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执行蒙特利尔议定书
多边基金执行委员会
第八十八次会议
2021 年 11 月 15 至 19 日，蒙特利尔[1]

关于具有具体报告要求的项目的报告

1. 本文件介绍了已经提交本次会议的关于具有具体报告要求的项目的报告。将氟氯烃淘汰管理计划第一和第二阶段的完成日期延长至 2022 年 12 月 31 日之后的申请也是本文件的一部分。此外，本文件还包括自第八十五次会议以来提交供个别审议，但根据在 COVID-19 大流行期间举行执行委员会会议的商定程序，没有予以审议的报告。

2. 本文件由以下四部分组成：

第一部分：	关于具有具体报告要求，且没有未决政策、费用或其他问题的项目的报告，执行委员会不妨根据秘书处的建议就这些报告作出决定，无需进一步讨论（“一揽子核准”）。执行委员会会议的报告将逐一介绍本部分所载每一份报告和委员会通过的决定
第二部分：	关于具有具体报告要求，供执行委员会个别审议的项目的报告
第三部分：	将氟氯烃淘汰管理计划第一/第二阶段的完成日期延长至 2022 年 12 月 31 日以后的申请
增编一：	包括五份与中国有关的报告：[2] 氟氯化碳生产、哈龙、聚氨酯泡沫塑料、二类加工剂、制冷维修和清洗行业的财务审计报告；第 83/41 号决定(e)段所列活动的执行进度报告；确定可能导致非法生产和使用 CFC-11 和 CFC-12 的监管、执法、政策或市场环境（第 83/41 号决定(d)段）；关于四氯化碳生产及其原料用途的最新报告；淘汰甲基溴生产的行业计划

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[1] 由于 2019 冠状病毒病（COVID-19），将于 2021 年 11 月和 12 月举行在线会议和闭会期间批准程序。

[2] UNEP/OzL.Pro/ExCom/88/18/Add.1。

关于具有具体报告要求的项目的报告

3. 表 1 开列了提交第八十八次会议，建议一揽子批准的关于具有具体报告要求的项目的报告。

表 1：建议一揽子核准的关于具有具体报告要求的项目的报告

国家	项目名称	段次
与氟氯烃淘汰管理计划有关的报告		
阿根廷	氟氯烃淘汰管理计划 (第二阶段 – 关于企业 Celpack 的财务生存能力的最新情况)	5 – 9
科特迪瓦	氟氯烃淘汰管理计划 (第一阶段 – 关于通过对消耗臭氧层物质的进口、出口、过境、转口和贸易实行监管的部际法令以及采取其他措施，加强与氟氯烃进出口有关的监测和报告制度的报告)	10 – 13
加纳	氟氯烃淘汰管理计划 (第一阶段 – 进度报告)	14 - 24
洪都拉斯	氟氯烃淘汰管理计划 (第一阶段 – 核查报告所载建议的最新执行进度)	25 – 32
牙买加	氟氯烃淘汰管理计划 (第二阶段 – 核查报告所述加强许可证和配额制度以及监测和报告氟氯烃消费情况的措施的最新执行情况)	33 – 38
肯尼亚	氟氯烃淘汰管理计划 (第二阶段，第二次付款 – 核查报告所述加强氟氯烃许可证和配额制度监测和报告工作的活动的最新实施情况)	39 – 47
墨西哥	氟氯烃淘汰管理计划 (第一阶段 – 进度报告)	48 - 53
圣卢西亚	氟氯烃淘汰管理计划 (第一阶段，第五次付款 – 签署小规模供资协定 (SSFA) 和根据这些协定发放第一笔分期付款的最新情况)	54 - 59
利比亚	氟氯烃淘汰管理计划 (第一阶段 – 进度报告)	60 – 77
圣文森特和格林纳丁斯	氟氯烃淘汰管理计划 (改进许可证和配额制度以及加强海关的进口管制能力的进度报告)	78 - 83
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)	84 - 89
低全球升温潜能值项目		
埃及	关于在埃及的空调行业推广低全球升温潜能值制冷剂的项目 (EGYPRA)的最后报告	90 - 100
沙特阿拉伯	在空调行业推广适用于高环境温度、基于氢氟烯烃的低全球升温潜能值制冷剂的示范项目 (进度报告)	101 - 109
维修行业示范项目		
突尼斯	氟氯烃淘汰管理计划 (第一阶段 – 最后进度报告)	110 - 118
突尼斯	氟氯烃淘汰管理计划 (第二阶段 – 一家泡沫塑料制造企业 (Le Panneau) 改变技术)	119 - 127
消耗臭氧层物质废物处置项目		
巴西	消耗臭氧层物质废物管理和处置试点示范项目 (进度报告)	128 – 133
执行机构变更		
毛里塔尼亚	氟氯烃淘汰管理计划 (第一阶段 – 执行机构变更)	134 – 149
甲基溴		
阿根廷	甲基溴淘汰计划	150 - 152

4. 表 2 开列了提交第八十八次会议个别审议的关于具有具体报告要求的项目的报告以及关于所涉问题的简短说明。

表 2：关于供个别审议的具有具体报告要求的项目的报告

国家	项目名称	问题	段次
与氟氯烃淘汰管理计划有关的报告			
朝鲜民主主义人民共和国	氟氯烃淘汰管理计划 (第一阶段 – 活动进度报告)	鉴于联合国安全理事会决议导致在开展活动方面遇到挑战，请求提供指导	153 - 167

第一部分： 关于建议一揽子核准的具有具体报告要求的项目的报告

与氟氯烃淘汰管理计划有关的报告[3]

阿根廷：氟氯烃淘汰管理计划（第二阶段 – 关于企业 Celpack 的财务生存能力的最新情况）（工发组织和意大利政府）

背景

5. 执行委员会第八十四次会议审议了为阿根廷氟氯烃淘汰管理计划第二阶段第二次付款供资的申请。[4] 付款申请包括一份进度报告，这份报告除其他外指出，挤塑聚苯乙烯泡沫塑料企业 Celpack 从 HCFC-22 改为采用 CO_2 的改造工作已被推迟，原因是该企业面临经济困难，并有兴趣评估用丁烷替代氟氯烃的办法。执委会在核准为付款供资时要求工发组织在第八十五次会议上提交关于该企业财务生存能力的最新报告，并说明该企业是否将利用多边基金的援助，且有一项谅解是，如果把该企业撤出项目，将退还改造资金（第 84/64 号决定(d)(二)段）。

6. 根据第 84/64 号决定(d)(二)段，工发组织在第八十五、八十六和八十七次会议上提交了进度报告，[5] 表明 Celpack 的大部分债务是欠联邦公共收入局（AFIP）的债务，而阿根廷议会认识到 COVID-19 疫情的经济影响，批准延期偿付债务，以便为 2020 年 7 月 31 日到期的债务筹措资金。自那时以来，Celpack 一直按照税务局批准的时间表偿还债务。预计这将对该企业的财务生存能力产生积极影响。

进度报告

7. 工发组织向第八十八次会议提交了最新报告，表明 Celpack 继续按照联邦公共收入局批准的时间表支付所有款项。阿根廷政府和工发组织确认将继续监测 Celpack 的财务状况，政府进一步重申，在问题得到解决（即该企业的财务健康状况得到确认）而且执行委员会审议了解决情况之前，不会发放与 Celpack 相关的资金。

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[3] UNEP/OzL.Pro/ExCom/88/39、UNEP/OzL.Pro/ExCom/88/51 和 UNEP/OzL.Pro/ExCom/88/62 号文件分别载有与以下国家的氟氯烃淘汰管理计划有关的报告：巴西（暂时采用高全球升温潜能值技术）、印度尼西亚（第一阶段）和塞内加尔（第一阶段）。

[4] UNEP/OzL.Pro/ExCom/84/39。

[5] 执行委员会在第 85/4、86/22 和 87/7 号决定中注意到了在第八十五至八十七次会议上提交的进度报告。

8. 如前几份报告所述，如果发现该企业不具备财务生存能力，将考虑到在核准为阿根廷挤塑聚苯乙烯泡沫塑料行业供资时使用的灵活性条款，计算退还多边基金的资金数额[6]

建议

9. 谨建议执行委员会：

(a) 请阿根廷政府根据第 84/64 号决定(d)(二)段通过工发组织向第九十次会议提供关于挤塑聚苯乙烯泡沫塑料企业 Celpack 财务可行性的最新情况，并就该企业是否将在阿根廷氟氯烃淘汰管理计划第二阶段利用多边基金的援助做出决定，

(b) 指出如果上文(a)分段所述企业将不利用多边基金的援助，会考虑到在分配为阿根廷政府核准的挤塑聚苯乙烯泡沫塑料行业资金方面的灵活性，计算与该企业的改造相关的资金数额，并从为阿根廷氟氯烃淘汰管理计划第二阶段核准的下一次付款中扣除该数额。

科特迪瓦：氟氯烃淘汰管理计划（第一阶段 – 关于通过对消耗臭氧层物质的进口、出口、过境、转口和贸易实行监管的部际法令以及采取其他措施，加强与氟氯烃进出口有关的监测和报告制度的报告）（环境规划署和工发组织）

背景

10. 执行委员会第八十七次会议注意到关于未来在科特迪瓦氟氯烃淘汰管理计划第一阶段下通过对消耗臭氧层物质的进口、出口、过境、转口和贸易实行监管的部际法令以及采取其他措施，加强与氟氯烃进出口有关的监测和报告制度的进度报告，并要求科特迪瓦政府通过环境规划署在第八十八次会议上提供关于通过部际法令的最新情况（第 87/10 号决定）。

11. 科特迪瓦政府根据第 87/10 号决定，通过环境规划署报告说，由于 COVID-19 疫情带来的限制，四个有关部委签署部际法令的速度缓慢。截至 2021 年 9 月 9 日，环境和可持续发展部长以及工商部长已经签署该法令，而预算和国家投资组合部长以及经济和财政部部长预计将在 2021 年 12 月 31 日前签署。鉴于这一拖延，环境规划署将继续与政府跟进此事，向执行委员会通报情况，直到所有相关部委都签署了该法令。

秘书处的评论

12. 秘书处注意到，虽然部际法令尚未签署，但国家臭氧机构继续在国家臭氧委员会的指导下监测消耗臭氧层物质进出口许可证制度的实施情况。

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[6] 为挤塑聚苯乙烯泡沫塑料行业的两家企业核准的供资数额为 348,767 美元，低于估计的 439,200 美元的增支费用；当时商定阿根廷政府可以灵活地在两家企业之间分配资金，且有一项谅解是，这两家企业都将按时改为采用选定的技术（UNEP/OzL.Pro/ExCom/79/27 号文件第 76 段）。

建议

13. 谨建议执行委员会：

(a) 注意到环境规划署根据第 87/10 号决定提交、载于 UNEP/OzL.Pro/ExCom/88/18 号文件的关于未来在科特迪瓦氟氯烃淘汰管理计划第一阶段下通过对消耗臭氧层物质的进口、出口、过境、转口和贸易实行监管的部际法令以及采取其他措施，加强与氟氯烃进出口有关的监测和报告制度的进度报告；

(b) 请科特迪瓦政府通过环境规划署在第九十次会议上提供关于通过上文 (a) 分段所述部际法令方面的最新情况。

加纳：氟氯烃淘汰管理计划（第一阶段 – 进度报告）（开发计划署和意大利政府）

背景

14. 执行委员会第八十四次会议除其他外，请加纳政府、开发计划署和意大利政府每年提交与最后一次付款相关的工作方案的执行进度报告，直至项目完成，并提交核查报告，直至氟氯烃淘汰管理计划第二阶段得到核准（第 84/73 号决定(b)段）。

15. 开发计划署在第八十六次会议上代表加纳政府提交了氟氯烃淘汰管理计划第二阶段，其中包括氟氯烃淘汰管理计划第一阶段执行进度报告和延长第一阶段的申请。但是，没有按要求提交 2020 年氟氯烃消费量核查结果。执行委员会随后核准将第一阶段延长至 2022 年 6 月 30 日，同时要求加纳政府向第八十八次会议提交氟氯烃淘汰管理计划第一阶段的最新进度报告和氟氯烃消费量核查报告，并向 2022 年第二次会议提交项目完成报告（第 87/39 号决定(a)和(b)段）。

16. 开发计划署作为牵头执行机构，按照上述决定代表加纳政府提交了与氟氯烃淘汰管理计划第六次，也是最后一次付款有关的工作方案的最新年度执行进度报告，[7] 并提交了 2020 年氟氯烃消费量核查报告。

氟氯烃消费量

17. 加纳政府报告的 2020 年氟氯烃消费量为 15.97 ODP 吨，比与执行委员会达成的协定中为当年规定的 51.57 ODP 吨的目标低 67%，比 57.30 ODP 吨的氟氯烃基准消费量低 72%。政府还在 2020 年国家方案执行情况报告中上报了氟氯烃行业消费数据，该数据与根据《议定书》第 7 条上报的数据相一致。

18. 由于执行氟氯烃淘汰管理计划和在市场上引进替代技术，主要是氢氟碳化合物和碳氢化合物，氟氯烃消费量逐渐下降。 2020 年，氟氯烃占制冷剂进口总量的 52%，其次是氢氟碳化合物（43%，包括 HFC-134a：21%；R-410A：7%；R-404A：6%；R- 407C：4%；其他各种氢氟碳化合物：4%）和碳氢化合物（5%）。

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[7] 第八十四次会议核准了氟氯烃淘汰管理计划第一阶段的第六次，也是最后一次付款，费用总额为 121,311 美元，外加开发计划署的机构支助费用 9,098 美元。

核查报告

19. 核查报告确认，政府正在实施氟氯烃进出口许可证和配额制度，经核查的消费量为15.97 ODP 吨，与根据《蒙特利尔议定书》第 7 条和在国家方案报告中上报的数量相一致。加纳政府遵守了《蒙特利尔议定书》及其与执行委员会达成的协定。

制冷维修行业的活动

20. 在第一阶段中于 2021 年 4 月至 10 月期间开展了以下活动：

(a) 更新 LI 1812 号法律，就易燃制冷剂的安全操作提出要求； LI 1812 号法律正处于议会审批的最后阶段；国家臭氧机构一直在此过程中提供支持；

(b) 印制了涵盖碳氢化合物制冷剂的安全使用、储存、操作、充注技术和运输的改进版快速参考指南（1500 册），在培训课上分发给制冷从业人员；

(c) 通用制冷循环测试板招标成功，选定了一家供应商；预计将在 2021 年 10 月下旬交付设备；

(d) 已经选定第四个用于技师培训的英才中心（塔马利发展研究大学），正在进行整修；将购买工具和设备来支持培训； 250 名技师接受了良好维修做法、制冷剂泄漏控制、易燃制冷剂安全操作和使用替代品进行设备维修的培训； 11 个改造中心也已开始向技师和学徒提供易燃制冷剂安全操作培训。

资金发放水平

21. 截至 2021 年 9 月 7 日，在为氟氯烃淘汰管理计划第一阶段核准的 1,356,311 美元中已经发放 1,231,173 美元（91%）（向开发计划署发放 1,031,311 美元，向意大利政府发放325,000 美元）。其余的 125,138 美元将在 2021-2022 年期间发放。

秘书处的评论

<u>氟氯烃淘汰管理计划第六次付款执行进度报告</u>

法律框架

22. 加纳政府已发布 2021 年氟氯烃进口配额，为 20 ODP 吨，低于《蒙特利尔议定书》的当年控制目标。

制冷维修行业

23. 虽然第一阶段活动的开展由于 COVID-19 大流行带来的限制而受到妨碍，但政府的执行工作一直向前推进。第一阶段规划的各项活动正在取得进展；第一阶段最迟将于 2022 年 6 月 30 日完成。

建议

24. 谨建议执行委员会注意到开发计划署提交、载于 UNEP/OzL.Pro/ExCom/88/18 号文件的加纳氟氯烃淘汰管理计划第一阶段的最新 2020 年执行进度报告。

洪都拉斯：氟氯烃淘汰管理计划（第一阶段 – 核查报告所载建议的最新执行进度）
（工发组织和环境规划署）

背景

25. 执行委员会第八十六次会议核准了洪都拉斯氟氯烃淘汰管理计划第一阶段的第五次，也是最后一次付款。与付款申请相关的核查报告确认，许可证和配额制度是健全的，可以保证履约；然而，经核实的 2016 至 2019 年氟氯烃消费数据与根据《蒙特利尔议定书》第 7 条报告的数据有差异。出现这些差异的原因是在执行制度或编写正式的氟氯烃消费报告时出现疏忽，其中包括：将未落实的进口授权记录为进口；在编制官方数据报告时忽略了一次出口和一次进口；有一次进口被记录了两次；把同一个许可证号码分配给同一个进口商的两次进口。

26. 因此，核查报告除其他外建议：继续努力获取准确的报关数字，特别是准确的申报净重；无一例外地要求每次氟氯烃（乃至所有消耗臭氧层物质）出口都需要出口授权（许可证）；确保签发的每份进口授权的数字号码都是唯一的；确保消费量报告的准确性。

27. 执行委员会在核准第一阶段第五次付款时请工发组织向第八十八次会议提交关于核查报告所载建议执行进度的最新报告，包括报告政府为确保分别提交多边基金和臭氧秘书处的国家方案执行数据和第 7 条数据的准确性所采取的行动。[8]

进度报告

28. 工发组织代表洪都拉斯政府提交了一份进度报告，表明海关署已将与第一阶段第五次付款相关的独立核查所提出的建议纳入其程序。具体而言，海关署对进出口程序进行了以下调整：

(a) 对进口记录程序进行了修改，以确保进口/出口申报始终包括所采用的许可证的国家臭氧机构标识码和许可证到期日期（指出如果进口是在许可证过期后发生，应予以拒绝）；

(b) 修改了记录进口的电子系统，以确保：

  (一) 不接受未列入国家臭氧机构登记进口商名单的进口商的进口申报；

  (二) 不接受申报净重等于或大于申报毛重的进口申报；

  (三) 如果申报的 HCFC-22 净重加上同一进口商此前在同一年度进口的相同物质的累计净重超过分配给该进口商的年度进口配额，则不接受 HCFC-22 进口申报；

(c) 国家臭氧机构已获得查阅海关当局电子系统的权限（用户名和密码）。

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[8] 第 86/53 号决定(a)段；UNEP/OzL.Pro/ExCom/86/100 号文件附件十五所载规定。

29. 此外，国家臭氧机构向多边基金秘书处（2021 年 10 月 14 日）和臭氧秘书处（2020 年 10 月 21 日）提交了申请，请求根据核查报告修订分别在国家方案执行报告中和根据《议定书》第 7 条上报的 2016-2019 年氟氯烃消费量数据。

秘书处的评论

30. 秘书处赞赏地注意到洪都拉斯政府调整了电子系统，并调整了消耗臭氧层物质进出口许可证和配额制度的执行程序。秘书处认为，这些调整符合独立核查提出的建议，将大大减少在进出口信息的记录和核查过程中出现的疏忽。秘书处还注意到，在氟氯烃淘汰管理计划第一阶段开发的进口商、供应商和最后用户电子登记系统也将有助于为进出口数据的交叉核对创造有利条件，并有助于更好地实施消耗臭氧层物质进出口许可证和配额制度。

31. 秘书处还注意到向多边基金和臭氧秘书处提交的修订所上报的 2016 至 2019 年氟氯烃消费数据的申请。已对数据进行相应更正。

建议

32. 谨建议执行委员会注意到载于 UNEP/OzL.Pro/ExCom/88/18 号文件、工发组织提交的洪都拉斯氟氯烃淘汰管理计划第一阶段第五次付款核查报告所载建议的最新执行进度，包括洪都拉斯政府为确保分别提交多边基金和臭氧秘书处的国家方案执行数据和第 7 条数据的准确性所采取的行动。

牙买加：氟氯烃淘汰管理计划（第二阶段 – 核查报告所述加强许可证和配额制度以及监测和报告氟氯烃消费情况的措施的最新执行情况）（开发计划署和环境规划署）

背景

33. 执行委员会第八十六次会议原则上核准了牙买加氟氯烃淘汰管理计划第二阶段和第一次付款，并除其他外，要求牙买加政府和开发计划署向第八十七次会议提供加强许可证和配额制度以及加强氟氯烃消费量监测和报告工作的措施的最新执行情况，这些都是提交第八十五次会议的核查报告所建议的措施[9]（第 86/72 号决定(e)段）。

34. 开发计划署按照第 86/72 号决定(e)段向第 八十七次会议提交了一份报告，说明为落实核查报告所载建议开展活动的情况。由于并非所有建议都得到跟进，执委会要求牙买加政府和开发计划署向第八十八次会议提供最新信息，说明为落实提交第八十五次会议的核查报告所载建议所采取的更多步骤（第 87/ 11 号决定)。

35. 开发计划署按照第 87/11 号决定向第八十八次会议提交了一份报告，提供以下信息：

(a) 经过与牙买加空调、制冷和通风协会以及进口商协商，最终确定了经过修改的用于从进口商收集氟氯烃和氢氟碳化合物数据的数据报告模板，将使用这个模板报告 2021 年及以后的数据；

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[9] UNEP/OzL.Pro/ExCom/85/31 号文件第 9 段开列了将在氟氯烃淘汰管理计划第一阶段第四次付款期间根据核查报告的建议采取的行动。

(b) 正如向第八十七次会议报告的那样，牙买加海关署按照国家环境和规划署的建议，向牙买加报关行和货运代理协会通报了氟氯烃混合剂的正确关税代码。随后，国家臭氧机构将与牙买加海关署合作，在氟氯烃淘汰管理计划第二阶段继续为报关行和相关利益攸关方开展使用正确关税代码的能力建设活动；

(c) 2014 年贸易指令修订工作队负责根据氟氯烃淘汰管理计划第二阶段修订年度氟氯烃进口分配办法，并起草与冷却设备和制冷剂进口相关的政策。工作队在 2021 年 4 月至 9 月期间举行了两次会议，并计划于 2021 年 10 月举行另一次会议，以根据氟氯烃淘汰管理计划第二阶段敲定年度氟氯烃进口分配办法，并在冷却设备和制冷剂进口政策方面取得进展；

(d) 聘用了两名本国顾问，以确定进一步加强氟氯烃和氢氟碳化合物数据收集和报告制度的行动。将根据他们定于 2021 年 12 月完成的报告来采取相关行动。

秘书处的评论

36. 秘书处注意到，牙买加政府在开发计划署的协助下继续采取措施，加强许可证和配额制度以及氟氯烃消费量的监测和报告工作。然而，由于与 COVID-19 疫情带来的限制，未能完成 2014 年贸易指令的修订工作。开发计划署根据请求作进一步澄清，解释说，政府继续举行工作队会议，以促进氟氯烃控制政策和法规的实施，并正在采取措施尽快敲定相关法规。根据咨询师的报告，将在氟氯烃淘汰管理计划的第二阶段采取相关行动，加强氟氯烃和氢氟碳化合物数据收集和报告制度，并开展与氢氟碳化合物相关的其他活动。

37. 鉴于并非提交第八十五次会议的核查报告中的所有建议都得到跟进，牙买加政府和开发署将向第九十次会议提供最新情况。

建议

38. 谨建议执行委员会：

(a) 注意到载于 UNEP/OzL.Pro/ExCom/88/18 文件、开发计划署提交的在牙买加氟氯烃淘汰管理计划第二阶段根据核查报告中的建议，为加强许可证和配额制度以及氟氯烃消费量监测和报告工作所采取措施的最新执行情况；

(b) 请牙买加政府和开发计划署向第九十次会议提供采取更多措施，落实提交第八十五次会议的核查报告所载建议的最新情况。

肯尼亚：氟氯烃淘汰管理计划（第二阶段，第二次付款 – 核查报告所述加强氟氯烃许可证和配额制度监测和报告工作的活动的最新实施情况）（法国政府）

背景

39. 执行委员会第八十六次会议核准了肯尼亚氟氯烃淘汰管理计划第二阶段第二次付款。与付款申请相关的核查报告确认，肯尼亚政府正在执行一个许可证和配额制度；然而，经核实的 2017 至 2019 年氟氯烃消费数据与根据《蒙特利尔议定书》第 7 条报告的数据有差

异。执委会注意到，在某些情况下，海关记录的数据没有完全反映实际进口的数量，或是在没有许可证的情况下进口了氟氯烃。

40. 因此，核查报告建议除其他外，通过以下方式加强数据监测和报告工作：加强国家环境管理局（NEMA）和肯尼亚税务局（KRA）之间的协调和信息共享；持续开展面向进口商和监管机构的关于氟氯烃监测和控制的宣传教育方案；为海关和执法人员举办关于数据报告以及电子数据监测和报告系统使用程序的培训和能力建设方案。

41. 执行委员会在批准第二阶段第二次付款时要求肯尼亚政府通过法国政府向 2021 年最后一次会议提交一份情况报告，说明加强氟氯烃许可证和配额制度的情况以及根据核查报告中的建议与肯尼亚税务局共享氟氯烃进口信息的情况。[10]

42. 法国政府根据第 86/53 号决定(a)段提交了以下信息：

(a) 国家臭氧机构和国家环境管理局的代表在 2021 年 6 月至 9 月期间就修订后的消耗臭氧层物质法规的实施情况及其他问题举行了磋商；发放了消耗臭氧层物质进口执照和许可证；就进口许可证与进口商进行后续接触方面的行政事项；与统一海关 (HS) 编码有关的问题；综合海关系统以及与提供证明文件为氟氯烃清关有关的问题；

(b) 国家臭氧机构和国家环境管理局的代表还在他们参加的研讨会和会议期间讨论了执法问题；

(c) 在 2016 年环境和林业部发出信函，请国家环境管理局提交氟氯烃执照和许可证的副本以及包括进出口数量在内的制冷剂气体数据报告之后，管理局一直在向肯尼亚税务局提交进出口执照和进口许可证的副本，这有助于海关官员根据执照和许可证对进口货物进行检查；

(d) 2021 年 2 月和 3 月，国家臭氧机构和国家环境管理局的代表访问了氟氯烃进口商，目的是收集 2020 年的受控物质数据；在这些访问期间讨论了与氟氯烃进口流程、适用于肯尼亚的 HCFC-22 淘汰期限以及修订后的把氢氟碳化合物包括在内的消耗臭氧层物质法规有关的问题。

43. 法国政府还报告说，由于 COVID-19 大流行带来的限制，作为体制强化项目活动的一部分，仅在 2021 年 6 月为 15 名海关官员举办了一个关于氟氯烃进出口许可证和配额制度的执行问题以及监测和报告问题的培训方案（在体制强化项目下举办），并在 2021 年 6 月于蒙巴萨为清关和转运代理举办了一个讲习班，其内容包括消耗臭氧层物质法规的各种规定、清关代理使用单一窗口系统的程序、氟氯烃执照/许可证的发放程序、最新的制冷剂制冷以及空调设备的最新海关编码。

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[10] 第 86/53 号决定(a)段；UNEP/OzL.Pro/ExCom/86/100 号文件附件十五所载规定。

秘书处的评论

44. 秘书处注意到，虽然由于 COVID-19 疫情带来的限制，与加强氟氯烃许可证和配额制度的面对面会议和协商有关的活动受到影响，但国家臭氧机构与海关和执法当局、进口商和清关代理进行了讨论并交换了信息。

45. 法国政府在答复秘书处的询问时解释说，在线培训班普遍得到接受，但培训教师有些犹豫，认为面对面的培训和互动将确保接受培训的人员更加集中注意力，并且是分享氟氯烃监测和控制经验的更好平台。鉴于 COVID-19 大流行带来的限制，需要在 2021 年下半年和 2022 年规划和举办对海关和执法人员（包括来自所有边境控制站的人员）的在线培训。

46. 已经商定，由法国政府向第九十次会议提供关于加强氟氯烃许可证和配额制度以及与肯尼亚税务局共享氟氯烃进口信息的活动的最新情况。

建议

47. 谨建议执行委员会：

(a) 注意到载于 UNEP/OzL.Pro/ExCom/88/18 号文件、肯尼亚政府通过法国政府提交的关于加强氟氯烃许可证和配额制度以及与肯尼亚税务局共享氟氯烃进口信息的情况报告；

(b) 请肯尼亚政府通过法国政府在第九十次会议上提供关于为加强氟氯烃许可证和配额制度以及与肯尼亚税务局共享氟氯烃进口信息所开展的活动的最新情况。

墨西哥：氟氯烃淘汰管理计划（第一阶段 – 进度报告）（工发组织和开发计划署）

背景

48. 执行委员会第八十四次会议根据第 75/29 号决定(a)段审议了墨西哥氟氯烃淘汰管理计划第五次，也是最后一次付款[11]相关工作方案的最后一份年度执行进度报告。[12]

49. 报告指出，所有投资活动均已完成，制冷维修行业的活动即将完成，将把与一家未参加该计划的挤塑聚苯乙烯泡沫企业 (Plásticos Espumados) 相关的资金退还多边基金，而且根据政府与执行委员会之间的协定，氟氯烃淘汰管理计划第一阶段将在 2019 年 12 月 31 日之前完成业务，最迟将在 2020 年 6 月 30 日根据第 82/33 号决定(c)段提交项目完成报告。因此，执行委员会决定除其他外注意到：

(a) 企业 Plásticos Espumados 没有参加氟氯烃淘汰管理计划的第一阶段，在氟氯烃淘

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[11] 氟氯烃淘汰管理计划第一阶段的第五次，也是最后一次付款是在第七十五次会议上核准的，费用总额为 1,449,982 美元，其中包括给工发组织 226,317 美元外加机构支助费用 16,974 美元，给开发计划署 1,122,503 美元外加机构支助费用 84,188 美元。

[12] 有关规定反映在 UNEP/OzL.Pro/ExCom/75/85 号文件的附件十二（要求墨西哥政府、工发组织和开发计划署每年提交与最后一次付款相关的工作方案的执行进度报告，直至项目完成）。

汰管理计划第一阶段财务结算后，将在第八十七次会议上向多边基金退还核准资金 683,300 美元；

(b) 工发组织将在第八十五次会议上退还 24 美元余额；在氟氯烃淘汰管理计划第一阶段财务结算后，开发计划署和工发组织将在第八十七次会议上分别退还聚氨酯泡沫塑料行业改造经费的估计余额 300,000 美元和维修行业的任何所剩余额；

(c) 开发计划署和工发组织将提交关于第一阶段剩余活动完成情况的最后报告，以之作为随后提交的与氟氯烃淘汰管理计划第二阶段相关的进度报告的一部分，并根据第 82/33 号决定(c)段，最迟在 2020 年 6 月 30 日提交第一阶段的项目完成报告（第 84/22 号决定）。

50. 工发组织根据第 84/22 号决定(b) 和 (c)段，于 2020 年 7 月 3 日提交了氟氯烃淘汰管理计划第一阶段的项目完成报告，并在第八十六次会议上退还了其泡沫塑料和制冷维修行业项目的所剩余额，[13] 其中包括来自第一次付款的 3,615 美元外加 271 美元的机构支助费用，[14] 来自第五次付款的 11,701 美元外加 878 美元的机构支持费用。[15] 此外，作为与提交第八十八次会议的氟氯烃淘汰管理计划第二阶段第四次付款申请[16]相关的进度报告的一部分，工发组织提供了补充信息，证实第一阶段的所有活动都已完成。

51. 关于与开发计划署项目相关的资金余额（来自挤塑聚苯乙烯泡沫塑料企业 Plásticos Espumados 的 683,300 美元、聚氨酯泡沫塑料行业的估计余额 300,000 美元以及第一阶段已完成活动的其他余额），该机构在第八十七次会议上解释说，已按照商定，在 2019 年的年底前完成了泡沫塑料行业计划的业务。原定于 2019 年 12 月举行现场核查，以便进行安全评估并授权向最后一家改造的泡沫塑料企业发放最后一笔款项，但由于邻近工厂发生火灾，不得不把核查重新安排到 2020 年初进行。随后，由于 COVID-19 大流行带来的限制，开发计划署只能在 2021 年初进行最后检查和安全审计。该机构确认，它正在完成该项目的财务工作，向第八十八次会议退还资金。执行委员会因此注意到（第 87/15 号决定）：

(a) 由于 COVID-19 大流行带来的限制，对一家企业的最后核查和付款延迟，开发计划署无法按照第 84/22 号决定(a)段和(b)段在 2020 年 12 月 31 日之前完成墨西哥氟氯烃淘汰管理计划第一阶段的财务工作并在第八十七次会议上退还余额；

(b) 开发计划署将在第八十八次会议之前完成墨西哥氟氯烃淘汰管理计划第一阶段的财务工作，并在第八十八次会议上向多边基金退还未参加氟氯烃淘汰管理计划第一阶段的企业 Plasticos Espumados 的 683,300 美元已核准资金、聚氨酯泡沫塑料行业改造活动的 300,000 美元估计余额和氟氯烃淘汰管理计划第一阶段所剩的任何余额。

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[13] UNEP/OzL.Pro/ExCom/86/4 号文件附件四。

[14] MEX/PHA/64/INV/157

[15] MEX/PHA/75/TAS/144

[16] 由于资金发放水平低于 20%阈值，付款申请被撤回。

秘书处的评论

52. 秘书处在第八十八次会议上就第 87/15 号决定所述余额的退还问题与开发计划署进行了后续接触。开发计划署报告说，对最后一家改造的泡沫塑料企业进行的安全审计发现，安装的设备存在一个小问题，需要在开发计划署得以授权发放最后一笔付款之前加以解决。开发计划署表示，这个问题不影响所选择的技术或是其效率，并且已经得到解决。开发计划署与该企业签署了移交协议，于 10 月中旬进行了最后一次技术考察。然而，即使问题现已得到解决，开发计划署仍无法在第八十八次会议之前完成项目的财务工作和退还资金。开发计划署预计将在今年年底之前完成这一进程。秘书处因此指出，开发计划署将在第九十次会议上退还余额。[17]

建议

53. 谨建议执行委员会注意到：

(a) 由于需要解决在对最后一个改造的企业进行安全审计时发现的一个问题，从而能够发放最后一笔付款，开发计划署无法根据第 87/15 号决定(b)段在第八十八次会议之前完成墨西哥氟氯烃淘汰管理计划第一阶段的财务工作，在第八十八次会议上退还余额；

(b) 开发计划署将在 2021 年 12 月 31 日之前完成墨西哥氟氯烃淘汰管理计划第一阶段的财务工作，在第九十次会议上向多边基金退还没有参加氟氯烃淘汰管理计划第一阶段的企业 Plásticos Espumados 的 683,300 美元核准资金、聚氨酯泡沫塑料行业改造活动的 300,000 美元估计余额以及氟氯烃淘汰管理计划第一阶段的任何剩余余额。

圣卢西亚：氟氯烃淘汰管理计划（第一阶段，第五次付款 – 签署小规模供资协定（SSFA）和根据这些协定发放第一笔分期付款的最新情况）（环境规划署和工发组织）

背景

54. 执行委员会第八十七次会议核准了圣卢西亚氟氯烃淘汰管理计划第一阶段的第五次付款，且有一项谅解是，环境规划署最迟将在 2021 年 11 月 15 日与政府签署该次付款的小规模供资协定，并要求环境规划署向第八十八次会议报告该协定的签署情况和根据该协定发放第一次笔付款的情况（第 87/28 号决定(a)段）。[18]

55. 环境规划署根据该决定通报说，已经起草了第五次付款的小规模供资协定，并于 2021 年 8 月 27 日将其送交圣卢西亚征求意见。由于 COVID-19 大流行带来的限制，于 2021 年 9 月 16 日才收到政府的评论。环境规划署随后向政府提交了修订稿供其最后批准，预计将于 2021 年 10 月 1 日得到批准。

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[17] 执行委员会第八十九次会议将仅讨论政策问题。

[18] UNEP/OzL.Pro/ExCom/87/58 号文件附件十一。

56. 环境规划署通报说，一旦得到批准，环境规划署和政府预计最迟将在2021年10月29日签署小规模供资协定，将在2021年11月5日之前划拨协定下的第一笔付款。

秘书处的评论

57. 环境规划署根据一项关于做出澄清的请求表示，它将与国家臭氧机构密切合作，确保签署小规模供资协定并在预期时限内划拨第一笔付款。

58. 经商定，环境规划署将在第八十八次会议闭会期间核准程序中提供有关签署小规模供资协定和划拨第一笔付款的最新情况。

建议

59. 谨建议执行委员会：

(a) 注意到载于UNEP/OzL.Pro/ExCom/88/18号文件、环境规划署提交的为执行圣卢西亚氟氯烃淘汰管理计划第五次付款签署小规模供资协定和根据该协定发放第一笔付款的最新情况；

(b) 请环境规划署在第八十八次会议闭会期间核准程序中提供签署小规模供资协定和根据该协定发放第一笔付款的最新情况。

利比亚：氟氯烃淘汰管理计划（第一阶段 – 进度报告）（工发组织）

背景

60. 缔约方第二十七次会议注意到，利比亚报告的2013年氟氯烃年消费量为144.0 ODP吨，2014年为122.4 ODP吨，超过了该国在这两个年度的上述受控物质的最大允许消费量118.38 ODP吨，利比亚因此对《议定书》下的氟氯烃消费控制措施违约。缔约方会议又赞赏地注意到，利比亚提交了一项行动计划，用于确保恢复对《议定书》的氟氯烃控制措施的履约，根据该计划，利比亚特别承诺将氟氯烃消费量从2014年的122.4 ODP吨减少到：

(a) 2015年不超过122.30 ODP吨；

(b) 2016年和2017年不超过118.40 ODP吨；

(c) 2018年和2019年不超过106.50 ODP吨；

(d) 2020年和2021年不超过76.95 ODP吨；

(e) 2022年和随后年度不超过《蒙特利尔议定书》允许的水平。

61. 执行委员会第七十五次会议随后核准了利比亚氟氯烃淘汰管理计划第一阶段，以有利于该国执行恢复履约的行动计划。行动计划中提出的控制目标被作为《蒙特利尔议定书》第一阶段的控制目标。

62. 执委会第八十二次会议核准了氟氯烃淘汰管理计划第一阶段的第二次，也是最后一次付款，要求利比亚政府和工发组织提交最后一次付款工作方案的执行进度报告，并每年报告消费量，直至第一阶段完成（第 82/75 号决定）。

