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EXECUTIVE COMMITTEE OF
THE MULTILATERAL FUND FOR THE
IMPLEMENTATION OF THE MONTREAL PROTOCOL
Ninety-second Meeting
Montreal, 29 May to 2 June 2023
Item 7(a) of the provisional agenda[1]

STATUS REPORTS AND REPORTS ON PROJECTS WITH SPECIFIC REPORTING REQUIREMENTS

1. The present document on the status of the reports and on projects with specific reporting requirements consists of the following sections:

I: Projects with implementation delays and projects for which special status reports were requested

II: Projects with specific reporting requirements:
- II.1 An overview
- II.2 "Blanket" approval
- II.3 Individual consideration

I. Projects with implementation delays and for which special status reports were requested

2. At the 91st meeting, the Executive Committee noted that the bilateral and implementing agencies would report, at the 92nd meeting, on 109 projects with implementation delays and 37 ongoing projects[2] or tranches of multi-year agreements (MYAs) recommended for additional status reports (decision 91/10(c)). Accordingly, relevant bilateral and implementing agencies submitted the requested reports to the 92nd meeting. In reviewing the reports, the Secretariat held discussions with relevant bilateral and implementing agencies and noted that several issues had been satisfactorily addressed. Table 1 provides a summary of projects with implementation delays and projects recommended for additional status reports including their levels of progress, recommendations by the Secretariat and references to annexes to the present document.

[1] UNEP/OzL.Pro/ExCom/92/1

[2] Thirteen of the 37 projects recommended for additional status reports were also classified as projects with implementation delays. The review for these projects is included in the implementation delays section.

Table 1. Summary of projects with implementation delays and additional status reports

Level of progress	Number of projects	Decision	Recommendation	Annex
Implementation delays				
Progress (Individual projects and MYAs)	70	32/4	To be removed from future reporting	n/a
Some progress (Individual projects and MYAs)	29	32/4	To continue monitoring until their final completion	Annex I
No progress for the first time (MYAs)	7	84/45	To continue monitoring until their final completion	Annex II
No progress for two consecutive meetings (MYAs)	3	84/45	To send notices of possible cancellation	Annex III
Total	**109**			
Status reports				
No outstanding issues	7	51/13	To be removed from future reporting	n/a
Issues still need to be resolved	17	51/13	To request submission of additional status reports	Annex IV
Total*	**24**			

*Excluding 13 projects that are included in the implementation delays section.

Recommendation

3. The Executive Committee may wish:

(a) To note:

(i) The implementation delay reports and status reports submitted by bilateral and implementing agencies, contained in document UNEP/OzL.Pro/ExCom/92/9;

(ii) That the Secretariat would send a letter to the Government of Myanmar and UNEP as the implementing agency regarding possible cancellation of the HCFC phase-out management plan: stage I, first tranche (MYA/PHA/68/TAS/14) and second tranche (MYA/PHA/80/TAS/18);

(iii) That the Secretariat would send a letter to the Government of Afghanistan and UNIDO as the implementing agency regarding possible cancellation of the HCFC phase-out management plan: stage I, third tranche (AFG/PHA/79/INV/22);

(iv) That bilateral and implementing agencies would report to the Executive Committee at the 93rd meeting on 39 projects with implementation delays, as indicated in Annexes I, II and III to the present document, and on 17 projects recommended for additional status reports, as indicated in Annex IV to the present document, as part of the 2022 annual and financial progress report of the bilateral and implementing agencies; and

(v) To approve the recommendations on ongoing projects with specific issues listed in the last column of the table in Annex IV to the present document.

II. Projects with specific reporting requirements

II.1 An overview

4. Table 2 lists the reports on projects with specific reporting requirements submitted to the 92nd meeting recommended for blanket approval.

Table 2. Reports on projects with specific reporting requirements recommended for blanket approval

Country	Project title	Paragraphs
Reports related to HCFC phase-out management plans		
Bangladesh	HCFC phase-out management plan (stage II – verification report)	7 - 13
Brazil	HCFC-phase out management plan (stage II – report on the temporary use of technology with high global-warming potential at U-Tech)	14 - 20
China	HCFC phase-out management plan (stage I – report on the disbursement of incremental operating costs under the industrial and commercial refrigeration and air-conditioning sector plan)	21 – 26
Côte d'Ivoire	HCFC phase-out management plan (stage I – report on the adoption of the interministerial decree ("arrêté interministériel") for regulating import, export, transit, re-export and trade of ODS and other measures on strengthening monitoring and reporting systems relating to HCFC import and export)	27 – 30
Egypt	HCFC phase-out management plan (stage II – request for flexibility provided under decision 79/34(e))	31 - 36
Ethiopia	HCFC phase-out management plan (stage I – progress report on the implementation of the work programme associated with the final tranche)	37 - 46
Iran (Islamic Republic of)	HCFC phase-out management plan (stage II - change of implementing agency)	47 - 53
Mauritania	HCFC phase-out management plan (stage I – review status of the HCFC survey report and recommendations on the revised starting point and the revised Agreement)	54 - 62
Mozambique	HCFC phase-out management plan (stage I – progress report on the implementation of the work programme associated with the fifth and final tranche and on the implementation of the verification recommendations)	63 - 78
Pakistan	HCFC phase-out management plan (stage II – progress report on the implementation of the third and fourth tranches)	79 – 94
Pakistan	HCFC phase-out management plan (stage III – report on the status of imports of pre-blended polyols containing HCFC-141b and the progress of implementation of technical assistance for the foam sector)	95 – 100
Pacific Island Countries	HCFC phase-out management plan (stage I – progress report on the implementation of the work programme associated with the final tranche of stage I and the submission of the project completion report for the 12 PICs)	101 – 117
Philippines (the)	HCFC phase-out management plan (stage II – progress report on the implementation of the final tranche and verification report)	118 - 131
Saint Lucia	HCFC phase-out management plan (stage I – final progress report on the implementation of the work programme associated with the final tranche and the submission of the project completion report)	132 – 140
Saudi Arabia	HCFC phase-out management plan (stage I – progress report on the implementation of the remaining activities	141 - 146
Reports related to HFCs		
Jordan	Report on the project for the conversion from HFC to propane of the facility manufacturing large commercial unitary roof-top air-conditioning units of up to 400 kW at Petra Engineering Industries Co.	147 - 160
Reports on ODS disposal		
Brazil	Pilot demonstration project on ODS waste management and disposal (final report)	161 - 172

Country	Project title	Paragraphs
Reports on low-global warming potential projects		
Saudi Arabia	Demonstration project on promoting hydrofluoroolefin-based low global warming potential refrigerants for the air-conditioning sector in high ambient temperatures (final progress report)	173 – 182

5. Table 3 lists two reports submitted to the 92nd meeting for individual consideration and a brief explanation of related issues.

Table 3. Reports on projects with specific reporting requirements for individual consideration

Country	Project title	Issue	Paragraphs
Report related to decision 83/41(e)			
China	Report on progress in the implementation of activities listed in decision 83/41(e)	Progress report on implementation of activities listed in decision 83/41(e)	184 – 190
Reports related to HFCs			
Argentina	Control of emissions of HFC-23 generated in the production of HCFC-22	Update on the status of the project, including that no further HFC-23 by-product had been emitted to the atmosphere and that the refurbishment of the incinerator was ongoing	191 - 198

II.2 "Blanket" approval

6. This section includes fifteen reports on projects related to HCFC phase-out management plans, one report on a HFC project, one ODS disposal project, and one low-GWP project.

A. Reports related to HCFC phase-out management plans

Bangladesh: HCFC phase-out management plan (stage II – verification report) (UNDP and UNEP)

Background

7. At the 90th meeting, through decision 90/44, the Executive Committee decided:

> "(b) To approve the second tranche of stage II of the HCFC phase-out management plan (HPMP) for Bangladesh, and the corresponding tranche implementation plan, in the amount of US $2,142,405, plus agency support costs of US $149,968 for UNDP, on the understanding that:
>
> (i) The Treasurer would be requested to transfer the approved funds to UNDP only following receipt and review of the verification report by the Secretariat in line with decision 72/19(b);
>
> (ii) UNDP committed to submitting the verification report by the end of June 2022 and no later than 12 weeks prior to the 91st meeting;
>
> (iii) The recommendations included in the verification report would be addressed during the implementation of the second tranche of stage II of the HPMP and that the actions implemented towards the end of the tranche would be included in the

progress report of the second tranche for stage II of the HPMP for Bangladesh to be submitted with the request for the third tranche; and

(iv) In the event that the verification report confirmed that Bangladesh had not been in compliance with the Montreal Protocol and its Agreement with the Executive Committee, the Secretariat would inform the Executive Committee so that relevant actions, including application of the penalty clause, could be considered at the 91st meeting."

8. At the 91st meeting, the Executive Committee noted the submission, by UNDP, of the verification report of HCFC consumption for Bangladesh for 2019-2021, which would be reviewed and presented to the Committee by the Secretariat at the 92nd meeting, and that the Treasurer would be requested to transfer the approved funds for the second tranche of stage II of the HPMP to UNDP only upon the review of the verification report by the Secretariat in line with decisions 72/19(b) and 90/44 (decision 91/18).

Verification report

9. The verification report confirmed that the Government is implementing a licensing and quota system for HCFC imports and exports and that the total consumption of HCFCs reported under Article 7 of the Montreal Protocol for 2019 to 2021 was correct (as shown in table 4 below), except for a small discrepancy between the Article 7 data and the verified consumption for 2019 for HCFC-142b. The verification concluded that the Government of Bangladesh is operating an effective licencing and quota system and has met its targets under its Agreement with the Executive Committee. The verification report also included the following recommendations: to issue quotas to importers only once a year, develop a plan for meeting servicing demands once HCFC-22 availability is further reduced, utilize available tools such as the OzonAction GWP-ODP calculator, undertake actions to ban ODS-containing equipment by 2025, and ensure customs officials have adequate equipment and training for ODS identification.

Table 4. HCFC consumption in Bangladesh (2019-2021 Article 7 data)

HCFC	2019	2020	2021	Baseline
Metric tonnes (mt)				
HCFC-22	875.51	844.97	852.73	825.86
HCFC-123	2.50	2.60	2.00	10.50
HCFC-124	0.00	0.00	0.00	3.18
HCFC-141b	0.00	0.00	0.00	193.00
HCFC-142b	9.77	0.00	0.00	88.04
(Sub-total / Total) (mt)	**887.72**	**847.57**	**854.73**	**1,120.58**
HCFC-141b in imported pre-blended polyols*	310	360	440	-
ODP tonnes				
HCFC-22	48.15	46.47	46.90	45.42
HCFC-123	0.05	0.05	0.04	0.21
HCFC-124	0.00	0.00	0.00	0.07
HCFC-141b	0.00	0.00	0.00	21.23
HCFC-142b	0.63	0.00	0.00	5.72
(Sub-total / Total) (ODP tonnes)	**48.84**	**46.53**	**46.94**	**72.65**
HCFC-141b in imported pre-blended polyols*	34.10	39.60	48.4	-

* Country programme data

Secretariat's comments

10. The Secretariat reviewed the verification report and requested clarification from UNDP concerning some information that had not been provided, including the description of how importers are registered and how quotas are decided and issued, and how the recommendations from the verification report would be implemented. UNDP provided the requested information and revised accordingly the verification report,

which the Secretariat has found to be consistent with the country's licensing system. With regard to the observation of a small discrepancy between the Article 7 data and the verified consumption for 2019 for HCFC-142b, of 0.02 mt less than reported, the Government acknowledged that this was due to reporting issues during the year, which had been rectified resulting in better reporting for the following years.

11. The Government of Bangladesh has issued a management response to the verification report with the commitment to implement the recommendations contained therein and report on the progress of their implementation to the Executive Committee at the next tranche request.

12. After this review, the Secretariat requested that the funding of US $2,142,405, plus agency support costs of US $149,968, approved in principle at the 90th meeting for the second tranche be released from the Treasurer to UNDP.

Recommendation

13. The Executive Committee may wish:

(a) To note the verification report on HCFC consumption for 2019 to 2021 for Bangladesh, as submitted by UNDP and contained in document UNEP/OzL.Pro/ExCom/92/9;

(b) To further note that the funding, in the amount of US $2,142,405, plus agency support costs of US $149,968, approved in principle at the 90th for the second tranche of stage II of the HCFC phase-out management plan (HPMP) for Bangladesh has been released by the Treasurer to UNDP; and

(c) To request UNDP to report on the progress of implementation of the verification recommendations as part of the progress report of the second tranche for stage II of the HPMP for Bangladesh to be submitted with the request for the third tranche.

Brazil: HCFC-phase out management plan (stage II – report on the temporary use of technology with high global-warming potential at U-Tech) (UNDP)

Background

14. At the 80th meeting, UNDP informed the Secretariat that the systems house U-Tech had requested to temporarily use HFC-134 in place of HCFC-22 in froth applications, as HFOs were not yet available on a commercial scale in the country. U-Tech had signed a commitment to stop the temporary use of HFC blends once HFOs were commercially available, and the systems had been developed and optimized at no additional cost to the Multilateral Fund.

15. Accordingly, the Executive Committee requested UNDP to continue assisting U-Tech in securing the supply of the alternative technologies selected, on the understanding that the incremental operational costs (IOCs) would not be paid until either the selected alternative or another technology with low global-warming potential (GWP) had been fully introduced, and to report on the status of use of the interim technology until the technology originally selected or another low-GWP technology had been fully introduced (decision 80/12(e)). The Committee also requested UNDP to provide to each meeting an update from the suppliers on the progress made toward ensuring that the selected technologies, including the associated components, were available on a commercial basis in the country (decision 81/9(b)). UNDP has reported on the status of the use of interim technology at each meeting since.

16. At the 88th meting, UNDP reported that U-Tech had concluded the development of a formulation using gaseous HFO (Solstice GBA), indicating that the high cost of the substance made it commercially unfeasible and indicated that, should Solstice GBA not become commercially available by 2024, the

remaining funds from U-Tech's conversion associated with the phase-out of HCFC-22 would be returned to the Fund by the end of stage II.

17. At the 91st meeting, UNDP reported that there were no new developments on the use of HFC-134a by U-Tech, and that due to the shortage of HFO-1233zd(E) in the domestic market, three systems houses that had already converted to low-GWP alternatives (Amino, Flexível and Purcom), requested authorization from the Government of Brazil to temporarily supply HFC-365mfc/HFC-227ea to some clients. Accordingly, the Executive Committee requested UNDP to continue assisting the Government of Brazil in securing the supply of alternative technologies with low GWP to the Amino, Flexível, Purcom and U-Tech systems houses, and to continue reporting on the matter in line with decisions 80/12(e) and 81/9(b) (decision 91/26(c)).

Progress report

18. In line with decision 91/26(c), UNDP reported that no further development had taken place regarding the temporary use of HFC-134a by the enterprise U-Tech, as the high cost of gaseous HFO (Solstice GBA) continued to make it commercially unfeasible. Regarding the other three systems houses temporarily using the HFC-365mfc/HFC-227ea blend, Purcom has discontinued its use and continues to use low-GWP technologies (e.g., methyl formate and water-based) for all its clients, while Amino and Flexível expect to continue using the blend up to August 2023 due to the high price of HFO, despite the negotiation efforts with the suppliers. UNDP reiterated that no IOCs had been paid for conversions associated with the temporary use of HFCs.

Secretariat's comments

19. Noting that Purcom discontinued the temporary use of HFCs, but the remaining three systems houses continue to use them due to issues related to the availability and cost of selected alternative technologies, the Secretariat recommends that UNDP continue to assist Amino, Flexível and U-Tech in securing the supply of the alternative technologies selected or another low-GWP technology, and to report on the temporary use of HFCs in line with decision 91/26(c).

Recommendation

20. The Executive Committee may wish:

(a) To note:

(i) The report provided by UNDP on the temporary use of alternatives with high global-warming potential (GWP) in the systems houses Amino, Flexível, Purcom and U-tech under stage II of the HCFC phase-out management plan for Brazil, contained in document UNEP/OzL.Pro/ExCom/92/9;

(ii) That the systems house Purcom discontinued the temporary use of high-GWP technology and introduced low-GWP technologies for all its clients; and

(b) To request UNDP to continue assisting the Government of Brazil in securing the supply of alternative technologies with low GWP to the Amino, Flexível and U-Tech systems houses, on the understanding that any incremental operating costs related to the conversions (where applicable) would not be paid until the technology originally selected or another low-GWP technology had been fully introduced, and to provide, at each meeting until the technology originally selected or another low-GWP technology had been fully introduced, a report on the status of temporary use of high-GWP alternatives, along with an update from the

suppliers on the progress made towards ensuring that the selected technologies, including the associated components, were available on a commercial basis in the country.

China: HCFC phase-out management plan (stage I – report on the disbursement of incremental operating costs under the industrial and commercial refrigeration and air-conditioning sector plan) (UNDP)

Background

21. The industrial and commercial refrigeration and air-conditioning (ICR) sector plan of stage I of the HCFC phase-out management plan (HPMP) was approved at the 64th meeting at a total cost of US $61,000,000 to contribute to the 10 per cent reduction from HCFC baseline consumption by 2015. The ICR sector plan was operationally completed in 2019, with the disbursement of the committed incremental operating costs (IOCs) planned to be completed in 2020. The project completion report was submitted to the 85th meeting. The outbreak of the COVID-19 pandemic at the end of 2019 slowed down economic activities, and the disbursement of IOCs was delayed. At its 86th meeting, the Executive Committee allowed the continuous production and sale of the converted products and the disbursement of IOCs until the end of 2021.

22. At the 90th meeting, UNDP submitted a report on IOC disbursement stating that it stood at 84 per cent and that the slow disbursement of IOCs related to the additional effort and time required for training and model design for HFC-32-based products due to flammability. Based on the request of the Government, the Executive Committee approved an extension of financial completion of stage I of the ICR sector plan for China to 31 December 2022 to allow for the disbursement of IOCs, on the understanding that no further extension would be requested. The Executive Committee further requested the Government of China and UNDP to submit, at the 92nd meeting, a report on IOC disbursement under stage I of the ICR sector plan (decision 90/27).

23. On behalf of the Government of China, UNDP submitted the report in line with decision 90/27(c). The additional disbursement of IOCs to enterprises during 2022 amounts to US $868,300. As of 31 December 2022, the remaining balance of IOC funds was estimated at US $1,163,094 (7 per cent of the total IOCs approved). The exact amount will be obtained after the financial audit and will be returned to the Fund after the approval of the financial audit report at the 93rd meeting.

Secretariat's comments

24. Upon enquiry, UNDP reported that the IOCs were disbursed based on products manufactured by the converted lines, verified to have been sold on the domestic market or exported to Article 5 countries. With the additional disbursement, a total of 356,092 units were produced by four enterprises: Shandong Geruide, Haier, Nanjing TICA and Ningbo Aux. The products were all based on HFC-32 technology and were for domestic use.

25. UNDP reported that the outstanding IOCs are associated with five manufacturing lines in five enterprises producing commercial and industrial water chillers, heat pumps and unitary air-conditioners using HFC-32 technology. The Foreign Environmental Cooperation Centre (FECO) and the China Refrigeration and Air-conditioning Industrial Association (CRAA) in collaboration with the enterprises continue to raise awareness to address the flammability concerns, promote market adoption and reduce the cost of HFC-32 technology. During the 2022 Refrigeration Expo in China, a series of seminars were organized by FECO and CRAA to share experience, exchange information, and discuss research and technical issues. The domestic sales of HFC-32-based units is increasing year by year. Based on industry statistics, a total of 2,345,010 units of HFC-32 water chillers, heat pumps, unitary air-conditioners and compressors had been sold by the end of 2022, which is a 60 per cent increase compared to sales of 1,469,714 units by the end of 2021.

Recommendation

26. The Executive Committee may wish to note:

(a) The report on the disbursement of incremental operating costs (IOCs) under the industrial and commercial refrigeration and air-conditioning sector plan under stage I of the HCFC phase-out management plan for China, submitted by UNDP on behalf of the Government of China, in line with decision 90/27 and contained in document UNEP/OzL.Pro/ExCom/92/9; and

(b) That the remaining balance of IOCs of US $1,163,094 plus agency support costs of US $81,417 for UNDP will be returned to the Fund after the approval of the financial audit report at the 93rd meeting.

Côte d'Ivoire: HCFC phase-out management plan (stage I – report on the adoption of the interministerial decree ("arrêté interministériel") for regulating import, export, transit, re-export and trade of ODS and other measures on strengthening monitoring and reporting systems relating to HCFC import and export) (UNEP)

Background

27. At its 90th meeting, the Executive Committee approved the fifth tranche of stage I of the HCFC phase-out management plan (HPMP) for Côte d'Ivoire on the understanding that the Government will provide an update, through UNEP, at the 91st meeting, on the adoption of the interministerial decree for regulating import, export, transit, re-export and trade of ODS and other measures on strengthening monitoring and reporting systems relating to HCFC import and export (decision 90/32).[3]

28. At the 91st meeting, in line with decision 90/32, the Government of Côte d'Ivoire, through UNEP, reported that the Minister of Environment and Sustainable Development had signed the interministerial decree in February 2022 and that by 20 October 2022, it had incorporated the comments from other three Ministers and resent the decree to them for their signatures. Subsequently, the Executive Committee requested the Government of Côte d'Ivoire to provide, through UNEP, at the 92nd meeting, an update on the adoption of the interministerial decree (decision 91/21(b)).

Progress report

29. In response to decision 91/21(b), the Government of Côte d'Ivoire, through UNEP has submitted a report confirming that, on 14 February 2023, the Minister of Commerce and Industry and Small and Medium Enterprises Promotion, the Minister of Budget and State Portfolio and the Minister of Environment and Sustainable Development signed the interministerial decree for regulating import, export, transit, re-export and trade of ODS and other measures on strengthening monitoring and reporting systems relating to HCFC import and export, and that the decree has been adopted.

Recommendation

30. The Executive Committee may wish to note:

(a) The report on the progress in the adoption of the interministerial decree ("arrêté interministériel") for regulating import, export, transit, re-export and trade of ODS and other measures on strengthening monitoring and reporting systems relating to HCFC

[3] Provision contained in Annex VIII of document UNEP/OzL.Pro/ExCom/90/40.

import and export under stage I of the HCFC phase-out management plan for Côte d'Ivoire, as submitted by UNEP and contained in document UNEP/OzL.Pro/ExCom/92/9; and

(b) With appreciation, the efforts made by the Government of Côte d'Ivoire in the adoption of the interministerial decree referred to in sub-paragraph (a) above.

Egypt: HCFC phase-out management plan (stage II – request for flexibility provided under decision 79/34(e)) (UNIDO, UNDP, UNEP and the Government of Germany)

Background

31. At its 79th meeting, the Executive Committee approved stage II of the HCFC phase-out management plan (HPMP) for Egypt which included, *inter alia*, the conversion of eight enterprises manufacturing domestic refrigerators to cyclopentane (decision 79/34). As part of that decision, the Government of Egypt was provided flexibility to allocate funding to eligible enterprises in the polyurethane (PU) foam sector for which funding had been not requested, if that were deemed necessary during implementation (decision 79/34(e)).

Request for flexibility

32. In line with stage II of the HPMP, UNIDO had procured and delivered the equipment necessary to convert the manufacturing line of one of the eight manufacturing enterprises, Bahgat, from HCFC-141b to cyclopentane. In light of the COVID-19 pandemic, the conversion was delayed and a new owner took over, who subsequently decided to withdraw from the project and exit the domestic refrigeration manufacturing sector given market changes following the pandemic.[4] In line with decision 79/34(e), UNIDO sought to find another enterprise who could use the equipment rather than attempt to auction it and, while unable to find an enterprise for which funding had not been requested, UNIDO did find an eligible enterprise that was participating in stage II of the HPMP, Tredco, that wished to purchase the existing manufacturing line from Bahgat and use the equipment procured by UNIDO to convert the line, effectively moving the manufacturing line to its own facility. The enterprise would undertake the necessary civil works to install the equipment and would need assistance to transport the equipment to its facilities and for engineering works.

33. On behalf of the Government of Egypt, UNIDO proposed to provide the equipment to Tredco and use the remaining balances from the PU foam manufacturing project, which as of May 2023 were US $7,214, to transport the equipment from Bahgat to Tredco, for any required engineering work, and to destroy/render unusable the existing HCFC-141b-based foaming machine.

Secretariat's comments

34. UNIDO noted that not using the remaining balances to enable the transfer of the equipment from Bahgat to Tredco might put that transfer at risk, which would leave UNIDO with the only option of trying to auction the equipment, which would not be the preferred option given the likelihood that only very limited funding may be offered for the equipment.

35. The Secretariat noted the limited remaining balances (US $7,214) and considered that the requested flexibility supported the objectives of the project, including by ensuring the sustainable conversion of the domestic refrigeration manufacturing sector to cyclopentane. Accordingly, and noting the exceptional circumstances, the Secretariat supports the request, noting that (a) Tredco would otherwise need to purchase similar equipment, (b) the specifications of the existing equipment are consistent with Tredco's needs so that the enterprise can quickly use the equipment once the necessary civil works are completed, (c) the

[4] The enterprise had ceased manufacturing domestic refrigerators but not gone bankrupt and remained active in other areas.

remaining balances would not be used for civil works but the cost for any civil work would be covered by Tredco, and (d) the remaining balances will be used only to transport the equipment, for any necessary engineering, and to destroy/render unusable the existing HCFC-141b-based foaming machine.

Recommendation

36. The Executive Committee may wish to approve, on an exceptional basis, the request for UNIDO to provide assistance to the enterprise Tredco so as to enable the transfer of equipment purchased to convert the HCFC-141b foam manufacturing line at the enterprise Bahgat to Tredco, under stage II of the HCFC phase-out management plan for Egypt.

Ethiopia: HCFC phase-out management plan (stage I – progress report on the implementation of the work programme associated with the final tranche) (UNEP and UNIDO)

Background

37. At its 85th meeting, the Executive Committee approved, on an exceptional basis given potential further delay in implementing phase-out activities due to the COVID-19 pandemic, and noting that no further extension of project implementation would be requested, the extension of the date of completion of stage I of the HCFC phase-out management plan (HPMP) for Ethiopia to 31 December 2022 (decision 85/22(a)).

38. In line with that decision, and on behalf of the Government of Ethiopia, UNEP as the lead implementing agency has submitted the final progress report on the implementation of the work programme associated with the third and final tranche of stage I of the HPMP.

HCFC consumption

39. Ethiopia only consumes HCFC-22, which is used exclusively in the servicing sector. The Government of Ethiopia reported under country programme (CP) implementation report a consumption of 3.17 ODP tonnes of HCFC in 2022, which is 42 per cent below the HCFC baseline for compliance. Consumption continues to decline with the implementation of activities of the HPMP and the licensing and quota system.

40. The Government of Ethiopia reported HCFC sector consumption data under the 2021 CP implementation report that is consistent with the data reported under Article 7 of the Montreal Protocol.

Progress report on the implementation of the final tranche of stage I

Legal framework

41. The Government continued to implement an effective licensing and quota system for HCFC imports and exports. Two meetings are held by the NOU each year to evaluate the effectiveness of the quota system and allocate quotas for the upcoming year. The Government of Ethiopia has already issued HCFC import quotas for 2023 at 3.15 ODP tonnes, which is lower than the Montreal Protocol control target of 3.58 ODP tonnes for that year.

42. Three training workshops were organized for 68 custom officers, of which 22 were women, on controlling and monitoring ODS, and the website for importers to apply online for a quota was finalized in line with the recommendations of the verification report submitted to the 77th meeting.

Refrigeration servicing sector

43. The following activities were implemented from May 2021 to December 2022:

(a) Two training workshops for 41 refrigeration and air-conditioning (RAC) technicians, of which three were women, on good servicing practices, emerging technologies, and safe servicing and maintenance of RAC equipment based on low-GWP refrigerants; and

(b) Delivery of training equipment (e.g., recovery units with cylinders, manifold gauge sets, gas detectors, and hydrocarbon teaching units) for the vocational training centres, refrigerant identifiers for customs and the training centres, and tools for servicing technicians (e.g., adjustable wrench, flaring set, swaging tools, brazing torch, tube bender, valves, and fittings).

Level of fund disbursement

44. As of April 2023, 100 per cent of the US $315,000 approved during stage I had been disbursed (i.e., US $175,000 for UNEP and US $140,000 for UNIDO).

Secretariat's comments

45. Notwithstanding the challenges due to the COVID-19 pandemic and political situation in the country, stage I of the HPMP was completed. Stage II of the HPMP, which was submitted to the 87th meeting and subsequently withdrawn, is expected to be submitted in 2024.

Recommendation

46. The Executive Committee may wish to note the final progress report on the implementation of the work programme associated with the final tranche of stage I of the HCFC phase-out management plan for Ethiopia, submitted by UNEP, in line with decision 85/22(a), and contained in document UNEP/OzL.Pro/ExCom/92/9.

Islamic Republic of Iran: HCFC phase-out management plan (stage II – change of implementing agency) (UNDP, UNEP, UNIDO and Germany)

47. On behalf of the Government of the Islamic Republic of Iran, UNDP as the lead implementing agency has submitted to the 92nd meeting a request to transfer those components of stage II of the HCFC phase-out management plan (HPMP) and of the preparation for stage III of the HPMP that were being implemented by the Government of Germany to UNDP.[5]

48. The total level of funds associated with projects that are to be transferred from the Government of Germany to UNDP is US $963,132 (plus agency support costs), consisting of the unused balances in the amount of US $836,272 from the second, third and fourth tranches of stage II of the HPMP, US $96,860 approved in principle for the fifth tranche of stage II, and an unused balance of US $30,000 from the preparation for stage III. Table 5 presents the status of disbursements and balances for each tranche approved under stage II and for the preparation of stage III of the HPMP for the Government of Germany.

