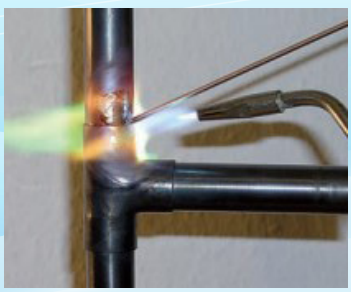
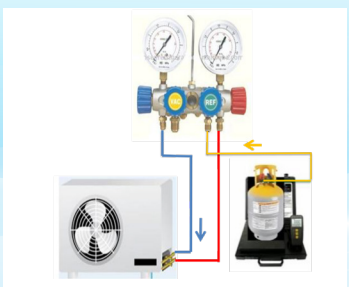
PROCEEDING OF

STAKEHOLDER CONSULTATION ON

STRENGTHENING OF REFRIGERATION AND AIR-CONDITIONING CERTIFICATION SYSTEM FOR RAC SERVICING TECHNICIANS


27th August 2019

New Delhi

Organised by

The Ozone Cell, Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India

&

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH - Proklima International

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Disclaimer

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सत्यमेव जयते

भारत सरकार
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE

FOREWORD

Refrigeration Air-conditioning (RAC) service sector in the country is predominantly in the informal sector. With an increase in the penetration of the air conditioning equipment the number of service technicians shall also rise. Skilling and certification of RAC service technicians have twin benefits of environmental protection and livelihood enhancement. It also provides a mechanism to formalize the trade. Accordingly, it is the focus under HCFC Phase out Management Plan (HPMP) Stage - II. The Government of India also prioritizes the upskilling and certification of RAC service on good servicing practices and knowledge of alternative refrigerants to Ozone depleting chemicals under the Skill India Mission – Pradhan Mantri Kaushal Vikas Yojana (PMKVY).

RAC Servicing sector trainings under HPMP is being implemented by Government of Germany represented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) – Proklima, under the guidance of Ozone Cell, MoEF&CC. Skilling and certification of RAC service technicians is also being undertaken under PMKVY Recognition of Prior learning Category III under the Memorandum of Understanding between the Ministry of Environment, Forest and Climate Change and Ministry of Skill Development and Entrepreneurship, Government of India. A skilled manpower base is an asset for the air-conditioning equipment manufacturing companies.

Servicing sector is directly related to the consumption of refrigerants and optimum and efficient operation of in-use RAC equipment. This sector is largely unorganized and presents an immediate opportunity for securing environment benefits and livelihoods enhancement of RAC service technicians through training and certification. Use of good servicing practices (GSPs) by service technicians reduce refrigerant leakage and minimize the indirect emissions of air conditioning equipment related to power generation by maintaining the rated energy efficiency of in-use equipment. The Training on good servicing practices and alternative refrigerants is not only essential for safe handling alternatives and but also enhances skills of technicians. Certification of trained technicians leads to better employability, income and recognition.

Under HPMP stage-II it has been envisaged to develop a strategy to strengthen the Certification system in the country. GIZ has developed a concept note for such a strategy under HPMP Stage II. Keeping in view the need to further strengthen the skill ecosystem in the country and also to understand the need of the industry, GIZ-Proklima and Ozone Cell, MoEFCC had organized a Stakeholder Consultation for Strengthening Certification System on 27th August, 2019 in Delhi, bringing all the stakeholders related to skilling of RAC service technicians on a common platform to deliberate on the way forward towards skilling and certification of service technicians. The Workshop was well attended by national experts from Government, Industry, Service Sector Associations, Think-tanks, vocational institutes, Electronic Sector Skill Council of India, Service aggregators and international experts from GIZ, UNIDO, European Commission, Galileo Institute, Italy.

I am glad to note that the Ozone Cell, MoEF&CC, and GIZ-Proklima have come out with a Proceedings of the jointly organised "Stakeholder Consultation on Strengthening of Refrigeration And Air-Conditioning Certification System" that includes the papers presented during the event on servicing sector particularly on certification of trained RAC technicians, I am sure, the information presented by the subject experts will serve as an working document to development of a robust evaluation and certification system for RAC trained technicians and lead to better employability, income and recognition.

(Anil Kumar Jain)

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CHALLENGES IN SERVICING SECTOR DUE TO USE OF ALTERNATIVE REFRIGERANTS

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ABSTRACT

The Refrigeration and Air conditioning (RAC) has been increasingly becoming as important as the necessary elements for economic and social development in the country. The demand of RAC is growing rapidly due to fast urbanization, construction of commercial and residential buildings, growing population, the necessity of preservation and distribution of perishable food and transportation system, the high growth rate of Gross Domestic Product (GDP) in the country, etc. It has been estimated that the average aggregated cooling demand will grow by 8 times in the next 20 years. A major proportion of cooling will be met by refrigerant based cooling systems in the country. It has been projected that the inventory of RAC appliances/equipment will grow significantly. The inventory of room air-conditioners alone will grow about 10 times from the current level.. Similar multifold growth is expected in other sub-sectors like refrigeration, transport, etc.

The servicing and service technicians requirement in this sector is also expected to grow in a similar proportion and provides opportunities for employment generation in the country. RAC Servicing Sector is becoming more important with the realization that most of the emissions of refrigerants to the environment are during servicing of RAC equipment and end of life disposal. The servicing sector consumes a large proportion of refrigerants used annually in this industry. Hydrofluorocarbons (HCFCs) widely used refrigerants in RAC including servicing sector, are being phased-out under the Montreal Protocol. The hydrofluorocarbons (HFCs) are also to be phased down as per the Kigali Amendment to the Montreal Protocol.

This paper discusses the potential non-Ozone Depleting Substances (ODS), low/lower Global Warming Potential (GWP) alternative refrigerants. Most of these refrigerants are flammable and/or have higher pressure; due to this the servicing sector poses several challenges. This paper presents the challenges in the servicing sector due to the use of alternative technologies. It also provides some inputs for overcoming the challenges.

The service technicians have very limited knowledge of handling of these gases, therefore training on good service practices (GSPs) including hand on practices needs to be provided on a large scale. There is a need to upgrade the skills and knowledge of trainers as well as the workshop facilities in institutions for training the new entrant technicians on alternative technologies. There is an also an urgent need to establish the State of Art Institute (s) for the RAC service sector to move along with technological developments in this sector. Equipment manufacturers have good training facilities, but there is a need to develop a mechanism to extend their training network to informal sector technicians. E-training module/ mobile training are some of the ways that may also be needed to reach to the target group. The lack of financial resources with the technicians to purchase tools and equipment for practicing GSPs is a big challenge especially for the informal sector. Technician's certification is becoming a necessity for the safe handling of alternative refrigerants in servicing. The customer awareness programmes for seeking quality servicing at some premium through certified technicians is one of the important elements for the adoption of GSPs and to reduce repeated servicing of equipment, refrigerant consumption/emissions as well as maintaining the energy efficiency of serviced RAC equipment.

Key words: Refrigeration and air conditioning, RAC Servicing sector, Service Technician, Alternative Refrigerant, Montreal Protocol, Good Service Practices, technician's certification.

1. INTRODUCTION

RAC is an important and essential sector both for social and economic development in the country. Air conditioning is becoming a necessity for a healthy working and living environment, and refrigeration is an essential component of the cold chain for the preservation and distribution of perishable food. Cooling is also widely used in several industrial processes, especially in the chemical and pharmaceutical industry and transport, including shipping of industrial products. The country has been witnessing a very rapidly growing building stock and urbanization. These developments have led to the rapid growth of the RAC sector in the country.

