Annex IV

DEMONSTRATION PROJECT ON REFRIGERANT QUALITY, CONTAINMENT AND INTRODUCTION OF LOW-GLOBAL-WARMING POTENTIAL (GWP) ALTERNATIVES

Final Report

85th meeting of the Executive Committee for the Implementation of the Montreal Protocol

March 2020

CARIBBEAN SUB-COMPONENT

Countries:	the Bahamas, Grenada, Saint Lucia, Saint Vincent and the Grenadines, Suriname
Title:	Safe handling of low-GWP flammable refrigerants
Project Budget:	USD 234,584
Implementing Agency:	UNIDO
National Counterparts:	National Ozone Units, National Refrigerant Associations, Vocational Schools

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I. Background

The phase-out of hydrochlorofluorocarbons (HCFCs), specifically in the refrigeration and air-conditioning sector, brought about a broader discussion on suitable long-term alternatives. Readily available refrigerant alternatives, which are hydrofluorocarbons (HFCs), have however high global warming potentials (GWPs) and contribute to global warming. The refrigeration and air-conditioning manufacturing sectors worldwide, are thus gearing towards the use of low-GWP alternatives, such as hydrocarbons (HCs) and novel refrigerant formulations of HFO and HFC blends, which are designed to have short atmospheric lifetimes.

It has been established that refrigeration service technicians in countries with large service sectors need to be well trained and equipped to cope with the installation and maintenance demands of next-generation appliances. HCs and HFOs have zero-ODP and low-GWP properties, but are flammable. HCs, such as propane, are classed as "A3 - highly flammable". HFOs and HFC blends are classified with "A2L – mild flammability" with slow propagation. Countries are steadily beginning to take up hydrocarbons as an alternative to HCFCs in air-conditioning although few technicians are trained to handle the alternatives effectively. It is anticipated that as old installations near decommissioning, more end-users will opt for hydrocarbon-based appliances.

However, specialised training for technicians on flammability needs to be done to ensure that only well-trained technicians service hydrocarbon-based equipment. Hydrocarbons such as propane, LPG and hydrocarbon mixtures have been used during service operations, where the risks associated with the flammability and the thermodynamically properties of the refrigerants has not always been taken into account. Hence it is important to increase the know-how and confidence of technicians with regard to using flammable low-GWP refrigerants when installing new units or servicing old units.

To address these barriers, the Executive Committee for the Implementation of the Montreal Protocol approved at its 76th in May 2016 a demonstration project on refrigerant quality, containment and introduction of low-global-warming potential (GWP) alternatives. The project was implemented through two components, one in the Caribbean, and one in Eastern African, by UNIDO (lead implementing agency) and UNEP (co-operating implementing agency).

The Caribbean component was implemented by UNIDO in the Bahamas, Grenada, Saint Lucia, Saint Vincent and the Grenadines, and Suriname for a total funding of USD 234,584.

II. Project objectives

In order to facilitate the introduction of low-GWP refrigerants in the servicing sector, the demonstration project aimed to:

- Enhance the expertise of technicians and train specialized trainers;
- Upgrade the training curricula at vocational centers;
- Augment the equipment at the regional training center;
- Expose stakeholders to the latest HC-based equipment and components on the market.

The activities planned under the project were linked to the countries' respective HPMPs. The use of flammable refrigerant alternatives is covered to varying extents in the HPMPs. However, the funding levels of the HPMPs could not adequately cover the issue of flammability. Therefore, regional, as well as country-specific activities were required to bring about a more comprehensive approach that would enable the countries to transition to flammable low-GWP refrigerants in a safe manner, as proposed in the project and described in more details below. Moreover, it was vital that these activities were carried out as soon as possible, so that current HC service practices are conducted safely, in light of the concerns pointed out under decision 72/17 of the Executive Committee.

III. Implementation plan

Activities	Budget (USD)	Countries
1. Design of training curriculum preparation and monitoring of training	30,000	All
2. Upgrading training centre	72,417	Grenada
3. Train the trainers regional workshop	42,792	All
4. Training sessions for technicians	49,375	All
5. Workshop and exhibition	5,000	Grenada
6. Regional expert group meeting and dissemination of results	35,000	All
Total	**234,584**	

IV. Implementation report

Activity 1: Design of training curriculum preparation and monitoring of training

A regional workshop for policy makers and curriculum developers was held in May 2017, where representatives from national ozone units and training providers were trained on preparing a training course and operational and organisational activities featuring the essential aspects of the training organisation. In addition, various types of certification schemes from different regions were introduced and discussed to serve as a platform to selecting the right components for a scheme for the Caribbean region.

The National Ozone Officers, their alternates, national consultants and training provider during the regional workshop

A regional training curriculum was designed to ensure that only qualified technicians are handling and servicing equipment and flammable fluids. This curriculum encompasses theoretical knowledge as well as specifies practical expertise that must be achieved to get the necessary skills to safely handle low-GWP alternatives and flammable refrigerants. It includes a list of the appropriate equipment and materials for training of technicians. In addition, the competence and requirements for an adequate assessor and venue requirements are also provided. This curriculum should be adapted by each country for their respective schemes, but it is already in use at the regional training center in Grenada, together with a training programme developed by the GIZ. The complete curriculum is provided in annex 1.

Activity 2: Upgrading Training Centre

In order to facilitate the introduction and the safe use of low-GWP refrigerants, the regional training centre in Grenada at the T.A. Marryshow Community College (TAMCC), St. George's was upgraded in 2017 with equipment, tools and materials suitable for low-GWP flammable refrigerants.

The list of items was established in consultation with the National Ozone Officer of Grenada, and other National Ozone Officers of the region, based on needs identified at the regional level and following the recommendations contained in the training and certification curriculum on flammable refrigerants developed as part of the project and the "Guidelines for the safe use of hydrocarbon refrigerants" developed by the GTZ Proklima in 2010.

Items delivered included manifolds with gauge for hydrocarbons, electronic leak detectors for flammable refrigerants, portable charging stations for hydrocarbons, propane and butane gas cylinders, and other tools and material for use of low-GWP refrigerants in air-conditioning. The complete list of equipment, tools and materials delivered is provided in annex 2.

In 2019, the regional training center was operating fully for the RAC technicians of Grenada, and will open to technicians of other countries of the region in 2020. The training center has the capacity to train up to 20 technicians per session, and it is envisaged that once open to other neighbouring and participating countries, up to 10 technicians could come from outside Grenada at each session. Participation of technicians from all countries in the training remains subject to availability of

financing. Countries are therefore invited to consider possible source of funding such as the national HPMPs or other ozone or climate related projects.

Activity 3: Train the trainers Regional Workshop

A regional train-the-trainers workshop was organised in Grenada on 22-25 August 2017. 20 RAC technicians, four from each of the participating countries, were trained as trainers on theoretical and practical aspects of refrigeration servicing, in particular on the safe handling of refrigerants and alternatives. Technicians who participated in the workshop already possessed consistent knowledge and practical skills on HFCs and other traditional refrigerants. The full list of technicians who attended the workshop is provided in annex 3.

The objectives of the workshop were more specifically to:

- Disseminate technical knowledge on the flammable refrigerants necessary to operate with these types of refrigerants;
- Showcase the reduction of direct and indirect global warming emissions that it is possible to obtain with systems using flammable refrigerants thanks to their better energy efficiency;
- Present the safety aspects, as mandatory knowledge required when dealing with the flammable refrigerants;
- Provide practical and technical skills, which would allow technicians to maintain andrepair flammable refrigerant-systems in safe conditions;
- Provide a consistent theoretical and practical knowledge (train-the-trainers) for future training of other technicians in their area;
- Activate a l knowledge process, which students could further develop for a life project of continuous learning.

The workshop consisted of both theory and practice sessions, preparing for the final assessment. The training took place at the TAMCC, recently upgraded with equipment, tools and materials suitable for low-GWP flammable refrigerants. Part of the theoretical lessons were prepared based on the REAL alternatives learning material, and on guidelines on F-gas refrigerants. Furthermore, additional material was prepared specifically by the trainer, based on European laws.

The theoretical topics presented during the workshop included:

- Information on HCFC-free technologies available or HCFC alternative substances in servicing including training on the safe handling of refrigerants and alternatives, mainly those with high toxicity, flammability or pressure;
- Refrigeration principles and fundamentals, refrigerants, temperature-pressure relation and diagrams, refrigerant properties;
- Thermodynamic principles, basic components of the refrigeration cycle;
- Applications with a choice of components, compressors, evaporators, condensers, calculations and sizing;
- Refrigerating plant: efficiency and refrigerating capacity, maintenance, disadvantages, correct installation, component functionality control (compressor, condenser, evaporator, valves), main electrical problems, different types of refrigerants, lubricants and problems connected with their utilisation, faulty functioning of refrigerating plants;
- Presentations of hydrocarbon applications in window and split type air-conditioners, chiller, etc.;
- Methodology for conducting risk assessments for systems and equipment using

hydrocarbon/flammable refrigerants, e.g. electrical components.

Participants during the theoretical session

The practical session covered the following aspects:

- Introduce good practices to avoid the refrigerant emissions during servicing, troubleshooting and maintenance, including refrigerant containment;
- Vacuum, charge. regulation, tools, recovery, retrofit, drop-in, manometer reading, pressure gauge;
- Research and damage detection, leak detection, valves, filters, oil and liquid separators;
- Practical applications of hydrocarbons in the refrigeration-servicing sector;
- Safe handling of flammable refrigerants.

At the end of the training course, an assessment was carried out and successful participants received the F-gas and the REAL alternatives certifications. These certifications are recognised worldwide and certify the competence level of technicians for handling refrigerant gases- in this case, F-gases and flammable refrigerants. An example of the REAL alternatives certificate is provided as annex 4.

Activity 4: Training sessions for technicians

Two hydrocarbon-based air-conditioning units were delivered to each country (apart from Grenada, which received units earlier for the regional training centre) to organise their in-country training sessions. This activity met with difficulties as manufacturers of hydrocarbon-based air-conditioners are still reluctant to sell small quantities commercially. Based on consultations with National Ozone Officers, additional purchases of materials were made in all countries but Grenada to ensure that each country is well equipped for their in-country training. The complete lists are provided as annex 5.

As of March 2020, 85 air-conditioning technicians have already been trained during the country training sessions organised since the train-the-trainers regional workshop which took place in August 2017 in Grenada. An additional 40 to 70 technicians will be trained before August 2020. When possible, the trainers trained during the workshop have been carrying out the country training sessions. The detail of the training sessions by country is provided hereafter.

The Bahamas:

A three-evening training course was organised on 20-22 August 2019 for 9 technicians. One local RAC trainer and the National Ozone Officer conducted the training. The full list of participants to the training is provided in annex 6.

The topics covered included: properties of hydrocarbons, toxicity, flammability restrictions on use of hydrocarbons, availability of hydrocarbons, design characteristics of appliances using hydrocarbons, leakage issues and leak detection, maintenance and repairs of appliances using hydrocarbons.

Grenada:

A two-day training course was organised on 8-9 May 2019 for 32 technicians. Two local RAC trainers and the National Ozone Officer (NOO) conducted the training. The technicians were required to have at least three years working experience in the field of RAC to participate in the training. The full list of participants to the training is provided in annex 6.

Major topics covered in the training included but were not limited to: properties of hydrocarbons, risk assessment, legislation, policy and standards, fire and electrical safety, charge limitation and room size calculations, personal protective equipment and specialise tools and equipment required for installation and servicing, leak detection, installation, servicing and maintenance practices, and brazing and pipe connections. The methodology used included a combination of power point presentations, lectures, handouts and multi-media.

Participants during the theoretical session

During the practical training, the participants were required to demonstrate their competence in brazing, flare joint connections, leak and pressure testing, evacuation, venting and charging of refrigerants.

Participants during the practical work

During the evaluation participants were asked to give their overall rating of the training. Out of 27 respondents, 18 rated the training as been excellent, eight as very good and one as good. At the end of the training, certificates of participation were awarded to all the participants.

Participants receiving their certificate

Saint Lucia:

A two-day training session was organised on 4-5 February 2020 for 11 air-conditioning technicians. The facilitators of the training were two refrigeration technicians who underwent training in flammable refrigerants and their technology under the "train the trainer" component of the project. The full list of participants to the training is provided in annex 6.

Participants during the theoretical session

The first day was dedicated to theoretical aspects, including a presentation of the Montreal Protocol and of the HPMP for Saint Lucia, descriptions of the most common types of refrigerants, measures for the safe handling of flammable refrigerants and good servicing practices for flammable refrigerants, and a reminder of thermodynamic notions relevant to refrigeration and air-conditioning, At the end of the first day, participants were given an examination to assess their knowledge and understanding on the subjects covered during the theoretical component. The second one consisted of practical sessions and hands-on exercise.

Overall, the technicians found the training to be very useful and informative. The recommendations which were made by participants included the organisation of longer training sessions and the possibility for RAC technicians to purchase HC-based servicing tools to familiarise themselves with the technology.

Saint Vincent and the Grenadines:

A four-day training course was organised on 10-13 February 2020 for 11 technicians on the safe handling of low-global warming potential flammable refrigerants. Two local RAC trainers and the National Ozone Officer conducted the training. The full list of participants to the training is provided in annex 6.

The range of topics selected for the training session were geared towards ensuring that technicians are adequately prepared for the introduction and use of flammable refrigerants. These topics included: refrigeration cooling system, hydrocarbon refrigerants, flammable refrigerant safety, GIZ cool training programme and overview of training, safe design and general criteria for hydrocarbon refrigerants, hydrocarbons vs hydrochloroflourocarbons.

Participants during the theoretical session

The training also included practical work and hands-on exercise on the following topics: brazing project, testing and evaluation, demonstration of brazing with and without nitrogen, fabrication according to best practice, installations of hydrocarbon air conditioner, collection of data and system's analysis, requirements for data recording and labelling of systems, leak testing.

Participants during the practical work

Full day sessions were well attended by all registered participants. Theoretical sessions not only created an opportunity for technicians to have a better understanding of the use of hydrocarbon refrigerants, but also created a forum where participants were able to interact and network with other personnel within the industry to share their experiences. The practical exercises were successfully completed by all technicians. Participants indicated their appreciation for the training workshop and expressed a desire to be involved in similar sessions.

Suriname:

22 technicians were trained following the train-the-trainers workshop in Grenada in August 2017. All the technicians are members of the Air-conditioning, Refrigeration & Ventilation Association Suriname (ARVAS).

This training programme is now being extended, with multiple sessions taking place from March to August 2020, for an additional 40 to 70 technicians, in particular non-ARVAS members technicians and technicians from the informal sector. Each session will last four days, with two days of theory on topics such as basic thermodynamics, the cooling system, refrigerants, alternative refrigerants (hydrocarbons, carbon dioxide), differences between alternative refrigerants and HCFC, safety aspects,and compressor replacement and instalment. The two following days will be dedicated to practical sessions.