63. 执行委员会第八十四次会议除其他外，注意到利比亚安全局势严峻，将氟氯烃淘汰管理计划第一阶段延长至 2021 年 12 月 31 日，但有一项谅解是，将向第八十六次会议提交利比亚政府与执行委员会之间的经修订的《协定》草案，同时提交工作方案执行进度报告和一份核查报告（第 84/20 号决定）。

64. 执行委员会第八十六次会议注意到年度进度报告，并注意到利比亚政府与执行委员会之间关于 2015 至 2021 年期间的协定已经更新。

65. 工发组织作为牵头执行机构，根据第 82/75 号决定(c)段代表利比亚政府提交了上述进度报告和核查报告。

氟氯烃消费量

66. 利比亚政府报告的 2020 年氟氯烃消费量为 75.00 ODP 吨，比行动计划为该年度设定的控制目标低 1.95 ODP 吨。由于执行氟氯烃淘汰管理计划，特别是实施限制了氟氯烃进口的许可证和配额制度，而且市场转向氟氯烃替代品，主要是氢氟碳化合物和氢氟碳化合物混合剂，氟氯烃消费量自 2014 年以来一直在下降。该国的安全和经济形势也是导致氟氯烃消费量减少的一个原因。

核查报告

67. 核查报告确认，政府正在实施氟氯烃进出口许可证和配额制度，而且利比亚遵守了《蒙特利尔议定书》的 2020 年控制目标。

进度报告

68. 利比亚的政治和安全局势不稳定，严重妨碍了氟氯烃淘汰管理计划的执行。 2020 年最后一个季度，安全局势有所改善，民族团结政府成立。新政府将环境总局（EGA）改为环境部。这将使国家臭氧机构能够进行氟氯烃淘汰管理计划下尚未完成的活动，并进一步获得议会的核准，来批准《基加利修正案》。

69. 泡沫塑料改造项目的执行工作已经恢复。 Al Najah（使用 105.37 公吨 HCFC-141b 生产用于制造连续板材的聚氨酯泡沫塑料）的若干设备已经交货；已经采购了包括环戊烷桶和发电机在内的更多设备，预计将于 2021 年 11 月交货，随后进行安装、调试和培训。由于前往利比亚的旅行禁令，供应商的工程师和培训人员无法进行安装、调试和培训。工发组织正在与供应商讨论完成改造的替代方案。预计该项目将于 2022 年 8 月完成该项目。

70. Al-Amal Alkhadar 公司（使用 17.53 公吨 生产 HCFC-141b 用于制造非连续聚氨酯泡沫塑料板材）的改造工作由于国内局势而被推迟。 2017 年，工发组织与设备供应商签署了采购订单，随后制造了设备，但交货被打断；目前，设备供应商、工发组织和国家臭氧机构一直在讨论向该国交付设备的备选方案。预计改造项目将于 2022 年 10 月完成。

71. 在维修行业开展了以下活动：

(a) 聘请了一名国际专家和一名本国专家为海关官员编制培训课程和手册；计划于 2021 年 11 月对 3 名主培训师和 25 名海关官员进行关于消耗臭氧层物质贸易管制、许可证和配额制度的强制执行、数据记录和消耗臭氧层物质识别的培训；

(b) 更新技师培训课程并编写技师培训手册；计划于 2022 年 1 月对 35 名技师进行关于氟氯烃淘汰、冷却理论以及制冷和空调系统安装、维修和保养期间的良好维修做法的培训；

(c) 制定并与国家臭氧机构商定了用于培训维修技师和供技师实际使用的设备和工具清单（包括制冷剂识别装置、双级真空泵、制冷工具包、泄漏检测器、便携式碳氢化合物充注机）；采购工作已经开始；预计将在 2021 年 12 月向利比亚交付设备；

(d) 制定良好维修做法国家标准和守则；预计将于 2021 年 10 月完成草案；

(e) 制定建立国家再生中心的国家准则；向国家臭氧机构提供 30 个便携式回收装置；为国家制冷剂再生中心采购设备；预计将于 2021 年 10 月下旬交付设备；

(f) 2020 年 11 月组织了一次研讨会/讲习班，介绍《蒙特利尔议定书》、利比亚的氟氯烃淘汰承诺以及许可证和配额制度，并分发了宣传材料。

资金支付水平

72. 截至 2020 年 10 月，在为氟氯烃淘汰管理计划第一阶段核准的 1,161,310 美元中，[19] 711,521 美元（占 61%）已经支付。 449,789 美元的余额将在 2022 和 2023 年支付。

秘书处的评论

法律框架

73. 政府发布了 2021 年配额，为 75 ODP 吨，低于该年度的《蒙特利尔议定书》控制目标。

进度报告

74. 缔约方在第 XXVII/11 号决定 2(c)段注意到，政府承诺在不久的将来禁止采购使用氟氯烃的空调设备，并考虑禁止此类设备的进口，秘书处注意到这点，询问此类禁令的执行情况。

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[19] 由于撤销泡沫塑料行业的一家企业（Alyem）的改造活动，扣除了 747,533 美元，此后对付款供资额进行了调整；已将这些资金退还多边基金。

75. 工发组织答复说，环境部将加快与有关行业的协调，确定控制程序的时间表以便发布禁令。做出决定时遇到的主要障碍是国家机构的分工，这可能妨碍该程序在所有省份的实施。预计政府将能够在 2023 年开始禁止进口使用氟氯烃的设备。

76. 根据第八十六次会议核准的协定第 14 段，第一阶段将于 2022 年 12 月 31 日之前完成。[20]

建议

77. 谨建议执行委员会注意到载于 UNEP/OzL.Pro/ExCom/88/18 号文件、工发组织提交的利比亚氟氯烃淘汰管理计划第一阶段执行进度报告。

圣文森特和格林纳丁斯：氟氯烃淘汰管理计划（改进许可证和配额制度以及加强海关的进口管制能力的进度报告）（环境规划署和工发组织）

背景

78. 圣文森特和格林纳丁斯政府执行了只有一个阶段的氟氯烃淘汰管理计划，并向第八十六次会议提交了氟氯烃淘汰管理计划的第四次付款。秘书处在审查所提交的文件时注意到核查报告中强调的数据差异以及许可证和配额制度的缺陷。经商定，政府将在环境规划署的协助下采取以下措施，进一步加强许可证和配额制度：

(a) 每半年与海关进行一次数据核对，以期建立国家臭氧机构和海关之间的共享数据库；从 2020 年开始根据核对后的消费量报告《议定书》第 7 条规定的数据；

(b) 通过更新实行新的协调制度（HS）编码，以便在 2023 年 6 月 30 日之前具备更好地识别每种氟氯烃的能力；对报关行和进口商进行有关使用正确 HS 编码，对氟氯烃、制冷剂及其产品进行正确分类以及在海关数据自动化系统（ASYCUDA）中输入数据的培训；[21]

(c) 每年 1 月 1 日之前向海关提供一份进口商名单和氟氯烃配额，以确保海关做好准备，支持许可证和配额制度的执行；政府将从 2022 年 1 月 1 日起实施这一改变，使该行业有时间为调整做准备。[22]

79. 执行委员会随后核准了氟氯烃淘汰管理计划的第四次付款，并请圣文森特和格林纳丁斯政府、环境规划署和工发组织向第八十八次会议提交一份报告，说明在改进许可证和配额制度以及加强海关的进口管制能力方面取得的进展。（第 86/53 号决定(a)段）。

80. 环境规划署根据第 86/53 号决定(a)段，代表圣文森特和格林纳丁斯政府提交了所要求的报告，说明加强许可证和配额制度的活动的开展情况如下：

(a) 财政、经济规划、可持续发展和信息技术部下属的国家臭氧机构于 2021 年 1 月

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[20] UNEP/OzL.Pro/ExCom/86/100 号文件附件八。

[21] 联合国贸易和发展会议的海关数据自动化系统。

[22] UNEP/OzL.Pro/ExCom/86/73 号文件第 14 段。

4 日向海关署提供了所有已登记进口商的名单和氟氯烃配额，以确保海关做好充分准备，支持执行许可证和配额制度；

(b) 由于苏弗里耶火山爆发和随后的恢复工作，没有在 2021 年 6 月进行海关署与国家臭氧机构之间半年一次的氟氯烃进口数据核对。海关署一直在全力关注与救援行动有关的紧急进口活动；现在计划于 2021 年底进行核对；

(c) 由于政府希望于 2022 年采用世界海关组织最近更新的 HS 编码，与海关署之间关于采用新的 HS 编码，更好地识别每种氟氯烃的讨论被推迟。一旦发布编码的最新版本，便将开始讨论；

(d) 由于 COVID-19 大流行和随后的火山爆发带来的限制，对报关行和进口商进行的关于使用正确 HS 编码、氟氯烃及其产品的正确分类以及在海关数据自动化系统中记录数据的培训被推迟。已重新安排在 2022 年进行培训。

秘书处的评论

81. 圣文森特和格林纳丁斯政府正计划开展一项本国进程，一旦世界海关组织发布 2022 版的 HS 编码，便着手制定关于该编码的法律，以便能够在每种氟氯烃之间进行区分，这是一个复杂的立法修订过程。

82. 秘书处注意到，政府已开始与海关署分享所有登记进口商的名单和氟氯烃配额；然而，由于自然灾害、COVID-19 大流行以及解决这些问题的优先行动，政府无法落实核查报告中的一些建议。秘书处认为，环境规划署和工发组织必须继续协助政府进一步加强许可证和配额制度以及数据报告制度，并继续报告这方面的进展。

建议

83. 谨建议执行委员会：

(a) 注意到载于 UNEP/OzL.Pro/ExCom/88/18 号文件、环境规划署提交的关于根据圣文森特和格林纳丁斯的氟氯烃淘汰管理计划，改进许可证和配额制度以及加强海关进口管制能力的进度报告；

(b) 请圣文森特和格林纳丁斯政府在环境规划署和工发组织的协助下继续开展所规划的活动，进一步加强许可证和配额制度，并在环境规划署的年度进度报告中和在提交氟氯烃淘汰管理计划第三次付款申请时报告所取得的进展。

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）（环境规划署）

84. 环境规划署根据第 86/16 号决定(f)(二)段，代表沙特阿拉伯政府提交了关于制冷维修行业剩余活动、海关培训和氟氯烃淘汰管理计划第一阶段监测工作的进度报告。

进度报告

85. 开展了以下活动：

(a) 国家臭氧委员会继续召开关于制定消耗臭氧层物质政策和法规的会议；一项新的消耗臭氧层物质法规于 2021 年 1 月 13 日生效，其中纳入了最新的海湾合作委员会条例；为 30 名参与者举行了两次会议，一次在 2020 年 12 月，另一次在 2021 年 1 月，目的是提高对新法规的认识；开发了一个关于新法规的网站。2017 年 1 月 22 日发布了一项与制冷和空调技师认证有关的法规，同时正在制定禁止一次性钢瓶的法规；

(b) 开发一个电子许可证系统，使进口商和出口商能够以电子方式提交申请；正在改进这个网站，使国家臭氧机构和相关利益攸关方加入电子许可证系统；

(c) 2021 年 4 月与技术和职业培训公司举行了一次会议，讨论为制冷和空调技师制定国家良好实践守则的问题，制定工作正在进行；还与负责技师认证的沙特工程师委员会举行了一次会议，讨论技师认证计划；

(d) 更新了技术和职业培训公司的培训课程，在其中纳入使用易燃制冷剂的制冷和空调设备的安全操作、维修和安装内容，并为 27 名制冷和空调技师举办了关于良好维修做法的讲习班；国家臭氧机构正在与技术和职业培训公司共同努力，重新启动已过期的谅解备忘录，以便合作实施培训和认证计划；

(e) 在 2019 年为泡沫塑料制造企业举办了三个讲习班，以提高对低全球升温潜能值发泡剂的认识，并对改造后制造厂家进行了监测考察。

秘书处的评论

86. 关于制冷和空调技师认证法规，环境规划署澄清说，根据与从事工程专业有关的法律，工程师只有在获得专业认证后才能从业；拥有毕业证书的技师（包括技术和职业培训公司的毕业生）在沙特阿拉伯被视为工程专业人员。迄今为止，已有 107 名技师在氟氯烃淘汰管理计划之下接受了培训，其中 59 人获得认证；尚不清楚该国有多少技师，也不清楚这些技师当中有多少获得认证。

87. 关于执行委员会与沙特阿拉伯政府之间的协定附录 8-A 所规定的与维修行业有关的四个条件，秘书处注意到：

(a) 正在制定针对一次性钢瓶的禁令；目前尚不清楚该禁令预计何时实施；

(b) 虽然有规定要求工程专业人士须得到认证，但该国似乎只有少数技师得到认证；目前，技术和职业培训公司正在讨论重新启动先前与国家臭氧机构之间的谅解备忘录问题，以进行氟氯烃淘汰管理计划下的培训；目前正在更新技师做法守则；

(c) 关于出台一个制度，仅允许那些有经过认证的技师对制冷和空调系统进行维修和监督维修的实体获得制冷剂的问题，环境规划署澄清说，虽然没有规定只允许向经过认证的技师出售制冷剂，但新通过的法规要求所有实体都拥有经过认证的技师，不合规的实体将面临处罚。通过实施这项法规，再加上对大量技师进行培训和认证以及实行良好做法守则，将意味着这一制度得到落实；

(d) 关于实行一项战略，鼓励制冷和空调设备的最后用户进行泄漏检测和采取维修措施的问题，环境规划署澄清说，正在将所有控制措施和消耗臭氧层物质法规纳入新法规的实施。秘书处的理解是，良好做法守则一旦敲定，将包括这样的措施。

88. 环境规划署鉴于沙特阿拉伯政府与其之间的小规模融资协定（SSFA）的结束日期为 2021 年 12 月 31 日，并注意到有 129,400 美元的余额，正在与政府讨论延长该协定的问题。秘书处回顾说，根据第 86/16 号决定(f)(三)段，只有在提交了氟氯烃淘汰管理计划第一阶段的项目完成报告，该阶段的财务工作已经完成，所有资金余额均已退还给多边基金的情况下，才会审议沙特阿拉伯氟氯烃淘汰管理计划的第二阶段。

建议

89. 谨建议执行委员会注意到载于 UNEP/OzL.Pro/ExCom/88/18 号文件、环境规划署提交的沙特阿拉伯氟氯烃淘汰管理计划第一阶段剩余活动的年度执行进度报告（第 86/16 号决定(f)(二)段）。

低全球升温潜能值项目

埃及：关于在埃及的空调行业推广低全球升温潜能值制冷剂的项目 (EGYPRA)的最后报告（工发组织）

背景

90. 工发组织代表埃及政府向第八十四次会议提交了关于在埃及空调行业推广低全球升温潜能值制冷剂项目（EGYPRA）的报告。[23]虽然 EGYPRA 项目下的几乎所有活动当时都已完成，但由于无法找到经过认证的独立实验室来测试功率超过 65,000 英热单位 (BTU)/小时的使用易燃制冷剂的空调机和起草最后报告，并开发一个可供当地制造商使用的建模工具，需要更多的时间来完成对已经建成的中央空调机的测试。执行委员会因此核准将氟氯烃淘汰管理计划第一阶段延长至 2020 年 6 月 30 日，以便可以完成 EGYPRA 项目（第 84/17 号决定(c)段），并请埃及政府和工发组织在第八十六次会议上提交关于 EGYPRA 项目的最后报告（第 84/17 号决定(d)段）。

91. 工发组织在第八十六次会议上报告说，[24] 计划进行的关于建模工具的工作已经完成；将在氟氯烃淘汰管理计划第二阶段的第二次付款期间进一步改进该模型。但是，由于 COVID-19 大流行导致无法利用测试实验室，中央空调机的测试被推迟。工发组织预计可

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[23] UNEP/OzL.Pro/ExCom/84/49。

[24] UNEP/OzL.Pro/ExCom/86/21。

在 2020 年最后一个季度进行测试，分析测试结果，并在 2021 年第一季度起草最后报告。执行委员会应工发组织的请求核准将氟氯烃淘汰管理计划的第一阶段延长至 2021 年 6 月 30 日，并要求埃及政府和工发组织在第八十七次会议上提交关于 EGYPRA 项目的最后报告（第 86/24 号决定）。

92. 工发组织根据第 86/24 号决定，代表埃及政府向本次会议提交了关于 EGYPRA 项目的最后报告。

93. 找到了一个独立、合适的实验室来测试这些机器，但最初计划的四个原型中只有两个可以测试，因此测试只进行了一部分。具体而言，使用替代品之一（R-448B）的原型由于存在机械问题，无法测试，而 HCFC-22 基准空调机的机械问题无法及时解决；因此，只能测试使用 R-457A 和 R-454C 的原型。然而，原始设备制造商为这些替代品提供的两台基准 HCFC-22 空调机均未达到铭牌容量。

94. 进行的有限测试表明，R-457A 的性能优于 HCFC-22，而 R-454C 的性能较差；然而，由于原始设备制造商提供的两台基准 HCFC-22 机型存在性能问题，很难得出结论。此外，R-457A 中央空调机的性能优于 HCFC-22 中央空调机，与分体式空调机的测试结果不同，R-457A 分体式空调机的性能通常不如 HCFC-22 空调机。

95. 本文件附有最后报告。

秘书处的评论

96. 工发组织指出，该项目吸取的一个教训是，埃及设备制造商缺乏能够测试容量超过 60,000 BTU/小时的设备的设施，这妨碍了它们制造符合其基本设计的设备的能力，从而减慢了行业的创新和为采用低全球升温潜能值技术进行的改造。原始设备制造商重新设计了原型和基本机型，但由于其控制装置在测试的高温下失灵，无法进行测试。尽管 EGYPRA 项目现已完成，但原始设备制造商仍在优化原型和基本机型，这可以为氟氯烃淘汰管理计划第二阶段下商用空调行业正在进行的改造提供信息。

97. 秘书处回顾指出，在第八十四次会议上提出的报告说，一家国际制造商为一台中央空调机提供了微通道换热器，一家原始设备制造商正在使用该微通道换热器制造使用 R-444B 的中央空调机原型。工发组织澄清说，无法成功建造出原型机，因此没有进行测试。在氟氯烃淘汰管理计划第二阶段为商用空调行业提供的技术援助可能包括对上述微通道换热器进行更多的工作。

98. R-457A 和 R-454C 在世界范围内都不是用于空调的主要制冷剂。工发组织澄清说，为原型机测试做出的制冷剂选择参考了在选择、设计和制造原型机时空调市场发生的转变。具体而言，埃及设备制造商当时仅在其中央空调机中使用 HCFC-22，因此选择了 HCFC-22 的替代品。在对这些空调机进行测试时，R-410A 及其替代品已成为市场上的主导技术，但无法用 R-410A 替代品重建新的原型。应该指出，所测试的替代品之一（R-457A）的制造商目前并未将其提供给商业用途。

99. 秘书处在第八十四次会议上考虑到提交该次会议的报告对于为空调制造行业选择低全球升温潜能值替代品的重要性，编写了该报告的全面摘要。由于 EGYPRA 项目的最后报告中与中央空调机有关的调查结果尚无定论，本文件附件一载有秘书处在第八十四次会议上提供的摘要，以供参考。

建议

100. 谨建议执行委员会：

(a) 注意到载于 UNEP/OzL.Pro/ExCom/88/18 号文件、工发组织提交的关于在埃及的空调行业推广低全球升温潜能值制冷剂的项目（EGYPRA）的最后报告；

(b) 邀请双边和执行机构在协助第 5 条国家编制对空调制造业进行改造，改为采用低全球升温潜能值制冷剂的项目时考虑上文(a)分段所述报告。

沙特阿拉伯：在空调行业推广适用于高环境温度、基于氢氟烯烃的低全球升温潜能值制冷剂的示范项目（进度报告）（工发组织）

背景

101. 工发组织代表沙特阿拉伯政府向第八十七次会议提交了关于在空调行业推广适用于高环境温度、基于氢氟烯烃（HFO）的低全球升温潜能值制冷剂的示范项目的进度报告。

102. 第七十六次会议核准了制造、测试和优化使用低全球升温潜能值氢氟烯烃/氢氟碳化合物混合剂以及 R-290 的空调机中试机型的项目，目的是进行示范生产运行和改造一条生产线，费用为 1,300,000 美元，外加工发组织的机构支助费用 91,000 美元。

103. 执行委员会第八十次会议上同意将该项目从 2018 年 5 月延长至 2018 年 12 月 31 日，但有一项谅解是，不再申请延长。执行委员会该次会议还请执行机构最迟向第八十三次会议提交最后报告（第 80/26 号决定(g)段）。随后向第八十二次会议提交了一份简明的进度报告，其中记录了许多活动取得的实质性进展，包括设备采购和零部件（例如压缩机）交货，但生产设备的交货和第一批 R-290 空调机的生产仍未完成。当时预计这些活动将于 2018 年 12 月完成。

104. 根据在第八十三次会议提出的报告，虽然制造设备已经交货，但由于企业已决定搬迁生产线，安装工作仍有待完成。不过，该企业计划初步安装有关设备，以便进行试运行和人员培训；该生产线将于 2019 年 9 月搬迁。需要进一步测试和优化设备。当时预计将于 2019 年 12 月完成这些活动和举办传播项目成果的讲习班。执行委员会就此注意到，执行工作已经进展到后期，而且项目成果有可能推广到若干第 5 条国家，从而决定破例把项目完成日期延至 2019 年 12 月 31 日，但有一项谅解是，不会请求进一步延长项目的执行工作。执委会并请工发组织最迟向第八十五次会议提交该项目的最后报告，并最迟向第八十六次会议退还所有资金余额（第 83/33 号决定）。

105. 根据在第八十五次会议上提出的报告，对空调机进行了进一步测试和优化；开发了一个能够充分运行的 R-290 微型分体式空调机原型，其容量为 18,000 英热单位（1.5 吨制冷量）。然而，第三方测试尚未进行，以待收到新一批原型压缩机和找到合适的实验室。

106. 已经搬迁了生产线，完成了土建工程，所有设备，包括完整的质量控制系统，都已安装完毕。然而，由于 COVID-19 大流行，原计划于 2020 年 2 月进行的生产线调试被推迟。根据计划，一旦因 COVID-19 疫情实行的旅行限制被取消，就对生产线进行测试。同样，虽然已经用所需设备和仪器对实验室和真实模拟测试室进行升级，但调试却被推迟。其他尚未完成的活动包括对生产线上的技师进行培训和举办最后一个讲习班，向利益攸关方传播项目成果。因此，执行委员会考虑到 COVID-19 大流行和项目已经进展到后期阶段，决定破例将项目完成日期延至 2020 年 12 月 15 日；要求工发组织在 2021 年 1 月 1 日前提交该项目的最后报告，并在第八十七次会议之前退还所有资金余额（第 85/17 号决定(b) 和(c)段）。

进度报告

107. 工发组织根据第 85/17 号决定，于 2021 年 10 月 1 日提交了一份项目报告。然而，由于时间有限，秘书处未能完成对该报告的彻底审查，包括未能与工发组织进行讨论。

108. 秘书处在初步审查中注意到，由于 COVID-19 大流行带来的持续限制，以下活动尚未完成：对意大利设备供应商（无法旅行）提供的生产线和实验室安全部件进行调试；R-290 逆变器压缩机的交货；[25] 改造后的生产线的试生产； R-290 空调设备的认证；[26] 完成面向技师的维修手册和培训材料；举办传播项目成果的讲习班。秘书处注意到进行中的活动可在近期内完成，建议破例将项目完成日期延至 2022 年 3 月 15 日，并要求工发组织最迟于 2022 年 3 月 28 日提交项目的最后报告。

建议

109. 谨建议执行委员会：

(a) 注意到载于 UNEP/OzL.Pro/ ExCom/88/18 号文件、工发组织提交的关于在沙特阿拉伯空调行业推广适用于高环境温度、基于氢氟烯烃的低全球升温潜能值制冷剂的示范项目的进度报告；

(b) 鉴于 COVID-19 大流行和项目已经进展到后期阶段，破例将上文(a)分段所述项目的完成日期延至 2022 年 3 月 15 日；

(c) 请工发组织最迟于 2022 年 3 月 28 日提交上文 (a) 分段所述项目的最后报告，并在第九十次会议之前退还所有资金余额。

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[25] 第一批采购的 R-290 压缩机没有达到制造商的质量标准，因此没有交货。压缩机制造商得以解决质量问题，但由于 COVID-19 大流行，压缩机尚未发货启运。

[26] 根据海湾合作委员会关于在市场上投放空调机的条例，需要得到认证（称为“G-mark 认证”）。

维修行业示范项目

突尼斯：氟氯烃淘汰管理计划（第一阶段 – 最后进度报告）（工发组织/环境规划署/法国政府）

背景

110. 工发组织作为牵头执行机构，根据第86/30号决定(c)段[27]，代表突尼斯政府提交了关于与氟氯烃淘汰管理计划阶段第三次，也是最后一次付款工作方案的年度执行进度报告，概述如下。

氟氯烃消费量

111. 突尼斯政府报告的2020年氟氯烃消费量为23.24 ODP吨，比40.7 ODP吨的氟氯烃履约基准消费量低43%，比该国与执行委员会之间的协定所规定的25.91 ODP吨最大允许消费量低10%。

112. 突尼斯政府发布的2021年配额为23.63 ODP吨，低于该国与执行委员会之间协定所规定的最大允许消费量。

进度报告

113. 截至2021年9月，开展了以下活动：

(a) 使制冷技师认证制度符合欧洲含氟气体条例的要求，并敲定了对培训中心（即组织培训活动的职业学校）的最起码要求。预计将在2021年底前批准上述条例，目前正在氟氯烃淘汰管理计划第二阶段之下实施认证方案；

(b) 制定了关于天然和易燃制冷剂安全操作措施认证培训的新模块，并将该模块用于15个培训班，对112名制冷和空调技师（其中50名是培训教员）进行了培训；

(c) 敲定了试点改造示范项目的标准，并选定了一家超市（Magasin Central）为受援的最后用户，将把该超市的商用冷藏柜改造为使用R-290技术；

(d) 对15名海关官员进行了关于控制和识别氟氯烃和氢氟碳化合物以及对氟氯烃/氢氟碳化合物进出口许可证制度进行监测的培训。

资金发放水平

114. 截至2021年9月，在为氟氯烃淘汰管理计划第一阶段核准的700,458美元资金总额中，已发放678,816美元（占97%）。21,642美元的余额最迟将于2021年12月发放。

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[27] 要求突尼斯政府、工发组织、环境规划署和法国政府每年提交氟氯烃淘汰管理计划第一阶段工作方案的最后执行进度报告，直至项目完成，每年提交核查报告，直至氟氯烃淘汰管理计划第二阶段获得核准，并向第八十八次会议提交项目完成报告。

秘书处的评论

115. 秘书处注意到，尽管发生 COVID-19 大流行，但还是开展了第三次付款的一些活动。

116. 工发组织解释说，最后用户奖励方案（将通过法国政府实施）虽然由于疫情而出现拖延，但将在 2021 年 11 月进行转为采用 R-290 技术的改造，随后举办一个实地讲习班，向小型装置的拥有者提供技术援助和咨询，鼓励他们改为采用与自己的应用相关的低全球升温潜能值制冷剂。这项该活动将于 2021 年 12 月结束。 法国政府根据第 84/84 号决定(d)段，将向第九十次会议提交一份详细报告，说明试点示范项目的成果，使秘书处能够编写为今后项目提供信息的简介。

117. 工发组织还确认，氟氯烃淘汰管理计划第一阶段将按计划于 2021 年 12 月 31 日完成。

建议

118. 谨建议执行委员会：

(a) 注意到载于 UNEP/OzL.Pro/ExCom/88/18 号文件、工发组织提交的关于突尼斯氟氯烃淘汰管理计划第一阶段的最后执行进度报告；

(b) 请法国政府向第九十次会议提交一份详细报告，说明维修行业中小型用户使用零消耗臭氧层物质和低全球升温潜能值替代技术的试点示范项目的成果，使秘书处能够根据第 84/84 号决定(d)段编写为今后项目提供信息的简介。

<u>突尼斯：氟氯烃淘汰管理计划（第二阶段 – 一家泡沫塑料制造企业 (Le Panneau) 改变技术）</u>（工发组织）

背景

119. 执行委员会第八十四次会议原则上核准了 2020 至 2025 年的突尼斯氟氯烃淘汰管理计划第二阶段，[28] 将基准氟氯烃消费量减少 67.5%，资金数额为 1,564,946 美元，外加机构支助费用。

120. 氟氯烃淘汰管理计划第二阶段包括一项泡沫塑料行业计划，目的是对 GAN 和 Le Panneau 这两家企业进行改造，使其转用碳氢化合物发泡剂，从而淘汰 7.38 ODP 吨 HCFC-141b，其中 5.02 ODP 吨符合供资条件。核准的供资是以符合条件的消费量为依据，如表 3 所示。

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[28] UNEP/OzL.Pro/ExCom/84/60。

表 3.为聚氨酯泡沫塑料行业核准的第二阶段增支费用

企业	消费量 (进口多元醇所含 HCFC-141b)				费用 (美元)	成本效益(美元/公斤)
	实际数量		符合供资条件的数量			
	公吨	ODP 吨	公吨	ODP 吨		
GAN	52.5	5.78	35.76	3.93	350,001	9.79
Le Panneau	14.5	1.60	9.88	1.09	108,305	10.96
共计	**67.0**	**7.38**	**45.64**	**5.02**	**458,306**	**10.04**

121. 鉴于符合条件的消费量较低，Le Panneau 转用正戊烷的改造工作将需要该企业提供大量资金，用于改造发泡机并安装所有安全系统和设备，从而能够使用易燃发泡剂（估计为 313,500 美元[29]）。在此基础上，该企业与当地一家可提供氢氟烯烃多元醇发泡剂的配方厂商进行了技术讨论，了解了氢氟烯烃发泡剂的技术要求以及比正戊烷发泡剂增加的费用（即 131,133 美元）。在这些讨论之后，该企业提交了一项申请，目的是将最初申请的技术改为基于 HFO-1233zd(E) 的技术。[30] 该企业已承诺承担氢氟烯烃发泡剂的较高费用。

122. 突尼斯政府随后根据其与执行委员会之间的协定第 7(a)(五) 段，通过工发组织提交了一项在 Le Panneau 改变技术的申请，将基于正戊烷的发泡剂改为 HFO-1233zd。

秘书处的评论

123. 工发组织在答复一项进行澄清的请求时解释说，另一家企业，即 GAN，正在按照最初核准的方法改用环戊烷，没有与费用相关的问题，而且突尼斯没有其他泡沫塑料企业使用 HCFC-141b。

124. 工发组织又解释说，HFO-1233zd 容易获得，可以从埃及和欧洲国家进口。关于氢氟烯烃的价格，工发组织强调，向企业提供的增支经营费用足以使其进行改造，并且企业承诺在改造之后继续使用氢氟烯烃技术，以确保改造成果的长期可持续性。

125. 秘书处对照第八十四次会议为 Le Panneau 核准的项目费用，审查了利用新技术进行改造的拟议费用。工发组织根据所提供的信息表示，Le Panneau 将利用向该企业提供的 108,305 美元资金改为采用氢氟烯烃，同时指出，计算得出的费用总额为 131,133 美元；该企业将提供资金支付其余的数额。由于氢氟烯烃和环戊烷发泡剂都是低全球升温潜能值技术，预计温室气体的影响微乎其微。工发组织还表示，通过这项技术改变，该企业最迟能够在 2022 年 6 月完成制造活动的改造。

126. 秘书处还指出，这一技术改变将使企业持续采用低全球升温潜能值技术，并将有助于突尼斯实现履约目标。

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[29] 在第八十四次会议上为 Le Panneau 商定的增支资本费用总额为 313,500 美元，在根据符合供资条件的剩余消费量进行调整后，其中仅有 108,000 美元得到核准。

[30] 提供了突尼斯地方事务和环境部的 2021 年 8 月 16 日的信，其中确认了这一技术改变。

建议

127. 谨建议执行委员会：

(a) 注意到载于 UNEP/OzL.Pro/ExCom/88/18 号文件、工发组织代表突尼斯政府提交的于突尼斯氟氯烃淘汰管理计划第二阶段在一家企业 – Le Panneau – 的改造工作中改变技术的申请，即从基于正戊烷的泡沫发泡剂改为 HFO-1233zd；

(b) 核准上文(a)分段所述技术改变，但有一项谅解是，任何增加的改造费用将由企业承担。

消耗臭氧层物质废物的处置

巴西：消耗臭氧层物质废物管理和处置试点示范项目（进度报告）（开发计划署）

背景

128. 开发计划署作为指定的执行机构，根据第 79/18 号决定(c)(三)段[31]提交了巴西消耗臭氧层物质废物管理和处置试点示范项目的执行进度报告。

进度报告

129. 开发计划署在第八十六次会议上报告说，Essencis[32] 已在一个再生中心（Ecosuporte）焚化了 3,386 公斤消耗臭氧层物质废物，另外两个再生中心（Frigelar 和 CRN[33]）正准备焚化更多消耗臭氧层物质废物。

130. 开发计划署向本次会议报告说，2021 年 8 月续签了 Essencis 的消耗臭氧层物质废物焚化许可证，总共收到了 14,223 公斤来自五个再生中心的消耗臭氧层物质废物，其中 8,655 公斤已经焚化（包括先前焚化的 3,386 公斤）；剩余的 5,568 公斤将在 2022 年年中焚化。另一家再生中心 (Regentech) 也表示，将于 2022 年初把一些消耗臭氧层物质运往 Essencis 焚化。

131. 根据开发计划署与各再生中心之间的谅解备忘录[34]中的规定，将对这些中心的实验室进行定期监测，并由这些中心编写报告，说明对消耗臭氧层物质废物进行的纯度分析测试，

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[31] 请开发计划署将巴西和哥伦比亚消耗臭氧层物质处置试点项目作为“具有具体报告要求的项目”，提交年度进度报告，直至项目完成。

[32] 巴西的焚化设施销毁消耗臭氧层物质的活动得到了圣保罗州环境公司（CETESB）的授权。

[33] 全称为东北地区再生和再循环中心。

[34] 与四个再生中心签订了谅解备忘录，使其能够开展以下这样的活动：增加储存容量和对其实验室进行改造/改进，以便分析收集的废物到底是仍然能够回收和再利用，还是可以随时处置；这些中心提供季度报告，详细说明所分析的制冷剂的数量，并显示实验室正在按照巴西法规进行运作。

并说明与实验室活动有关的许可证。已在 CRN 成功安装了气相色谱设备，[35] 正在对实验室员工进行培训，以支持该系统的运行。

秘书处的评论

132. 秘书处指出，该试点示范项目正在按照第七十九次会议核准的经过修订的行动计划取得进展。开发计划署在答复一项关于澄清的请求时解释说，销毁设施自 2020 年 6 月以来一直运行，各再生中心一直在向该设施发送消耗臭氧层物质废物。根据第 79/18 号决定(c)(一)段的规定，[36] 将在 2022 年 12 月项目完成后向 2023 年的执行委员会第一次会议提交一份全面报告，其中将包括对消耗臭氧层物质废物的管理和处置进行评估。

建议

133. 谨建议执行委员会注意到载于 UNEP/OzL.Pro/ExCom/88/18 号文件、开发计划署提交的巴西消耗臭氧层物质废物管理和处置试点示范项目的进度报告。

执行机构变更

毛里塔尼亚：氟氯烃淘汰管理计划（第一阶段 – 执行机构变更）（环境规划署、开发计划署和工发组织)

背景

134. 毛里塔尼亚政府于 2020 年 9 月 9 日正式来函，申请由工发组织取代开发计划署作为氟氯烃淘汰管理计划第一阶段的合作机构。

135. 当时预计将向第八十七次会议提交毛里塔尼亚氟氯烃淘汰管理计划第二次付款申请，届时将申请变更合作机构，并将对政府与执行委员会之间的协定进行相关修改。

136. 执行委员会第八十七次会议注意到，由于没有提交进度报告和财务报告及其他原因，未能提交氟氯烃淘汰管理计划第二次付款申请，而且政府申请变更合作机构。执行委员会因此请秘书处致函毛里塔尼亚政府，敦促其与环境规划署合作提交所规定的进度报告和财务报告，要求开发计划署把在第一阶段下核准的所有资金退还多边基金，又敦促政府与环境规划署和工发组织合作，从而能够向第八十八次会议提交第二次付款，同时提交经过修订的行动计划，以便考虑到 2020 年和随后几次付款的资金重新分配以及合作机构的变更（第 87/26 号决定）。

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[35] 开发计划署指出，提供气相色谱设备的目的是改进和加强对所收集的废弃制冷剂的分析，确认这些制冷剂需要销毁，这是考虑到巴西试点项目的延长而经过修订的行动计划的一部分。

[36] 在 2022 年 12 月完成巴西的消耗臭氧层物质处置试点项目，向 2023 年第一次会议提交最后报告，最迟在 2023 年 7 月提交项目完成报告，并最迟在 2023 年 12 月退还资金余额，且有一项谅解是，执行委员会将不再考虑进一步推迟项目的完成日期。

137. 随后，秘书处为筹备第八十八次会议，与作为牵头执行机构的环境规划署、开发计划署和工发组织讨论了今后落实第 87/26 号决定的途径。环境规划署解释说，由于资金发放数额低，不太可能向会议提交付款申请，导致发放数额低的部分原因是开发计划署的技术援助出现执行拖延，另一部分原因是需要完成一次全面调查，确定毛里塔尼亚的实际消费量，而这次调查由于 COVID-19 大流行带来的限制而被推迟。因此，为了能够在合作机构负责的那一部分取得进展，秘书处建议在提交第二次付款之前连同执行工发组织所负责的那部分项目的行动计划提交合作机构变更申请，并提交经过修订的毛里塔尼亚政府与执行委员会之间的协定，在其中反映合作机构的变化以及因执行拖延而导致的 2020 年和随后几次付款的资金重新分配。

提交行动计划和经过修订的协定

138. 环境规划署代表毛里塔尼亚政府向第八十八次会议提交了变更合作机构的申请，包括工发组织所负责的那部分项目的行动计划以及经过修订的政府与执行委员会之间的协定。

139. 工发组织所负责部分的第一次付款的行动计划包括采购和分发 10 个制冷剂识别装置，用以加强海关对消耗臭氧层物质进口进行管制的能力（40,000 美元）；为两个制冷技师培训中心采购和分发设备（包括真空泵、回收气瓶、泄露检测装置、钎焊套件和基本工具）（20,000 美元）；采购和分发设备（即视听设备、笔记本电脑和消耗品），使制冷工程师和技师协会的七个分会能够为技师提供制冷培训（35,000 美元）；由一名国际专家提供相关技术援助（10,000 美元）。