The current market penetration of air conditioners is only about 7%. However, the demand for air conditioners will continue to grow with about 10-12% per year. As per India Cooling Action Plan (ICAP, 2019), the estimated number of ACs in operation in 2017 is about 39 million and expected to grow to 350-400 million by 2037-2038. Similarly, other sub-sectors like ducted AC systems, chillers (scroll, screw and centrifugal chillers), mobile air conditioning (MAC), domestic refrigeration, commercial refrigeration, cold chain are also growing rapidly. It has been projected that the cold-chain and refrigeration sectors will grow around 4 times while transport air-conditioning around 5 times by 2037-38 from the 2017-18 levels. Overall, refrigerant-based equipment stock is likely to increase by around 10 times in the next 20 years; and room air conditioners will continue to dominate at 80-90% share.

The servicing requirements are also growing in a similar proportion in the country. It is expected that the requirement will grow by multifold in the next 20 years, say by ten times. Moreover, the new alternative refrigerants to HCFC and HFC are either mildly flammable or highly flammable. These refrigerants call for additional safety standards to address issues such as pressure-safety, toxicity, electrical-safety, flammability and explosion protection, and general safety of machinery and technicians.

A large number of skilled as well as semiskilled service technicians are currently engaged in this sector. Servicing sector provides further a huge opportunity for employment generation in the country.

1.1 Servicing Sector in India

Servicing sector is an integral part of the RAC industry. In recent years its importance is further increasing with the realization that most of the emissions of refrigerants to the environment are during servicing of RAC equipment and end of life disposal. Servicing sector consumes a large proportion of refrigerants used in the industry. The servicing sector accounts for about 40% (HPMP Stage-II,2017) of refrigerants consumed annually in the country.

The servicing sector in India is made up of a diverse range of establishments that provide maintenance services for all types of refrigeration and air conditioning systems. Manufacturers operate the service network either own and/or franchises (so-called 'authorized' or 'franchised' service workshops) across the country. Besides, there is a considerably large informal service sector with no tie-up to manufacturers. These workshops are present from larger cities down to small towns and thus closest to the customers. It is estimated that there are around 200,000 technicians in the stationary air conditioning service sector as per existing AC stock present in the country (HPMP Stage II, 2017). A majority of the technicians engaged in this sector are who have not gone through the formal technical education and/or training and these technicians have learnt while working in the field over several years.

Service of RAC equipment during the warranty period is done through the manufacturer's service centers or through the network of franchised repair workshops. The manufacturers conduct training programmes for their service network technicians across the country, The manufacturer service network technicians acquire a good understanding of the particular manufacturer's brand equipment. Most of the installed equipment beyond the warranty period is serviced by the informal sector due to cost considerations.

Another important sector is MAC, which is responsible for significant consumption of refrigerant. Currently, MAC uses HFC-134a refrigerant, the estimate of consumption of refrigerant and the number of technicians involved is yet to be studied. As per the Federation of Automobile Dealers Association (FADA) reports, approximately 50% of servicing enterprises are from the informal sector. Among the formal enterprises in MAC, about 75% are authorized service centers and remaining is constituted by multi-brand service centers.

1.2 Current Servicing Practices

As it has been mentioned above, most of the technicians engaged in the servicing sector are from the unorganized sector without formal technical education and have learnt by working in the field over several years. The upgradation of skills of these servicing technicians and new entrants would go a long way to continue their livelihood and would also enhance employment opportunities within the country as well as overseas.

As per ICAP, 2019, the GSPs for the reduction of refrigerant consumption and emissions are largely not followed by the service technicians. The service practices that are followed currently by most of the technicians lead to significant wastage of refrigerants and emissions of HCFCs and HFCs to the environment like flushing with refrigerants, leak testing using compressed air or refrigerant; inadequate evacuation; poor brazing; inaccurate charging; lack of or inadequate recovery & recycling of refrigerant.

Proper skill development and tools and equipment are the keys to overcome barriers in applying GSPs and handling the upcoming flammable and high pressure refrigerants. Recognizing that the servicing sector has mostly micro enterprises, operated by one or two technicians, their ability to afford servicing tools and equipment is very low.

2. THE MONTREAL PROTOCOL

The Montreal Protocol on Substances that Deplete the Ozone Layer has served for three decades as a mechanisms to coordinate global actions to protect the stratospheric ozone. The Montreal Protocol has been recognized as the most successful international environmental treaty. In terms of cooperation, the Montreal protocol happens to be the first treaty of any kind to have garnered truly global participation; it achieved ratification by every country in the world.

In terms of performance, as of now, the Parties to the Montreal Protocol have already phased out more than 98 percent of the Ozone Depleting Potential (ODP) weighted level of the production and consumption of ODSs controlled under the Montreal Protocol. The Montreal Protocol has not only put the Ozone Layer on the path of recovery to its 1980 level but has also benefitted to the climate system by reducing 11 Giga tonnes CO2 equivalent per year from 2010 (UNEP, OzoneAction) by phasing out production and consumption of high ODP chlorinated and brominated compounds including refrigerants.

This regime of implementation of the Montreal Protocol mainly introduced HFCs as the alternatives to Chlorofluorocarbons (CFCs). These are similar compounds to ODS refrigerants but do not deplete the stratospheric ozone

2.1 Accelerated Phase-out of HCFCs

HCFC refrigerants are having low-ODP. These refrigerants are still widely used, especially in developing countries. The Parties to the Montreal Protocol in 2007 decided to accelerate the phase-out of production and consumption of HCFCs by 10 years through the Decision XIX/6 of the 19th meeting of Parties to the Montreal Protocol in 2007 (UNEP, 2007). Parties to the Montreal Protocol also decided while accelerating the phase-out of HCFCs to encourage Parties to promote the selection of alternatives to HCFCs that minimize environmental impact, in particular impacts on climate. The Accelerated phase-out schedule for developing countries is shown in Figure1(Agarwal, et al., 2017).

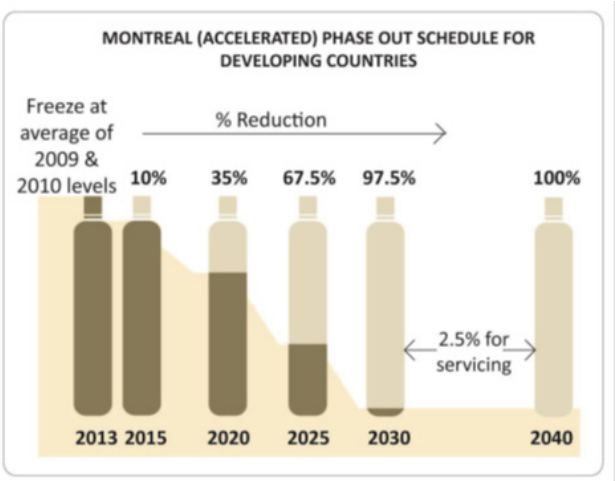


Figure 1. HCFC Phase-out Schedule in Developing Countries

2.2 Kigali Amendment to the Montreal Protocol for Phase-Down of HFCs

HFCs were introduced as zero-ODP alternatives to CFCs and HCFCs. Use of HFCs is growing rapidly with a very high growth rate globally. Most of HFCs are potent greenhouse gases, and their contribution to CO2 emission is growing rapidly. HFC emissions are projected to rise to about 3.5 to 8.8 GtCO2-eq in 2050 (Velders, et al, 2009.) which is comparable to the reduction of 11 GtCO2-eq achieved due to phasing out of ODS between 1988 and 2010. This clearly means that without intervention, HFC emissions are projected to offset the climate benefits achieved by the Montreal Protocol through phasing out ODSs. Recognizing the concerns due to increasing in GHG emissions due to increasing use of HFCs, globally, there were many efforts and discussions during 2009-2016 to address this issue of HFC phase down as part of the Montreal Protocol.