[5] As per the letter of 19 March 2023 from the Department of the Environment of the Islamic Republic of Iran to UNDP.

Table 5. Status of fund disbursement for projects being transferred from the Government of Germany to UNDP (US $)

Project details			Funding for the Government of Germany		
Funding request	**Code**	**Sector**	**Approved***	**Disbursed**	**Balances to be transferred**
Stage II of the HPMP					
First tranche	IRA/PHA/77/INV/225	Foam	645,500	645,500	0
Subtotal			**645,500**	**645,500**	**0**
Second tranche	IRA/PHA/84/INV/236	Servicing	962,860	869,843	93,017
	IRA/PHA/84/INV/242	Foam	84,175	84,175	0
Subtotal			**1,047,035**	**954,018**	**93,017**
Third tranche	IRA/PHA/86/INV/244	Foam	139,754	139,754	0
	IRA/PHA/86/INV/250	Commercial refrigeration	145,255	0	145,255
Subtotal			**285,009**	**139,754**	**145,255**
Fourth tranche	IRA/PHA/90/INV/259	Commercial refrigeration	502,500	0	502,500
	IRA/PHA/90/INV/260	Foam	95,500	0	95,500
Subtotal			**598,000**	**0**	**598,000**
Subtotal for stage II			**2,575,544**	**1,739,272**	**836,272**
Stage III of the HPMP					
Preparatory funding	IRA/PHA/87/PRP/251	Overarching	15,000	10,000	5,000
	IRA/PHA/87/PRP/252	Industrial refrigeration	25,000	0	25,000
Subtotal for stage III			**40,000**	**10,000**	**30,000**
Grand total			**2,615,544**	**1,749,272**	**866,272**

***** As reflected in the Fund Secretariat's Inventory of projects

49. The request for a change of agency included a progress report on the status of activities already implemented with assistance from the Government of Germany under the first four tranches of stage II of the HPMP and the plan of action for continuing the implementation of these activities through UNDP, once the transfer was completed. These activities were:

(a) In the polyurethane foam sector, completion of the development of water-blown systems with one systems house; conversion of the last enterprise manufacturing integral skin foam; and continued technical assistance and training provided to the assisted small and medium-sized enterprises on the adopted technologies with low global-warming potential (GWP) (US $95,500);

(b) In the commercial refrigeration sector, provision of further technical assistance to the assisted enterprises, including training on low-GWP technologies; issuance of training material on handling carbon dioxide (CO_2) and new virtual training modules on technologies based on propane (R-290) and CO_2; integration of the European Union training standards into the Technical and Vocational Training Organization (TVTO) training material and standards; issuance of guidelines for the use of refillable cylinders and introduction of a ban on non-refillable cylinders; promotion of CO_2-based technology as an alternative to centralized refrigeration systems; demonstration of the operation of an HC-based chiller unit with high tech controls; demonstration of low-GWP technology in refrigerated trucks; and capacity building on the use of electronic expansion valves (US $647,755); and

(c) In the refrigeration servicing sector, establishment of the technicians' certification scheme; continuation of training with the TVTO; completion of a study on the barriers to introduction of building codes for R-290; provision of capacity building and cylinders to retainers and distributors; and finalized set-up of the refrigerant distribution system (US $93,017).

Secretariat's comments

50. The Secretariat noted that a consultation process took place between the Government of the Islamic Republic of Iran, the Government of Germany and UNDP regarding the transfer of the ongoing activities under the HPMP. As lead agency, UNDP confirmed that they would be able to efficiently integrate the transferred activities in their current activities under the HPMP. UNDP also committed to ensure the completion of all activities under stage II by the established date of December 2025, and confirmed that the details of implementation would be discussed with the relevant authorities. The progress report on the status of these activities will be included in the submission of the request for the fifth tranche, planned for the second meeting of 2023.

51. The Secretariat has updated the Agreement between the Government of the Islamic Republic of Iran and the Executive Committee, as contained in Annex V to the present document, to reflect in Appendix 2-A the transfer of unused balances from the second, third and fourth tranches from the Government of Germany to UNDP's fourth tranche component, and the transfer of the Government of Germany's entire fifth tranche, approved in principle, to UNDP's fifth tranche component. Paragraph 17 of the Agreement has been adjusted to indicate that the revised updated Agreement supersedes that reached at the 90th meeting.

52. The return of balances by the Government of Germany and the transfer of funds to UNDP for the second, third and fourth tranches of stage II and for the preparation of stage III of the HPMP are addressed in the Report on balances and availability of resources.[6]

Recommendation

53. The Executive Committee may wish:

(a) To note the request from the Government of the Islamic Republic of Iran to transfer to UNDP all remaining activities included in stage II of the HCFC phase-out management plan (HPMP) and the preparation of stage III of the HPMP that were approved for the Government of Germany;

(b) With regard to stage II of the HPMP:

(i) To note decision 92/XX on the return of balances by the Government of Germany for the second, third and fourth tranches, and the corresponding total fund transfer to UNDP for the implementation of its fourth tranche;

(ii) To approve:

a. The transfer of funds to UNDP in the amount of US $836,272, plus agency support costs of US $58,539, to be included in the ongoing fourth tranche of stage II of the HPMP;

b. The transfer from the Government of Germany to UNDP of the funding of US $96,860, plus agency support costs of US $6,780, approved in principle, associated with the fifth tranche of stage II of the HPMP;

(iii) To further note that the Fund Secretariat has updated the Agreement between the Government of the Islamic Republic of Iran and the Executive Committee for stage II of the HPMP, as contained in Annex V to the present document, specifically Appendix 2-A on the basis of the transfer of the Government of

[6] UNEP/OzL.Pro/ExCom/92/4

Germany's components to UNDP, and paragraph 17 which has been modified to indicate that the revised updated Agreement supersedes that reached at the 90th meeting; and

(c) With regard to the preparation of stage III of the HPMP, to note decision 92/XX on the return of balances by the Government of Germany and the transfer of funds to UNDP for the preparation of the overarching strategy and the preparation of investment activities in the industrial refrigeration and air-conditioning sector.

Mauritania: HCFC phase-out management plan (stage I – review status of the HCFC survey report and recommendations on the revised starting point and the revised Agreement) (UNEP)

Background

54. Stage I of the HPMP for Mauritania was approved at the 80th meeting, based on the starting point for aggregate reductions in HCFC consumption estimated at 6.60 ODP tonnes (120.00 mt), and on the understanding, *inter alia*, that a comprehensive survey to determine the actual level of consumption in the country would be undertaken and independently verified prior to the submission and approval of the second funding tranche; and that the starting point could be revised on the basis of the results of the survey (decision 80/57).

55. At the 91st meeting, UNEP requested funding for the second tranche, which included the HCFC survey[7] and an independent verification report[8] to support the request to revise the starting point to 20.50 ODP tonnes (372 mt). The Secretariat and UNEP discussed several matters related to the survey results, including the relatively high HCFC consumption per capita in Mauritania compared to neighbouring countries, the methodology used to determine the aggregated level of consumption in different subsectors, the unusually high leakage rates, and additional details on the consumption in the fisheries sector. Noting that UNEP required more time to provide all information, the Secretariat agreed with UNEP to finalize the discussion on the revision of the starting point based on the results of the survey conducted and to submit an analysis to the 92nd meeting.

56. Accordingly, the Executive Committee noted[9] that the Secretariat would present at the 92nd meeting the review of the report on the HCFC survey for Mauritania, recommendations on the revised starting point for aggregate reductions in HCFC consumption, and the revised Agreement between the Government and the Executive Committee based on further consultations with UNEP on the HCFC survey submitted to the 91st meeting.

Status report

57. In preparation for the 92nd meeting, the Secretariat had further consultations with UNEP on the details of the HCFC survey report submitted to the 91st meeting.

58. UNEP provided additional justification on consumption in the refrigeration and air-conditioning (RAC) subsector, explained by industrial development based on mining (gold and iron) and fisheries. UNEP added that over half of Mauritanians lived in urban areas, and that the high ambient temperature in the country contributed to the high number of air conditioners per household compared to other African countries. Furthermore, UNEP explained that HCFC leakage rates were around 40 per cent in cold rooms,

[7] The survey collected the 2021 HCFC consumption data, equipment details and age, particularly in large air-conditioning applications, and cross-checked that information with the verified import data.

[8] The verification report for Mauritania showed HCFC consumption in ODP tonnes of 15.80 for 2017; 15.05 for 2018; 13.91 for 2019; 13.19 for 2020; and 13.12 for 2021 that was consistent with the survey results.

[9] Provision contained in Annex XVI of UNEP/OzL.Pro/ExCom/91/72.

central air-conditioning and industrial applications due to the instability of electricity supply, age and inadequate maintenance of equipment, and the fact that much of the equipment in operation was second-hand. UNEP confirmed that refrigeration servicing of international fishing vessels was part of the survey.

59. At the time of issuance of this document, the Secretariat and UNEP were still discussing equipment population per subsector and its correlation with the country's economic structure to track HCFC imports and servicing requirements. Based on these discussions, UNEP was preparing an update on the consumption for each RAC subsector.

Secretariat's comments

60. The Secretariat notes that additional information on the population of equipment using HCFCs for each subsector for the years covered by the survey is needed to undertake further assessment of the starting point. The Secretariat agreed with UNEP that the Government of Mauritania, with the support of the regional Compliance Assistance Programme team, would continue processing socio-economic data to justify the use of HCFCs in the country.

61. In view of the above, the Secretariat will present the final review of the survey report, the recommendation on the revised starting point for aggregate reductions in HCFC consumption, and the revised Agreement between the Government and the Executive Committee at the 93rd meeting.

Recommendation

62. The Executive Committee may wish:

(a) To note the status of the review of the HCFC survey report and recommendations on the revised starting point and the revised Agreement for stage I of the HCFC phase-out management plan (HPMP) for Mauritania contained in document UNEP/OzL.Pro/ExCom/92/9;

(b) To request UNEP to provide additional information on the population of equipment and the use of HCFCs for each subsector for the years covered by the survey; and

(c) To note that the Secretariat will present at the 93rd meeting a review of the survey report including additional information referred to in subparagraph (b) above, a recommendation on the revised starting point for aggregate reductions in HCFC consumption, and a revised Agreement for stage I of the HPMP between the Government of Mauritania and the Executive Committee, pursuant to decision 91/41.

Mozambique: HCFC phase-out management plan (stage I – progress report on the implementation of the work programme associated with the fifth and final tranche and on the implementation of the verification recommendations) (UNEP and UNIDO)

Background

63. Stage I of the HPMP for Mozambique was originally approved at the 66th meeting and revised at the 83rd meeting to reduce HCFC consumption by 35 per cent from the baseline by 2020, at the amount of US $332,500, plus agency support costs of US $36,825.

64. The fifth and final tranche of stage I was approved at the 90th meeting on the understanding that UNEP, UNIDO and the Government would intensify efforts to implement the remaining activities in stage I; that UNEP would submit a progress report to the first meeting of 2023 on the implementation of

activities, including progress in the implementation of the verification recommendations; and that stage II would only be considered once the Secretariat had received confirmation that the equipment from the UNIDO component had been distributed to the beneficiaries and relevant training had taken place (decision 90/32(a)).[10]

65. At the same meeting, the duration of stage I of the HPMP was extended to 30 June 2023, on an exceptional basis, given the implementation delays caused by the COVID-19 pandemic, on the understanding that no further extension would be requested.

Progress report

66. In line with decision 90/32, on behalf of the Government of Mozambique, UNEP as the lead implementing agency submitted the progress report on the implementation of the remaining activities of stage I of the HPMP and of the recommendations of the verification.

67. In the course of implementation of the fifth tranche, the country signed the relevant agreement with UNEP (SSFA[11]) in February 2023 and the first payment was made in February 2023. The delay was caused by administrative changes in the Ministry. Despite the late signing of the SSFA the country was able to implement project activities.

68. The National Ozone Unit (NOU) organized a capacity building workshop for customs officers in February 2023, where 15 customs officers from different border points participated, including four women. Another workshop has been organized for 40 customs officers, who will be trained in the control and monitoring of ODS trade. The NOU also conducted workshops on HCFC phase-out and relevant upcoming targets, that were attended by refrigeration and air-conditioning (RAC) technicians, bureau of standards officers, municipality police officers, the patrol control body, environmental and economy activities inspectors, as well as private sector technicians. Special efforts were deployed to ensure that all workshops were attended by women.

69. Workshops on the safe handling of flammable refrigerants will be conducted in May 2023, and basic toolkits for good servicing will be provided to 60 technicians. Support is being provided to the RAC Association through technical assistance to develop the certification scheme. The NOU organized multiple environmental visits to public institutions and private companies with the objectives to identify all the equipment in the RAC sector, i.e., total number of equipment which uses ODSs or alternative refrigerants. The visits also checked the quality of refrigerants that are on the market and helped detect some mislabelled refrigerants.

70. The NOU organized public awareness workshops with participation from Mozambique Radio Broadcast and national public television. Both media are raising awareness regarding the HPMP and the Kigali Amendment in different local languages in all provinces.

71. Under the monitoring and reporting component, two national and three regional steering committee meetings, with 20 participating members each, including women, were held. The committee membership comprises a wide variety of stakeholders. The recruitment of a consultant, who will assist with the relevant tasks, is about to be completed.

72. Regarding the UNIDO component, under which the existing refrigerant reclaiming centre would be upgraded, and a second centre established, including procurement of two reclamation units for the reclaiming centre, the NOU informed that reclamation is not a priority at the moment and requested UNIDO to rather increase tools to technicians to handling refrigerants and maintenance. Consequently, UNIDO

[10] Provision contained in Annex VIII of document UNEP/OzL.Pro/ExCom/90/40.
[11] Small Scale Funding Agreement

submitted to the NOU a proposed list of RAC tools and equipment. The NOU endorsed the proposed list of tools and equipment and UNIDO is in the process of procuring the equipment with distribution planned for June 2023.

73. Regarding the implementation of the recommendations of the verification report, a new regulation, revising the quota system to ensure that registered importers are allocated annual import quotas rather than approving quotas on a first come first save basis, was drafted and passed through the processes of various endorsements. It is expected that the Council of Ministers will approve the new regulation by July 2023. The Government has also implemented the recommendation indicating that annual HCFC quotas, once agreed upon by the National Steering Committee, should be advertised in the print or electronic media requesting potential registered importers to apply for the quotas based on their needs and in light of the country's commitments under the Montreal Protocol and the multi-year agreement. Quotas of HCFCs are advertised in December every year so that all applications are processed in February of the following year, to make sure that all imports of the allocated quotas are done in same year. The NOU is further establishing an online application system, which will be in place by December 2023, as a way of improving the overall system. It will include an online registry of controlled substances under the Montreal Protocol. A sensitization campaign is currently taking place in preparation for the online system.

Completion of stage I

74. Both UNEP and UNIDO confirmed completion of the activities of stage I by 30 June 2023, in line with decision 90/32(a).

Secretariat's comments

75. The Secretariat noted the status of implementation of stage I and the intensified efforts of the Government of Mozambique, UNIDO and UNEP to implement the remaining activities in this stage, which has led the implementing agencies to confirm completion of the activities of stage I in accordance with the exceptional extension decided by the Executive Committee.

76. The Secretariat noted with appreciation the efforts deployed to ensure that all workshops were attended by women; and the endorsement by the NOU of the list of tools and equipment proposed by UNIDO, whose associated procurement process is ongoing, with the equipment expected to be distributed in June 2023, followed by the relevant training. Further to decision 90/32(a), stage II will be considered once the Secretariat has received confirmation that the equipment from the UNIDO component had been distributed to the beneficiaries and relevant training had taken place.

77. On the implementation of the recommendations of the verification report, the Secretariat noted progress that would indicate that the national licensing and quota system for HCFC imports is fully operational and capable of ensuring the country's compliance with the Montreal Protocol HCFC phase-out schedule.

Recommendation

78. The Executive Committee may wish to note the progress report on the implementation of the work programme associated with the fifth and final tranche of stage I of the HCFC phase-out management plan for Mozambique, and on the implementation of the verification recommendations, as submitted by UNEP and contained in document UNEP/OzL.Pro/ExCom/92/9.

Pakistan: HCFC phase-out management plan (stage II – progress report on the implementation of the third and fourth tranches (UNIDO and UNEP)

Background

79. At the 90th meeting, the Executive Committee approved a change in technology for the conversion of the air-conditioner (AC) manufacturing enterprise Dawlance from R-290 to HFC-32 and approved the associated fourth and final tranche of stage II of the HCFC phase-out management plan (HPMP) for Pakistan and requested the Government of Pakistan and UNIDO to submit progress reports on the implementation of the work programme associated with the third and fourth tranches of stage II of the HPMP on a yearly basis through the completion of the project and the project completion report to the first meeting of 2025 (decision 90/47). UNIDO has submitted the progress report in line with decision 90/47 to the present meeting.

Report on HCFC consumption

80. The Government of Pakistan reported a consumption of 119.09 ODP tonnes of HCFC in 2022, which is 52 per cent below the HCFC baseline for compliance and 4 per cent below the targets set in the Agreement with the Executive Committee of 124.06 ODP tonnes. The 2018-2022 HCFC consumption is shown in table 6.

Table 6. HCFC consumption in Pakistan (2018-2022 Article 7 data)

HCFC	2018	2019	2020	2021	2022	Baseline
Metric tonnes						
HCFC-22	2,806.38	2,752.41	2,021.71	2,045.99	2,032.85	1,908.25
HCFC-123	0.00	0.00	0.00	0.00	1.00	0.00
HCFC-141b	298.67	495.50	73.00	73.25	66.00	1,259.10
HCFC-142b	46.00	44.00	46.00	0.00	0.00	71.55
Total (mt)	**3,151.05**	**3,291.91**	**2,140.71**	**2,119.24**	**2,099.85**	**3,238.90**
HCFC-141b in imported pre-blended polyols*	0.00	0.00	690.00	0.00	119.00	n/a
ODP tonnes						
HCFC-22	154.35	151.38	111.19	112.53	111.81	104.95
HCFC-123	0.00	0.00	0.00	0.00	0.020	0.00
HCFC-141b	32.85	54.51	8.03	8.06	7.26	138.50
HCFC-142b	2.99	2.86	2.99	0	0.00	4.65
Total (ODP tonnes)	**190.19**	**208.75**	**122.21**	**120.59**	**119.09**	**248.11**
HCFC-141b in imported pre-blended polyols*	0.00	0.00	75.90	0.00	13.09	n/a

* Country programme (CP) data

Country programme implementation report

81. The Government of Pakistan reported HCFC sector consumption data under the 2022 CP implementation report that is consistent with the data reported under Article 7 of the Montreal Protocol.

Progress report

82. The following activities were implemented between December 2021 and April 2023.

Update on the progress of the conversions in the polyurethane (PU) foam sector

83. At the 88th meeting[12] the conversions of seven enterprises manufacturing PU thermoware (i.e., Shoaibee Industries, Asif Zubair and Co., Decent Plastic, Delight Plastic, Full Bright Industries, Tropical Plastic, and Unique Plastic) and other small enterprises were reported as completed with a phase-out of 31.21 ODP tonnes (283.75 mt) of HCFC-141b as equipment had been installed and commissioned in all enterprises; however, UNIDO has reported that some of the beneficiary enterprises have not commenced the use of the replacement foaming machines as they are facing difficulties in sourcing water-blown PU foam systems due to the viscosity, pressure generation and heat generated in the PU reaction. To address these issues, UNIDO has contacted three major system houses to undertake testing of chemicals with full water-blown, reduced - HFO/water-blown and Ecomate foam systems and is in the process of working with the enterprises to test the formulations.

84. Stage II also included the conversion of four enterprises manufacturing PU discontinuous panels (i.e., Koldkraft Refrigeration (Koldkraft), Pakistan Air-Conditioning Engineering Co. (Pvt.) Ltd. (PAECO), Pakistan Insulation, and Foster Refrigerators (Foster)) and other small enterprises to cyclopentane, with an aggregated consumption of 26.64 ODP tonnes (224.02 mt) of HCFC-141b. As of November 2022, the conversions at Foster and Koldkraft were completed and verified, and old equipment was decommissioned; this resulted in the phase out 9.60 ODP tonnes (82.37 mt) of HCFC-141b. In the case of PAECO and Pakistan Insulation, the equipment was received and installation at the enterprises began in January 2023; both projects are expected to be complete by June 2023. Foster and Koldkraft will be used as practical examples for the small enterprises which may select to convert their production operation to cyclopentane as a foam blowing agent. The information and consultation for other zero- ODP and low-GWP technologies with relevant stakeholders is yet to be arranged and are expected to be completed during 2023.

85. The conversion of the extruded polystyrene (XPS) foam enterprise (Symbol Industry) to dimethyl ether (DME)/CO_2/HFO was completed and verified; the destruction of the old equipment is scheduled for May 2023. The resulting phase out is 1.69 ODP tonnes (30.73 mt) of HCFC-22 and 2.99 ODP tonnes (46 mt) of HCFC-142b.

Update on the progress of the conversion in the air-conditioner manufacturing sector

86. Since approval of the change in technology for the conversion of manufacturing at the Dawlance enterprise from R-290 to HFC-32, activities relating to research and product development for HFC-32-based ACs; sourcing of 1,000 sets of complete knockdown kits of HFC-32-based equipment; assembly and manufacturing of 995 HFC-32-based units; and the preparation of a training agenda to provide technical support for technicians on the installation, servicing and maintenance of HFC-32-based split ACs were completed. A list of equipment to be procured has been agreed with Dawlance based on the needs and equipment delivery is anticipated in the first half of 2023 and the conversion is expected to be complete by end of December 2023.

Servicing sector activities

87. Activities in the servicing sector which were to be implemented by UNEP in the second and third tranches were delayed mainly because of COVID-19-related challenges, changes in the NOU staff and lack of technical experts. The signature of the small-scale funding agreement (SSFA) for the third tranche was delayed and was signed only in August 2022. The NOU staff issue was resolved by February 2023 when a new national project manager was appointed and following this, implementation of the activities was reinitiated. There are challenges in identifying and appointing technical experts for training and policy support in the RAC servicing sector. All RAC training activities under the second tranche were completed and related activities in the third tranche are ongoing and planned to be completed by the end of the year.

[12] Document UNEP/OzL.Pro/ExCom/88/59

Similarly, planning for implementing the remaining custom and enforcement training is ongoing; and the training activities will be completed by the end of the year.

88. The NOU will participate in a heating, ventilation, air-conditioning and refrigeration (HVACR) exposition in Karachi in June 2023 to provide more information on low-GWP technologies and alternatives to participants; and the guide on safe use of flammable alternatives in refrigeration servicing will be distributed in the second half of 2023.

Level of fund disbursement

89. Of the total funding approved in the third and fourth tranches at the amount of US $264,340, US $42,940 (16 per cent) was disbursed; the balance in the amount of US $221,400 will be disbursed by end of the year once the remaining activities are implemented over the next six months.

Secretariat's comments

Report on the implementation of the third and fourth tranches of stage II of the HPMP

Progress of the conversions in the polyurethane (PU) foam sector

90. The Secretariat requested additional clarifications on whether the projects in the thermoware enterprises would be completed by the end of December 2023. UNIDO explained that due to challenges in sourcing the alternatives, the enterprises are currently using HCFC-141b contained in imported pre-blended polyols; they need additional technical support for the development and testing of formulations using water-blown and other low-GWP technologies; with support from the three systems houses, the issues are expected to be resolved and after their successful resolution, the enterprises would convert to the low-GWP technologies.

Progress of the conversion in the air-conditioner manufacturing sector (Dawlance)

91. Regarding the conversion of the manufacturing facility at Dawlance to HFC-32-based ACs, UNIDO informed that the activities are progressing and in accordance with the decision to convert 80 per cent of its production to HFC-32-based ACs by December 2023 and the complete conversion by December 2024.

Servicing sector activities

92. On the delays in the implementation of activities in the service sector, UNEP explained that they are working closely with the NOU to ensure fast-track implementation of training activities, specifically on the recruitment of technical experts for supporting implementation of training and other policy work. With the resolution of the NOU staffing issue, it is expected that the activities relating to training activities will be completed over the next six months.

Gender policy implementation[13]

93. In line with the gender mainstreaming policy of the Multilateral Fund, women's participation in training, meetings, and workshops has been promoted through better dissemination of information on the gender policy, and targeted promotion to women. There has been an increase in gender parity for

[13] In line with decision 84/92(d), decision 90/48(c) encouraged bilateral and implementing agencies to continue ensuring that the operational gender mainstreaming policy was applied to all projects, taking into consideration the specific activities presented in table 2 of document UNEP/OzL.Pro/ExCom/90/37.

international and national experts. Further, nationally recruited experts are required to complete gender sensitization courses and staff at the NOU have received training on gender awareness.

Recommendation

94. The Executive Committee may wish:

(a) To note the report on the progress in the implementation of the third and fourth tranches of stage II of the HCFC phase-out management plan submitted by UNIDO and contained in document UNEP/OzL.Pro/ExCom/92/9; and

(b) To request the Government of Pakistan, through UNIDO to continue submitting progress reports on the implementation of the work programme associated with the third and fourth tranches of stage II of the HPMP on a yearly basis through the completion of the project and the project completion report to the first meeting of 2025.

Pakistan: HCFC phase-out management plan (stage III – report on the status of imports of pre-blended polyols containing HCFC-141b and the progress of implementation of technical assistance for the foam sector) (UNIDO and UNEP)

Background

95. At the 90th meeting, the Executive Committee approved stage III of the HCFC phase-out management plan (HPMP) for Pakistan and requested the Government of Pakistan and UNIDO to continue monitoring and to report on an annual basis information on the status of imports of pre-blended polyols containing HCFC-141b until the ban on such imports was in place and on the progress of implementation of technical assistance for the foam sector (decision 90/43(a) and (g)(ii)).

96. In line with decision 90/43(a) and (g)(ii), UNIDO has submitted a progress report to the present meeting.

Progress report

Status of imports of pre-blended polyols containing HCFC-141b

97. The total import of HCFC-141b contained in pre-blended polyol for 2022 is 13.9 ODP tonnes (119 mt) and no such import was reported in the year 2021. The NOU is working on the formal ban on the import of pre-blended polyols containing HCFC-141b and it is planned to be introduced via a Statutory Regulatory Order by the Ministry of Commerce Board of Revenues effective from 1 January 2024 in line with decision 90/43(b)(iii).

Implementation of technical assistance for the foam sector under stage III

98. On the report on the implementation of the technical assistance for the foam sector under stage III, UNIDO informed that a field visit was jointly conducted by an international foam expert, national project coordinator (NPC) and the National Ozone Unit (NOU) to beneficiaries to raise awareness of alternative technologies (e.g., water-blown, methylal, methyl formate, HFO-based formulations); alternative chemicals were procured and provided to one of the spray foam enterprises in April 2023 for testing; and a foam testing procedure and a spray foam certification programme were developed to test the performance of alternatives in May 2023; and technical specifications of foam equipment were drafted for commercial refrigeration foam and polyurethane pipe insulation foam.

Secretariat's comments

99. The Secretariat noted that the Government is planning to implement regulations to ban the import of pre-blended polyols containing HCFC-141b and has taken several steps relating to evaluation of performance and testing of alternatives to HCFC-141b in foam applications covered under the conversion project and this would help in implementing the conversion projects from HCFC-141b in a timely and systematic manner.

Recommendation

100. The Executive Committee may wish:

(a) To note the report on the status of imports of pre-blended polyols containing HCFC-141b and the progress of implementation of technical assistance for the foam sector under stage III of the HCFC phase-out management plan, submitted by UNIDO, and contained in document UNEP/OzL.Pro/ExCom/92/9;

(b) To note that the ban on imports of HCFC-141b contained in imported pre-blended polyols will be effective from 1 January 2024; and

(c) To request the Government of Pakistan, through UNIDO to continue reporting on an annual basis information on the status of imports of pre-blended polyols containing HCFC-141b until the ban on such imports was in place and on the progress of implementation of technical assistance for the foam sector.

Pacific Island Countries: HCFC phase-out management plan (stage I – progress report on the implementation of the work programme associated with the final tranche of stage I and the submission of the project completion report for the 12 PICs) (UNEP)

Background

101. Stage I of the HCFC phase-out management plan (HPMP) for the Governments of the Cook Islands, Kiribati, the Marshall Islands, the Federated States of Micronesia, Nauru, Niue, Palau, Samoa, Solomon Islands, Tonga, Tuvalu, and Vanuatu (hereinafter referred to as the Pacific Island Countries (PICs)), was approved at the 63rd meeting,[14] to meet the 35 per cent reduction target by 2020, at a total cost of US $1,696,000, plus agency support costs and included the following two components:

(a) *Regional component:* standardized activities in all 12 PICs such as the provision of policy advice and development of legislation/regulations, capacity building of customs officers and refrigeration and air conditioner (RAC) master trainers, and HCFC phase-out awareness and outreach; and

(b) *National component:* specific activities in each PIC to control the supply and demand of HCFCs, create an enabling environment for the phase-out of HCFCs and the introduction of alternatives and the management, coordination, and monitoring of HPMP implementation.

