcement and testing methods, MEE has established 8 laboratories for testing ODS in industrial products and issued relevant testing standards, so as to provide timely and effective technical support for law enforcement inspections. By issuing *the Guideline on the Supervision of Ozone Depleting Substances (Trial)* and providing law enforcement detectors for local EEBs and organizing training for law enforcement officers from provincial, municipal and county levels, China has been continuously strengthening ODS supervision and law enforcement capabilities of local law enforcement officers, resulting in systematic and regular ODS supervision and law enforcement.

**In terms of ODS atmospheric monitoring and evaluation,** in response to the lack of scientific monitoring capabilities and the lack of effective compliance evaluation mechanisms, the Chinese government has initiated the planning and construction of an ODS atmospheric monitoring network. Through establishment of a unified technical system of monitoring technology and comprehensive evaluation methods, quality management, data sharing and information release, monitoring and evaluation work will be organized to timely collect, analyze and evaluate the background and trend of ODS in the atmosphere, strengthen compliance monitoring and early warning capabilities and performance evaluation capabilities, so as to provide technical support for compliance management.

On the basis of summarizing previous experience in compliance practice, the Chinese government has made further improvement in compliance supervision and management by adopting the above measures in terms of scientific monitoring, law and regulation system, supervision and law enforcement, capacity building etc., so as to comprehensively enhance the implementation of the Montreal Protocol. At the same time, public participation and industry collaboration have been further consolidated to form a sound system of ODS supervision and management. The system will continue to operate effectively in the future to provide a strong guarantee for ensuring effectiveness of compliance.

**Appendix I: Progress of Decision 83/41 and all relevant work**

| No. | Activities | Decision 83/41 | Progress |
|---|---|---|---|
| 1 | Improve Law and Regulation System | a)i) Increase and extension of penalties for enterprises' non-compliance with the controlled substance regulations<br>C)d) Extension of penalties and prohibitions to consumers of controlled substances or products containing controlled substances, where appropriate; | ● The implementation of the Regulation has been assessed and *the Regulation on the Administration of Ozone Depleting Substances and Hydrofluorocarbons (Draft for Soliciting Opinions*) has been formulated based on the assessment opinions and new requirements for implementing the Protocol. The revision reinforces the punishment measures on various cases of violations, and incorporate HFCs into scope of control;<br>• As of the end of June 2020, MEE has completed the public opinion solicitation. At present, it is being revised based on the opinions and feedback;<br>• The Regulation (Revised Draft for Approval) will be submitted to the State Council for review in 2020. |
| 2 | Carry out law enforcement actions | a)ii) Intensification of inspections of enterprises currently or formerly using controlled substances<br>a)iii) Implementation of controlled-substance inspection plans for ecology and environment bureaus (EEBs);<br>a)iv) Increased provision of support and enforcement tools to EEBs;<br>c)ii) Increased direction on enforcement at the provincial | • During the 2019 special ODS law enforcement inspection organized by MEE, it is confirmed that 16 enterprises have been engaged in illegal use of CFC-11, the local EEBs have handled these cases in accordance with the law. In one case, the enterprise's legal representative was sentenced to 10 months of imprisonment for the crime of environmental pollution by |

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| | | level from the national government;<br>c)vi) Random testing of products that might contain controlled substances;<br>c)viii) Reporting on the details of enforcement activities, including the capacity of the reactor, amount of controlled substance on site, relevant records on feedstock purchases and sales, any penalties resulting from the enforcement action | the local court.;<br>• As of December 2019, 50 portable ODS instant detectors have been distributed to local EEBs;<br>• MEE launched a new round of special ODS law enforcement inspection nationwide at the end of July 2020. The inspection is mainly targeted at HCFC-141b and HCFC-22 production enterprises and illegal production and use of CFC-11;<br>• *The Guideline on the Supervision of Ozone Depleting Substances (Trial)* was issued and distributed to local EEBs in December 2019;<br>• In 2020, another joint special law enforcement action will be organized with participation by both central and local law enforcement officers.<br>• In 2021, through the national CTC online monitoring platform and industrial rewards for reporting platform, MEE will further intensify source control, crack down on illegal ODS production, and improve the identifying mechanism, investigation mechanism and disclosure mechanism of illegal ODS production cases in steps . |
| 3 | Intensify Source Control | b)iii) Real-time flow monitoring of CTC at chloromethane production enterprises | • All 16 chloromethane enterprises with CTC by-production have completed the installation of the CTC online production monitoring systems. MEE compiled |