The parties to the Montreal Protocol reached to a historical agreement for an amendment to the Protocol for phase-down of HFCs under the ambit of the Montreal Protocol at its 28th Meeting of Parties held in Kigali Rwanda on 15th October 2016 (UNEP, 2016). As per the agreement, countries are expected to reduce the manufacturing and use of HFCs by roughly 80-85% from their respective baselines, by 2045. This phase down is expected to arrest the global average temperature rise up to 0.50 C (Velders, et al.) by the end of the century. The HFC phase-down schedule for parties operating under Article of the Montreal Protocol is depicted in Figure 2.

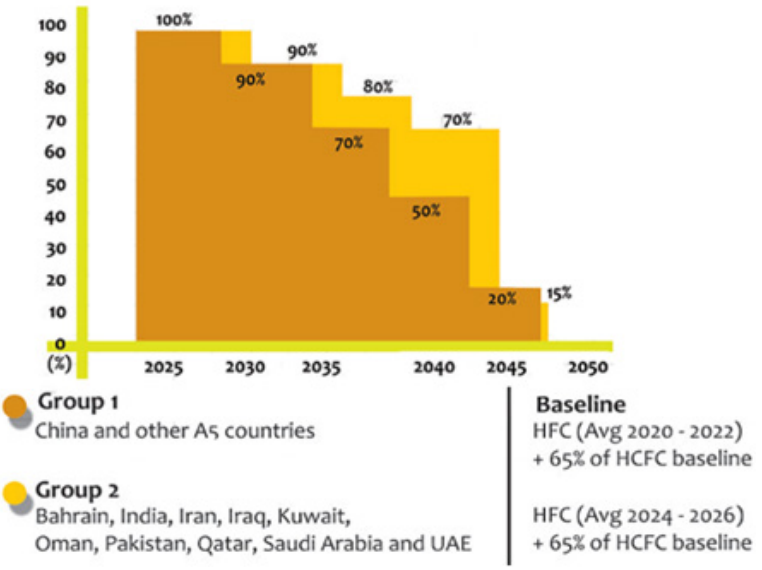


Figure 2: HFC Phase-down Schedule for Article 5 Parties

The implementation of the Montreal Protocol, the RAC industry, including servicing sector, has faced several challenges with respect to the availability of safe, economically viable technologies, especially the refrigerants. The low-GWP refrigerants are not yet available for all the applications. and for some of the applications are still emerging.

3. ALTERNATIVE REFRIGERANTS

HFCs have emerged as the main alternative refrigerants to ODS refrigerants for various applications. A number of HFCs have been commercially developed (19 HFCs). However, only five HFCs, e.g., HFC-32 (GWP=675), HFC-125 (GWP=3500), HFC-134a (GWP=1430), HFC-143a (GWP=4470) and HFC-152a (GWP=124) could be used either as singe component refrigerant or a component of blends of refrigerant. Some of the HFC refrigerants like HFC-134a, (non–Flammable: A1 Category), HFC-32 (mildly flammable; A2L category), (ASHRAE Standard 34) etc. have been commercially used for a number of applications. Following next generation refrigerants-historical review, considerations and outlook, was presented as earlier as in 2008 (Calm, James M, 2008).

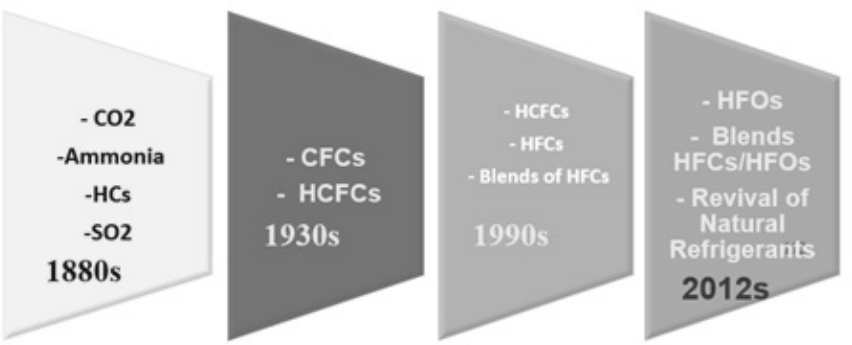


Figure 3: Evolution of Refrigerants

HFCs and blends of HFCs are non-ODS but have an impact on the environment, particularly on the climate, due to their very high GWP in many cases. As shown in Figure 3, natural refrigerants which have negligible GWP like ammonia, carbon dioxide (CO2) and hydrocarbons have been reconsidered for use in refrigeration and air conditioning wherever applicable, A number of ultra-low-GWP unsaturated-HFCs (Hydrofluoroolephenes-HFOs) molecules have been developed which may prove to be potential refrigerants to replace HFCs. Recently, HFC-32 and propone (R-290) have emerged as potential alternative to HCFC-22 especially for small unitary systems which are widely used in the country. HFC-32 and R-290

as A2L (mildly flammable) and A3 (highly flammable) categories respectively, it is a major challenge in RAC servicing sector that all the potential alternatives are flammable.

3.1 Lower-GWP Single Component Alternative Refrigerants

Recently, (McLinden, et al., 2017) carried out a comprehensive study to search for alternative refrigerants as replacements to currently used HFCs refrigerants in RAC systems by applying screening criteria to a very comprehensive chemical database (more than 60 million compounds). The results show that there are only a few single component fluids (pure fluids) possess the combination of chemical, environmental, thermodynamic, and safety properties necessary for a refrigerant and these fluids are at least slightly flammable. Some of the commercially available potential single component refrigerants are given in Figure 4.

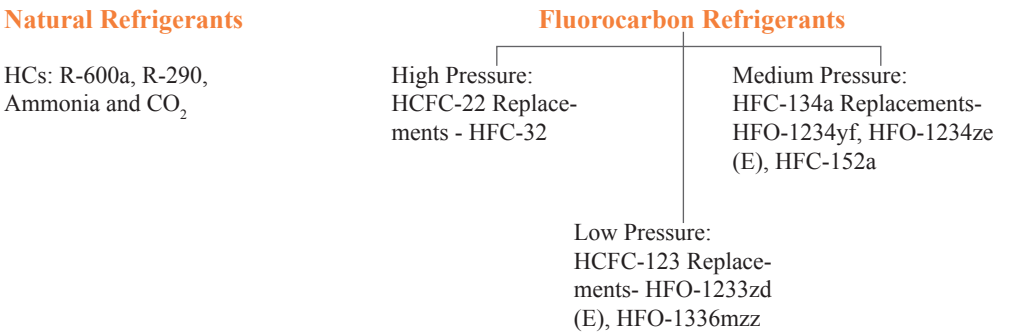


Figure 4: Lists the Single Component Lower GWP Refrigerants.

3.2 Challenges for RAC Industry

RAC industry, including the service industry has been so far using mainly single component refrigerants like HCFC-22, HCFC-123, HFC-134a, etc. or azeotropic/ and some zeotropic blends with a very small temperature glide. It is becoming quite challenging for the industry cater the need for growing RAC requirement.