102. At its 87th meeting, the Executive Committee inter alia approved, on an exceptional basis, the extension of the date of completion of stage I of the HPMP for the PICs to 31 December 2022, given the delays in implementing phase-out activities due to the COVID-19 pandemic, and requested the Governments of the PICs and UNEP to submit a progress report on the implementation of the work

[14] UNEP/OzL.Pro/ExCom/63/46 and Annex XXI of document UNEP/OzL.Pro/ExCom/63/60.

programme associated with the final tranche and the project completion report to the first meeting of the Executive Committee in 2023 (decision 87/18).

103. On behalf of the Governments of the PICs, UNEP as the designated implementing agency has submitted the progress report in line with decision 87/18.

Report on HCFC consumption

104. The Governments of the PICs[15] reported under the country programme (CP) implementation report a total consumption of 0.17 ODP tonnes of HCFC in 2022, which is 95 per cent below the HCFC baseline for compliance and 70 per cent below the maximum allowable consumption in the Agreement with the Executive Committee of 10.32 mt (0.57 ODP tonnes). The 2018-2022 HCFC consumption is shown in table 7.

Table 7. HCFC consumption in the PICs (2018-2022 Article 7 data)

HCFC-22	2018	2019	2020	2021	2022[b]	Baseline
Cook Islands	0.00	0.00	0.00	0.00	0.00	0.86
Kiribati	0.22	0.45	0.07	0.01	0.00	0.97
Marshall Islands	0.00	0.00	0.00	0.00	0.00	3.99
Micronesia (Federated States of)	0.00	1.82	0.00	0.24	1.11	2.55
Nauru	0.00	0.00	0.00	0.00	[c]	0.18
Niue	0.00	0.00	0.00	0.00	[c]	0.15
Palau	1.20	0.13	0.34	0.00	0.07	2.97[d]
Samoa	0.23	0.19	0.78	0.12	0.29	4.60
Solomon Islands	3.63	1.49	1.47	1.41	1.68	35.05[d]
Tonga	0.09	0.02	0.02	0.15	0.00	2.55[d]
Tuvalu	0.03	0.00	0.00	0.03	0.00	1.64
Vanuatu	0.29	0.22[a]	0.00	0.15	0.00	5.11[d]
Total (mt)	**5.68**	**4.32**	**2.68**	**2.11**	**3.15**	**60.62**
Cook Islands	0.00	0.00	0.00	0.00	0.00	0.1
Kiribati	0.01	0.02	0.00	0.00	0.00	0.1
Marshall Islands	0.00	0.00	0.00	0.00	0.00	0.2
Micronesia (Federated States of)	0.00	0.10	0.00	0.01	0.06	0.2
Nauru	0.00	0.00	0.00	0.00	[c]	0.00[e]
Niue	0.00	0.00	0.00	0.00	[c]	0.00[e]
Palau	0.07	0.01	0.02	0.00	0.00	0.20[d]
Samoa	0.01	0.01	0.04	0.01	0.02	0.3
Solomon Islands	0.20	0.08	0.08	0.08	0.09	2.00[d]
Tonga	0.00	0.00	0.00	0.01	0.00	0.10[d]
Tuvalu	0.00	0.00	0.00	0.00	0.00	0.1
Vanuatu	0.02	0.01[a]	0.00	0.01	0.00	0.30[d]
Total (ODP tonnes)	**0.31**	**0.23**	**0.14**	**0.12**	**0.17**	**3.6**

[a] Including 0.002 mt (0.0001 ODP tonnes) of HCFC-142b and 0.003 mt (0.0001 ODP tonnes) of HCFC-124.
[b] CP data.
[c] CP data not received.
[d] HCFC consumption for 2009 was revised as per decision XXIII/29 of the Meeting of the Parties.
[e] Very low consumption; rounding of figures to two digits shows zero consumption.

[15] With the exception of Nauru and Niue which have not yet submitted their 2022 CP implementation report, but which are very low consumption countries.

Progress report

Regional component

105. UNEP supported the regional component of stage I of the HPMP by providing guidance in strengthening legislation, regulations and enforcement mechanisms related to the control of HCFCs. In the third tranche four countries maintained zero HCFC consumption, four countries implemented bans on the import and export of HCFC-based equipment, two countries streamlined the quota allocation process for better monitoring and two countries issued bans on HCFCs in bulk. Legislative achievements in stage I are summarized in table 8.

Table 8. Status of HCFC legislative and regulatory measures in the 12 PICs

PICs	Legislative measures (status)
Licensing and quota system	
All	Establishment and operation of the licensing and quota system for import/export of all HCFCs
Cook Islands, Marshall Islands, Nauru, and Niue	Maintained zero consumption during the implementation of the third tranche
Tonga and Micronesia	Strengthened the licensing system and quota allocation requirements, enabling a more streamlined and transparent process for quota allocation
Banning the import of HCFCs in bulk	
Cook Islands and Federated States of Micronesia	Cook Islands since 7 December 2021 Federated States of Micronesia since 12 February 2021
Adoption of harmonized code for HCFCs	
All	Adoption of pacific harmonized commodity description and coding system 2022 (PACHS22)
Control of/ban on the import and export of HCFC-based equipment	
Cook Islands, Federated States of Micronesia, Niue, Palau, Tonga, Vanuatu,	Prohibited in these countries. In the third tranche Cook Islands, Federated States of Micronesia, Niue, and Vanuatu implemented bans. Palau and Tonga implemented the ban under previous tranches.
Kiribati, Samoa, Solomon Islands, Tuvalu	In the process of putting in place a regulation to ban the import of HCFC-based equipment
Nauru	Banned air-conditioning units that have no English labels since 2016
Permit/license requirement for handling, storage, and sale of HCFC	
Cook Islands, Kiribati, Marshall Islands, Federated States of Micronesia, Palau, Samoa, Solomon Islands, Tonga, and Vanuatu	Requirement in place
Nauru, Niue, and Tuvalu	In the process of putting in place a regulation to require permit/license requirement for handling, storage, and sale of HCFCs
Ban on the import and export of HCFC-141b contained in pre-blended polyols	
All	Banned import of pre-blended polyols containing HCFCs

106. The regional training workshop for customs authorities on development of the ODS risk profiling system and development of standard operating procedures could not be organized due to restrictions related to the COVID-19 pandemic. Instead, UNEP engaged the Oceania Customs Organization (OCO) to collaborate on the following to strengthen the control of HCFC supply:

(a) The Governments of the PICs, OCO and UNEP jointly assigned specific HS code for controlled substances under the Montreal Protocol under the PACHS22;[16]

(b) UNEP developed a simplified training material for OCO officers in delivering training to customs brokers as part of OCO's activities to strengthen licensing systems in particular the accurate customs declaration mechanism; and

(c) OCO partnered with UNEP to develop standard operating procedures (SOP), which delineate procedures to guide the customs authority of the PICs in enforcement of the licensing system.

107. In January 2021, UNEP recruited an international RAC trainer to develop the standard operating guidelines (SOG) for handling of flammable refrigerants, which will be circulated to the PICs for adoption.

National component

108. Under the third tranche nine PICs (excluding Kiribati, Nauru and Niue) delivered training for a total of 412 customs and enforcement officers on prevention of illegal trade of ODS and ODS-based equipment, fire and safety hazards from refrigerants, and the use of tools for enforcement of ODS trade; new topics covered included risk profiling and misdeclaration of HCFCs by customs brokers.[17] Under the first tranche of stage I UNEP procured and delivered 16 refrigerant identifiers to the PICs and under the third tranche numerous of these were serviced by the manufacturer with the support of UNEP and presently 15 are in working condition. Meetings and consultations were held in nine PICs (excluding Kiribati, Nauru, and Niue) with importers and customs brokers.

109. Eight PICs (excluding Kiribati, Marshall Islands, Nauru, and Niue) conducted training workshops on good servicing practices with 402 RAC technicians trained in the third tranche. Gender participation in HPMP activities in the PICs was tracked starting in the third tranche and 66 women participated in the customs and enforcement trainings and 21 women participated in the RAC technician training. Kiribati, Marshall Islands (for the RAC training), Nauru and Niue could not organize trainings and meetings under the third tranche due to the pandemic and lack of trainers/resource persons. The training for customs officers and RAC technicians delivered in total during stage I are shown in table 9 below.

Table 9. Summary of training workshops for customs officers and RAC technicians in stage I

PIC	Customs training		Refrigeration training	
	Workshops	Participants	Workshops	Participants
Cook Islands	7	83	10	138
Kiribati	8	119	6	181
Marshall Islands	6	72	4	58
Micronesia (Federated States of)	13	187	12	263
Nauru	4	45	4	49
Niue	7	74	6	41
Palau	9	143	6	141

[16] PACHS22 is a multipurpose goods nomenclature that forms the basis for Customs Tariffs and International Merchandise Trade Statistics, meant to assist the Oceania Customs Organisation (OCO) members who are not members of the World Customs Organization to adopt the HS codes 2022.

[17] There have been data discrepancies between NOU records and customs statistics during the implementation of stage I of the HPMP due to misdeclaration, which the Governments have been addressing.

PIC	Customs training		Refrigeration training	
	Workshops	Participants	Workshops	Participants
Samoa	9	230	7	279
Solomon Islands	11	165	10	311
Tonga	13	716	11	370
Tuvalu	7	136	5	126
Vanuatu	12	122	13	228
Total	**106**	**2,092**	**94**	**2,185**

110. During the implementation of the third tranche the NOU followed up on RAC servicing equipment/tools procured in the first tranche conducting periodic inspections to monitor the status of the equipment. The PIC NOUs collaborated with the key stakeholders in the technical institutes to establish/strengthen the operation of RAC associations. RAC associations have been established in 10 of the PICs and in the Marshall Islands and Niue, due to the limited number of RAC technicians for forming a RAC association, the NOU decided to conduct outreach visits to the RAC technicians to provide them with information related to the HCFC phase-out.

111. Six countries (Cook Islands, Federated States of Micronesia, Samoa, Solomon Islands, Tonga, and Vanuatu) explored options to establish competency-based certifications systems and 15 consultation meetings were held in total. All six countries reported interest from stakeholders towards the establishment of a competency-based certification system to raise the working standard. During the third tranche communication and outreach activities were carried out in all 12 PICs and included consultation meetings, news articles and press releases on the Montreal Protocols, printed awareness materials on HCFC phase-out, and the promotion of WhatGAS application for customs.

Project implementation and monitoring

112. The NOUs are responsible for the implementation, coordination, and monitoring of the HPMP and the budget provided was used to cover the cost of travelling for the delivery of workshops, training, meetings, and consultations related to the stage I of the HPMP.

Gender policy implementation[18]

113. In line with the gender mainstreaming policy of the Multilateral Fund the participation of women was encouraged in planning, decision making, monitoring and evaluation of the HPMP; gender participation was tracked in various activities; and gender mainstreaming was included on the agenda at network meetings.

Level of fund disbursement

114. As of April 2023, of the US $1,696,000 approved, US $1,576,290 (93 per cent) had been disbursed as shown in table 10. UNEP is working to ensure the project is financially completed by the end of December 2023. Any balance after conclusion will be returned to the subsequent meeting.

Table 10. Financial report of stage I of the HPMP for the PICs (US $)

Component	First tranche		Second tranche		Third tranche		Total		
	Approved	Disbursed	Approved	Disbursed	Approved	Disbursed	Approved	Disbursed	Balance
National	739,375	739,375	530,525	463,716	141,100	91,031	1,411,000	1,294,122	116,878
Regional	134,000	134,000	106,000	106,000	45,000	42,168	285,000	282,168	2,832
Total	873,375	873,375	636,525	569,716	186,100	133,199	1,696,000	1,576,290	119,710

[18] In line with decision 84/92(d), decision 90/48(c) encouraged bilateral and implementing agencies to continue ensuring that the operational gender mainstreaming policy was applied to all projects, taking into consideration the specific activities presented in table 2 of document UNEP/OzL.Pro/ExCom/90/37.

Disbursement rate (%)	**100**	**90**	**69**	**93**

Secretariat's comments

115. The Secretariat noted that UNEP and the Governments of the PICs have successfully completed the implementation of all activities associated with stage I of the HPMP and that the project completion reports (PCRs) for the individual countries and the regional component were submitted in April 2023.

116. The Secretariat further notes with appreciation the commitment that the PICs have demonstrated to ensure the timely implementation of activities in stage I, and the substantive progress in implementation, noting the achievements in monitoring the import of HCFCs in the region through close collaboration with the OCO. This will support the PICs in helping their customs authorities implement procedures in different steps of the enforcement chain to track the movement of ODS in the region.

Recommendation

117. The Executive Committee may wish to note with appreciation:

(a) The final progress report on the implementation of the work programme associated with the third and final tranche of the HCFC phase-out management plan (HPMP) for the Pacific Island Countries (PICs), submitted by UNEP and contained in document UNEP/OzL.Pro/ExCom/92/9; and

(b) The submissions of the project completion report of stage I of the HPMP by the Governments of the Cook Islands, Kiribati, the Marshall Islands, the Federated States of Micronesia, Nauru, Niue, Palau, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.

Philippines (the): HCFC phase-out management plan (stage II – progress report on the implementation of the final tranche and verification report) (UNIDO)

Background

118. At the 90th meeting the Executive Committee decided:

"(b) To extend, on an exceptional basis, due to the delays imposed by the COVID-19 pandemic, the completion date of stage II of the HPMP for the Philippines until 31 December 2023 noting that no further extension would be requested;

(c) To request the Government of the Philippines, through UNIDO, to submit:

(i) The verification report of HCFC consumption for 2021 to the 91st meeting; and

(ii) Progress reports on the implementation of the work programme associated with the final tranche on a yearly basis through the completion of the project, verification reports until approval of stage III and the project completion report at the first meeting in 2024" (decision 90/17(b) and(c)).

119. The verification report was submitted by UNIDO after the deadline for consideration at the 91st meeting, thus could not be reviewed; this submission was noted by the Executive Committee, with the understanding that the Secretariat would review and present the report at the 92nd meeting. In addition, in line with decision 90/17(c)(ii) the Government of the Philippines, through UNIDO, has submitted the progress report to the present meeting.

Report on HCFC consumption

120. The Government of the Philippines reported a consumption of 69.66 ODP tonnes of HCFC in 2022, which is 57 per cent below the HCFC baseline for compliance and 15 per cent below the targets set in the Agreement with the Executive Committee of 82.56 ODP tonnes. The 2018-2022 HCFC consumption is shown in table 11.

Table 11. HCFC consumption in the Philippines (2018-2022 Article 7 data)

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

Country programme implementation report

121. The Government of the Philippines reported HCFC sector consumption data under the 2022 country programme (CP) implementation report at 44.41 ODP tonnes. The difference with the data reported under Article 7 of the Montreal Protocol was explained as that CP data is based on use while Article 7 data is based on imports which, for 2022, included stockpiles.

Verification report

122. The verification report confirmed that the Government is implementing a licensing and quota system for HCFC imports and exports and that the total consumption of HCFCs reported under Article 7 of the Montreal Protocol for 2021 was correct (as shown in table 11 above). The verification concluded that the Government of the Philippines is operating an effective licencing and quota system and has met its targets under its Agreement with the Executive Committee. The verification report also included recommendations to encourage the Environmental Management Bureau (EMB) to continue its data management and surveillance tasks in cooperation with importers and other stakeholders; and to finalize the memorandum of understanding between the EMB and the Bureau of Customs (BOC) as well as the handbook on national regulations for the import and licensing system.

Progress report

123. Since the last progress report at the 90th meeting the following activities were undertaken:

(a) Technical assistance for policy/enforcement and customs authorities:

(i) One technical forum on the promotion of alternatives for ozone and climate protection was held with more than 100 attendees from government, air-conditioning (AC) manufacturers and servicing enterprises, importers and

end-users. At the forum an updated energy labelling program for refrigeration and air-conditioning (RAC) appliances was presented by the Department of Energy (DOE);

(ii) Forty trainers were trained on the monitoring of imports of ODS and the use of multi-refrigerant identifiers and the safe handling of refrigerants, and a training session for 30 customs and enforcement officers were held on the use of updated harmonized system (HS) codes. Five multi-refrigerant identifiers were provided to BOC;

(iii) A circular was issued in July 2021 requiring registration with the EMB of all persons engaged in servicing both mobile and stationary RAC equipment of any cooling capacity using ODS through the online permitting system; two meetings were held for more than 30 distributors and suppliers of HCFCs and HCFC-based equipment to discuss requirements for registration and data reporting.

(b) Technical assistance for the servicing sector to promote good refrigeration practices, and to demonstrate and encourage the use of low-GWP alternatives:

(i) One train the trainers programme was conducted for 20 RAC trainers on good refrigeration practices to minimize refrigerant leaks from equipment and safety considerations for flammable refrigerants. Field visits to eight regional HCFC collection centres were conducted to assess how these centres collect these substances; this was discussed at the coordination meeting with the designated central collection facility to review options for disposal of these unwanted substances and the technical assistance needed;

(ii) The code of practice for technicians is under assessment to ensure that safe practices on the handling of flammable refrigerants are included, and is expected to be completed by August 2023;

(iii) An initial list of potential alternatives for fire protection applications was identified and initial discussions were held with the Bureau of Fire Protection to support the study on the potential alternatives to HCFC-123 for firefighting.

(c) Technical assistance to promote low-GWP alternatives for the AC manufacturing sector:

(i) A two-day training attended by 25 participants from academia and the RAC industry on ODS alternatives in RAC and safe handling of flammable refrigerants was conducted in collaboration with the Technical Education and Skills Development Authority (TESDA) and the Cold Chain Innovation (CCI) Hub. Two courses on alternative technologies were conducted for trainers at the CCI-Hub in TESDA and an expert on ammonia-based technology was engaged;

(ii) Initial discussions were held regarding the preparation of a pilot online training programme on the safe handling of flammable, toxic, and high-pressure refrigerants targeted towards manufacturing enterprises, technicians, end-users, and importers, with the view to include this in the overall servicing technician training programme; and

(d) The implementation and monitoring of activities of the project management unit (PMU) included the hiring of a national coordinator; organizing of events, awareness activities and stakeholder consultation; the preparation of reports; information dissemination; and gender

mainstreaming considerations.

Level of fund disbursement

124. As of March 2023, of the US $811,750 approved for stage II, US $357,217 (44 per cent) had been disbursed. The balance of US $454,533 will be disbursed by 31 December 2023.

Implementation plan for 2023

125. The following activities will be implemented until December 2023:

(a) Issuance of a circular to notify AC market suppliers that any AC model containing HCFC-22 cannot be registered and sold in the Philippines market; policy awareness-raising activity with stakeholders to facilitate the transition to energy-efficient AC equipment; two trainings on effective enforcement of the licensing and quota systems (US $5,500);

(b) Three customs training workshops for 100 customs and enforcement officers on monitoring ODS imports and control of HCFCs; an orientation seminar and a training workshop for brokers to discuss the ODS importation policies and avoiding the use of incorrect HS codes; update the country handbook on national regulations for the import and licensing system (US $88,410);

(c) Workshops on the updated online permitting system for 30 participants from the Government and suppliers of HCFCs and HCFC-based equipment; two coordination meetings with importers and distributors of HCFCs and pre-blended-polyols suppliers to discuss requirements for registration including data reporting and submission (US $13,500);

(d) Verification of HCFC consumption and HPMP implementation for 2022;

(e) Training programme for trainers for TESDA and TESDA-accredited institutions; one training workshop on the revised code of practice for RAC equipment and alternatives to HCFC-141b for at least 25 RAC technician trainers; three training sessions for 60 RAC technicians on the revised code of practice and new service procedures for HCFC-22, HFC-32 and other alternatives (US $68,000);

(f) Review of the business model for the central recycling centre; collection of HCFCs and other refrigerants and management of stocks at the regional collection centres and procurement of tools and equipment[19]; review of disposal options for the country; two trainings for 100 RAC technicians on good practices to minimize leakage of HCFC-22 in RAC equipment (US $103,021);

(g) Complete the study on available cost-effective alternatives to HCFC-225ca, HCFC-225cb for cleaning and HCFC-123 for firefighting; provide training to educate firefighting authorities on alternatives; identify users of HCFC-141b and where it is used as a solvent; complete the study and recommendations on potential alternatives for flushing and hold training workshops on outcomes of the study for 60 participants from relevant enterprises (US $72,700);

(h) Technical assistance to promote low-GWP alternatives for the RAC sector: three safety training and awareness programmes for low-GWP alternatives for 100 AC technicians in collaboration with TESDA and the CCI-Hub; procurement and delivery of additional

[19] Small recovery machines, vacuum pumps, gas identifier, storage tanks and cylinders.

training units and tools[20]; a study tour to an AC manufacturing facility using low-GWP alternatives (proposed new activity); one online training on the safe handling of flammable, toxic, and high-pressure refrigerants targeted towards 800 manufacturing enterprises, technicians, end-users and importers (US $73,902); and

(i) PMU (US $29,500) for the hiring of a national coordinator and experts, monitoring of activities, stakeholder consultations and travel (US $14,500); organizing information and awareness events on relevant topics (US $8,000); and hiring an expert to consider and monitor gender results and indicators and the development of training and awareness raising activities (US $7,000).

Secretariat's comments

Progress report

126. The Secretariat noted that the consumption of the country grew by 19 per cent in 2021 and then again by 15 per cent in 2022; UNIDO explained that it was due to the market recovery after the COVID-19 restrictions were lifted, noting the steep decrease in consumption between 2019-2020 and that the consumption in the country had remained below the Montreal Protocol consumption limits and the maximum allowable consumption in the Country's Agreement with the Executive Committee.

127. UNIDO explained that project implementation is progressing well as shown by the activities completed during the period. While there are still several training and other activities that need to be completed, UNIDO reiterated the commitment of the Government of the Philippines to ensure that these are completed by the date of completion, as demonstrated in the work plan provided.

128. With regard to the development of minimum energy performance standards for RAC equipment in close coordination with the Department of Energy (DOE) and the issuance of the Implementing Guidelines of the Philippine Energy Labelling Program for Air Conditioners, discussions with DOE are continuing to ensure that HCFC-22-based refrigerators are included in the list of products to be controlled and that this would be applicable to both manufactured and imported products.

Verification report

129. The Secretariat queried about the workflow process after the issuance of a pre-importation shipment certificate (PSIC) when imports are received, including the responsible authorities for monitoring, checking, and releasing the goods imported and requested a workflow for the establishment of quotas, and their eventual distribution. UNIDO clarified that the Bureau of Customs (BOC) does not currently provide a process flow for the release of goods after the PSIC and that this could be an output for next year's verification. UNIDO also clarified the process for quota distribution and that HCFC importation is determined as a percentage of individual importer's importations during baseline years and the baseline percentage is the basis for the quota assignments for the subsequent years.

130. UNIDO also provided a revised report which included recommendations specifically focusing on ensuring that finalization and signature of the MOU between the BOC and the EMB for more effective monitoring of ODS imports, and finalization of the handbook on national regulations on the import and licensing system for the phase-out of ODS.

[20] Vacuum pumps, pliers, hoses, and tools to handle flammable refrigerants.

Recommendation

131. The Executive Committee may wish:

(a) To note the submission by UNIDO of the verification report of HCFC consumption for the Philippines for 2021 and the progress report on the implementation of the work programme associated with stage II of the HCFC phase-out management plan (HPMP) for the Philippines as submitted by UNIDO and contained in document UNEP/OzL.Pro/ExCom/92/9; and

(b) To request the Government of the Philippines through UNIDO to continue submitting progress reports on a yearly basis on the implementation of the work programme associated with the final tranche until the completion of the project, verification reports until approval of stage III, and the project completion report to the first meeting in 2024.

Saint Lucia: HCFC phase-out management plan (stage I – final progress report on the implementation of the work programme associated with the final tranche and the submission of the project completion report) (UNEP and UNIDO)

Background

132. At its 87th meeting, the Executive Committee approved the fifth and final tranche of stage I of the HCFC phase-out management plan (HPMP) for Saint Lucia and requested the Government, UNEP and UNIDO to submit a progress report on the implementation of the work programme associated with the final tranche and the project completion report to the first meeting of the Executive Committee in 2023 (decision 87/28(a)).[21]

133. In line with decision 87/28(a), UNEP, as the lead implementing agency, has submitted the abovementioned progress report.

HCFC consumption

134. The Government of Saint Lucia reported a consumption of 0.24 ODP tonnes of HCFCs in 2021, which is 78 per cent below its HCFC baseline for compliance of 1.09 ODP tonnes and 66 per cent below the maximum allowable consumption in the Agreement with the Executive Committee for that year of 0.71 ODP tonnes.

135. The HCFC consumption for Saint Lucia is showing a decreasing trend since 2016; the consumption decreased to 0.03 ODP tonnes in 2020 due to constraints related to the COVID-19 pandemic that impacted the tourism industry and reduced the demand of servicing for refrigeration air-conditioning (RAC) equipment. The subsequent increase in 2021 to 0.24 ODP tonnes is primarily due to resumption of activities in servicing RAC applications in the country.

Progress report on the implementation of the final tranche of stage I

136. The following activities were implemented:

(a) Training of 20 customs and other enforcement officers, including two female participants, on the application of the HCFC licensing and quota system and the proper classification of ODS, refrigerants and their products. There were three female trainers from the national ozone unit and the customs department;

[21] Provision contained in Annex XI of document UNEP/OzL.Pro/ExCom/87/58.

(b) Training of 32 technicians, including one female, on good practices while maintaining and servicing RAC equipment; and

(c) Public awareness and outreach including production and dissemination of updated education and awareness products on HCFCs and alternatives, press releases and media messages on major activities relating to HCFC phase-out including stage II of the HPMP.

137. As of 31 December 2022, of the US $210,000 approved, US $205,419 have been disbursed (US $82,650 for UNEP and US $122,769 for UNIDO); UNIDO had returned US $4,581.[22]

138. The activities relating to stage I of the HPMP were completed as of 31 December 2022; the project completion report is under preparation and would be submitted by the end of June 2023.

Secretariat's comments

139. The Secretariat requested information on why only 20 customs officers (out of a target of 40) were trained during the implementation of the final tranche. UNEP explained that it was difficult for the customs department to release more officers for training due to competing priorities in the department and certain internal administrative challenges.

Recommendation

140. The Executive Committee may wish to note the final progress report on the implementation of the work programme associated with the fifth and final tranche and the submission of the project completion report for the HCFC phase-out management plan for Saint Lucia, as submitted by UNEP and contained in document UNEP/OzL.Pro/ExCom/92/9.

Saudi Arabia: HCFC phase-out management plan (stage I – progress report on the implementation of the remaining activities (UNEP)

Background

141. At its 86th meeting, the Executive Committee *inter alia* requested UNEP to submit an annual progress report on the implementation of the remaining activities in the refrigeration servicing sector, customs training, and monitoring of stage I of the HCFC phase-out management plan (HPMP) to the last meeting of the Executive Committee of each year until their completion (decision 86/16(f)(ii)).

142. On behalf of the Government of Saudi Arabia, UNEP has submitted a progress report in line with decision 86/16(f)(ii).

Progress report

143. The following activities were undertaken since the 88th meeting:

(a) A virtual refresher training workshop was held for 60 customs officers on monitoring and reporting of HCFC consumption, and meetings of the National Ozone Committee on ODS policies and regulations continued, with the development of a ban on disposable cylinders ongoing;

[22] Balance from the first and second tranches.

(b) An e-licensing system was implemented that allows importers and exporters to submit requests electronically. Further improvements to that system, which include linking the permits with enterprises and the relevant Government agencies, were being implemented with the Government's resources and are expected to be finalized in 2024;

(c) A national code of good practice for refrigeration and air-conditioning (RAC) technicians was developed, including best practices for the safe handling of flammable refrigerants, and an updated training curriculum for the Technical and Vocational Training Corporation (TVTC) was adopted in line with that code of good practice; and

(d) The memorandum of understanding with the TVTC was reactivated to enable the cooperation on the RAC technician training and certification programme in cooperation with the Saudi Council of Engineers. A total of 9,903 RAC technicians had been certified to date.

Secretariat's comments

144. Regarding the four conditions related to the servicing sector specified in Appendix 8-A of the Agreement between the Executive Committee and the Government of Saudi Arabia, the Secretariat noted:

(a) The development of the ban on disposable cylinders is ongoing; it was unclear when then ban was expected to be implemented;

(b) While there is a regulation requiring the engineering professions be certified, it appears that a small proportion of technicians in the country are certified;

(c) Regarding the introduction of a system regulating access to refrigerants only to entities where certified technicians are carrying out and supervising the work on servicing RAC systems, UNEP clarified that while there is no regulation only allowing the sale of refrigerants to certified technicians, the newly adopted regulation requires all entities to have certified technicians and that uncompliant entities would face penalties. The implementation of that regulation, combined with the training and certification of a substantial number of technicians and the implementation of a code of good practice, would represent the implementation of such a system; and

(d) Regarding a strategy to encourage end-users of RAC equipment to carry out leak detection and repair measures, UNEP clarified that all control measures and ODS regulations are being introduced in the implementation of the new regulation.

145. The end date of the small-scale financing agreement between the Government of Saudi Arabia and UNEP was 31 December 2021. At the 88th meeting, UNEP reported a balance of US $129,400. Since that time, US $121,900 had been disbursed for activities already undertaken, leaving a remaining balance of US $7,500. The Secretariat recalled that, in line with decision 86/16(f)(iii), stage II of the HPMP for Saudi Arabia would be considered only after the project completion report of stage I of the HPMP had been submitted, stage I of the HPMP had been financially completed, and all funding balances had been returned to the Multilateral Fund.