Activity 5: Workshop and exhibition

The workshop and exhibition was intended to showcase the offer of appliances using low-GWP alternative and servicing equipment offered by regional and international suppliers. Representatives from these suppliers would have participated to present their offers and answer questions from workshop participants. It was in particular envisaged to organise the exhibition back to back with the regional expert group meeting to create synergies between the discussions with the suppliers' representatives, and those on the success and challenges of the project among shareholders.

As international suppliers expressed the desire to understand better regional market conditions and trends, market surveys for each country have been considered and started, but the lack of data

available, both in the countries and from public sources, did not allow to draw any certain and conclusive results. More generally, the lack of data on the market remains a challenge to encourage international suppliers of HC equipment to increase their presence in the region. The geographical distance from markets which are more mature in terms of natural refrigerants is also seen as a barrier to the growth of trade between the region and international suppliers or manufactures. Hence, only documentation and catalogues were collected from international suppliers and no representative participated in the event.

Regarding regional suppliers, a representative from Grenz concept, a reseller of R290 appliances and RAC equipment participated remotely in the regional expert group which took place in Paramaribo, Suriname, on 5 October 2019. The representative gave on this occasion a presentation on its offer and business model, and answered the questions from participants. He indicated in particular that the recent end of the production of the 12,000 BTU units by Godrej is an issue as these models are the most popular in the country. It is supposed that Godrej stopped the production of these units due to the dynamics of its domestic market, India, where the 18,000 and 24,000 BTU units are preferred because of the very high ambient temperature.

The representative of Grenz concept further indicated that warranty is not offered by the company to customers if the appliances are not maintained by trained technicians. The manufacturer on its side guarantee the compressor for 10 years, and five years for the rest of the unit. Grenz concept currently sells in Guyana and Trinidad and Tobago, and estimates that there is a potentially large market in the Caribbean for R290 appliances. Shipping time from India is three months, therefore Grenz concept mostly operates based on stocks. The 12,000 BTU units are sold nationally for USD 900, and the 18,000 BTU for USD 1,300, both excluding transportation. The supplier's representative indicated that it would be ready to supply other countries, as the the representative from Saint Lucia in particular demonstrated strong interest.

Activity 6: Regional expert group meeting and dissemination of results

The regional expert group meeting took place in Paramaribo, Suriname, on 5 October 2019. 11 persons, including National Ozone Officers or their alternate representatives, attended the event. Two additional persons joined the meeting remotely. The attendance per country or organisation is as follows: the Bahamas (1), Grenada (2), Saint Lucia (2), Saint Vincent and the Grenadines (2), Suriname (3), Grenz concept, a supplier of R290 appliances in Grenada (1), and UNIDO (2). The topics discussed during the expert group meeting included among others the barriers to the introduction of low-GWP alternative, the curriculum and national training programs, as well as the

lessons learned of the project. The full list of participants to the regional expert group meeting is provided as annex 7.

Participants during a working session

Persistent Barriers to the introduction of low-GWP alternative:

In Suriname, R290 appliances and maintenance equipment are not present in the country to date. However, R32 equipment are available as well as R600a ones to a lesser extent. There are only two suppliers of refrigerants in the country, but they do not supply R290 gas. The main problem to the uptake of natural refrigerant in the country is the cost of the appliances, which is a complex issue to address due to the low consumption of the country.

In Saint Lucia, R290 appliances, maintenance equipment and gases are also not present in the country to date, except some R290 chillers. For the phase-out of CFCs, the government played an instrumental role in bringing alternative equipment in the country by developing collaboration with suppliers, but similar actions are still to be implemented for natural refrigerants. A majority of technicians still refuse to use R290 as a refrigerant, due to safety concerns, and even ignore that some chillers operating with R290 exist in the country.

In Saint Vincent and the Grenadines**,** R290 appliances, maintenance equipment and gases are as well not present. Further, there is a fatigue with regard to HC training and sensitisation. There are only three RAC maintenance companies in the country. Out of the four trainers trained during the train-the-trainers workshop, only one is ready to train technicians. The lack of availability of trainers locally remains an issue in organising more training sessions. The high number of private islands in the Grenadines is an additional challenge to control the equipment and technologies entering the country.

In Grenada, there is a lack of institutional and technical capacity to deal with natural refrigerants, in particular economic and fiscal barriers. The government could take further appropriate measures in this regard. Regarding availability of equipment, the situation in Grenada is different from the one in other countries. There are two suppliers of R290 appliances, all manufactured by Godrej. There are few suppliers of gases, different from the resellers of equipment. However, R290 specific maintenance equipment are not available in the country. All these suppliers embarked on alternative refrigerants supply following business recommendations and support from the National Ozone Office. There is also a need for additional awareness raising, as HC suffers from bad press and create fears among technicians. Additionally, standards and codes (in particular regarding charging procedures, room. size, brazing methods, venting, etc.) are not yet well known by the whole technician community. This should improve as training sessions are extended to more technicians. Specific technical topics, such as moisture prevention on equipment operating with R290 or R600a, are to be better addressed by the continuous training programme as technicians are not familiar with the specificities of hydrocarbons.

In the Bahamas, most if not all technicians in the country still ignore hydrocarbon use. The main barrier is the lack of equipment in the country since the market is mainly dependent on the US market. The country does not have any supplier of R290 appliances, maintenance equipment or gas.

Curriculum and subsequent training:

The curriculum is not yet officially adopted by individual countries, but it has already integrated the

body of reference material available in the region to design training on the safe handling of low-global warming potential flammable refrigerants. At the regional training centre at TAMCC in Grenada, it is used in combination with training material developed as part of a project with the GIZ.

In Suriname, 22 technicians were trained following the train-the-trainers workshop in Grenada in August 2017. In Saint Vincent and the Grenadines, the training of technicians following the train-the-trainers workshop did increase their confidence in alternative technologies.

The group agreed together with UNIDO that the curriculum will be further discussed.

Other discussions:

The group had extensive discussion on the voltage and frequency for the operation of R290 air-conditioners. Currently no equipment are available for countries using 110V/60Hz mains electricity. Technicians from Suriname, Grenada and Saint Lucia further indicated that countries with 60Hz frequency cannot use appliances made for 50Hz. This is a major limitation to the intake of R290 in the Caribbean and elsewhere. Using appliances designed to operate at a frequency of 50Hz in countries having 60Hz was deemed as counterproductive, as it increases energy consumption, reduces appliance lifetime, and leads to early malfunctioning. However, it was noted that technical assessments could be carried out with R290 appliances to examine how they operate under 110V/60Hz mains electricity, and if local alternatives could be developed. Finally, it was indicated that no appliances operating at 110V/60Hz is to be expected to be developed as long as .

The group also exchanged views on the risks associated with brazing and retrofitting appliances for use with R290. Grenada indicated that the GIZ developed a step-by-step guide on retrofitting, and that if correctly done, with all the necessary safety measures to prevent ignition, retrofitting can be consider as a viable option in absence of R290 appliances in the countries. Grenada explained that, in the national training, one full day is dedicated to brazing and safety measures while brazing. Grenada however strongly discouraged against using 290 as a drop-in replacement in appliances designed for the other refrigerants. It was further noted that the MLF and UNIDO strongly advise against the retrofitting of appliances or drop-in replacement, due to the safety risks and lack of awareness on dangers of hydrocarbon use in both scenarios.

Finally, tools available to promote good servicing practices were discussed by the group. Grenada in particular presented how to use the Android application "Good Servicing: Flammable Refrigerants Quick Guide". Grenada showed for example how to calculate the minimum floor area based on refrigerant charge, and vice versa. Grenada encouraged the group to promote the mobile application among their national technician community.

V. Financial status

Activities	Budget (USD)	Total expenditures (USD)
1. Design of training curriculum preparation and monitoring of training	30,000	28,701
2. Upgrading training centre	72,417	77,874
3. Train the trainers' regional workshop	42,792	42,769

4. Training sessions for technicians	49,375	62,643
5. Workshop and exhibition	5,000	0
6. Regional expert group meeting and dissemination of results	35,000	21,989
Total	**234,584**	**233,976**

VI. Lessons learned and recommendations for the sustainability of the project

Some of the following recommendations were made during the expert group meeting held in Paramaribo in October 2019 and after observations from project implementation:

- Individual countries to consider legally adopting the curriculum with small adaptations for country specificity where needed;
- Take appropriate measures to ensure that the regional training center in Grenada opens to RAC training technicians of other participating countries in 2020;
- Assess on a regular basis the capacity of the regional training center in Grenada and consider the need for a second regional training center in another country if capacities are not sufficient;
- Develop appropriate mechanisms and partnerships to encourage international suppliers or manufacturers of HC equipment and tools to offer a stronger presence in the region;
- Collect and analyse RAC market data with the view to encourage international suppliers or manufacturers to offer a stronger presence in the region;
- Develop appropriate mechanisms to encourage local suppliers to distribute HC equipment and tools;
- Envisage group purchases at the regional level of HC equipment and tools for distribution to local resellers with the view to limit the impact of transportation costs;
- Consider the opportunity to create a regional refrigeration association;
- Formulate monitoring and incentive mechanisms to encourage trainers and trained technicians to increase their participation in awareness raising and capacity building exercises conducted at the national and regional levels;
- Attract additional financial support from international funding bodies for the introduction of low-GWP alternatives refrigerants, in particular to fund capacity building programmes for technicians in the region (through the regional training center in Grenada or at the national level);
- Consider developing eco-labeling schemes for cooling appliances and/or reward schemes when consumers buy green cooling appliances;
- Increase in public tenders the minimum COP required for RAC appliances so as to encourage other users to switch to more energy efficient and modern equipment such as those using low-GWP refrigerants;
- Consider the opportunity to impose fees on appliances which use high GWP refrigerants;
- Consider compulsory technical requirements for designing, constructing or retrofitting civil

buildings (offices, hotels, hospitals, schools, apartment blocks, or trade and service facilities, etc.) with a floor space above a certain size;

- Carry out technical assessments with R290 appliances to examine how they operate under 110V/60Hz mains electricity (as found in the Bahamas among others);
- Develop platforms in each country (e.g. social media, mobile messaging applications) for information sharing among technicians. Such solutions have been implemented in Grenada, and have been facilitating the dissemination of information (e.g. event, training, technical information) by the National Ozone Office and favored mutual assistance by technicians;
- Reinforce presence of RAC technicians in regional meetings, in particular in the Caribbean Network Meeting of the National Ozone Officers. In the past, RAC technicians used to participate in regional meetings. Their involvement in the Regional Expert group provided valuable technical inputs, and participants expressed the wish to benefit from their expertise on technical issues on a more frequent basis.

Annex 1: training curriculum

See next page.

CURRICULUM TRAINING ON FLAMMABLE REFRIGERANTS

"Refrigeration and Air conditioning using Flammable Refrigerants"

Summary

Curriculum Training on flammable refrigerants

Scope

Design of a regional training curriculum for Refrigeration and A/C technicians working with HC A3 (HydroCarbon - HC) and A2L refrigerants. Training curriculum intends to provide the appropriate and practical knowledge and skills to safely and efficiently install, maintain, repair and dismantle refrigeration systems that utilize HC and to a lesser extend A2L refrigerants.

Training is to be devised with a maximum of practical skills and with the minimum of required theoretical content.

Training curricula and necessary equipment

Course details

1) Major (safety / environmental) differences between non- flammable, HC and " A2L" refrigerants
2) Thermodynamic characteristic of Hydrocarbons as refrigerant - p/h diagram
3) Specific components for Hydrocarbons – difference between conventional components and HC specific components
4) Electronic components suitable for flammable refrigerants
5) Refrigeration and Air conditioning applications with HC refigerants
6) Recovery or Venting of HC refrigerants
7) Recovery of A2L refrigerants
8) Vacuum-Charging procedures for HC refrigerants – accuracy / repercussions for over-undercharging
9) Leak testing
10) Mechanical/compression joint connections – avoid brazing
11) Flammability and safety issues
12) Review of Local (if any) guidelines for HC refrigerants – gases
13) Review of International guidelines for the use of HC refrigerants – practical and basic
14) Transport and storage requirements
15) Documentation

Venue requirements and necessary equipment details

See Annex 1

Learning / assessment components

T – Theoretical P – Practical	**HC**
BASIC THERMODYNAMICS AND PHYSICS	
Thermodynamic properties of HC refrigerant: temperature, pressure, density, thermal capacity, log p/h diagram	T/P
Differences between HC refrigerants and HFCs	T
Characteristic of flammability of the substances, velocity of propagation, LFL, UFL, occupancy	T
Specific components for HC / A2L refrigerant in the refrigeration cycle	T/P
Oil compatibility, oil safety, requirements and oil return	T
REGULATIONS AND STANDARDS	
If available;review of local guidelines for HC (refrigerants) as well as review of international safety guidelines	T
Storage and transportation of HC refrigerant	T
Instructions to end user / customer	P
GOOD PRACTICE[1]	
State and identify the commonly used refrigerants' designation	P
How to label HC refrigerant RAC systems[6]	P
Identify appropriate tools, equipment and PPE for work on HC RAC systems	P
Recovery of A2L refrigerant (when / when not – precautions)	P
Safely removing (venting) HC refrigerant from Refrigeration or A/C system	P
Calculate the max fill weight for a refrigerant recovery cylinder for (A2L) refrigerants	P
Pressure test check direct assessment using appropriate techniques	P
Vacuming the refrigerant circuit – purpose, process	P
Charging of an HC refrigerant system without refrigerant loss (emission) – accuracy / procedure	P
Make a connection without brazing with alternative connections	P
Check the correct functioning of the safety ventilation system	P
Check the correct functioning of the safety system controls	P
HEALTH AND SAFETY REQUIREMENTS	
Safe system shutdown and isolation [6]	P
Extinguish a fire, identify the appropriate fire extinguisher	P
First aid treatment for frostbite	P
First aid treatment for fire burn	P
First aid treatment for suffocation due to breathing problems	P
Safety issues related to high pressures	T
Calculate LFL (confined space)	T
Calculate confined space risk for asphyxiation (heavier than air)	T
Check that Health and Safety rules in the refrigeration system location are respected (emergency exits, fire alarms, leak detectors…)	T
Correct use of Personal Protective Equipment	P

Assessment Structure

Structure of the Exam, tests multiple choice, written (also oral will be considered) with bank of questions, papers for the practical session, Open Book.