- Limited single component lower-GWP refrigerants, both in natural and fluorocarbon family of refrigerants especially for high pressure applications.
- Most of the single component refrigerants are either highly (A3) or mildly (A2L) flammable. There are safety concerns within the industry.

3.3 Lower GWP Blends of HFCs and HFOs

Recognizing that there are limited single-component HFC refrigerants, the global fluorocarbon industry and research institutions have been developing several blends (UNEP, 2014) by mixing two or more of these refrigerants. Commonly used blends of HFCs are R-410A, R-407C and R-404A. R-410A, a blend of HFC-32 and HFC-125, has been used globally in RACs as an alternative to ODS refrigerants. All such blends are high-GWP and going to be phased-down as per the Kigali Amendment to the Montreal Protocol. A large number (UNEP, 2018) of such blends have been proposed but only a few are at the stage of commercialization.

Table 1 gives the characteristics of some of the potential lower-GWP alternative blends of HFCs and HFOs developed in recent years.

Table 1: Potential Blends of HFCs and HFOs

Blend	Composition	Temperature Glide 0°C	Safety Class	GWP (100Year)	Equiva-lent to
R-444B	HFC-32/1234ze/152a	~10	A2L	300	HCFC-22
R-446A	HFC-32/1234ze/ 600	~5.4	A2L	460	R-410A
R-447A	HFC-32/125/ 1234ze	~5	A2L	570	R-410A
R-452B	HFC-32/1234yf/125	0.9	A2L	680	R-410A
R-449A	HFC-32/125/1234y-f/134a	6.1	A1	1300	R-404A
R-448A	HFC-32/ 125/ 1234yf/ 134a/1234ze	5.7	A1	1300	R-404A
R-450A	HFO-1234ze/R-134a	0.6	A1	550	R-134a
R-513A	HFO-1234yf/134a	0.0	A1	570	R-134a
R-514A	HFO-1236mzz(Z)/ Trans-1,2 dichloro-ethylene	0.0	A1	2	R-123

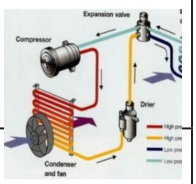
It could be seen from Table 1 that most of the refrigerant's blends are flammable.

3.4 RAC Equipment-wise Potential low/lower-GWP alternative refrigerants

Table 2 gives the RAC equipment-wise potential alternative refrigerants. These refrigerants have ultra-low to moderate GWPs. R-290, HFOs and some HFO and HFC blends are of lower GWP as compared to HFC-32. It could also be noted that alternatives to high pressure applications, the replacements of HCFC-22 have

moderate GWP except R-290, which is highly flammable. It is very challenging to handle and service equipment with such a refrigerant with the presently used practices as the alternative refrigerants are flammable and/or have a higher pressure, good service practices and all safety procedures must be known and followed while performing servicing.

Table 2: RAC Equipment wise Potential Alternative Refrigerants

Room ACs	Ducted Packaged AC	Scroll Chillers	Screw & Centrifugal Chillers	MAC
				
R-290 (12)A3 R-452B(680) A2L R-444 (300) A2L	R-452B (680) A2L R-444B (300) A2L	R-452B; (680) A2L	A2L R-513A (570) A1 R-450 A (550) A1 R-514A (<2) A1	R-513 A(680) A1 R450 A(570) A1

4. CHALLENGES IN ADDRESSING THE SERVICING SECTOR

Currently commonly used HCFC and HFC refrigerants so far have been non-flammable, non-toxic and with moderate operating pressures. The servicing sector is required to service equipment with a number of technologies; each of the technologies has its own requirements as all these technologies have different operating pressures, charge quantities, lubricating oil, safety requirements, etc. The simultaneous implementation of phase-out of HCFCs and the introduction of low-GWP technologies is becoming challenging, especially for the servicing sector.

It is challenging to develop enabling an environment for the servicing sector for seamless transitioning of the sector from current level to a level where servicing technicians are equipped with both the skills and tools and equipment for handling of upcoming new flammable refrigerants.

It has been well recognized that the servicing sector comprises of formal and informal sectors. It has also been recognized that the informal sector is dominating because the servicing is seasonal and cost sensitive. Due to the lack of consumer awareness towards the importance of quality service, most of the servicing jobs are being done by informal sector. As per the industry estimates, more than 75% of service technicians are from the informal sector. The service technicians who are in the formal sector currently they are also not very well equipped to take up the challenges which are faced due to changing technologies.

The following sections are being focused on some of the important aspects, like the capacity building of training infrastructure for preparedness of both the new entrants technicians in the field of servicing and existing technicians for safe handling and servicing with flammable and high pressure alternative refrigerants, accessibility of training, good service practices & minimum requisite tools and equipment, safety of service personnel and end users in using new alternative refrigerants.

4.1 Capacity building of training infrastructure for handling and servicing with low-GWP technologies

Training and certification are the key to the successful adoption of non-ODS low/ lower- GWP refrigerants. Currently, there are various training channels that offer courses for RAC technicians trainings such as equipment manufacturing industry that train their network technicians, Industry and associations (ISHRAE), Directorate General of Training (DGT), National Skill Development Corporation –Electronic Sector Skill Council of India (NSSCI) and Multilateral agencies like GIZ-HCHC Phase-out Management Plan (HPMP) projects

There are main three streams for imparting skills/ training to the servicing technicians:

- Formal Technical Training in RAC: Directorate General of Training (DGT)
  - o National Skill Training Institute (NSTI)
  - o Industrial Training Institutes (ITIs)
- Industry Training Network
- Training of informal sector technicians (Short term Refresher Training)

4.1.1 Formal Technical Training in RAC

India has a very good technical education network including for vocational training. The country currently has NSTIs, Instructor Training of Trainers (ITOT), 765 ITIs and 238 Private providing training in the area of RAC servicing.

National Skill Training Institute (NSTI)

There are two NSTI and one ITOT across the country conducting long term training for the trainers/instructors in the RAC field as well as conducting short term refresher programmes for the trained teachers in RAC. The current capacity of these institutes is about 250 trainers per year.

These institutes are not yet equipped both in terms of faculty and tools and equipment for providing training to the trainers on upcoming changing technologies. There is an urgent need to strengthen these institutes as it is going to have a very significant sequential impact in this trade. The trainers coming out from these institutes will be employed in ITIs for training technicians. It is challenging, but essential for skill development of new entrants/next generation technicians.

Establishment of the State of Art Institute (s) is also an urgent need in this sector to facilitate training network on technological developments. Such institute (s) will continuously be engaged in updating the curricula for NSTIs and ITIs under the guidance of DGT. This will not only develop qualified well versed technicians and increase the employability in this sector but also result in reduced consumption & emissions of refrigerants and maintain the energy efficiency of the services appliances/equipment.

Industrial Training Institutes (ITIs)

India has a very good network of ITIs across the country. There are more than 1000 institutes in the country imparting training in RAC trade. These institutes are producing about 15,000 formally trained technicians annually who take up a variety of jobs from manufacturing, installation, and operation to servicing.

Although, it is challenging, but it is an urgent requirement of strengthening these institutes for handling new technologies including flammable refrigerants-based equipment. This would necessitate the upgradation of skills and knowledge of instructors as well as the workshop facilities for training on new/next generation technologies.