Recommendation

146. The Executive Committee may wish to note the annual progress report on the implementation of the activities remaining from stage I of the HCFC phase-out management plan for Saudi Arabia (decision 86/16(f)(ii)) submitted by UNEP and contained in document UNEP/OzL.Pro/ExCom/92/9.

B. Reports related to HFCs

Jordan: Report on the project for the conversion from HFC to propane of the facility manufacturing large commercial unitary roof-top air-conditioning units of up to 400 kW at Petra Engineering Industries Co. (UNIDO)

Background

147. At its 81st meeting, the Executive Committee approved a project for the conversion from HFC (HFC-134a, R-407C, R-410A) to propane (R-290) of the facility manufacturing large commercial unitary roof-top air-conditioning (AC) units of up to 400 kW at Petra Engineering Industries Co. (Petra) in Jordan, in the amount of US $1,637,610, plus agency support costs for UNIDO (decision 81/62).

148. Petra is the largest manufacturer of AC units and the only manufacturer of unitary roof-top AC units in the country. The project was designed to simulate, design, test, and convert the production of unitary roof-top AC units using R-290 to replace HFC-based units of up to 400 kW (114 tonnes of refrigeration (TR)) used for commercial and industrial applications and achieve an energy efficiency ratio (EER) 10 to 15 per cent higher than the minimum EER in the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) 90.1 standard. Of its eight assembly lines and eight charging areas, two were to be converted to R-290. The two prototypes were planned to have a capacity of 80 kW and 185 kW, cover the whole range of unitary AC units manufactured at Petra, and include two different designs with all related safety measures.

149. By the 90th meeting, the two lines were converted, and two R-290 prototypes with a capacity of 80 kW and 185 kW were designed, built, and tested, in addition to a third prototype based on HFC-32, all exceeding the cooling capacity (by 2 to 9 per cent) and EER (by 2 to 11 per cent) of the baseline units. However, the enterprise had not manufactured any large commercial unitary roof-top AC units based on the new technology.

150. The approved total cost of US $1,637,610 comprises US $889,800 in incremental capital costs (ICCs) and US $747,810 in incremental operating costs (IOCs). At the 90th meeting, UNIDO reported ICCs of US $1,521,120 and zero IOCs as, other than the prototypes, no R-290-based unitary roof-top AC units had been manufactured.

151. The project was to be completed by July 2020 and a comprehensive completion report submitted within six months of project completion; at the 90th meeting, the date of completion was extended to 31 July 2025 to allow for the introduction of the new technology following changes in market demand and a decrease in sales.

152. Further, at its 90th meeting, the Executive Committee decided, *inter alia*, to note that the remaining balance of US $113,089 would be disbursed exclusively for IOCs related to the manufacture of large commercial unitary roof-top AC units based on R-290; that the enterprise would report, through UNIDO, separately and for each year, through the completion of the project, the annual sales of R-290-based large commercial unitary roof-top AC units in Article 5 countries and in non-Article-5 countries; and that IOCs would be provided only on the basis of sales of R-290-based large commercial unitary roof-top AC units in Article 5 countries (decision 90/25).

153. On behalf of the Government of Jordan, UNIDO submitted a progress report on the implementation of the project, including a report on the annual sales of R-290-based large commercial unitary roof-top AC units in Article 5 countries and in non-Article-5 countries, an update on the remaining balances to be disbursed, and an update on training and awareness-raising activities.

Progress report

154. The enterprise has had no sales of R-290-based large commercial unitary roof-top AC units since the 90th meeting; however, two orders for an Article 5 country are pending and awaiting final confirmation.

155. The enterprise continued its efforts to introduce the technology into the market and increase market acceptance, including through the training and certification of their technicians and installers on good and safe installation and maintenance practices for AC systems based on flammable refrigerants, and through awareness-raising events for potential customers on the benefits and risks of flammable refrigerants in AC systems; further, a new safety standard is being developed for AC systems based on flammable refrigerants.

156. Of the remaining balance of US $113,089 to be disbursed exclusively for IOCs, none has been disbursed given the lack of sales since the 90th meeting.

Secretariat's comments

157. The Secretariat understands that Petra has been facing a challenging business environment: the enterprise's HFC-based manufacturing continued to decrease, with sales of HFC-based units in 2022 75 per cent below those in 2021. Sales of HFC-based equipment are not expected to recover until 2024. The enterprise attributed the substantial reduction in sales to consequences of the COVID-19 pandemic, which included a general decrease in investments in commercial AC units; the economic situation in the region, which may be affected by the political situation in some countries; and changes in market demand, including an increased demand for chilled water systems. UNIDO also noted that the introduction of small R-290-based units to the European Union (EU), which only started in 2022 given shifting priorities during the pandemic, was expected to help overcome barriers to the market introduction of R-290-based equipment.

158. At the 90th meeting, UNIDO had confirmed that the enterprise remained committed to manufacturing R-290-based large commercial unitary roof-top AC units, and an extension was granted to give additional time to allow policy and regulatory changes to take place and build confidence in the technology. Expected changes to the EU fluorinated gas (F-gas) regulation, while delayed, are likely to facilitate the uptake of R-290-based large commercial unitary roof-top AC units in the EU.[23] Expected changes in regulations in the state of California of the United States of America may similarly encourage an uptake of the technology in that market.[24] In addition, expected updates to building codes in Article 5 countries in the region (Jordan, Saudi Arabia, and the United Arab Emirates) would allow the installation and use of R-290-based large commercial unitary roof-top AC units.

159. The Secretariat requested an update on the status of those regulations and building codes. UNIDO clarified that the European Commission proposal to amend the F-gas regulations was adopted by the European Parliament on 30 March 2023; consultations between the Council of the EU, the European Parliament, and the European Commission are ongoing, with the revised regulation expected to be adopted by September 2023 for entry into force 1 January 2024. Further, in December 2020 the California Air Resources Board (CARB) approved a regulatory proposal to increase restrictions on the use of high-GWP refrigerants and the sale and distribution of HFCs and HFC blends. The regulation began in 2022 and is

[23] On 5 April 2022, the European Commission released a proposal updating the EU F-gas regulation with measures to further reduce the use of HFCs in the EU, including *inter alia* a 1 January 2027 ban on certain AC equipment that use F-gases with a global warming potential (GWP) of 750 or greater; and measures to increase the number of engineers and technicians qualified to handle R-290.

[24] Existing regulations specify that new stationary RAC equipment with a charge greater than 22.7 kg are required to use a refrigerant with a GWP less than 150. Amendments to the regulations were submitted in February 2022 that would *inter alia* limit the GWP of HFCs sold in California after 2030 to 750 or less and would require the California Air Resources Board to develop deadlines for the adoption of AC equipment with refrigerants that have a GWP of 150 or less.

being implemented in phases, with a full transition to low- or no-GWP alternative technologies planned for 2035. UNIDO indicated that regulations in other non-Article 5 countries, including the United States of America, Canada, and Japan, may also encourage the uptake of these technologies in the market. The previously mentioned revisions to building codes in Jordan, Saudi Arabia, and the United Arab Emirates were ongoing.

Recommendation

160. The Executive Committee may wish to note the progress report on the implementation of the project for the conversion from HFC to propane (R-290) of the facility manufacturing large commercial unitary roof-top air-conditioning units of up to 400 kW at Petra Engineering Industries Co., submitted by UNIDO, and contained in document UNEP/OzL.Pro/ExCom/92/9.

C. Reports on ODS disposal

Brazil: Pilot demonstration project on ODS waste management and disposal (final report) (UNDP)

Background

161. At its 72nd meeting, the Executive Committee approved the pilot demonstration project on ODS waste management and disposal for Brazil at the amount of US $1,490,600, plus agency support costs of US $104,342 for UNDP (decision 72/28). At its 79th meeting, the Executive Committee, approved an extension of the project to December 2022 and requested UNDP to submit the final report to the first meeting of 2023 and a project completion report no later than July 2023, and return to the fund balances no later than December 2023, on the understanding that no further extensions of the completion date of the project would be considered by the Executive Committee (decision 79/18(c)(i)).

162. UNDP submitted on behalf of the Government of Brazil and in line with decision 79/18(c)(i) the final report on the pilot demonstration project on ODS waste management and disposal, attached to document UNEP/OzL.Pro/ExCom/92/9.

Report summary

163. The objective of the pilot project was to demonstrate, through an environmentally appropriate, efficient, and economically viable solution, the management and final disposal of ODS, through the establishment of a national ODS waste management system and to explore opportunities to integrate ODS waste management and end-of-life destruction into the broader national waste management and energy efficiency programs of the country. The project as approved included the disposal of 120 mt of ODS waste which had previously been collected and earmarked for destruction.

164. The project was implemented through four components: capacity building in the handling and transport of ODS waste and improving waste storage capacity; qualifying national capacity for the disposal of ODS waste according to standards through burn tests in two selected incineration facilities and analysis of logistics and costs; technical assistance for the evaluation and standardization of procedures and criteria for the management and final disposal of ODS waste; and project management and supervision.

165. The project resulted in the destruction of 24.74 mt of ODS waste and the qualification of Essencis Soluções Ambientais (Essencis) as the beneficiary destruction facility who received the necessary equipment to carry out burn tests, adapt the plant incinerator for ODS destruction to Montreal Protocol

standards and install a gas supply system among other modifications. Four[25] reclamation centres were also identified and supported with equipment to increase their storage capacity,[26] three of these also received equipment[27] to improve reclamation operations. Training was carried out throughout the project for the four centres, environmental agencies, waste managers, and other relevant stakeholders on the management and environmentally acceptable final disposal of ODS. These reclamation centres will constitute the network for aggregating and collecting ODS waste for final destruction by Essencis. Technical standards were established to support the project such as the specifications for collection, recycling and reclamation of refrigerant fluids and a regulation on the environmental management of ODS was drafted and submitted to the Ministry of Environment for consideration.

166. Several challenges were faced during project implementation which led to the delays in completion including the complex and lengthy equipment procurement process due to fluctuation in equipment and transportation costs and the impact of the COVID-19 pandemic on the operation of the reclamation centres and the incineration facility. It was also noted that the initial project implementation period envisaged during approval (i.e., 24 months) was not sufficient for the full implementation of all activities, thus contributing to the delays.

167. The project had numerous lessons learned for the sustainability of an ODS waste management and disposal system in a country the size of Brazil, including: the need to clearly identify and strengthen the roles and responsibilities of each stakeholder in the overall process; regular monitoring of the economic, political and social risks; the importance of awareness raising to change the market's view of the quality of the reclaimed substances to encourage their use for servicing; and the importance of close collaboration between the Ministry of Environment, Brazilian Institute of Environment and Renewable Resources, Environmental Company of São Paulo State and UNDP which was fundamental to the overall success of the project.

168. The project resulted in the destruction of 24,744 kgs (24.74 mt) and reported an expenditure of 100 per cent of the approved US $1,490,600, plus agency support costs, resulting in a cost-effectiveness of US $60/kg of ODS wastes destroyed.

Secretariat's comments

169. The Secretariat noted that the final report included the following aspects of decision 58/19:

(a) The estimated amount of ODS that was eventually destroyed by the project;

(b) Descriptions of collection systems, especially where the Multilateral Fund projects were in synergy with other projects;

(c) Detailed steps of the overall process; and

(d) The main challenges encountered and how they were addressed, and lessons learned so far in undertaking the pilot project.

170. In explaining why, the target was not met for ODS waste expected to be destroyed, UNDP noted that this was primarily due to the pandemic, which negatively impacted the collection from the reclamation centres. In addition, Essencis was required to lower its feed limit for destruction of ODS for safety reasons

[25] Ecosuporte Soluções em Gestão Ambiental, Frigelar, Northeast Regeneration and Recycling Center (CRN) and Recigases.
[26] Additional large capacity cylinders (1,000 lbs) were provided.
[27] Refrigerant identifiers, collectors, leak detectors and other equipment and tools.

after burn test emissions exceeded the limits for dioxins and furans, which was resolved after the adjustment.

171. The resulting cost-effectiveness of US $60/kg of ODS waste destroyed is higher than the anticipated US $12.42/kg approved for the project at the 72nd meeting.[28]

Recommendation

172. The Executive Committee may wish to note the final report on the pilot demonstration project on ODS waste management and disposal for Brazil, submitted by UNDP, and attached to document UNEP/OzL.Pro/ExCom/92/9.

D. Reports on low-GWP projects

Saudi Arabia: Demonstration project on promoting hydrofluoroolefin-based low-global-warming-potential refrigerants for the air-conditioning sector in high ambient temperatures (final progress report) (UNIDO)

Background

173. The demonstration project was approved at the 76th meeting to manufacture, test, and optimize pilot model air-conditioning (AC) units with low-global-warming-potential (GWP) hydrofluoroolefin (HFO)/HFC blends, as well as R-290, to undertake a demonstration production run and to convert a production line, at the amount of US $1,300,000, plus agency support costs of US $91,000 for UNIDO.

174. The project was originally expected to be completed by May 2018. Between the 80th and 88th meetings,[29] the Executive Committee decided to extend the project four times in light of constraints imposed by the COVID-19 pandemic, the potential replicability of the results in several Article 5 countries, and the progress achieved, which included *inter alia* delivery of the manufacturing equipment, moving the manufacturing line and installation of the manufacturing equipment and a quality control system, upgrade of the laboratories and testing rooms, completion of civil works, and testing and optimization of the R-290 units.[30]

175. At the 90th meeting, it was reported that, while commissioning of the manufacturing line and delivery of safety components for the laboratories had been completed, and R-290 compressors delivered, the certification of R-290 AC units had not yet been finalized, as the enterprise was continuing to optimize the equipment design to ensure the charge remained at 500 g/unit while achieving an energy efficiency ratio (EER) at least 5 per cent higher than the minimum energy performance standards. An international expert would visit the enterprise to provide technical assistance for the model design and verification, after which the certification of the R-290 AC units and the servicing manual could be finalized; in addition, third-party safety testing of the R-290 AC units would be conducted, and promotion of R-290 AC equipment and a dissemination workshop were planned. Accordingly, the Executive Committee decided to extend the completion date of the project to 30 September 2022 given the advanced progress achieved, and to request UNIDO to submit the final report of the project and to return all remaining balances by the 92nd meeting (decision 90/20).

[28] Decision 72/28

[29] As further detailed in documents UNEP/OzL.Pro/ExCom/88/18 and UNEP/OzL.Pro/ExCom/90/9.

[30] At the 83rd meeting, it was reported that based on the testing by the enterprise, as well as results from the demonstration project on promoting refrigerant alternatives for high-ambient-temperature countries (PRAHA-II), the enterprise decided to focus its production on R-290-based equipment, though future use of HFO and HFO blends could not be excluded.

176. In line with decision 90/20(c), and on behalf of the Government of Saudi Arabia, UNIDO submitted to the 92nd meeting the final progress report on the demonstration project on promoting HFO-based low-GWP refrigerants for the AC sector in high ambient temperatures. The final report is attached to the present document.

Progress report

177. Testing and optimization of the R-290 units continued: additional prototypes were tested; laboratory testing at the manufacturer was upgraded and accredited by the Saudi Standards, Metrology and Quality Organization (SASO) technical regulation, resulting in higher testing accuracy; and two rooms with variable conditions were set up for practical testing of the units. A final product was developed, a mini-split R-290 AC unit with optimum refrigerant charge of 500 g; further, the unit has an EER of 12.2 and cooling capacity of 17.60 BTU/h which, compared to the high-GWP base unit, is an improvement to the EER but with a 5 per cent lower cooling capacity. In light of the laboratory achieving SASO accreditation and the unit meeting SASO standards, third-party safety testing of the R-290 AC units was no longer necessary. The unit received the certification necessary for production and entering the market.

178. The production line and heat exchanger testing facility were prepared with modifications required for mass production, including safety assessments, and changes to the charging, testing, and production process were implemented. The enterprise estimates a production capacity of 300,000 units per year.

179. A servicing manual and training materials were developed and finalized; the trainers, managers, and technicians of the enterprise were trained on manufacturing the new equipment and on good and safe practices when handling R-290. The test rooms were also used as part of the training to promote the R-290 AC equipment and disseminate information on the project results.

180. Of the US $1,300,000 approved, US $1,188,813 was disbursed. UNIDO confirmed it had initiated the process for financial closure but had been unable to complete it in time for the 92nd meeting. Accordingly, the balance of US $111,187, plus agency support costs of US $7,783, will be returned to the 93rd meeting.

Secretariat's comments

181. Notwithstanding challenges in implementing the project due to the COVID-19 pandemic and numerous delays, the project was successfully completed. In particular, the Secretariat noted that the project successfully demonstrated the conversion of an AC manufacturing line from HCFC-22 to R-290, including by assisting the enterprise to establish the supply chain for necessary materials and components, including 5 mm inner-grooved copper tubing and a 60 Hertz[31] compressor suitable for use at high ambient temperature conditions, and the testing and optimization of a 1.5 tonnes of refrigeration (TR) split AC, the most common unit sold in the market in Saudi Arabia. Relative to R-410A-based equipment, the R-290-based unit achieved a better EER and, notwithstanding the slightly lower cooling capacity, was able to better achieve test room set temperatures, including when the outside temperature was above 30 °C.

Recommendation

182. The Executive Committee may wish to note the final progress report on the demonstration project on promoting hydrofluoroolefin-based low-global-warming-potential refrigerants for the air-conditioning sector in high ambient temperatures in Saudi Arabia, submitted by UNIDO in line with decision 90/20(c), and contained in document UNEP/OzL.Pro/ExCom/92/9.

[31] The power supply in Saudi Arabia is 220 Volts alternating current/60 Hertz.

II.3 Individual consideration

183. This section includes two reports for individual consideration.

A. Report related to decision 83/41(e)

China: Report on progress in the implementation of activities listed in decision 83/41(e)

Introduction

184. At its 83rd meeting, the Executive Committee considered the following two documents:

(a) Review of current monitoring, reporting, verification and enforcement (MRVE) systems in accordance with HCFC consumption and production phase-out management plan Agreements between the Government of China and the Executive Committee, submitted by UNDP on behalf of the Government of China in line with decisions 82/65 and 82/71(a); and

(b) Desk study on the current system of monitoring consumption of foam-blowing agents at enterprises assisted under stage I of the HCFC phase-out management plan and verification methodology, submitted by the World Bank on behalf of the Government of China in line with decision 82/67(c).

185. In its deliberations, the Committee *inter alia* welcomed a number of regulatory and enforcement actions to be undertaken by the Government; noted with appreciation that the Government will undertake additional actions in support of its enforcement actions; and further noted with appreciation that the Government will consider a set of suggestions to supplement and augment its regulatory and enforcement actions. The Executive Committee also noted that the Government of China would submit a report to the 84th meeting, and again to the 86th meeting, on its progress in implementing the activities described in sub-paragraphs (a) to (d) of decision 83/41.

186. At its 84th meeting, the Executive Committee considered the progress report submitted by the Government of China in line with decision 83/41(e)[32] and subsequently took note of the information provided by the representative of the Government of China regarding implementation of the activities listed in decision 83/41. Pursuant to decision 83/41, the Government of China then submitted to the 86th meeting a progress report, consideration of which was deferred to each subsequent meeting until the 91st meeting.[33]

187. At its 91st meeting, the Executive Committee considered the reports on projects with specific reporting requirements pertaining to China,[34] including the report on progress in the implementation of activities listed in decision 83/41(e), the study to determine the regulatory, enforcement, policy or market circumstances that might have led to the illegal production and use of CFC-11 and CFC-12 (decision 83/41(d)), and the updated report on the production of CTC and its feedstock uses in China (decision 84/41(b) and (c)). Following an exchange in plenary, the Executive Committee agreed to discuss the document further in an informal group.

188. Subsequently, it was reported that the informal group had had a useful exchange of information. The representative of China had indicated that the country continued to make progress on implementation of the activities listed in decision 83/41, including that a network of atmospheric monitoring stations was being established, and confirmed that the data collected would be shared with the international scientific

[32] UNEP/OzL.Pro/ExCom/84/22/Add.1
[33] Deferred at the 87th, 88th, and 90th meetings in accordance with the agreed procedures for conducting those meeting and at the 90th meeting on account of the online participation of key representatives of one member's delegation.
[34] UNEP/OzL.Pro/ExCom/91/18/Add.1

community. China had also indicated that increased feedstock use of carbon tetrachloride had not led to a substantial increase in emissions as the processes were very well managed by producers. China had expressed its willingness to continue, at the 92nd meeting, discussions on matters related to its implementation of the activities described in decision 83/41.

189. The Executive Committee agreed to continue, at the 92nd meeting, its discussions on the report on progress in the implementation of activities listed in decision 83/41(e) and on any updates that the Government of China might wish to provide regarding its progress in implementing the activities described in decision 83/41.

190. The progress report is attached in its entirety to the present document without editing or further review.

B. Reports related to HFCs

Argentina: Control of emissions of HFC-23 generated in the production of HCFC-22 (UNIDO)

Background

191. At its 87th meeting, the Executive Committee approved the project for the control of emissions of HFC-23 generated in the production of HCFC-22 at Frio Industrias Argentina (FIASA) (decision 87/52(b)), followed by, at its 88th meeting, approval of the draft Agreement (decision 88/77(c)) and 2021-2022 annual implementation plan (decisions 87/52(f) and 88/77(b)).

192. The 2021-2022 annual implementation plan *inter alia* anticipated that any HFC-23 by-product generated after 1 January 2022 and before the completion of the refurbishment of the incinerator would be stored in the on-site cryogenic tank until the maximum capacity of the cryogenic tank had been reached. UNIDO noted that in case of unforeseen delays caused by *force majeure*, such as the COVID-19 pandemic, FIASA, the Government of Argentina, and UNIDO would immediately inform the Executive Committee and propose HFC-23 emission mitigation measures.[35]

193. At the 90th meeting, UNIDO reported delays finalizing a contract for the refurbishment of the incinerator. The cryogenic storage tank could have been used to store HFC-23 by-product while the incinerator refurbishment was ongoing at FIASA; however, due to concern by the Government that the cryogenic tank would reach its maximum capacity before the refurbishment was complete, FIASA had not connected the cryogenic tank, and HFC-23 had been vented to the atmosphere between January 2022 and March or April 2022 when it was reconnected. In March 2022, FIASA had also temporarily stopped producing HCFC-22 due to challenges in purchasing raw materials given supply chain disruptions. It was agreed that once the enterprise restarted production of HCFC-22, it would store the HFC-23 by-product generated in the cryogenic tank until the refurbishment of the incinerator was complete or the maximum capacity of the cryogenic tank was reached, as originally planned.

194. At the 91st meeting, UNIDO reported that the cryogenic tank was connected and storing the HFC-23 by-product generated, and that there had been no further emissions of HFC-23 vented to the atmosphere beyond those reported to the 90th meeting. FIASA resumed production of HCFC-22 in June 2022. From then until September 2022, production of HCFC-22 at the enterprise had been intermittent due to delays in the supply of anhydrous hydrogen fluoride caused by supply chain disruptions. HFC-23 by-product generated during that period of intermittent production was stored in the cryogenic tank. Many but not all the parts needed to refurbish the incinerator had been delivered: the natural gas flow control and block valves, purchased directly by FIASA, were expected to arrive in November 2022, and some parts from SGL

[35] Paragraph 5 of document UNEP/OzL.Pro/ExCom/88/77.

Carbon Group of Meitingen, Germany (SGL), the technology provider for the incinerator, were delayed as the required documentation to initiate the diplomatic franchise process would not be provided until October 2022; it was expected that delivery of those parts would take up to three months. After the delivery of the natural gas flow control and block valves, FIASA planned to start the incinerator with local parts while waiting for the shipment from SGL to arrive and expected to operationalize the incinerator by December 2022.

Progress report submitted to the 92nd meeting

195. In line with decision 90/24, the Government of Argentina, through UNIDO, has submitted a progress report to the 92nd meeting. The report confirms that the cryogenic tank is storing the HFC-23 by-product generated, and that there have been no further emissions of HFC-23 vented to the atmosphere beyond those reported to the 90th meeting; however, the incinerator is not yet operational. While the natural gas flow control and block valves were delivered, the shipment from SGL was not yet delivered, and testing of the local parts revealed they were not sufficient for use with the incinerator. The documents required for the diplomatic franchise were sent on 19 January 2023 and were processed by the Government; delivery of those parts was expected by mid-June 2023, after which the programmable logic controller (PLC) sensor will be installed and test runs (without and with flame ignition) undertaken. Accordingly, the incinerator was expected to be operational by the end of June 2023.

196. The enterprise increased production of HCFC-22 from November to January 2023, which aligns with the Argentine summer and increased demand; produced HCFC-22 in February 2023 at a reduced rate; and temporarily ceased production in March 2023. Given the enterprise's production of 964.93 mt of HCFC-22 since the cryogenic tank was reconnected, the maximum capacity of the storage tank was not reached. As of March 2023, an estimated 2.08 mt of capacity remained and 29.87 mt of HFC-23 by-product was stored in the cryogenic tank.

Secretariat's comments

197. Notwithstanding the challenges faced in the implementation of the project, no further HFC-23 by-product has been emitted to the atmosphere. Noting that the shipment from SGL was expected to arrive by mid-June 2023; the only steps remaining to complete the refurbishment of the incinerator once the shipment from SGL arrives are to install the PLC sensor and do the test runs; and that the incinerator was expected to be in operational by the end of June 2023, the Secretariat requested and FIASA provided a written commitment to the Government of Argentina confirming that the enterprise will not vent HFC-23 by-product to the atmosphere should there be a further delay in completing the refurbishment of the incinerator, and that the enterprise would temporarily cease producing HCFC-22 if the maximum capacity of the cryogenic tank was reached until the incinerator was operational.[36]

Recommendation

198. The Executive Committee may wish:

(a) To note the progress report on the implementation of the project for the control of emissions of HFC-23 generated in the production of HCFC-22 at Frio Industrias Argentina, submitted by UNIDO, and contained in document UNEP/OzL.Pro/ExCom/92/9; and

[36] As per the letter of 20 April 2023 from Frio Industrias Argentina to UNIDO.

(b) To request UNIDO, on behalf of the Government of Argentina, to provide a report on the implementation of the project referred to in sub-paragraph (a) above to the second meeting of 2023 that includes the quantity of HFC-23 by-product generated, stored and vented to the atmosphere.