In Annex 2 a bank of questions is listed for flammable refrigerants (Certifications on Real Alternatives flammable refrigerants Category HC)

[1] All practical trainings should include theoretical training

Assessment: practical organization issues

It is recommended that the following guidance is followed for the organization of Assessments:

1) The assessment should last 1 day and the candidate will be informed on the same day if they passed. The certificate will be printed and sent after approximately 2 weeks

Theoretical assessment	60 minutes i.e. 9 am – 10 am
Practical assessment	Start just after the theoretical assessment i.e. starting from 10 am . Each candidate in max 2.5 hours should perform all the activities

Theoretical assessment – examination session

2) The candidate should arrive 30 minutes before the scheduled exam time
3) Each candidate MUST have a photo ID to present to the assessor. No one will be allowed to take the exam without it.
4) All electronic devices should be turned off and left in a safe area designated
5) Maximum 20-25 candidates per class dependent on number of assessors (1 assessor/assistant every 10 candidates)
6) Multiple answers tests, 30 questions for 60 minutes duration
7) The same test among candidates with variation of questions to prevent predictability among candidates
8) Open books and specific technical tools such as calculator and pressure-temperature comparator should be available
9) NO! mobile phones or cameras
10) NO! copying or communication between candidates
11) YES! speaking to the assessor for clarification; many candidates use different words and vocabulary to identify the same concept (eg. Valves)
12) Theoretical assessment: Pass mark above 60% correct answers
13) The test could be performed orally if the candidate has asked prior to the beginning of the exam and the assessor has agreed to this arrangement

Practical Exam and Tasks

Practical assessment:

In Annex 3 there are papers to complete during the Practical session and in Annex 4 there are the Instructions

14) The laboratory should be properly equipped for performing the practical test (see Annex 1 for Venue Requirements). Measuring instruments should be calibrated.
15) There are 3 stages of assessment (1. thermodynamic parameter reading, 2. Pressure test, Vacuum, Charge, Recovery, 3. Brazing) for assessing 3 candidates at time, divided by the practical activities to speed up the process. An alternative is to combine " thermodynamic exercise" (P/T, Superheat,

Subcool, comments) and pressure test, vacuum, recovery in one exercise and brazing in another. Increase the difficulty on brazing by adding an expansion valve, check valve or rotalock fitting.

16) Pass if candidate proves competence in performing all (100%) main RAC service technicians activities without or with only small hesitations (remember candidates could be knowledgeable but be nervous!):
    - **B)** Thermodynamic parameters reading through gauges and devices, temperature, pressure, subcooling, superheating,
    - **C)** Parameters interpretation, troubleshooting
    - **D)** Perform a pressure/leak test
    - **E)** Vacuum, charge, recovery with minimum emissions
    - **F)** System Logbook reading, understanding and completing
    - **G)** Brazing leak tight joints with proper capillary flow.

Training Material and Real Alternatives

Training material can be found at the following link which is a project financed by EU and to which Centro Studi Galileo, the Italian Association of Refrigeration and the European Association AREA has worked for Blended Learning on Alternative Refrigerants. Free of charge but with Licences to use it for commercial purposes (Enquire Licencing modalities to buoni@centrogalileo.it).

www.realalternatives.eu

Assessor Qualification and competence

Assessors and Trainers should be sufficiently skilled in the curriculum

Assessors should be unbiassed in trainees' evaluation

Annex 1 Venue requirements for training and assessment

A Venue is required both for the training and assessment sessions. It is of paramount importance that safety of teacher, students and staff is warranted.

For the theoretical section, technical teaching aids such as beamer/LCD screen, PC/Laptop and white or chalkboard are required. Adequate seating arrangements as well as air conditioning / heating and sufficient light must be provided.

As for the practical section; the venue must be well ventilated, lit and have sturdy workbenches.

Necessary equipment and components (minimum)

1) Training model HC a/c and refrigerator unit
2) Nitrogen Regulator - Cylinder of High Purity Nitrogen
3) Electronic Weighing Platform (accuracy 1 gram)
4) Electronic Vacuum gauge
5) Manifold set - Hoses with ball valves
6) Vacuum Pumps and Hose
7) Recovery Unit
8) Recovery Cylinder
9) Electronic Leak Detector
10) Proprietary Leak Spray
11) Temperature meter
12) Ammeter
13) Tools, Pipe Cutters, Pipe Deburring Tool, Pipework Expanders, Hacksaws, Brazing Rods
14) Flaring Tool
15) Personal protective equipment PPE

Annex 2 Bank of questions (#40)

Question 1 A2L

Mod 3 Eff leak test	Which system is not as suitable for a fluorescent additive leak detection system	One with a coalescing oil separator
		A trans critical system
		A cascade system
		A two stage system

Question 2 A2L

Mod 3 Eff leak test	How frequently should a hand-held electronic leak detector used for R32 be checked?	At least once per year
		There is no requirement for leak detection of R32
		The frequency depends on the charge size
		After every 100 hours of operation

Question 3 A2L

Mod 3 Press testing	What is the benefit of using hydrogen as a trace gas with nitrogen for pressure testing	It has a small molecule and diffuses more readily
		It is easily detectable
		It has an odour
		It is non flammable

Question 4 A2L

Mod 3 Leak test regime	Under the revised F Gas regulation (from 01.01.2015) how frequently would a system containing a charge of 60 tonnes CO2-equivalent of	Twice per year
		Once per year
		Four times per year
		Leak testing is not required

	refrigerant need to be leak tested?	

Question 5 A2L

Mod 3 Indirect leak testing	What is the effect on the high pressure side of a system (with no head pressure control) if it is short of refrigerant?	The discharge pressure will be lower and the degree of subcooling will be lower
		The discharge pressure will be higher and the degree of subcooling will be lower
		The discharge pressure will be higher and the degree of subcooling will be higher
		The discharge pressure will be lower and the degree of subcooling will be higher

Question 6 A2L

Mod 4 Flam refs	Why should you not use an HFC recovery machine on R1234ze?	It contains sources of ignition
		The recovery machine oil is not miscible with R1234ze
		The recovery machine will not withstand the operating pressure of R1234ze
		The low pressure switch setting will not be suitable for R600a because of its lower operating pressure

Question 7 A2L

Mod 4 Flam refs	How do you make sure it is safe to switch on a vacuum pump to evacuate an R32 system?	Use an R32 gas detector to ensure there is no Flammable refrigerant in the area
		Recover the system down onto a slight vacuum before fully evacuating the system with the vacuum pump
		Flush the area with nitrogen before switching on the pump
		Fit a long hose on the outlet of the vacuum pump to discharge the R32 away from the work area

Question 8 A2L

Mod 4 Flam refs	How do you remove as much refrigerant as possible from a condensing unit system with a charge of 800 g R1234ze?	Recover the R1234ze so the system is on a vacuum, break the vacuum with oxygen free nitrogen to pressure of 0.1 bar g
		Recover the R1234ze so the system is on a vacuum
		Vent the R1234ze outside and evacuate the system
		Vent the R1234ze outside; fill the system with oxygen free nitrogen to a positive pressure, vent and evacuate twice, fill the system with nitrogen for a third time and vent

Question 9 A2L

Mod 2 R32	What is the typical PS for the low side of an R32 system with an air cooled condenser in a 32^{O}C ambient?	19.3 bar g
		14.3 bar g
		34.2 bar g
		65 bar g

Question 10 A2L

Mod 3 Leak Points	Which document provides torque values for manually made flared joints	EN378
		The F Gas regulation
		The Pressure Equipment Directive
		EN60079

Question 11 A2L

Mod 3 Indirect leak testing	What is the effect on the low pressure side of a system (with no suction pressure control) if it is short of refrigerant?	The suction pressure will be lower and the useful superheat will be higher
		The suction pressure will be higher and the useful superheat will be higher
		The suction pressure will be lower and the useful superheat will be lower

		The suction pressure will be higher and the useful superheat will be lower

Question 12 A2L

Mod 2 R32	What is the typical PS for the high side of an R32 system with an air cooled condenser in a 32^{O}C ambient?	34.2 bar g
		24.8 bar g
		19.3 bar g
		120 bar g

Question 13 A2L

Mod 2 R1234ze	What is the typical PS for the high side of an R1234ze system with an air cooled condenser in a 32^{O}C ambient?	10.3 bar g
		19.3 bar g
		24.8 bar g
		120 bar g

Question 14 A2L

Mod 3 Leak Points	Why are flare solder adaptors used	They have a factory machined face
		They are brazed onto the pipe work
		They cannot be disconnected once fitted
		They only need to be hand tight

Question 15 A2L

Mod 3 Press testing	What is the approximate rise in nitrogen pressure if its temperature increases by 5^{O}C?	0.7 bar
		There is no change in pressure
		7 bar
		4.75 bar

Question 16 A2L

Mod 1 Intro, Safety	The hazards of R32 include:	Mild flammability
		High flammability
		High toxicity
		Mild toxicity

Question 17 A2L

Mod 3 Leak test regime	According to the latest F Gas regulation (EU517/2014) how frequently must an R1234ze system with a charge of 300kg and no fixed leak detection system be chacked?.	It does not need to be leak tested
		Once per year
		Twice per year
		Four times per year

Question 18 A2L

Mod 1 Intro, Safety	The hazards of R1234ze include:	Mild flammability
		High flammability
		High toxicity
		Highly corrosive

Question 19 A2L

Mod 1 Intro	R32 is used in systems which traditionally use …	R410A
		R134a
		R404A
		R290

Question 20 A2L

Mod 1 Intro	What type of refrigerant is R1234ze?	An HFC which has unsaturated carbon
		A hydrocarbon
		Carbon dioxide
		An HFC which has saturated carbon

HC

Question 1 HC

Mod 1 Restr on use HC	What is the maximum charge of R1270 that can be used on a supermarket shop floor (occupancy category A)	1.5 kg
		150 g
		It cannot be used in this application
		There is no limit

Question 2 HC

Mod 1 Intro HC	What is the predominant application for R600a?	Domestic refrigerators and freezers
		Car air conditioning systems
		Glycol chillers for process cooling
		Central plant retail systems

Question 3 HC

Mod 1 Perf HC	What compressor displacement is required for R1270 compared to that used for R404A?	Similar
		50%
		150%
		600%

Question 4 HC

Mod 2		To disperse the refrigerant safely in the event of a leak

R717 R32 R1234ze HCs	On some systems which use a flammable refrigerant, why does the condenser fan run constantly?	To avoid a build up of contamination on the condenser
		To ensure the head pressure is never excessively high
		To reduce energy consumption

Question 5 HC

Mod 4 Intro HC	Why is the charge weight accuracy more important on critically charged R1270 systems compared to HFC systems?	Because the density is less so the charge weight is less compared to a similar HFC system
		Because these systems never have liquid receivers
		Because R1270 is only used in systems with less than 150 g charge weight
		Because of the lower operating pressures

Question 6 HC

Mod 4 Flam refs HC	What is the safe R290 fill weight for a recovery cylinder which has a safe fill weight of 10 kg for R404A?	4.5 kg
		10 kg
		15.4 kg
		22 kg

Question 7 HC

Mod 4 Flam refs HC	Why should you not use an HFC recovery machine on R600a?	It contains sources of ignition
		The recovery machine oil is not miscible with R600a
		The recovery machine will not withstand the operating pressure of R600a
		The low pressure switch setting will not be suitable for R600a because of its lower operating pressure

Question 8 HC

Mod 4 Flam Refs HC	How do you avoid the risk associated with the on/off switch on a standard vacuum pump when evacuating an HC system?	Use the vacuum pump in a well ventilated area and switch on at least 3 m away from the pump
		Fit a long hose to the pump's outlet to discharge the HC away from the system
		Position the vacuum pump 3 m above the floor
		Position the pump outside

Question 9 HC

Mod 4 Flam refs HC	How do you make sure it is safe to light a brazing torch to un braze a joint on a system which operates on a flammable refrigerant?	Ensure the area is well ventilated and use a flammable gas detector to check the area
		You must not un braze connections on a flammable refrigerant system, they should be cut using a pipe cutter
		Work outside
		Purge with oxygen free nitrogen

Question 10 HC

Mod 1 Safety HC	A refrigerant which is classified in refrigerant safety group A3 has which hazards?	High flammability, lower toxicity
		Mild flammability, lower toxicity
		High toxicity, no flame propagation
		Lower toxicity, no flame propagation

Question 11 HC

Mod 1 Intro HC	What is the GWP of R600a (according to EN378)?	3
		550
		0
		6

Question 12 HC

Mod 1 Intro R290	R290 is	Propane
		Propene
		Propylene
		Iso butane

Question 13 HC

Mod 1 Restr on use HC	Which factors are used to determine the maximum charge in a comfort cooling / heating application? HC	Lower flammability level, height of the indoor unit, floor area
		Practical limit, height of the indoor unit, floor area
		Practical limit, room volume
		Lower flammability level, room volume

Question 14 HC

Mod 2 HCs	What is the approximate cooling capacity of R1270 compared to R404A?	100%
		50%
		200%
		7 times

Question 15 HC

Mod 2 R717 R32 R1234ze HCs	What is area classification (with regard to the application of flammable refrigerants)	Testing which determines the extent of a flammable zone in the event of a leak of flammable refrigerant
		Zoning of an area where invasive work on a system containing a flammable gas is to be carried out
		Determining where flammable warning diamonds should be located
		Erection of safety barriers while working on systems which use a flammable refrigerant

Question 16 HC

Mod 2 R717 R32 R1234ze HCs	Which of these devices will not ignite a leak of flammable refrigerant?	An EX "n" rated device
		An EC evaporator fan motor
		A high pressure switch
		A thermostat

Question 17 HC

Mod 4 Intro HC	What implication does the density difference between HC and HFC have?	The HC refrigerant charge weight is lower
		The system must be evacuated for longer
		The HC system must be charged with gas not liquid
		The system must be charged very slowly to prevent damage to the compressor

Question 18 HC

Mod 4 Flam refs HC	How do you make sure it is safe to light a brazing torch when working on an HC system?	Ensure the area is well ventilated and use a flammable gas detector to check the area
		You must not un braze connections on an HC system, they should be cut using a pipe cutter
		Work outside
		Purge with oxygen free nitrogen

Question 19 HC

Mod 2 HCs	What is the typical PS for the high side of an R600a system with an air cooled condenser in a $32^{O}C$ ambient?	6.8 bar g
		10.3 bar g
		19.3 bar g
		24.8 bar g

Question 20 HC

Mod 2 R717 R32 R1234ze HCs	What is ATEX?	A European directive which covers equipment intended for use in a potentially explosive atmosphere
		A type of enclosure which can be safely used on a system which operates with a flammable refrigerant
		An electrical device which can be safely used on a system which operates with a flammable refrigerant
		A type of system which uses a flammable refrigerant