140. 工发组织作为合作机构的行动计划将尽可能遵循最初商定的开发计划署的活动范围，包括加强两个培训中心和五个回收中心以及建立一个中央储存中心（其中一些活动将在工发组织的第一次付款的行动计划中启动)。如果在第一次付款的执行过程中出现对计划活动进行细微修改的必要性，将把这些调整纳入今后付款的行动计划。

141. 所提交的经过修订的协定包括合作机构变更，将 2020 年和 2022 年的付款合并为 2022 年的一次付款，并反映出将第一次付款的核准资金从开发计划署转拨给工发组织。将维持第一阶段的原定持续时间，最后目标年度为 2025 年，在 2026 年 12 月完成业务。

秘书处的评论

142. 秘书处注意到，把氟氯烃淘汰管理计划第一阶段的合作机构从开发计划署变更为工发组织的申请是在各有关方面通过协商达成一致后提出的，本次会议对变更合作机构的审议将使该国能够在第一阶段第一次付款的执行工作中取得更大进展。

143. 此外，开发计划署确认，没有发放在第一次付款下核准的资金（105,000 美元外加机构支助费用 7,350 美元）。这些资金将退还多边基金，转给工发组织。此外，本文件附件二所载经过更新的政府与执行委员会之间的协定提出，将原则上为第一阶段今后付款核准的资金从开发计划署转给工发组织。表 4 开列了开发计划署将退回的核准资金数额和原则上核准转给工发组织的资金数额。

表 4. 将从开发计划署转给工发组织的氟氯烃淘汰管理计划第一阶段资金 (美元)

说明	**数额**	**机构支助费用**	**共计**
第一次付款 (已核准) (MAU/PHA/80/TAS/25)	105,000	7,350	112,350
原则上为第二和第三次付款核准的资金	200,000	14,000	214,000
共计	**305,000**	**21,350**	**326,350**

144. 本文件附件二还载有拟议对毛里塔尼亚政府与执行委员会之间的协定进行的更新，即合作机构的变更和付款的重新分配。 表 5 开列了相关的变化。

表 5. 毛里塔尼亚氟氯烃淘汰管理计划第一阶段付款的拟议再分配 (美元)

具体说明	**2017 年**	**2018 年 2019 年**	**2020 年**	**2021 年**	**2022 年**	**2023 年 2024 年**	**2025 年**	**共计**
第八十次会议核准的资金分配								
牵头执行机构(环境规划署)的商定供资	150,000	0	25,000	0	41,750	0	85,750	302,500
牵头执行机构的支助费用	19,500	0	3,250	0	5,428	0	11,148	39,325
合作执行机构(开发计划署)的商定供资	105,000	0	50,000	0	150,000	0	0	305,000
合作执行机构的支助费用	7,350	0	3,500	0	10,500	0	0	21,350
商定供资共计	255,000	0	75,000	0	191,750	0	85,750	607,500
支助费用共计	26,850	0	6,750	0	15,928	0	11,148	60,675
商定费用共计	281,850	0	81,750	0	207,678	0	96,898	668,175
在第八十八次会议上拟议的资金分配								
牵头执行机构(环境规划署)的商定供资	150,000	0	**0**	0	**66,750**	0	85,750	302,500
牵头执行机构的支助费用	19,500	0	**0**	0	**8,678**	0	11,148	39,325
合作执行机构(**工发组织**)的商定供资	105,000	0	**0**	0	**200,000**	0	0	305,000
合作执行机构的支助费用	7,350	0	**0**	0	**14,000**	0	0	21,350
商定供资共计	255,000	0	**0**	0	**266,750**	0	85,750	607,500
支助费用共计	26,850	0	**0**	0	**22,678**	0	11,148	60,675
商定费用共计	281,850	0	**0**	0	**289,428**	0	96,898	668,175

氟氯烃消费量调查的进展情况和对上报的氟氯烃消费数据的修订

145. 在第八十次会议核准第一阶段期间，由于许可证和配额制度尚未运行，毛里塔尼亚政府根据最佳估计上报的氟氯烃消费量为 17 ODP 吨，国家臭氧机构在 2008 至 2015 年期间停止活动，只是在 2016 年初才重新建立。

146. 在进行项目审查时，根据该国的人口数量和地理分布、电力供应情况和人均国内生产总值估计，氟氯烃消费量大约为 6.60 ODP 吨。以这个水平为依据确定了氟氯烃消费量总减少数的起点，且有一项谅解是，一旦通过全面调查确定了实际消费量，而且进行了独立核查以证实数据的真实性，并确认有一个有效和运行中的氟氯烃进口、许可证和配额制度，可以对起点进行修订。还商定，如果经核实的氟氯烃消费量高于 6.60 ODP 吨的估计

起点，将不适用协定所载因未能履约而减少供资的条款。[37]

147. 秘书处在审查关于变更合作机构变的提议时注意到， 所报告的 2017 至 2020 年氟氯烃消费量（分别为 15.95、15.13、13.92 和 13.75 ODP 吨）超过了估计的起点。环境规划署解释说，在完成了氟氯烃消费量调查，确定了毛里塔尼亚的实际消费量之前，这些消费数据是临时数据。因此，将根据已完成和经过独立核实的调查结果修订所报告的消费量。

148. 由于氟氯烃消费量调查尚未完成，目前无法对协定进行这些可能的更多修改。然而，秘书处认为，现在需要对协定进行修订，反映合作机构的变更，使毛里塔尼亚能够采购为完成在第一次付款下启动的海关官员和制冷技师培训所需要的设备。

建议

149. 谨建议执行委员会：

(a) 注意到：

  (一) 毛里塔尼亚政府请求将氟氯烃淘汰管理计划第一阶段中最初计划由开发计划署实施的所有活动转给工发组织；

  (二) 多边基金秘书处更新了本文件附件二所载毛里塔尼亚政府与执行委员会之间关于氟氯烃淘汰管理计划第一阶段的协定，特别是根据将开发计划署所负责的部分转给工发组织而对附录 2-A 和第 9 段进行的更新，以及添加第 16 段，表明更新后的协定取代了在第八十次会议上达成的协定；

(b) 关于氟氯烃淘汰管理计划第一阶段第一次付款：

  (一) 请开发计划署在第八十八次会议上向多边基金退还 105,000 美元的资金外加 7,350 美元的机构支助费用（MAU/PHA/80/TAS/25）；

  (二) 核准将 105,000 美元的资金外加 7,350 美元的机构支助费用转给工发组织；

(c) 进一步核准把原则上为氟氯烃淘汰管理计划第一阶段第二和第三次付款核准的 200,000 美元供资外加 14,000 美元的机构支助费用从开发计划署转给工发组织。

<u>甲基溴</u>

<u>阿根廷：甲基溴淘汰计划</u>（工发组织）

150. 执行委员会第三十次会议核准了在阿根廷草莓、受保护蔬菜和切花生产中淘汰甲基溴的项目，并在第三十六次会议上核准了在烟草和无保护蔬菜的苗床土壤熏蒸中淘汰甲基溴的项目。随后在第四十五次会议上修订政府与执行委员会之间的协定。该协定虽然明确将检疫和装运前消毒处理方面的应用排除在国家甲基溴消费量目标之外，但并未把蒙特利尔议定书缔约方会议可能批准的必要用途豁免排除在外，而是明确规定在 2015 年实现零

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[37] 第 80/57 号决定(e)、(f)和(g)段。

国家甲基溴消费量。缔约方在 2015 年（第二十六次会议）至 2020 年（第三十一次会议）的每次会议上都为阿根廷批准了必要用途豁免。

151. 阿根廷报告的 2020 年甲基溴消费量为 12.35 ODP 吨，低于为该年度批准的 12.37 ODP 吨必要用途豁免数量。秘书处因此认为，阿根廷的 2020 年甲基溴消费量为零，这是协定规定的除了缔约方会议批准的任何必要用途豁免数量之外的消费量上限。

建议

152. 谨建议执行委员会注意到，根据政府与执行委员会之间达成的协定，除了蒙特利尔议定书缔约方会议核准的必要用途豁免数量之外，阿根廷 2020 年报告的甲基溴消费量为零。

第二部分：关于具有具体报告要求，供个别审议的项目的报告

与氟氯烃淘汰管理计划有关的报告

朝鲜民主主义人民共和国：氟氯烃淘汰管理计划（第一阶段 – 各项活动的执行进度报告）（工发组织）

背景

153. 执行委员会第七十三次会议原则上核准了朝鲜民主主义人民共和国氟氯烃淘汰管理计划的第一阶段，由工发组织作为牵头执行机构，环境规划署作为合作执行机构，在 2018 年 1 月 1 日之前将氟氯烃消费量减少到和维持在 66.30 ODP 吨的水平（比 78.00 ODP 吨的氟氯烃履约基准数低 15%）。这项核准是在执行机构确认，可以在遵守联合国安全理事会关于朝鲜民主主义人民共和国的决议[38]的情况下执行氟氯烃淘汰管理计划的第一阶段后做出的。

154. 执行委员会自核准第一阶段以来供核准了四次付款中的三次，总额为 808,550 美元（站原则上核准的 848,550 美元资金总额的 95.3%），并把原定由环境规划署实施的所有淘汰活动转交工发组织。根据政府与执行委员会之间的协定，计划在第八十一次会议上提交氟氯烃淘汰管理计划第一阶段的最后一笔付款，数额为 40,000 美元。然而，由于安理会决议，工发组织无法提交付款申请。

提交第八十五次会议的进度报告

155. 工发组织向第八十五次会议提交了氟氯烃淘汰管理计划第一阶段的执行进度报告，其中列出了迄今开展的活动、资金发放水平和在按照安理会决议继续开展活动方面遇到的挑战，并请执行委员会提供指导。

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[38] 在提交氟氯烃淘汰管理计划第一阶段之前征求了联合国安理会第 1718 号决议所设委员会的意见，以确认是否可以向该国提供该计划要求的设备或其他服务。

156. 报告指出，尽管安理会决议带来的困难，在第一和第二次付款期间开展的主要活动包括：

(a) 为该国海关采购了三台制冷剂识别装置；

(b) 在安理会委员会于 2015 年批准后，为 Puhung 建材厂购买了一台喷射发泡机，并编写了一份辅助设备合同和运送了这些设备，以便能够安装/调试喷射发泡设备；

(c) 经安理会委员会根据其第 2270(2016)号决议规定的程序予以批准，采购了聚氨酯泡沫塑料设备（甲酸甲酯）；对设备供应商签发了采购合同；该设备由于不能直接运往朝鲜民主主义人民共和国，采用了通过中国运输的办法，但由于中国海关当局拒绝放行，被退回供应商；

(d) 经安理会委员会批准采购和运送了制冷和空调维修技师培训设备，并于 2016 年 6 月分发给制冷维修技师；

(e) 于 2016 年 8 月和 9 月为 35 名制冷和空调维修技师举办了一个培训员培训班；

(f) 完成了为五名培训员增加的一次关于最佳制冷和空调维修做法的培训课程，这次培训于 2016 年 12 月在印度举办；

(g) 于 2017 年 5 月为 40 名海关官员举办了第一期培训员培训班。

资金发放水平

157. 截至 2020 年 3 月 30 日，在核准的 808,550 美元资金总额中，已发放 303,313 美元（38%），如表 6 所示。

表 6. 朝鲜民主主义人民共和国氟氯烃淘汰管理计划第一阶段财务报告 (美元)

付款	核准数	发放数	发放率 (%)
第一次	134,003	87,386	65.2
第二次	506,680	214,110	42.3
第三次	167,867	1,817	1.1
共计	**808,550**	**303,313**	**37.5**

氟氯烃淘汰管理计划第一阶段执行计划的最新情况

158. 尚未开展的活动包括：

(a) 制冷和空调维修技师和海关官员培训班的后续行动；

(b) 查明现有的再生和回收中心并采购更多设备；

(c) 一旦资金划拨渠道得到核准，投入运行，便设立一个项目管理单位。

159. 此外，由于 2017 年进一步发布的第 2397 号决议明令禁止“所有工业机械（HS 编码84和85）、运输工具（HS编码86至89）以及铁、钢和其他金属（HS编码72至83）”，被中国海关退回供应商的聚氨酯泡沫塑料设备不能再进口。在此决议之后，建议工发组织向安理会提交一份新的豁免申请，同时附上该国将进口的设备的最新清单。工发组织于2019 年 5 月 8 日提交了正式豁免申请，安理会委员会于 2019 年 6 月 18 日拒绝予以豁免。鉴于上述情况，工发组织无法着手交付该设备。

160. 非投资活动也因无法在国内转拨资金而受到影响，由于通过了第 2397(2017) 号决议，实施更严格的制裁，情况变得更加困难。

161. 鉴于上述情况，工发组织在其报告中表示，无法继续为朝鲜民主主义人民共和国执行氟氯烃淘汰管理计划，并将请求执行委员会提供指导。

秘书处的评论

162. 对工发组织在第八十五次会议上提交的报告的审议被推迟，并根据执行委员会为举行第八十六和第八十七次会议商定的程序将报告重新提交这两次会议。该报告已重新提交第八十八次会议。

163. 缔约方第三十二次会议[39]指出，朝鲜民主主义人民共和国的 2019 年氟氯烃消费量为72.27 ODP 吨，超过该国当年最高允许消费量 70.2 ODP 吨，氟氯烃年产量为 26.95 ODP吨，超过该国的最高允许产量 24.8 ODP 吨，因此，自从向第八十六次会议提交报告之后，该国未遵守《议定书》下的氟氯烃消费量和产量控制措施。此外，缔约方会议除其他外赞赏地注意到，该国提交了关于违约的解释和一项行动计划，以确保在 2023 年恢复遵守《议定书》的氟氯烃消费量和产量控制措施；还注意到根据该行动计划，朝鲜民主主义人民共和国承诺在不影响《议定书》财务机制运作的情况下，落实具体的氟氯烃产量和消费量削减数；敦促该国与相关执行机构合作，探索执行其行动计划的备选方案，在适用安理会相关决议的情况下淘汰氟氯烃的消费和生产；请该国制定更多的国家政策，促进氟氯烃淘汰，这些措施可以包括，但不限于进口禁令、生产禁令或安装新设备的禁令，以及对制冷技师和公司进行认证（第 XXXII/6 号决定）。[40]

164. 秘书处注意到，工发组织在整个项目执行过程中继续进行尽职调查和监测。在 2017年通过另一项安理会决议后，该机构根据第 1718 号决议向安理会委员会提交了豁免申请，同时附上经过更新的将进口到该国的设备清单，并就采购和出口为在该国淘汰受控物质所设计的设备与有关的联合国会员国保持密切合作。

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[39] 2020 年 11 月 23 日至 27 日。

[40] 朝鲜民主主义人民共和国政府根据第 7 条报告的 2020 年氟氯烃消费量和产量符合第 XXXII/6 号决定所载恢复履约的行动计划规定的消费量和产量。

165. 在筹备第八十七次会议时，秘书处询问朝鲜民主主义人民共和国氟氯烃淘汰管理计划的执行工作是否有任何新进展，工发组织答复说，除了在第八十六次会议提供的信息外，没有其他信息，只有安理会取消制裁或给予豁免的情况下，工发组织执行氟氯烃淘汰管理计划才是可行的。然而，工发组织无法获得这种豁免。工发组织因此重申，该组织无法继续为朝鲜民主主义人民共和国执行氟氯烃淘汰管理计划，并请求执行委员会提供指导。

166. 有人请求澄清，是否有任何新进展，使得能够向第八十八次会议提交第一阶段最后一次付款，工发组织对此表示没有任何更多的信息可以报告。

建议

167. 谨建议执行委员会适当考虑缔约方会议的第 XXXII/6 号决定，审议工发组织提交的关于朝鲜民主主义人民共和国氟氯烃淘汰管理计划第一阶段活动开展情况的信息。

第三部分：　将氟氯烃淘汰管理计划第一/第二阶段的完成日期延长至 2022 年 12 月 31 日以后的申请

背景

168. 已向第八十八次会议提交了 15 个国家的氟氯烃淘汰管理计划第一阶段和一个国家的氟氯烃淘汰管理计划第二阶段的延长申请，其完成日期均为 2021 年 12 月 31 日，现申请延长至 2022 年 12 月 31 日以后。秘书处认为， 由于拖延原因并非都与 COVID-19 大流行有关，需要逐案审查这些延长。[41]

169. 表 7 概要开列了 16 个第 5 条国家在完成氟氯烃淘汰管理计划第一或第二阶段方面出现拖延的原因。

表 7. 16 个第 5 条国家的氟氯烃淘汰管理计划第一/第二阶段延长申请概览

国家	机构	氟氯烃淘汰管理计划第一阶段		申请延长至	核准第二/第三阶段的会议	申请延长的理由
		上次付款 (会议)	尚未提交的最后一次付款			
巴巴多斯 (氟氯烃淘汰管理计划第一阶段)	开发计划署 / 环境规划署	第八十四次会议	是，给环境规划署的第四次付款	2023 年 12 月 31 日		海关培训、维修行业培训和认证、宣传教育活动以及核查报告的定稿出现拖延
博茨瓦纳 (氟氯烃淘汰管理计划第一阶段)	环境规划署 / 工发组织	第八十六次会议	否	2023 年 12 月 31 日	第八十六次会议	政府的行政审批过程发生延误，导致海关执法培训、维修行业培训和卓越中心设备的采购出现拖延

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[41] 原定于 2021 年 12 月 31 日完成，但由于 COVID-19 大流行带来的困难，需要最多延长至 2022 年 12 月 31 日的氟氯烃淘汰管理计划第一阶段分别在相关双边机构和执行机构的进度报告中述及；正在申请氟氯烃淘汰管理计划第二或第三阶段付款的第一阶段延长申请则分别在有关项目文件中述及。

国家	**机构**	**氟氯烃淘汰管理计划第一阶段**		**申请延长至**	**核准第二/第三阶段的会议**	**申请延长的理由**
		上次付款 (会议)	**尚未提交的最后一次付款**			
刚果 (氟氯烃淘汰管理计划第一阶段)	环境规划署 / 工发组织	第八十四次会议	给环境规划署的第五次付款	2023 年 12 月 31 日		海关培训、维修行业培训和宣传教育活动出现拖延；内部银行问题导致资金发放的拖延
科特迪瓦 (氟氯烃淘汰管理计划第一阶段)	环境规划署 / 工发组织	第八十四次会议	给环境规划署的第五次付款	2023 年 12 月 31 日		海关和执法培训、维修行业培训、维修行业和卓越中心设备采购以及核查报告的定稿出现拖延
多米尼克 (氟氯烃淘汰管理计划第一阶段)	环境规划署	第八十四次会议	给环境规划署的第三次付款	2023 年 12 月 31 日		玛丽亚飓风(2017 年)导致拖延；海关和执法官员培训、维修技师培训、宣传教育和外联活动以及核查报告的定稿进而出现拖延
格林纳达 (氟氯烃淘汰管理计划第一阶段)	环境规划署 / 工发组织	第七十七次会议	给环境规划署的第三次付款	2023 年 12 月 31 日		核查报告的定稿和第三次付款的提交出现拖延
海地 (氟氯烃淘汰管理计划第一阶段)	开发计划署 /环境规划署	第七十六次会议	给环境规划署的第三和第四次付款	2024 年 12 月 31 日		政治局势和自然灾害导致项目执行的拖延
牙买加 (氟氯烃淘汰管理计划第一阶段)	开发计划署 / 环境规划署	第八十五次会议		2023 年 12 月 31 日	第八十六次会议	海关和执法官员培训以及维修行业活动出现拖延；银行详细资料有误，导致资金划拨的拖延
马里 (氟氯烃淘汰管理计划第一阶段)	开发计划署 / 环境规划署	第八十三次会议	给开发计划署和环境规划署的第五次付款	2023 年 12 月 31 日		政治和安全局势导致项目执行的拖延
莫桑比克 (氟氯烃淘汰管理计划第一阶段)	环境规划署 / 工发组织	第八十三次会议	给环境规划署的第五次付款	2023 年 12 月 31 日		COVID-19 在 2020 和 2021 年带来限制，导致剩余的技师和海关官员培训活动，尤其是那些需要亲身到场的培训活动出现拖延
圣基茨和尼维斯 (氟氯烃淘汰管理计划第一阶段)	开发计划署 / 环境规划署	第七十四次会议	给环境规划署的第三次付款	2023 年 12 月 31 日		由于国家臭氧机构结构变化(2021 年 2 月)和过渡到新的蒙特利尔议定书项目组合行政管理，执行工作出现拖延
南苏丹 (氟氯烃淘汰管理计划第一阶段)	开发计划署 / 环境规划署	第七十七次会议	给环境规划署和开发计划署的第二和第三次付款	2024 年 12 月 31 日		政治和安全局势导致项目执行工作，包括核查报告，出现拖延
南非 (氟氯烃淘汰管理计划第一阶段)	工发组织	第八十三次会议	给工发组织的第五次付款	2023 年 12 月 31 日		泡沫塑料行业改造情况的技术检查和培训活动出现拖延
苏里南 (氟氯烃淘汰管理计划第一阶段)	环境规划署 / 工发组织	第八十一次会议	给环境规划署和工发组织的第四次付款	2023 年 12 月 31 日		海关和执法培训、维修行业培训、设备采购和向维修技师的分发以及宣传教育活动出现拖延
委内瑞拉玻利瓦尔共和国 (氟氯烃淘汰管理计划第二阶段)	工发组织	第八十二次会议	给工发组织的第二和第三次付款	不详		经济危机影响了为进口原料或制成品所需外汇的供应，国家臭氧机构工作人员减少，并出现其他机构变化
赞比亚 (第一阶段)	环境规划署 / 工发组织	第八十五次会议		2023 年 12 月 31 日	第八十六次会议	海关和维修行业培训以及设备采购出现拖延

170. 秘书处根据提交的信息注意到以下几点：

(a) 环境规划署在对 2020 年核准的博茨瓦纳、牙买加和赞比亚氟氯烃淘汰管理计划第二阶段进行项目审查的过程中通报说，这些项目原先预计在 2021 年 12 月 31 日之前完成，但出于各种原因，执行出现拖延，项目完成日期将为 2023 年 12 月 31 日；

(b) 环境规划署通报说，巴巴多斯、科特迪瓦、刚果、多米尼克、格林纳达、莫桑比克、圣基茨和尼维斯、南非和苏里南的氟氯烃淘汰管理计划第一阶段在执行中出现拖延的原因除了疫情造成的限制之外，还包括：与项目审批有关的行政手续拖延、与银行有关的问题引起的资金划拨拖延以及国家臭氧机构/蒙特利尔议定书活动行政管理的变化；

(c) 导致海地、马里和南苏丹氟氯烃淘汰管理计划第一阶段的执行工作出现拖延的原因，是国家臭氧机构和执行机构无法控制的国家政治和安全局势；

(d) 委内瑞拉玻利瓦尔共和国氟氯烃淘汰管理计划第二阶段的执行工作之所以出现拖延，是因为经济危机影响了为进口原料或制成品所需外汇的供应、国家臭氧机构工作人员减少和其他机构变化以及无法解决与核查氟氯烃消费量有关的问题。

秘书处的评论

171. 秘书处与环境规划署和工发组织进行了详细的磋商，同时考虑到 16 个第 5 条国家当中每个国家所遇到的挑战可能是独特的，并且需要尽早完成这些国家的氟氯烃淘汰管理计划第一阶段或第二阶段的执行工作，以避免剩余活动的实施时间过长，指出这将导致与氟氯烃淘汰管理计划其他阶段正在进行的活动以及与今后有关氢氟碳化合物的其他活动相重叠。

172. 根据讨论，商定了以下办法：

(a) 为了完成其氟氯烃淘汰管理计划第二阶段已经得到核准（2020 年）的博茨瓦纳、牙买加和赞比亚的第一阶段最后一次付款的相关活动，有关机构将向第九十次会议提交一份详细的执行计划，说明最后完成日期，同时指出，将继续进行未完成的活动，将其尽快完成；

(b) 巴巴多斯、科特迪瓦、刚果、多米尼克、格林纳达、莫桑比克、圣基茨和尼维斯、南非和苏里南的氟氯烃淘汰管理计划第一阶段的最后一次付款将于 2022 年提交，第二阶段正在编制中，为了完成与这些国家的氟氯烃淘汰管理计划第一阶段有关的活动，相关执行机构将继续进行未完成的活动，并向第九十次会议提交完成第一阶段的综合行动计划；

(c) 鉴于与海地、马里和南苏丹的政治和安全局势有关的不确定性，商定由环境规划署继续密切监测氟氯烃淘汰管理计划第一阶段未完成活动的进行情况，并在执行委员会的每次会议上提交执行情况报告，在氟氯烃淘汰管理计划第一阶段

业务完成之前，不为开展氟氯烃淘汰管理计划和氢氟碳化合物项目活动提交任何更多供资申请；

(d) 鉴于委内瑞拉玻利瓦尔共和国当前充满挑战的经济和政治局势，工发组织将继续进行氟氯烃淘汰管理计划第二阶段未完成的活动，并将向第九十次会议提交一项完成这些活动的综合行动计划。

建议

173. 谨建议执行委员会：

(a) 注意到UNEP/OzL.Pro/ExCom/88/18号文件表7所列将16个第5条国家的氟氯烃淘汰管理计划的完成日期从2021年12月31日延至2022年12月31日之后的申请；

(b) 破例允许继续进行下列国家的氟氯烃淘汰管理计划第一阶段的未完成相关活动：巴巴多斯（环境规划署）、博茨瓦纳（环境规划署和工发组织）、刚果（环境规划署）、科特迪瓦（环境规划署和工发组织）、多米尼克（环境规划署）、格林纳达（环境规划署）、莫桑比克（环境规划署和工发组织）、牙买加（环境规划署）、圣基茨和尼维斯（环境规划署）、南非（工发组织）、苏里南（环境规划署和工发组织）和赞比亚（环境规划署和工发组织），并请相关执行机构向第九十次会议提交经过修订的执行计划，包括在适用情况下提交氟氯烃淘汰管理计划第一阶段剩余付款的申请；

(c) 破例允许环境规划署继续进行海地、马里和南苏丹氟氯烃淘汰管理计划第一阶段的未完成相关活动，并向执行委员会的每次会议提交一份关于这些活动的执行进度报告，且有一项谅解是，在氟氯烃淘汰管理计划第一阶段业务完成之前，不为开展氟氯烃淘汰管理计划和氢氟碳化合物项目活动提交任何更多供资申请；

(d) 破例允许工发组织继续进行委内瑞拉玻利瓦尔共和国氟氯烃淘汰管理计划第二阶段的未完成相关活动，并向第九十次会议提交一项综合行动计划。

附件一

埃及空调业推广低全球升温潜能值制冷剂项目

1. 使用 Arkema、Chemours、Daikin 和 Honeywell 提供的制冷剂，在当地可利用的经认证实验室中测试了由多家企业提供的 19 台带有专用压缩机的定制的分体式样机。重复测试以进行优化。

2. 结果表明，使用 HCFC-22 和 R-410A 的替代品运行的样机具有提高制冷量和能效的潜力（R-410A 替代品的改进程度更高）。这些改进取决于能够提供所需性能的设备的正确部件的可用性和选择。

3. 需要进行能力建设，使制造厂家能够设计、优化和测试使用易燃制冷剂的空调机，以提高性能并满足能效标准，并在仪器和处理易燃制冷剂方面提升其测试设施。测试结果表明，从热力学角度来看，项目中使用的所有制冷剂都是可行的替代品；然而，与埃及的最低能效标准相比，结果显示，该行业在今后几年提供满足严格要求的高效空调机方面会遇到挑战。此外，在兼容性、商业可用性、安全性和成本等其他标准方面的可行性还需要进一步研究。

4. 表 1 比较了四个测试方案设计标准、测试协议、测试的制冷剂和限制条件：AREP 第二阶段[1]、埃及空调业推广低全球升温潜能值制冷剂项目、ORNL[2]和 PRAHA[3]：

表 1.PRAHA、埃及空调业推广低全球升温潜能值制冷剂项目、ORNL 和 AREP 第二阶段测试方案比较

方案		PRAHA	埃及空调业推广低全球升温潜能值制冷剂项目	ORNL – 第一阶段（小型分体空调）	AREP 第二阶段
1	**测试类型**	定制测试样机，与基准空调机相比：HCFC-22 和 R-410A	定制测试样机，与基准空调机相比：HCFC-22 和 R-410A	软优化测试，与基准空调机相比：HCFC-22 和 R-410A	对基准 R-410A 空调机进行软优化或无须改造设备的单个空调机
2	**样机数量**	13 台样机，每种具体的性能和制冷剂由一个或两个原始设备制造厂家制造，与基准制冷剂相比：HCFC-22 和 R-410A。样机和基准空调机总数 = 22	28 台样机，每种具体的性能和制冷剂由一个原始设备制造厂家制造，与基准制冷剂相比：HCFC-22 和 R-410A。样机和基准空调机总数 = 37	2 台商业可用的空调机，软修改以与基准制冷剂进行比较：HCFC-22 和 R-410a	22 台来自不同原始设备制造厂家的空调机，范围包括从分体式到水冷式

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[1] 美国制冷空调与供暖协会替代制冷剂评价方案，http://www.ahrinet.org/arep

[2] Abdelaziz，2015 年 Abdelaziz O、Shrestha S、Munk J、Linkous R、Goetzler W、Guernsey M 和 Kassuga T，2015 年。“高环境温度环境下的替代制冷剂评价：小型分体式空调的 R-22 和 R-410A 替代品”，ORNL/TM-2015/536。可查阅：https://www.energy.gov/sites/prod/files/2015/10/f27/bto_pub59157_101515.pdf。

[3] PRAHA 项目报告：https://www.unenvironment.org/resources/report/promoting-lowgwp-refrigerants-air-conditioning-sectors-high-ambient-temperature

方案		**PRAHA**				**埃及空调业推广低全球升温潜能值制冷剂项目**				**ORNL – 第一阶段（小型分体空调）**		**AREP 第二阶段**
3	**类别数量**	60 Hz		50 Hz		50 Hz				60 Hz		60 Hz
		窗式	小型分体式	有管	台柜式	小型分体式	小型分体式	小型分体式	中央	分体空调机	分体空调机	34 MBH 冷却、2x 36 MBH 分体式、48 MBH 台柜式、60 MBH 台柜式、72 MBH 台柜式
		18 MBH	24 MBH	36 MBH	90 MBH	12 MBH	18 MBH	24 MBH	120 MBH	18 MBH 相当于 R-22	18 MBH 相当于 R-410a	
4	**测试条件**	在 T1、T3 和 T3+（50°C）下的 ANSI/AHRI 标准 210/240 和 ISO 5151，以及在 52°C 下持续 2 小时的连续性测试				EOS 4814 和 3795（ISO 5151）T1、T2 和 T3 条件				ANSI/AHRI 标准 210/240 和 ISO 5153 T3（2010）条件		在 T1、T3 和 125°F 下的 ANSI/AHRI 210/240
5	**提供的样机和进行的测试**	在六个原始设备制造厂家制造的样机，在 Intertek 测试				在八个原始设备制造厂家制造的样机，在原始设备制造厂家的实验室进行有人见证的测试				ORNL，一个供应商——就地软优化		个别供应商，在自己的场所进行测试
6	**测试的制冷剂**	相当于 HCFC-22：HC-290、R-444B(L-20)、DR-3				相当于 HCFC-22：HC-290、R-444B(L-20)、DR-3、R-457A (ARM-32d)				相当于 HCFC-22：N-20B、DR-3、ARM-20B、R-444B(L-20A)、HC-290		相当于 R-410A：HFC-32、DR-5A、DR-55、L-41-1、L-41-2、ARM-71a、HPR2A
		相当于 R-410A：HFC-32、R-447A(L-41-1)、R-454B (DR-5A)				相当于 R-410A：HFC-32、R-447A (L-41-1)、R-454B (DR-5A)、ARM-71d				相当于 R-410A：HFC-32、R-447A (L-41-1)、DR-55、ARM-71d、HPR-2A		
		最终报告截至 2016 年 3 月										
7	**限制条件**	使用专用压缩机为选定的制冷剂制造新的样机，这些样机与原始设计的箱体尺寸相同，并将性能和效率与使用 HCFC-22 和 R-410A 设备的基准模型进行比较				使用专用压缩机为选定的制冷剂制造新的样机，条件是与 HCFC-22 和 R-410A 空调机相比，能够满足与选定模型相同的设计能力				在“软优化”流程中，更改两个样机的某些部件以适应不同的制冷剂		-无须改造设备； -通过调整膨胀装置、调整加注量和改变油种进行软优化； -使用变速驱动器调节压缩机转速的一种情况

*MBH = 英制热量单位

5. 虽然埃及空调业推广低全球升温潜能值制冷剂项目在设计上与其他项目相似，但它具有以下显著特点：

(a) 埃及空调业推广低全球升温潜能值制冷剂项目是氟氯烃淘汰管理计划的一个方案，旨在使当地制造厂家参与关于其行业最佳制冷剂替代品的决策。该方案的第二阶段将使制造厂家对优化流程有所了解；

(b) 参与该方案的制造厂家数量仅次于 AREP，并且与其他三个方案相比测试的样机数量更多。使用的八种替代制冷剂涵盖了制造样机时可用的制冷剂；

(c) 埃及空调业推广低全球升温潜能值制冷剂项目不仅关注高环境温度，而且关注埃及可能普遍存在的整个温度范围；以及

(d) 显示的测试结果更易于说明制冷剂、环境温度、设备应用和性能之间的关系

附件二

将列入经过更新的毛里塔尼亚政府与多边基金执行委员会关于减少氟氯烃消费量的协定的案文

（为易于查阅，有关改动用粗体显示）

9. 国家同意全面负责管理和执行本协定以及为履行本协定的义务由国家或以国家名义开展的所有活动。环境规划署同意担任牵头执行机构（“牵头执行机构”），**工发组织**同意在牵头执行机构的领导下担任国家根据本协定所开展活动的合作执行机构（合作执行机构）。国家同意接受各种评价，评价可能在多边基金监测和评价工作方案下或参与协定的任何机构的评价方案之下进行。

16. 开发计划署在第八十八次会议上停止担任国家在本协定下所开展活动的合作执行机构。本经过更新的协定取代毛里塔尼亚政府与执行委员会在后者的第八十次会议上达成的协定。

附录 2-A：目标与供资

行	详情	**2017 年**	**2018-2019 年**	**2020 年**	**2021 年**	**2022 年**	**2023-2024 年**	**2025 年**	**共计**
1.1	《蒙特利尔议定书》削减附件 C 第一类物质的时间表（ODP 吨）	18.45	18.45	13.33	13.33	13.33	13.33	6.66	不适用
1.2	附件 C 第一类物质的最高允许消费总量（ODP 吨）	6.60	6.60	5.94	5.94	5.94	5.94	2.14	不适用
2.1	牵头执行机构（环境规划署）议定的供资（美元）	150,000	0	**0**	0	**66,750**	0	85,750	302,500
2.2	牵头执行机构支助费用（美元）	19,500	0	**0**	0	**8,678**	0	11,148	39,325
2.3	合作执行机构（**工发组织**）议定的供资（美元）	*****105,000	0	**0**	0	**200,000**	0	0	305,000
2.4	合作执行机构的支助费用（美元）	*****7,350	0	**0**	0	**14,000**	0	0	21,350
3.1	议定的总供资（美元）	255,000	0	**0**	0	**266,750**	0	85,750	607,500
3.2	总支助费用（美元）	26,850	0	**0**	0	**22,678**	0	11,148	60,675
3.3	议定的总费用（美元）	281,850	0	**0**	0	**289,428**	0	96,898	668,175
4.1.1	本协定下要完成的议定的 HCFC-22 淘汰总量（ODP 吨）								4.46
4.1.2	之前阶段中要完成的 HCFC-22 淘汰量（ODP 吨）								0.0
4.1.3	剩余的符合资助条件的 HCFC-22 消费量（ODP 吨）								2.14

***在第八十八次会议上从开发计划署转给工发组织的资金。**

EGYPRA – Promotion of Low-GWP Refrigerants for the Air Conditioning Industry in Egypt

2021

Report

Project supported by the Multilateral Fund of the Montreal Protocol

UNITED NATIONS ENVIRONMENT

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

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We would like to acknowledge the assistance given by the government and the National Ozone Unit Officers of Egypt for their support in the implementation of the project phases and their assistance in facilitating communication with the different stakeholders.

We also acknowledge the independent International Technical Review Team that assist the project team in reviewing the process, results and the report of the project.

Prof. Roberto Peixoto (Brazil)
Prof. Walid Chakroun (Kuwait)
Dr. Omar Abdel Aziz (USA/UAE)

Acknowledgement also goes to the “Technology Providers” for providing refrigerant, compressors, and components free of charge

Refrigerant Providers: Arkema, Chemours, Daikin, and Honeywell.
Compressor providers: Emerson, Highly, and GMCC.
Components: Danfoss

The project team also acknowledges the OEM manufacturers who built the split system prototypes and tested them at their own facilities.

Elaraby
Fresh
Miraco
Power
Unionaire

And the OEMs who built the central units. These units were independently tested at MIRACO.

Delta Construction Manufacturing (DCM)
Egyptian German Air Treatment Company (EGAT)
Volta

Project Team

The National Ozone Unit – Ministry of Environment, Egypt: The ministry team provided guidance and direction and participated at project meetings and discussions. EGYPRA is funded by the HCFC Phase-out Management Plan (HPMP) of Egypt.

The Project Management: UN Environment and UNIDO provided overall management and coordination of the project, established the link with the technology providers, and oversaw the development of the report of the project. The Project was managed by Dr. Lamia Benabbas, Programme Officer – UNIDO and Mr. Ayman Eltalouny, International Partnership Coordinator, OzoneAction Programme – UN Environment

The Egyptian Organization for Standards: provided guidance on the Egyptian standards for testing as well as the minimum energy performance standards (MEPS).

The Technical Consultant, Dr. Alaa Olama advised OEMs during prototype design and construction. Devised testing methodology and testing TOR, consulted with OEMs to provide technical solutions for problems as they arose. The Technical Consultant witnessed-testing of all prototypes and baseline units, compiled testing data, and provided analysis of data.