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| | | | *the CTC Monitoring Platform Construction Plan;* the platform is currently in the stage of system design and development;<br>• From June 2019 to January 2020, MEE has dispatched supervisory working groups to 16 CTC by-production enterprises to carry out the on-site inspection which achieved continuous daily on-site supervision. A total of 14 rounds of on-site supervision with attendance reaching 577 had been conducted.. During the COVID-19 outbreak, the enterprises were required to report CTC related data weekly, and local EEBs have taken measures to conduct on-site inspections as needed.<br>• The online trial operation of the national CTC monitoring platform is expected to be completed by the end of 2020 to realize the online monitoring of CTC as by-product in all chloromethane enterprises. |
| 4 | Build capacity for implementing the Protocol | a)v) Development of an online registration and tracking system for controlled-substance users;<br>a)vi) Increased training for customs officers;<br>b)ii) Establishment of an additional six testing laboratories for controlled substances in products;<br>c)iii) Development of performance indicators for enforcement activities, such as the number of customs | • MEE had completed the construction of 8 ODS testing laboratories for industrial products, and all of them have obtained the expansion of CMA certificate for these laboratories to ensure testing results with legal effect could be provided;<br>• In October 2019, MEE has approved and issued two national environmental protection standards for the |

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| | | officers trained or inspections undertaken | determination of ODS in polyurethane foam and pre-blended polyols.<br>• In December 2019, MEE held a training workshop on ODS phase-out management, which trained about 120 officers and technical support personnel from the atmospheric environmental division of local EEBs. In December 2019 and July 2020, MEE held two training workshops for law enforcement personnel, the two workshops trained a total of 400 environmental law enforcement officers at the provincial, city and county level;<br>• Trainings have been conducted by key local EEBs: In October and November 2019, Henan, Jiangxi and Shanxi carried out training workshops respectively, a total of 1,130 personnel from provincial, city and county level atmospheric environmental management departments received training;<br>• MEE and the General Administration of Customs will continue to jointly organize the training workshops on ODS import and export management for a total of 70 customs officers in this October.<br>• Since October 2019, MEE has launched the construction of the ODS data information management system, which will be comprehensively updated based on |

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| | | | the existing HCFCs online information system to realize the online data reporting of enterprises. The online test of the system module will be completed before the end of 2020. |
| 5 | Enhance Cooperation with Industries | a)vii) Conduct an annual mass balance analysis of foam blowing components to determine the market size of the foam sector;<br>a)viii) Publicizing the outcome of investigations and increased communication with industry;<br>c)v) Regular and frequent consultations with industry and enterprises to ascertain market conditions;<br>c)vii) Conduct annual mass balance analysis of refrigeration and air-conditioning market to determine market size and verify reported HCFC consumption; | • Industrial associations have been providing technical support for supervision and management, policy formulation and law enforcement, and some technical experts directly participate in special law enforcement operation and on-site inspection supervision etc. During the revision of the Regulation, communications are conducted actively with industrial associations, experts, scientific research institutions and others, and their suggestions are fully incorporated during the revision process;<br>• China Plastic Processing Industry Association (CPPIA) cooperated with industry experts to analyze the situation of the polyurethane foam market in 2018 and consumption of various blowing agents by using mass balance analysis;<br>• MEE has communicated with industrial associations and experts to discuss the feasibility and methodology of mass balance analysis in the refrigeration and air-conditioning market. The feasibility research on the mass balance analysis of the ICR sector and RAC sector |

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| | | | has been completed. The analysis found that mass balance analysis was applicable to the use of HCFC-22 in the room air-conditioning manufacturing sector, but not to the industrial and commercial refrigeration sector. |
| 6 | Establishment of measuring and alerting capability | b)i) Establishment of a national controlled atmospheric monitoring network for controlled substances;<br>c)i) Fast-track atmospheric monitoring through movement or modification of existing equipment and/or flask sampling | • The National ODS Monitoring Expert Committee has been established and a joint expert team has been formed.<br>• MEE is organizing relevant domestic research institutions to develop high-sensitivity ODS atmospheric monitoring equipment.<br>• MEE will start the construction of ODS monitoring stations in 2021 and conduct ODS monitoring in 2022 as planned. |
| 7 | Non-governmental study | d) To note that the Government of China will consider engaging a non-governmental consultant to undertake a study (including quantitative data, where available, and qualitative market information) to determine the regulatory, enforcement, policy or market circumstances that might have led to the illegal production and use of CFC-11 and CFC-12 | • Through public bidding, MEE selected an independent non-governmental consulting agency (ESD China Limited) to conduct a study to evaluate the ODS phase-out regulations, policies, law enforcement and market circumstances and risks in China. At present, the study report has been completed and will be submitted to the 86$^{th}$ meeting of the ExCom. |