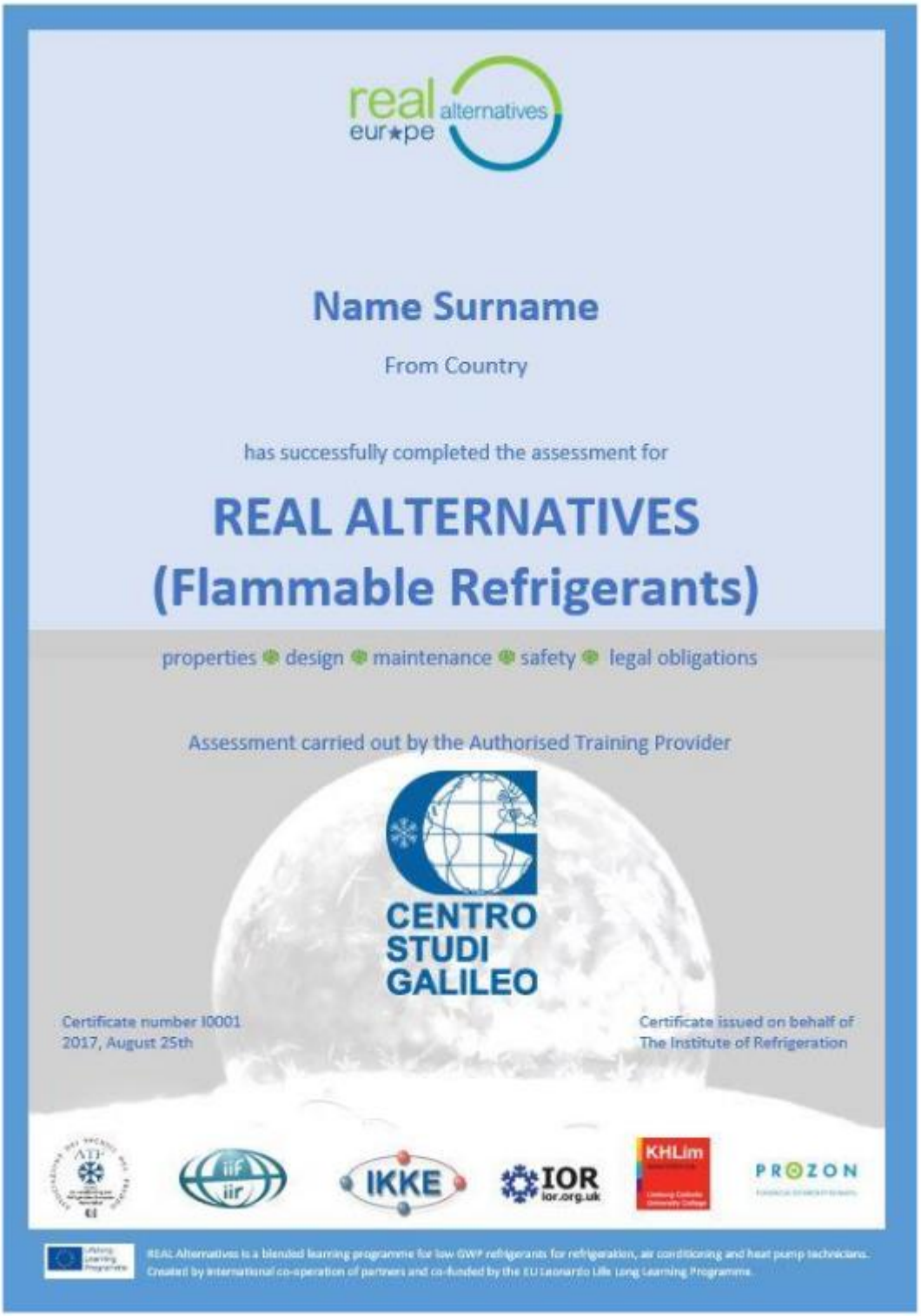
Annex 2: list of equipment, tools and material provided to the regional training centre in Grenada

Item	Quantity	Item	Quantity
4 way manifold gauge set	20	Steel brush	20
Electronic leak detector for halogenated refrigerants and blends	5	Wire stripper	20
Electronic leak detector for HC refrigerants	20	Mains tester with LED	20
Double stage vacuum pump	10	Oxy/Acetylene brazing unit	5
Digital scale	10	Metallic tool box	20
Portable charging station for R600a and HC blends	5	Cylinder with HC refrigerant R290	20
Refrigerant reclaim unit	2	HC refrigerant R600a	20
Advanced refrigerant identifier ID Pro	2	Cans HC blend refrigerant	20
Split air conditioning unit (R-22)	2	Refillable refrigerant recovery cylinders	20
Precise Electronic Thermometer	4	Set of copper tube rolls	10
Nitrogen cylinder with valve and cap	5	Packet of brazing rods	40
Nitrogen cylinder pressure regulator	5	Box of Flux	20
Set of 7 screw drivers	20	Set of filter drier for HC refrigerant	40
Set of 4 pliers	20	Set of adapters, fitting, flare nuts	20
Piercing pliers	20	Portable CO2 Fire extinguishers	5
Set of tubing tools	20	Portable Dry powder extinguishers	5
Cable reel	10	Refrigerant recovery unit with external recycling module	10
Combination wrenches set	20	Gallon of compressor mineral lubricant	10
Adjustable wrench	20	Gallon of compressor synthetic lubricant	10
Ratchet wrench	20	Pair of safety gloves refrigerant handling	20
Safety goggle	20	Pair of safety gloves for mechanical work	20
Cable knife	20	Pipe wrench 35 mm.	20
Hack saw and extra blades	20	Folding rule 2 m	20
Hammer	20		

Annex 3: list of participants to the train the trainer workshop

Name	Surname
Giltan	Baptiste
Frederick Perceival Philip	Beausoleil
Michael	Cadore
Alexander	Darville Jr
Ells	Breuno
Lance	Simpson
Henry	Frederick
Wayne	Grant
Earl Michael	Harte
Vincent	Lorde
Andrew	Miller
Alfred Tyrone	Paul
Gary	Peters
David	Ramsey
Satiesh	Sardjoe
Curtis	James
Stanley	Sovan
Milton	Spier
William	Sturrup
Jerry	Van Ommeren

Annex 4: REAL alternatives certificate



Annex 5: list of tools and material provided to National Ozone Units, National Refrigerant Associations, Vocational Schools to support the in-country training sessions

The Bahamas

Item	Quantity
Leak Detector D-400 (UN)	2
Manifold Set 4 valve UNIDO	2
Refrigerant Control Valve 1/4" flare	2
1⁄4" Charging Hose Gasket 10 pcs	2
3/8" hose gasket K10	2
Gauge HD R-600a,R-290, R22, B/PSI, C/F 80mm T-line	4
Gauge LD R-600a,R-290, R22, B/PSI, C/F 80mm T-line	4
Gauge HP R-134a,404A,410A,407C B/PSI, C/F 80mm T-line	4
Gauge HP R-134a,404A,410A,407C B/PSI, C/F 80mm T-line	4
Fieldpiece dual input thermometer ST4	2
Fieldpiece K-Type thermocoupler Bead Tip ATB1	4
Compact Clamp Meter w/Temp SC240 Fieldpiece	2
Filter copper capillair SM-20M Metric	5
Cylinder refrigerant 12.5 ltr.	2
Pair of safety gloves	10
Portable Charging unit HC, K-PGTB-A3	1
Charging Scale 0-5000 gr P&M	2
Oil 1 liter ISO32 (3GS)	5
Label Flammable Gas 100 x 100 (roll 1,000 pcs)	5

Saint Lucia

Item	Quantity
Leak Detector D-400 (UN)	2
Manifold Set 4 valve UNIDO	2
Refrigerant Control Valve 1/4" flare	2
1⁄4" Charging Hose Gasket 10 pcs	2
3/8" hose gasket K10	2
Gauge HD R-600a,R-290, R22, B/PSI, C/F 80mm T-line	2
Gauge LD R-600a,R-290, R22, B/PSI, C/F 80mm T-line	2
Gauge HP R-134a,404A,410A,407C B/PSI, C/F 80mm T-line	2
Gauge HP R-134a,404A,410A,407C B/PSI, C/F 80mm T-line	2
Fieldpiece dual input thermometer ST4	2
Fieldpiece K-Type thermocoupler Bead Tip ATB1	4
Compact Clamp Meter w/Temp SC240 Fieldpiece	2
Filter copper capillair SM-20M Metric	4
Cylinder refrigerant 12.5 ltr.	6
Pair of safety gloves	10

Portable Charging unit HC, K-PGTB-A3	1
Charging Scale 0-5000 gr P&M	2
Oil 1 liter ISO32 (3GS)	2
Label Flammable Gas 100 x 100 (roll 1,000 pcs)	5

Saint Vincent and the Grenadines

Item	**Quantity**
Manifold Set four way	10
Portable Charging unit for HC, K-PGTB-A3	5
Leak Detector for HC's D-400	10
Fieldpiece dual input thermometer ST4 including: 2 x Fieldpiece K-Type thermoc. Bead Tip ATB1	10
Compact Clamp Meter w/Temp SC240 Fieldpiece	10
Filter copper capillair SM-20M Metric	20
Flammable Gas Label	2500
Pair of safety gloves	20
Charging Scale 0-5000 gr P&M	10
Oil 1 liter ISO32 (3GS)	10

Suriname

Item	**Quantity**
Fridges (R600a)	2
Flammable Gas Label (set of 30)	2

Annex 6: lists of participants to training sessions for technicians

The Bahamas (20-22 August 2019)

The names of the technicians that paticipated in the training exercise are;

- Mr. Jerry Josey
- Mr. Deon Ferguson
- Mr. Keno Munroe
- Mr. Maurice Knowles
- Mr. Robert McKinney Jr.
- Mr. Dwight Forbes
- Mr. Refshinko Stubbs
- Mr. Kevin Gibbs
- Mr. Kashmir Colebrooke

Grenada (8-9 May 2019)

List of participants

Natural Refrigerants Workshop

T A Marryshow Community College (TAMMCC)

May 8th and 9th, 2019

ATTENDANCE REGISTER

#	Name	Company	Gender	Tel #	email
1	Amanaki Millette	Phillip's AC & Refrigeration	M	4101454	amanakimillette123@gmail.com
2	Allen Rick Lyons	Rapid Cool	M	4109620	rapdcoolgda@gmmail.com
3	Nicholas Joseph	BL International	M	4072531	
4	Chad Walcott	Total Engineering Co. Ltd	M	4560413	cwalcott@totalengineeringgd.com
5	Razzum Baptiste	Viking Engineering Co ltd	M	4222849	
6	Everton Connor	ELCICS	M	4065068	evertonconnor3113@gmail.com
7	Ian Benoit	ELCICS	M	4160616	
8	Glendon Regis	ELCICS	M	5340331	
9	Javid Mitchell	Modern Electrical Solutions	M	4232364	javidmitchell@techie.com
10	Shane Roberts	Modern Electrical Solutions	M	4141931	shane.roberts01@gmail.com
11	Arnold Fraser	Grenada Airports Authority	M	4155555160	arnoldfraser1@gmail.com
12	Kwesi Hamlet	LA Purcell/ Courts	M	5383431	ultrakool82@gmail.com
13	Devon Fraser	Courts	M	5373971	ultrakool82@gmail.com
14	Godfrey Debellotte	General Hospital	M	4495250	desmondg1691@hotmail.com
15	Ronald Mark	General Hospital	M		
16	Levon Philbert	General Hospital	M	4220975	
17	Kelly Ann Telesford	Self Employed	F	4178838	kellyanntelesford@gmail.com
18	Kenneth Stephen	STE-TECH	M	4590150	propertygrenada@gmail.com
19	David Ganpot	Ganpot's Technical Services	M	4202823	davidganpot@hotmail.com
20	Vonnet John	NEWLO	F	5342455 4236154	vonnetjohn24@gmail.com
21	Jade Pursue	NEWLO	M	4207966	jpersue@gmail.com
22	Trevor Andrew	Spice Island Beach Resort	M	4060507	
23	Karvin Johnson	Spice Island Beach Resort	M	5367077	
24	Ramesh Patrick	Grenada Elctrical/Franks Refrigeration	M	4578758	rameshpatrick917@hotmail.com
25	Jordan Paredes	Cool Breeze	M	4102192	oldwester28@outlook.com
26	Presley Thomas	Cool Breeze	M	4195246	presleythomas@hotmail.com
27	Jerry Coutain	Self Employed	M	5358284	jerrycoutain@hotmail.com
28	Aldrin Cox	James Refrigeration Services	M	4208769	aldrincox90@gmail.com
29	Britnay Frank	Grenada Electrical/ Franks Refrigeration	F	4584297	
30	Dondre Sandy	Ultra Kool	M	4199293	dondre473@gmail.com
31	Meril Fraser	Courts	F		
32	John Campbell	SGU (Observer)		4052718	jcampbell@sgu.edu
36					
37					
38					
39					
40					

List of Facilitators

Name	Company/Institution	Telephone	email
Mr. Lance Simpson	Cooling Tech Limited	534 6423	lsimpson@coolingtech.gd
Mr. Henry Frederick	Maurice Bishop International Airport	415 1198	hfrederick@mbiagrenada.com
Mr. Leslie Smith	National Ozone Unit	409 8128	Smithld31@gmail.com

Saint Lucia (4-5 February 2020)

Name of participants
Lambert Calixte
Brandon Mathurin
Keisha Lansiquot
Clemence Charlemagne
Archibald Anderson
Rudolph Felix
Sherwin Joseph
Collin Mondesir
David Charles
Daniel Jn Baptiste
Aaron Doxilly
Facilitators
Michael harte
Percival Beausoliel
National Ozone Unit
Kasha Jn Baptiste
Shanna Scott

Saint Vincent and the Grenadines (10-13 February 2020)

ATTENDANCE SHEET

1) Ronald Jessop	East Caribbean Metal Industry	Technician	wayneip@yahoo.com	593-2855
2) Cameron Julian Conliffe	AIW Fish Market	Technician	cameron.conliffe@gmail.com	530-8228
3) Lou-Anne Dover	Thompson Cooling & Electrical	Office manager	louloupeng@gmail.com	497-3060
4) Vondon Herbert	Thompson Cooling & Electrical	Technician	vondonherbert@live.com	434-9327
5) Bernard Celestine	Mustique Company	Technician	Juiceberryxs60@gmail.com	530-0138
6) Jason Raguette	AIW Fish Market	Technician	Jason24783@hotmail.com	530-4555
7) Kenny Campbell	Self Employed	Technician	Jjken21@hotmail.com	532-2181
8) Clyde Gurley	JAD	Technician	Docgurley32@gmail.com	531-3222
9) Damien Hinds	JAD	Technician	dodley@gmail.com	531-6946
10) Arthur A. Matthews Jr.	Self Employed	Technician	Mathur1318@gmail.com	431-6980
11) Zoanie Bailey	OSV	Technician	doaniebailey@gmail.com	492-7920

Annex 7: list of participants to the regional expert group meeting (Paramaribo, Suriname, on October 5, 2019)

Participant name	Participant function	Country
Ryan PERPALL	National Ozone Officer	the Bahamas
Leslie SMITH	National Ozone Officer	Grenada
Henry FREDERICK	Technician, consultant with National Ozone Office	Grenada
Kelly CYRUS (remote)	CEO from Grenz concept, RAC and R290 appliances supplier	Grenada
Shanna SCOTT	Alternate to the National Ozone Officer	Saint Lucia
Frederick BEAUSOLEIL	Technician and national supplier, consultant with National Ozone Office	Saint Lucia
Janeel MILLER	National Ozone Officer	Saint Vincent and the Grenadines
Brentin QUAMMIE	Alternate to the National Ozone Officer	Saint Vincent and the Grenadines
Cedric NELOM	National Ozone Officer	Suriname
Jerry VAN OMMEREN	Technician, consultant with National Ozone Office	Suriname
Satiesh SARDJOE	Technician, consultant with National Ozone Office	Suriname
Ozunimi ITI (remote)	Project manager, Industrial development officer	UNIDO
Guillaume CAZOR	Consultant	UNIDO

EASTERN AFRICA SUB-COMPONENT

Contents

Executive Summary

The project "Demonstration project on refrigerant quality, containment and introduction of low-global warming potential alternatives (Eastern Africa and Caribbean regions)" was planned to be implemented by UNIDO, as lead agency, and UNEP on behalf of the Governments of Eritrea, Kenya, Tanzania, Uganda, and Zambia. The demonstration project was approved at a funding level of USD 369,150 including PSC for UNIDO and USD 56,500 plus PSC for UNEP – in total USD 425,650.