The Coordination Consultant, Mr. Bassam Elassaad provided logistical support and coordination for the project and helped with writing of the final report.

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Acronyms

AHRI	Air Conditioning, Heating, and Refrigeration Institute
ANSI	American National Standards Institute
AREP	Alternative Refrigerant Evaluation Program
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
Btu/hr	Also denoted as Btuh, BTU/h or B.t.u/hr = British Thermal Unit per Hour
BV	Burning Velocity
CAP	Capacity
CC	Cooling Capacity
CFC	Chloro Fluoro Carbon
COP	Coefficient of Performance
DB	Dry Bulb
DC	District Cooling
DX	Direct Expansion
EE	Energy Efficiency
EER	Energy Efficiency Ratio
EGYPRA	Egyptian Program for Promoting Low-GWP Refrigerant Alternatives
EN	European Norms (Standards)
EPA	Environmental Protection Agency (US)
GWP	Global Warming Potential
HAT	High Ambient Temperature
HC	Hydrocarbons
HCFC	Hydro Chloro Fluoro Carbon
HFC	Hydro Fluoro Carbon
HFO	Hydro Fluoro Olefins
HPMP	HCFC Phase-out Management Plan
HVACR	Heating, Ventilation, Air Conditioning and Refrigeration
HX	Heat Exchanger
IU	Indoor Unit
IEC	International Electrotechnical Commission
IPR	Intellectual Property Rights
ISO	International Standards Organization
Kg	Kilograms
kW	Kilowatts
LCCP	Life Cycle Climate Performance
LFL	lower Flammability Limit
MEPS	Minimum Energy Performance Standards
MOP	Meeting of Parties
MP	Montreal Protocol
NOU	National Ozone Unit
ODP	Ozone Depleting Potential
ODS	Ozone Depleting Substances
OEM	Original Equipment Manufacturer
PRAHA	Promoting Low-GWP Refrigerants for the Air Conditioning in HAT Countries
PSI	Pounds per Square Inch
RAC	Refrigeration and Air Conditioning
ROWA	UNEP Regional Office for West Africa
RTOC	Refrigeration, Air Conditioning, and Heat pump & Technical Options Committee

SCFM	Standard Cubic Foot per Minute
SHR	Sensible Heat ratio
SNAP	Significant New Alternative Policy
Tdb	Dry Bulb Temperature
Twb	Wet Bulb Temperature
TEAP	Technical & Economic Assessment Panel
TEWI	Total Equivalent Warming Impact
TF	Task Force
TWB	Wet Bulb Temperature
UNEP	United Nations Environment
UNIDO	United Nations Industrial Development Organization
USD	US Dollars
VC	Vienna Convention
VRF	Variable Refrigerant Flow
WB	Wet Bulb
WG	Working Group

Executive Summary

HCFCs are used extensively in the refrigeration and air conditioning industry, in particular in the air-conditioning industry. Parties to the Montreal Protocol, in their 21st meeting, adopted a decision concerning HCFCs and environmentally sound alternatives. The decision calls for further assessment and support work to enable parties to find the best ways of moving forward particularly for those with forthcoming compliance targets related to consumption of HCFC in the air-conditioning sector. The program called *Promotion of Low-GWP Refrigerants for the Air-Conditioning Industry in Egypt (EGYPRA)* was adopted to respond to this need.

The aim of the project is to individually manufacture custom-built AC split unit prototypes and central unit prototypes operating with alternative refrigerants to test their performance and compare against baseline units operating with HCFC-22 and R-410A. The list of refrigerants used and the units produced and tested is as per the table below.

		Split system (mini-split)			**Central 120,000 Btu/hr**	
	Replacement for	**12,000 Btu/hr**	**18,000 Btu/hr**	**24,000 Btu/hr**	**Std. coil**	**Micro channel**
HC-290	HCFC-22	🟩	🟩	🟩	🟥	
HFC-32	R-410A	🟩	🟩	🟩	🟥	
R-457C (Arkema ARM-20a)	HCFC-22	🟩	🟩	🟩	🟩	
R-459A (Arkema ARM -71a)	R-410A	🟩	🟩	🟩	🟥	
R-454C (Chemours DR-3)	HCFC-22	🟩	🟩	🟩	🟩	
R-454B (Chemours DR-5A)	R-410A	🟩	🟩	🟩	🟥	
R-444B (Honeywell L-20)	HCFC-22	🟩	🟩	🟩	🟩	🟥
R-447A (Honeywell L-41)	R-410A	🟩	🟩	🟩	🟥	
HCFC-22 baseline		🟩	🟩	🟩	🟩	
R-410A baseline		🟩	🟩	🟩	🟥	

EGYPRA involved building and testing 19 custom built split unit prototypes with dedicated compressors provided by Emerson, GMCC, and Hitachi Highly, and 16 base units by five OEMs. The refrigerants were provided by Arkema, Chemours, Daikin, and Honeywell. All the prototypes and the base units were tested at locally available accredited labs at the time the tests were conducted and witnessed by the project's Technical Consultant who also advised the OEMs during the manufacturing stage. Tests were repeated for optimization by tweaking some of the components. A total of 140 witnessed tests were performed.

The program also involved testing three central unit prototypes with dedicated refrigerants provided by the technology providers and three HCFC-22 base units. All the prototypes and the base units were tested at an independent laboratory (the lab at MIRACO, an OEM involved in the split unit phase of the program, was used to test the central units). The tests were not witnessed by the technical consultant since they were performed at an independent lab and not at the equipment builders' labs. The tests were performed on units as received. The results from the tests were analyzed by an independent consultant. This report includes the results of the two prototypes that were tested.

The units were tested in the following conditions:

Outdoor temperature	Indoor dry bulb/wet bulb temperature	Observations
T_1 (35 °C)	27/19 °C	ISO 5151 condition
T_3 (46 °C)	29/19 °C	ISO 5151 condition
T_{High} (50 °C)	32/23 °C*	Maximum testing condition in ISO 5151
$T_{Extreme}$ (55 °C)	32/23 °C*	Max temperature in heat isles in cities

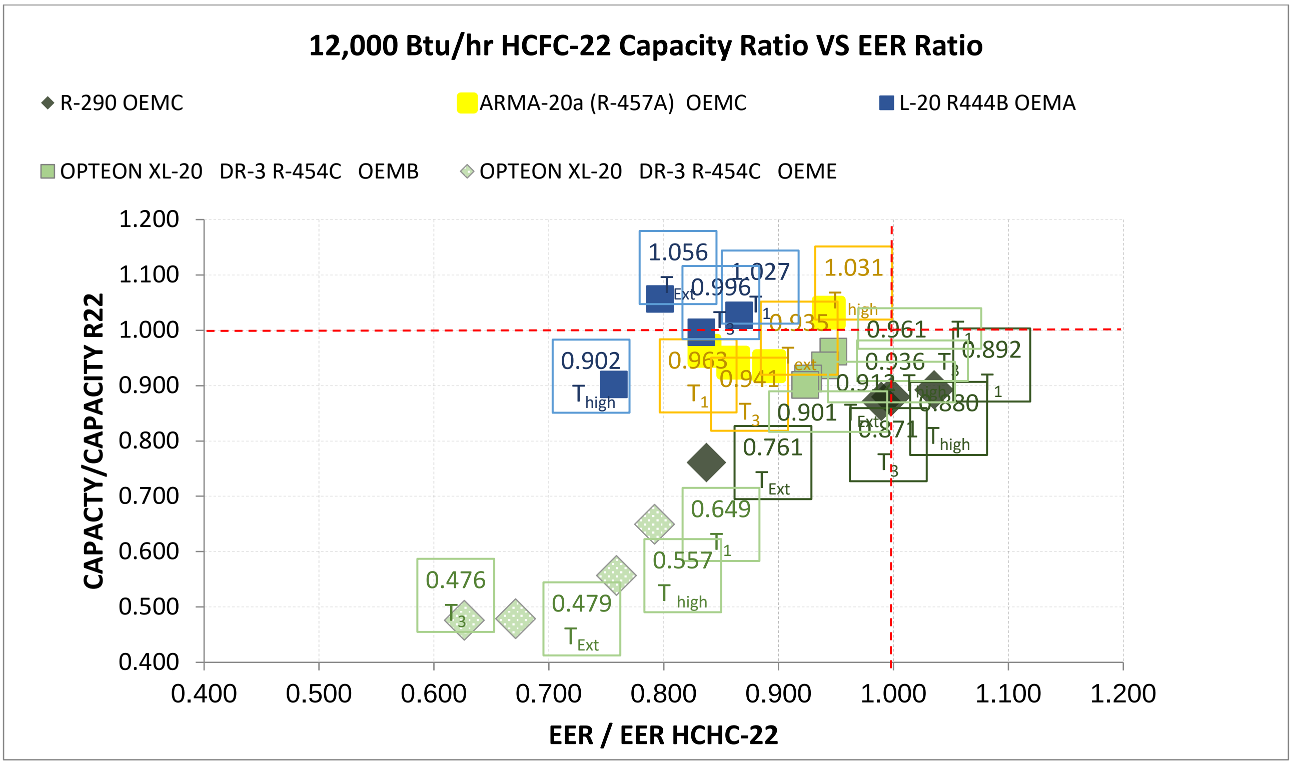
** These indoor temperatures are different from the ones used by other testing programs such as PRAHA, AREP and ORNL*

The test results gave higher capacities at T_{High} than at T_3.

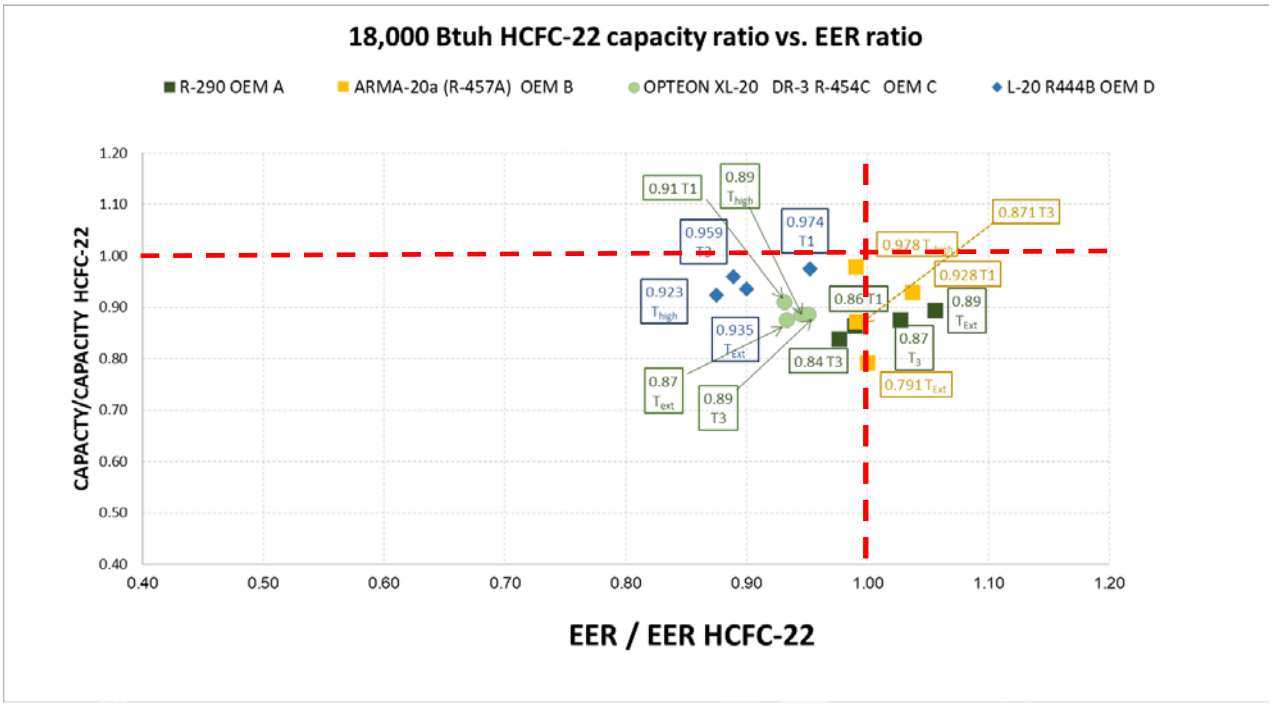
The casual reading of the results may establish confusion, even among specialists, in relation to the increase in capacity and EER at T_{High} (50 ^{o}C) compared to T_3 (46 ^{o}C). This result is not witnessed in other similar research projects; however, by understanding the impact of changing the dry bulb and wet bulb indoor testing conditions i.e. T_{high} (indoor dry bulb/wet bulb 32/24 ^{o}C) compared to T_3 (indoor 29/19 ^{o}C), the results can be explained. These results were randomly double checked through a simulation exercise.

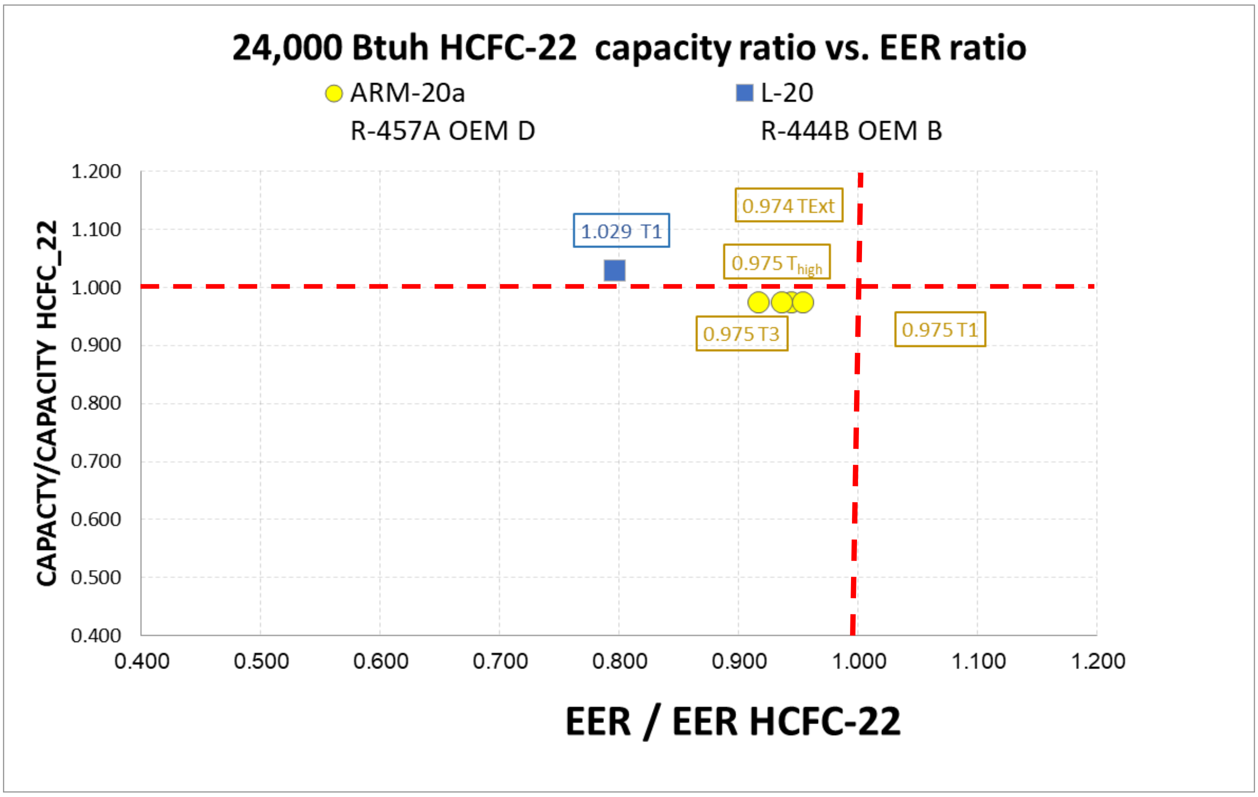
The test results are presented in comparison to the baseline units and color coded to denote the performance over or below the performance of the comparative baseline units. Scattered charts are plotted for the capacity ratio and EER ratio for the prototypes vs. the baseline units for each of the three split unit categories and for the HCFC-22 alternatives and the R-410A alternatives. The red lines denote performance comparable to the base unit

HCFC-22 alternatives

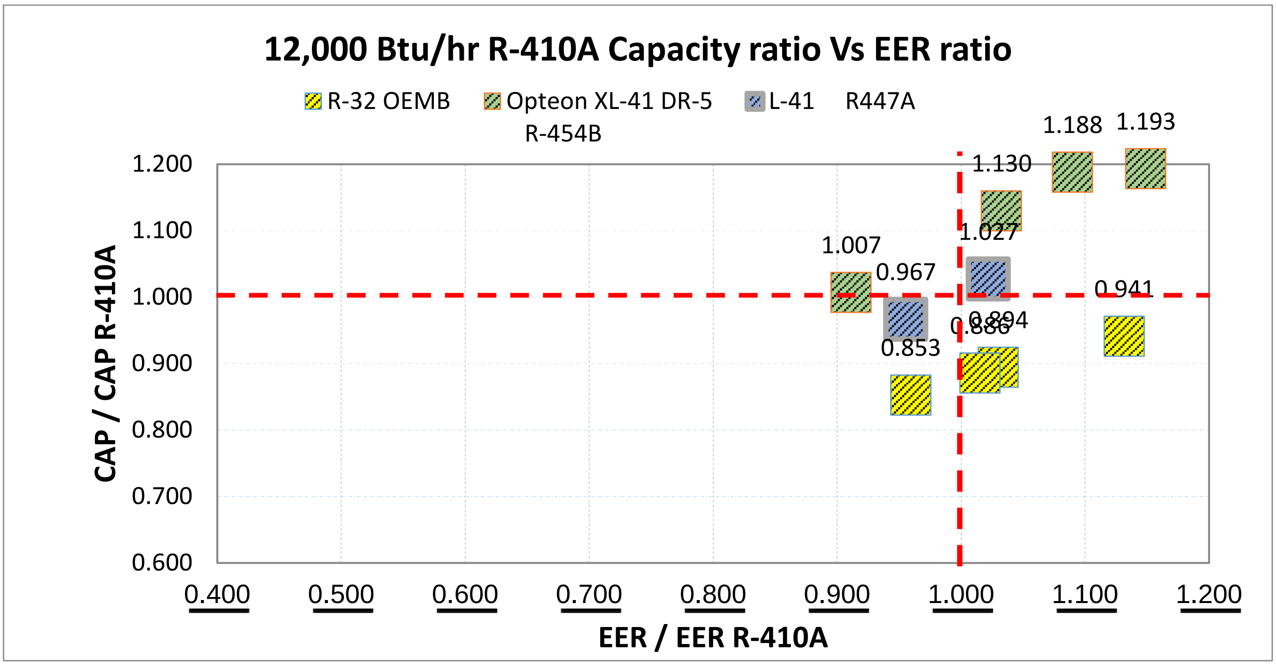


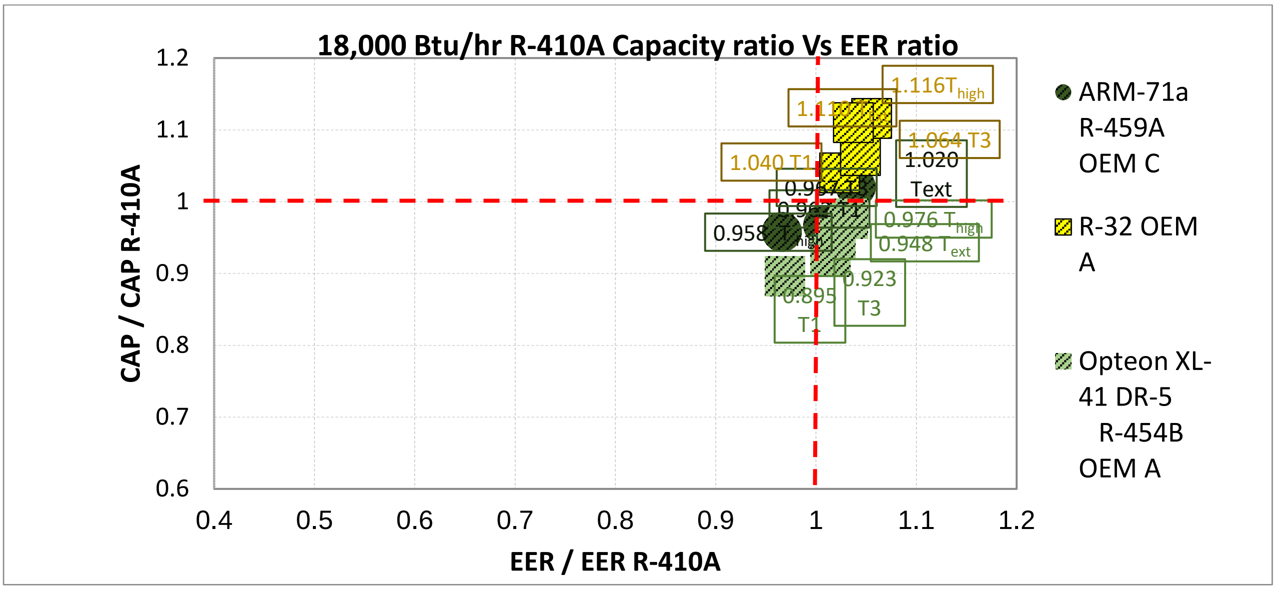
12,000 Btu/hr HCFC-22 Capacity Ratio VS EER Ratio

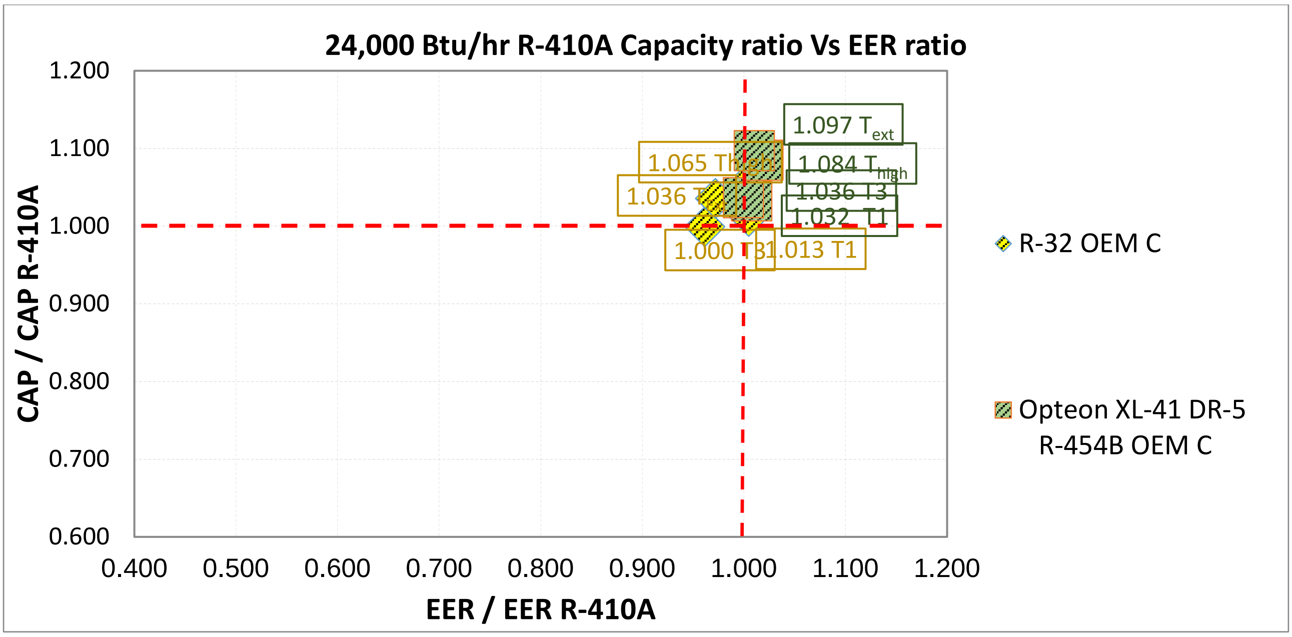

18,000 Btuh HCFC-22 capacity ratio vs. EER ratio
■ R-290 OEM A
■ ARMA-20a (R-457A) OEM B
● OPTEON XL-20 DR-3 R-454C OEM C
◆ L-20 R444B OEM D
CAPACITY/CAPACITY HCFC-22
EER / EER HCFC-22
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
0.91 T1
0.89 T_{high}
0.959 T3
0.974 T1
0.923 T_{high}
0.935 T_{Ext}
0.87 T_{ext}
0.89 T3
0.978 T_{high}
0.871 T3
0.928 T1
0.86 T1
0.89 T_{Ext}
0.87 T_3
0.84 T3
0.791 T_{Ext}


24,000 Btuh HCFC-22 capacity ratio vs. EER ratio
● ARM-20a R-457A OEM D
■ L-20 R-444B OEM B
CAPACTY/CAPACITY HCFC_22
EER / EER HCFC-22
0.400
0.500
0.600
0.700
0.800
0.900
1.000
1.100
1.200
1.029 T1
0.974 TExt
0.975 T_{high}
0.975 T3
0.975 T1

R-410A alternatives


12,000 Btu/hr R-410A Capacity ratio Vs EER ratio


18,000 Btu/hr R-410A Capacity ratio Vs EER ratio



Test results for HCFC-22 alternatives refrigerants demonstrate that:

- Several HCFC-22 alternatives showed that in 60% of the tests, capacity matching or improvement was achieved compared to base line units across all categories and at different testing temperatures.
- Most alternatives showed that in 50% of the tests, EER improvement across all categories and at different testing temperatures is possible.

Test results for R-410A alternatives refrigerants demonstrate that:

- All refrigerants showed improvement in capacity by 25 % to 67 %
- All refrigerants showed improvement in EER by 67 % to 75 %

The results show that there is a potential to improve the capacity and energy efficiency of the prototypes working with alternatives to HCFC-22; however, the potential for improvements for the prototypes working with alternatives to R-410A is much better. This conclusion is based on the percentage of test results that were within plus or minus 10% of the baseline unit results in the same category of equipment. This improvement is dependent on the availability and selection of the right components that can deliver the required performance while still be commercially viable. This conclusion is in line with the outcome of other testing projects like PRAHA, AREP, and ORNL shown in Annex 4

The results of testing central units with HCFC-22 alternatives were less conclusive since only two prototypes of the originally planned four could be tested a couple of years after they were built. The HCFC-22 alternatives used are not among the main refrigerants adopted for air conditioning applications worldwide. As a matter of fact, one of the two alternative refrigerants tested is not currently offered by its manufacturer for commercial use.

Scattered charts plotted for the capacity and EER ratios for the prototypes vs. baseline units show a positive result for one refrigerant and a negative one for the other for all temperatures conditions tested. The analysis of the results indicated possible issues with either the baseline units or the prototypes contributing to the outcome since the units have not the refrigerant charge optimized before testing.

An outcome of the project is a need for capacity building to enable the participating OEMs to design and test units with flammable refrigerants and optimize them in order to improve the performance and meet the energy efficiency standards. There is a need to upgrade their testing facilities both in terms of instrumentation as well as to handle flammable refrigerants (refer to Annex 3 for a description of the OEM labs).

In conclusion, test results show that all refrigerants used in the project are viable alternatives for split units from a thermodynamic point of view; however, when compared to MEPS (Minimum Efficiency Performance Standards) for Egypt - see chapter 4 - results show there are challenges faced by the industry to provide high efficiency AC units meeting the upcoming stringent requirements. Moreover, the viability in terms of the other criteria like compatibility, commercial availability, safety, and cost among others needs to be further researched.

Regarding the assessment of HCFC-22 alternatives for central units, the project was not able to have a robust conclusion, due to lack of sufficient number of prototypes developed and the few alternatives used for testing

Chapter 1

1. Introduction

HCFCs are used extensively in the refrigeration and air conditioning industry, in particular in the air-conditioning industry. Parties to the Montreal Protocol, in their 21st meeting, adopted a decision concerning HCFCs and environmentally sound alternatives. The decision calls for further assessment and support work to enable parties to find the best ways of moving forward particularly for those with forthcoming compliance targets related to consumption of HCFC in the air-conditioning sector.

The PRAHA project (*Promoting Low-GWP Refrigerant Alternatives for the Air Conditioning Industry in High Ambient Temperature Countries*) was a pioneer project in testing specially built prototypes by local industries in the Middle East and West Asia region using alternatives refrigerants.

Manufacturers of residential and commercial air conditioning equipment in Egypt met with the Montreal Protocol implementing agencies in July 2014 and agreed on participating in a project to build and test prototypes using various HCFC-22 alternatives at preset conditions in order to compare the performance and efficiency of those refrigerant alternatives.

The project’s key elements are to:

a) Asses available low-GWP refrigerant alternatives by building, optimizing, and testing and comparing prototypes using those alternatives;
b) Asses local Energy Efficiency (EE) standards and codes and evaluate the effect of equipment using low-GWP refrigerant alternatives on those standards;
c) Promoting technology transfer by examining and facilitating technology transfer through the HPMP.

The last two elements are part of the Egyptian HPMP and are not included in this report.

1.1. Egypt HPMP

Egypt’s starting point for aggregate reductions in its HCFC consumption is the same as its HCFC baseline consumption of 386 ODP tonnes (ODPt). The analysis of the data by substance and by sector showed that HCFC-22 is used almost entirely in the RAC sector and is the most predominant ODS in metric terms. However, in terms of ODS the use of HCFC-141b is significant, being 35% of the total baseline consumption. Egypt reduced its consumption by 25% and 35% by 2018 and 2020 respectively.

The air conditioning manufacturing sub-sector accounts for about 35% of the HCFC-22 consumption. About 56% is used for servicing with RAC manufacturers accounting for the majority of this service consumption, while other service companies account for just 3% of the HCFC-22 consumption.

The significant consumption of HCFC-22 by local AC manufacturers, especially in the room air conditioning sub-sector, is the reason for adopting a project for testing locally built prototypes using low-GWP alternatives. The program has been given the name EGYPRA (*Promotion of Low-GWP Refrigerants for the Air-Conditioning Industry in Egypt)*

1.2. Project Objectives

The aim of the project is to individually test especially manufactured prototype split units and central units, to operate with alternative refrigerants and compare their performance against baseline units. Those baseline units are designed with either HCFC-22 or R-410A refrigerants.

The project objectives were decided upon in agreement with the local stakeholders and can be summarized as follows:

- Guide the Egyptian air conditioning manufacturers to lower-GWP refrigerants including those with low and high flammability;
- Support technical and policy decisions regarding long-term HCFC alternatives for the air-conditioning industry as part of the of Egypt's HPMP;
- Streamline the HCFC phase-out program with the work on Energy Efficiency in Egypt;
- Promote the introduction of relevant standards/codes that ease the adoption of alternatives needing special safety or handling considerations;
- Exchange the experience with other relevant initiatives and programs which aim at addressing long term alternatives;
- Assess the capacity building and training needs for deploying low-GWP alternatives for different groups dealing or handling refrigerants in Egypt.

The outcomes from the above objectives are not presented in this report which focuses on the results of the tests that were carried out for the various air conditioning prototypes.

1.3. Selection of Alternative Refrigerants

The selection of the alternative refrigerants was based on the following aspects which are derived from decision XXIII/9 of the Meeting of Parties (MOP):

I. Commercially available;
II. Technically proven;
III. Environmentally sound;
IV. Economically viable and cost effective;
V. Safety consideration;
VI. Easy to service and maintain.

EGYPRA took into consideration refrigerants that were still not commercially available at the time the prototype building and testing was done. The refrigerants were selected to replace either HCFC-22 or R-410A as shown in Table 1 and Table 2 below, based on availability, cost, expected performance, and ease of handling due. It is worth noting that EGYPRA is a larger testing program than PRAHA; it tested a total 39 units: 19 specially made split unit and two central prototypes and 18 baseline units,. It also witness-tested all split units at the manufacturers' labs to ensure adherence to testing standards and help in guiding technicians when particular challenges arose.

In all 156 tests were made including baseline refrigerants and eight low GWP refrigerants. Witnessing tests that were carried on at the respective OEM labs was needed to

Table 1 List of HCFC-22 alternative refrigerants

Refrigerant	ASHRAE classification	GWP (100 years) – RTOC
HC-290	A3	5
R-444B	A2L	310
R-454C	A2L	295
R-457A	A2L	251

Table 2 List of R-410A alternative refrigerants

Refrigerant	ASHRAE classification	GWP (100 years)*
HFC-32	A2L	704
R-447A	A2L	600
R-454B	A2L	510
R-459A	A2L	466

*RTOC 2018 assessment report

While not all the selected refrigerants are commercially available or cost effective at present, they have all received “R” numbers as per ASHRAE standard 34.

For testing central units, only alternatives to HCFC-22 were used since the OEMs had not built units with R-410A refrigerants when the units were produced in 2016/2017. Presently, those alternatives are not as commercially adopted as those of R-410A; however, it was decided to continue with the tests in order to accomplish the planned goals.

1.4. Selection of Capacity Categories

The selection of prototypes categories to build took into consideration that the majority of the units produced in Egypt are of the mini-split type with capacities of 12,000 Btu/hr, 18,000 Btu/hr, and 24,000 Btu/hr (equivalent to 3.5, 5.25, and 7 kW). Some of the units are still manufactured with HCFC-22 and some with HFC refrigerants which prompted building prototypes for alternatives to HCFC-22 as well as R-410A.

Manufacturers also built what is termed as Central or Packaged units. Several manufacturers produce these units in the 10 Tons (120,000 Btu/hr or 35 kW) capacity but also in larger capacities of 20 and 25 tons. A 10 Ton Central unit was added to the categories to be tested. Only HCFC-22 alternatives were used for this category. The Central category does not include a prototype with HC-290 because of the higher amount of charge needed. The stakeholders preferred to wait for the result of further risk assessment work related to the use of flammable refrigerants being done in the region.

Table 3 below shows the matrix of the prototypes that were agreed upon. Green highlighted areas are for units built, while red denotes the unused portion of the central units as mentioned above.

Table 3 Matrix of prototypes showing refrigerants selected for each equipment category

		Split units			**Central Units**
Central	**Replacement for**	**12,000 Btu/hr**	**18,000 Btu/hr**	**24,000 Btu/hr**	**120,000 Btu/hr**
HC-290	HCFC-22	🟩	🟩	🟩	🟥
HFC-32	R-410A	🟩	🟩	🟩	🟥
R-457C	HCFC-22	🟩	🟩	🟩	🟩
R-459A	R-410A	🟩	🟩	🟩	🟥
R-454C	HCFC-22	🟩	🟩	🟩	🟩
R-454B	R-410A	🟩	🟩	🟩	🟥
R-444B	HCFC-22	🟩	🟩	🟩	🟩
R-447A	R-410A	🟩	🟩	🟩	🟥
HCFC-22 base		🟩	🟩	🟩	🟩
R-410A		🟩	🟩	🟩	🟥

OEMs were asked to supply baseline units from their standard manufacturing line with equivalent capacity to each prototypes in order to compare units built by the same OEM.

1.5. Stakeholders:

The project stakeholders comprises the following entities:

The Ministry of Environmental Affairs. The following entities at the ministry provided overall supervision and monitoring of the project**:**

- **The Egyptian Environmental Affairs Agency (EEAA):** The Chief Executive Director of EEAA has direct responsibility for the supervision of the activities of the National Ozone Unit.
- **The National Ozone Unit (NOU):** The NOU as an integral part of the Ministry for Environmental Affairs may draw on the legal and technical expertise and resources of the Ministry to undertake its responsibilities. It cooperates with other relevant divisions and field offices of the Ministry and EEAA for carrying out its activities**.**

The Manufacturers (OEMs): Local manufacturers cooperated with Technology Providers to build and test agreed upon prototypes. Eight OEMs participated in the project, listed below in alphabetical order:

- **DCM: (Delta Construction Manufacturing):** a manufacturer of central air conditioning equipment;
- **EGAT (Egyptian German Air Treatment Company):** a manufacturer of ducted split and central air conditioners along with airside equipment for commercial and industrial air conditioning;
- **Elaraby Company for Air Conditioning:** a manufacturer of air conditioners and home appliances, Elaraby partners with Sharp on technology for air conditioning equipment;
- **FRESH Electric for Home Appliances:** a manufacturer of air conditioners and home appliances;
- **Miraco Carrier:** a manufacturer of residential and commercial air conditioning equipment. Miraco also partners with Midea. The lab of Miraco was used to test the central units of the three OEMs
- **Power Egypt:** a manufacturer of small and central commercial & residential air conditioning equipment;
- **Unionaire:** a manufacturer of air conditioners and home appliances;
- **Volta Egypt:** a manufacturer of central air conditioning equipment.

Note on Confidentiality: To ensure the confidentiality of results, OEMs were given random designations from A to H and the results were reported under this designation.

The Technology Providers: Provided components (refrigerants, compressors, and micro-channel coils) in addition to technical support when needed;

- **Chemours (ex-DuPont):** Provided refrigerants R-454C and R-454B;
- **Daikin:** Provided refrigerant HFC-32;
- **Danfoss:** provided components for a central unit;
- **Emerson:** provided compressors for some split systems and all central units;
- **GMCC:** Provided compressors for some of the split systems;
- **Hitachi Highly:** provided compressors for some of the split systems;
- **Honeywell:** provided refrigerants R-444B and R-447A.

1.6. Methodology

The local manufacturers volunteered to build a certain number of prototypes and provided standard units from their production line with baseline refrigerants against which the particular prototypes were compared. Baseline units are with either HCFC-22 or R-410A refrigerants.

The assignment of categories and refrigerants to each of the OEMs was based on a questionnaire in which they listed their preferences and their capabilities to take on the work. The questionnaire can be found in Annex 2. Coordination meetings were held with the OEMs in which some of the technology providers were also present. These meetings and the subsequent contacts with the OEMs facilitated the logistics of shipping both the compressors and the refrigerants to the different OEMs

The prototypes were built with the following constraints:

- Using dedicated compressors provided by the project for each type of alternative refrigerant;
- Using the same baseline-unit overall dimensions, i.e. the heat exchangers could not be oversized in order to compare with the baseline unit. The overall dimensions of the unit were hence kept the same;
- Prototypes needed to meet the MEPS as set out by the Egyptian Organization for Standards EOS 3795:2013 equivalent to ISO 5151 at T_1 conditions as a minimum.
- OEMs provided throttling devices (capillary tubes, flow controls…) according to guidance from refrigerant manufacturers for optimization.