Annex I

PROJECTS THAT ARE CLASSIFIED AS "SOME PROGRESS" AND ARE RECOMMENDED FOR CONTINUED MONITORING

Country	Code	Project title	Agency
Algeria	ALG/PHA/66/INV/76	HCFC phase-out management plan (stage I, first tranche) (conversion from HCFC-22 in the manufacture of room air conditioners at Condor)	UNIDO
Algeria	ALG/PHA/66/INV/77	HCFC phase-out management plan (stage I, first tranche) (activities in the refrigeration servicing sector including phase-out of HCFC-141b used for flushing, and project monitoring)	UNIDO
Bangladesh	BGD/PHA/81/TAS/50	HCFC phase-out management plan (stage II, first tranche) (refrigeration servicing sector)	UNEP
Bosnia and Herzegovina	BHE/PHA/82/INV/36	HCFC phase-out management plan (stage I, fourth tranche) (activities in the refrigeration servicing sector including policy actions)	UNIDO
Bosnia and Herzegovina	BHE/PHA/72/INV/29	HCFC phase-out management plan (stage I, second tranche) (activities in the refrigeration servicing sector including policy actions)	UNIDO
Bosnia and Herzegovina	BHE/PHA/76/INV/33	HCFC phase-out management plan (stage I, third tranche) (activities in the refrigeration servicing sector including policy actions)	UNIDO
Botswana	BOT/PHA/75/INV/18	HCFC phase-out management plan (stage I, first tranche)	UNIDO
Botswana	BOT/PHA/82/INV/21	HCFC phase-out management plan (stage I, second tranche)	UNIDO
Cambodia	KAM/PHA/83/INV/36	HCFC phase-out management plan (fourth tranche)	UNDP
Cameroon	CMR/PHA/82/INV/45	HCFC phase-out management plan (stage II, first tranche)	UNIDO
Chile	CHI/PHA/76/TAS/191	HCFC phase-out management plan (stage II, first tranche) (refrigeration servicing sector)	UNEP
Chile	CHI/PHA/81/TAS/196	HCFC phase-out management plan (stage II, second tranche) (refrigeration servicing sector)	UNIDO
China	CPR/PHA/77/INV/574	HCFC phase-out management plan (stage II, first tranche) (room air-conditioner manufacturing sector plan)	Italy
China	CPR/PHA/77/INV/576	HCFC phase-out management plan (stage II, first tranche) (room air-conditioner manufacturing sector plan)	UNIDO
China	CPR/PHA/81/INV/588	HCFC phase-out management plan (stage II, second tranche) (room air-conditioner manufacturing sector plan)	UNIDO
Dominica	DMI/PHA/62/TAS/19	HCFC phase-out management plan (stage I, first tranche)	UNEP
Dominica	DMI/SEV/80/TAS/01+	Enabling activities for HFC phase-down	UNEP
Kuwait	KUW/PHA/74/INV/24	HCFC phase-out management plan (stage I, second tranche) (polyurethane foam sector phase-out: Kuwait polyurethane Industry Co.; Kirby Building Systems, technical assistance to spray foam users and other small users)	UNIDO
Kuwait	KUW/PHA/74/INV/25	HCFC phase-out management plan (stage I, second tranche) (extruded polystyrene foam sector phase-out: Gulf Insulating Materials Manufacturing and Trading; Isofoam Insulating Materials Plants; and Al Masaha Company)	UNIDO
Kuwait	KUW/PHA/83/INV/36	HCFC phase-out management plan (stage I, third tranche) (polyurethane foam sector phase-out)	UNIDO
Mozambique	MOZ/PHA/83/INV/31	HCFC phase-out management plan (stage I, third and fourth tranches)	UNIDO
Nauru	NAU/PHA/74/TAS/10	HCFC phase-out management plan for PIC countries through regional approach (stage I, second tranche, Nauru)	UNEP
Philippines (the)	PHI/PHA/83/INV/104	HCFC phase-out management plan (stage II, first tranche) (air-conditioning sector)	UNIDO

Country	Code	Project title	Agency
Philippines (the)	PHI/PHA/83/TAS/105	HCFC phase-out management plan (stage II, first tranche) (refrigeration servicing sector)	UNIDO
Saint Kitts and Nevis	STK/PHA/74/TAS/20	HCFC phase-out management plan (stage I, second tranche)	UNEP
Saint Vincent and the Grenadines	STV/SEV/80/TAS/01+	Enabling activities for HFC phase-down	UNEP
Suriname	SUR/SEV/80/TAS/01+	Enabling activities for HFC phase-down	UNEP
Türkiye	TUR/PHA/75/INV/107	HCFC phase-out management plan (stage I, second tranche) (refrigeration servicing and monitoring)	UNIDO
Türkiye	TUR/PHA/84/INV/111	HCFC phase-out management plan (stage I, third tranche) (refrigeration servicing and monitoring)	UNIDO

Annex II

PROJECTS THAT ARE CLASSIFIED AS "NO PROGRESS" AND ARE RECOMMENDED FOR CONTINUED MONITORING

Country	Code	Project title	Agency
Botswana	BOT/PHA/82/TAS/22	HCFC phase-out management plan (stage I, second tranche)	UNEP
Brunei Darussalam	BRU/PHA/82/TAS/24	HCFC phase-out management plan (stage I, third tranche)	UNEP
Chile	CHI/PHA/81/TAS/195	HCFC phase-out management plan (stage II, second tranche) (refrigeration servicing sector)	UNEP
Dominica	DMI/PHA/84/TAS/25	HCFC phase-out management plan (stage I, second tranche)	UNEP
Myanmar	MYA/PHA/80/INV/19	HCFC phase-out management plan (stage I, second tranche)	UNIDO
Saudi Arabia	SAU/PHA/77/INV/31	HCFC phase-out management plan (stage I, fourth tranche) (polyurethane foam sector plan)	UNIDO
Saint Vincent and the Grenadines	STV/PHA/75/TAS/23	HCFC phase-out management plan (stage I, second tranche)	UNEP

Annex III

PROJECTS THAT ARE CLASSIFIED AS "NO PROGRESS" AND ARE RECOMMENDED FOR LETTER OF POSSIBLE CANCELLATION

Country	Code	Project title	Agency
Afghanistan	AFG/PHA/79/INV/22	HCFC phase-out management plan (stage I, third tranche)	UNIDO
Myanmar	MYA/PHA/68/TAS/14	HCFC phase-out management plan (stage I, first tranche)	UNEP
Myanmar	MYA/PHA/80/TAS/18	HCFC phase-out management plan (stage I, second tranche)	UNEP

Annex IV

PROJECTS FOR WHICH ADDITIONAL STATUS REPORTS ARE REQUESTED

Country	Code	Project title	Agency	Recommendation
Afghanistan	AFG/PHA/85/TAS/27	HCFC phase-out management plan (stage I, fourth tranche)	UNEP	To request UNEP to submit a status report to the 93rd meeting on implementation progress including updates on the resumption of activities
Afghanistan	AFG/PHA/85/TAS/29	HCFC phase-out management plan (stage II, first tranche)	UNEP	To request UNEP to submit a status report to the 93rd meeting on implementation progress including updates on the resumption of activities
Afghanistan	AFG/PHA/85/INV/28	HCFC phase-out management plan (stage I, fourth tranche)	UNIDO	To request UNIDO to submit a status report to the 93rd meeting on implementation progress including updates on the resumption of activities
Afghanistan	AFG/PHA/85/INV/30	HCFC phase-out management plan (stage II, first tranche)	UNIDO	To request UNIDO to submit a status report to the 93rd meeting on implementation progress including updates on the resumption of activities
Afghanistan	AFG/SEV/87/INS/31	Extension of institutional strengthening project (phase X: 1/2022-12/2023)	UNEP	To request UNEP to submit a status report to the 93rd meeting on implementation progress including updates on the resumption of activities
Antigua and Barbuda	ANT/PHA/73/PRP/17	Preparation of a HCFC phase-out management plan (stage II)	UNEP	To request UNEP to submit a status report to the 93rd meeting on the status of preparation of stage II of the HPMP
Antigua and Barbuda	ANT/SEV/73/INS/16	Extension of institutional strengthening project (phase V: 1/2015-12/2016)	UNEP	To request UNEP to submit a status report to the 93rd meeting on the status of submission of progress and financial reports
Central African Republic (the)	CAF/SEV/68/INS/23	Extension of the institutional strengthening project (phase VI: 1/2013-12/2014)	UNEP	To request UNEP to submit a status report to the 93rd meeting on the status of submission of progress and financial reports and completion of the project
Dominica	DMI/PHA/86/TAS/26	Verification report on the implementation of stage I of the HCFC phase-out management plan	UNEP	To request UNEP to submit a status report to the 93rd meeting on the status of preparation of verification reports
Dominica	DMI/SEV/81/INS/24	Extension of the institutional strengthening project (phase VII: 6/2018-5/2020)	UNEP	To request UNEP to submit a status report to the 93rd meeting on the status of submission of progress and financial reports
Mali	MLI/PHA/84/PRP/42	Preparation of a HCFC phase-out management plan (stage II)	UNEP	To request UNEP to submit a status report to the 93rd meeting on the status of preparation of stage II of the HPMP
Myanmar	MYA/PHA/83/PRP/21	Preparation of a HCFC phase-out management plan (stage II)	UNEP	To request UNEP to submit a status report to the 93rd meeting on implementation progress including updates on the resumption of activities

Country	Code	Project title	Agency	Recommendation
Myanmar	MYA/PHA/86/TAS/23	HCFC phase-out management plan (stage I, third tranche)	UNEP	To request UNEP to submit a status report to the 93rd meeting on implementation progress including updates on the resumption of activities
Myanmar	MYA/PHA/86/TAS/24	Verification report on the implementation of the HCFC phase-out management plan	UNEP	To request UNEP to submit a status report to the 93rd meeting on implementation progress including updates on the resumption of activities
Myanmar	MYA/SEV/84/INS/22	Extension of institutional strengthening project (phase V: 7/2020-6/2022)	UNEP	To request UNEP to submit a status report to the 93rd meeting on implementation progress including updates on the resumption of activities
Myanmar	MYA/PHA/83/PRP/20	Preparation of a HCFC phase-out management plan (stage II)	UNIDO	To request UNIDO to submit a status report to the 93rd meeting on implementation progress including updates on the resumption of activities
South Sudan	SSD/SEV/76/INS/03	Institutional strengthening project (phase I: 5/2016-4/2018)	UNEP	To request UNEP to submit a status report to the 93rd meeting on the status of the signing of the small-scale funding agreement and first disbursement

Annex V

TEXT TO BE INCLUDED IN THE UPDATED AGREEMENT BETWEEN THE GOVERNMENT OF THE ISLAMIC REPUBLIC OF IRAN AND THE EXECUTIVE COMMITTEE OF THE MULTILATERAL FUND FOR THE REDUCTION IN CONSUMPTION OF HYDROCHLOROFLUOROCARBONS IN ACCORDANCE WITH STAGE II OF THE HCFC PHASE-OUT MANAGEMENT PLAN

17. This updated Agreement supersedes the Agreement reached between the Government of the Islamic Republic of Iran and the Executive Committee at the **90th** meeting of the Executive Committee.

APPENDIX 2-A: THE TARGETS, AND FUNDING

Row	Particulars	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
1.1	Montreal Protocol reduction schedule of Annex C, Group I substances (ODP tonnes)	342.4	342.4	342.4	342.4	247.33	247.33	247.33	247.33	247.33	n/a
1.2	Maximum allowable total consumption of Annex C, Group I substances (ODP tonnes)	342.45	342.45	266.35	266.35	247.33	247.33	247.33	95.13	95.13	n/a
2.1	Lead IA (UNDP) agreed funding (US $)	1,298,170	0	1,593,980	0	1,307,980	0	**1,300,503**	**337,860**	0	**5,838,493**
2.2	Support costs for Lead IA (US $)	90,872	0	111,579	0	91,559	0	**91,035**	**23,650**	0	**408,695**
2.3	Cooperating IA (UNIDO) agreed funding (US $)	473,567	0	584,000	0	524,000	0	0	521,638	0	2,103,205
2.4	Support costs for Cooperating IA (US $)	33,150	0	40,880	0	36,680	0	0	36,515	0	147,224
2.5	Cooperating IA (UNEP) agreed funding (US $)	200,000	0	190,000	0	170,000	0	0	140,000	0	700,000
2.6	Support costs for Cooperating IA (US $)	24,857	0	23,614	0	21,129	0	0	17,400	0	87,000
2.7	Cooperating IA (Germany)* agreed funding (US $)	645,500	0	**954,018**	0	**139,754**	0	**0**	**0**	0	**1,739,272**
2.8	Support costs for Cooperating IA (US $)	73,420	0	**111,723**	0	**16,176**	0	**0**	**0**	0	**201,320**
2.9	Cooperating IA (Italy) agreed funding (US $)	403,203	0	504,004	0	0	0	0	0	0	907,207
2.1	Support costs for Cooperating IA (US $)	48,797	0	60,996	0	0	0	0	0	0	109,793

Row	Particulars	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
3.1	Total agreed funding (US $)	3,020,440	0	**3,826,002**	0	**2,141,734**	0	**1,300,503**	**999,498**	0	11,288,177
3.2	Total support costs (US $)	271,096	0	**348,792**	0	**165,544**	0	**91,035**	**77,565**	0	**954,032**
3.3	Total agreed costs (US $)	3,291,536	0	**4,174,794**	0	**2,307,278**	0	**1,391,538**	**1,077,063**	0	**12,242,209**
4.1.1	Total phase-out of HCFC-22 agreed to be achieved under this Agreement (ODP tonnes)										71.27
4.1.2	Phase-out of HCFC-22 to be achieved in the previous stage (ODP tonnes)										38.6
4.1.3	Remaining eligible consumption for HCFC-22 (ODP tonnes)										53.73
4.2.1	Total phase-out of HCFC-141b agreed to be achieved under this Agreement (ODP tonnes)										91.1
4.2.2	Phase-out of HCFC-141b to be achieved in the previous stage (ODP tonnes)										125.8
4.2.3	Remaining eligible consumption for HCFC-141b (ODP tonnes)										0.0

*** The Government of Germany ceased being the cooperating agency for stage II of the HPMP at the 92nd meeting. Unused balances from the second, third and fourth trances as well as the entire funding approved in principle for the fifth tranche were transferred to UNDP.**

BRAZIL

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

FINAL PROGRESS REPORT

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prepared by

MINISTRY OF THE ENVIRONMENT AND CLIMATE CHANGE

supported by

UNITED NATIONS DEVELOPMENT PROGRAM (UNDP)

APRIL 2023

Abbreviations

ABNT - Brazilian Association of Technical Standards

CADRI - Certificate of Movement of Waste of Environmental Interest

CETESB - Environmental Company of São Paulo State

CFC - Chlorofluorocarbon

COVID-19 – Coronavirus Disease 2019

RC- Reclaim Center

CRN - Northeast Regeneration and Recycling Center

CTC - Carbon Tetrachloride

CPE - Collective Protection Equipment

PPE - Personal Protective Equipment

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

MLF - Multilateral Fund for the Implementation of the Montreal Protocol

GWP - Global Warming Potential

HCFC - Hydrochlorofluorocarbons

HFC – Hydrofluorocarbon

HPMP – HCFC Phase-out Management Plan

Ibama - Brazilian Institute of Environment and Renewable Resources

EOI- Expression of Interest

MMA - Ministry of the Environment

MoU - Memorandum of Understanding

ODP - Ozone Depletion Potential

NPP – National CFC Phase-out Management Plan

UNDP - United Nations Development Program

PU - Polyurethane Foams

RAC - Refrigeration and Air Conditioning

EPR - Extended Producer Responsibility

ODS – Ozone Depleting Substance

TEAP - Technical and Economic Assessment Panel

DRU - Decentralized Recycling Unit

NOU - National Ozone Unit

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1 INTRODUCTION

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

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

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

1.1 Historical background

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

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

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

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

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

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

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

1.2 Project context

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

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

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

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

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

2 PROJECT SCOPE

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

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

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

2.1 Project Components

The project design established four components, namely:

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

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

3 PROJECT IMPLEMENTATION

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

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

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

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

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

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

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

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

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

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

3.1 ODS Waste Management System - results achieved

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

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

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

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

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

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

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

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

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

3.1.1 Increased ODS storage capacity

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

3.1.2 Improvements to the regeneration operation by RC

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Date: 11/17 and 18/2022.

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

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

3.1.5 Strengthening / Consolidation of the Integrated ODS Waste Management System

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

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

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

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

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

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

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

3.2 Destruction of ODS - results achieved

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

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

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

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

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

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

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

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

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

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

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

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

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

3.2.1 Installation License for adjustments to the incinerator

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

3.2.2 Incinerator adjustments

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

a) Installation of gas supply system,

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

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

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

a) Installation of the gas supply system

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3.2.3 Burn Test

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

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

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

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

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

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

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

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

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

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

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

Table 1 – Feed rate by parameter

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

5. Carry out Burn Test every two years.

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

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

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

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

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

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

I - Waste feeding rate in each chamber,

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

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

IV – Outflow of the gaseous effluent in the chimney,

V - Pressure in the chambers,

VI - Furnace rotation; and

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

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

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

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

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

III. Gases:

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

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

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

3.2.4 CETESB Operating License for thermal destruction of ODS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Table 5 - Feed rate by parameter

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

(*) New feed rates.

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

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

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

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

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

3.2.5 Destruction of ODS identified by the project

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

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

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

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

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

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

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

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

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

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

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

3.4 Counterpart

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

Table 8 – Counterpart of the Reclaim Centers

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

Table 9 – Counterpart of the enterprise Essencis

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

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

3.5 Financial Execution

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

Table 10 – Financial Execution of the Project

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

4 LESSONS LEARNED

4.1 Challenges

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

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

4.2 Lessons Learned

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

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

5 APPENDIX I

6 ANNEXES

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

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

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

6.4 Annex IV - Decision ExCom 58/19

6.5 Annex V - Decision ExCom 57/19

6.6 Annex VI - Approved Project

6.7 Annex VII - Expression of Interest 32016 of 2017

6.8 Annex VIII - Expression of Interest 30431 of 2017

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

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

6.11 Annex XI - Results of the 2019 Burning Tests

6.12 Annex XII - Results of the 2021 Burning Tests

6.13 Annex XIII - Results of the 2022 Burning Tests

6.14 Annex X - Waste Destruction Certificate

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

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

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

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

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

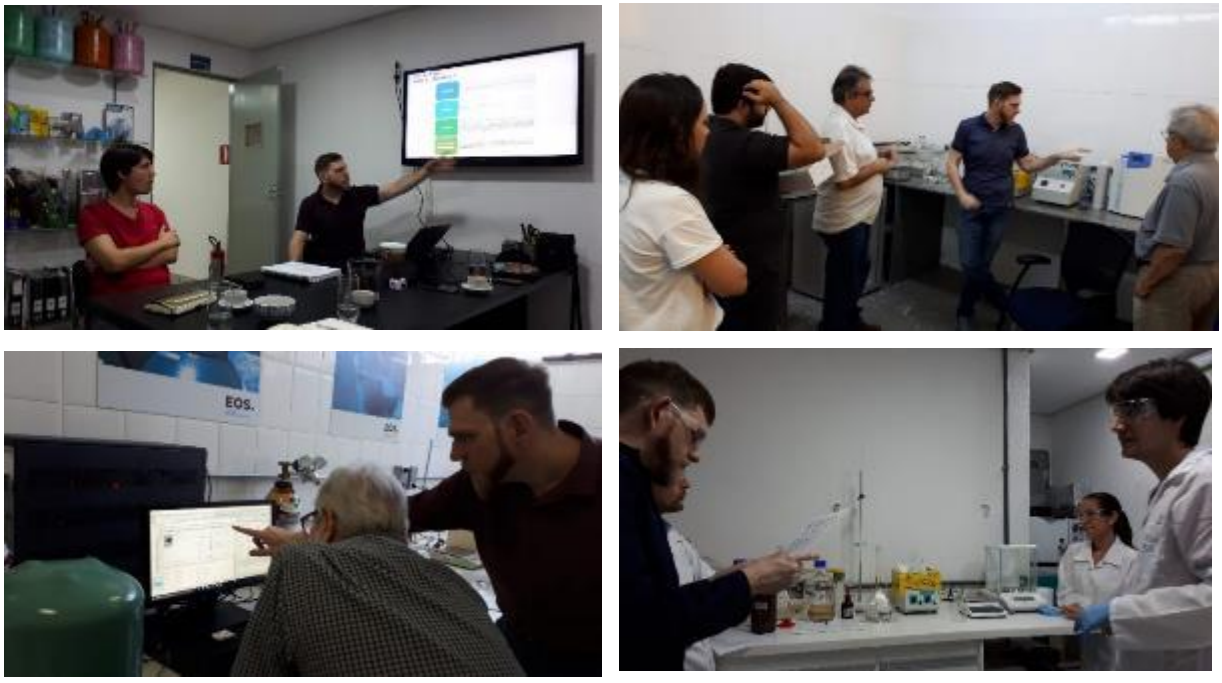


Figure 6 – Equipment, accessories and glassware acquired under the Project.

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

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

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

Figure 10 – Cyclone: before and after installation.

Figure 11 – Bag filter: before and after installation.

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

Figure 13 – Transport of cylinders.

Report

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

SAU/REF/76/DEM/28

Final report Dec 2022

Table of content

1. Introduction

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

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

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

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

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

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

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

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

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

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

2. Research and Development

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

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

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

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

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

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

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

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

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

Compressor development

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

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

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

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

Split unit Development

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

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

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

[3] HAT High Ambient Temperature

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

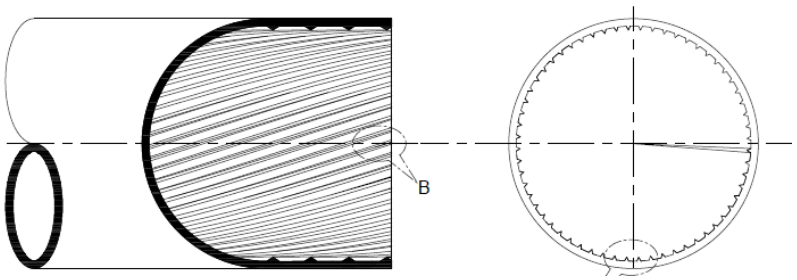


Figure 1. Inner grooved copper tubing

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

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

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

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

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

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

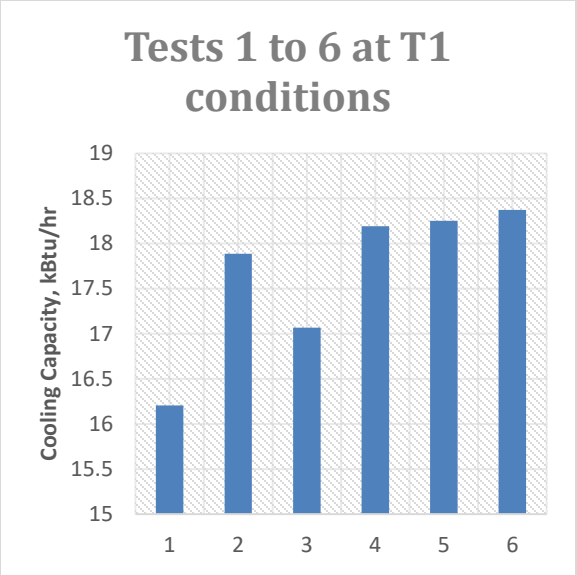
Date	06 October 2019	**2**
Model	DS18CE7HY7HC-290 / DSA120FE7HY7CL (TCL)	
Compressor	DSG280N1VKT S# 906000002K (GMCC)	
Comments	60 Hz – changed indoor unit	

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

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

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

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



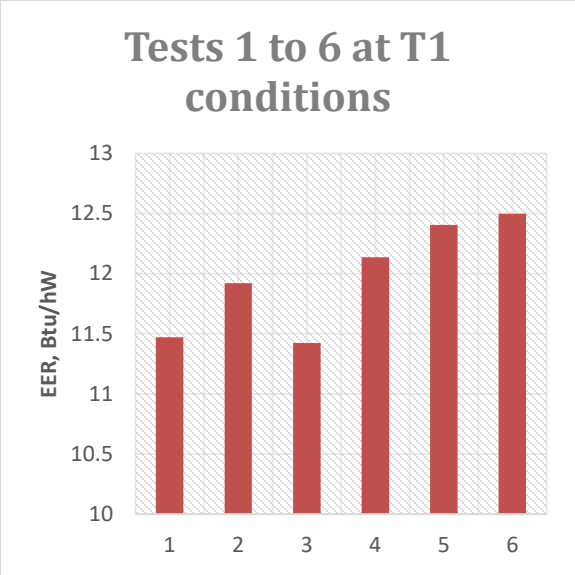
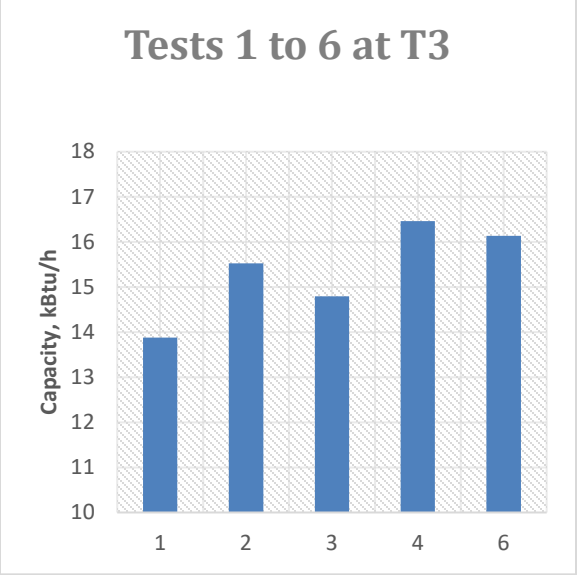


Figure 2. Cooling capacity (Left) and EER (Right) for the different tests at T1 conditions

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



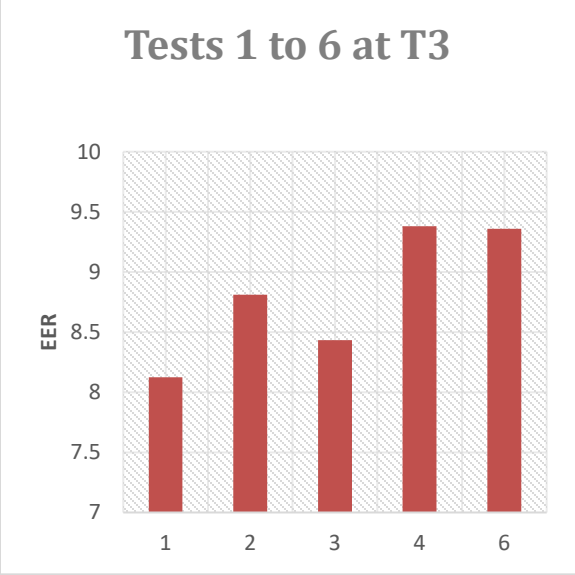


Figure 3. Cooling capacity (Left) and EER (Right) for the different tests at T3 conditions

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

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

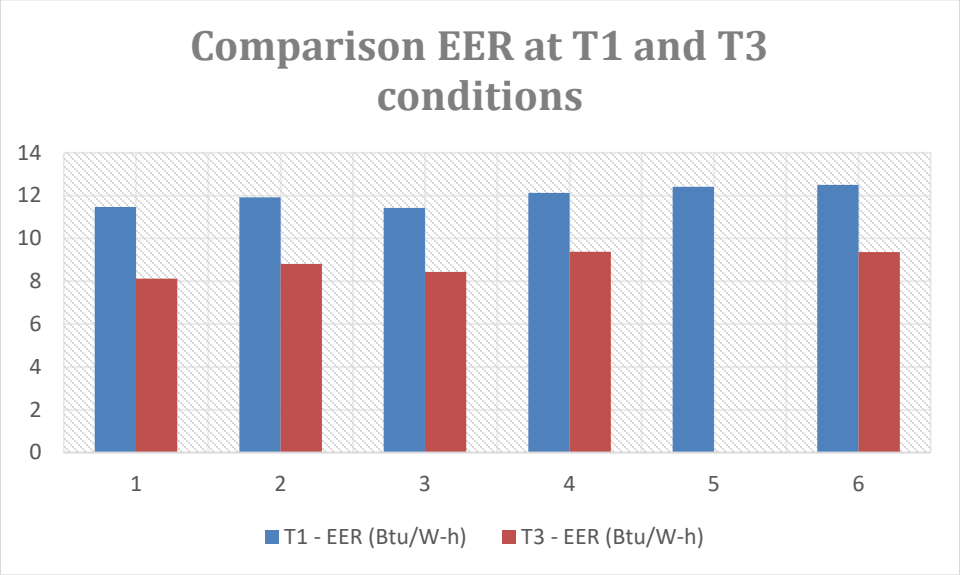


Figure 4. Comparison between EER at T1 and T3 for the different tests.

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

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

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

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

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

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

3. Laboratory development / G-Mark certification

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

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

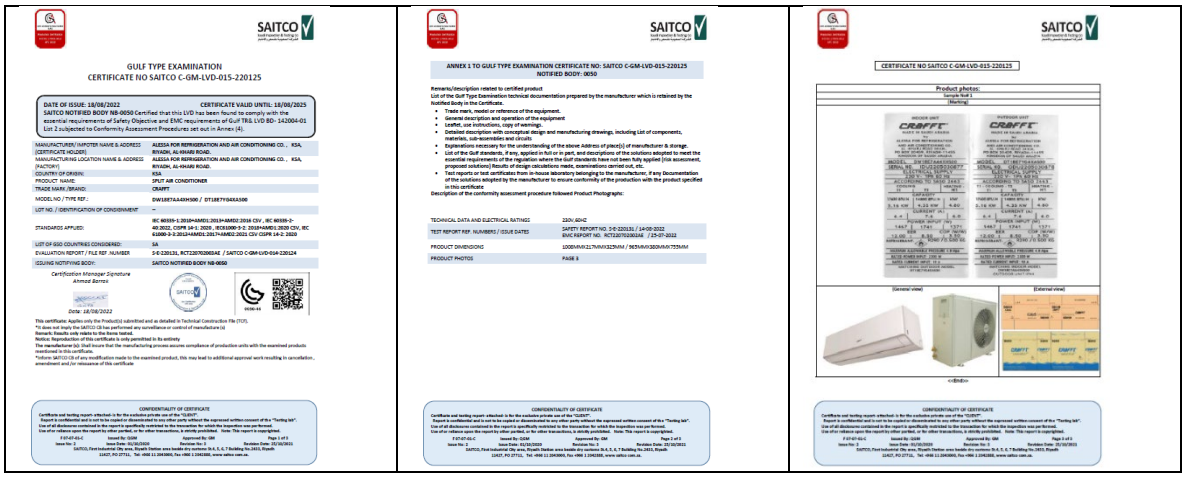
Figure 5: Alessa laboratory Certificate of Accreditation IAS and SAC

G-Mark certification

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

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

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


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

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

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

Table 2: G-Mark certification

4. TüV third party testing

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

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

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

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

5. Production line

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

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

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

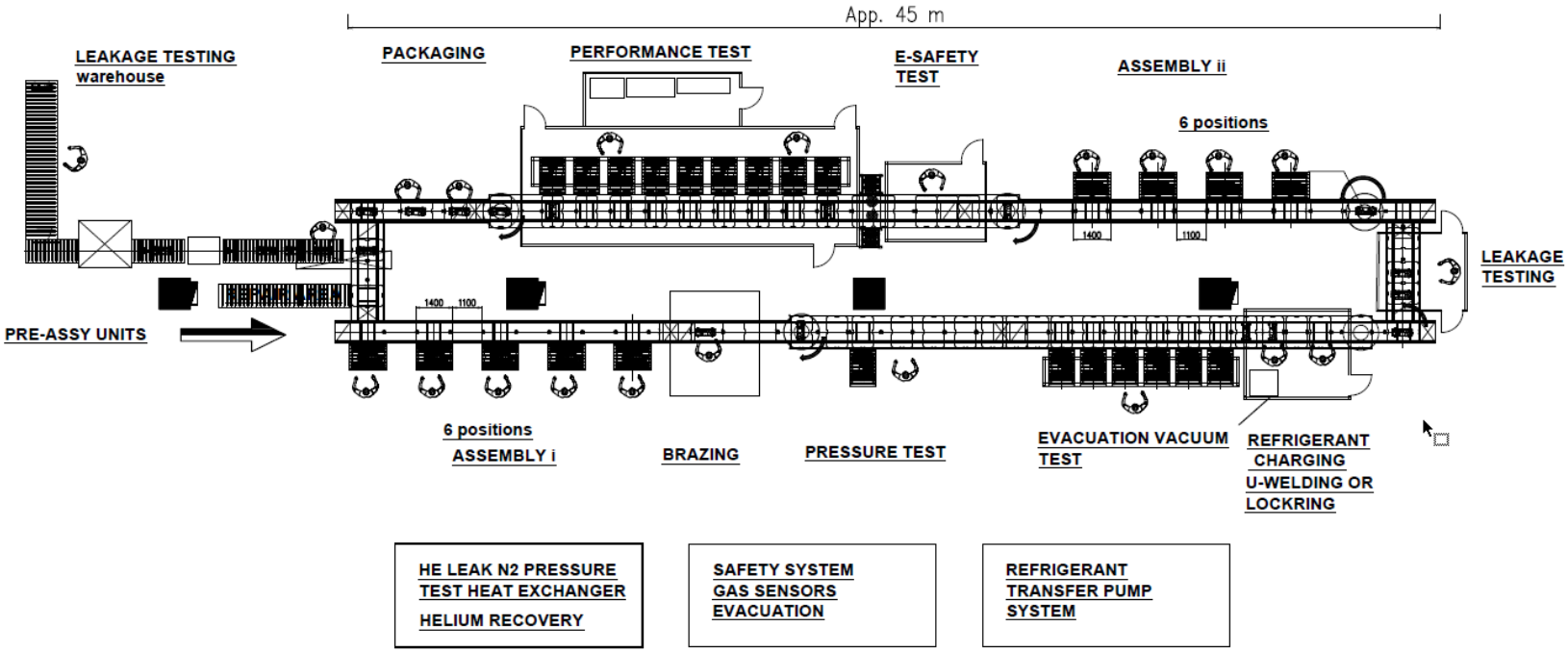


Figure 6. Original production line layout.