It was approved in May 2016 at the 76th Meeting of the Executive Committee (ExCom) of the Multilateral Fund of the Montreal Protocol, at the funding level of USD 345,000 for UNIDO, and USD 50,000 for UNEP (excluding Project Support Cost (PSC)). For the refrigerant quality component, UNIDO allocate USD < 110,415 > and for the Caribbean component USD < 234,584 >. Preliminary project expenditures are USD < 110,181 > related to UNIDO, and USD < 0 > related to UNEP. Thus, the overall expenditure of the project is USD < 110,181 >.

The project aimed to demonstrate the availability of fake refrigerant; the lack of awareness of stakeholders; gaps in customs and legislation; and propose ways to ensure refrigerant quality in the market in Eritrea, Kenya, Uganda, Tanzania, and Zambia. The United Republic of Tanzania was selected as the lead pilot country for leading the implementation of the project due to its geographical location and the biggest by size and population among target countries.

The project included a series of activities:
i) carrying out surveys on refrigerant availability in the markets; ii) conducting a regional train-the-trainer workshop for refrigeration technicians; iii) training national for customs officers, environmental inspectors, importers, and staff from the Tanzanian Bureau of Standards in Tanzania and Eritrea; iv) equipping project stakeholders; v) establishing testing centres and; vi) supporting awareness raising among refrigeration technicians and all stakeholders.
Results of the activities are described within the report.

The project achieved all the goals as follows:

1) Availability: Through the surveys, it was clear that counterfake refrigerant is available in the majority of shops in project countries. Even there are shops were there are two prices for the same refrigerant, meaning better or lower quality. Also that for National Ozone Units, it is complete unknown fact, 'in this country there is no fake refrigerant'.
2) Availability mimetic: Refrigerant packed as R-22 were found containing several non-standard blends, expanded refrigerants, recovered refrigerant and more. The same for HFC, blends of refrigerants, hydrocarbons etc. The main source were cans and small cylinders. In general the counterfake refrigerants can be detected due to misleading information in the labels, colours of cylinder, trade names, mistakes in nomenclature, etc.
3) Lack of awareness: It is clear the fact that stakeholders e.g. technicians, importers, custom officers, government officers (including NOU) were not aware of counterfake refrigerant, consequences, extra costs generated – refrigerant consumption, more energy, potential compressor damage, reduce efficiency etc.
4) Gaps in policy: No legislation regarding refrigerant quality is available. Customs ensure that control substances are regulated, there is lack of awareness on counterfake. Since stakeholders are not aware, there is no legislation or standards for refrigerants.
5) Quality assurance: To ensure refrigerant quality, demonstration on the opposite was the first step. A workshop for trainers to demonstrate fake refrigerant and consequences; workshop for stakeholders, customs, bureau of standards, etc. Establishment of testing centers through the provision of tools and equipment including Ultima ID – HVAC Refrigerant Identifiers.

6) Quality assurance awareness: The project raised awareness on counterfeit refrigerants taking into account mislabelling, consequences of using fake refrigerants, potential safety risks and dangers including tips for indentifying fake refrigerants. Brochurs were developed and distributed to the technicians and other stakeholders.

Recommendations

16) The counterfake refrigerant are not only present in countries included in this Demo Project. UNIDO staff member has surveyed the situation and found the same cases in many countries. In general the same situation, lack of awareness, cheap prices offered, gaps in customs and legislation. The subject should be included in the HPMP and Enabling Activities since the consequences – more refrigerant leaking, more consumption, extra energy, etc – were demonstrated.
17) This issue needs to be tackled because refrigerant being phase out from some countries, ends in other countries under the label 'new'. This became excellent business, just collecting recovered refrigerant, bottling and deliver. In some cases, the blends tested shows the right composition but not percentages, blends recovered and repacked in original cylinders.
18) It is required to establish testing centres, work in standards and public awareness. The counterfake refrigerant will likely be vented and more refrigerant consumed since, due to lack of awareness, the technicians blame the equipment.
19) It is important also to work with the importers and create awareness, it is clear that some of them are not aware of fake refrigerants.

I. Context and background

Context

Refrigerant supply is growing in line with the demand due to the increasing number of comfort, industrial and commercial equipment. However, low quality refrigerants of various sources and origins are finding their ways to the domestic market. This negatively affects not only the whole refrigerant market, but it also has become one of the major concerns and a serious obstacle to the development of the refrigeration-servicing sector. Contaminated, mixed or recovered refrigerants can lead to decreased cooling capacity and energy efficiency, reduced lifetime, increased servicing needs, they can damage the compressor of the equipment and end up being vented to the atmosphere.

All of the target countries are Low-Volume Consuming Article 5 countries, where the refrigerant market is small with loose standards, so low-quality substances can easily and quickly spread. Moreover, since the countries of the region have strong economic and commercial connections, refrigerants can easily cross borders. It is particularly true for Kenya, Tanzania and Uganda.

The predominant HCFC consumed in the region is HCFC-22 which is solely used in the refrigeration and air-conditioning servicing sector. The complex issue of low-quality refrigerants (contaminated, recovered, mixed) should be addressed in the first place in order to enhance the technical level of the servicing sector. For this, it is necessary to use policy instruments, monitoring mechanisms and raising awareness of dealers, technicians and end-users.

The root of the problem is that the purity of virgin refrigerant is questioned neither by the importers nor by the end-users. Most technicians assume that the refrigerant in the cylinder is "good enough" until the RAC system develops failures or cooling problems. Furthermore, even if a technician suspects the refrigerant is somehow contaminated, there is no proper mechanism/strategy to detect or avoid low-quality refrigerants.

The present proposal fits into the concept of the ongoing HPMPs: it would benefit from the established network of stakeholders and the experience gained so far. At the same time, it would give new impetus to improve efficiency and impact of the HPMP by extending its scope of activities and widening the group of stakeholders.

It should be noted that the project has an enormous relevance not only for the phase out of HCFCs but also for the phase down of HFCs. It is clear that counterfake refrigerant are available for all kind of refrigerants, including hydrocarbons. The presence of counterfake in article V countries is directly linked with the increase of consumption due to failure in the refrigeration systems and consequent recharge.

The lack of awareness at all levels, - service technicians, importers, trainers, custom officers – standards, policies and testing options are increasing the potential for more availability of fake. As mentioned before, fake refrigerant includes also ‘refrigerant phased out’ in other countries, recovered and mixed or expanded. In all cases, the refrigerant will end vented generating more ozone depletion, global warming and consumption.

Background

The quality of refrigerants available on the market in many developing countries is of major concern in relation to the development of the refrigeration servicing sector and the proper adoption of best practices. The main problems and challenges identified are mixed refrigerants on the market, fake refrigerants, i.e. substances sold as refrigerant but not in conformity with the requirements and specification related to any classified standard refrigerant, improper drop-ins i.e. some refrigerants sold as drop-ins but incapable of fulfilling the technical requirements and performing the task required, and incorrect labelling i.e. by mistake or on purpose. These discrepancies are driven by economic interests, deficiencies of the regulatory framework, insufficient and inefficient control mechanisms, and lack of technical knowledge.

The objective of the project was to demonstrate: i) the availability of fake refrigerant; ii) the lack of awareness of stakeholders; iii) gaps in customs and legislation; and iv) propose ways to ensure refrigerant quality in the domestic market in Eritrea, Kenya, Uganda, Tanzania and Zambia.

For this purpose, the project begin with surveys of refrigerant available in project countries. It was clear that the counterfake refrigerants are available in different forms. It was also clear that stakeholders were not aware of the fact.

Among other activities: surveys on quality of refrigerant; train-the-trainer workshop; training for customs officers, environmental inspectors, importers, etc; establishing testing centres; gap analysis; and awareness raising.

All the activities were completed, but more public awareness and workshops for stakeholders were missing and should be carried out in line with other projects activities.

Approval and cancellation

The project was approved for 'Demonstration project on refrigerant quality, containment and introduction of low-global warming potential alternatives (Eastern Africa and Caribbean regions)'. Despite that, the two components are related to refrigeration service and HPMP the implementation activities were split due to regional execution and different activities and therefore the funds were also divided internally in UNIDO.

The project "Demonstration project on refrigerant quality, containment and introduction of low-global warming potential alternatives (Eastern Africa and Caribbean regions)" was submitted jointly by UNIDO, as lead agency, and UNEP on behalf of the Governments of Eritrea, Kenya, Uganda, Tanzania and Zambia. It was approved at the 76th Meeting of the ExCom of the Multilateral Fund in May 2016 (UNEP/OzL.Pro/ExCom/76/66, Decision 76/36).

UNIDO's component (GLO/REF/76/DEM/336) was approved at USD 369,150 including PSC. From this amount, US$ 110,415 were destined for 'Demonstration project on refrigerant quality, containment' to be implemented in Eastern Africa region. UNEP's component (GLO/REF/76/DEM/334) was approved at USD 56,500 including PSC. Since UNEP was not able to implement their component of the project, this was cancelled and funds returned at 82nd ExCom Meeting held in Montreal in December 2018.

> "*UNEP/OzL.Pro/ExCom/82/72*
> *115. Concerning the cancellation of the UNEP component of the global demonstration project in the Eastern Africa and Caribbean regions, the representative of the Secretariat said that, despite the best efforts of UNEP, the project had not yet been initiated, although the part being implemented by UNIDO was in its final stages. After consultations with UNEP, the*

recommendation to the Committee was to cancel the part of the project being implemented by UNEP.

(c) Regarding the global demonstration project on refrigerant quality, containment and introduction of low-GWP refrigerants in the Eastern Africa and Caribbean regions implemented by UNEP and UNIDO:

(i) To cancel the component implemented by UNEP (GLO/REF/76/DEM/334), and to note that US $50,000, plus agency support costs of US $6,500 for UNEP had already been returned at the 82nd meeting;
(ii) To extend to 31 July 2019 the project completion date for the component implemented by UNIDO (GLO/REF/76/DEM/333), on the understanding that no further extension would be requested, and to request UNIDO to submit the final report no later than the 84th meeting;"

Project components and implementation strategy

The demonstration project on refrigerant quality, containment and introduction of low-global warming potential alternatives was divided into three components:

Component 1: Policy review including detailed assessment of the current national policy frameworks. Certifying the presence of fake, mixed and/or recovered refrigerants. Detailed gap analysis on control mechanisms at the local and regional level and provision of technical advice.

Component 2: Technical assistance through provision of tools and equipment. Training of stakeholders on the importance of refrigerant quality and establishing testing centres to provide free service of identification to ensure quality and providing information on potential fake based on labelling.

Component 3: Awareness raising among stakeholders regarding the importance of refrigerant quality, related costs of using fake (operational, energy consumption, redo jobs, etc) and its relationship with the efficiency of equipment.

Strategy

The project concept included the following strategy and implementation plan. In the report it can be found that in general the project was well planned, due to different circumstances some activities were replaced.

Due to the nature of the demonstration project and the common characteristics of the target countries, Tanzania was selected as lead pilot country. While most of the activities targeted all beneficiary countries, many of the activities were implemented in the pilot country. This allowed the demonstration and monitoring of the project results at the country level, while ensuring that the experience and lessons learned are shared at a regional level offering the potential for regional replications.

II. Project objective

The objective of the project is to facilitate safer and more efficient operation of equipment in the RAC sector through the improved availability of appropriate quality refrigerants.

The objectives were slightly adapted to the needs of the project during the project implementation it may differ with those planned in the Project Concept.

- Demonstrate that fake refrigerant is widely available in the markets and the lack of awareness on the stakeholders including NOUs, service technicians, importers;
- Increase the awareness among technicians and end-users of the benefits to the RAC performances from the use of high-quality refrigerants;
- Identify the gaps in customs and legislation.
- Establish strategy to reduce the availability of fake refrigerant and provide means to test refrigerant quality;
- Foster the market availability of high-quality refrigerant;

III. Activities and Achievements

General approach

The project was planned with Tanzania as main country for the implementation activities due to the geographical location (borders with three countries included in the project), the port in Dar es Salam, the results of HPMP implementation in the country at the time. Based on that, a Tanzanian coordinator, Mr. Japhet Nidja, former Ozone Officer was selected and the project launched.

Having selected the project coordinator the implementation plan was decided and a brief mission to Kenya, Tanzania and Zambia undertaken. For the other two countries in the project, the project manager was informed and coordinated the activities. A copy of the project implementation plan can be found attached in Annex I.

The first activity was visiting the respective National Ozone Units of Kenya, Uganda, Tanzania, and Zambia. The project activities, approach and goals were defined during the visits. In addition, some refrigerant dealers were visited and a first approach for the market situation was obtained. In general, fake refrigerant, based on the packing, labels, codes and names, among others, is widely available. In some cases, they have a different price level. A copy of the mission report can be found attached in the Annex II.

Component 1: Policy incl. actual National Policy Frameworks and Gap Analysis

The project implementing activities includes the three components, the report will be focussed on the activities related to each component rather than chronological or logical order.