EOS 3795:2013 stipulates for split units less than 65,000 Btu/hr capacity an EER of 9.5 equivalent to a COP of 2.78 at T_1 conditions.

The OEMs optimized the prototypes using dedicated compressors and by changing the refrigerant charge and the expansion devices. No special coil designs were made for this project. The constraint of keeping the same coils has an effect on the optimization of the prototype; however, since the purpose of the tests is to compare to a baseline unit using HCFC-22 or R-410A refrigerants with the same dimensions, this constraint was accepted by the stakeholders.

The selection of the baseline units and the categories was agreed upon with the OEMs to represent the current market landscape and trend in Egypt.

Table 4 and Table 5 below show the number and type of prototype built by each of the OEMs

Table 4 Prototypes and type of refrigerant built by the different OEMs (split systems)

Category	**12 000 Btu/hr**		**18 000 Btu/hr**		**24 000 Btu/hr**	
OEM	**HCFC-22 Alternatives**	**R-410A Alternatives**	**HCFC-22 Alternatives**	**R-410A Alternatives**	**HCFC-22 Alternatives**	**R-410A Alternatives**
A	R-444B	R-447A	R-290	HFC-32 and R-454B	-	-
B	R-454C	HFC-32	R-457A	-	R-444B	-
C	R-290 and R-457C	-	R-457A	R-459A	-	HFC-32 and R-454B
D	-	-	R-444B	-	R-457C	-
E	R-454C	R-454B	-	-	-	-

Table 5: Prototypes and refrigerants for 120,000 Btu/hr central units

OEM	Central units
X	**R-454C**
Y	**R-457C**
Z	**R-444B**

1.7. Testing Parameters and Facilities

EGYPRA testing protocol followed the following testing conditions, for both split systems and central units:

Table 6 Testing conditions for outdoor and indoor dry and wet bulb temperatures

	T_1	T_3	T_{High}	$T_{Extreme}$
Outdoor °C db/wb	35/24	46/24	50/24	55/24
Indoor °C db/wb	27/19	29/19	32/23	32/23

The indoor conditions at T_{High} and $T_{Extreme}$ are not the same as those at T_3 conditions, they were chosen in agreement with the OEMs and are in conformity with ISO 5151 which is followed in Egypt. These indoor conditions are also not the same as in the other testing projects shown in Annex 4. Since the objective of EGYPRA is to compare the performance of AC units with medium and low-GWP alternative refrigerants against units with baseline refrigerants, this comparison remains true as long as the conditions of testing are consistent.

EGYPRA testing facilities: The project managers wanted to use one independent testing lab for testing all units in order to provide a continuity and similitude of testing. The government's accredited lab was contacted for that purpose; however, the lab did not have the capability of testing flammable refrigerants. Efforts at upgrading the lab capabilities could not be finished in time for the project timeline and the project adapted the strategy of witness testing at the manufacturers' testing facilities. The Technical Consultant witnessed all the tests and verified the results. A brief description of the OEM testing facilities can be found in Annex 3.

The independent lab selected to test the central units, Miraco, is one of the OEM participants for the split units. Miraco's lab accommodates central units in both packaged and split configurations. Central units can be installed in the field either as packaged units or as split depending on the application. The units were tested in the split configuration. a.

Testing Methodology:

Testing of the units followed the Egyptian standard EOS 4814, non-ducted AC & HP testing and rating performance. The standard is derived from ISO-5151 and is followed by all manufacturers. The standard stipulates that,

> *"4.1.1.2.5 Machines manufactured for use in more than one of the climatic conditions as T_3, T_2 and T_1 shall be rated and recorded at each of the conditions for which the unit was designed."*

The Egyptian standards do not stipulate testing at temperatures higher than T_3. The T_{High} and $T_{Extreme}$ conditions were derived from ISO 5151 with the agreement of the OEMs.

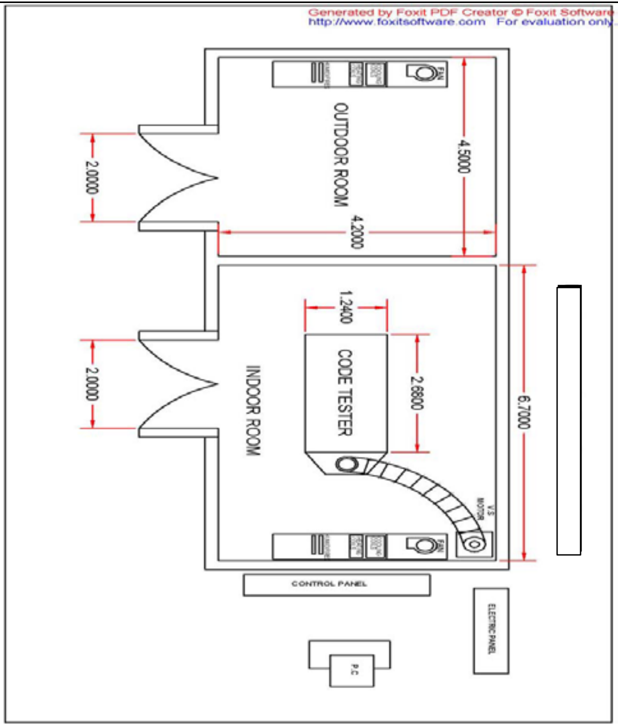
For the room splits, the tests were witnessed by the Technical Consultant. Re-testing the units was permitted when the results were inconsistent or did not meet the minimum EER stipulated in EOS 3795. In these cases, the Technical Consultant advised the OEMs on possible modifications to the design and helped them in the determination of the charge and the expansion device setting to achieve better results.

For the central units, the testing at the independent lab were not witnessed by the technical consultant as modifications could not be done at the independent lab.

Testing procedure

Table below describes the testing procedure applied by all OEMs

Table 7: Testing procedure

No.	Item	Description
1	Testing lab infrastructure: - Testing chamber description Note: (Typical testing laboratory's testing chambers schematic diagram shown. Dimensions and arrangement of equipment are for indicative purposes only.)	 I. Laboratory consists of two thermally insulated chambers (indoor and outdoor chambers). Both chamber's temperature and humidity can be controlled precisely to achieve the required required testing conditions (as per standards) using AC units, humidifiers and electric heaters. II. III. Laboratory is used for measuring capacities less than 1, 1, 1.5, 2 TR. Laboratory of the psychometric type where the air conditioner cooling capacity, heating capacity and efficiency (EER, COP) can be measured accurately. IV. Other parameters such as unit working pressure, superheat, subcooling and state point's temperature of the refrigeration cycle could also be measured. V. The accuracy of temperature control for dry and wet bulb temperatures are in the range 0.01 ^{o}C or better. VI. The indoor room to have a thermal insulated code tester to collect all outlet air from the air conditioner, measuring its dry bulb and wet bulb temperatures and volumetric flow rate.

	• Parameters measured & instrumentation used	• All temperature sensors for inlet and leaving air in indoor room as well as outdoor room air temperatures are to be measured. • Surface temperatures to be measured by sensors - accuracy 0.1 ^{o}C or better-for both indoor and outdoor chambers. A minimum of 15 measuring points to be used for each room at various locations on the air conditioner. • All data gathered during an experiment to be read by a computer through a specialized program with multi channels data acquisition to get the required data in a live format fashion. • Factory supplied control panel located outside the chambers space to have all necessary control switches to operate the laboratory and set the required conditions with power meters for single phase and 3 phase and all electrical data for tested units. Data to be measured and transferred to computer system.
2	Standards to be used:	All tests for cooling and heating performance to be performed according to the following standards: • EOS 4814 non-ducted AC & HP testing and rating performance • ASHRAE testing standards • ISO 5151 for non-ducted air conditioners • ISO 13253 for ducted type split • EOS 3795-1/2016 • EOS 3795-2/2017
3	Description of the testing procedures: • Description of testing method	• Psychometric testing method is used as per ISO 5151-2017 annex C, G. Nozzles were used to measure for both entering and leaving dry and wet bulb temperatures.
	• *Method of selection of capillary tube and choosing refrigerant charge. This information was used by OEMs to help select the right expansion device*	• *Optimum selection of capillary size, length, number and refrigerant charge to achieve good matching and improved performance for the unit according to the following:* *i) Select from preliminary capillary chart size, number and length of the required capillary to match the specified load.* *ii) Accumulated experience plays an important role in determining the preliminary refrigerant charge.* *iii) Testing the unit based on pervious selections give an indication for system optimization including increasing or decreasing the charge and/or the size of the capillary.* *iv) System pressure, superheat, subcooling, power consumption, cooling capacity and refrigerant temperature at various points of the cycle give a strong indication on how the matching is proceeding.*
	• Achieving steady state for outdoor and indoor conditions (description, time needed…)	• 2 hours' time are needed as a minimum to achieve the steady state condition for testing cooling capacity of the unit as well as EER or COP.
4	Calculating EER and capacity: • How the EER is calculated measurements used and formula	EER= cooling capacity/ total power consumed by the system in Btu/hr/W or equivalent.
	• How the capacity was calculated measurements used and formula	As per ISO 5151 equations in annex C

Chapter 2

2. Results

The results of the various tests were combined under two major headings: results of alternatives to HCFC-22 and results of alternatives to R-410A.

The casual reading of the results may establish confusion, even among specialists, in relation to the increase in capacity at T_{High} compared to T_3. This result is not witnessed in other similar research projects; however, by understanding the impact of changing the dry bulb and wet bulb indoor testing conditions i.e. T_{high} (outdoor 50/24 ^{0}C, indoor 32/24 ^{0}C) compared to T_3 (outdoor 46/24 ^{0}C, indoor 29/19 ^{0}C), the results can be justified since the indoor temperatures both for dry and wet bulb have increased in T_{High} compared to T_3 which has a larger effect on the capacity rather than the outdoor temperature.

Modeling Using ORNL Heat Pump Design Model

Since the measurements provided by the labs were somehow limited, it was difficult to explain the hypothesis for the increase in performance under T_{High} conditions. As such, a full-scale modeling using the ORNL Flexible Heat Pump Model was performed on a sample packaged air conditioning system and the indoor and outdoor conditions were changed according to the EGYPRA conditions: T_1, T_3, T_{High}, and $T_{Extreme}$. Table 6above provides a summary of the indoor and outdoor conditions for the four simulations along with the capacity ratio (capacity/capacity at T_1), compressor mass flow rate, compressor power, sensible heat ratio (SHR), and evaporator overall area integral heat transfer for the vapor (UA_vap) and the 2 phase (UA_2-ph) portions respectively.

The T_{High} condition was selected to simulate the same ambient conditions as that tested by the OEMs but with the same indoor conditions as T_1 and T_3. The result from this simulation follows the simple intuition that as the outdoor temperature increases, the performance degrades at a rough order of magnitude of 1% point per 1°C of outdoor temperature increase. However, when examining the performance of the $T_{Extreme}$ condition; we notice a sudden increase in capacity – coupled with an increase in refrigerant mass flow rate, and reduction in SHR. The simulation results show that for T_1, T_3 and T_{High} conditions, the suction saturation temperature change was less than 1°C, while when the indoor conditions were changed to the T_{High} condition, the suction saturation temperature changed by more than 4°C. This has an impact on the compression ratio, compressor suction density, and compressor performance (volumetric and isentropic efficiencies). Furthermore, the higher humidity associated with the $T_{Extreme}$ condition induces the evaporator coil to become wetter and as such results in higher airside performance and higher SHR.

Table 8: Conditions and relevant results for the rooftop unit simulated using the ORNL Flexible HPDM simulation tool

Condition	**EDB**	**EWB**	**Outdoor air**	**Capacity/Capacity at T1**	**Compressor mass flow rate**	**Compressor Power**	**SHR**	**Evaporator vapor UA**	**Evaporator 2-ph UA**
	°C	°C	°C	%	g/s	W	%	W/K	W/K
T1	29	19	35	100%	379.8	14,074.9	88%	5.6	265.7
T3	29	19	46	89%	383.7	16,952.9	93%	6.7	265.1
T_{High}	29	19	50	86%	384.6	18,077.2	95%	6.7	265.2
$T_{Extreme}$	32	24	50	94%	433.9	18,693.8	78%	9.4	261.3

Hypothesis summary

When the indoor dry bulb and wet bulb temperatures are increased from the T_3 conditions to the T_{High} conditions; the sensible heat ratio of the AC system is reduced, and a large portion of the evaporator is wetted by the water vapor condensate. This results in heat transfer enhancement due to reduced free flow area and increased surface velocity and the concurrence of heat and mass transfer at the tubes and fin surfaces. From further analysis provided by the detailed study from OEM C; the evaporator log mean temperature difference is also increased due to the increased air inlet temperature. Hence on the air side, both the increase in overall heat transfer coefficient along with the increased evaporator LMTD and increased latent capacity contribute directly to the increased heat capacity between T_3 and T_3 with elevated indoor conditions (subsequently also the increased capacity at the T_{High} conditions).

At the refrigerant side, when the indoor conditions are changed from the T_3 to the T_{High} conditions – the compressor pressure ratio is reduced while the refrigerant density at the compressor inlet is increased. The refrigerant flow rate also increases which further justifies the increased cooling capacity from the refrigerant side analysis.

2.1 Presentation and Analysis of Results for Split Units

The analysis of the results is presented in table form. The complete results and comparative bar charts are found in Annex 1.

The Results for capacity in Btu/hr and energy efficiency in EER (energy efficiency ratio in Btu/hr/1,000 or MBH output/kW input) are given for the four testing temperatures. The tables show the test results and the percentage increase or decrease in capacity and EER compared to the baseline unit. As a reminder, each OEM was asked to test a baseline unit from their own standard production for each prototype built in order to compare with the prototype testing results.

The analysis uses shades of color to denote the performance comparison to the baseline unit as follows:

No shading	Performance is same as base unit – for capacity and EER
Green	**Increase** in EER or cooling capacity over baseline unit
Yellow	**Decrease** in EER or cooling capacity by **- 0.01 % to - 5 %**
Orange	**Decrease** in EER or cooling capacity from **-5 % to - 10 %**
Red	**Decrease** in EER or cooling capacity over **-10 %**

The results are then plotted on a scattered chart for the ratio of capacity of the prototype to that of the baseline unit vs. the EER ratio at the four testing temperatures. The baseline unit performance is denoted by the two red dotted lines at a ratio of one for both capacity and EER.

The analysis is presented for the alternatives of HCFC-22 and R-410A separately. Some results for inconclusive tests mentioned in the Annex were not used in the analysis.

2.1.1. Analysis of Capacity and EER Performance for HCFC-22 Alternatives

The tables in this section are for alternatives to HCFC-22 for the three categories of mini-split units: 12,000 Btu/hr, 18,000 Btu/hr, and 24,000 Btu/hr.

Results for the 12,000 Btu/hr category

Table 9 Comparison of HCFC-22 alternatives for 12,000 Btu/hr split units

HFCF-22 12,000 Btu/hr	T_1	T_3	T High	T Extreme	T_1	T_3	T High	T Extreme
	Capacity in Btu/hr				EER			
Base Units								
R-22(OEM C)	11,452	9,960	10,560	10,181	10.0	7.25	6.98	6.23
R-22(OEM B)	11,410	9,988	10,900	10,035	8.4	6.4	6.3	5.5
R-22(OEM A)	11,479	9,699	11,353	8,407	9.7	6.9	7.3	5.6
Prototypes								
HC-290 (OEMC)	10,219 (-10.8%)	8,677 (-12.9%)	9,289 (-12.0%)	7,747 (-23.9%)	10.4 (+3.53%)	7.17 (-1.1%)	7.0 (-0.23%)	5.2 (-16.2%)
R-457A (OEM C)	11,023 (-3.8%)	9,376 (-5.9%)	10,892 (+3.1%)	9,517 (-6.5%)	8.4 (-16.4%)	6. (-13.3%)	6.6 (-5.6%)	5.6 (-10.8%)
R-454 C (OEM B)	10,968 (-3.9%)	9,349 (-6.4%)	9,946 (-8.8%)	9,042 (-9.9%)	8.0 (-5.2%)	6.0 (-6.0%)	5.9 (-7.4%)	5.1 (-7.7%)
R-444 B (OEM A)	11,790 (+2.7%)	9,661 (-0.4%)	10,241 (-9.8%)	8,881 (+5.6%)	8.4 (-13.5%)	5.7 (-16.2%)	5.5 (-24.4%)	4.5 (-20.3%)

The table shows that for HC-290, the capacity of the prototype at all four temperatures is less than that of HCFC-22 baseline, while the EER is higher at T_1 and within 1% at T_3 and $T_{High.}$ The results for R-457A and R-454C show results for capacity up to 10% less than the baseline with R-457A showing a better capacity at Thigh which is not the case for R-454C. For R-444B, capacity is better than the baseline at both T_1 and $T_{Extreme}$ but around10% worse at T_{High} which cannot be explained. EER for R-444B is more than 10% worse than the baseline for all testing conditions. The comparison is plotted on a scattered chart as follows

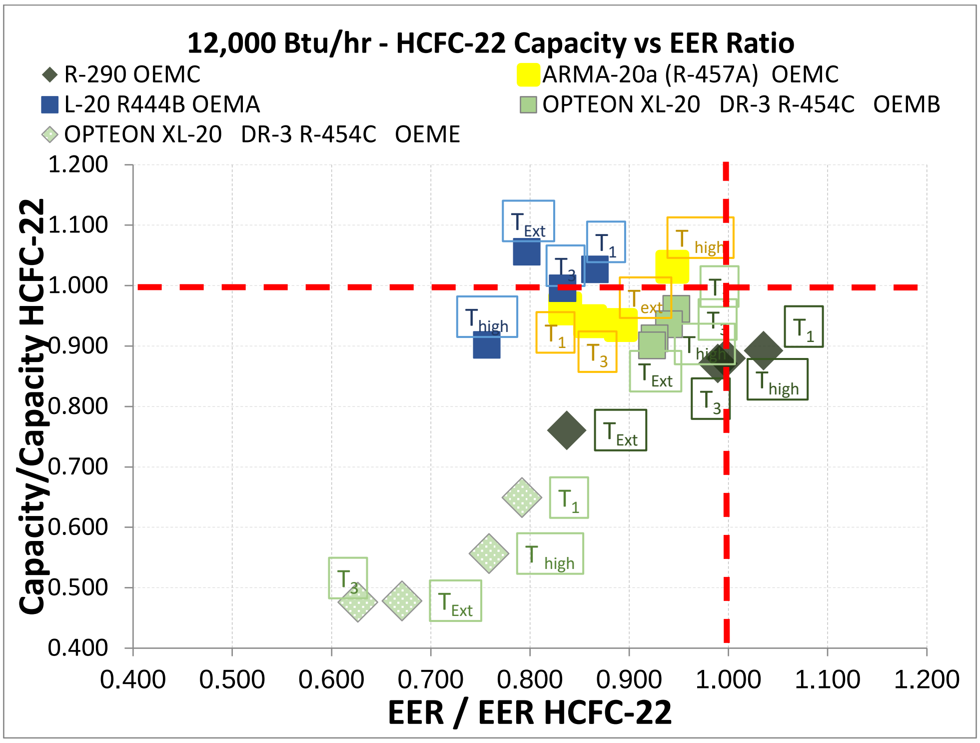


Figure 1 Capacity vs. EER ratio for HCFC-22 alternatives in 12,000 Btu/hr split units

Results for 18,000 Btu/hr Splits

Table 10 Comparison of HCFC-22 alternatives for 18,000 Btu/hr split units

18,000 Btu/hr	T_1	T_3	T_{High}	$T_{Extreme}$	T_1	T_3	T_{High}	$T_{Extreme}$
Refrigerant	Capacity				EER			
Baseline Units								
HCFC-22								
OEM A	18,659	16,799	17,543	15,046	9.4	7.2	7.0	5.6
OEM B	16,433	14,545	13,718	15,350	8.9	6.7	6.4	5.33
OEM C	18,160	16,182	17,632	16,292	10.0	7.4	7.4	6.5
OEM D	17,548	16,422	14,624	13,948	10.5	8.8	7.2	6.0
Prototypes								
R-290 *(OEM A)*	*16,111* *(-13.66%)*	*14,067* *(-16.26%)*	*15,343* *(-12.54%)*	*13,442* *(-10.66%)*	9.1 (-1.06%)	7.1 (-2.34%)	7.2 (+2.72%)	5.9 (+5.59%)
R-457 A *(OEM B)*	*15,257* *(-7.2%)*	*12,672* *(-13.0%)*	*13,418* *(-2.2%)*	*12,149* *(-20.9%)*	9.3 (+3.7%)	6.6 (-0.9%)	6.3 (-0.9%)	5.3 (0.00%)
R-454 C *(OEM C)*	*16,510* *(-9.1%)*	*14,327* *(-11.5%)*	*15,619* *(-11.4%)*	*14,250* *(-12.3%)*	9.3 (-6.88%)	7.0 (-5.43%)	7.0 (-4.88%)	6.0 (-6.67%)
R-444 B *(OEM D)*	*17,098* *(-2.6%)*	*15,746* *(-4.1%)*	*13,498* *(-7.7%)*	*13,047* *(-6.5%)*	10.0 (-4.76%)	7.8 (-11.01%)	6.3 (-12.47%)	5.4 (-10.00%)

The results for HC-290 for capacity are consistent with the results of the 12,000 Btu/hr category, while the EER shows better results than the baseline at T_{High} and $T_{Extreme}$. The results for R-457C capacity compared to the 12,000 Btu/hr category show a further degradation compared to the baseline for the 18,000 Btu/hr category, while the EER results at the four temperatures are better than the 12,00 Btu/hr category. The same can be said about R-454C, while R-444B has comparable results with the 12,000 Btu/hr category with a variation with temperature. The results of this category show higher values for both capacity and EER for T High results compared to T3 in line with the discussion at the beginning of this chapter.

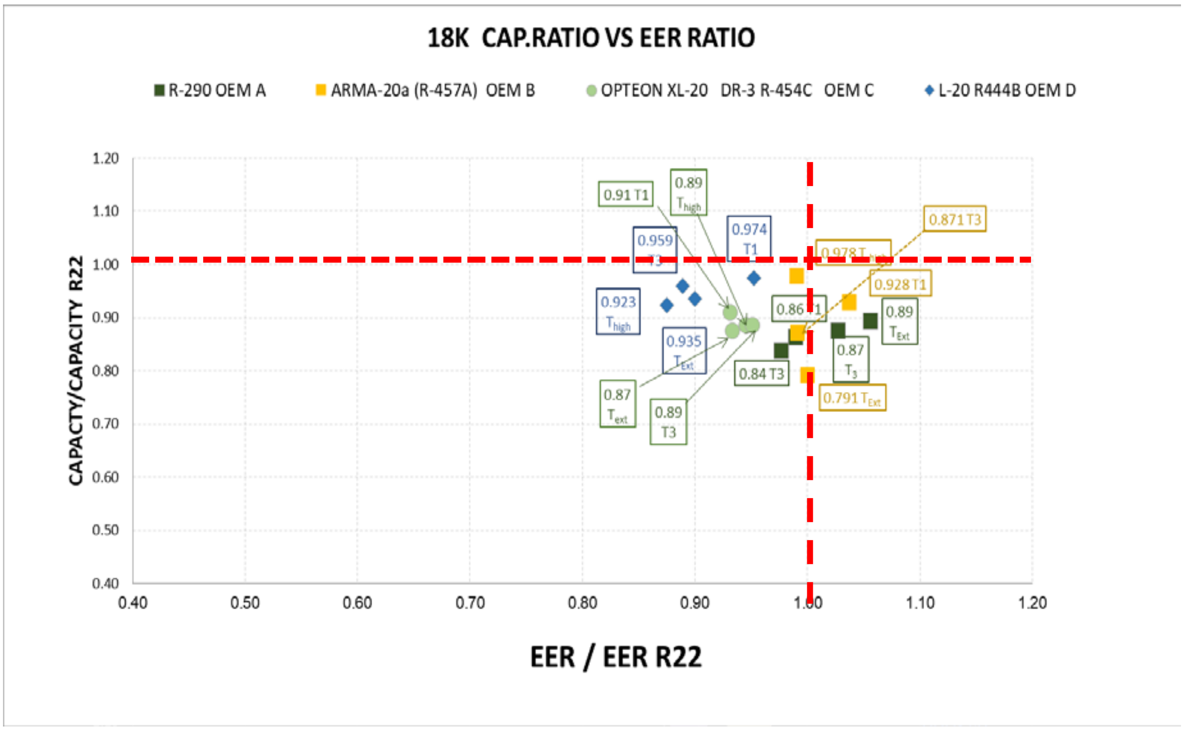


Figure 2 Capacity vs EER Ratio for HCFC-22 alternatives in 18,000 Btu/hr split units

Results for 24,000 splits

Table 11 Comparison of HCFC-22 alternatives for 24,000 Btu/hr split units

24,000 Btu/hr	T_1	T_3	T_{High}	$T_{Extreme}$	T_1	T_3	T_{High}	$T_{Extreme}$
Refrigerant	Capacity				EER			
Baseline								
HCFC-22 OEM B OEM D	 22,782 22,318	 N/A 21,202	 N/A 20,144	 N/A 19,148	 9.27 9.3	 N/A 7.3	 N/A 6.0	 N/A 5.7
Prototypes								
R-444 B (OEM B)	23,436 (+2.87%)	N/A	N/A	N/A	7.38 (-20.39%)	N/A	N/A	N/A
R-457 A (OEM D)	21,758 (-2.5%)	20,670 (-2.5%)	19,636 (-2.5%)	18,657 (-2.6%)	8.8 (-5.6%)	6.9 (-6.4%)	5.8 (-4.6%)	5.3 (-8.4%)

Unfortunately, the data for R-444B at temperatures other than T_1 were not available. Data for R-457A as a percentage of the baseline by the same OEM show a better trend than for the other two categories; however, in absolute terms the EER of the baseline of the 24,000 Btu/hr category is lower than the other two categories which explains the higher percentage.

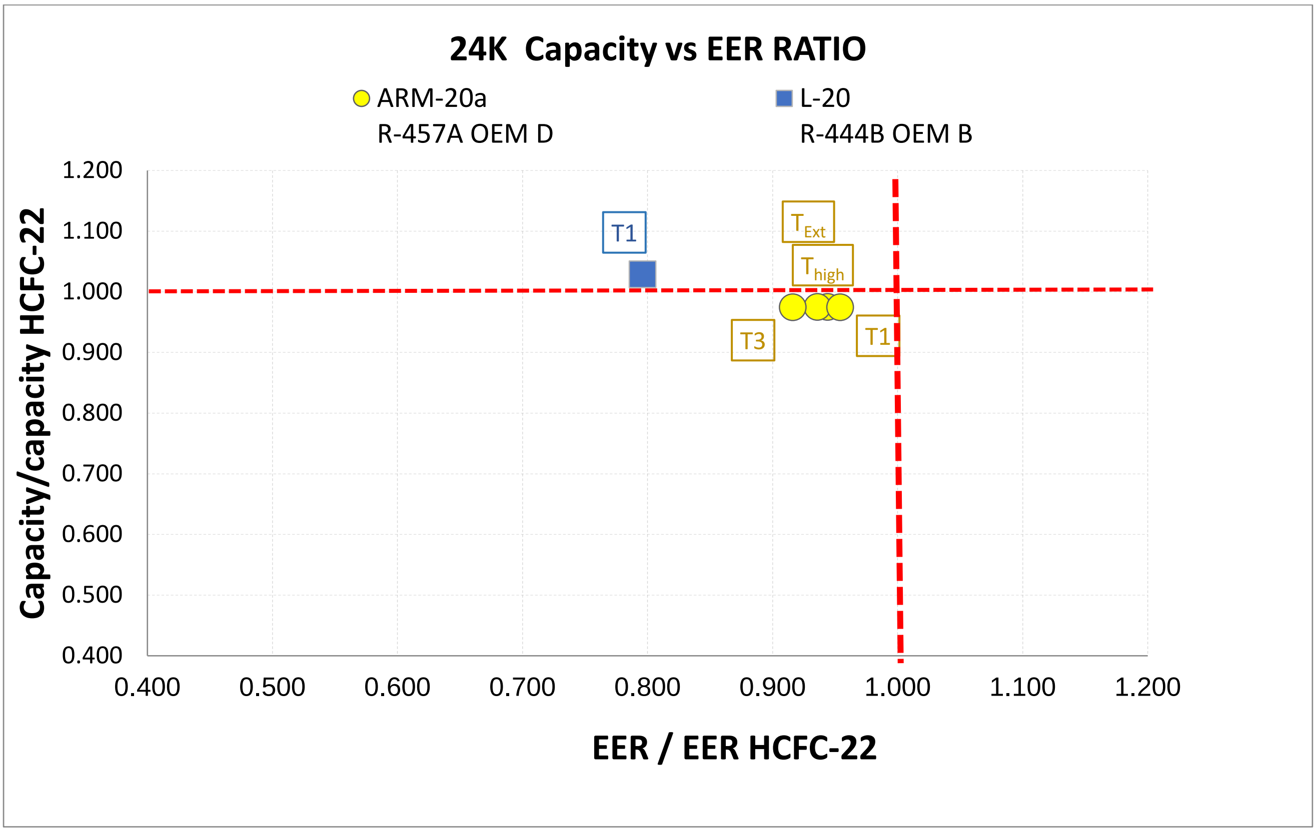


Figure 3 Capacity vs. EER ratio for HCFC-22 alternatives in 24,000 Btu/hr split units

Note that the results for the capacity for R-457A at the four temperatures are similar and hence the yellow circle label points seem almost concentric.

2.1.2. Analysis of Capacity and EER Performance for R-410A Alternatives

Results for 12,000 Btu/hr splits

Table 12 Comparison of R-410A alternatives for 12,000 Btu/hr split units

12,000	T_1	T_3	T_{High}	$T_{Extreme}$	T_1	T_3	T_{High}	$T_{Extreme}$
Refrigerant	Capacity				EER			
Baseline								
R-410A								
OEM A	10,307	N\A	8,313	N\A	8.77	N\A	5.43	N\A
OEM B	12,068	10,343	11,089	9,968	10.17	7.31	7.2	5.9
OEM E	11,905	9,369	10,848	9,299	10.88	7.3	7.4	5.9
Prototype								
HFC-32 (OEM B)	11355 (-5.9%)	9,249 (-10.9%)	9,822 (-11.4)	8,499 (-14.7%)	11.5 (+13.2%)	7.5 (+3.0%)	7.3 (+1.5%)	5.7 (-4.1%)
R-454B (OEM E)	11,987 (+0.7%)	11130 (+18.8%)	12,257 (+13.0%)	11,094 (+19.3%)	9.9 (-8.82%)	8.0 (+9.05%)	7.7 (+3.27%)	6.7 (+14.90%)
R-447A (OEM A)	9963 (-3.3%)	N\A N\A	8539 (+2.2%)	N\A N\A	8.4 (-4.4%)	N\A N\A	5.6 (+2.2%)	N\A N\A

The results for R-454B compared to the baseline is better except for the EER at T_1. Results for HFC-32 compared to the baseline show a higher performance for EER but lower for capacity.

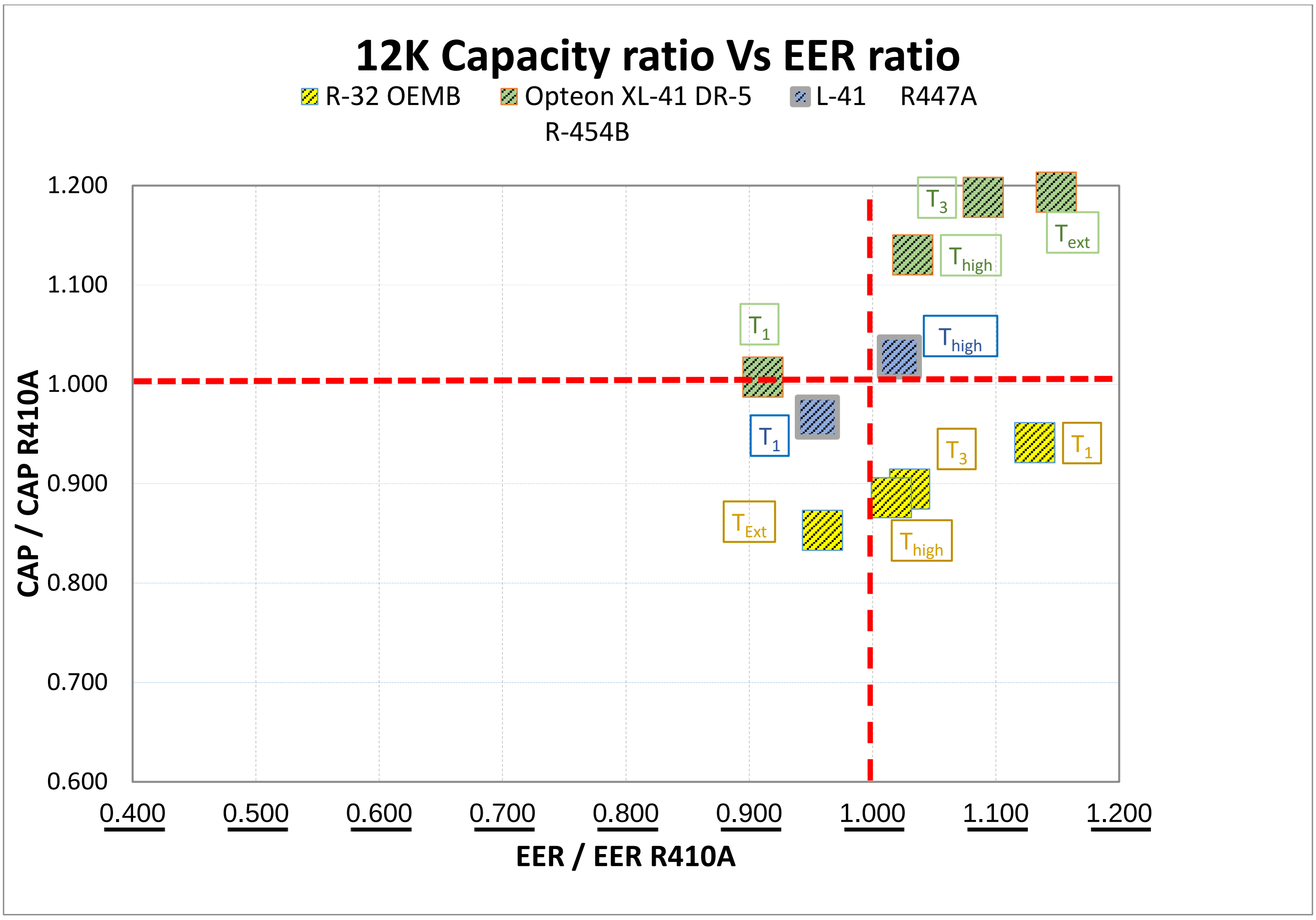


Figure 4 Capacity vs EER ratio for R-410a alternatives in 12,000 Btu/hr split units

Results for 18,000 Btu/hr

Table 13 Comparison of R-410A alternatives for 18,000 Btu/hr split units

18,000	T_1	T_3	T_{High}	$T_{Extreme}$	T_1	T_3	T_{High}	$T_{Extreme}$
Refrigerant	Capacity				EER			
Baseline								
R- 410 A								
OEM A	16,938	14,337	14,123	12,441	9.8	6.8	6.3	5.1
OEM C	17,800	14,924	16,075	13,746	9.2	6.5	6.5	5.
Prototype								
R-459A (OEM C)	17,115 (-3.9%)	14,430 (-3.3%)	15,392 (-4.3%)	14,023 (+2.0%)	9.28 (+1.4%)	6.54 (+0.7%)	6.27 (-3.4%)	5.32 (+4.0%)
HFC-32 (OEM A)	17616 (+4.0%)	15,255 (+6.4%)	15,761 (+11.6%)	13,809 (+11.0%)	10.03 (+2.4%)	7.10 (+4.4%)	6.65 (+5.6%)	5.29 (+3.7%)
R-454B (OEM A)	15,167 (-10.5%)	13,229 (-7.7%)	13,782 (-2.4%)	11,800 (-5.2%)	9.5 (-3.1%)	6.90 (+1.5%)	6.50 (+3.2%)	5.20 (+2.0%)

The results for R-454B show a similar trend of higher values against the baseline to the 12,000 Btu/hr category for EER but lower for capacity. Results for HFC-32 are higher than the baseline for both capacity and EER, which is different from the 12,000 Btu/hr category.

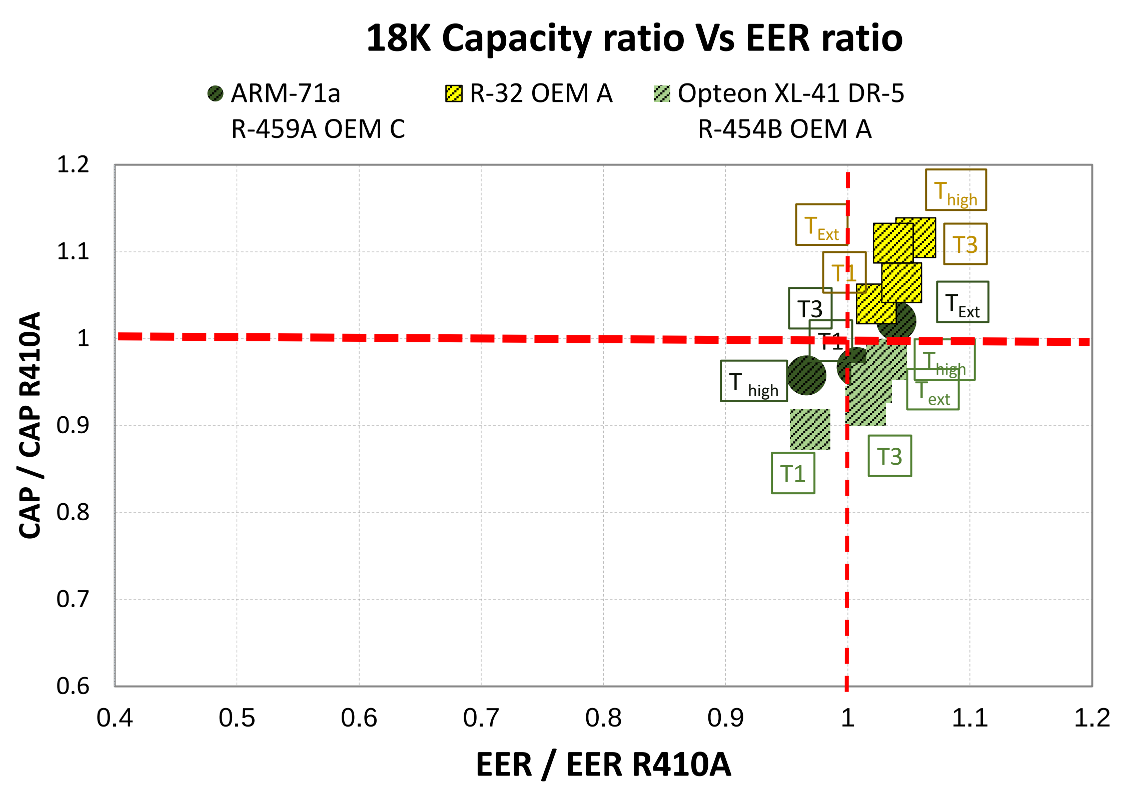


Figure 5 Capacity vs EER ratio for R-410A alternatives in 18,000 Btu/hr split units

The plot shows that most of the results are on the positive side when compared to the baseline units for EER with some results for capacity showing lower values.