4.1.2 Industry Training Network

Most of the RAC equipment manufacturers in India have established training facilities for servicing personnel to meet the challenges in the introduction of new products and technologies. Equipment manufacturers have developed their own service network to train the service providers on their products. The network includes company owned service centers, authorized dealers, franchisees retailers/distributors, service associates and freelance technicians. The industry network caters the servicing needs of their products mainly during warranty period of the product. During the peak sales season, the industry also largely utilizes the freelancer technicians who are similar to informal sector technicians.

It is challenging how to motivate the industry to include GSPs in general rather than only training on their products and extend its training network to informal sector technicians.

4.1.3 Training of Informal Sector Technicians (Short term Training)

The informal sector caters about 75% of the servicing sector. The characteristics of the informal servicing sector like lack of awareness, motivation for learning, resources for accessing training and acquiring a minimum set of tools and equipment, etc. makes the sector challenging. As it has been mentioned, the informal sector technicians require maximum attention and training for safe handling of new refrigerants during servicing. It poses a huge challenge to train these large numbers of technicians on GSPs which are required for safe, quality service and to minimize the drop in the energy efficiency of serviced units from designed value during operation of the equipment.

Successful efforts have been made to provide refresher training through MLF funded projects by GIZ Proklima in close cooperation with Ozone Cell, MoEF &CC for the past 15 years. More than 30,000 technicians have already been trained on GPSs and further trainings are being conducted.

The Ozone Cell, MoEF&CC has developed a project jointly with the Electronic Sector Skill Council of India (ESSCI) for upskilling and certifying 100,000 RAC technicians in the country under the Skill India Mission - Pradhan Mantri Kaushal Vikas Yojana (PMKVY) of Ministry of Skill Development & Entrepreneurship (MSDE). A Memorandum of Understanding (MoU) was signed between MoEF&CC and MSDE. The project is being implemented.

4.1.4 Technological Challenges- Multiple Refrigerants

Most of the new technologies being flammability and/or high pressure, therefore, there are safety concerns within the service industry, including during refrigerant handling, equipment installation and servicing. Currently, the servicing sector is to handle a number of technologies like HCFC-22, R-410A, HFC-32, R-290, etc. It is becoming increasingly challenging for the service sector to cope up for handling multiple technologies. The technicians also have almost no understanding of GSPs and lack of resources for the purchase of tools and equipment for practicing GSPs.

4.1.5 Good Service Practices

The GSP include the following:

- Safe handling of Refrigerants including flammable and high-pressure refrigerants;
- Safe handling of high-pressure gases (dry-nitrogen) to avoid fatal accidents;
- Proper installation of RAC equipment;
- Minimise refrigerant emissions by recovery, recycling and reuse the refrigerant;
- Cleaning and flushing of the system with dry nitrogen;
- Safe brazing technologies for connecting tubes;
- Leak and Pressure Testing - Use Oxygen-Free Dry Nitrogen (OFDN);
- System evacuation using two stage vacuum pump & vacuum holding;
- Charge the system by weight and use quality refrigerants.

The training on GSPs for flammable and/or high-pressure refrigerant poses several challenges like:

- Creation and/or upgradation of existing training centres;
- Equipment support to the Training Centres;
- Development of pool of trained trainers;
- Awareness among the technicians to motivate for training;
- Outreach to the technicians across the country;
- Training material and technician service manuals in regional languages;

- Development of mechanisms for financial support and/or to facilitate the technicians for purchasing tools and equipment for practicing GSPs and handling flammable refrigerants

4.2 Tools & Equipment Support

Technicians mainly in the informal sector don't have financial resources to purchase tools and equipment which are must for practicing GSPs.

Recognizing tools & equipment is the key to the adoption of GSPs and bring down the consumption and emissions of refrigerants. It is becoming increasingly important for upcoming technologies. There is a need for developing equipment support scheme or link with some existing scheme in consultation with industry and the stakeholders for providing minimum tool kit & equipment to the technicians.

5. AWARENESS AMONG THE TECHNICIANS

Awareness is one of the key elements to prepare the informal sector technicians for understanding the needs of adoption of GSPs and motivation for moving towards the formal sector. The lack of motivation among the target group poses a challenge for imparting of training to these technicians. Although, it is challenging but very important to develop awareness programmes like developing e-training module platform catering the needs of this target group.

5.1 Developing e-training modules/ platform

Recognizing that alternative technologies have not yet been stabilized in RAC sector and the low-GWP technologies are still emerging, there is a need for providing periodically updated information on technical developments in simple language and format; including (a) technical and commercial information on alternative refrigerants especially the low-GWP refrigerants, their characteristics, prices, sources of availability, safety standards and precautions to be taken while use. (b) GSPs.

Information sharing (web based/app based information dissemination system) should be developed, it may ensure the accessibility of the information to the servicing enterprises/technicians. The e-training module includes audio/video contents.

5.2 Outreach of training to the target group

Developing mobile training units is one of the possible options to ensure that train-

ing is brought to the doorsteps of the servicing enterprises, rather than technicians traveling to a centralized training place. This concept, however, needs to be developed in detail, so that it is sustainable.

6. CERTIFICATION SYSTEM OF TECHNICIANS

India has introduced technician certification program in room AC sub sector on a voluntary basis. The certification process is in its development stage, it requires 2 day training on theoretical as well as practical aspects and on the third day, there will be an assessment for each of the candidate. However, the technicians who possess technical knowledge and hands on experience of servicing, they can undergo for certification directly.

There is a lack of awareness about certified technicians in the market, especially in the informal sectormarket. Another challenge is the recertification of already certified technicians as the servicing practices are evolving with changing technologies with respect to refrigerants, including flammable refrigerants. Therefore, regardless of the technicians have formal technical training and field experience but the refresher training and recertification is becoming a necessity.

6.1 Improvement in Technician Certification System

It is essential to develop a competency based certification for these technicians. This would not only provide an opportunity to end users' satisfactory services from a certified technician but also enhance the employability of these technicians within the country and overseas. The current certification system, including a robust evaluation mechanism needs to be developed.

There is a need for mass awareness program about the certification program. Currently, the consumers are largely not aware of the certificated technician and benefits (such as energy efficiency and safety aspects, especially for alternative refrigerants) of getting servicing done by a certified technician. The certification should be valid only for a limited period say 5 years and it could be renewed after the successfully clearing reevaluation test.

The certification process would require the development of infrastructure for testing individual candidates. There is a need to develop evaluation centres across the country. It would enhance the capacity by taking on board the RAC industry and industry associations. However, the overall certification system may be operated under the Government.

7. AWARENESS AMONG END USERS

Mass customer awareness is necessary to educate them on the importance of quality and regular servicing and its impact on the energy performance of the AC system. The customer appreciation and demand for quality service needs to be enhanced. This will bring a change in customer behavior to look for certified technicians and due payment for their services. It would also motivate the technicians for learning and practicing GSPs, and this would create a Win-WIN situation in this sector.

8. CREATING THE INDIA SPECIFIC SERVICING STANDARDS

The servicing of the RAC equipment with stringent environmental requirements and technological changes is a continued process. Most of the manufacturers develop operation and service manuals, it may be little challenging but useful to develop a common Standards/manual for servicing for Indian conditions to be followed by the service to ensure a certain product quality, safety consideration in working and equipment/system performances. The standards should cover GSPs for all the technologies currently in the market and possibly with provision periodic up-dates. The standard/ manual should be developed in consultation with the industry.