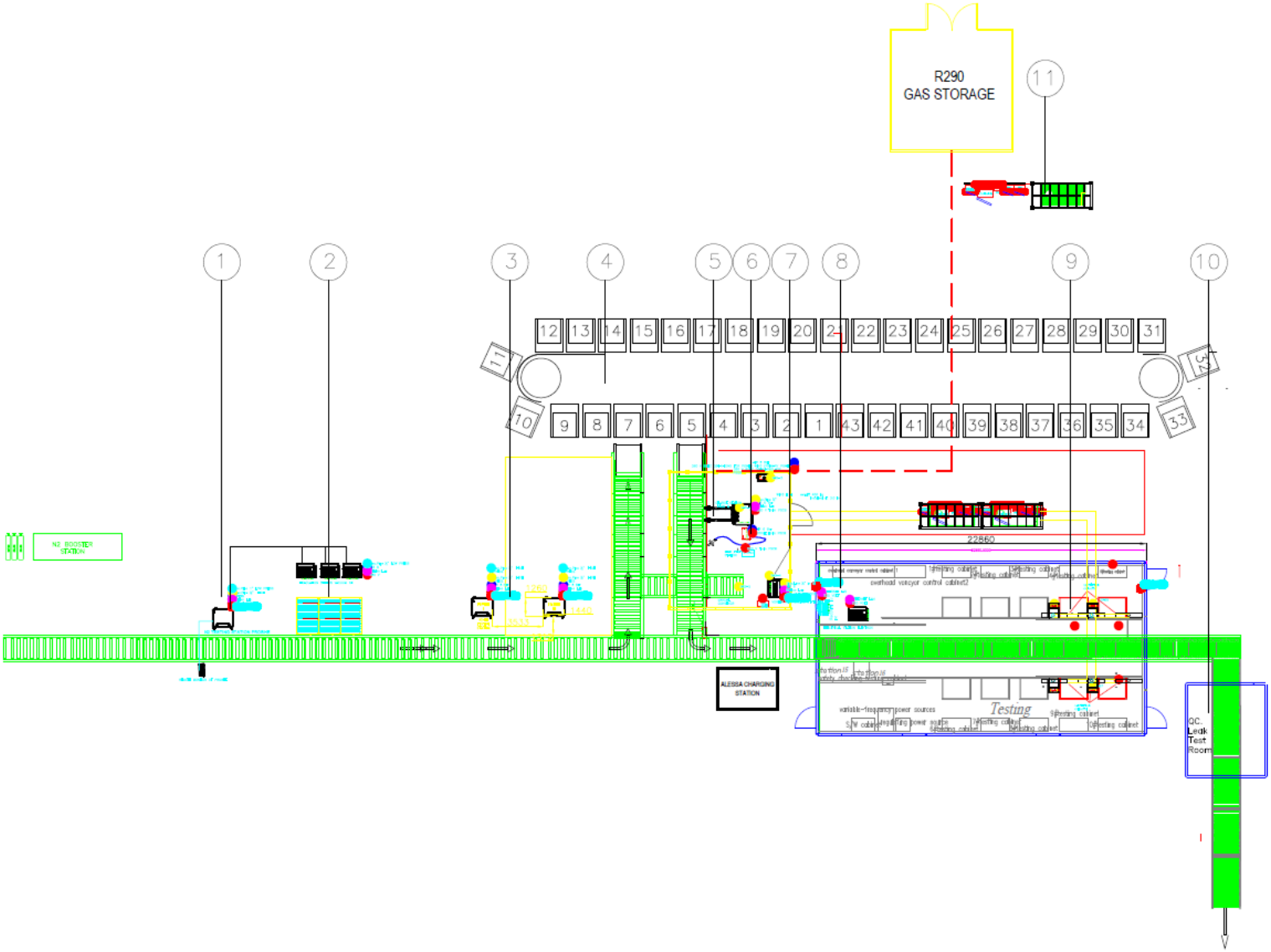


Figure 7. Installed manufacturing line

The different stations enumerated on Figure 7 include:

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

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

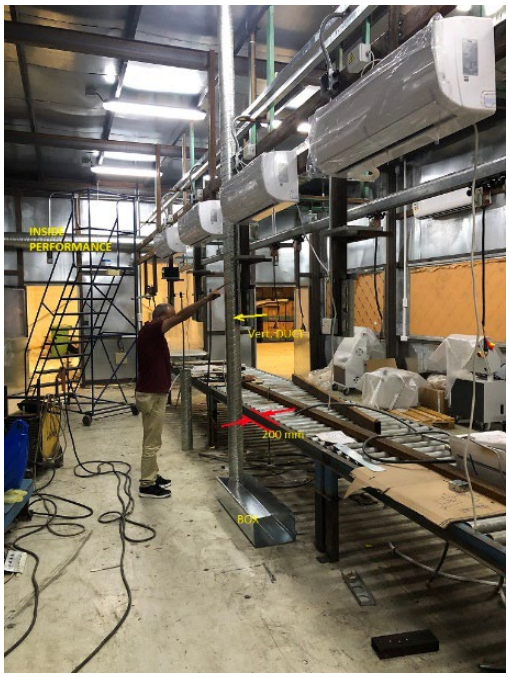


Figure 8. Equipment upgrades in the performance room.

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

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

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

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

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

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

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

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

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

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

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

6. Servicing

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

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

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

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

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

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

Office 1 – app. 16 m^2

Office 2 next to office 1 and identical

Building Exterior

Sample Outdoor Unit

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

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

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

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

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

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

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

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

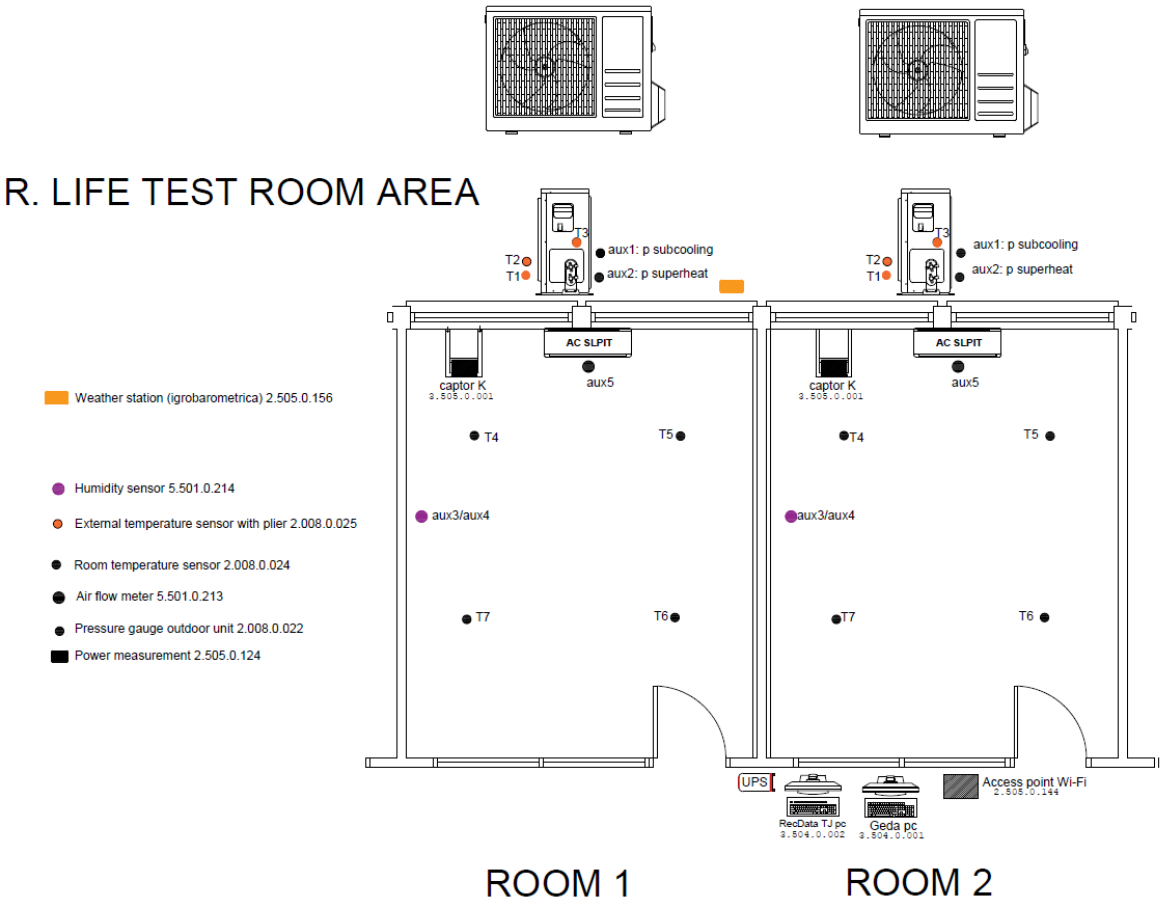


Figure 12: Layout of the rooms and position of the sensors

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

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

Figure 13: weather station

Performance of splits under test

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

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

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

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

Real-life test room results

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

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

A: Ability to provide adequate cooling and meet setpoint

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

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

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

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

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

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

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

C: Overall performance of the unit and operation issues

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

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

R410A room

HC-290 room

Figure 14: Insulation of windows with EPS foam

Please note that:

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

The results showed what we already knew:

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

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

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

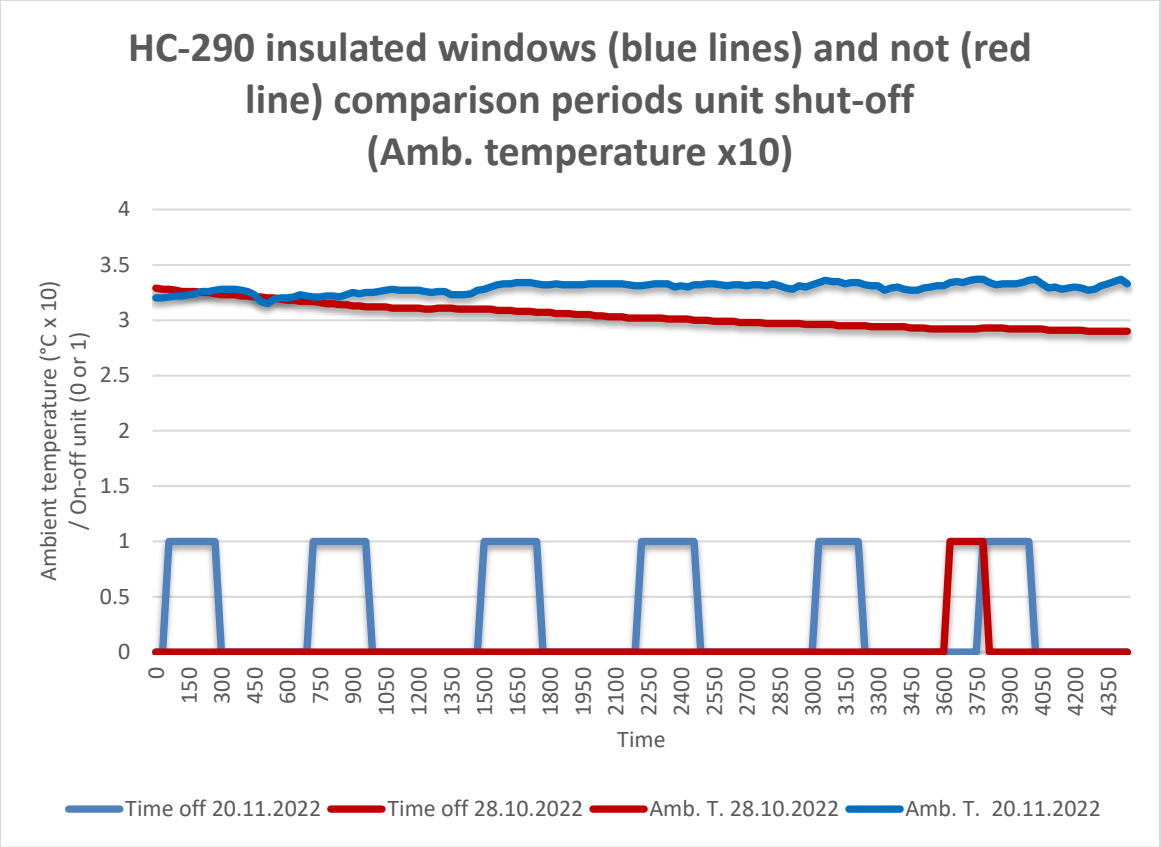


Figure 15: Graph for HC-290, blue lines with insulated windows and red without insulation.

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

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

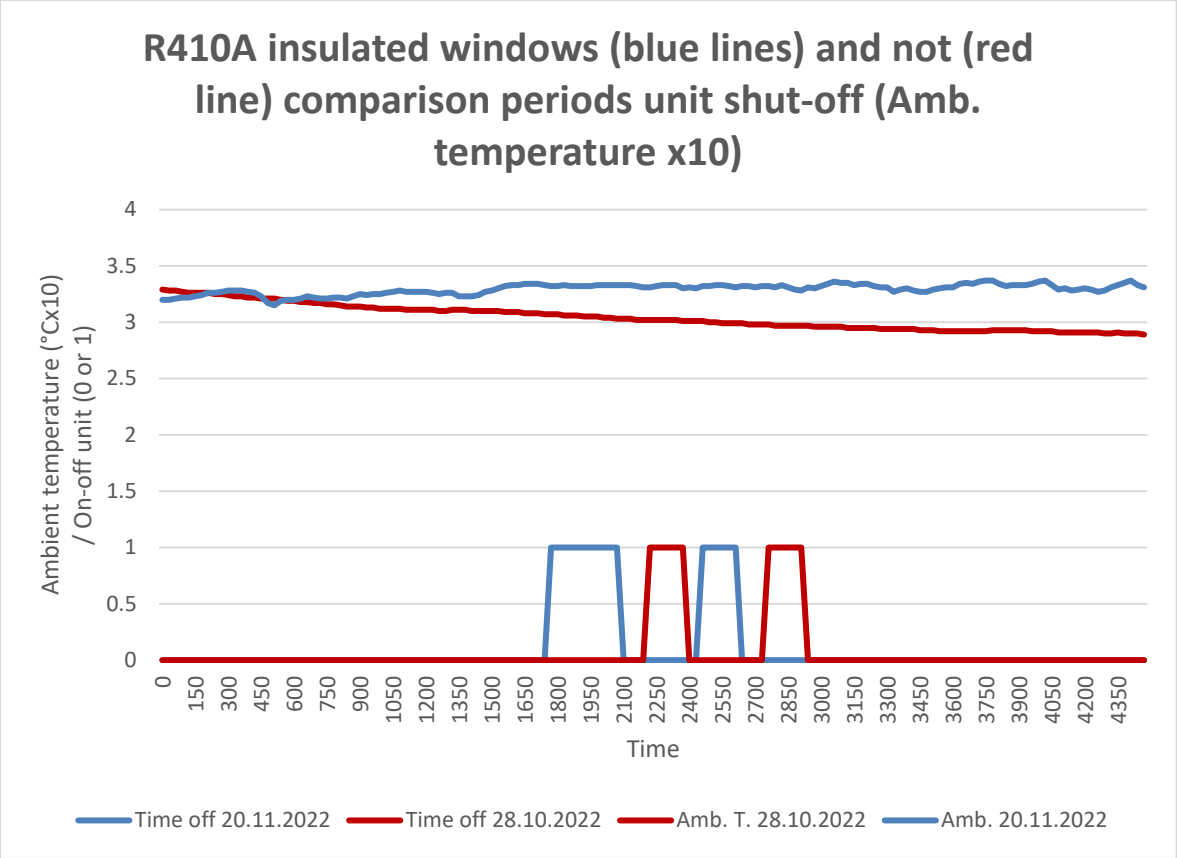


Figure 16: R410A results comparison for insulated (blue lines) and not insulated test setup (red).

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

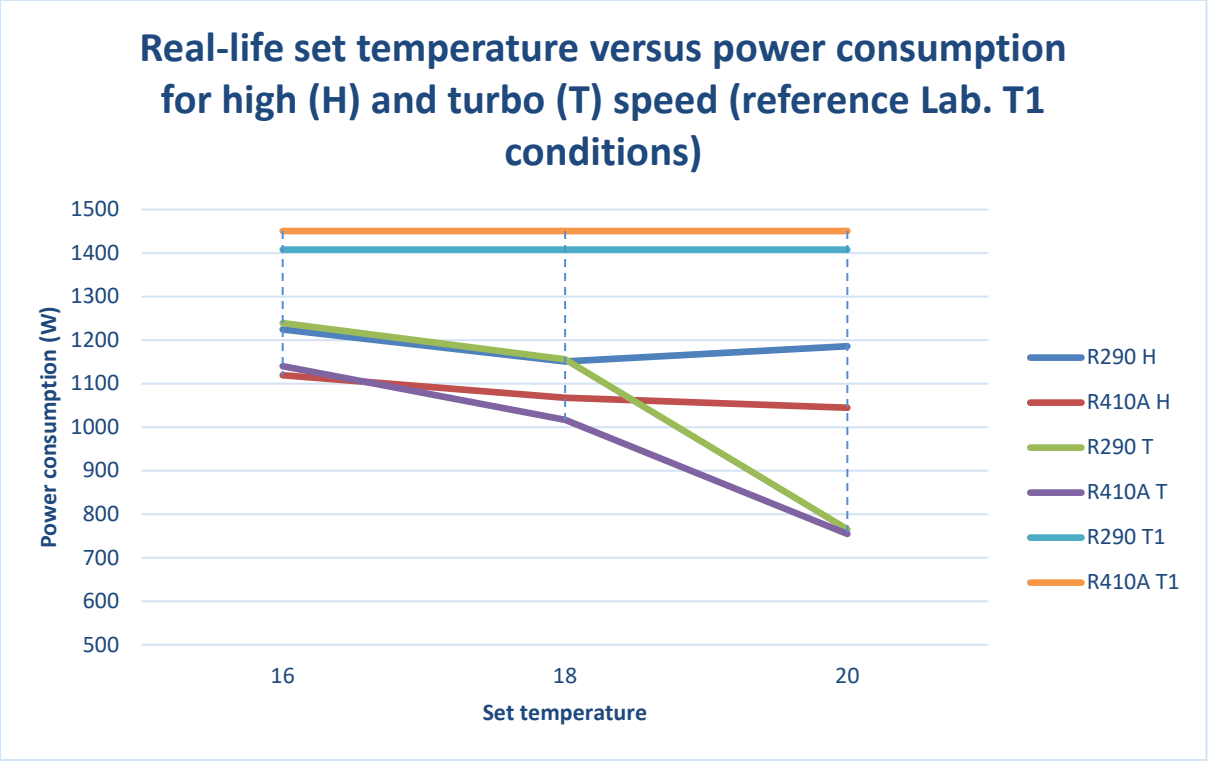


Figure 17: Power consumption for real-life room set temperatures 16, 18, and 20°C.

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

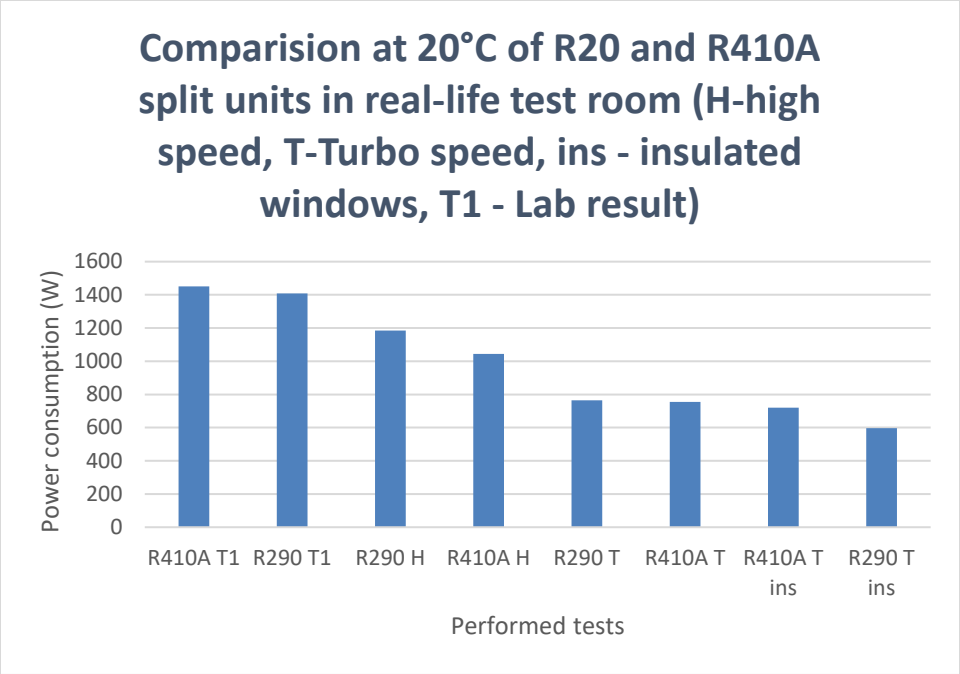


Figure 18: Comparison real-life test room set temperature of 20°C of energy consumption.

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

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

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

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

Conclusions

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

8. Environmental assessment

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

Looking at the unit we identify the following emission sources:

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

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

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

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

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

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

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

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

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

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

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

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

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

Tabel 1: summary environmental impact

9. Management and monitoring

The Alessa product development team consisted of

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

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

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

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

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

Co-financing Alessa

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

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

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

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

10. Project implementation

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

11. Future outlook HC-290 units

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

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

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

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

12. Financial status

Project operationally completed.

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

- *Not financially completed.

13. Conclusions

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

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

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

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

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

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

Appendices Detailed Condenser Design Document

Executive Summary

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

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

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

Introduction

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

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

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

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

Prototype Performance Analysis

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

Table 5: Prototype HC-290 Heat Pump components

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

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

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

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

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

Table 6: Performance Results and Analysis Summary

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

Analysis

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

Results

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

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

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

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

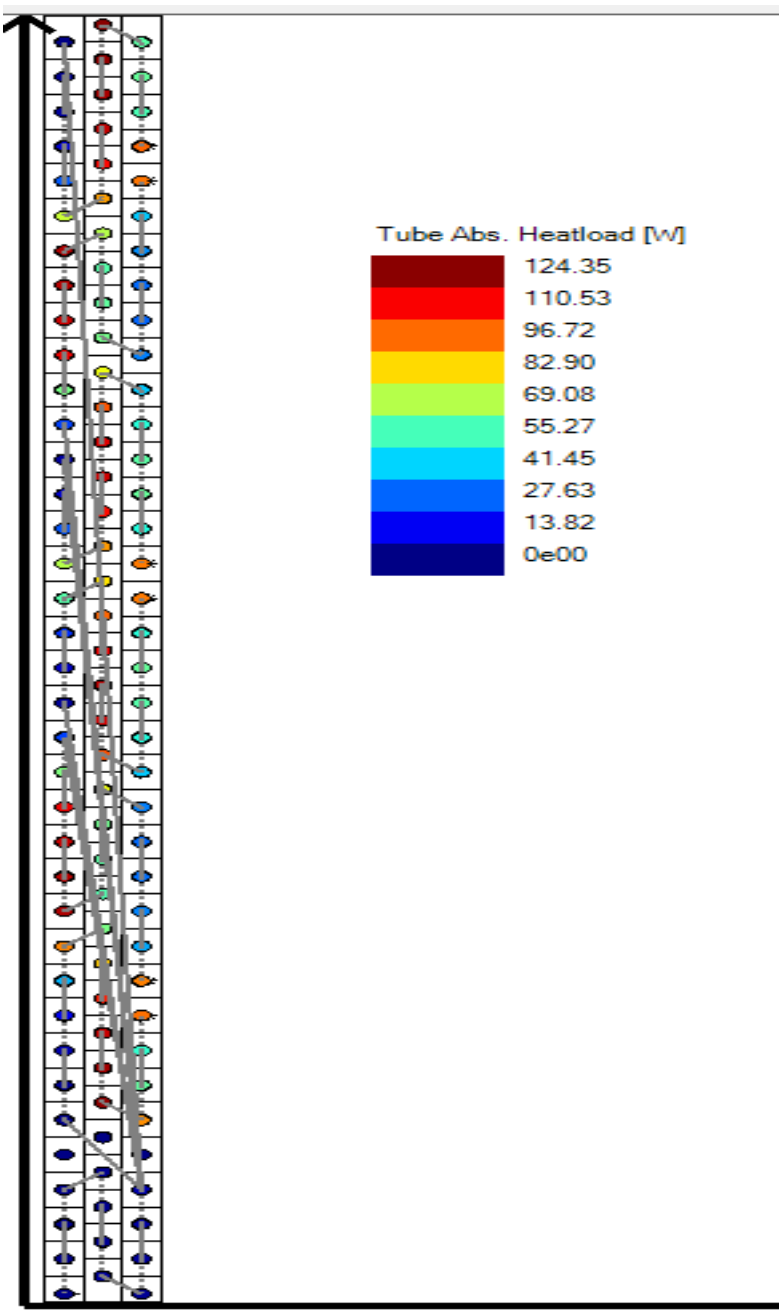


Figure 19: Baseline condenser circuit, tubes colored by the heat load modeled using CoilDesigner®.