Appendix 2: Mass balance analysis of the PU foam sector in 2018

## 1. Background

Polyurethane (PU) foam can be divided into flexible foam (sponge), rigid foam and integral skin foam. Flexible PU foam is highly resilient and is widely used in sectors such as furniture manufacturing. The integral skin PU foam has high-resilience inner core and good strength skin, and is mainly used in sectors including automobiles and furniture in the manufacturing of auto seat, steering wheels, armrests, etc. Rigid PU foam mainly serves as thermal insulation materials, and as the material with the best thermal insulation performance known so far, it has been widely used in various sectors of the national economy. The main subsectors using PU rigid foam currently include household appliances (insulation), solar water heaters (water tanks), building materials (insulation materials), cold storage, refrigerated transportation (reefer containers, refrigerated vehicles, and square cabin, etc.), petrochemicals (pipelines), automobiles (integral skin foam for steering wheels, seat, ceilings, etc.), aerospace, furniture manufacturing, etc., and a small amount is used for non-insulation purposes such as shoemaking, floating body, etc.

The blowing agents of PU foam products are grouped into two categories, namely chemical blowing agents and physical blowing agents. Up to now, the main chemical blowing agent is water. PU physical blowing agents include the phased-out CFC-11, HCFC-141b in the phase-out process, as well as cyclopentane, hydrofluorocarbons (HFCs), hydrofluoroolefins (HFO) and methyl formate etc.. Due to the differences in molecular weights, different physical blowing agents require different amount of blowing agents to achieve the same foaming effect. Ratio of various blowing agents in PU foam pre-blended polyols is shown in Table 1.

**Table 1 Ratio of various blowing agents in pre-blended polyols**

| Blowing agent | Ratio in pre-blended polyols | HCFC-141b equivalent coefficient |
|---|---|---|
| CFC-11 | 24-28%，maximum distribution 25% | 0.80 |
| HCFC-141b | 18-25%, maximum distribution 20% | 1 |
| Water | 2.5-5%, maximum distribution 2.5% | 8 |
| Hydrocarbon (cyclopentane etc.) | 10-12.5%, maximum distribution 12% | 1.67 |
| HFC-245fa/365mfc | 10-12.5% (compared with CFC/HCFC system, more water is needed), maximum distribution 12% | 1.67 |

| | | |
|---|---|---|
| HFO | Around 20% (more water is needed) | 1 |

**Note**: HCFC-141b equivalent coefficient is the ratio of the blowing effect by an amount of other blowing agents to that of HCFC-141b of the same amount with HCFC-141b as the baseline blowing agent. For example, the equivalent coefficient HCFC-141b of the hydrocarbon blowing agent is 20%/12%=1.67, indicating that, for the same amount of hydrocarbon and HCFC-141b blowing agent, hydrocarbon can produce 167% foam produced by HCFC-141b. The coefficient is used to simplify the calculation of the amount of various raw materials when a foam product uses multiple blowing agents. The HCFC-141b equivalent coefficient is not completely related to the molecular weight of the blowing agent because considering different costs of different blowing agents, water is usually added to the higher-cost blowing agents when needed.

**2. Calculation and data sources of blowing agent consumption in the PU foam sector**

There are two main raw materials for PU foam: isocyanates (polymeric MDIs) and pre-blended polyols, into which the blowing agents are usually pre-blended. For foam products mainly using physical blowing agents (blowing agents other than water), the ratio of MDI to pre-blended polyols ranges from 1.05 to 1.1. When water is added to replace part or all of the physical blowing agents, MDI consumption will increase gradually and could bring the ratio up to 2. In addition, for foam products with high flame-retardant requirements or heat-resistant requirements (such as polyisocyanurate panels and pipes), the ratio can also reach 2.