CONCLUSIONS

This paper presents the challenges in the servicing sector due to the use of alternative refrigerants and provides recommendations to overcome those challenges. India is going to witness a substantial demand increase in RAC and refrigerant consumption. There are safety challenges during servicing the RAC system due to the introduction of highly (A3) or mildly (A2L) flammable and high pressure alternative refrigerant.The service technicians have very limited knowledge of handling of these gases, therefore training to enhance their skills, including the hand on experience and GSPs to be provided on a large scale.

There is a need to upgrade skills and knowledge of trainers as well as the workshop facilities for training on new/ next generation technicians on new technologies in formal technical training institutes. There is an urgent need to establish the State of Art Institute(s) for the RAC service sector for technological developments. Equipment manufacturers have good training facilities, but there is a need for a mechanism to extend their training network to informal sector technicians. E-training module/ mobile training are some ways to reach to the target group.

Lack of resources and the inability to purchase tools and equipment for practicing GSPs is a big challenge for the informal sector. Technician's rigorous training and certification is the key to harnessing climate benefits as well as for safe operation and safety of the service personnel. The customer awareness program for the demand for quality service and readiness to commensurate payment for the services are to be regularly featured. The technician's certification system to be carried out at initially on a voluntary basis and making it mandatory at an appropriate time keeping in view the informal sector.

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OVERVIEW OF REFRIGERATION & AIR CONDITIONING (RAC) SERVICE TECHNICIANS TRAINING IN INDIA

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ABSTRACT

The international environment treaty Montreal Protocol on Substances that Deplete the Ozone Layer was signed to reduce the ozone depleting substances (ODS) in the atmosphere by implementing control measures to phase-out ODSs. The Protocol was ratified by India in 1992. This led to a) regulatory measures for production and consumption of ODS and b) appliance manufacturers changing over to new technology and new refrigerants. These cooling appliances and systems need to be properly installed, operated and maintained to work at highest efficiency and minimal environmental impact. Servicing of the appliances with new technology and refrigerants in particular for the informal sector service technicians would be a challenge. As they have limited resources to enhance their skills. Some of the equipment lasts for more than 15 years. This implies that there would be many equipment that may need to be serviced using ODS long after the manufacturing side has been converted. The technicians will have to ensure of applying Good Service Practices (GSP) primarily for avoiding leakages and recovery of refrigerants. This would be possible through regular training to the technicians. OEMs regularly train their technicians; the crucial part is training for technicians from the informal sector. A healthy service sector will practice GSP so that the market can be prepared to accept the new technologies. Certification of trained technicians is key to guarantee that only qualified personnel handles certain technologies and refrigerants. Certification will lead to better employability, income and recognition.

Key words: Ozone Depleting Substances (ODS), service technicians, training;

INTRODUCTION

The refrigerant consumption in the servicing sector depends on the quality of the product and the quality of servicing during product life cycle. Often, the original refrigerant charge amounts to only ca. 10% of the overall consumption of its life time. The quality of servicing depends on knowledge and skill levels of service technicians, using appropriate equipment and tools. The servicing practices need to be improved for reducing the refrigerant requirement during servicing, also for proper and efficient functioning of the refrigeration and air-conditioning (RAC) equipment. During servicing, recovery of refrigerant is not a common practice, especially in developing countries. The refrigerant is often simply vented out and after repair or maintenance the equipment is recharged with virgin refrigerant.

Good service practice is important due to environmental issues and to maintain the design energy efficiency of the product appliances because efficiency decreases due to age, defects and poor service practices. The quality of servicing of the appliances depends on knowledge & skill levels of technicians and using appropriate equipment & tools.

Quality of the product is taken care of by OEMs' through a well-established quality control & assurances process, have been provided by OEMs. About the service quality there is a wide variation on failure rates depending on knowledge & skill levels of technicians, who are primarily from the unorganized / informal sector without formal access to technology, tools & training. Further the ageing of the products also has a direct impact on consumption of the refrigerants.

The international environment treaty Montreal Protocol on Substances that Deplete the Ozone Layer was signed to reduce the ozone depleting substances (ODS) in the atmosphere by implementing control measures to phase-out ODSs. The Protocol was ratified by India in 1992. The production and consumption of ODSs like CFCs, CTC and halons are already phased out globally, including in India. The ODS Phase-out projects in India is being implemented under the direct supervision of the Ozone Cell, Ministry of Environment, Forests and Climate Change (MoEF&CC), Government of India, in cooperation with UNDP, UN Environment and Germany (represented by GIZ). Sustainable phase-out needs to include the refrigeration servicing sector due to the risk of reverse conversions and to train the technicians in Good Servicing Practices (GSPs) leading to reduction in consumption and avoiding leaks of refrigerants to environment.

A unique feature of the RAC sector is conversion to multiple refrigerant alternatives for specific applications. This poses special challenges to the servicing technicians. Some of the equipment lasts for more than 15 years. This implies that there would be many equipment that may need to be serviced using ODS long after the manufacturing sectors have been converted. Else, premature retirement or stoppage of use would have socio-economic implications.

Every technician in the RAC-Sector has huge impact in terms of climate change, with their daily work. They have the greatest mitigation potential greenhouse gas of all vocational professions in the world. Hence they should take this opportunity seriously in order to make our planet a better place.

1. TRAINING OF RAC SERVICE TECHNICIANS BEGAN FROM….

Ecological Refrigeration (ECOFRIG) began within the framework of Indo-German-Swiss cooperation in 1992. The objective of the project was to establish a level playing field between synthetic fluids e.g. hydrofluorocarbons (HFCs) and hydrochlorofluorocarbons (HCFCs) and the more environment friendly natural refrigerants like hydrocarbons (HCs) fluids in the RAC appliance manufacturing sector. HCs do not deplete the ozone layer and have a very low global warming potential compared to HFCs and HCFCs.

In the late 1990s, it became clear that refrigeration servicing enterprises (RSEs) generally would not be able to adapt on their own and in time to the new and more demanding non-CFC technologies selected by the dominant market players. The survival and employment of many small and informal enterprises in an important industrial sub-sector was at stake. Without well-functioning RSEs, the servicing of old and new equipment would be compromised. Enhancing the skills of more than 39,000 RSEs with over 77,000 technicians was therefore recognized as an important aspect to support the Government of India's goals to achieve national CFC phase-out targets.

The Swiss Agency for Development and Cooperation (SDC) focused on Refrigeration Service Enterprises (RSEs) from a development policy and environmental protection perspective. As a result of this, the Human & Institutional Development in Ecological Refrigeration (HIDECOR) project was developed by SDC, first in a pilot phase under the umbrella of ECOFRIG, and later as a separate project under Indo-Swiss bilateral cooperation. The basic methodologies and infrastructure for geographically limited region of the country were developed under HIDECOR. This formed the basis to formulate a national strategy for the phase-out of CFCs

focusing on RSEs. The national strategy was then approved as the National CFC Consumption Phase out Plan (NCCoPP) at the 42nd Meeting of the Executive Committee (ExCom) of the Multilateral Fund (MLF).

NCCoPP was India's final CFC phase-out project for the Refrigeration and Air Conditioning (RAC) servicing sector. CFCs were banned from use in manufacturing of refrigeration and air- conditioning appliances / equipment under the Ozone Rules 2000 since 2003. It was funded by the Multilateral Fund of the Montreal Protocol and was approved in 2004 by the Executive Committee of the Multilateral Fund (MLF). The objective of the project was to support India to completely phase out CFC consumption from the refrigeration servicing sector by 1st January 2010 The ground for NCCoPP was prepared by the 'Indo-Swiss Project Human and Institutional Development in Ecological Refrigeration' (HIDECOR). The HIDECOR operation, initiated in 1998, was geographically restricted to selected states of the country and the target group consisted of micro, small and medium sized service enterprises in the RAC sector, whereas NCCoPP had presence in all the states of India.