Context

This component was focused on the non-investment component. The planned activities were achieved with some changes but the results are considered satisfactory. The following paragraphs include the activities, the results and reports can be found in the annexes.

Activities

1. Assessments of the actual situation of the refrigerant supply chain including the quality of refrigerants available on the domestic market. Assessments of national policy frameworks were carried out for Kenya, Uganda, Tanzania, and Zambia.

2. National experts were hired in each country and survey assessments of the actual situation of the refrigerant supply chain, including the quality of refrigerants available on the domestic market were carried out. All reports were received and information shared with respective NOUs. The activity was coordinated by Mr. Japhet Kanizius, project coordinator and the report is attached as Annex III. The annex also includes a special report and country program from Kenya.

3. Samples of R-22, R-134a were randomly picked from refrigerant selling shops and tested for their qualities using refrigerant identifiers. Consequently, a general impression of the quality reliability of the supplied refrigerants in the local market was obtained. The results showed that counterfake refrigerants are available especially for HCFC-22 and HFC-134a. Detailed information on the standards and market availability of quality refrigerants is included in the mentioned report Annex III.

4. For the gap analysis, it was planned to contract Tanzanian Bureau of Standards - TBS. Some visits were paid to Ms. Agnes NJAU and the aim of the project agreed. UNIDO requested the services through the Terms of Reference, copy attached in Annex IV. The offer was received by UNIDO with budget beyond the available funding.

5. At the time of negotiation, UNIDO found out that UNEP was cancelling their participation in the project and decided to cancel the proposal. Since the gap analysis was a pillar for the project implementation, it was decided to contract national experts in Kenya and Uganda. The most relevant and accurate information had been received before from both countries.

6. The activity was carried out by Ms. Selelah OKOTH in Nairobi; Mr. Reuben LANGART in Mombasa and Mr. Paulo ODU in Kampala. A sample of the Terms of Reference for the consultant is attached in Annex IV.

7. The reports from the three experts were received and analysed. So far, the information was only shared with the respective National Ozone Units of the countries under the Demonstration Project. The socialization of the information was a component of the activities to be implemented by the cooperation agency UNEP.

8. The most relevant findings, comments and conclusions are summarized below. Table includes Gap Analysis, after proposed counter measures, conclusion and recommendations applicable to all countries under the demo project and other not only in the region.

Summary of Gap Analysis

No	Thematic Area	Gap(s) Identified
1	Policy and Legal Framework	The existing policy has inadequate statements relating to the RAC sector. This therefore fails in providing a strong guiding framework towards the growth of the sector The Controlled Substances Regulations has no provisions on use of spectrophotometer analyzer which would be essential in quality assurance The Regulations have no stringent punitive measures upon ODS/RAC gases importers in the event of shipment of fake refrigerants The Regulations have no framework for tracking movement of RAC gases once cleared at the port of entry. This makes it difficult to ascertain the end point for RAC gases declared as on transit.

2	Licensing and Licensing Conditions	While the accessed licenses show that all refrigerants are regulated, the aspect of quality control is not emphasized beyond the provision that only licensed refrigerants are allowed. There is no provision instructing the importer to ensure that certificate of conformance (CoC) is obtained prior to shipment. The use of the licensing system that has no linkage with the upcoming Integrated Customs Management System (ICMS) raises a gap in quality control as some refrigerants may easily pass the border point if due diligence is not undertaken by the Customs officials.
3	Standards	There are no easily accessible standards relating to the quality of refrigerants.
4	Enforcement	Inadequate presence of e*nvironmental inspectors* at the border points.
5	Interagency coordination	No clearly documented framework is in place regarding working relationship among the various stakeholders more specifically the regulators in the RAC sector

Proposed counter measures to prevent counterfeit/contaminated refrigerants from entry to local market

The counter measures that can be put in place include:

i. Encouraging collaboration between all the stakeholders involved thus; Anti-Counterfeit Agency, Customs, Bureau of Standards, NOUs and RAC importers Association to come up with the strategy to counter and minimize the influx of the contaminated/ counterfeit refrigerants into the local market.
ii. Encourage all importers who have not been using the Electronic Single Window Licensing System (or equivalent) to procure their goods through the system for transparency and accountability.
iii. As for lack of awareness on newly manufactured equipment containing fake / contaminated refrigerant, public awareness creation campaign to be conducted on use of quality refrigerants, on reviewed cylinder general appearance in terms of colour, labels and specifications according to UN numbers including testing of the refrigerants.
iv. Entry through illegal routes and diversion of transit counterfeits should be controlled by the sharing of intelligence information by all the relevant enforcement authorities by tracking the illegal routes and prosecuting those involved in diversion of goods on transit.
v. The dishonest importers/traders who request repackaging/refilling of contaminated refrigerants from the exporting countries should be prosecuted upon conviction. This can be done through government to government collaboration/agreement on the enforcement of the policies, standards and laws relating to prevention of contaminated refrigerants getting into the market. Both Governments could arrange meetings for the importers and exporters from the two countries to strategize on how to minimize circulation of the contaminated refrigerants in the local market. This effort will address the loopholes due to refilling /repackaging of contaminated refrigerants from country of origin by dishonest traders, as a result of requests made by importers.
vi. The NOUs to review their database of compliant RAC Importers from time to time and blacklist those that sneak contaminated refrigerants into the country.

Conclusion

Countries should put strategies in place to prevent or minimize the importation of contaminated /counterfeit refrigerants which include the enforcement of use of the *Electronic Single Window Licensing System* by all validated RAC importers.

However, there is a challenge in enforcement due to the activities of traders who import contaminated refrigerants through illegal entry ports and hence are not easy to prosecute. RAC importers reported that Contaminated / counterfeit refrigerants are popular to some traders because they are cheap, require low investment and guarantee them maximum profits.

During the process of survey, some RAC importers disclosed that some travel abroad to the source of refrigerants and influence them to refill/ repackage the contaminated/counterfeit in genuine popular branded cylinders and import them through either illegal routes/ entry points to avoid paying taxes or comprise by means of negligence/deceit of the control points and legally import.

In order to control this, there should be a Government to Government agreement /policy on standards of the export refrigerants meant for export by enforcing quality. Further this framework should explore convening of regular meetings of all RAC importers and Exporters of the countries concerned. This will call for training of the customs officers, and other inspectors involved in law enforcement. The customs officials should immediately alert the NOUs inspectors on imports of counterfeit refrigerants through illegal ports of entry.

Adequate human capacity and analyser equipment to be available in all entry points for use to test for any contamination of the refrigerants. These efforts require that any illegal entry points must be monitored through collaboration of all the regulatory agencies by deploying more personnel to man them.

To further strengthen compliance and enforcement there is a need to raise awareness among the stakeholders, the RAC Sector, Customs, NOUs, ACA, including the public on the relevant regulatory requirements on quality refrigerants.

A combination of all these efforts of regulatory, capacity building, awareness campaigns will minimize consumption of the contaminated refrigerants because the equipment owners and end users will be aware of the risk that can cause damage to their equipment.

These strategies will eventually reduce demand for these refrigerants in the local market.

Recommendations

This report was prepared by the consultants with the input of the relevant stakeholders through one to one interviews, telephone calls interviews and review of the existing legislation in coming up with the following recommendations:

i. The National Ozone Office (NOU) should ensure that it is always in touch with refrigerant importers so that trust could be developed, and hence transparency is seen to prevail and sharing of information on how to identify counterfeits refrigerants.
ii. There is need for continuous capacity building programmes for customs officers and NOUs officers. This should be well mapped out to include new officers based at border points. There is a need to include the Anti-counterfeit agency as currently their role in the RAC sector is not clear.

iii. NOUs and Customs must strengthen enforcement of refrigerants on transit. One possible solution is to consider a tracking system that must be endorsed by the importer and NOUs as well as Customs upon entry and exit of the refrigerants on transit.
iv. The inter agency Collaboration between NOU, Standard offices, Customs Department, Ports Authority and other enforcement officials needs to be strengthened in order to eliminate or minimize influx of illegal imports of contaminated/counterfeit refrigerants.
v. The NOU should ensure that refrigerant identifiers are functional, distributed and regularly provide trainings to customs officers at all entry points to increase efficiency in the identification of counterfeit refrigerants.
vi. The Anti-Counterfeit Authority should build human capacity through training among all the counterfeit inspectors.
vii. A harmonized Coding system should be embraced by Customs including use of UN number, chemical formula and ASHRAE number among others.
viii. ODS regulations should be reviewed to include all refrigerants and ensure that counterfeits refrigerants are not imported.
ix. The refrigeration and air conditioning sectors importers Association and technicians should be more involved in awareness campaign to minimize counterfeit refrigerants being imported into the local market.
x. NOU or Environment Authorities must ensure that the refrigerants are specified before endorsing the importing permits. This could be done by creating awareness of possibilities of repackaging of refrigerants, brand identification, labelling and colour codes.
xi. Provide enforcement officers with the necessary skills and equipment to identify, monitor and control imports of contaminated refrigerants. Incentives/awards to customs officers who manage to seize counterfeit refrigerants should be given incentives by way of rewards for their seriousness in work
xii. Develop brochures and flyers that should be displayed at all border points that can guide Customs and NOUs on chemical composition of the various refrigerants during analysis.
xiii. Strengthen the network for RAC technicians that would make it possible to avail information on quality of refrigerants to the regulators since they have direct contact with these refrigerants during servicing and maintenance works.
xiv.

Please note that the reports were shared with NOUs from Eritrea, Kenya, Uganda, Tanzania and Zambia. Since project funds were reduced and this activity was intended by the Cooperating Agency, UNIDO could only share the reports and advice to find the best way to implement in their own countries.

Training on refrigerant quality

Component 2: Technical assistance through provision of tools and equipment.

This component was focused on the investment component. The results reached mainly the trainers in project countries and, in some cases, refrigeration technicians. The planned activities were achieved with interesting results and an innovative approach. The results are satisfactory for UNIDO and, based on received comments, for the involved NOUs. The following paragraphs include the activities, the results and reports can be found in the Annex V.

Context

1. There are two main reasons for the wide availability of counterfeit refrigerants in the market, not only in those countries under the present project. The first is the absence of awareness among stakeholders on the availability of fake refrigerants in the market and, the second, the lack of testing methods for the technicians.

2. Lack of awareness is an asset for *fake refrigerant dealers* and the consequences were demonstrated during project implementing activities. Good refrigeration practices and procedures with the best available tools can be applied, however, the fake refrigerant spoil the efforts. At the end, more refrigerant is released, efficiency is reduced and energy consumption increased, among other potential consequences. Refrigeration technicians, in general, consider that the refrigerant is 'good enough' even if they have paid for 'cheap gases'.

3. In line with the absence of awareness, once the issue is addressed, it is required to deal with the lack of testing facilities or tools. This is a challenge since refrigerant identifiers are expensive and delicate tools and to establish a testing centre is also difficult.

4. Prior to the project approval, a testing centre had been established in Asmara, Eritrea. At the time, one of the main issues in the country was the availability of contaminated refrigerant in the country and lack of testing centre. As HPMP component, the service for testing refrigerant was offered in the National Ozone Unit office. The results at the time were remarkable and fake refrigerant was drastically reduced.

5. Once the testing centre was operating, before purchasing refrigerants the condition of previous testing in some cases was established. Since this is an LVC country and the number of stakeholders is manageable, the refrigerant tested as contaminated was returned to the supplier.

6. As a consequence, after some meetings, the importers in Eritrea decided to request 'certificate of origin' and some quality assurance documents for the refrigerant.

Activities

1. The first activity was to provide all countries with Refrigerant Identifiers Ultima id. Pro. The quantity of identifiers were decided based on the size of the country and the needs as per agreement with respective NOUs. The table below was used for the supplier at the delivery time.

Component 2. Table 1. Distribution of refrigerant identifiers.

Country	# of Units	Contact person	Email	Address	Telephone
Eritrea	1	Kibrom WELDEGEBRIEL National Ozone Officer	kibromaw@gmail.com	Ministry of Land, Water & Environment Asmara Eritrea	290.0049525
Kenya	2	*To be delivered to UNIDO office in Kenya.* Emmanuel KALENZI (UNIDO Representative)	E.Kalenzi@unido.org	P.O. Box 41609 United Nations Avenue Nairobi KENYA	+254 207624369
Tanzania	2	Zainabu KUHANWA National Ozone Officer	zaikuhanwa@yahoo.com	Vice President's Office P.O. Box 5380, Dar-es-Salaam Tanzania	+ 255 222113857
Uganda	1	Margaret AANYU National Ozone Officer	maanyu@nemaug.org	National Environment Management Authority (NEMA), NEMA-House, Kampala. Uganda.	256 (0)414 251064 /5 /8
Zambia	2	Mathias BANDA National Ozone Officer	mbanda@zema.org.zm	Environmental Management Agency, Corner Suez and Church Road, Lusaka 10101, ZAMBIA.	260 211254023 /59

2. Following the success case in Eritrea, it was agreed with all NOUs involved in the project that a testing centre was required. In each country the conditions differ and based on that, centres were created in Training Centres, NOU offices, Refrigeration Technicians Associations or even refrigeration dealers. The testing service was agreed to be provided for free. In some countries like Kenya and Tanzania, two testing centres were established.

3. A workshop for training of trainers and government officials in refrigerant quality was held in Tanzania in February 2017. For this training, 20 participants, in the main trainers from seven countries attended. The participants from non-demo project countries were financed by the respective HPMPs. A list of participants, including the trainers can be found below.

	Name	Country	Comment
1	Kamthunzi Marvin	Malawi	Trainer
2	Peter Kiarie Nyagah	Kenya	
3	Joseph Kibet Rugut	Kenya	
4	Stephen Kanyoni K	Kenya	
5	Raymond Sichembe	Zambia	
6	Kelvin Kwila	Zambia	
7	Stephen Ngoma	Zambia	
8	Paulo Odu	Uganda	Associate trainer
9	Mohammed Kanyike	Uganda	
10	Basile Sebulikoko	Rwanda	
11	Alphonse Dushimimana	Rwanda	
12	Wabi Marcos	Benin	

13	Codjo Dedji	Benin	
14	Robinson Swai	Tanzania	
15	Scholastica Mbena	Tanzania	
16	Daudi Kadinda	Tanzania	
17	Said Mziwanda	Tanzania	
18	Haji Maalim Sinani	Tanzania	Local participant (Kibaha)
19	Victor A. Ngowi	Tanzania	Local participant (Kibaha)
20	Japhet Kanizius	Tanzania	UNIDO national expert

4. The aim of the training was to demonstrate the availability and consequences of contaminated or fake refrigerant in the system. For this purpose, the training started with the concept of good practices, good refrigerant management and introduction of alternatives. A copy of the Agenda and certificate can be found in the annex V.