In Chinese PU foam sector, the number of MDI suppliers is extremely limited, and they are all super large enterprises. Many organizations in the polyurethane sector have conducted continuous statistical analysis on the consumption data of the entire sector and its sub-sectors, and the data is highly credible. In contrast, pre-blended polyol suppliers are numerous and vary considerably. Statistics of the sector, especially its sub-sectors, is inaccurate. Therefore, MDI is used as the base data for analyzing blowing agent consumption in the PU foam sector: the amount of pre-blended polyols in different sub-sectors can be achieved by calculating the ratio of MDI to pre-blended polyols in various sub-sectors through the proportion of HCFC-141b conversion in each sub-sector and the distribution of the various blowing agent consumption in each sub-sector; consumption of various blowing agents can be calculated in different sub-sectors by using the estimated ratio of various blowing agents in each sub-sector, and the ratio of blowing agent in pre-blended polyols. In this way, the consumption of various blowing agents in each sub-sector could be reached, and the total amount of various blowing agents can be compared with the annual amount of various blowing agents obtained by our investigation.

**2.1 MDI consumption**

MDI consumption in the PU foam sector and its sub-sectors is provided by the consulting firm in collaboration with the China Plastics Processing Industry Association (CPPIA). During estimation of blowing agents consumption in the sub-sectors, MDI consumption in polyurethane products (such as adhesives, sealants, elastomers, etc.) that use no or few blowing agents is excluded.

Table 2 MDI consumption in the PU foam sector and its sub-sectors in 2018

| Consumption sub-sectors | Consumption of isocyanates (polymeric MDIs), 10,000T |
|---|---|
| Refrigerators and freezers | 48.67 |
| Small household appliances such as electric water heaters | 4.33 |
| Solar water heaters | 1.08 |
| reefer container | 3.47 |
| Automotive foam | 15.20 |
| Pipeline | 8.62 |
| Spraying foam | 5.20 |
| Panels | 6.24 |
| Filling (security doors) | 2.00 |
| Total | 94.81 |

**2.2 Investigation of various blowing agents consumption in the PU foam sector**

1. HCFC-141b consumption in the PU foam sector comes from annual data reporting by the government. In 2018, HCFC-141b consumption in the PU foam sector was 34,176.74 metric tons.

2. Consumption of HFCs/HFOs blowing agents and hydrocarbon blowing agents were obtained through investigation of suppliers by CPPIA. The categories of HFCs blowing agents used in Chinese PU foam sector include HFC-245fa/365mfc (HFC-365mfc may also be mixed with HFC-227ea), with a total consumption of about 8,300 metric tons in 2018. HFO-1233zd(E) is mainly used in refrigerator foam, with a consumption of about 1,800 metric tons in 2018. The main hydrocarbon blowing agents is cyclopentane, and two other categories, namely n-pentanes and isopentanes are also used. The total consumption in 2018 was about 43,000 metric tons.

3. No objective data source was found for consumption of water foaming agents, but we know water foaming applications in the Chinese PU foam market well. Water foaming is mainly used in automotive foam (seat, car parts of integral skin foam and ceilings, etc.), pipe insulation and filling foam sectors with low thermal insulation requirements.

4. In China, the PU foam sector also consumes other blowing agents such as methyl formate and liquid carbon dioxide, and their consumption in 2018 did not exceed 3,000 metric tons.

## 3. Calculation of various blowing agents consumption in the PU foam sector

### 3.1 Analysis of rationality of blowing agent consumption in terms of foaming efficiency of various blowing agent and the total sector scale

**Table 3 Proportion of blowing agents in foam products in the PU foam sector**

| Blowing agent | Amount, MT | HCFC-141b equivalent coefficient | Equivalent amount of HCFC-141b, MT |
|---|---|---|---|
| HCFC-141b | 34,177 | 1 | 34,177 |
| hydrocarbon | 43,000 | 1.67 | 71,810 |
| HFCs | 8,300 | 1.67 | 13,861 |
| HFOs | 1,800 | 1 | 1,800 |
| Water | 5,600 | 8 | 44,800 |
| Total | 92,877 | | 166,448 |

| | |
|---|---|
| PU foam production, 10,000 MT | 174.58 |
| The proportion of blowing agent in foam products based on HCFC-141b blowing agent | 9.5% |

According to the above calculations, the total consumption of blowing agents based on HCFC-141b accounts for about 9.5% of the total foam production. This is generally consistent with the practice of the PU foam raw materials, including HCFC-141b accounting for about 20% of pre-blended polyols and the ratio of MDI to pre-blended polyols being around 1.1. The above calculations are rational analysis, but it should be pointed out that there are other blowing agents such as methyl formate and liquid carbon dioxide in the Chinese PU foam market, and the total consumption should not exceed 3,000 tons.