Results for 24,000 Btu/hr

Table 14 Comparison of R-410A alternatives for 24,000 Btu/hr split units

24,000	T_1	T_3	T_{High}	T_{Extreme}	T_1	T_3	T_{High}	T_{Extreme}
Refrigerant	Capacity				EER			
Baseline								
R- 410 A OEM C	23022	19531	20534	18379	10.6	7.5	7.4	6.2
Prototype								
HFC-32 (OEM C)	23310 (+1.3%)	19522 (-0.1%)	21876 (+6.5%)	19035 (+3.6%)	10.62 (-0.5%)	7.228 (-3.9%)	7.459 (+1.1%)	5.988 (-2.1%)
R-454B (OEM C)	23766 (+3.2%)	20241 (+3.6%)	22268 (+8.4%)	20160 (+9.7%)	10.653 (+0.8%)	7.516 (-0.03%)	7.515 (+1.9%)	6.224 (+1.0%)

Results are mostly positive for the two refrigerants tested at this category.

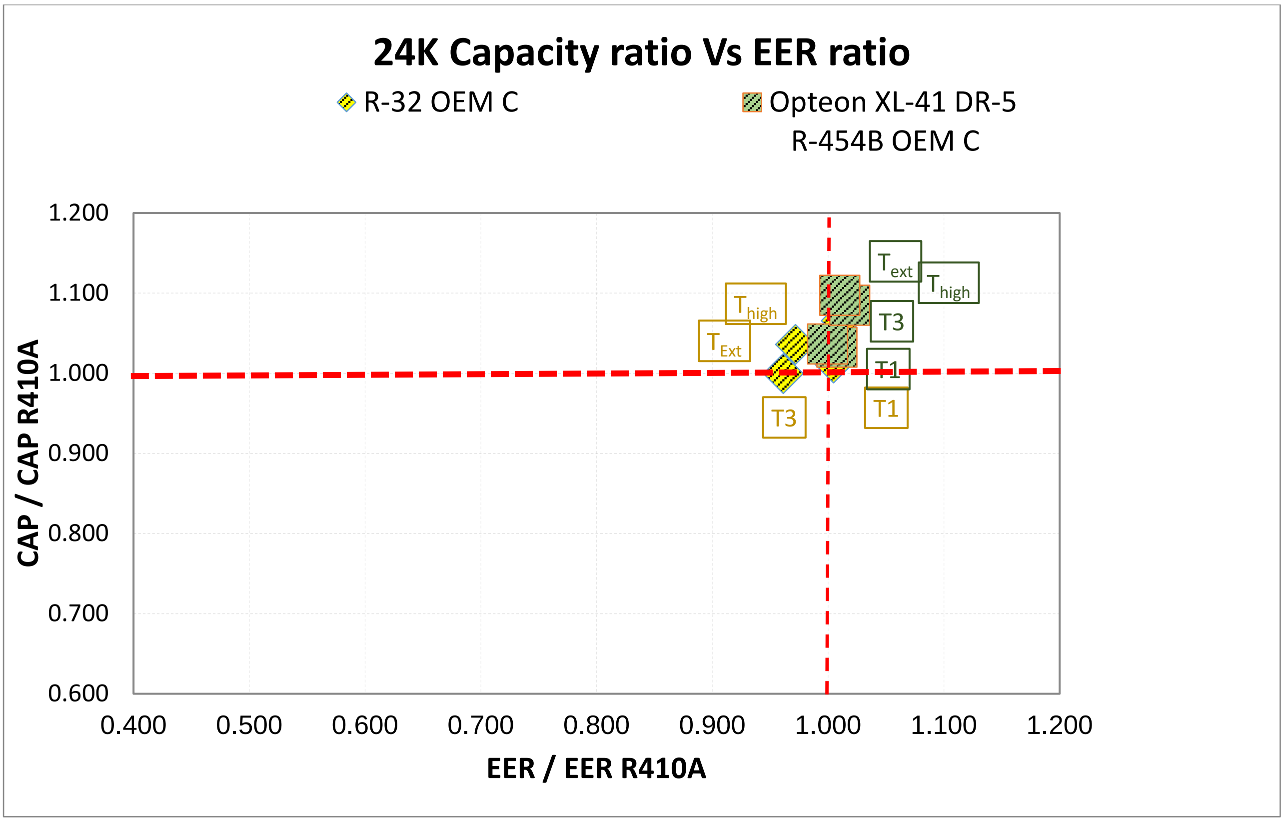


Figure 6 Capacity vs EER ratio for R-410A alternatives in 24,000 Btu/hr split units

2.2. Presentation and Analysis of Results for the central units

The central units were tested in the only commercial units accredited lab in Egypt with the OEMs' technicians attending the tests. The testing procedure was approved the technical consultant, and explained to the lab operators. Although optimization was allowed, the tests were carried on the units as received from the OEMs with no optimization at the facility, except adjusting the charge in the case of HCFC-22 baseline unit by OEM X. Optimization of refrigerant charge was the practice used for the split units at each OEM lab and witnessed by the technical consultant.

The Results for capacity in Btu/hr and energy efficiency in EER (energy efficiency ratio in MBH output/ kW input) are given for the four testing temperatures. The tables show the test results and the percentage increase or decrease in capacity and EER compared to the baseline unit. Each OEM was asked to provide a baseline unit from their own standard production in order to compare with the results. Red highlight denotes performance more than 10% below those of the baseline unit, while green is better performance as shown in the color code chart.

The results from only two prototypes were available. The third prototype working with R-444B could not be tested due to a technical problem with the prototype and the base unit that the OEM could not be solved in time. Table 15 shows the results for R-454C and R-457A.

Table 15: Presentation and comparison of results for the central units

120,000 Btu/hr	**T_1**	**T_3**	**T_{HIGH}**	**$T_{Extreme}$**	**T_1**	**T_3**	**T_{High}**	**$T_{Extreme}$**
	Capacity in BTU/h				**EER in BTU/Watt.h**			
Baseline								
R-22 (OEM-X)	84,330	76,030	81,860	76,430	7.0	5.4	5.6	4.6
R-22 (OEM-Y)	55,210	48,270	49,060	41,910	4.4	3.4	3.3	2.6
Prototypes								
R-454C (OEM-X)	**69,010 (18.2%)**	**64,530 (15.1%)**	**66,600 (18.6%)**	**66,070 (13.6%)**	**5.36 (23.1%)**	**4.48 (16.9%)**	**4.32 (23.0%)**	**3.98 (13.3%)**
R-457A (OEM-Y)	77,160 39.8%	63,280 31.1%	65,490 33.5%	57,670 37.6%	5.9 33.4%	4.1 21.8%	4.0 21.9%	3.3 27.8%

It is evident from the table that:

- The two baseline units do not meet the nameplate capacity at design conditions that was selected for the project. OEM X is at 70% while OEM Y is at 46% of the designated capacity at T_1 conditions;
- EER values at 7.0 and 4.4 (at T_1 conditions) also fall short of the comparative results of baseline units of split systems tested in the project;
- The prototypes' capacities are closer to each other but still around 60% of the designated capacity. It is this noteworthy that the OEM with the higher capacity baseline unit had a lower capacity prototype (OEM X), while OEM Y with the lower capacity base unit had the higher capacity prototype. The same trend was also demonstrated for EER.

Figure 7 shows the scatter graph for capacity vs. EER plotted against a reference for the baseline units at the value of one shown by the dotted lines. The results for R-457A are in the upper right hand quadrant indicating better performance than the corresponding HCFC-22 unit, while those for R-454C are in the bottom left hand quadrant indicating worse results than the base HCFC-22 unit built by the same OEM.

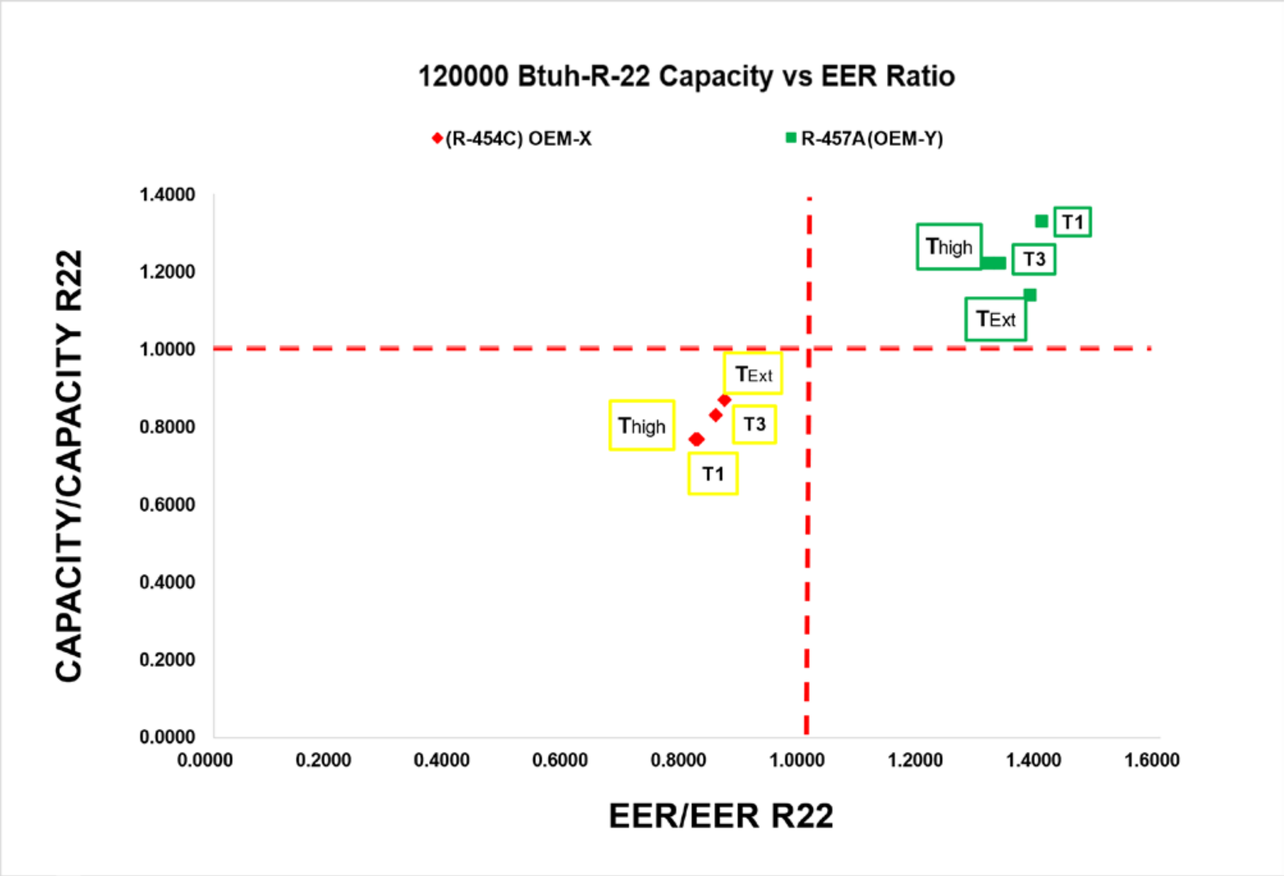


Figure 7: Capacity vs. EER ratio for HCFC-22 alternatives for the 120,000 Btu/h central units

In light of the above, it is difficult to draw a conclusion from the two set of tests since it was not possible to analyze the reason behind the performance of the baseline units which reflects on the comparison with the prototypes. On the other hand, the following facts might have a bearing on the results:

a) The prototypes were built in 2016 to 2017. The delay in testing was due to the unavailability of a test lab to test units of that capacity;
b) A lack of consistency in the production of the prototypes due to the high OEM technician rotation and lack of training in the period between 2016 to 2021;
c) In practice, units are normally optimized (charge mass) on site during installation rather than at the OEM facility. This practice is mainly due to a lack of proper well equipped labs for commercial units at the OEMs and the absence of MEPS for commercial units in Egypt;
d) The central unit can be installed in two configurations, either as a packaged unit or as a split. The unit was tested as a split unit;
e) The refrigerant charge of OEM X for the prototype unit needed further optimization;
f) R-454C is mainly used as a replacement for HCFC-22 and R-404A in refrigeration applications. Chemours advises that the refrigerant is also sometimes used for air conditioning applications;
g) R-457A has not been commercialized yet by its manufacturer.

Chapter 3

3. Analytical comparison & way forward

The purpose of the comparative analysis in this section is to determine the potential for improvement for the different alternative refrigerants at the different testing temperatures and for the three split system categories. Since there are three variables: type of refrigerants, testing temperatures, and category of equipment, the analysis fixed one of the variables and then calculated the percentage of incidence of cases where either the capacity or the EER as compared to the baseline unit falls in the five color categories defined earlier and repeated here for ease of reference.

No shading	Performance is same as base unit
Green	**Increase** in performance or cooling capacity over base unit
Yellow	**Decrease** in performance or cooling capacity by **- 0.01 % to - 5 %**
Orange	**Decrease** in performance or cooling capacity from **-5 % to - 10 %**
Red	**Decrease** in performance or cooling capacity over **-10 %**

As an example, consider the 12,000 Btu/hr category for all refrigerants and at all testing temperatures for the capacity comparison. We come up with the following table:

Table 16 Example of calculation of the comparative pie charts

12,000 Btu/hr category	**Capacity**				
Refrigerant	T_1	T_3	T_{High}	$T_{Extreme}$	
R-290	10,219	8,677	9,289	7,747	
(OEM C)	(-10.8%)	(-12.9%)	(-12.1%)	(-23.9%)	
R-457 A	1,1023	9,376	10,892	9,517	
(OEM C)	(-3.7%)	(-5.9%)	(+3.1%)	(-6.5%)	
R-454 C	10,968	9,349	9,946	9,042	
(OEM B)	(-3.9%)	(-6.4%)	(-8.7%)	(-9.9%)	
R-444 B	11,790	9,661	10,241	8,881	
(OEM A)	(+2.7%)	(-0.4%)	(-9.8%)	(+5.6%)	
	Calculation of incidence percentage				
	Green	Yellow	Orange	Red	No shading
Incidence: number of entries per color	**3**	**3**	**6**	**4**	**0**
Percentage of the 16 entries	**18.7%**	**18.7%**	**37.5%**	**25.0%**	**0%**

And the respective pie chart will look as in Figure 7 with the percentage of each incidence marked on the respective color. The pie chart indicates that when considering all the HCFC-22 refrigerant alternatives at all testing temperatures for the 12,000 category, there is

- 18.7% certainty that the result is better than the base,
- 18.7% that the result is up to 5% less compared to the base,
- 37.5% that the result between 5 and 10% less, and
- 25% that the results is over 10% less than the base.

Similar comparative analysis will be made for the different cases for HCFC-22 alternatives and R-410A alternatives. The analysis clarifies the way forward and recommendations can be made for all the cases.

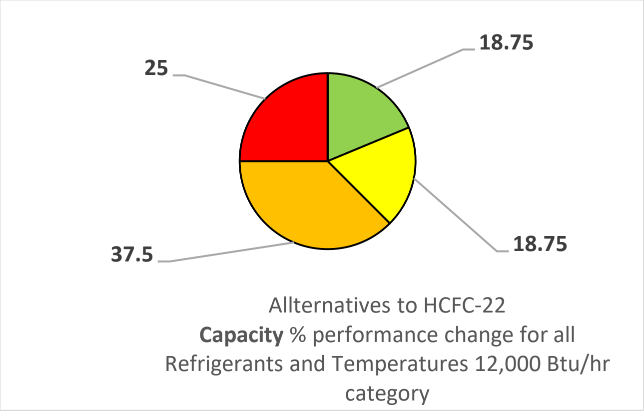


Figure 8 Example of pie chart for HCFC-22 alternatives in the 12,000 Btu/hr category

3.1. Capacity and EER behaviour of HCFC-22 Alternatives for each category across all refrigerants and testing temperatures

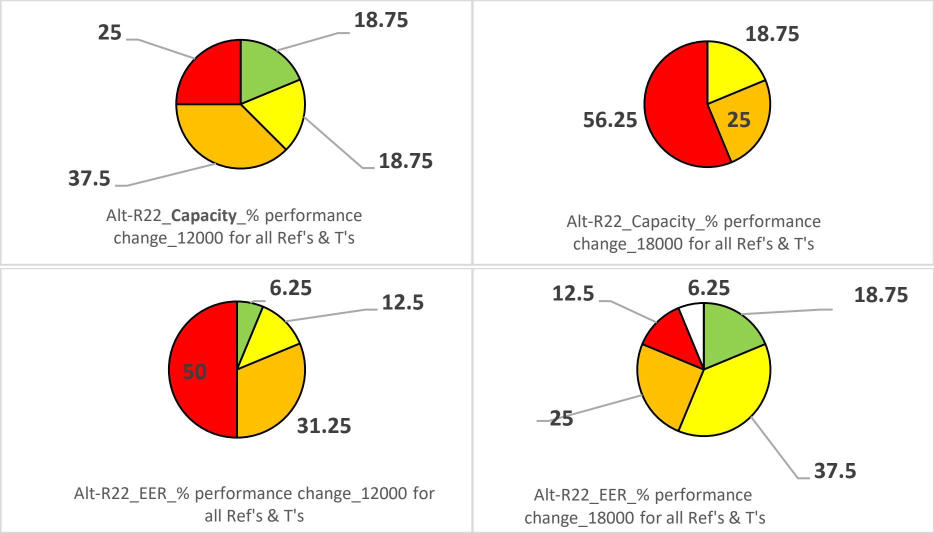


Figure 9 capacity and EER Performance of HCFC-22 alternatives for each category across all refrigerants and all testing temperatures

This analysis shows the following key observations:

For 12,000 Capacity:

- There is, certainly, potential to improve the capacity across 75% of refrigerants and at different testing temperatures
- On the EER side, the potential improvement drops down to 50%

For 18,000 Capacity:

- There is less potentiality to improve capacity across all refrigerants and at different testing temperatures compared to the 12,000 category.
- However, opportunities to improve EER is much higher reaching over 85% across all refrigerants and at different testing temperatures

The 24,000 prototypes results were disregarded, since only one OEM tested one refrigerant across all test temperatures conditions. The other OEM tested another refrigerant at only one testing temperature condition. Therefore, a comparison of the results would be misleading.

3.2. Capacity and EER behaviour of HCFC-22 Alternatives for each refrigerant across all categories and testing temperatures

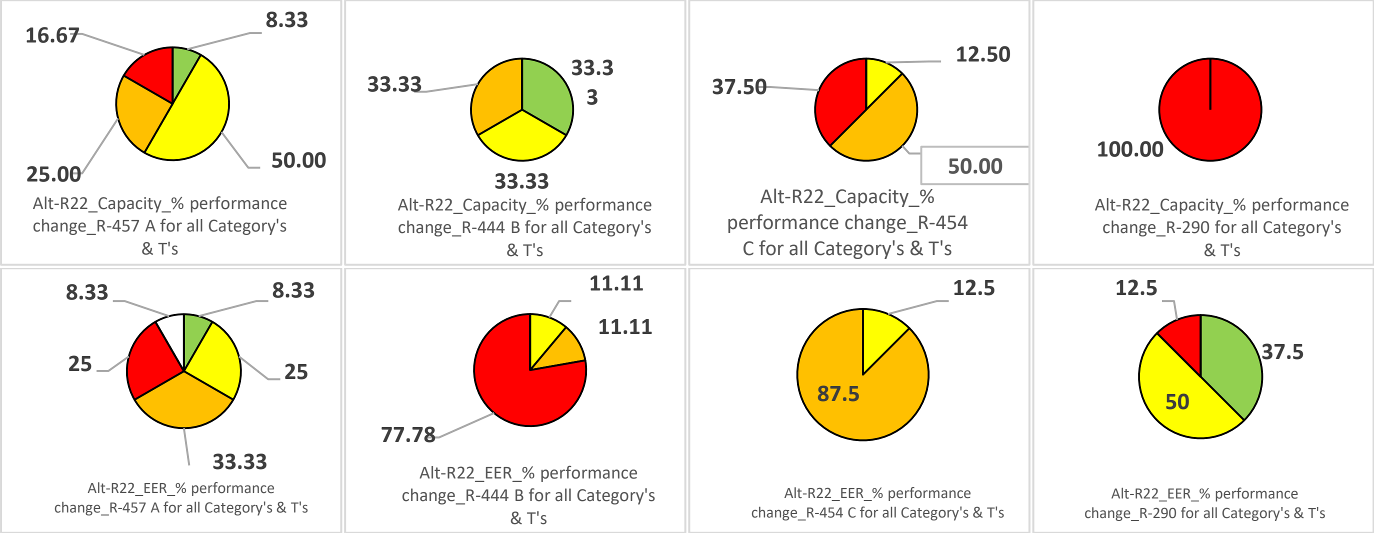


Figure 10 capacity and EER performance for HCFC-22 alternatives for each refrigerant across all categories and all testing temperatures

- Several alternatives to R-22 shows 60%, or above, chance for Capacity matching or improvement across all categories and at different testing temperatures.
- Most alternatives to R-22 shows 50%, or above, chance for EER improvement across all categories and at different testing temperatures.

3.3. Capacity and EER behaviour of HCFC-22 Alternatives for each testing temperature across all categories and refrigerants

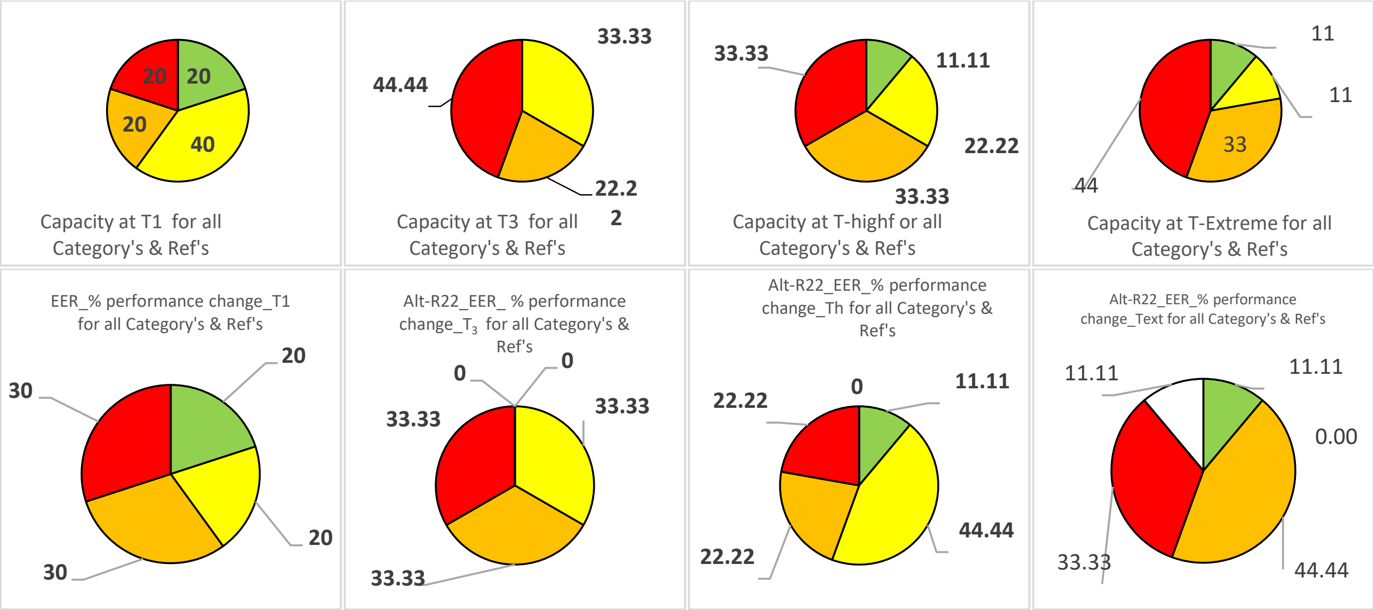
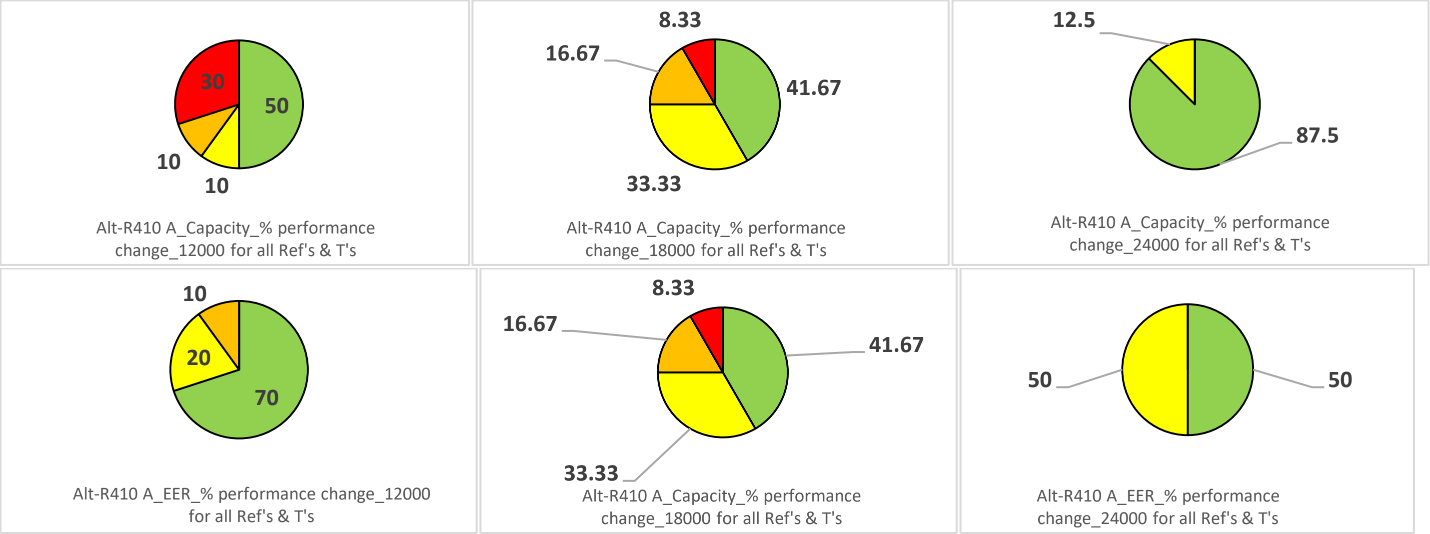


Figure 11 Capacity and EER performance of HCFC-22 alternatives for each testing temperature across all categories and all refrigerants

- As expected, moving from T1 to T3 testing temperatures, both capacity and EER deteriorate, at different levels, across all categories and refrigerants
- At T $_{High}$, the increased indoor wet bulb testing condition, as per EOS & ISO-5151, leads to better results for EER and capacity compared to T3

- Since T Extreme testing condition is similar to T High, with regard to indoor wet bulb testing condition, both EER and capacity re-deteriorate.
- In general, there are candidates with potential improvement, more than 50%, across all categories at all high temperature testing conditions i.e. T_3, T high & T extreme.

3.4. Capacity and EER behaviour of R-410A Alternatives for each category across all refrigerants and testing temperatures



Alt-R410 A_Capacity_% performance change_12000 for all Ref's & T's

Alt-R410 A_Capacity_% performance change_18000 for all Ref's & T's

Alt-R410 A_Capacity_% performance change_24000 for all Ref's & T's

Alt-R410 A_EER_% performance change_12000 for all Ref's & T's

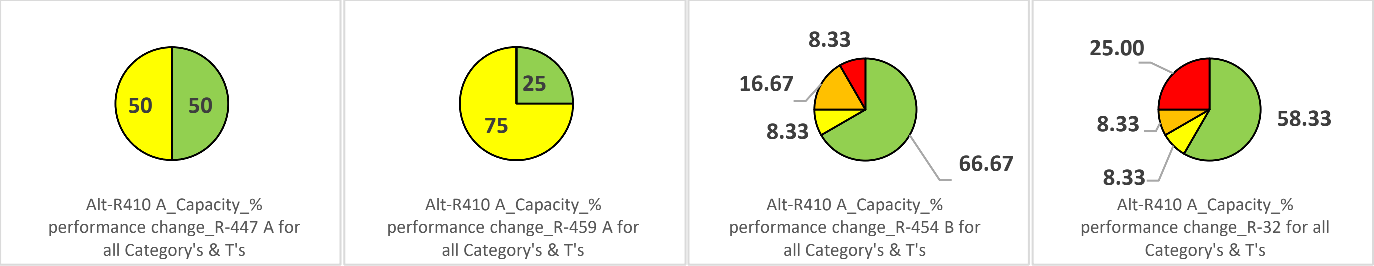
Alt-R410 A_Capacity_% performance change_18000 for all Ref's & T's

Alt-R410 A_EER_% performance change_24000 for all Ref's & T's

Figure 12 capacity and EER performance of R-410A alternatives for each category across all refrigerants and all testing temperatures

- Increase in capacity as category size increases, across all refrigerants and all testing temperate conditions.
- Capacity increases are from 50 % to 87.5 %.
- However, EER decreased as category size increases.
- EER improvement decreases from 70 % to 50 %.
- 18,000 showed capacity readings for all ranges similar to EER readings.
- 18,000 in the range (-0.1 % to - 5 %) readings for both capacity and EER were the same, 33.33 % instead of 10 % and 20 % in 12,000 size.
- The possibility of improving by optimization capacity and EER compared to R-410A are high

3.5. Capacity and EER behaviour of R-410A Alternatives for each refrigerant across all categories and testing temperatures



Alt-R410 A_Capacity_% performance change_R-447 A for all Category's & T's

Alt-R410 A_Capacity_% performance change_R-459 A for all Category's & T's

Alt-R410 A_Capacity_% performance change_R-454 B for all Category's & T's

Alt-R410 A_Capacity_% performance change_R-32 for all Category's & T's

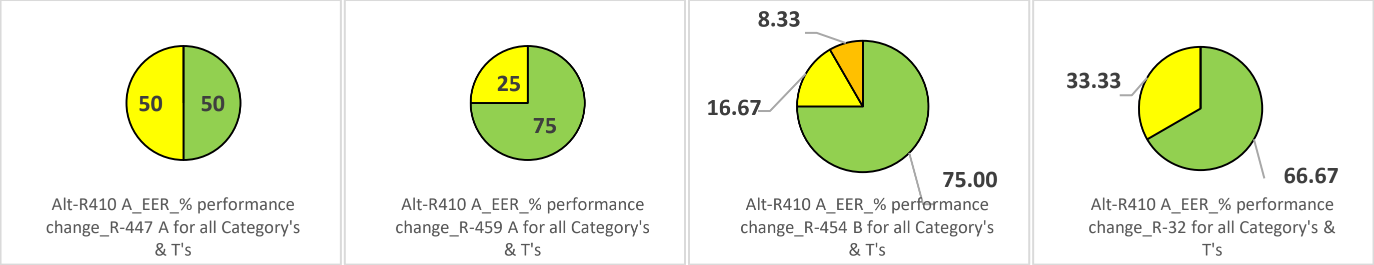


Figure 13 Capacity and EER performance of R-410A alternatives for each refrigerant across all categories and all testing temperatures

- All refrigerants showed improvement in capacity by 25% to 67 % and 50 % to 75 % in EER.
- One refrigerant was excluded from the comparison because of lack of data.
- All refrigerants have excellent chances of improvement in capacity and EER by optimization.

3.6. Capacity and EER behaviour of R-410A Alternatives for each temperature across all categories and refrigerants

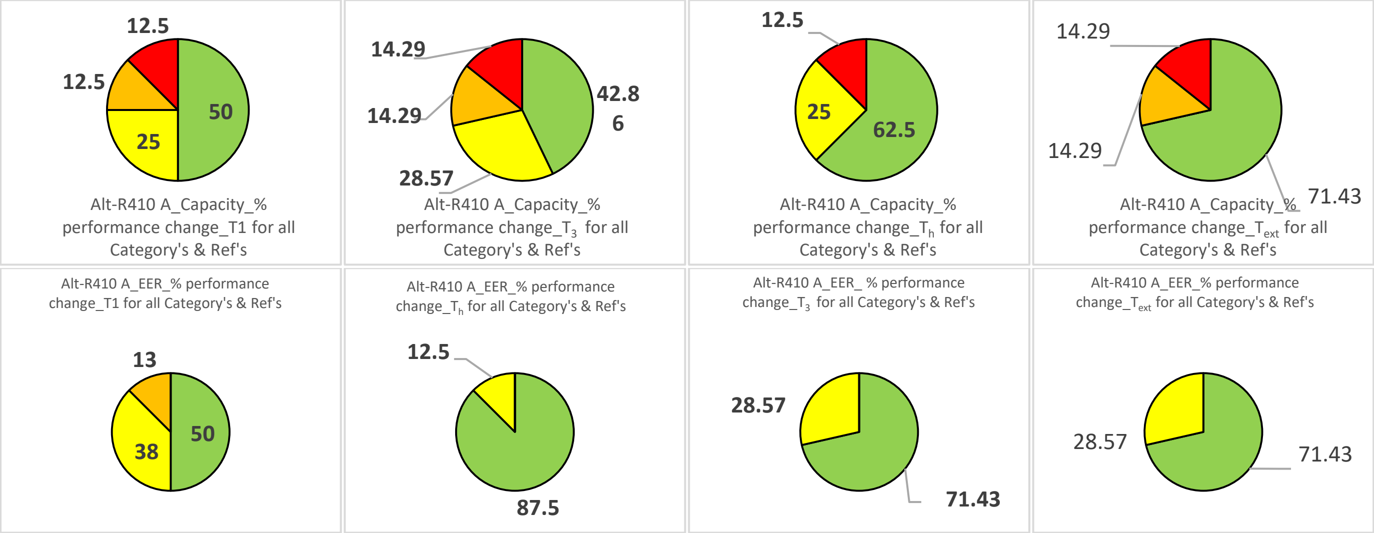


Figure 14 Capacity and EER performance of R-410A alternatives for each testing temperature across all categories and refrigerants

- At T_1: 50 % of all test readings show better capacities than R-410 A for all refrigerants and categories and 50% better EER.
- At T_3 : 42.86 % decrease in capacity improvement to 42.86% and then improvement rose to 62.5% and 71.43 % at T_h and T_{ext}.
- At T_3 : 87.5 %improvement in EER. Improvement diminished slightly to 71.43 % for both T_h and T_{ext}.

Excellent prospects for improvement in capacity and EER by optimization compared to R-410 A across all temperature testing conditions for all categories and all refrigerants.

3.7. Capacity and EER behaviour of HCFC-22 alternatives for central units

For central units, only two tests were carried out for two refrigerant alternatives; consequently, the charts for the different variables all show the same result as shown in Figure 15 where one result is better than the base unit (green) and the other is more than 10% below the base unit (red).

A more significant way of analysing the result for central units is to compare with the results for split units for the same alternative refrigerants tested in the project.

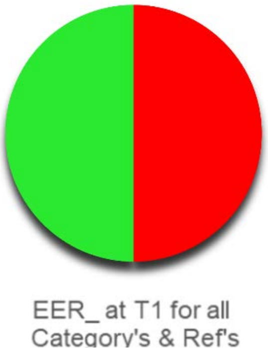


Figure 15: Chart for central units

Table 17 below shows the result for R454C. The table shows a consistent performance below that of HCFC-22 base units for both capacity and EER. The results for the central unit are however all in the red category, i.e., more than 10% below.

Table 17: Comparison of results for R-454C across all categories

R-454C	T_1	T_3	T High	T Extreme	T_1	T_3	T High	T Extreme
	Capacity in Btu/hr				EER			
12,000 Btu/hr	10,968 (3.9%)	9,349 (6.4%)	9,946 (8.7%)	9,042 (9.9%)	7.97 (5.2%)	6.00 (6.0%)	5.86 (7.4%)	5.05 (7.7%)
18,000 Btu/hr	16,510 (9.1%)	**14,327 (11.5%)**	**15,619 (11.4%)**	**14,250 (12.5%)**	9.31 (6.9%)	6.97 (5.4%)	7.01 (4.9%)	6.02 (6.7%)
Central unit	**69,010 (18.2%)**	**64,350 (15.1%)**	**66,600 (18.6%)**	**66,070 (13.6%)**	**5.36 (23.1%)**	**4.48 (16.9%)**	**4.32 (23.0%)**	**3.98 (13.3%)**

Table 18 below shows the results for R-457A. The extremely good results for the central unit stand out in contrast to those of the split unit which indicates a problem with the results of the central unit.