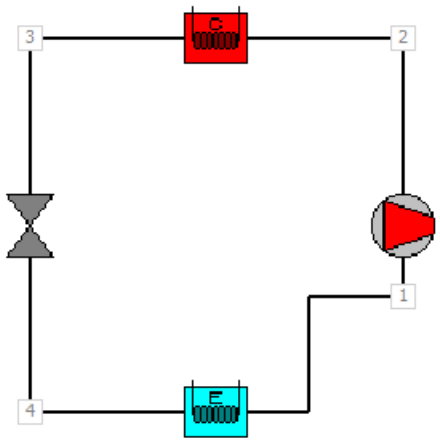
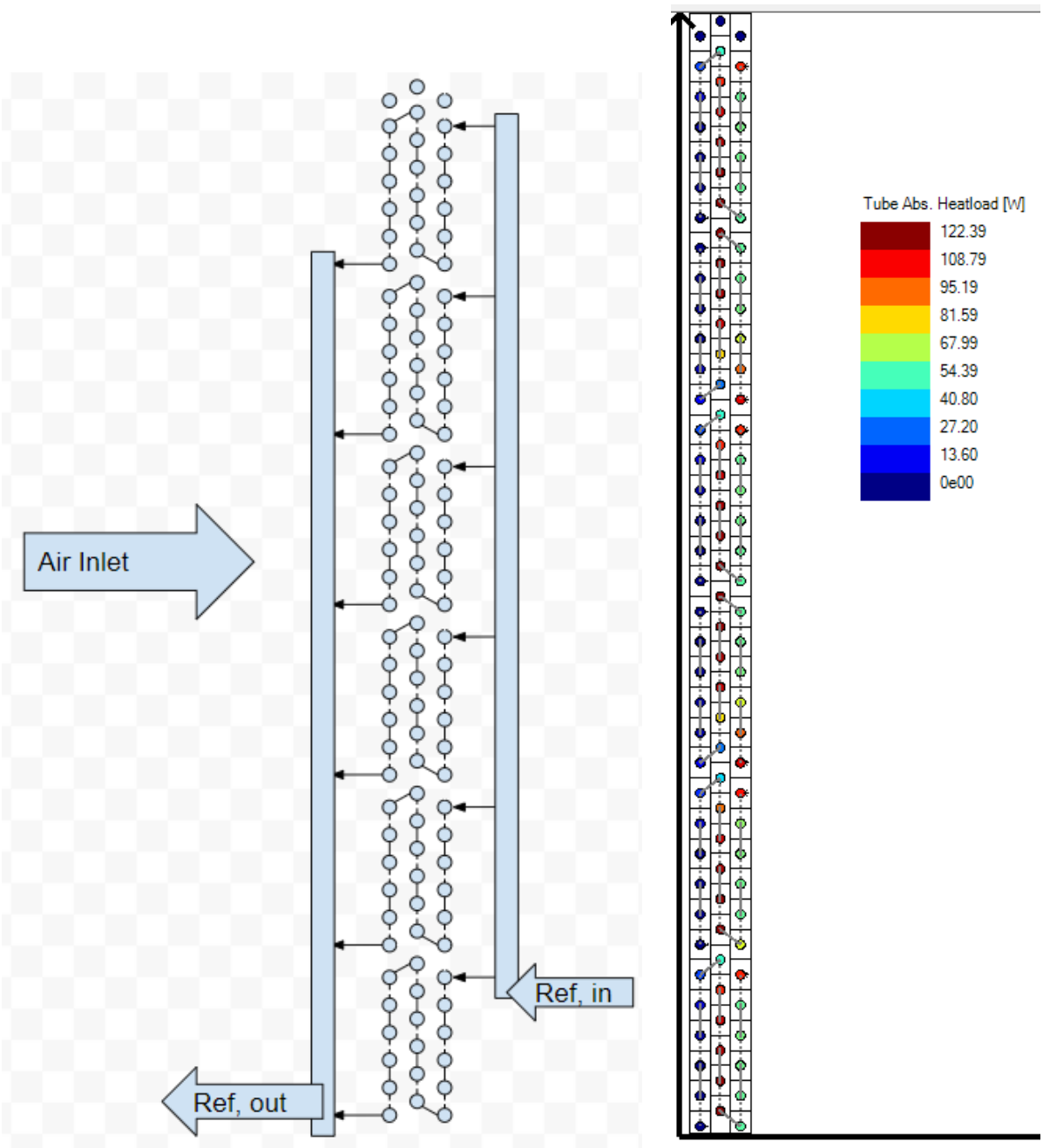


Figure 20: Baseline vapor compression system model using VapCyc®.



(a) (b)

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

Conclusions

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

Prototype Compressor Performance

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

Table 7. Prototype compressors performance

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

Table 8. Test conditions for the prototype compressors

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

Sample Detailed Report for Experimental Testing add last version

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

PO BOX 20409, RIYADH-11455, KSA

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

PSYCHROMETRIC LABORATORY TEST REPORT تقرير اختبار مختبر سيكرومتري

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

NAMEPLATE RATINGS معلومات لوحة البيانات

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

TEST CONDITIONS ظروف الاختبار

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

TEST RESULTS نتائج الاختبار

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

Remarks ملاحظات ☐ PASSED نجحت ☒ FAILED فشلت

Tested @ Turbo Speed

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

Appendices - Installation report (ALESSA)

Production line

Pressure strength testing- ProHe I – no comments

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

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

Vacuum NK –

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

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

Helium Leakage testing- PROBHe – no comments

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

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

Helium leakage tester – Protec 3000 -

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

Other comments:	No comment

Refrigerant charging – Kion M11 – No comments

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

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

Ultrasonic welder UWM –

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

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

Leak testing after charging – Ecotec E3000

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

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

Electrical testing - Elektron

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

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

Performance testing – CAPTOR K

Performance Testing – Captor K

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

Final leak test before packaging :

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

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

Software and Data Acquisition GEDA-Recdata TJ

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

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

Production line Ancillary equipment

Purging station - VORTEX

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

Helium recovery and distribution HEREC NK HP No comments

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

Nitrogen distribution and gas booster – No comment

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

Gas storage feed station and ancillary – RP4

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

Real-life testing equipment

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

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

Production line and laboratory Safety equipment

CERBERUS N – gas sesors and ventilation control panel

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

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

DREAGER IR Gas Sensors

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

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

Wind Ventilators

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

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

Guard House Remote safety alarm

Guard House Remote Safety Alarm

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

Ventilation ducting

Ventilation Ducting	
Date:	13-Oct-2021
Number of machines and machine number(s):	Dustings Installed at Production Area, Gas Room Area & LAB Area. (done by local contractor and followed as per Galileo drawing)
Machine number:	N/A
Open points:	As per Galileo .. we need to fix roof shed for the Wind outside R&D Lab for rain & direct sun protection.
Machine working:	All working OK
Items to be replaced or repaired:	Increased the height of the wind ducting outside LAB area from 1 mtr. To 2.5 mtr. . Fixed Ladder at the wind structure for maintenance access. (outside LAB area) Job Done
Training received:	No Training Required
Documentation:	No document Available … Only Drawings given directly by Galileo to Local Contractor
Components missing:	Nothing missing
Other comments:	No comment
!!!!!	Layout of ducting available from Galileo / provided needs to be checked by Alessa
Testing	We need Test Procedure to follow. / to be provided by GTP. *GTP: we already sent the report of the verification of the ventilation (attached again)*

Spare parts

Please go through it and check if everything is there.

Used spare parts during the installation/commissioning need to be replaced by the supplier

Already parts missing noted during Unido mission

Jaws of the lockring clamping tool

Torque wrench

Maybe you found them otherwise they need to be provided.

General remarks:

- The final approval of the risk assessment of the area is under customer's responsibility.

- The line was commissioned and a pre-series of 20 units was properly produced. No problems were detected. The line is working correctly.

Already parts missing noted during Unido mission

- Jaws of the lockring clamping tool

- Torque wrench

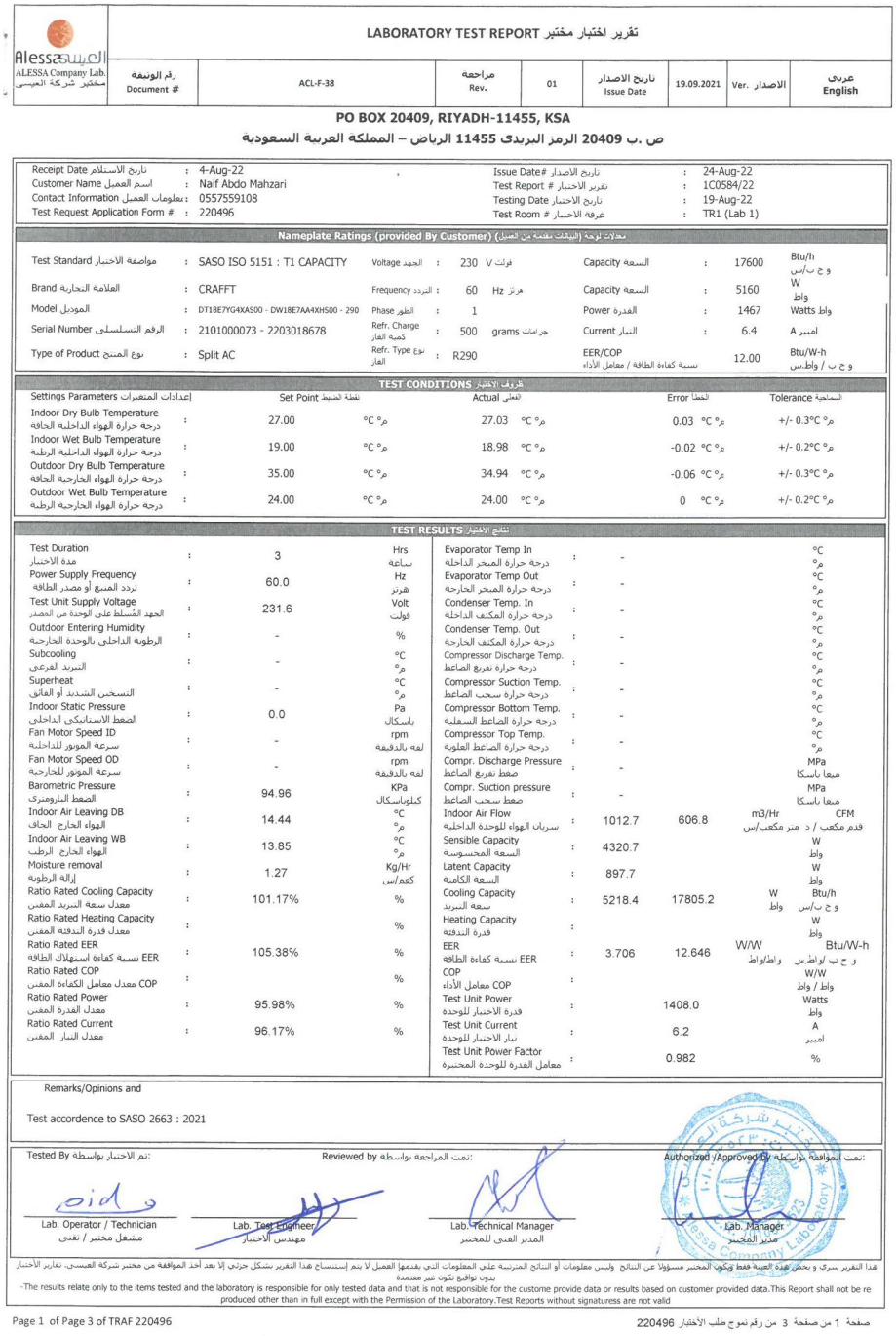
These parts were shipped inside box nr. 19.

"Note : Jaws of the lockring clamping tool - Not Found" to be provided by GTP

GTP: we are sure that they were sent as they were included in the packing list; in any case we will provide them under warranty. Our OA will follow shortly.

Appendix lab test reports real-life testing room split units HC-290 and R410A

HC-290 test report



ALESSA Company Lab. مختبر شركة العيسى

LABORATORY TEST REPORT تقرير اختبار مختبر

رقم الوثيقه Document #	ACL-F-38	مراجعه Rev.	01	تاريخ الاصدار Issue Date	19.09.2021	Ver. الاصدار	عربى English

PO BOX 20409, RIYADH-11455, KSA

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

Receipt Date تاريخ الاستلام	: 4-Aug-22	Issue Date# تاريخ الاصدار	: 24-Aug-22
Customer Name اسم العميل	: Naif Abdo Mahzari	Test Report # تقرير الاختبار	: 1C0584/22
Contact Information معلومات العميل	: 0557559108	Testing Date تاريخ الاختبار	: 19-Aug-22
Test Request Application Form #	: 220496	Test Room # غرفة الاختبار	: TR1 (Lab 1)

Nameplate Ratings (provided By Customer) معلومات لوحة (البيانات مقدمة من العميل)

Test Standard مواصفة الاختبار	: SASO ISO 5151 : T1 CAPACITY	Voltage الجهد	: 230	V فولت	Capacity السعة	: 17600	Btu/h و ح ب/س
Brand العلامة التجارية	: CRAFFT	Frequency التردد	: 60	Hz هرتز	Capacity السعة	: 5160	W واط
Model الموديل	: DT18E7YG4XAS00 - DW18E7AA4XHS00 - 290	Phase الطور	: 1		Power القدرة	: 1467	Watts واط
Serial Number الرقم التسلسلى	: 2101000073 - 2203018678	Refr. Charge كمية الغاز	: 500	grams جرامات	Current التيار	: 6.4	A امبير
Type of Product نوع المنتج	: Split AC	Refr. Type نوع الغاز	: R290		EER/COP نسبة كفاءة الطاقة / معامل الأداء	12.00	Btu/W-h و ح ب / واط.س

TEST CONDITIONS ظروف الإختبار

Settings Parameters إعدادات المتغيرات	Set Point نقطة الضبط		Actual الفعلى		Error الخطأ		Tolerance السماحية
Indoor Dry Bulb Temperature درجة حرارة الهواء الداخلية الجافة	: 27.00	°C م°	27.03	°C م°	0.03	°C م°	+/- 0.3°C م°
Indoor Wet Bulb Temperature درجة حرارة الهواء الداخلية الرطبة	: 19.00	°C م°	18.98	°C م°	-0.02	°C م°	+/- 0.2°C م°
Outdoor Dry Bulb Temperature درجة حرارة الهواء الخارجية الجافة	: 35.00	°C م°	34.94	°C م°	-0.06	°C م°	+/- 0.3°C م°
Outdoor Wet Bulb Temperature درجة حرارة الهواء الخارجية الرطبة	: 24.00	°C م°	24.00	°C م°	0	°C م°	+/- 0.2°C م°

TEST RESULTS نتائج الإختبار

Test Duration مدة الاختبار	: 3	Hrs ساعة	Evaporator Temp In درجة حرارة المبخر الداخلة	: -			°C م°
Power Supply Frequency تردد المنبع أو مصدر الطاقة	: 60.0	Hz هرتز	Evaporator Temp Out درجة حرارة المبخر الخارجة	: -			°C م°
Test Unit Supply Voltage الجهد المُسلط على الوحدة من المصدر	: 231.6	Volt فولت	Condenser Temp. In درجة حرارة المكثف الداخلة	: -			°C م°
Outdoor Entering Humidity الرطوبة الداخلى بالوحدة الخارجية	: -	%	Condenser Temp. Out درجة حرارة المكثف الخارجة	: -			°C م°
Subcooling السبريد الفرعى	: -	°C م°	Compressor Discharge Temp. درجة حرارة تفريغ الضاغط	: -			°C م°
Superheat التسخين الشديد أو الفائق	: -	°C م°	Compressor Suction Temp. درجة حرارة سحب الضاغط	: -			°C م°
Indoor Static Pressure الضغط الاستاتيكى الداخلى	: 0.0	Pa باسكال	Compressor Bottom Temp. درجة حرارة الضاغط السفلية	: -			°C م°
Fan Motor Speed ID سرعة الموتور للداخلية	: -	rpm لفة بالدقيقة	Compressor Top Temp. درجة حرارة الضاغط العلوية	: -			°C م°
Fan Motor Speed OD سرعة الموتور للخارجية	: -	rpm لفة بالدقيقة	Compr. Discharge Pressure ضغط تفريغ الضاغط	: -			MPa ميغا باسكا
Barometric Pressure الضغط الباروميترى	: 94.96	KPa كيلوباسكال	Compr. Suction pressure ضغط سحب الضاغط	: -			MPa ميغا باسكا
Indoor Air Leaving DB الهواء الخارج الجاف	: 14.44	°C م°	Indoor Air Flow سريانات الهواء للوحدة الداخلية	: 1012.7	606.8	m3/Hr متر مكعب/س	CFM قدم مكعب / د
Indoor Air Leaving WB الهواء الخارج الرطب	: 13.85	°C م°	Sensible Capacity السعة المحسوسة	: 4320.7			W واط
Moisture removal إزالة الرطوبة	: 1.27	Kg/Hr كغم/س	Latent Capacity السعة الكامنة	: 897.7			W واط
Ratio Rated Cooling Capacity معدل سعة التبريد المقنن	: 101.17%	%	Cooling Capacity سعة التبريد	: 5218.4	17805.2	W واط	Btu/h و ح ب/س
Ratio Rated Heating Capacity معدل قدرة التدفئة المقنن	:	%	Heating Capacity قدرة التدفئة	:			W واط
Ratio Rated EER نسبة كفاءة استهلاك الطاقة EER	: 105.38%	%	EER نسبة كفاءة الطاقة EER	: 3.706	12.646	W/W واط/واط	Btu/W-h و ح ب /واط.س
Ratio Rated COP معدل معامل الكفاءة المقنن COP	:	%	COP معامل الأداء	:			W/W واط / واط
Ratio Rated Power معدل القدرة المقنن	: 95.98%	%	Test Unit Power قدرة الاختبار للوحدة	:	1408.0		Watts واط
Ratio Rated Current معدل التيار المقنن	: 96.17%	%	Test Unit Current تيار الاختبار للوحدة	:	6.2		A امبير
			Test Unit Power Factor معامل القدرة للوحدة المختبرة	:	0.982		%

Remarks/Opinions and

Test accordence to SASO 2663 : 2021

Tested By تم الاختبار بواسطة:	Reviewed by تمت المراجعة بواسطة:	Authorized /Approved By تمت الموافقة بواسطة:
Lab. Operator / Technician مشغل مختبر / تقنى	Lab. Test Engineer مهندس الاختبار	Lab. Technical Manager المدير الفنى للمختبر
		Lab. Manager مدير المختبر

هذا التقرير سرى و يخص عينة العينة فقط وتكون المختبر مسؤولا عن النتائج المترتبة على المعلومات التي يقدمها العميل لا يتم إستنساخ هذا التقرير بشكل جزئي إلا بعد أخذ الموافقة من مختبر شركة العيسى. تقارير الاختبار بدون توقيع تكون غير معتمدة

-The results relate only to the items tested and the laboratory is responsible for only tested data and that is not responsible for the custome provide data or results based on customer provided data.This Report shall not be re produced other than in full except with the Permission of the Laboratory.Test Reports without signaturess are not valid

Page 1 of Page 3 of TRAF 220496

صفحة 1 من صفحة 3 من رقم نموج طلب الاختبار 220496

R410A test report

	TCL indoor & Alessa outdoor / DSG280							
Compressor	DSG280N1VKT S# 906000002K (GMCC)							
Condenser Coil	3 rows (2.5 coil), 5 mm, IGT, 6 ckt., 36 tubes per row, 18 FPI, 1 row (375 mm x 705 mm) & 2 rows (818 mm x 705 mm) L-bend. **New condenser coil circuitry without sub-cooler.**							
Capillary	0.064" x 40" x 2#							
Cond. FM	DC Motor (1000 rpm)							
Evaporator Coil	2 rows, 7 mm, IGT, 4 ckt., 18 FPI (gold fins), 760 mm x 340 mm							
Frequency (Hz)	60							
R290 charge (g)	520		490					
Test Condition	T1 (°F, psi)	T1 (°C, Bar)	T1 (°F, psi)	T1 (°C, Bar)	T3 (°F, psi)	T3 (°C, Bar)	H1 (°F, psi)	H1 (°C, Bar)
Cooling Capacity (BTU/Hr)	**18253.6**		**18373.0**		**16133.4**		-	
Sensible Capacity (BTU/Hr)/(W)	14047.6		14153.6		15410.4		4659.4	
SHR (%)	77.0		77.0		95.5		100.0	
Latent Capacity (BTU/Hr)/(W)	4206.0		4219.5		723.0		0.0	
Heating Capacity (W)	-		-		-		**4659.4**	
Power (W)	1471.3		1470.1		1723.9		1404.1	
EER (BTU/W-Hr)	**12.406**		**12.498**		**9.359**		-	
COP (W/W)	-		-		-		**3.318**	
Current (A)	6.5		6.5		7.6		6.3	
Voltage (V)	230.1		230.1		229.9		230.0	
CFM (ft^3/min)	579.0		580.7		606.7		620.6	
Evap. Header Inlet Temp.	60.3	15.7	60.2	15.7	65.2	18.4	96.6	35.8
Evap. Header Outlet Temp.	49.7	9.8	49.8	9.9	52.3	11.3	105.6	40.9
Cond. Header Inlet Temp.	128.5	53.6	133.8	56.2	151.3	66.3	32.0	0.0
Cond. Outlet Temp.	99.9	37.7	100.4	38.0	124.0	51.1	42.3	5.7
Suction Temp.	50.4	10.2	57.1	13.9	57.0	13.9	33.3	0.7
Discharge Temp.	131.4	55.2	135.8	57.7	153.9	67.7	112.9	44.9
Compressor Bottom Temp.	124.7	51.5	127.8	53.2	147.1	63.9	107.0	41.7
Compressor Top Temp.	132.0	55.6	136.4	58.0	154.6	68.1	115.0	46.1
Suction Pressure	71.8	4.95	71.9	5.0	75.4	5.2	53.8	3.7
Liquid Pressure (condenser)	201.0	13.9	201.0	13.9	258.9	17.8	64.2	4.4
Discharge Pressure	209.0	14.4	209.5	14.4	264.7	18.2	186.0	12.8
Sub-cooling	10.6	5.6	10.1	5.3	6.1	2.9		
Superheating	4.5	2.7	11.2	6.4	8.6	4.8		

Progress Report Pursuant to Decision 83/41 of the 83rd Meeting of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol

I. Background

According to Decision 83/41 of the 83rd Meeting of the Executive Committee (ExCom) of the Multilateral Fund, the Government of China will report to the ExCom, at the 86th meeting, on its latest progress in implementing the activities related to China's ODS monitoring and law enforcement.

II. Progress of monitoring and law enforcement activities

The Government of China attaches great importance to the unexpected emission increase of trichlorofluoromethane (CFC-11) in the atmosphere. On the one hand, control of CTC supply is strengthened to prevent diversion of CTC to illegal ODS production. On the other hand, China is constantly strengthening monitoring and law enforcement of ODS to prevent illegal sales and use of ODS. Since the beginning of 2020, although the COVID-19 pandemic has posed adverse impacts on monitoring and law enforcement in implementing the Montreal Protocol, the Government of China is still striving to overcome difficulties and take active actions to improve law and regulation system, conduct law enforcement actions, intensify CTC supervision and management, build capacity for implementing the Montreal Protocol, strengthen cooperation with the industry, and establish monitoring network, etc. The progress of relevant work from October 2019 to July 2020 is as follows (see Annex 1):

(I) Improve law and regulation system

In August 2019, the Ministry of Ecology and Environment (MEE) launched the revision of *the Regulation on the Administration of Ozone Depleting Substances* (hereinafter referred to as the Regulation), conducted an assessment of the implementation of the Regulation, and formulated *the Regulation on the Administration of Ozone Depleting Substances and Hydrofluorocarbons (Draft for Soliciting Opinions*) based on the assessment and new requirements for implementing the Montreal Protocol. The revision mainly includes: 1) Considering the future compliance requirements of the Kigali Amendment, hydrofluorocarbons (HFCs) are incorporated into the scope of control; 2) To further clarify definition and classification of uses, it is stipulated that co-production and by-production are classified as production activities, pre-blended polyols are included in the monitoring scope as mixtures, and pre-blended polyols manufacturing enterprises are strictly supervised as consumption enterprises with controlled use. At the same time, targeted monitoring measures are formulated for supervising controlled use and feedstock use; 3) Work related to monitoring and evaluation is included, a national monitoring network of controlled substances under the Montreal Protocol will be established, and the monitoring and evaluation work will be organized accordingly; 4) The legal responsibilities of both market entities

and supervisors are further elaborated, and the punishment measures on various violations are further reinforced, 5) Supporting policy measures will be improved and the R&D and application of testing and monitoring methods of controlled substances will be encouraged and supported.

As of the end of June 2020, public opinion solicitation has been completed. At present, it is being revised based on opinions and feedback. The Regulation (Revised Draft for Approval) will be submitted to the State Council for review within 2020, and will be issued upon the approval by the State Council in accordance with relevant procedures.

(II) Carry out law enforcement actions

1. Cracking down on illegal use of CFC-11

From June to August 2019, MEE dispatched law enforcement officers to form joint enforcement groups with local law enforcement personnel to 11 key provinces/municipalities including Shandong, Hebei, Henan, Jiangsu, Zhejiang, and Guangdong to conduct special inspections. In this action, 656 system houses and polyurethane foam enterprises were inspected. Testing through portable instant detectors found that samples from 37 enterprises, including 6 system houses and 31 foam manufacturers, contained CFC-11. After the laboratory retesting, it's confirmed that 16 enterprises have been engaged in illegal use of CFC-11. None of these 16 enterprises received funds from the Multilateral Fund or was registered with the China Plastic Processing Industry Association (CPPIA). The local ecology and environment bureaus (EEBs) have handled these cases in accordance with the law. Through laboratory testing, samples from the 21 enterprises were found to contain no or only trace of CFC-11. Hence, these 21 enterprises could not be confirmed using CFC-11.

Among these cases, one enterprise's legal representative was sentenced to 10 months of imprisonment for the crime of environmental pollution by the local court. The specific circumstance is: Through the sudden unannounced inspection in Huzhou Deqing Minghe Insulation Materials Co., Ltd. (hereinafter referred to as Minghe Company), Zhejiang working group found clues of the company's illegal practice which pointed out the criminal facts of Minghe Company's three-year illegal purchase and use of 849.5 tons of CFC-11 in the production of pre-blended polyols. The sentence of the case was pronounced by the People's Court in Deqing County in March 2020: Minghe Company was fined 700,000 RMB yuan for environmental pollution caused by its illegal production of pre-blended polyols using CFC-11, and illegal gains of more than 1.4 million RMB yuan was recovered; its legal representative Qi was sentenced to 10 months of imprisonment for the crime of environmental pollution and was fined 50,000 RMB yuan. Among the 4 suppliers (all dealers) of CFC-11 raw materials in this case, 2 were held criminally responsible for the crime of environmental pollution (one was sentenced to 8 months of imprisonment, the other was sentenced to 9 months of imprisonment), and the other 2 people are still under investigation. It is the first case that was sentenced to substantial punishment for the illegal use of ODS in the domestic polyurethane foam sector to date, which fully reflects China's

firm zero-tolerance attitude towards illegal activities related to ODS. MEE issued a public report with the theme of *China's First Case of Illegal Use of ODS Sentenced to Criminal Punishment*.

Among the other 15 enterprises which involved violations, including 4 system houses and 11 polyurethane foam enterprises, about 9.4 tons of CFC-11 raw materials, 4.35 tons of pre-blended polyols and 2.2 tons of polyurethane foam products were seized and soundly disposed of, a fine of 2,816,900 RMB yuan was imposed (including the confiscation of illegal gains). Facilities and equipment of one enterprise were dismantled, violation of one enterprise has been transferred to the public security bureau (the case is still under investigation), and another enterprise was shut down.

2. Additional law enforcement equipment for local EEBs

As of the end of December 2019, a total of 50 portable ODS instant detectors have been distributed to EEBs of 30 provinces (autonomous regions and municipalities) and law enforcement officers from some key cities and counties, so as to help them conduct on-site inspection.

3. Strengthen supervision and law enforcement

In December 2019, MEE formulated *the Guideline on Supervision of Ozone Depleting Substances (Trial)*, including specific requirements for methods and contents of law enforcement inspection and handling of illegal behaviors. The Guideline has been issued and distributed to local EEBs.

MEE has formulated and issued *the 2020 Work Plan for Law Enforcement Inspection on Ozone Depleting Substances* in July 2020 and launched a new round of special ODS law enforcement inspection nationwide at the end of July 2020 mainly targeting at HCFC-141b and HCFC-22 production enterprises and illegal production and use of CFC-11. Outcome of this special law enforcement inspection will be reported to MEE from local EEBs by the end of this year.

In 2021, through the national CTC online monitoring platform and industrial rewards for reporting platform, MEE will further intensify source control, crack down on illegal ODS production, and improve the identifying mechanism, investigation mechanism and disclosure mechanism of illegal ODS production cases in steps.

(III) Intensify source control

1. Establishment of CTC monitoring platform

MEE has imposed stricter control measures on the chloromethane producers generating CTC as by-product since 2019, requiring every enterprise to install a verifiable and quantitative CTC online production monitoring system. At present, all chloromethane producers have completed the installation

of the online monitoring systems. Meanwhile, MEE is working on establishing a national CTC monitoring platform, which is currently in the stage of system design and development. The online trial operation is expected to be completed by the end of 2020 to realize online monitoring of CTC by-production in all chloromethane enterprises.

With regard to perchloroethylene (PCE) production enterprises, according to the current available information, there is only one enterprise that uses the alkane chlorination process during the PCE production in China. On September 5th 2019, MEE conducted an on-site survey on this enterprise with local EEBs. In light of the survey, during the PCE production process of this enterprise, CTC is only generated as an intermediate conversion product and reactor diluent, which is not separated or purified as by-products in the system. Since CTC does not flow out of the system and the production facility has no outlet pipes for CTC, there is no need to take daily supervision measures targeting at CTC on this enterprise as applied to chloromethane enterprises.

2. On-site supervision

From June 2019 to January 2020, MEE dispatched supervisory working groups to 16 chloromethane enterprises with CTC by-production to carry out the on-site inspection on CTC crude output, purification, residue, storage, conversion and sales, and other key processes to ensure legal production and use. By January 2020, 14 rounds of on-site supervision with attendance reaching 577 had been conducted. Each round lasted for two weeks (including holidays), achieving continuous daily on-site supervision. Since February 2020, the on-site inspection of CTC by-production enterprises has been suspended due to the COVID-19 pandemic, however, MEE still requires chloromethane production enterprises to report CTC related data weekly, and local EEBs have taken measures to conduct on-site inspections as needed.

(IV) Building Capacity for implementing the Montreal Protocol

1. Construction of testing laboratories and development of testing standards

For construction of testing laboratories, by the end of 2019, MEE had completed the construction of 8 ODS testing laboratories for industrial products, and all of them have obtained the expansion of CMA (China Inspection Body and Laboratory Mandatory Approval) certificate to ensure testing reports with legal effect could be provided.

For the formulation of laboratory testing method standards for ODS in industrial products, in October 2019, MEE approved and issued two national environmental protection standards, *Determination of ozone-depleting substances including HCFC-22, CFC-11, and HCFC-141b in pre-blended polyols — Headspace/gas chromatography-mass spectrometry (HJ 1057-2019*) and *Determination of ozone-depleting substances including CFC-12, HCFC-22, CFC-11 and HCFC-141b in rigid polyurethane foam and pre-blended polyols—Portable headspace/gas chromatography-mass*

spectrometry (HJ 1058-2019), to standardize testing of controlled substances under the Montreal Protocol. At present, testing standards for ODS in liquid refrigerants and solvents are being developed and is progressing on schedule, and it is expected to be officially released by the end of 2020.