### 3.2 Calculation of various blowing agents consumption in the PU foam sub-sectors (see

**Table 4)**

### 3.3 Analysis of differences

According to Table 3 and Table 4, the consumption of HCFC-141b and water is relatively consistent, but the total consumption of hydrocarbons and HFC/HFO calculated in Table 4 is about 4,700 metric tons more than that in Table 3. In our analysis, the main reason for the difference lies in our investigation focus on the cyclopentanes because there are a limited number of cyclopentane suppliers with whom we have established long-term information cooperation. However, n-pentane and isopentane, the two blowing agents with increased consumption in recent years and with broad applications, have received relatively little attention because we are not familiar with suppliers of n-pentane and isopentane. Another reason for the difference in blowing agent consumption is the fact that there are about 3,000 tons of other blowing agents in the PU foam sector, such as methyl formate, and liquid carbon dioxide.

## 4. Conclusion

The above analysis demonstrates that the consumption of MDI and various blowing agents obtained through various information channels is relatively consistent and reasonable.

The uncertainty of the analysis is mainly derived from the judgment on the ratio of water foaming. Due to lack of objective sources, making professional judgments based on our understanding of the sector is the only way. We believe that the sub-sectors of Chinese PU foam sector that use water foaming can support our judgment on water consumption in the PU foam sector.

**Table 4 Proportion of blowing agents and consumption calculation in the PU foam sub-sectors in 2018 (Unit: 10,000 MT)**

| Consumption sectors | MDI | ratio of MDI to pre-blended polyols | pre-blended polyols | Foam production | Hydrocarbon+ HFC+HFO | Hydrocarbon+ HFC+HFO | Water foaming | Water consumption | The amount of HCFC-141b in pre-blended polyols | HCFC-141b consumption |
|---|---|---|---|---|---|---|---|---|---|---|
| Refrigerators and freezers | 48.67 | 1.15 | 42.32 | 90.99 | 97% | 4.93 | 0% | - | 20% | 0.25 |
| Small household appliances such as electric water heaters | 4.33 | 1.15 | 3.77 | 8.10 | 92% | 0.42 | 0% | - | 20% | 0.06 |
| Solar water heaters | 1.08 | 1.08 | 1.00 | 2.08 | 10% | 0.01 | 15% | 0.006 | 20% | 0.15 |
| Reefer container | 3.47 | 1.15 | 3.02 | 6.49 | 100% | 0.36 | 0% | - | 20% | - |
| Automotive foam | 15.20 | 1.50 | 10.13 | 25.33 | 0% | - | 95% | 0.385 | 12% | 0.06 |
| Pipeline | 8.62 | 1.25 | 6.90 | 15.52 | 3% | 0.02 | 60% | 0.166 | 20% | 0.51 |
| Spraying foam | 5.20 | 1.05 | 4.95 | 10.15 | 0% | - | 5% | 0.010 | 25% | 1.18 |
| Panels | 6.24 | 1.08 | 5.78 | 12.02 | 5% | 0.03 | 0% | - | 21% | 1.15 |
| Filling (security door) | 2.00 | 1.05 | 1.90 | 3.90 | 0% | - | 85% | 0.065 | 20% | 0.06 |
| Total | 94.81 | | 79.77 | 174.58 | | 5.78 | | 0.641 | 1.78 | 3.42 |

**Note**: In China's PU foam industry, hydrocarbon blowing agents and HFC blowing agents are mainly used in refrigerators, freezers and reefer containers. They are usually mixed, and they have the same HCFC-141b equivalent coefficients, so they are calculated together. HFO's HCFC-141b equivalent coefficient is different from that of hydrocarbons, but it is also mainly used in refrigerators, freezers and reefer containers. Considering small amount of HFO, it is also calculated in

combination with hydrocarbons and HFC.