Table 18: Comparison of results for R-457C across all categories

R-457A	T_1	T_3	T High	T Extreme	T_1	T_3	T High	T Extreme
	Capacity in Btu/hr				EER			
12,000 Btu/hr	11,023 (3.7%)	9,376 (5.9%)	10,892 +3.1%)	9,517 (6.5%)	**8.36 (16.4%)**	**6.24 (13.9%)**	6.58 (5.6%)	**5.56 (10.8%)**
18,000 Btu/hr	15,257 (7.2%)	**12,672 (12.9%)**	13,418 (2.2%)	**12,149 (20.9%)**	9.3 +3.7%	6.6 (0.9%)	6.3 (0.9%)	5.3 0.00%
24,000 Btu/hr	21,758 (2.5%)	20,670 (2.5%)	19,636 (2.5%)	18,657 (2.5%)	8.78 (5.6%)	6.85 (6.4%)	5.82 (4.6%)	5.25 (8.4%)
Central unit	77,160 39.8%	63,280 31.1%	64,490 33.5%	57,670 37.6%	5.9 33.4%	4.1 21.8%	4.0 21.9%	3.3 27.8%

Chapter 4

4. Energy Efficiency and Progressive Changes in MEPS for Egypt

Egypt's MEPS (Minimum Energy Performance Standards) energy efficiency label requirement for mini split air conditioning units and window type, ES: 3795-/2013 and ES: 3795-/2016 Part 1-for constant speed compressors- define EER (BTU/W.hr) at T_1 condition (ISO 5151) across several efficiency classes, A 5+ to E as listed in the tables below according to regulation years, 2014 to 2021.

MEPS progression across the years:

The standards, starting June 2014, lists EER values for energy efficiencies that define a certain class, termed calibration level, starting from E to A^{++}, see table below.

Table 19: Egypt Energy Ratings per 2014 Standard

Calibration	**Energy Efficiency ratio of a room air conditioner (Split AC)**	
	Watt/ Watt	**B.T.U/ Watt/h**
A^{++}	Higher or equal to 4.1	Higher or equal to 14
A+	Higher than or equal to 3. 81 and less than 4.1	Higher or equal to 13 and less than 14
A	Higher than or equal to 3.51 and less than 3. 81	Higher or equal to 12 and less than 13
B	Higher than or equal to 3.22 and less than 3.51	Higher or equal to 11 and less than 12
C	Higher than or equal to 3.08 and less than 3.22	Higher or equal to 10.5 and less than 11
D	Higher than or equal to 2.93 and less than 3.08	Higher or equal to 10 and less than 10.5
E	Higher than or equal to 2.78 and less than 2.93	Higher or equal to 9.5 and less than 10

Those EER classes' changes to become progressively stricter, as of June 2017, see table shown below, new class created **A^{+++}** and class **E** removed:

Table 20: Egypt Energy Ratings per 2017 Standard

Calibration	**Energy Efficiency ratio of a room air conditioner (Split AC)**	
	Watt/ Watt	**B.T.U/ Watt/h**
A^{+++}	Higher or equal to 4.4	Higher or equal to 15
A^{++}	Higher than or equal to 4,1 and less than 4.4	Higher or equal to 14 and less than 15
A+	Higher than or equal to 3.81 and less than 4.1.	Higher or equal to 13 and less than 14
A	Higher than or equal to 3.51 and less than 3.81	Higher or equal to 12 and less than 13
B	Higher than or equal to 3.22 and less than 3.51	Higher or equal to 11 and less than 12
C	Higher than or equal to 3,08 and less than 3.22	Higher or equal to 10.5 and less than 11
D	Higher than or equal to 2,93 and less than 3.08	Higher or equal to 10 and less than 10.5

And in June 2019 as shown below, new class created **A^{++++}** and class D removed:

Table 21: Egypt Energy Ratings per 2019 Standards

Calibration	**Energy Efficiency ratio of a room air conditioner (Split AC)**	
	Watt/ Watt	**B.T.U/ Watt/h**
A^{++++}	Higher or equal to 4.69	Higher or equal to 16
A^{+++}	Higher or equal to 4.4 and less than 4.69	Higher or equal to 15 and less than 16
A^{++}	Higher than or equal to 4.1 and less than 4.4	Higher or equal to 14 and less than 15
A+	Higher than or equal to 3.81 and less than 4.1	Higher or equal to 13 and less than 14
A	Higher than or equal to 3.51 and less than 3.81	Higher or equal to 12 and less than 13
B	Higher than or equal to 3. 22 and less than 3.51	Higher or equal to 11 and less than 12
C	Higher than or equal to 3. 08 and less than 3.22	Higher or equal to 10.5 and less than 11

Finally in June 2021 it becomes as shown below, new class created **A^{+++++}** and class **C** removed:

Table 22: Egypt Energy ratings per 2021 Standard

Calibration	**Energy Efficiency ratio of a room air conditioner (Split AC)**	
	Watt/ Watt	**B.T.U/ Watt/h**
A^{+++++}	Higher or equal to 4.98	Higher or equal to 17
A^{++++}	Higher or equal to 4.69 and less than 4. 98	Higher or equal to 16 and less than 17
A^{+++}	Higher or equal to 4.4 and less than 4.69	Higher or equal to 15 and less than 16
A^{++}	Higher than or equal to 4.1 and less than 4.4	Higher or equal to 14 and less than 15
A+	Higher than or equal to 3. 1 and less than 4.1	Higher or equal to 13 and less than 14
A	Higher than or equal to 3.51 and less than 3.81	Higher or equal to 12 and less than 13
B	Higher than or equal to 3.22 and less than 3.51	Higher or equal to 11 and less than 12

When the EER values are tabulated according to efficiency class (calibration) versus the year(s) when standards come into operation, the below table is obtained, where the most efficient class for each year(s) is in red followed by green, violet, sky blue, orange, light blue and navy blue as the class of efficiency becomes less and less . For all years there are 7 classes of efficiency.

The highest EER in 2014-2016 was 14 for class A^{2+} while in 2021 the highest EER will be 17 and a new classis created; A^{5+}. This continuous progression to more efficient systems is reflected in the graph below, where EERs are plotted across all years from 2014 to 2021. The top line denotes the highest EER for each regulation year, while the other lines are in descending order. The colors of the rows in the table correspond to the colors of the lines of efficiency classes for each year(s) in Figure 16.

Table 23: EER Values at T1 according to the Egyptian Standard ES: 3795/2016

Eff. class /yr.	2014-2016	2017-2018	2019-2020	2021
A^{5+}				17
A^{4+}			16	16
A^{3+}		15	15	15
A^{2+}	14	14	14	14
A^{+}	13	13	13	13
A	12	12	12	12
B	11	11	11	11
C	10.5	10.5	10.5	
D	10	10		
E	9.5			

The table shows how the energy efficiency classes are increasing progressively with the years.

EER versus years:

The graph below shows the highest to lowest EER plotted against the years it came/comes into effect. The graph shows the progression to higher EER with the years. The values are taken from the table above. Seven classes are represented for each year.

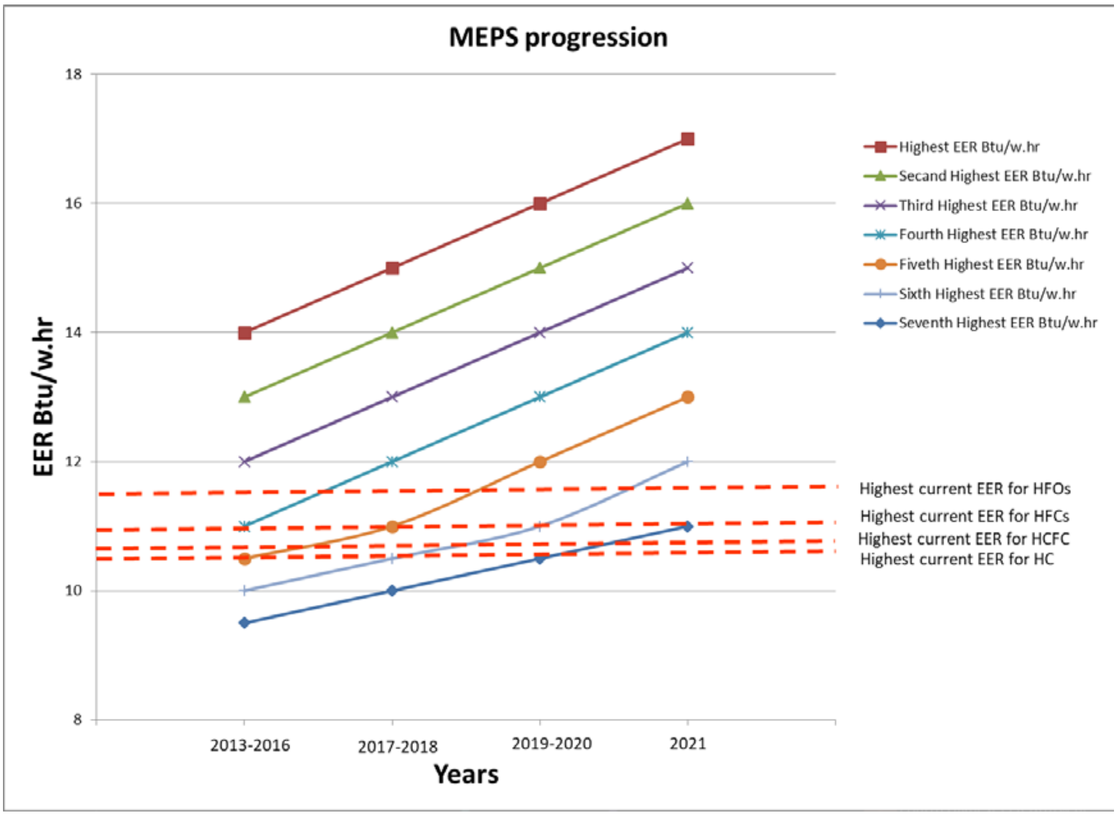


Figure 16: EER curves for the highest in each class plotted vs. the standard regulation year

When the results of the Egyptian program for testing alternative low-GWP refrigerants for the Egyptian air conditioning industry, EGYPRA, are plotted on the graph as straight lines showing the best EER achieved for HCFCs, HFCs, HC and HFO, the following is shown:

- The highest EER of prototypes using HC-290 refrigerant is 10.35

- The highest EER of tested units using HCFC refrigerant is 10.5
- The highest EER of tested units using HFC refrigerant is 10.88
- The highest EER of prototypes using HFO refrigerant is 11.5

EGYPRA prototypes, especially made for the program, were optimized by choosing an optimum refrigerant charge and suitable selection of capillary tube (expansion device). No changes were made to either evaporator or condenser.

The best EER of alterative refrigerants cannot achieve at current optimization more than class B (light blue) for MEPS 2019-2020 and class B (navy blue) for 2021.

However, there is potential for improvement. The potential for improvement is based on the fact that the prototypes were built with many constraints (size and type of heat exchangers, size if the units, etc…). In future further optimization through the selection of compressors better suited to alternative refrigerants and the selection of heat exchangers that can improve the efficiency of the units will increase EER of the systems.

it is unlikely that EER improvement can be made from the current 11.5 to 16 in 2019 and 17 in 2021. The extent of EERs improvement is related to the optimization process which requires research and development capabilities and capital cost and time. This might be beyond the capability of the majority of the manufacturers.

Further results of this correlation is as follows:

- Shifting to variable speed split units is inevitable if the higher efficiency EER standards are to be achieved by 2019 and beyond, with the resultant additional incremental costs associated with this shift, in manufacturing equipment and end product cost i.e., USD 50 to 100 (TEAP 2019)
- The introduction of Not-In-Kind cooling technology must be accelerated if energy efficiency rates are to be improved for the air conditioning sector.

Chapter 5

5. Conclusion

EGYPRA is funded from Egypt's HCFC Phase-out Management Plan (HPMP) as an enabling activity for the benefit of the Egyptian air conditioning industry to help local manufacturers experiment working with new alternative lower-GWP refrigerants.

EGYPRA tested refrigerants with medium pressure characteristics similar to HCFC-22 and others with high pressure similar to R-410A in split system units.

This conclusion is in two parts: technical and institutional regarding capacity building requirements.

5.1. Technical Conclusion

EGYPRA results lead to the following conclusions:

- As expected, and for all refrigerants, moving from T_1 to T_3 testing temperatures, both capacity and EER deteriorate, at different levels, across all categories and refrigerants;
- At T_{High}, the increased indoor wet bulb testing condition, as per EOS & ISO-5151, leads to better results for EER and capacity compared to T_3;
- Since $T_{Extreme}$ testing condition is similar to T_{High}, with regard to indoor wet bulb testing condition, both EER and capacity re-deteriorate;
- In general, there are candidates with potential for improvement; however, since high pressure refrigerants show better results vs. R-410A, the potential for improvement is higher.

Almost all of the OEMs who have participated in EGYPRA have already introduced R-410A units into the split unit market. One uncorroborated study shows that more than 10% of the units sold in 2017 were with R-410A. This might make it easier for OEMs to leap-frog solutions for HCFC-22 and pass directly to high pressure alternatives to R-410A as the possibility for performance and EER improvement is higher for those alternatives.

Split unit results also show that the potential for improvement applies also at higher ambient temperatures, an important factor for some of the regions in the south of Egypt that experience higher ambient temperatures than 35 °C. This is also important for the export market as some manufacturers export to neighboring HAT countries in the region.

Central units results do not lead to a definite conclusion. The main reason for not having a more robust conclusion on performance is the absence of enough tests involving refrigerants that are being used or considered today. The air conditioning market has adopted alternatives to R-410A rather than those equivalent to HCFC-22 used in the project. At the time the prototypes were built, the OEMs were only using HCFC-22 for their central units and hence alternative equivalent to HCFC-22 were selected. A couple of years later, when the units were going to be tested, it was not possible to rebuild new prototypes with R-410A alternatives and the decision was made to go ahead with the HCFC-22 alternatives.

Additionally, the central units were tested as received (except for baseline unit of OEM X) which affected the results since no optimization of charge was made.

5.2. Capacity Building Requirements

The conclusion from chapter 4 is clear: at the current optimization level, none of the prototypes tested will be able to meet more than class B of the 2021 MEPS values; however, the fact is that prototypes were built with many constraints

- The prototypes could be further optimized through the selection of compressors better suited to the tested refrigerants and the selection of heat exchangers that can improve the efficiency of the units, as well as the use of electronic expansion valves instead of capillary tubes for split units which has an effect on the cost of the unit;
- Variable speed technology would improve the Seasonal EER of the units where applicable;
- The optimization process requires research and development capabilities that might go beyond those available at some of the manufacturers;
- A further conclusion concerns the testing facilities of the EGYPRA OEMs. Witness testing has enabled the Technical Consultant to carefully assess the capabilities of each lab, especially for testing flammable refrigerants. For confidentiality purposes, the general description of the lab facilities given in Annex 2 does not aim to critique the individual labs or divulge where the individual labs need to be upgraded; however, the fact remains that some of the labs could benefit from an upgrade program;
- Test results show that all refrigerants used in the project are viable alternatives from a thermodynamic point of view. The viability in terms of the other criteria like commercial availability, cost, and safety – among others - needs to be further researched.

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Annex 1: Test Results

The annex includes tables and charts from the test results. All OEMs results were compiled by category, for HCFC-22 equivalent refrigerants and for R-410A equivalent refrigerants.

The tables show the results for capacity in Btu/hr and EER at the four testing temperatures. The tables are per category of 12,000 Btu/hr split units, 18,000 split units and 24,000 Btu/hr split units. They include all alternatives refrigerant tested by each OEM.

The equivalent bar charts reflect the results in the tables: one bar chart for capacity and one bar chart for EER.

The sequence in which they are presented is:

- Table and bar chart equivalents for HCFC-22 alternatives in the 12,000 Btu/hr category;
- Table and bar chart equivalents for HCFC-22 alternatives in the 18,000 Btu/hr category;
- Table and bar chart equivalents for HCFC-22 alternatives in the 24,000 Btu/hr category;
- Table and bar chart equivalents for R-410A alternatives in the 12,000 Btu/hr category;
- Table and bar chart equivalents for R-410A alternatives in the 18,000 Btu/hr category;
- Table and bar chart equivalents for R-410A alternatives in the 24,000 Btu/hr category.

Table 24 A1: Capacity and EER Results for HCFC-22 alternatives in 12,000 Btu/hr category

HCFC-22 eq. 12,000 Btu/hr		OEM A				OEM B				OEM C				OEM E			
Ambient		**T_{1}**	**T_{3}**	**T_{high}**	**T_{Ext}**	**T_{1}**	**T_{3}**	**T_{high}**	**T_{Ext}**	**T_{1}**	**T_{3}**	**T_{high}**	**T_{Ext}**	**T_{1}**	**T_{3}**	**T_{high}**	**T_{Ext}**
R-22	CAP	11479	9699	11353	8407	11410	9988	10900	10035	11452	9960	10560	10181	10753	10415	10352	9381
	EER	9.74	6.88	7.31	5.61	8.410	6.380	6.330	5.470	10.002	7.249	6.975	6.231	10.290	8.300	7.380	6.230
R-290	CAP									10219	8677	9289	7747				
	EER									10.355	7.171	6.959	5.217				
ARM-20a R-457A	CAP									11023	9376	10892	9517				
	EER									8.358	6.239	6.582	5.556				
Opteon XL-20 R-454C	CAP					10968	9349	9946	9042					6980.6	4958.27	5762.15	4489.25
	EER					7.970	6.000	5.860	5.050					8.150	5.200	5.600	4.180
L-20 R-444B	CAP	11790	9661	10241	8881												
	EER	8.43	5.73	5.53	4.47												

Figure 17 A1 - Equivalent capacity charts for HCFC-22 alternatives in 12,000 Btu/hr category plotted vs HCFC-22 results

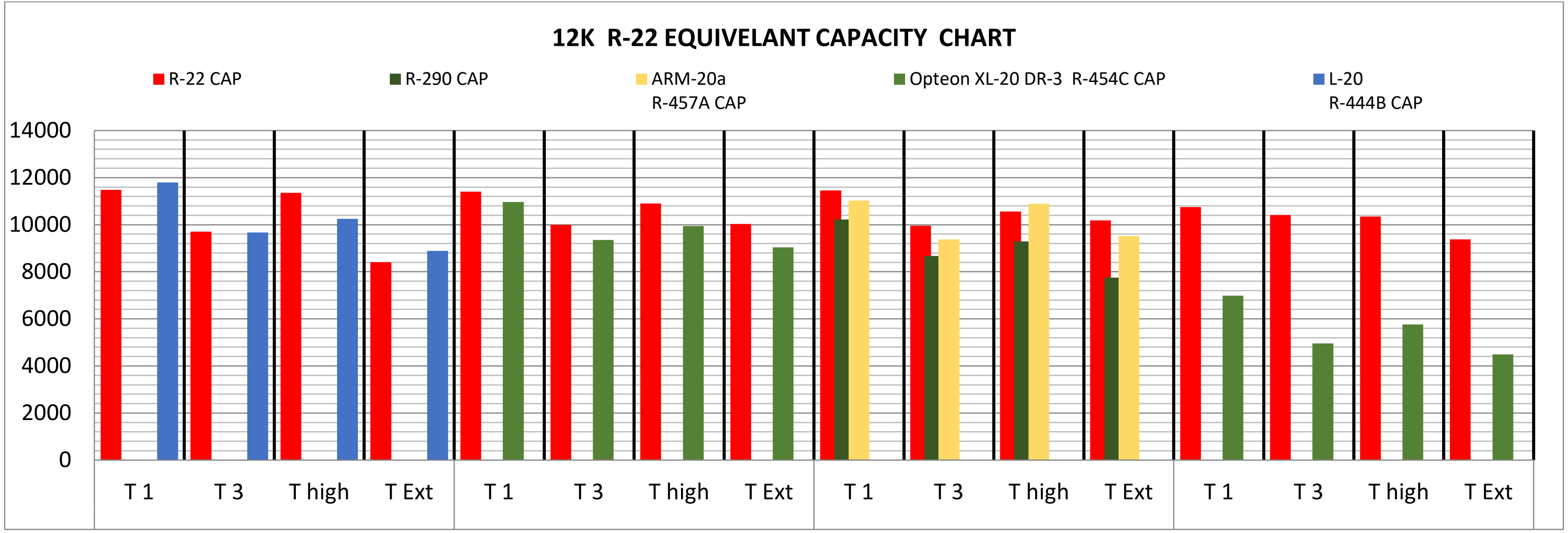


Figure 18 A1 - Equivalent EER chart for HCFC-22 alternatives in 12,000 Btu/hr category plotted vs HCFC-22 results

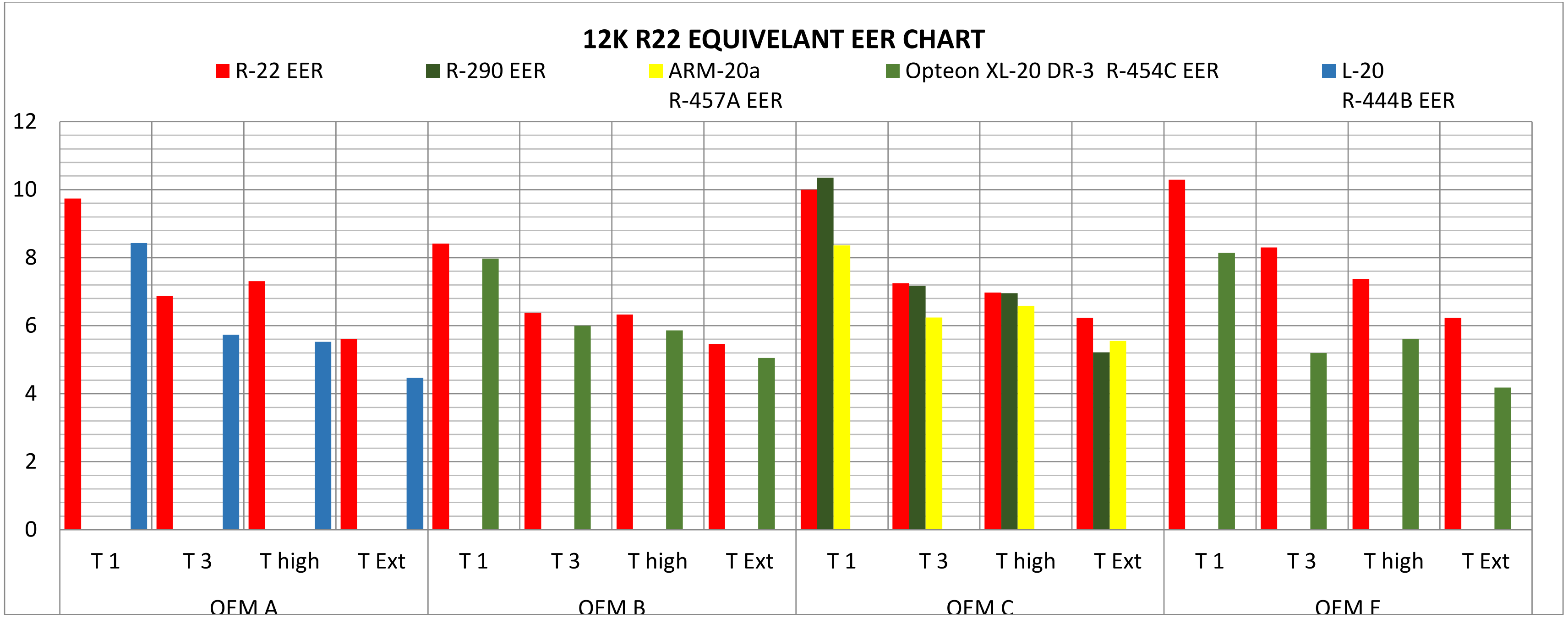


Table 25 A1- Capacity and EER results for HCFC-22 alternatives in 18,000 Btu/hr category

HCF-22 eq. 18,000 Btu/hr		OEM A				OEM B				OEM C				OEM D			
Ambient		**T 1**	**T 3**	**T high**	**T Ext**	**T 1**	**T 3**	**T high**	**T Ext**	**T 1**	**T 3**	**T high**	**T Ext**	**T 1**	**T 3**	**T high**	**T Ext**
R-22	CAP	18659	16799	17543	15046	16433	14545	13718	15350	18160	16182	17632	16292	17548	16422	14624	13948
	EER	9.410	7.260	6.980	5.550	8.930	6.650	6.370	5.330	10	7.372	7.371	6.445	10.500	8.750	7.220	6.00
R-290	CAP	16111	14067	15343	13442												
	EER	9.310	7.090	7.170	5.860												
R-457A	CAP					15257	12672	13418	12149								
	EER					9.260	6.590	6.310	5.330								
R-454C	CAP									16510	14327	15619	14250				
	EER									9.312	6.972	7.011	6.015				
R-444B	CAP													17098	15746	13498	13047
	EER													10.000	7.780	6.320	5.400

Figure 19 A1 - Equivalent capacity charts for HCFC-22 alternatives in 18,000 Btu/hr category plotted vs HCFC-22 results

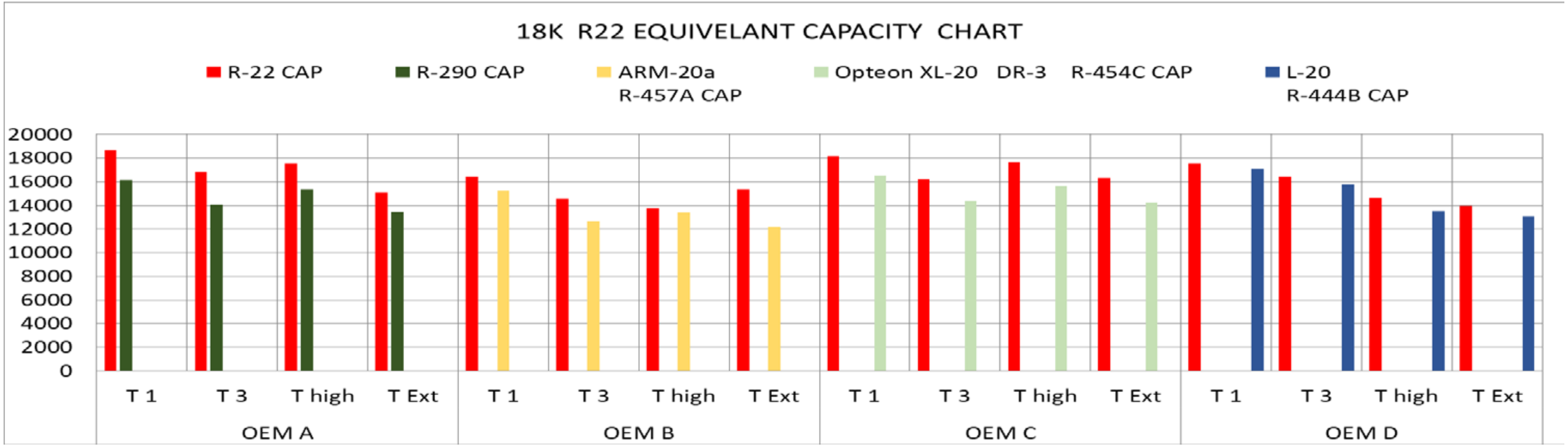


Figure 207 A1 - Equivalent EER charts for HCFC-22 alternatives in 18,000 Btu/hr category plotted vs HCFC-22 results

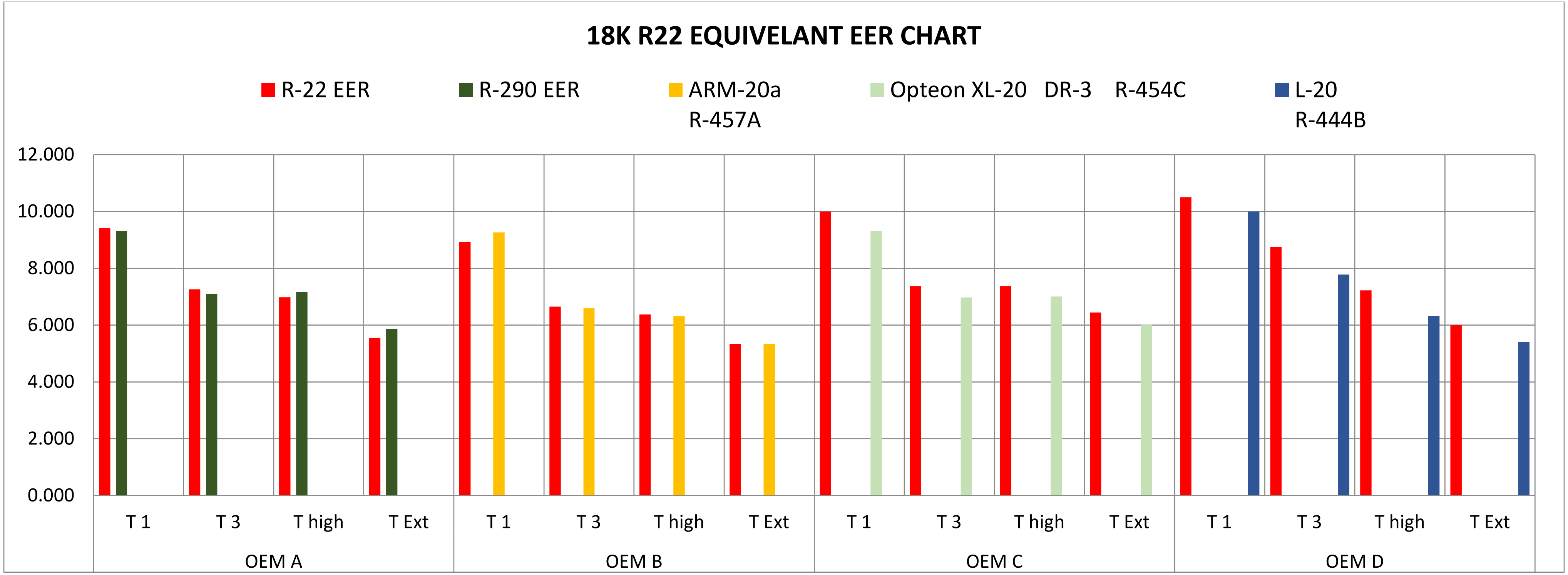


Table 26 A1 - Capacity and EER results for HCFC-22 alternatives in 24,000 Btu/hr category

HCFC-22 eq. 24,000 Btu/hr		OEM B				OEM D			
Ambient		**T 1**	**T 3**	**T high**	**T Ext**	**T 1**	**T 3**	**T high**	**T Ext**
R-22	CAP	22782				22318	21202	20144	19148
	EER	9.270				9.300	7.320	6.100	5.73
R-290	CAP								
	EER								
ARM-20a R-457A	CAP					21758	20670	19636	18657
	EER					8.78	6.85	5.82	5.25
Opteon XL-20 DR-3 R-454C	CAP								
	EER								
L-20 R-444B	CAP	23436							
	EER	7.38							

Figure 21 A1 - Equivalent capacity charts for HCFC-22 alternatives in 24,000 Btu/hr category plotted vs HCFC-22 results

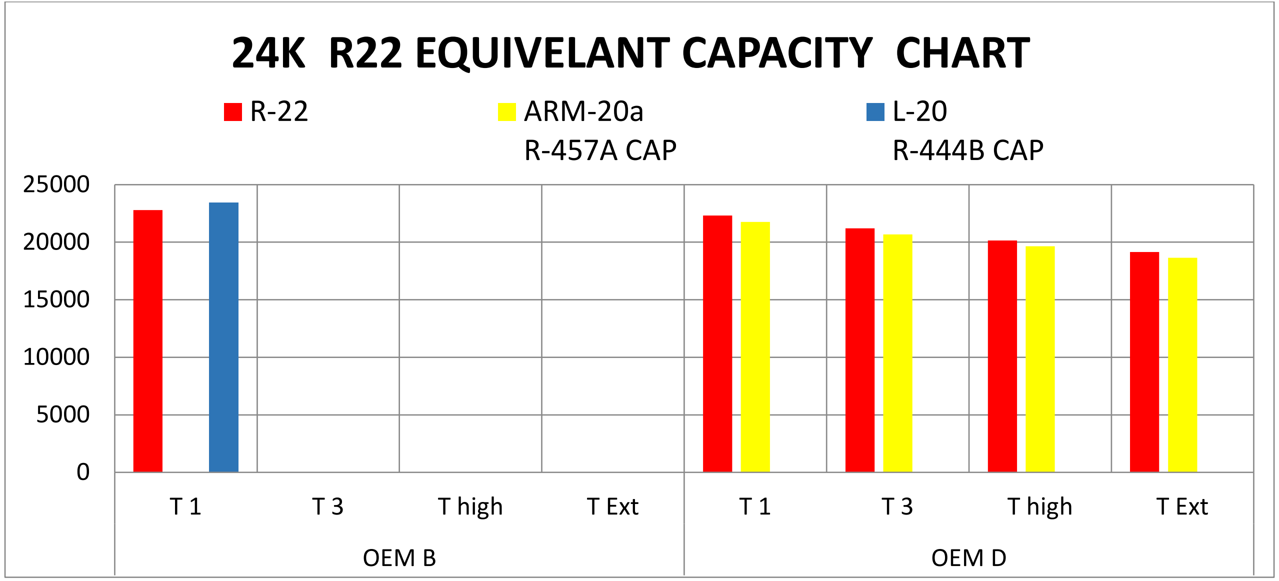


Figure 22 A1 - Equivalent EER chart for HCFC-22 alternatives in 24,000 Btu/hr category plotted vs HCFC-22 results

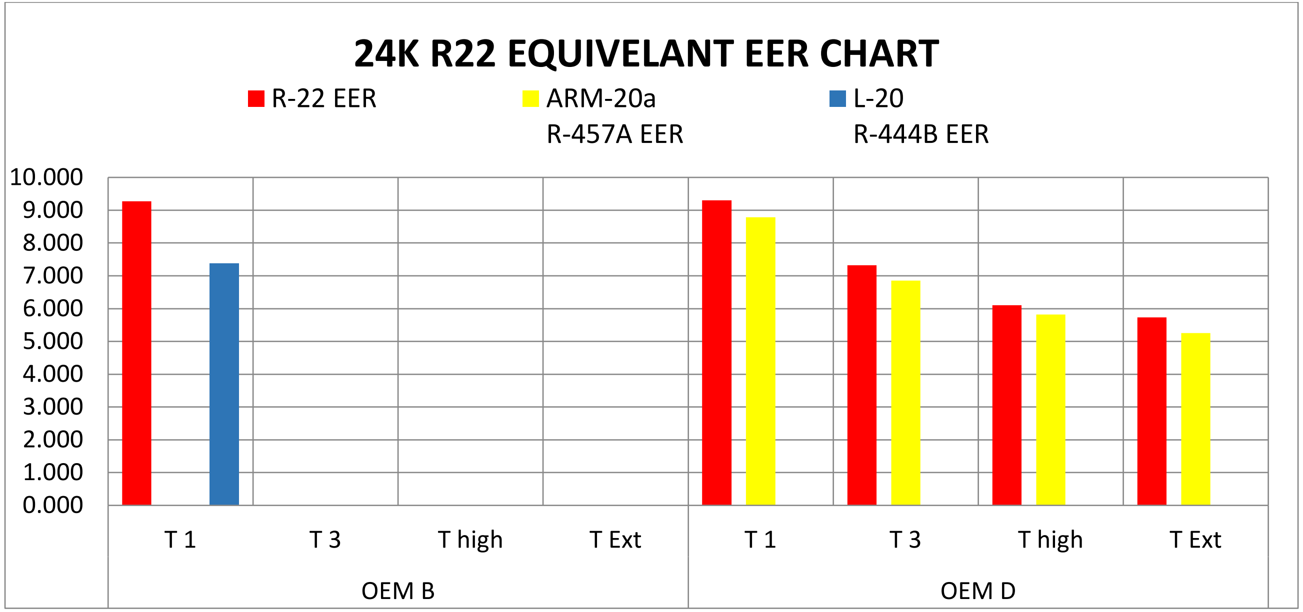


Table 27 A1 - Capacity & EER results for R-410A alternatives in 12,000 Btu/hr category

R-410 A eq.		OEM A				OEM B				OEM E			
12,000 Btu/hr Ambient		**T 1**	**T 3**	**T high**	**T Ext**	**T 1**	**T 3**	**T high**	**T Ext**	**T 1**	**T 3**	**T high**	**T Ext**
R-410A	CAP	10307	-	8313	-	12068	10343	11089	9968	11905	9369	10848	9299
	EER	8.77	-	5.43	-	10.17	7.31	7.15	5.93	10.88	7.29	7.42	5.89
ARM-71a R-459A	CAP												
	EER												
R-32	CAP					11355	9249	9822	8499				
	EER					11.51	7.53	7.26	5.69				
Opteon XL-41 DR-5 R-454B	CAP									11987	11130	12257	11094
	EER									9.92	7.95	7.66252	6.7676
L-41 R447A	CAP	9963	-	8539	-								
	EER	8.38	-	5.55	-								

Figure 23 A1 - Equivalent capacity chart for R410A alternatives in 12,000 Btu/hr category plotted vs R-410A results

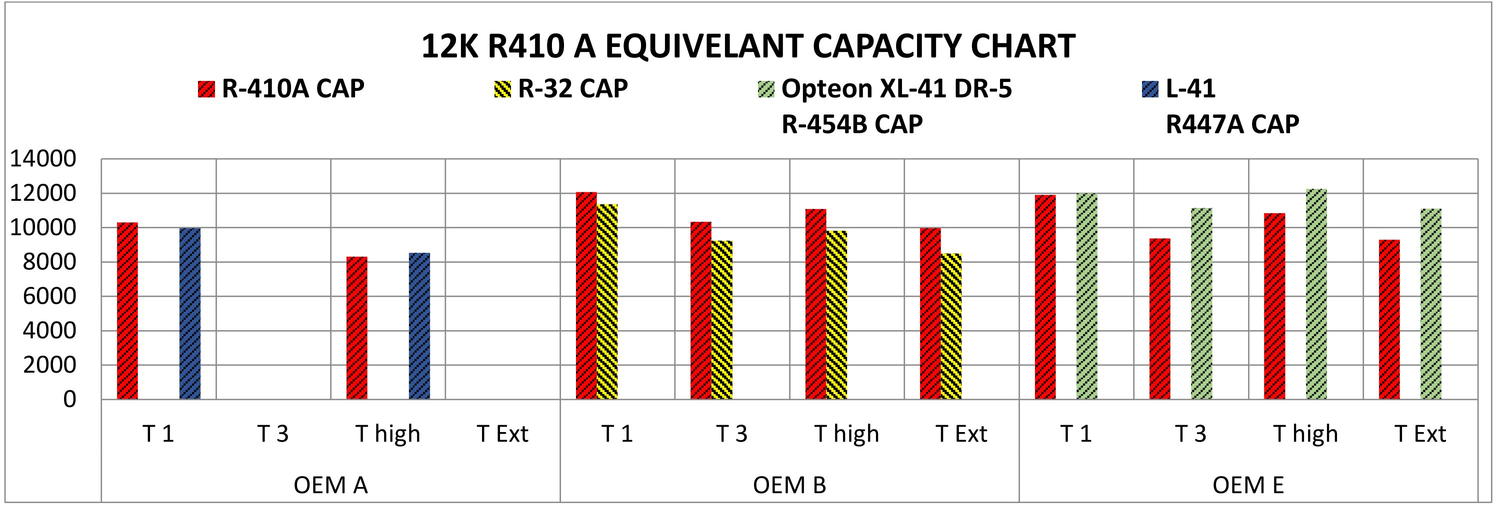


Figure 24 A1 - Equivalent EER chart for R-410A alternatives in 12,000 Btu/hr category plotted vs R-410A results