The bilateral predecessor projects ECOFRIG & HIDECOR together with NCCoPP have demonstrated how the bilateral development assistance combined with multilateral contributions can effectively strengthen international environmental agreements. This paved way to implementation of the HCFC Phase-out Management Plan (HPMP) in 2012.

The 19th Meeting of Parties (MOP) held in September 2007 in Montreal, decided to advance the phase-out of production and consumption of Hydrochlorofluorocarbons (HCFCs) by 10 years for an early recovery of the ozone layer. HCFCs are not only Ozone Depleting Substances (ODSs), but also are potent greenhouse gases (GHGs). The service sector in India has significant relevance as the total share of HCFC consumption in this sector is more than 40%. HCFCs has a range of applications however it is widely used in room air conditioners. The accelerated HCFC phase-out schedule for Article-5 countries is the freeze in 2013 at the base-line level (an average of 2009 and 2010) for production and consumption respectively and subsequently, 10% reduction of the baseline in 2015, 35% reduction in 2020, 67.5% in 2025 and complete phase-out in 2030 while allowing for servicing an annual average of 2.5% during the period 2030-2040.

GIZ-Proklima on behalf of the Government of Germany and in close co-operation with the Ozone Cell in the Ministry of Environment and Forests and Climate Change is implementing phase-out activities in the Indian RAC servicing sector.

HCFCs are being replaced by alternatives refrigerants, like Hydrofluorocarbons (HFCs) and natural refrigerants. GIZ had implemented the HPMP Stage – I and now is implementing HPMP Stage – II.

2. TRAINING FOR RAC TECHNICIANS

Population of service technicians in the refrigeration and air conditioning (RAC) sector is almost 200,000 in the country. This leads to a requirement of training for building their capacities. Trainings at regular intervals is a need to upgrade their skills and understand Good Service Practices (GSP) to remain relevant in the business. The turnover of technicians is high in this sector owning to the business being seasonal.
Wide and dispersed presence of service technicians and many of them in the informal sector is a challenge in India. New technologies use refrigerations that are often either flammable (HFO, HC, blends), toxic (Ammonia) or operate under much higher pressure (CO2). The challenge of the technology change is to provide training to facilitate technology adoption to such dispersed workforce. Create awareness on the alternative technologies for phasing out ODS in servicing sector. Also, public at large is still not much aware of ODS phaseout and its implications.

Standardization holds the key also many participants of the training programs have acknowledged that for effective servicing, systems standardization is a must. This will help customers know what to expect when they visit different workshops. Such uniformity can be achieved by standardizing various service practices

The training provides preliminary and practical information to the technicians that can be applied on day-to-day basis. For example, air-conditioner the skills acquired during training can be applied while installation and servicing of room air-conditioners.

It is often seen that recovery of the refrigerant is not a common practice during servicing. Often, the refrigerant is vented out and the appliance is subsequently recharged with virgin/fresh refrigerant. It is also found that the system is topped up with refrigerant without a proper leak detection. This leads to continued leakage. There is a huge potential for saving provided the technician properly recovers the refrigerant.

Here are some of the advantages of GSP in servicing:

(a) Generates the best possible performance from the appliances being serviced, also ensures reliable working and long life of the appliance.

(b) Ensures minimal returns from customers for rework due to customer dissatisfaction. This enables protection of the profits earned by the servicing entrepreneur.

(c) Enhances customer/user satisfaction and reputation of the servicing firm/technician as being reliable and quality conscious and paves the way for growth in volume of business and profitability. Good Servicing Practices (GSP), apart from delivering a well-done job, is also key to reduction in emission of refrigerant.

Emphasis on Safety during training, both in theoretical & practical sessions, greater emphasis is given to the safety aspects the technicians should keep in mind while servicing the appliances. Wearing hand gloves and goggles whilst brazing and handling refrigerants, and thorough evacuation of the appliances are stressed repeatedly and demonstrated in the workshops. How can you be safe? With the use of proper equipment and tools for one's own and others safety are reinforced during the training programs.

3. TRAINING STRUCTURE

Training Partners

The ODS Phase-out projects have successfully demonstrated that technical know-how can be transferred to the huge and widespread informal sector. Changing over to environment-friendly technologies helps both the environment as well as the technicians. Achieving this objective is possible through a well-knit system and the development of innovative processes for implementation. India is a vast country and the technicians are widely spread. In order to reach the technicians a network of training partners has been conceptualized and developed. Each state in the country is represented by a training partner. A training partner along with recruiter and team of trainers. The trainers are trained through Training of Trainers (ToT) for training partner is supported with equipment and tools for conducting the trainings. There are 15 training partners with a team of over 60 trainers all over the country.

Picture – 1 Training Partners in the Country

Trainers

The trainers identified to train the technicians are trained in a 'Training of Trainers' workshop. Training of Trainers (ToT) programme designed for the trainers to impart training to the RSE technicians is for five days. The ToT includes theory as well as practical training. Thereafter the trainers can conduct the training programs for the technicians. Complementary, selected trainers also attend the Cool Training programme at the well renowned, international vocational training center BFS Kaelte und Klima in Germany.

Picture – 2 Training of Trainers Workshops

4. TRAINING MATERIAL

The training material is developed by RAC experts which is tested by conducting pilot training. Feedback is sought from the trainers and technicians which is then discussed with the RAC experts and incorporated. The training material includes the presentations for the technicians training, handbook for the trainers and technicians resp.

Picture – 3 Training material for Technicians and Trainers

5. TECHNICIANS TRAINING

The technicians are spread throughout India in cities and small towns where they practice their trade. The training programmes for technicians are conducted not only in the state capitals or big cities of the country but also the small towns where the number of technicians is more.

Training Modules / schedule is developed for the RAC technicians training program, considering the availability of the technicians the training modules of two days are developed by the experts. This includes theory and practical training.

Picture – 4 Technicians – theory class and at practical

6. ODS PHASE – OUT PROJECTS ACHIEVEMENTS

The results, the number of technicians trained under the ODS phase – out projects speak for themselves, the project team has been successful reaching out to the RAC technicians in the country and there is requirement in the country to continue conducting training for the technicians from the informal sector, not forgetting the formal sector too.