5. Since the core of the workshop was to demonstrate the consequences of the fake refrigerant, three kinds of refrigerant were used in three HCFC based brand new mini spilt air conditioners of 12,000 BTU. For this First HCFC-22 original from the system, which was tested and approved. The second was charged with R-290 after recovery of HCFC-22 and the third was charged with contaminated HCFC-22 purchased locally, as pure HCFC-22, for the training. *(It should be noted that as a component of the training of trainers, the safety use and introduction of hydrocarbon as refrigerant was also included. The activity included good refrigeration practices, demonstration of HC as refrigerant using HC based equipment and fake refrigerant and its consequences). (It was also cleared that retrofit from HCFC-22 to HC is not recommended, and if the case, it will be under the responsibility of the user).*

6. Based on the refrigerant identifier, the contaminated HCFC-22 contained 80% HCFC-409A (R-22/R-124/R-142b) with (60%/25%/15%) and 10% air and 10% other gases. As it can be seen in the table below, taken from Honeywell refrigerants, the liquid density and boiling point of R-22 and R-409A are quite similar, therefore it can be easily mimetized. It is to be noted that the lubricant type differs, for HCFC-22 mineral oil is recommended and for HCFC-409A Alkylbenzene.

Genetron® Product	ASHRAE Number	Refrigerant Type	Refrigerant Class	Typical Lubricant Used*	Liquid Density (lbs/ft^3)** 0 °F	80 °F	Boiling Point °F
Genetron 11†	11	Single Component	CFC	MO	98.2	91.9	74.7
Genetron 12†	12	Single Component	CFC	MO	90.6	81.5	-21.6
Genetron 13†	13	Single Component	CFC	MO	76.9	49.0	-114.7
Genetron 22	22	Single Component	HCFC	MO	83.6	73.9	-41.5
Genetron 23	23	Single Component	HFC	POE	72.0	–	-115.6
Genetron 123	123	Single Component	HCFC	AB	97.9	91.1	82.1
Genetron 134a	134a	Single Component	HFC	POE	84.4	74.9	-14.9
Genetron 422D	422D	Blend	HFC	MO	82.2	70.9	-45.7
Genetron MP39	401A	Blend	HCFC	AB	82.8	73.9	-27.3
Genetron MP66	401B	Blend	HCFC	AB	82.8	73.8	-30.2
Genetron HP80	402A	Blend	HCFC	AB	82.7	71.0	-56.1
Genetron HP81	402B	Blend	HCFC	AB	82.1	71.3	-52.6
Genetron 404A	404A	Blend	HFC	POE	75.8	64.7	-51.2
Genetron 407C	407C	Blend	HFC	POE	81.0	70.6	-46.5
Genetron LT	407F	Blend	HFC	POE	79.9	69.2	-50.9
Genetron 409A	409A	Blend	HCFC	AB	84.3	75.4	-30.0
Genetron AZ-20®	410A	Azeotropic Mixture	HFC	POE	77.2	65.6	-60.6
Genetron 500†	500	Azeotrope	CFC	MO	79.6	70.9	-28.5
Genetron 502†	502	Azeotrope	CFC	MO	86.9	75.4	-49.3
Genetron 503†	503	Azeotrope	CFC	MO	73.6	–	-126.0
Genetron AZ-50®	507	Azeotrope	HFC	POE	76.3	64.9	-52.1
Genetron 508B	508B	Azeotrope	HFC/PFC	POE	72.1	–	-125.3

7. The parameters were verified once the units were commissioned and several times, as can be seen in the report for trainers and some experts in the Annex V. After ca. 2 hours working, the conditions of the first and second units were stable as expected. The performance with HC-290 can be stated as little better and in this case was just to demonstrate how to operate this kind of refrigerant.

8. The third unit was consuming ca. 35% more energy based on the design, the efficiency of the system drop ca. 30%. Most importantly, the compressor became so hot that it was decided to stop the system and recover the refrigerant. After the procedure, the system was cleaned without using HCFC-141b, in this case with high efficient filters.

9. From the report of the main trainer, Mr. Marvin Kamthunzi, the conclusions and some technical comments were extracted for the present report:

Practical session: *Practical covered three days of the workshop interspaced with theory presentations. There were 3 new min-split units designed for use with R22. The participants were then divided in 3 groups.*

- *Group 1: install and operate pure R22*
- *Group 2: use unknown and assumed R22 (fake)*
- *Group 3: replace R22 with R290 (refrigerant grade)*

Refrigerant charging:

- *Unit design and pre-charged R22 – 583 gm;*
- *Fake refrigerant unit – as R22 – 583 gm;*
- *Unit for R290 (42% of R22 charge) 203 gm.*

Outcome: After several readings of various parameters, results were as follow:

- *Unit charged with fake refrigerant depicted highest temperature (82°C)*
- *R22 unit registered 62°C*
- *R290 unit had discharge temp of only 41°C*

It was also observed that:

- *R290 unit had lowest evaporator off coil temp of 14.3°C followed by R22 unit at 15°C and fake at 18°C.*
- *Overall power consumption was lowest for R290 unit at 974 watts followed by R22 at 1339 watts and fake at 1935 watts.*
- *The capacity (output) of the units was 12000 Btu/hr. this shows that on Energy Efficiency Ratio:*

R22 gives 8.96, Fake gives 6.20 while R290 is at 12.32 BTU per H per watt input.

The fake refrigerant was later identified to contain about 80% R409A, 10% air and 10% some unknown trace gases. Air in a system is considered a contaminant and results in high compressor head pressure resulting in high power consumption. Running for a long time on this refrigerant would eventually damage the system. Besides, R409A is HFC and could not work with mineral oil (lubricant) that is used in HCFC systems like the one with R22.

<u>Conclusion</u>

At the end of the 'Train-the-Trainer workshop (4 days for technicians and 2 days for non-technical (back to back)) the participants assured UNIDO, Demo Project coordinator that they would use the knowledge gained and would also share with those they work with in order to positively and effectively contribute to their respective countries' efforts to phase out HCFCs and promote environmentally friendly technologies including Carbon Dioxide, Hydrocarbons, Ammonia etc.

On fake refrigerants, the participants found it very useful and informative as a few countries in the region reported to have experienced unexplained equipment failures that were never thought to have been caused by use of fake and or contaminated refrigerants. In this regard, the Refrigerant Identifier has become an invaluable tool to counter fake refrigerants. There are also a number of falsely labelled refrigerants in order to conceal the real type of chemical contained.

Participants further reiterated their desire to build capacity within their respective fields through training so as to keep pace with the changing technologies.

The two day Non-technical group also requested training to last at least three days. After using the refrigerant identifier they felt UNIDO should assist Tanzania Bureau of Standards and Customs with similar equipment for use in strategic locations to effectively control fake refrigerants as a means of refrigerant quality control.

10. In addition, a training for Customs Officers, Border Police, Ministry of Environment staff, Tanzania Bureau of Standards, importers and other relevant staff was held back to back with the training of trainers. The report from Mr. Kamthunzi includes the results of this workshop.

11. The same activity, training of trainers including test of fake refrigerants was carried out in Eritrea in June 2019. The results do not differ much from those from the demonstration in Tanzania. The report from the trainer, Mr. Kamthunzi, is attached in the annex V. Some comments and conclusion extracted from the report are below:

Practical session: Practical was for one day of the workshop period in each location interspaced with theory presentations. There were 2 new min-split units designed for use with R22. The participants were then divided in 2 groups.

- *Group 1: install and operate pure R22*
- *Group 2: install and operate with unknown and assumed R22 (fake)*

Refrigerant charging:

- *Unit design and pre-charged R22 – 910 gm;*
- *Fake refrigerant unit – (as R22) – 910 gm;*

Comments:

- *Unit charged with fake refrigerant depicted highest compressor temperature (109 and 95°C)*
- *R22 unit registered compressor temperature of 84 to 92°C*
- *R22 split unit was run for a longer period than the one with assumed fake. This was due to the fact that group 2 had to recover original refrigerant, weigh and recharge with deferent refrigerant.*
- *The assumed contaminated/fake refrigerant was actually mixture of R22, R134a and 409a (50%, 45%, and 5%) since the available cylinders had pure refrigerant composition, though contaminated/fake refrigerants are available in certain places in the country.*
- *HFC 134a, 409a are not compatible with mineral oil used with HCFC 22. This may explain the rise in compressor casing temperature. Running this system for longer period, say full day, would have resulted in oil degradation and compressor failure.*
- *R 134a, though not suitable as retrofit alternative to R 22, is a low pressure refrigerant and therefore the other recorded parameters cannot be used for comparison. Fake refrigerant would have showed the high pressures and temperatures associated with characteristics and therefore corresponding higher energy consumption.*
- *Availability of suitable alternative to R22, for example R 290 would have shown favourable (lower) pressures/temperatures and therefore lower energy use.*

Conclusion

At the end of workshop in both Asmara and Massawa, Stakeholders and technicians, the participants assured NOU that they would use the knowledge gained and would also share with those they work with in order to positively and effectively contribute to efforts to phase out HCFCs and where available and cost effective, promote environmentally friendly technologies including Carbon Dioxide, Hydrocarbons, Ammonia and other L-GWP alternatives.

*On fake refrigerants, the participants found it very useful and informative. Some reported unexplained equipment failures that could not have been linked to use of fake and or contaminated refrigerants. The pamphlet provided by UNIDO**, 'REFRIGERANT CAN BE COUNTERFEIT!'** came at the right time as well.*

In this regard, the Refrigerant Identifier has become an invaluable tool to counter fake refrigerants. There are also a number of falsely labelled refrigerants in order to conceal the real type of chemical contained. However, for Eritrea, they only have two working units and therefore more would be required.

Follow up action

For continuation of the training objectives the NOU should ensure that trainers have access to equipment and specialized tools, so as to provide meaningful and effective training in a professional manner. It is encouraging though, to UNIDO to note, that those trained last year,

have been able to conduct training workshops, to train others, at least twice locally to date already.

Measures are to be taken for effective public awareness involving government agencies, importers, end users and technicians on influx of counterfeits. It is through government involvement that suitable registration and regulations can be enacted and implemented in order for those with lawful authority to enforce compliance.

Some of the participants deliver reports with lessons learned and recommendation. The following summarized of some of the reports:

Peter Nyagah - Kenya

I wish to express my appreciation for the chance to take part in the regional training in Tanzania starting on the 20-2-2017 to 24 -2-2017. The training was very helpful. We learnt several things such as:-
-how to detect fake refrigerants
-measuring performance parameters using pure and fake refrigerants
-how to use the refrigerant analyzer
exchange of experiences from various countries.
I look forward to participating in more of such trainings in the future
Too I would request that one of those analyzers be stationed at NITA Mombasa because it is more strategic and has the most interaction with the refrigeration industry.
Regards

Mr. Rugut – Kenya

1. The demonstration through practical means for the use of fake/wrong type of refrigerant in a designated system affect the sector adversely.
2. Awareness of the presence of impure gases in the market.
3. We need to pass this knowledge as fast as possible.
4. Availability of testing and proving equipment is paramount.
5. A follow up in how to place control systems especially views from the RAC techs is the way to speed this up.

RECOMMENDATION
I take this opportunity firstly to give my sincere thanks to Vice President's Office and UNIDO for my nomination to attend this workshop; I have acquired new knowledge and skills towards my career. It is therefore, this workshop has prepared me to share acquired knowledge, skills and experience with my fellow RAC Technicians and Artisans.
Secondly, the workshop duration was not enough for the participants to cover the materials given; therefore, I am laying a special request that the preparations of this kind of workshop(s) should consider the adequate time to meet the planned contents.

Prepared By: Said Mziwanda, Tanzania

RECOMMENDATIONS
To be in a good position the authority concerned should be provided:

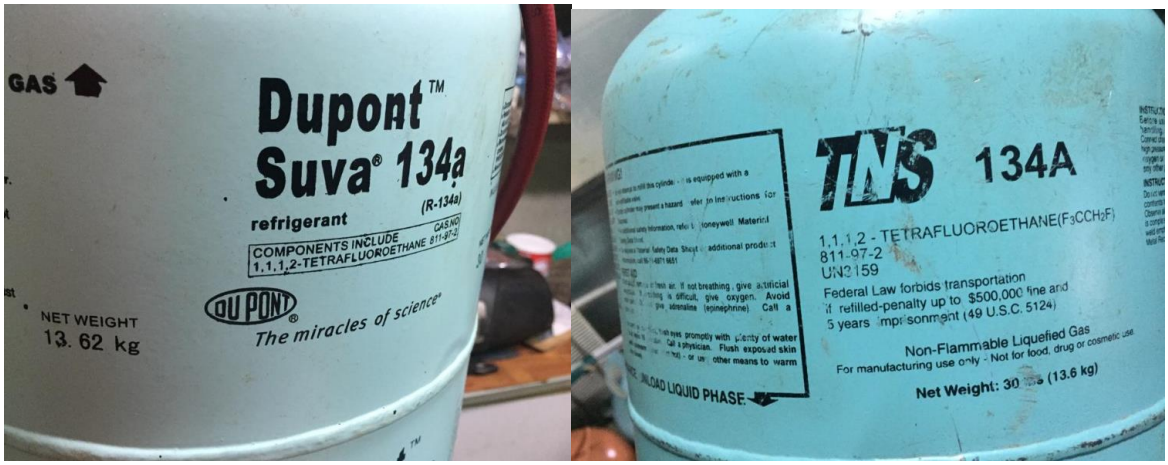
- *standby generator before*
- *adequate time of training which is relevant with the materials provided*

- *adequate tools and equipment for recovery, recycling, reclamation, and refrigerant handling containment etc*
- *several workshops be completed within a short time*

IMPLEMENTATION PLAN IN MY DAILY WORK
The phase-out of unwanted refrigerant like R22 and introduces (in the market) new refrigerant, like R290, is a global strategies and the aim is to protect the ozone layer. The following is the implementation plan which I thought will work

(i) to inform or educate the Centre Management to be aware of the refrigerant quality
(ii) to prepare / purchase new refrigerants
(iii) to involve other staff and trainees concerning protection of ozone layer
(iv) to prepare schedule of removing unwanted refrigerant and charging new refrigerant

Mr. Kadinda, Tanzania



'Dupont' Suva and R-134A

Component 3: Awareness Raising including Information Dissemination

This component was planned to be implemented by the Cooperating Agency. Unfortunately, it was not possible to carry out the activities and UNIDO took over and redistribute the funds and activities to complete the project in the best possible way.