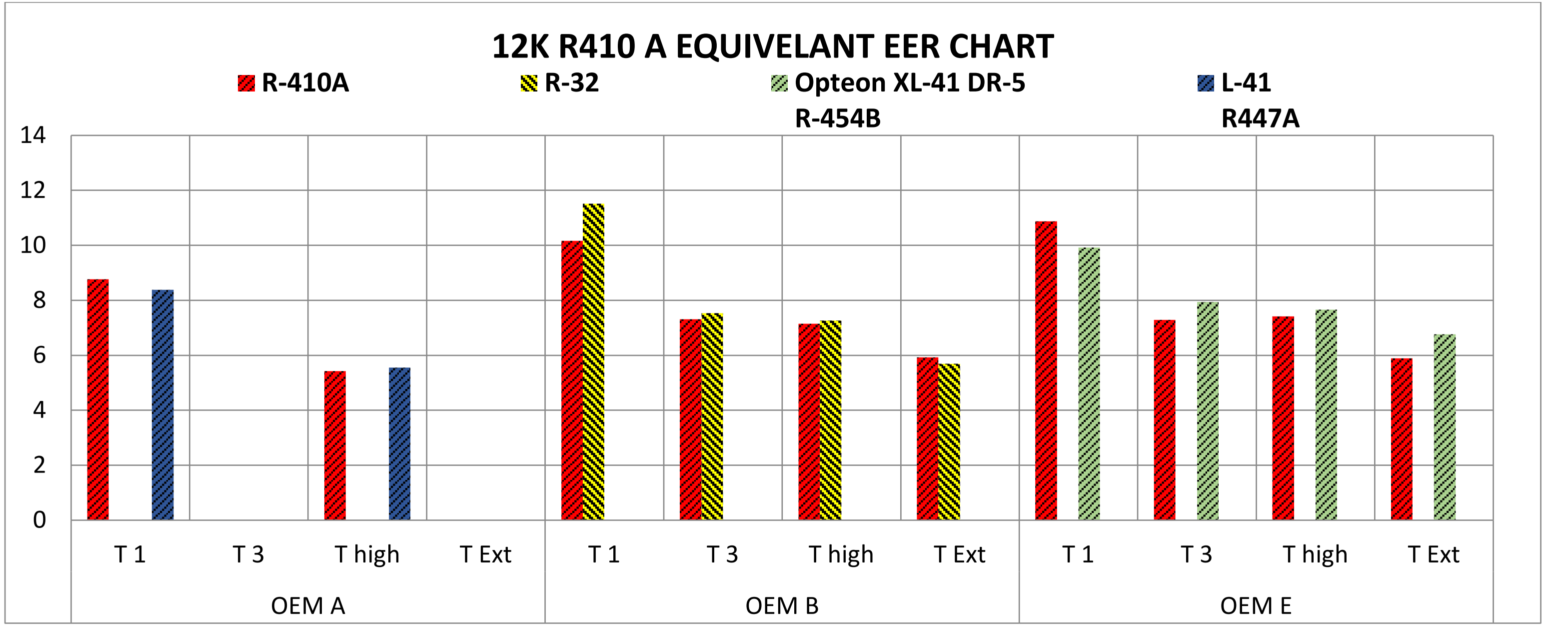


Table 28 A1 - Capacity & EER results for R-410A alternatives in 18,000 Btu/hr category

R-410 A eq. 18,000 Btu/hr		OEM A				OEM C			
Ambient		**T 1**	**T 3**	**T high**	**T Ext**	**T 1**	**T 3**	**T high**	**T Ext**
R-410A	CAP	16938	14337	14123	12441	17800	14924	16075	13746
	EER	9.8	6.8	6.3	5.1	9.152	6.497	6.485	5.116
ARM-71a **R-459A**	CAP					17115	14430	15392	14023
	EER					9.282	6.544	6.265	5.32
R-32	CAP	17616	15255	15761	13809				
	EER	10.03	7.1	6.65	5.29				
Opteon XL-41 DR-5 **R-454B**	CAP	15167	13229	13782	11800				
	EER	9.5	6.9	6.5	5.2				
L-41 R447A	CAP								
	EER								

Figure 25 A1- Equivalent capacity charts for R-410A alternatives in 18,000 Btu/hr category plotted vs R-410A results

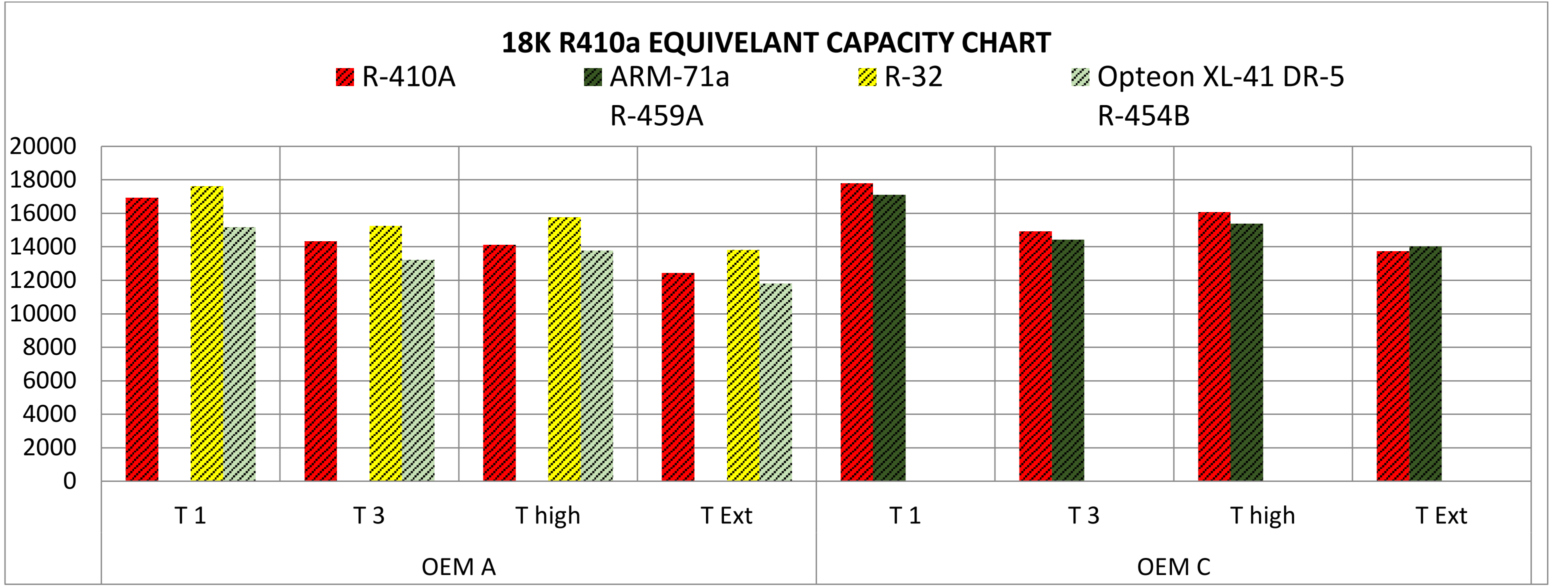


Figure 26 A1 - Equivalent EER chart for R-410A alternatives in 18,000 Btu/hr category plotted vs R-410A results

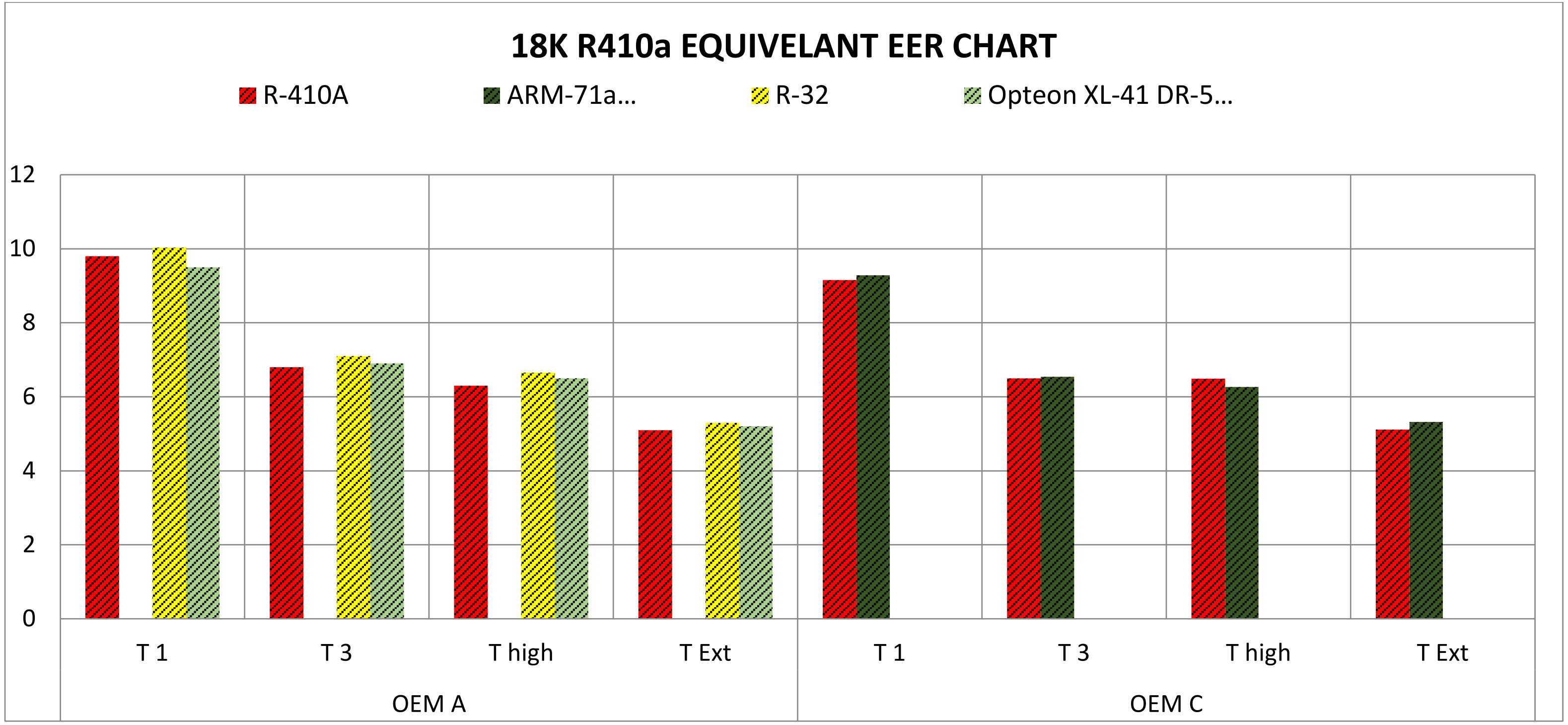


Table 29 A1 - Capacity & EER results for R-410A alternatives in 24,000 Btu/hr category

R-410 A eq. 24,000 Btu/hr		OEM C			
Ambient		**T 1**	**T 3**	**T high**	**T Ext**
R-410A	CAP	23022	19531	20534	18379
	EER	10.57	7.518	7.376	6.161
ARM-71a **R-459A**	CAP				
	EER				
R-32	CAP	23310	19522	21876	19035
	EER	10.62	7.228	7.459	5.988
Opteon XL-41 DR-5 **R-454B**	CAP	23766	20241	22268	20160
	EER	10.653	7.516	7.515	6.224
L-41 R447A	CAP				
	EER				

Figure 27 A1 - Equivalent capacity charts for R-410A alternatives in 24,000 Btu/hr category plotted vs R-410A results

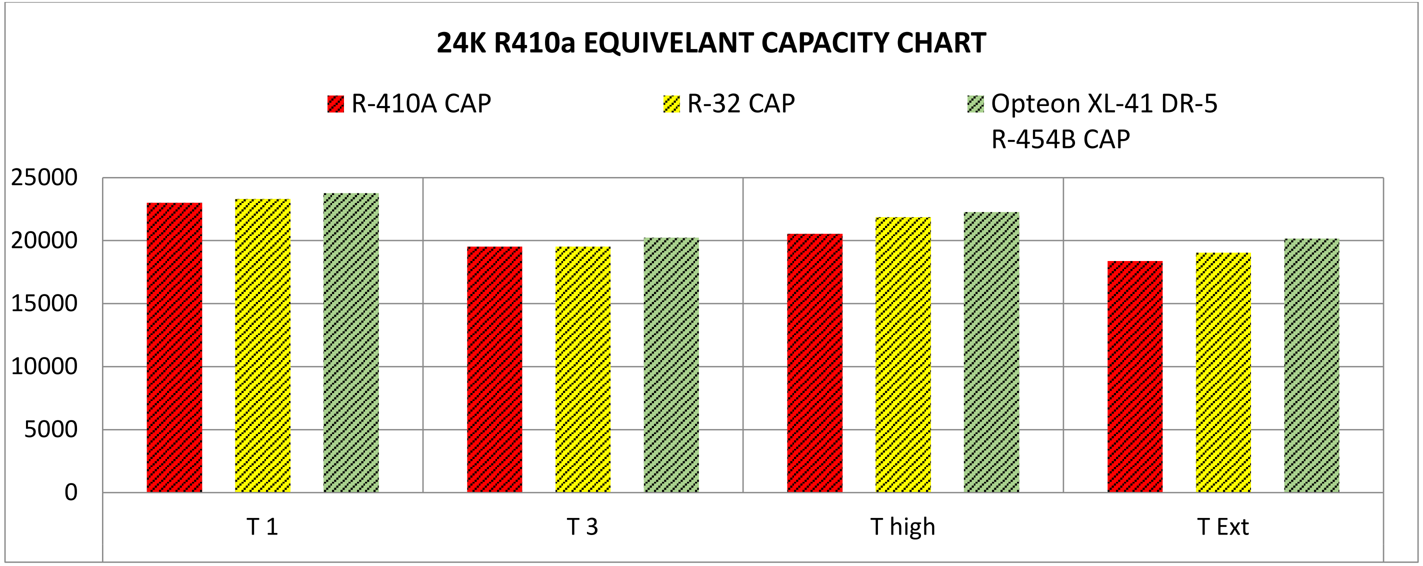
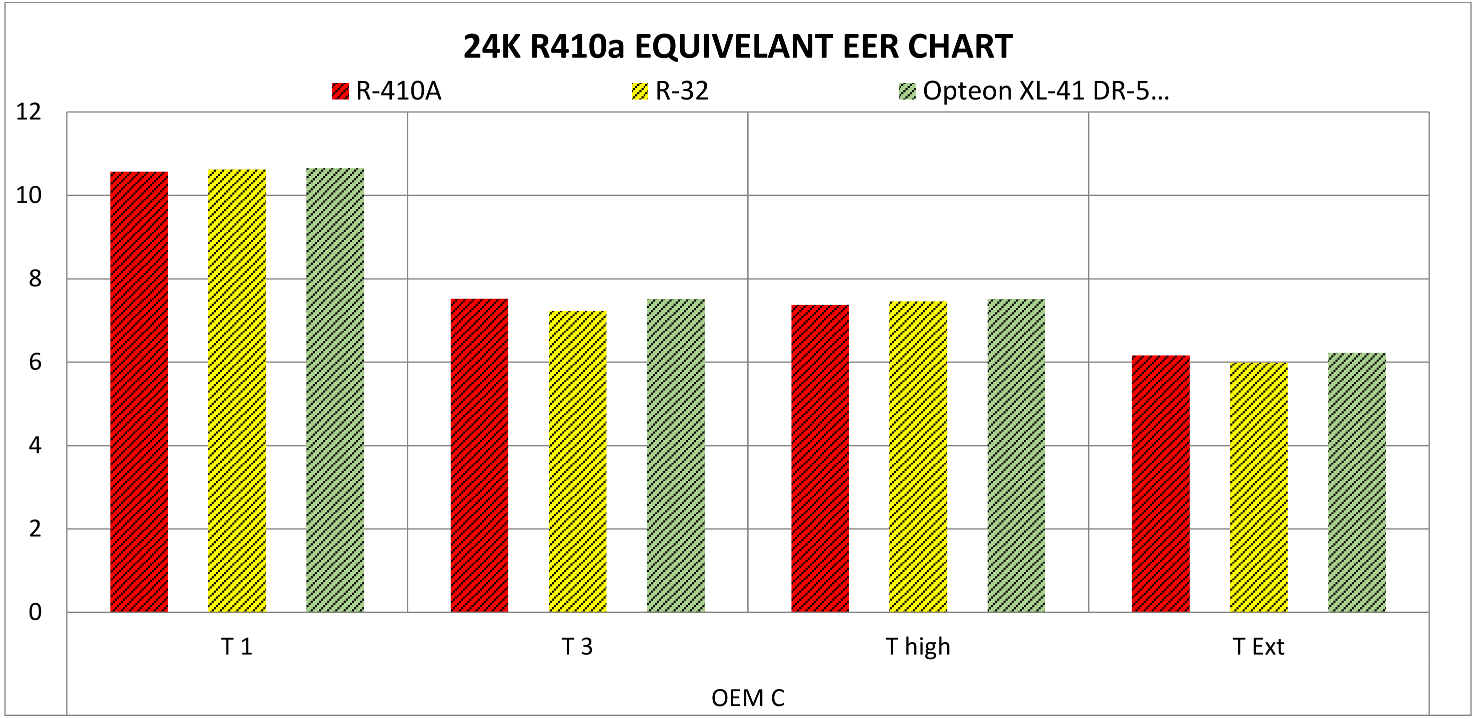


Figure 28 A1 - Equivalent EER chart for R-410A alternatives in 24,000 category plotted vs R-410A results



Annex 2: Sample Questionnaire for Local Manufacturers

Goal:

The Initiative objective is to test prototype air-conditioning units using low-GWP alternative technologies and share recommendations with manufacturers and decision makers in Egypt

Questionnaire:

This questionnaire is aimed at selected air-conditioning manufacturers in Egypt. The purpose of the questionnaire is to ask the preferences of the selected manufacturers in as far as technology selection and partnership with other stakeholders as well as getting a confirmation on their willingness to participate. All information complied of this questionnaire will be treated as confidential.

A. General Conditions	**Participant response**
My company is willing to participate in the project. If you answer YES, please proceed to rest to questionnaire.	YES NO

B. Technology Selection	**Participant response**
1. Do you have a preference for the alternative refrigerant?	YES NO
2. Alternative refrigerant choice (*you can provide more than one selection by deleting what is not applicable)*	➢ HFO Honeywell ➢ HFO DuPont ➢ R-32 ➢ Hydrocarbon
3. Do you have a preference for the compressor manufacturer?	YES NO
4. Provide name of compressor manufacturer(s)	

C. Application Selection	**Participant response**
5. Do you have a preference for the type and capacity of equipment for which you will build the prototype?	YES NO
6. My selection of equipment: (*you can provide more than one selection)*	➢ Decorative split ➢ Ducted split ➢ Rooftop package ➢ Self-contained
7. My selection of cooling capacity	➢ 1 – 5 tons ➢ 6 – 10 tons ➢ No preference

D. Building Prototypes	**Participant response**
8. My company can design and/or build prototypes	YES NO
9. How many prototypes are you willing to build?	➢ One ➢ More (*pls specify number)*

E. Testing Prototypes	**Participant response**
10. Which type of testing do you prefer?	➢ Independent 3rd party Testing ➢ Witness Testing at own premises
11. If you answered **3rd Party Testing**, are you willing to pay the cost for the test?	YES NO

12. If you answered **Witness Testing**, is your lab certified and by whom?	YES NO Certified by:

F. Logistics	**Participant response**
13. My company will allow independent consultants appointed by UNEP/UNIDO to oversee the development of the prototypes.	YES NO
14. If NO, pls describe what limitations you want to impose.	
15. My company will allow independent consultants appointed by UNEP/UNIDO to oversee the testing of the prototypes.	YES NO
16. If NO, pls describe what limitations you want to impose.	

G. Information about the Company	**Participant response**
17. Company Name	
18. Brand names used in market	
19. Company headquarters location	
20. Manufacturing location where prototype will be built	
21. Ownership percentage pertaining to the nationality where prototype is manufactured (*This information is needed to determine whether the limitations for project participation set by the Ozone Secretariat of the Montreal Protocol are applicable)*	
22. Name and title and Contact details of designated contact person for this project	

Annex 3: Brief description of Manufacturers' testing labs

The test labs of the different OEMs had varying capabilities. The best equipped labs have the following characteristics:

- Psychrometric type laboratory in which the air enthalpy test method is used to determine the cooling and heating capacities from measurements of entering and leaving wet-and dry-bulb temperatures and the associated airflow rate;
- Air sampling devices in each room (indoor room, code tester and outdoor room) are used to measure an average temperature. The airflow induced using blower through the tree (photo on left) and insulated duct passing over the temperature instruments (photo on the right) at velocity of 4-5 m/s.

- Air flow measuring apparatus (code tester) is attached to air discharge of UUT by insulated duct. The first section (receiving chamber) delivers air from UUT and contains the static pressure measuring instrument. The air is then mixed by a mixer in next section to measure its temperature by the air sampling device installed inside the code tester.

- Nozzles section, consisting of a receiving chamber and a discharge chamber separated by a partition in which four nozzles are located (see photo below). Air passes through the nozzles and is then exhausted to the test room. The pressure drop across the nozzles is measured using differential pressure transmitter. Air flow rate is calculated according to ISO 5151:2017.


- Voltage stabilizer(photo on left) is used to adjust the applied voltage for UUT, and the Power meter device is used to measure electrical parameters for it like applied voltage, power consumption, current consumption and power factor.

- Most labs are capable of testing up to 5 TR capacity (17.5 kW of cooling) measuring unit working pressure, super-heat, sub-cooling, and various temperature points on the refrigeration cycle;
- Lab consists of two well thermally insulated rooms: indoor room and outdoor room. In both rooms, temperature and humidity can be controlled accurately to achieve the required environment, as per different standards, thru refrigeration units, humidifiers and electric heaters;
- The accuracy of temperature control for dry and wet bulb temperature is 0.01 °C;
- In the indoor room there is a thermal insulated code tester where outlet air dry bulb, wet bulb and volume are measured;
- Thermocouple sensors with accuracy of 0.1 °C are used for measuring surface temperatures at various points;
- Information gathered during the test are monitored on a computer screen, using a data acquisition screen;

The table below shows the parameters that are shown on the monitor

Table 30 A3: Typical parameters shown on a testing lab monitoring screen

Test Screen Display
Inlet DB
Inlet WB
Inlet Enthalpy
Outlet DB
Outlet WB
Outlet Enthalpy
Enthalpy Differential
Specific Density
Air velocity
Air volume
Standard air volume
Atmospheric pressure
Differential pressure
Heat Loss
Total capacity
Capacity ratio
EER
EER ratio
COMPRESSOR
FM surface temperature
high pressure
low pressure
Super-heat
Sub-cooling
ADDITIVE TEMP.
Accumulator outlet temp
Outlet air temperature
Evaporator coil sensor temp
Compressor inlet
O/D Motor surface
OUTDOOR UNIT
Inlet DB
Inlet WB
POWER
Voltage
Current
Wattage
Power Factor
Frequency

Annex 4: Other Research Programs

Research at High Ambient Temperature

The dedicated research on the performance of refrigerants at High Ambient Temperatures (HAT) was driven by the need to find low-GWP alternative refrigerants that have no or lower capacity and efficiency degradation than the commercial HFCs that are replacing HCFCs in the HAT countries. The need to meet higher Minimum Efficiency Performance Standards (MEPS) while phasing out the current production of HCFC-based units was a challenge facing both the local industry in the HAT countries and the global exporters to those markets.

Three research programs were announced and completed in the time period between 2013 and 2016. While the three programs had a common goal in testing the refrigerant alternatives at temperatures higher than the standard T1 testing conditions, they were distinct in their protocols, approach, and the entity who was behind the project.

The PRAHA program mentioned in Chapter 1 is a Multilateral Fund financed project to test custom-built prototypes in four equipment categories that built by manufacturers located in HAT countries and testing them all at one independent lab. The results were compared to base units running with HCFC-22 and R-410A refrigerants.

The AREP (Alternative Refrigerant Evaluation Program) is an industry association program by the Air Conditioning, Heating, and Refrigeration Institute (AHRI) to test various categories of equipment, by various manufacturers, at their own labs by either dropping in the refrigerant or “soft” optimizing the unit.

The Oak Ridge National Laboratory (ORNL) program by the United States Department of Energy (DoE) tested two similar capacity standard units running with HCFC-22 and R-410A and soft optimizing them for the various alternative refrigerants. All tests were carried on at ORNL labs.

In the next sections of this chapter is a resume of the test results for the three programs and a comparison of these results.

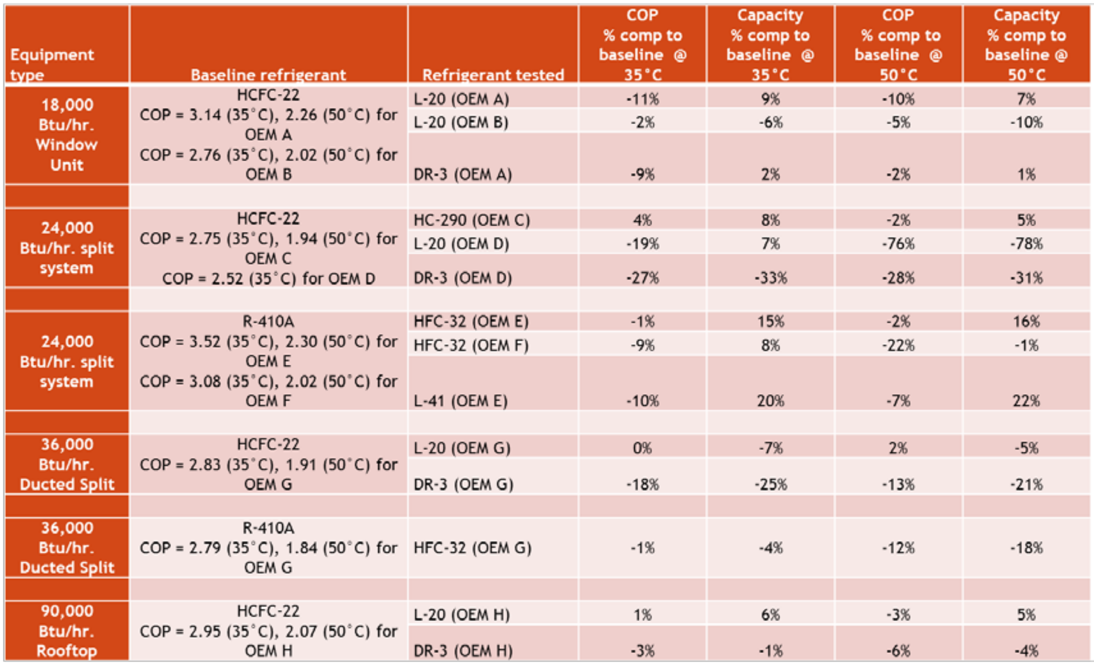
PRAHA program

Six local Original Equipment Manufacturers (OEMs) built 14 prototypes running with five refrigerant alternatives and shipped 9 other “base units’ operating with HCFC or HFC for direct comparison purposes. Testing was done at 35, 46, and 50 °C ambient temperatures with an “endurance” test at 55 °C ambient to ensure no tripping for two hours when units are run at that temperature. The indoor conditions will be kept the same for all tests; dry bulb temperature of 27 ^{0}C and a relative humidity of 50 % as per AHRI test procedures for T1 conditions (35 ^{0}C), and 29 ^{0}C and 50% for T3 (46 ^{0}C and 50 ^{0}C) conditions. A memorandum of understanding (MOU) was signed with AHRI (Air-Conditioning, Heating and Refrigerating Institute) for exchanging experience on the testing methodology benefiting of AHRI relevant research project known as AREP.

The project compares the following refrigerants: R-290, HFC-32, R-444B (herein referred to as L-20), R-447A (L-41), and DR-3 to HCFC-22 or R-410A. Prototypes operating with R-290, R-444B, and DR-3 are compared with HCFC-22 as they portray similar characteristics to HCFC-22, while HFC-32, and R-447A are compared with R-410A.

All the prototypes in every category were built to have the same cooling capacity and fit in the same box dimensions as their respective base units, and they were all required to meet the minimum energy efficiency (EER) of 7 at 46 °C. Tests were performed at an independent reputable lab for result consistency; Intertek was selected through competitive bidding. Verification for repeatability was performed to ensure that results are within the acceptable accuracy levels.

Table 31 A4 - Results for PRAHA-I program

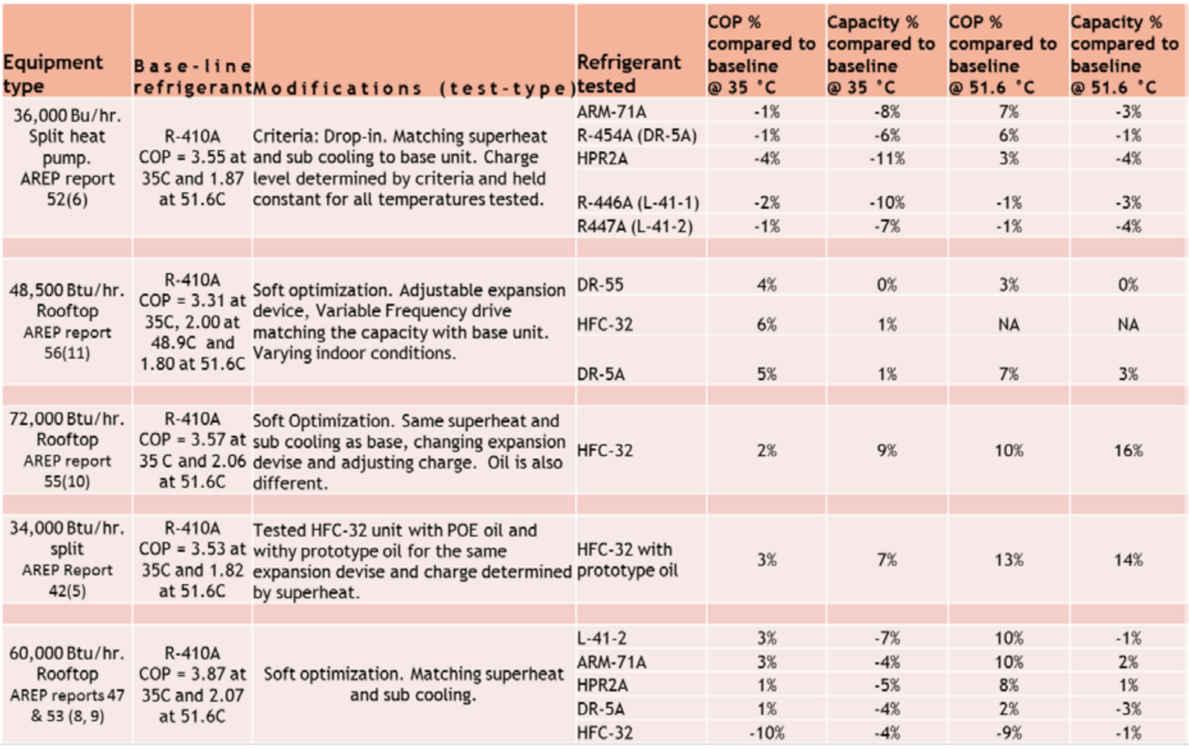


Equipment type	Baseline refrigerant	Refrigerant tested	COP % comp to baseline @ 35°C	Capacity % comp to baseline @ 35°C	COP % comp to baseline @ 50°C	Capacity % comp to baseline @ 50°C
18,000 Btu/hr. Window Unit	HCFC-22 COP = 3.14 (35°C), 2.26 (50°C) for OEM A COP = 2.76 (35°C), 2.02 (50°C) for OEM B	L-20 (OEM A)	-11%	9%	-10%	7%
		L-20 (OEM B)	-2%	-6%	-5%	-10%
		DR-3 (OEM A)	-9%	2%	-2%	1%
24,000 Btu/hr. split system	HCFC-22 COP = 2.75 (35°C), 1.94 (50°C) for OEM C COP = 2.52 (35°C) for OEM D	HC-290 (OEM C)	4%	8%	-2%	5%
		L-20 (OEM D)	-19%	7%	-76%	-78%
		DR-3 (OEM D)	-27%	-33%	-28%	-31%
24,000 Btu/hr. split system	R-410A COP = 3.52 (35°C), 2.30 (50°C) for OEM E COP = 3.08 (35°C), 2.02 (50°C) for OEM F	HFC-32 (OEM E)	-1%	15%	-2%	16%
		HFC-32 (OEM F)	-9%	8%	-22%	-1%
		L-41 (OEM E)	-10%	20%	-7%	22%
36,000 Btu/hr. Ducted Split	HCFC-22 COP = 2.83 (35°C), 1.91 (50°C) for OEM G	L-20 (OEM G)	0%	-7%	2%	-5%
		DR-3 (OEM G)	-18%	-25%	-13%	-21%
36,000 Btu/hr. Ducted Split	R-410A COP = 2.79 (35°C), 1.84 (50°C) for OEM G	HFC-32 (OEM G)	-1%	-4%	-12%	-18%
90,000 Btu/hr. Rooftop	HCFC-22 COP = 2.95 (35°C), 2.07 (50°C) for OEM H	L-20 (OEM H)	1%	6%	-3%	5%
		DR-3 (OEM H)	-3%	-1%	-6%	-4%

AREP Program

The Alternative Refrigerant Evaluation Program (AREP) by the Air Conditioning, Heating, and Refrigeration Institute (AHRI) tested several refrigerants either as a drop-or in soft optimized units built and tested at various manufacturers who are members of AHRI (AREP 2014). Testing was done in two phases for several applications including refrigeration and at various temperatures.

Table 32 A4 - Results for the AREP program



Equipment type	Base-line refrigerant	Modifications (test-type)	Refrigerant tested	COP % compared to baseline @ 35 °C	Capacity % compared to baseline @ 35 °C	COP % compared to baseline @ 51.6 °C	Capacity % compared to baseline @ 51.6 °C
36,000 Bu/hr. Split heat pump. AREP report 52(6)	R-410A COP = 3.55 at 35C and 1.87 at 51.6C	Criteria: Drop-in. Matching superheat and sub cooling to base unit. Charge level determined by criteria and held constant for all temperatures tested.	ARM-71A	-1%	-8%	7%	-3%
			R-454A (DR-5A)	-1%	-6%	6%	-1%
			HPR2A	-4%	-11%	3%	-4%
			R-446A (L-41-1)	-2%	-10%	-1%	-3%
			R447A (L-41-2)	-1%	-7%	-1%	-4%
48,500 Btu/hr. Rooftop AREP report 56(11)	R-410A COP = 3.31 at 35C, 2.00 at 48.9C and 1.80 at 51.6C	Soft optimization. Adjustable expansion device, Variable Frequency drive matching the capacity with base unit. Varying indoor conditions.	DR-55	4%	0%	3%	0%
			HFC-32	6%	1%	NA	NA
			DR-5A	5%	1%	7%	3%
72,000 Btu/hr. Rooftop AREP report 55(10)	R-410A COP = 3.57 at 35 C and 2.06 at 51.6C	Soft Optimization. Same superheat and sub cooling as base, changing expansion devise and adjusting charge. Oil is also different.	HFC-32	2%	9%	10%	16%
34,000 Btu/hr. split AREP Report 42(5)	R-410A COP = 3.53 at 35C and 1.82 at 51.6C	Tested HFC-32 unit with POE oil and withy prototype oil for the same expansion devise and charge determined by superheat.	HFC-32 with prototype oil	3%	7%	13%	14%
60,000 Btu/hr. Rooftop AREP reports 47 & 53 (8, 9)	R-410A COP = 3.87 at 35C and 2.07 at 51.6C	Soft optimization. Matching superheat and sub cooling.	L-41-2	3%	-7%	10%	-1%
			ARM-71A	3%	-4%	10%	2%
			HPR2A	1%	-5%	8%	1%
			DR-5A	1%	-4%	2%	-3%
			HFC-32	-10%	-4%	-9%	-1%

ORNL Program

The Oak Ridge National Laboratory (ORNL) program consisted of testing alternatives of HCFC-22 and R-410A in two units of the same capacity (Abdelaziz, et al 2015). Testing was done at the ORNL labs at various temperatures. Table below shows the criteria and a comparison of the result.

Table 33 A4 - Results for the ORNL program

Equipment Type	Lab utilized	Baseline Refrigerant	Equipment Criterion	Refriger. Tested	COP % comp to baseline @ 35˚C	Capacity % comp to baseline @ 35˚C	COP % comp to baseline @ 52˚C	Capacity % comp to baseline @ 52˚C
18,000 Btu/hr. Split unit (Carrier)	ORNL	HCFC-22 COP = 3.07 at 35˚C and 1.98 at 52˚C	Same machine to test all refrigerants. Criteria: matching superheat and sub cooling to base unit. Changing expansion devise. Charge level optimized at 35C	N-20B	-13%	-14%	-11%	-15%
				DR-3	-16%	-12%	-14%	-12%
				ARM-20B	-12%	-3%	-11%	-3%
				R-444B (L-20A)	-11%	-9%	-7%	-4%
				HC-290	7%	-8%	7%	-4%
18,000 Btu/hr. split unit (Carrier)	ORNL	R-410A COP = 3.4 at 35˚C and 2.07 at 52˚C	Same machine to test all refrigerants. Criteria: matching superheat and sub cooling to base unit. Changing expansion devise. Charge level optimized at 35C	HFC-32	4%	5%	5%	11%
				DR-55	3%	-3%	3%	0%
				R-447A (L-41)	-5%	-14%	3%	-6%
				ARM-71a	-1%	-8%	2%	-4%
				HPR-2A	-2%	-9%	5%	-1%