2. Hold Supervision and law enforcement training

In December 2019, MEE held a training workshop on ODS phase-out management, which trained about 120 officers and technical support personnel from the atmospheric environmental management division of local EEBs. In December 2019 and July 2020, MEE held two training workshops for law enforcement personnel, training a total of 400 environmental law enforcement officers at the provincial, city and county levels.

In order to further enhance the capacity of grassroots environmental protection personnel below the provincial level, some provinces and municipalities have also held ODS phase-out management training workshops within their provinces or municipalities. In October and November 2019, Henan, Jiangxi and Shanxi carried out training workshops respectively, a total of 1,130 personnel of atmospheric environmental management departments from provincial, city and county levels received training.

MEE and the General Administration of Customs will continue to jointly organize the training workshop on ODS import and export management for a total of 70 customs officers in this October.

3. Optimize ODS information management system

Since October 2019, MEE has launched the construction of the ODS data information management system, which will be comprehensively updated based on the existing HCFCs online information system to realize the online data reporting of enterprises. The online test of the system modules will be completed before the end of 2020.

(V) Enhance cooperation with industries

1. Enhance communication with industries

Industrial associations have been providing technical support for supervision and management, policy formulation, and law enforcement of the government over the long term. Some technical experts recommended by industrial associations directly participate in special law enforcement operation and on-site inspection, providing technical support for supervision and law enforcement from a professional perspective. During the revision of the Regulation, communications have been conducted actively with industrial associations, experts, scientific research institutions and others, and their suggestions have been fully incorporated during the revision process.

2. Market analysis of the PU foam sector

China Plastic Processing Industry Association (CPPIA) cooperated with industry experts to analyze the situation of the polyurethane foam market in 2018 and consumption of various blowing agents by using mass balance analysis. See Annex 2 for details.

3. Market analysis of refrigeration and air-conditioning sector

MEE has communicated with industrial associations and experts to discuss the feasibility and methodology of mass balance analysis in the refrigeration and air-conditioning market. The feasibility research on the mass balance analysis of the industrial and commercial refrigeration and air-conditioning (ICR) sector and room air-conditioning (RAC) sector has been completed.

Studies have shown that for the RAC sector, the use of HCFC-22 in the RAC manufacturing sector could be analyzed and calculated by collecting data on the annual output of various product types, charging quantity of various product types, and the proportion of using HCFC-22 as the refrigerant (See Annex 3 for details). However, scattered maintenance of room air-conditioners brings great difficulties on data collection, therefore it is impossible to conduct a mass balance analysis on the HCFC-22 consumption in the servicing sector.

The ICR sector has a wide range of equipment products and applications. The size of various products varies greatly and there are numerous models, which makes it difficult to obtain statistics on product data. A number of equipment in the ICR sector are non-standard or customized products. Considering factors include application occasions, customer needs, technologies and energy efficiency levels, even for similar products with the same cooling capacity, the refrigerant charge amount would vary greatly when different refrigerants are applied. In addition, various products' sales are affected by the domestic and international economic situation, policy changes, and weather, making it difficult to collect data on refrigerant consumption. Therefore, it is impossible to carry out mass balance analysis on refrigerant consumption in the ICR sector.

(VI) Establishment of monitoring and alerting capacity

In 2019, the Government of China officially launched the planning of the ODS atmospheric monitoring network to strengthen compliance monitoring and early warning capability and performance evaluation capability. According to the regional characteristics of the distribution of ODS production and consumption in China, through the scientific assessment of the existing atmospheric pollutant monitoring background stations, 6 stations which are suitable for monitoring ODS have been selected preliminarily. The monitoring capability will be progressively improved. National atmospheric ODS

monitoring network will be established in phases and steps, and a unified technical system of monitoring technology and comprehensive evaluation method, quality management, data sharing and information release will be built. At present, the National ODS Monitoring Expert Committee has been established and a joint expert team has been formed. At the same time, MEE is organizing relevant domestic research institutions to develop high-sensitivity ODS atmospheric monitoring equipment. MEE will start construction of ODS monitoring stations in 2021 and conduct ODS monitoring in 2022.

(VII) Non-governmental study

In accordance with the decision of the 83rd Meeting of the ExCom, MEE selected an independent non-governmental consulting agency (ESD China Limited) through public bidding to conduct a study to evaluate the ODS phase-out regulations, policies, law enforcement and market circumstances and risks in China. At present, the study report has been completed and will be submitted to the ExCom.

In general, since the unexpected increase in global emissions of CFC-11, the Government of China has promptly taken a series of actions to comprehensively strengthen the capacity of compliance management and supervision and law enforcement, to further provide guarantees to ensure sustainable compliance.

In terms of improving the laws and regulations, the Government of China has organized the revision of the Regulation to further clarify management measures and law enforcement basis for all aspects of ODS. For management scope, the life-cycle supervision of production, sales, use, import and export, recycle, reuse and destruction of ODS are to be achieved. For management system, the full process supervision on ODS monitoring and evaluation, directory management, technology research and development, quota approval, supervision and inspection, and violation punishment are to be realized. At the same time, the legal force and deterrence have been further enhanced by reinforcing the intensity of penalties for various cases of violations.

In terms of source control, all chloromethane production enterprises have installed a verifiable and quantitative CTC online production monitoring system, realizing real-time monitoring of the entire process of CTC from production to disposal. For the management of the production and consumption of ODS raw materials, through measures including the revision of the Regulation and establishment of the ODS data information management system, targeted supervision and reporting measures have been formulated for implementation. By adopting these measures, the Government of China has carried out more systematic and strict control over ODS from the source of supply to prevent the illegal outflow of ODS.

In terms of supervision and law enforcement, through a combination of national special law enforcement and daily supervision and inspection in all provinces and cities, the Chinese government has been severely cracking down on illegal ODS behavior and holding the offenders accountable,

continuously imposing high pressure and deterrence against illegal ODS behavior, which has fully demonstrated China's firm attitude of "zero tolerance" towards illegal ODS behavior. In response to the issue such as inadequate inspection capabilities of ODS law enforcement and testing methods, MEE has established 8 laboratories for testing ODS in industrial products and issued relevant testing standards, so as to provide timely and effective technical support for law enforcement inspections. By issuing *the Guideline on the Supervision of Ozone Depleting Substances (Trial)* and providing law enforcement detectors for local EEBs and organizing training for law enforcement officers from provincial, municipal and county levels, China has been continuously strengthening ODS supervision and law enforcement capabilities of local law enforcement officers, resulting in systematic and regular ODS supervision and law enforcement.

In terms of ODS atmospheric monitoring and evaluation, in response to the lack of scientific monitoring capabilities and the lack of effective compliance evaluation mechanisms, the Chinese government has initiated the planning and construction of an ODS atmospheric monitoring network. Through establishment of a unified technical system of monitoring technology and comprehensive evaluation methods, quality management, data sharing and information release, monitoring and evaluation work will be organized to timely collect, analyze and evaluate the background and trend of ODS in the atmosphere, strengthen compliance monitoring and early warning capabilities and performance evaluation capabilities, so as to provide technical support for compliance management.

On the basis of summarizing previous experience in compliance practice, the Chinese government has made further improvement in compliance supervision and management by adopting the above measures in terms of scientific monitoring, law and regulation system, supervision and law enforcement, capacity building etc., so as to comprehensively enhance the implementation of the Montreal Protocol. At the same time, public participation and industry collaboration have been further consolidated to form a sound system of ODS supervision and management. The system will continue to operate effectively in the future to provide a strong guarantee for ensuring effectiveness of compliance.

Appendix I: Progress of Decision 83/41 and all relevant work

No.	Activities	Decision 83/41	Progress
1	Improve Law and Regulation System	a)i) Increase and extension of penalties for enterprises' non-compliance with the controlled substance regulations C)d) Extension of penalties and prohibitions to consumers of controlled substances or products containing controlled substances, where appropriate;	● The implementation of the Regulation has been assessed and *the Regulation on the Administration of Ozone Depleting Substances and Hydrofluorocarbons (Draft for Soliciting Opinions*) has been formulated based on the assessment opinions and new requirements for implementing the Protocol. The revision reinforces the punishment measures on various cases of violations, and incorporate HFCs into scope of control; • As of the end of June 2020, MEE has completed the public opinion solicitation. At present, it is being revised based on the opinions and feedback; • The Regulation (Revised Draft for Approval) will be submitted to the State Council for review in 2020.
2	Carry out law enforcement actions	a)ii) Intensification of inspections of enterprises currently or formerly using controlled substances a)iii) Implementation of controlled-substance inspection plans for ecology and environment bureaus (EEBs); a)iv) Increased provision of support and enforcement tools to EEBs; c)ii) Increased direction on enforcement at the provincial	• During the 2019 special ODS law enforcement inspection organized by MEE, it is confirmed that 16 enterprises have been engaged in illegal use of CFC-11, the local EEBs have handled these cases in accordance with the law. In one case, the enterprise's legal representative was sentenced to 10 months of imprisonment for the crime of environmental pollution by

		level from the national government; c)vi) Random testing of products that might contain controlled substances; c)viii) Reporting on the details of enforcement activities, including the capacity of the reactor, amount of controlled substance on site, relevant records on feedstock purchases and sales, any penalties resulting from the enforcement action	the local court.; • As of December 2019, 50 portable ODS instant detectors have been distributed to local EEBs; • MEE launched a new round of special ODS law enforcement inspection nationwide at the end of July 2020. The inspection is mainly targeted at HCFC-141b and HCFC-22 production enterprises and illegal production and use of CFC-11; • *The Guideline on the Supervision of Ozone Depleting Substances (Trial)* was issued and distributed to local EEBs in December 2019; • In 2020, another joint special law enforcement action will be organized with participation by both central and local law enforcement officers. • In 2021, through the national CTC online monitoring platform and industrial rewards for reporting platform, MEE will further intensify source control, crack down on illegal ODS production, and improve the identifying mechanism, investigation mechanism and disclosure mechanism of illegal ODS production cases in steps .
3	Intensify Source Control	b)iii) Real-time flow monitoring of CTC at chloromethane production enterprises	• All 16 chloromethane enterprises with CTC by-production have completed the installation of the CTC online production monitoring systems. MEE compiled

			the CTC Monitoring Platform Construction Plan; the platform is currently in the stage of system design and development; • From June 2019 to January 2020, MEE has dispatched supervisory working groups to 16 CTC by-production enterprises to carry out the on-site inspection which achieved continuous daily on-site supervision. A total of 14 rounds of on-site supervision with attendance reaching 577 had been conducted.. During the COVID-19 outbreak, the enterprises were required to report CTC related data weekly, and local EEBs have taken measures to conduct on-site inspections as needed. • The online trial operation of the national CTC monitoring platform is expected to be completed by the end of 2020 to realize the online monitoring of CTC as by-product in all chloromethane enterprises.
4	Build capacity for implementing the Protocol	a)v) Development of an online registration and tracking system for controlled-substance users; a)vi) Increased training for customs officers; b)ii) Establishment of an additional six testing laboratories for controlled substances in products; c)iii) Development of performance indicators for enforcement activities, such as the number of customs	• MEE had completed the construction of 8 ODS testing laboratories for industrial products, and all of them have obtained the expansion of CMA certificate for these laboratories to ensure testing results with legal effect could be provided; • In October 2019, MEE has approved and issued two national environmental protection standards for the

		officers trained or inspections undertaken	determination of ODS in polyurethane foam and pre-blended polyols. • In December 2019, MEE held a training workshop on ODS phase-out management, which trained about 120 officers and technical support personnel from the atmospheric environmental division of local EEBs. In December 2019 and July 2020, MEE held two training workshops for law enforcement personnel, the two workshops trained a total of 400 environmental law enforcement officers at the provincial, city and county level; • Trainings have been conducted by key local EEBs: In October and November 2019, Henan, Jiangxi and Shanxi carried out training workshops respectively, a total of 1,130 personnel from provincial, city and county level atmospheric environmental management departments received training; • MEE and the General Administration of Customs will continue to jointly organize the training workshops on ODS import and export management for a total of 70 customs officers in this October. • Since October 2019, MEE has launched the construction of the ODS data information management system, which will be comprehensively updated based on

			the existing HCFCs online information system to realize the online data reporting of enterprises. The online test of the system module will be completed before the end of 2020.
5	Enhance Cooperation with Industries	a)vii) Conduct an annual mass balance analysis of foam blowing components to determine the market size of the foam sector; a)viii) Publicizing the outcome of investigations and increased communication with industry; c)v) Regular and frequent consultations with industry and enterprises to ascertain market conditions; c)vii) Conduct annual mass balance analysis of refrigeration and air-conditioning market to determine market size and verify reported HCFC consumption;	• Industrial associations have been providing technical support for supervision and management, policy formulation and law enforcement, and some technical experts directly participate in special law enforcement operation and on-site inspection supervision etc. During the revision of the Regulation, communications are conducted actively with industrial associations, experts, scientific research institutions and others, and their suggestions are fully incorporated during the revision process; • China Plastic Processing Industry Association (CPPIA) cooperated with industry experts to analyze the situation of the polyurethane foam market in 2018 and consumption of various blowing agents by using mass balance analysis; • MEE has communicated with industrial associations and experts to discuss the feasibility and methodology of mass balance analysis in the refrigeration and air-conditioning market. The feasibility research on the mass balance analysis of the ICR sector and RAC sector

			has been completed. The analysis found that mass balance analysis was applicable to the use of HCFC-22 in the room air-conditioning manufacturing sector, but not to the industrial and commercial refrigeration sector.
6	Establishment of measuring and alerting capability	b)i) Establishment of a national controlled atmospheric monitoring network for controlled substances; c)i) Fast-track atmospheric monitoring through movement or modification of existing equipment and/or flask sampling	• The National ODS Monitoring Expert Committee has been established and a joint expert team has been formed. • MEE is organizing relevant domestic research institutions to develop high-sensitivity ODS atmospheric monitoring equipment. • MEE will start the construction of ODS monitoring stations in 2021 and conduct ODS monitoring in 2022 as planned.
7	Non-governmental study	d) To note that the Government of China will consider engaging a non-governmental consultant to undertake a study (including quantitative data, where available, and qualitative market information) to determine the regulatory, enforcement, policy or market circumstances that might have led to the illegal production and use of CFC-11 and CFC-12	• Through public bidding, MEE selected an independent non-governmental consulting agency (ESD China Limited) to conduct a study to evaluate the ODS phase-out regulations, policies, law enforcement and market circumstances and risks in China. At present, the study report has been completed and will be submitted to the 86th meeting of the ExCom.

Appendix 2: Mass balance analysis of the PU foam sector in 2018

1. Background

Polyurethane (PU) foam can be divided into flexible foam (sponge), rigid foam and integral skin foam. Flexible PU foam is highly resilient and is widely used in sectors such as furniture manufacturing. The integral skin PU foam has high-resilience inner core and good strength skin, and is mainly used in sectors including automobiles and furniture in the manufacturing of auto seat, steering wheels, armrests, etc. Rigid PU foam mainly serves as thermal insulation materials, and as the material with the best thermal insulation performance known so far, it has been widely used in various sectors of the national economy. The main subsectors using PU rigid foam currently include household appliances (insulation), solar water heaters (water tanks), building materials (insulation materials), cold storage, refrigerated transportation (reefer containers, refrigerated vehicles, and square cabin, etc.), petrochemicals (pipelines), automobiles (integral skin foam for steering wheels, seat, ceilings, etc.), aerospace, furniture manufacturing, etc., and a small amount is used for non-insulation purposes such as shoemaking, floating body, etc.

The blowing agents of PU foam products are grouped into two categories, namely chemical blowing agents and physical blowing agents. Up to now, the main chemical blowing agent is water. PU physical blowing agents include the phased-out CFC-11, HCFC-141b in the phase-out process, as well as cyclopentane, hydrofluorocarbons (HFCs), hydrofluoroolefins (HFO) and methyl formate etc.. Due to the differences in molecular weights, different physical blowing agents require different amount of blowing agents to achieve the same foaming effect. Ratio of various blowing agents in PU foam pre-blended polyols is shown in Table 1.

Table 1 Ratio of various blowing agents in pre-blended polyols

Blowing agent	Ratio in pre-blended polyols	HCFC-141b equivalent coefficient
CFC-11	24-28%，maximum distribution 25%	0.80
HCFC-141b	18-25%, maximum distribution 20%	1
Water	2.5-5%, maximum distribution 2.5%	8
Hydrocarbon (cyclopentane etc.)	10-12.5%, maximum distribution 12%	1.67
HFC-245fa/365mfc	10-12.5% (compared with CFC/HCFC system, more water is needed), maximum distribution 12%	1.67

HFO	Around 20% (more water is needed)	1

Note: HCFC-141b equivalent coefficient is the ratio of the blowing effect by an amount of other blowing agents to that of HCFC-141b of the same amount with HCFC-141b as the baseline blowing agent. For example, the equivalent coefficient HCFC-141b of the hydrocarbon blowing agent is 20%/12%=1.67, indicating that, for the same amount of hydrocarbon and HCFC-141b blowing agent, hydrocarbon can produce 167% foam produced by HCFC-141b. The coefficient is used to simplify the calculation of the amount of various raw materials when a foam product uses multiple blowing agents. The HCFC-141b equivalent coefficient is not completely related to the molecular weight of the blowing agent because considering different costs of different blowing agents, water is usually added to the higher-cost blowing agents when needed.

2. Calculation and data sources of blowing agent consumption in the PU foam sector

There are two main raw materials for PU foam: isocyanates (polymeric MDIs) and pre-blended polyols, into which the blowing agents are usually pre-blended. For foam products mainly using physical blowing agents (blowing agents other than water), the ratio of MDI to pre-blended polyols ranges from 1.05 to 1.1. When water is added to replace part or all of the physical blowing agents, MDI consumption will increase gradually and could bring the ratio up to 2. In addition, for foam products with high flame-retardant requirements or heat-resistant requirements (such as polyisocyanurate panels and pipes), the ratio can also reach 2.

In Chinese PU foam sector, the number of MDI suppliers is extremely limited, and they are all super large enterprises. Many organizations in the polyurethane sector have conducted continuous statistical analysis on the consumption data of the entire sector and its sub-sectors, and the data is highly credible. In contrast, pre-blended polyol suppliers are numerous and vary considerably. Statistics of the sector, especially its sub-sectors, is inaccurate. Therefore, MDI is used as the base data for analyzing blowing agent consumption in the PU foam sector: the amount of pre-blended polyols in different sub-sectors can be achieved by calculating the ratio of MDI to pre-blended polyols in various sub-sectors through the proportion of HCFC-141b conversion in each sub-sector and the distribution of the various blowing agent consumption in each sub-sector; consumption of various blowing agents can be calculated in different sub-sectors by using the estimated ratio of various blowing agents in each sub-sector, and the ratio of blowing agent in pre-blended polyols. In this way, the consumption of various blowing agents in each sub-sector could be reached, and the total amount of various blowing agents can be compared with the annual amount of various blowing agents obtained by our investigation.

2.1 MDI consumption

MDI consumption in the PU foam sector and its sub-sectors is provided by the consulting firm in collaboration with the China Plastics Processing Industry Association (CPPIA). During estimation of blowing agents consumption in the sub-sectors, MDI consumption in polyurethane products (such as adhesives, sealants, elastomers, etc.) that use no or few blowing agents is excluded.

Table 2 MDI consumption in the PU foam sector and its sub-sectors in 2018

Consumption sub-sectors	Consumption of isocyanates (polymeric MDIs), 10,000T
Refrigerators and freezers	48.67
Small household appliances such as electric water heaters	4.33
Solar water heaters	1.08
reefer container	3.47
Automotive foam	15.20
Pipeline	8.62
Spraying foam	5.20
Panels	6.24
Filling (security doors)	2.00
Total	94.81

2.2 Investigation of various blowing agents consumption in the PU foam sector

1. HCFC-141b consumption in the PU foam sector comes from annual data reporting by the government. In 2018, HCFC-141b consumption in the PU foam sector was 34,176.74 metric tons.

2. Consumption of HFCs/HFOs blowing agents and hydrocarbon blowing agents were obtained through investigation of suppliers by CPPIA. The categories of HFCs blowing agents used in Chinese PU foam sector include HFC-245fa/365mfc (HFC-365mfc may also be mixed with HFC-227ea), with a total consumption of about 8,300 metric tons in 2018. HFO-1233zd(E) is mainly used in refrigerator foam, with a consumption of about 1,800 metric tons in 2018. The main hydrocarbon blowing agents is cyclopentane, and two other categories, namely n-pentanes and isopentanes are also used. The total consumption in 2018 was about 43,000 metric tons.

3. No objective data source was found for consumption of water foaming agents, but we know water foaming applications in the Chinese PU foam market well. Water foaming is mainly used in automotive foam (seat, car parts of integral skin foam and ceilings, etc.), pipe insulation and filling foam sectors with low thermal insulation requirements.

4. In China, the PU foam sector also consumes other blowing agents such as methyl formate and liquid carbon dioxide, and their consumption in 2018 did not exceed 3,000 metric tons.

3. Calculation of various blowing agents consumption in the PU foam sector

3.1 Analysis of rationality of blowing agent consumption in terms of foaming efficiency of various blowing agent and the total sector scale

Table 3 Proportion of blowing agents in foam products in the PU foam sector

Blowing agent	Amount, MT	HCFC-141b equivalent coefficient	Equivalent amount of HCFC-141b, MT
HCFC-141b	34,177	1	34,177
hydrocarbon	43,000	1.67	71,810
HFCs	8,300	1.67	13,861
HFOs	1,800	1	1,800
Water	5,600	8	44,800
Total	92,877		166,448

PU foam production, 10,000 MT	174.58
The proportion of blowing agent in foam products based on HCFC-141b blowing agent	9.5%

According to the above calculations, the total consumption of blowing agents based on HCFC-141b accounts for about 9.5% of the total foam production. This is generally consistent with the practice of the PU foam raw materials, including HCFC-141b accounting for about 20% of pre-blended polyols and the ratio of MDI to pre-blended polyols being around 1.1. The above calculations are rational analysis, but it should be pointed out that there are other blowing agents such as methyl formate and liquid carbon dioxide in the Chinese PU foam market, and the total consumption should not exceed 3,000 tons.

3.2 Calculation of various blowing agents consumption in the PU foam sub-sectors (see

Table 4)

3.3 Analysis of differences

According to Table 3 and Table 4, the consumption of HCFC-141b and water is relatively consistent, but the total consumption of hydrocarbons and HFC/HFO calculated in Table 4 is about 4,700 metric tons more than that in Table 3. In our analysis, the main reason for the difference lies in our investigation focus on the cyclopentanes because there are a limited number of cyclopentane suppliers with whom we have established long-term information cooperation. However, n-pentane and isopentane, the two blowing agents with increased consumption in recent years and with broad applications, have received relatively little attention because we are not familiar with suppliers of n-pentane and isopentane. Another reason for the difference in blowing agent consumption is the fact that there are about 3,000 tons of other blowing agents in the PU foam sector, such as methyl formate, and liquid carbon dioxide.

4. Conclusion

The above analysis demonstrates that the consumption of MDI and various blowing agents obtained through various information channels is relatively consistent and reasonable.

The uncertainty of the analysis is mainly derived from the judgment on the ratio of water foaming. Due to lack of objective sources, making professional judgments based on our understanding of the sector is the only way. We believe that the sub-sectors of Chinese PU foam sector that use water foaming can support our judgment on water consumption in the PU foam sector.

Table 4 Proportion of blowing agents and consumption calculation in the PU foam sub-sectors in 2018 (Unit: 10,000 MT)

Consumption sectors	MDI	ratio of MDI to pre-blended polyols	pre-blended polyols	Foam production	Hydrocarbon+ HFC+HFO	Hydrocarbon+ HFC+HFO	Water foaming	Water consumption	The amount of HCFC-141b in pre-blended polyols	HCFC-141b consumption
Refrigerators and freezers	48.67	1.15	42.32	90.99	97%	4.93	0%	-	20%	0.25
Small household appliances such as electric water heaters	4.33	1.15	3.77	8.10	92%	0.42	0%	-	20%	0.06
Solar water heaters	1.08	1.08	1.00	2.08	10%	0.01	15%	0.006	20%	0.15
Reefer container	3.47	1.15	3.02	6.49	100%	0.36	0%	-	20%	-
Automotive foam	15.20	1.50	10.13	25.33	0%	-	95%	0.385	12%	0.06
Pipeline	8.62	1.25	6.90	15.52	3%	0.02	60%	0.166	20%	0.51
Spraying foam	5.20	1.05	4.95	10.15	0%	-	5%	0.010	25%	1.18
Panels	6.24	1.08	5.78	12.02	5%	0.03	0%	-	21%	1.15
Filling (security door)	2.00	1.05	1.90	3.90	0%	-	85%	0.065	20%	0.06
Total	94.81		79.77	174.58		5.78		0.641	1.78	3.42

Note: In China's PU foam industry, hydrocarbon blowing agents and HFC blowing agents are mainly used in refrigerators, freezers and reefer containers. They are usually mixed, and they have the same HCFC-141b equivalent coefficients, so they are calculated together. HFO's HCFC-141b equivalent coefficient is different from that of hydrocarbons, but it is also mainly used in refrigerators, freezers and reefer containers. Considering small amount of HFO, it is also calculated in

combination with hydrocarbons and HFC.

Appendix 3: Mass balance analysis in room air-conditioning sector

1. Background

Based on the overall manufacturing and sales scale of the room air-conditioning (RAC) sector and the sales of room air-conditioners using HCFC-22 as refrigerant, China Household Electrical Appliance Association (CHEAA) conducted a mass balance analysis of HCFC-22 consumption in the RAC manufacturing sector for 2017 and 2018 to assess HCFC-22 consumption in the RAC sector and analyze HCFC-22 phase-out status in the sector in China.

2. Data sources

1) The total production of the RAC sector comes from statistical data of CHEAA;

2) Product mix and scale data of room air-conditioners for domestic sales are from Beijing All View Cloud Data Technology Co., Ltd.

3) Product mix and scale data of room air-conditioners for export come from the General Administration of Customs;

4) Sales of room air-conditioners using different refrigerants are from statistical and calculated data of CHEAA;

5) The HCFC-22 consumption per unit of room air-conditioners for various product types comes from investigation of refrigerant consumption in the RAC sector organized by CHEAA in 2011.

3. Calculation methodology

（1）At present, room air-conditioners using HCFC-22 refrigerant are mainly fixed-frequency products, which can be further subdivided into five categories: window air-conditioner, split air-conditioner with cooling and heating, stationary air-conditioner with cooling and heating, cooling only split air-conditioner and cooling only stationary air-conditioner.

（2）Since import of HCFC-22 air-conditioner products in non-A5 countries has been gradually banned around 2010, air-conditioners using HCFC-22 refrigerant for export are only sold to A5 countries.

（3）According to the calculation by CHEAA, the proportion of HCFC-22 refrigerant used in fixed-frequency room air-conditioners for domestic sale and export to A5 countries is about 70% at present;

（4）According to linear regression calculation results, marked HCFC-22 refrigerant charging quantity of a typical window air-conditioner (cooling capacity: 3 kW), split air-conditioner with cooling and heating (cooling capacity: 3 kW), a stationary air-conditioner with cooling and heating (cooling capacity: 5.5 kW), cooling only split air-conditioner (cooling capacity 3 kW), and cooling only stationary air-conditioner (cooling capacity: 5.5 kW) are respectively 0.89 kg, 0.89 kg, 1.66 kg, 0.84 kg, and 1.40 kg;

（5）According to sale scale of various product types, proportion of air-conditioners using

HCFC-22 refrigerant and charging quantity per unit, HCFC-22 consumption of various product types can be calculated separately, and the total HCFC-22 consumption of the RAC sector could be reached.

（6）Considering refrigerant leakage in the process of storage, transportation, charging, and repair, actual refrigerant charging quantity in the manufacturing process is often slightly larger than the quantity marked on the nameplate due to the manufacturer's consideration of product quality. Therefore, actual HCFC-22 consumption should be 10%~15% higher than the above calculation results.

4. Calculation results

According to the above methodology, HCFC-22 consumption in the RAC sector from 2017 to 2018 is estimated in the following table. HCFC-22 consumption in the RAC sector is about 53,600 metric tons in 2017, and about 51,500 metric tons in 2018, which are generally consistent with the annual sector consumption data reported to the Multilateral Fund Secretariat in 2017 and 2018.

Year	2017	2018
Sales of fixed frequency stationary air-conditioner with cooling and heating / 10,000	1161	1082
Sales of fixed frequency split air-conditioner with cooling and heating / 10,000	3800	3667
Sales of cooling only stationary air-conditioner / 10,0000	26	23
Sales of cooling only split air-conditioner / 10,000	254	306
Sales of window air-conditioner/ 10,000	1356	1445
Consumption of fixed frequency stationary air-conditioner with cooling and heating/ T	15273	13962
Consumption of fixed frequency split air-conditioner with cooling and heating consumption/ T	26743	25335
Consumption of cooling only stationary air-conditioner/ T	284	249
Consumption of cooling only split air-conditioner T	1691	1994
Consumption of Window air-conditioner consumption/ T	9568	10007

HCFC-22 consumption/ T	53559	51547