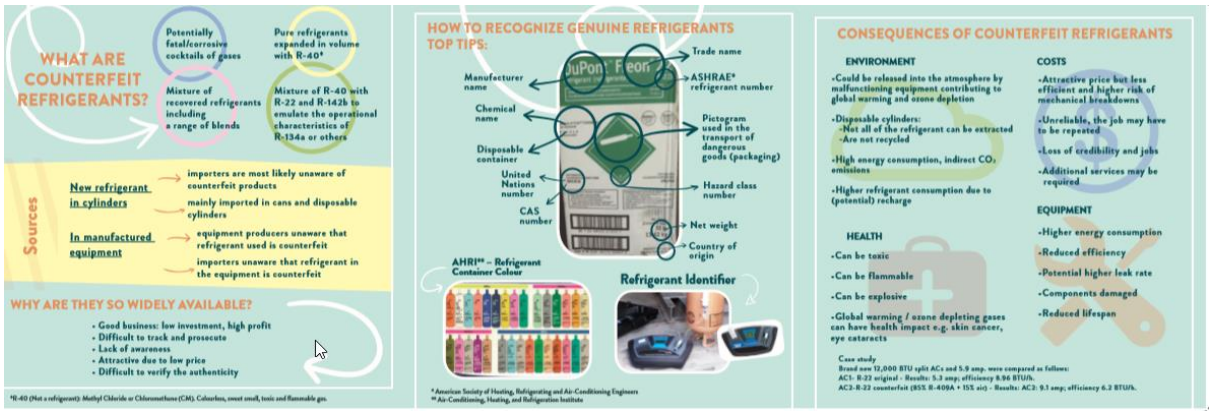
Context

The awareness and information dissemination is as relevant as the previous components. One of the main conclusions of the present report is the need of public awareness for the stakeholders. A second important final step is sharing information with not only the National Ozone Units but other institutions and policy makers. The report includes only the activities undertaken by UNIDO which unfortunately could not fulfil the plan.

Activities

1. The main activity carried out for public awareness was the design and print a brochure with information related to Counterfeit Refrigerants. The design was shared with some of the Ozone Officers, trainers and stakeholders involved in Demo Project and other.

2. Below the English version of the brochure, a Spanish version was also completed. In the Annex VI copies of the brochures can be find.



3. Copies were delivered to the respective NOUs Eritrea, Kenia, Tanzania, Uganda and Zambia for distribution. More than 200 copies and file to be reprinted if required were sent. Each country has the right to distribute the brochures as per they own criteria.

4. The complementary activities related to this component are included in the report of trainings held in Tanzania and Eritrea. Unfortunately, this component could not be completed.

Replace for R-134a and R-600

IV. Financial report

The demonstration project was approved at a funding level of USD 369,150 including PSC for UNIDO and USD 56,500 plus PSC for UNEP – in total USD 425,650.

The project "Demonstration project on refrigerant quality, containment and introduction of low-global warming potential alternatives (Eastern Africa and Caribbean regions)" was approved as Global including two regions. Based on that, the funds received by UNIDO were divided as follows:

1. Demonstration project on refrigerant quality and containment - Eastern Africa region. US$ 110,415
2. Demonstration project on introduction of low-global warming potential alternatives Caribbean region US$ 134,585

The present report includes only information related to the first component related

Upon project completion, the estimated project expenditures are USD <110,181> related to UNIDO's component, it is to be noted that UNEP's component was returned with balance of expenditures equal cero USD <0>. Thus, the overall cost estimate of the project is USD <110,181>. Any balances will be returned to the Multilateral Fund after financial completion.

At the time of presenting this report almost 100% of the funds approved for UNIDO - East Africa component have been committed and spent and 98% delivered. The table below shows the budget and actual expenses.

Activity	Planned Expenditures (US $)	Actual Expenditures As of Sep 2019 (US $)	Disbursement As of Sep 2019 (US $)	Funds available As of Sep 2019 (US$)

a. International experts	12,000	12,289	12,289	-289
b. Project management	5,000	2,031	2,031	2,969
c. National experts	25,000	24,886	24,620	114
c. Workshops	30,000	30,947	28,919	-947
d. Equipment	35,000	37,633	37,633	-2,633
e. Subcontract public awareness	3,000	2,395	2,395	605
f. Contingencies	415			415
TOTAL	**110,415**	**110,181**	**107,888**	**234**

The funds spent in equipment were used to purchase the refrigerant identifiers and room air conditioners used for the workshops as indicated in component 2 of the present report. A total of 8 identifiers Ultima Id Pro were purchased and delivered as per table 1 in Component 2. It also includes 5 mini-split units of 12,000 BTU, fake refrigerant and other materials and tools purchased for workshops.

V. Conclusions and recommendations

This paragraph does not include the conclusions already inserted above from the national and international experts. The present conclusions are from the project findings and implementation activities.

Conclusions

1. The first conclusion is that lack of knowledge from all stakeholders, even Implementing Agencies, on the fact that Counterfake or contaminated refrigerant is widely available in the market. It cannot be stated that 'all over the world' but it is more and more available.

2. Nowadays, the web commercial pages increased the availability of this kind of refrigerant. It is possible to find and purchase many kind of refrigerants at different prices without any restriction.

3. The project was implemented in direct cooperation with the experts in the countries, the involvement of NOU and local technicians was the main factor for the success. In cooperation with the project manager, many local refrigeration dealers were visited and different kind of refrigerants with misleading labeling and packing were found.

4. The demonstration carried out during workshops was one of the most important activities. With this, the technicians understood the consequences they can expect using the counterfake refrigerant. It was clear that the good refrigeration practices and proper use of tools are useless if the refrigerant has not standard quality.

5. Among the consequences of fake refrigerant can be listed the following:

    a) More energy consumption, indirect CO_2 emissions.
    b) Damage of components, compressor burnout, equipment to be cleaned.
    c) Reduce of equipment life spam.
    d) Lost of efficiency in the system.
    e) Can be flammable or toxic.

f) Cannot be recycled or reclaimed.
g) Potential increase in refrigerant consumption due to recharge.
h) Potential increase of leaks, if higher pressure refrigerant charged.
i) Unreliable, the job may have to be repeated. Loss of credibility for the technicians.
j) Counterfake refrigerant will end vented releasing ODS and GWP gases.

6. The couterfake refrigerant are widely available among other due to the following reasons.

a) It is a profitable business.
- In some cases it is matter just of bottling recovered refrigerant. This include all kind of pure of blend refrigerants that can be contaminated by particles, other gases, acidity etc. or unbalanced blends.
- It is also possible to expand pure refrigerants with no-standard gases like R-40.
- Just recovered phase-out gases bottled and reselled.
- More and more examples can be found in the market.
b) Difficult to track and prosecute.
- As per the results of surveys included in the present report. In some cases, customs allow refrigerants which are not banned. For customs, the quality is not a requirement.
- Refrigerant are not entering the countries through the regular ways.
- Refrigerant are not properly declared in customs
- No country of origin, no proper import licences.
- More and more examples
c) Lack of awareness
- This can be the most important conclusion. In general, the concept is that there is only one quality, even if refrigerant of the same denomination is available at quite different prices in the same market.
- Even importers, seems to be, are not aware on the refrigerant quality.
- Stakeholders are unaware of quality and consequences.
- Good refrigeration practices and, in general, training does not include the refrigerant quality as subject.
d) Attractive due to low price
- Price drive market.
- It is repacked in some countries and distributed in low quantities
e) Difficult and expensive to verify authenticity
- One of the first activities implemented in the project.
- Refrigerant identifiers should be also provided to training centres

7. The refrigerant identifiers are very expensive but delicate tools. So many units have been distributed all over the article 5 countries and are damaged. The refrigerant identifiers are designed to be used for gas and includes a device to be used for liquid. One of the issues is that if couterfake refrigerant is being tested, the identifier can be used with liquid refrigerant and the consequences are well known after some uses. It is recommended to emphasize the uses to use always the identifier with the liquid testing device and also with the small ‘capillary valve’ included and seldom used.

8. As per the brochure prepared by UNIDO, there are some tips on how to identify counterfake refrigerants:

a) Lower or upper case: E.g. R-134a is different to R-134A or R-141b to R-141B, and R-410A to R-410a, inclusive R-600 is not R-600a and R-600A does not exist.
b) Small letter is used for single refrigerant to indicate change in chemical composition. R-134 is different than R-134a.

c) Capital letter is use to indicate the composition of the blend R-410A, R-508B or R-401C. Eg. R-409A (60% R-22/25% R-124/15%R-142b) and R-409B (65% R-22/25% R-124/10%R-142b)
d) Brand names: Dupont can be found in some cylinders and it is DuPont. Genatron is used instead of Genetron.
e) General appearance of the cylinders: Some cylinders or cans are scrapped, repainted, soiled or damaged. Some are out of dimension or even renamed.
f) AHRI colour code: The colour code is a good guidance, sometimes same refrigerant is available in cylinders of two different colours.
g) Misleading advertising: from R-600a or R-290 non-flammable to 'replace for' can be found in the market.
h) The brochure include some tips on how to recognize genuine refrigerants. It is to be noted that not all should be included, but it can be used as guidance. Some tips are: manufacturers name; trade name; ASHRAE refrigerant number; chemical name; UN number; CS number; country of origin; net weight.

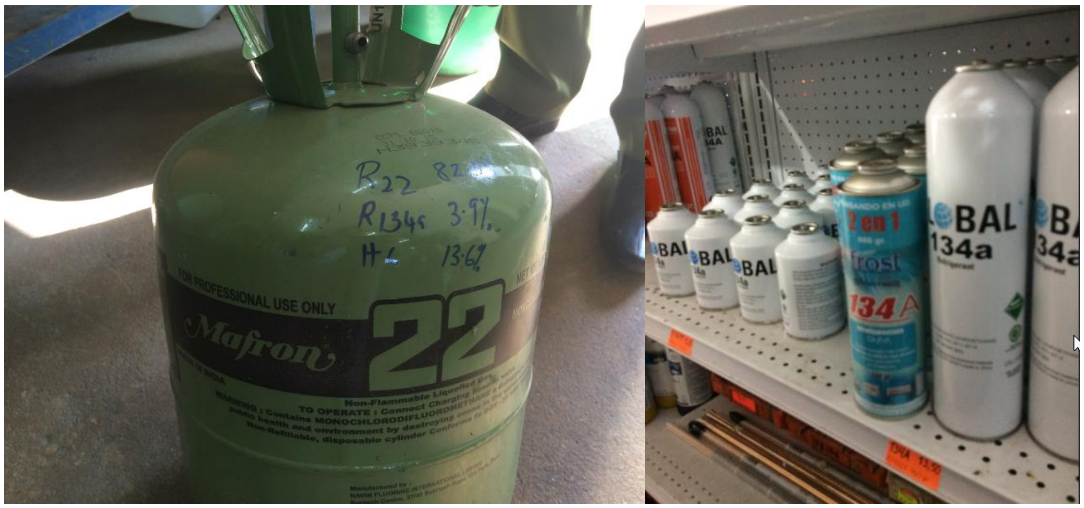
9. The lack of knowledge on the refrigerant quality is also found in the custom officers. In general, the training is focused in the substances and licensing systems but the general aspects of the packing and labeling is not included.
10. The best way to stop the counterfeit refrigerants is through the training of technicians and public awareness. The brochure also includes some tips on this issue: - Check the packing or cylinder based on described; if possible, test the refrigerant; report counterfeit refrigerant to enforcement agencies, refrigeration service technicians association, relevant authorities; do not accept counterfeit (it is for your own safety); no demand, no offer; public awareness, spread the word; low enforcement, policy and standards.
11. Project manager have found counterfake refrigerant in many countries beyond those included in the present demonstration project. Even, in some countries, the refrigerant available in the training centres was first externally verified and then tested, the results showed that there is clear relation between packing and containment. In many cases contaminated refrigerant was found and good examples to teach on ways to identify potential fake refrigerants based on the label.
12. Conclusion of the project implementation:
    a) Due to geographical distribution, the project was indirectly implemented in two parts. The main was for the neighbor countries Kenia, Uganda, Tanzania and Zambia and the second for Eritrea. In both cases the same activities were implemented and the results are summarized in the present report.
    b) The support received from the National Ozone Units from Kenia and Uganda was very valuable for the project implementation.
    c) The lack of funds for public awareness and information dissemination jeopardize the project implementation plan. Since the activities from UNIDO side were well advanced, the project was redirected and completed in the best possible way.

Recommendations

The recommendations given are intended to be applicable and not a wish list which would require big investment and impossible activities.

1. In the training activities for trainers and technicians, is should be included the subject of fake refrigerants. The basic tips for identification, the testing options with or without identifiers and the demonstration with refrigeration units, hopefully new refrigerant identifiers should be included.

2. Wherever possible, a testing centre should be established. It should provide the service for free and have statistic information on counterfake refrigerant available in the country. At least one testing centre should be located in the main city and second in a port city if the case. Training centre is a good option, however, every country can find the best venue for this purpose.
3. Public awareness at all levels is the most important tool to combat the counterfake refrigerants. Since so many environmental treats are included in the fact that counterfake refrigerant is entering the markets, it is a good opportunity to join national public awareness campaigns to protect the environment.
4. It is required to include the basic information and provide brochures, like the one designed by UNIDO, to the custom officers. It will be necessary to include the requirements in the check lists.
5. The brochures were design in English and Spanish language. Some copies have been delivered to countries were UNIDO is implementing projects. It can be distributed in other countries or at least copied and adapted to the local requirements.
6. It is time to work on standards for refrigeration, as already included in the Enabling Activities for the Kigali Amendment. The standard should not be only for HFC but for all kind of refrigerant, labeling and packing.



Composition for R-22 and R-134A and R-134a

ANNEXES

Final Report

Demonstration project on refrigerant quality, containment and introduction of low-global warming potential alternatives (Eastern Africa and Caribbean regions)

Annex I. Agreed Work Plan for the project implementation.

Tanzania_Workplan _UNIDO Assignment

Annex II. Report of joint mission Project Manager and Project leader.

Mission report Zam-Kan-Tan JN Sep

Annex III. Reports of:

Standards and Market Availability of Quality Refrigerants in Tanzania, Kenya, Uganda and Zambia)

Tanzania_UNIDO Assignment_DEMO I

Standards and market availability of Quality Refrigerants in Kenya

Standards and Market Availability o

Country program Kenya

Country program Kenya Oct 16 -.docx

Annex IV. Reports on gap analysis

Reports on gap analysis

UNIDO FINAL SURVEY REPORT.doc

ODU's Survey June 19.docx

Refrigerant Survey_Gap Analysis

REFRIGERANTS SURVEY IN NAIROBI

Annex V. UNIDO Brochures

Refrigerant can be Counterfeit! English version

Brochure_Gas_En.pdf

!Los refrigerantes también los falsifican! Spanish version

Brochure_Gas_Sp.pdf