## Appendix 3: Mass balance analysis in room air-conditioning sector

### 1. Background

Based on the overall manufacturing and sales scale of the room air-conditioning (RAC) sector and the sales of room air-conditioners using HCFC-22 as refrigerant, China Household Electrical Appliance Association (CHEAA) conducted a mass balance analysis of HCFC-22 consumption in the RAC manufacturing sector for 2017 and 2018 to assess HCFC-22 consumption in the RAC sector and analyze HCFC-22 phase-out status in the sector in China.

### 2. Data sources

1) The total production of the RAC sector comes from statistical data of CHEAA;

2) Product mix and scale data of room air-conditioners for domestic sales are from Beijing All View Cloud Data Technology Co., Ltd.

3) Product mix and scale data of room air-conditioners for export come from the General Administration of Customs;

4) Sales of room air-conditioners using different refrigerants are from statistical and calculated data of CHEAA;

5) The HCFC-22 consumption per unit of room air-conditioners for various product types comes from investigation of refrigerant consumption in the RAC sector organized by CHEAA in 2011.

### 3. Calculation methodology

（1）At present, room air-conditioners using HCFC-22 refrigerant are mainly fixed-frequency products, which can be further subdivided into five categories: window air-conditioner, split air-conditioner with cooling and heating, stationary air-conditioner with cooling and heating, cooling only split air-conditioner and cooling only stationary air-conditioner.

（2）Since import of HCFC-22 air-conditioner products in non-A5 countries has been gradually banned around 2010, air-conditioners using HCFC-22 refrigerant for export are only sold to A5 countries.

（3）According to the calculation by CHEAA, the proportion of HCFC-22 refrigerant used in fixed-frequency room air-conditioners for domestic sale and export to A5 countries is about 70% at present;

（4）According to linear regression calculation results, marked HCFC-22 refrigerant charging quantity of a typical window air-conditioner (cooling capacity: 3 kW), split air-conditioner with cooling and heating (cooling capacity: 3 kW), a stationary air-conditioner with cooling and heating (cooling capacity: 5.5 kW), cooling only split air-conditioner (cooling capacity 3 kW), and cooling only stationary air-conditioner (cooling capacity: 5.5 kW) are respectively 0.89 kg, 0.89 kg, 1.66 kg, 0.84 kg, and 1.40 kg;

（5）According to sale scale of various product types, proportion of air-conditioners using

HCFC-22 refrigerant and charging quantity per unit, HCFC-22 consumption of various product types can be calculated separately, and the total HCFC-22 consumption of the RAC sector could be reached.

（6）Considering refrigerant leakage in the process of storage, transportation, charging, and repair, actual refrigerant charging quantity in the manufacturing process is often slightly larger than the quantity marked on the nameplate due to the manufacturer's consideration of product quality. Therefore, actual HCFC-22 consumption should be 10%~15% higher than the above calculation results.

**4. Calculation results**

According to the above methodology, HCFC-22 consumption in the RAC sector from 2017 to 2018 is estimated in the following table. HCFC-22 consumption in the RAC sector is about 53,600 metric tons in 2017, and about 51,500 metric tons in 2018, which are generally consistent with the annual sector consumption data reported to the Multilateral Fund Secretariat in 2017 and 2018.

| Year | 2017 | 2018 |
|---|---|---|
| Sales of fixed frequency stationary air-conditioner with cooling and heating / 10,000 | 1161 | 1082 |
| Sales of fixed frequency split air-conditioner with cooling and heating / 10,000 | 3800 | 3667 |
| Sales of cooling only stationary air-conditioner / 10,0000 | 26 | 23 |
| Sales of cooling only split air-conditioner / 10,000 | 254 | 306 |
| Sales of window air-conditioner/ 10,000 | 1356 | 1445 |
| Consumption of fixed frequency stationary air-conditioner with cooling and heating/ T | 15273 | 13962 |
| Consumption of fixed frequency split air-conditioner with cooling and heating consumption/ T | 26743 | 25335 |
| Consumption of cooling only stationary air-conditioner/ T | 284 | 249 |
| Consumption of cooling only split air-conditioner T | 1691 | 1994 |
| Consumption of Window air-conditioner consumption/ T | 9568 | 10007 |

| | | |
|---|---|---|
| HCFC-22 consumption/ T | 53559 | 51547 |