CFC Phase-Out Projects - HIDECOR & NCCOPP
20000 + technicans trained

HCFC Phase-out Stage - I
11000 + technicians trained

HCFC Phase-out Stage – II
17000 technicians planned to be trained

7. SUCCESSFUL IMPLEMENTATION

ODS phase-out servicing sector projects until now has achieved over and above the set targets. Over 30000 technicians have benefited from the training. This was possible

- With the thoughtful planning for implementation of the projects;
- Reaching out to the technicians in the field by conducting training within the proximity of the technicians' work /cluster vicinity;
- Through close interaction with industry stakeholders and strong commitment from the Government on implementation of the ODS phase-out;
- Strategic project planning through a joint consultation process with the leading technical experts, industry and other stakeholders;
- Awareness and information outreach activities play an important role in faster adoption of ozone friendly technologies.
- Development of an infrastructure and methodologies specifically tailored to the needs of the target group and creating synergies for all the components.
- Experiences from servicing sector projects in India have shown that technicians which have undergone training significantly reduce consumption of refrigerants due to better servicing practices.
- Regular monitoring is important to ensure equally high quality of all training programs;
- Successfully demonstrated that technical know-how can be transferred to the huge and widespread informal sector
- Regular review of the systems developed for implementation of the projects
- Team of dedicated implementing agencies with a strong agenda to support implementation of the project
- Highly dedicated bilateral agency leading the project with the required leadership

8. IMPACT OF SERVICING SECTOR

- Good service practices result in
  - Ca 30% less leakage
  - Ca 30% better energy-efficiency
- Market better prepared for absorbing new technologies
- Stakeholders better informed about developments (technical alternatives, …)

- Improved services (certified technicians)
- Safe, green jobs for technicians

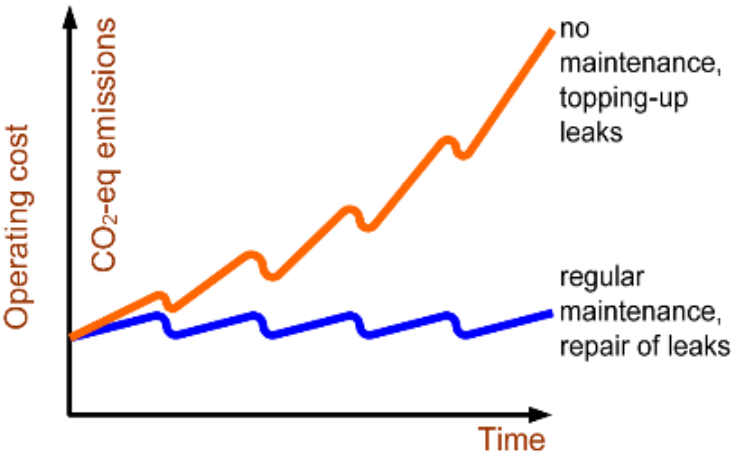

Figure 1

9. WAY FORWARD

Ongoing training

Presently, production and consumption of HCFC-22 is being phased out under the Montreal Protocol. Therefore, alternative refrigerants to HCFC-22 that have similar or better properties suitable for all sub sectors, considering the zero-ozone depleting potential and low or negligible global warming potential are being considered as alternatives. There are some alternative refrigerants commercially available and used all over the world. Although these refrigerants are suitable for air-conditioner, they have some unique characteristics viz high pressure and flammability as compared to HCFC-22 and some refrigerants have safety issues. So, as a technician it is very important to know the characteristics of these refrigerants.

Often, the air-conditioning system also just gets topped up with refrigerant without proper leak detection and will, therefore, continue to leak. The HCFC-22 alternative refrigerants are flammable and/or have higher pressure, therefore, it is essential to follow good service practices and all safety procedures while performing servicing. Understanding GSP, safety and handling of new refrigerants would require ongoing training.

Recovery and reuse

During servicing, recovery of the refrigerant is not a common practice. The refrigerant is often vented out during servicing or repair, and the air-conditioner will be completely recharged. There will be huge savings in refrigerant consumption if proper recovery is carried out by the service technicians. However, the effort for applying such recovery, recycling and reclaim practices is high. Very rarely profitable business models are available. Nonetheless such practices need to be established and promoted, in particular for bigger equipment and systems. No doubt this becomes even more difficult with the increasing number of refrigerant blends being promoted and placed on the market.

Technicians to use personal protective equipment (PPE) and proper equipment & tools for servicing

Work must be done by properly trained personnel equipped with the tools and equipment in good condition and of good quality. When at work, the technician must protect himself from any injuries. PPE viz. safety glasses, protective shoes, gloves and safety belt should be worn. A proper dress code must be observed.
The term 'safety' is applicable to any air-conditioning activity. It may apply to safety of the operator, technician & customer and of the tools and equipment. Personal protective equipment (PPE) must be worn by the technician when at work, to protect him from hazards. There is no exception to the rule that 'The safe way is the right way.' Work must be done by properly trained personnel equipped with the tools and equipment in good condition and of good quality.

Team of trained trainers

For ensuring quality training for the technicians a team of qualified well-trained trainers would be essential. Identifying trainers and training them to further impart training to technicians will have to be undertaken at a larger scale.

Certification programs to be established – based on national schemes;

Certification for service technicians is important as a proof of their professional competency and it enhances employability within the country as well as abroad. The servicing personnel require handling of high pressure, flammable and toxic gasses. Further, it has been well understood that trained and certified technicians could provide better services to the customers, increase their income and help in reducing refrigerant consumption and their emissions as well as maintain designed energy efficiency of the system resulting in conservation of energy.

Implementation of Good Practice Servicing through Qualification, Certification and Compliance (Q2C)

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ABSTRACT

When energy efficient appliances are introduced without proper maintenance, the impact is difficult to predict and the performance likely to decrease continuously. Consequently energy consumption remains higher than expected and operational costs will be increased as well.

Today service technicians are faced with many new challenges when servicing highly efficient equipment, such as electronics, charging of new refrigerants and others. Proper maintenance is a matter of good knowledge, skills and annual servicing periods as a minimum.

To sustain a high quality of services and installations it becomes necessary to establish a quality infrastructure that facilitates high qualification and certification of personnel and companies in the market and a mechanism to ensure that the performance of services and equipment comply with the national standards and mitigation targets.

This generally requires a review and harmonization of international and national standards and norms and an increasingly formalized verification and certification of equipment, plants and services. Periodic inspection and maintenance is the most reliable path forward to warrant high efficiency of air conditioning. Such policies provide multiple incentives for education, local value generation and additional mitigation potential of up to 20% reductions per annum.

Periodic, planned preventative maintenance and inspection can further facilitate the introduction of widely acceptable Minimum Energy Performance Standards (MEPSs), helps managing seasonal peaks of servicing, providing better economic benefits, lower costs for imports, material consumption, employment and avoid the need to invest in technologies with excessive costs that cannot be maintained.

Key words: Qualification, Certification, Refrigeration and air conditioning, Quality Infrastructure, RAC Servicing sector, Preventative Maintenance.

1. INTRODUCTION

India has quite a number of vocational training institutions with high output of educated technicians. ITI alone sends 15,000 trained technicians to the market every year. ESSCI plans to adds another 100,000 within the next years. In total about 5 to 10% of the technicians population in the country come newly into the market every year. This indicates that in general there is no general lack of educated people, however there are number of concerns with regards to specific practices and qualitative and environmental aspects in the market, largely due to a lack of incentives and enforcement of quality of services.

Some private actors such as Daikin or ISHRAE offer training opportunities for old (410A) and new (R32) refrigerants. Feedback from personal communications with the suppliers showed that there is sufficient market penetration of these institutions.

With regard to natural refrigerants training possibilities are neither existent or only available to the service technicians that are part of the Godrej network. Possibilities for extending these efforts beyond the company owned network could be a possible way forward.

Therefore, from a national perspective the main lack is on R22 replacements such as hydrocarbons (HC) in air conditioning and at a later stage CO2 in the commercial sector[1]. Ammonia has some recognition in the training sector, but plays only a minor role for the vast majority of technicians.

Considering the very limited resources available, the focus under HPMP Stage II technicians trainings will be on the containment of R22 and the introduction to alternative refrigerants like HCs (R290) for AC units that are already sold in the market, so that technicians get familiar with alternative (flammable) refrigerants too.

2. BACKGROUND

The hydrochlorofluorocarbon (HCFC) Phase-Out Management Plan (HPMP) Stage II of India induces the transition from ozone depleting substances (ODS) to hydrofluorocarbons (HFCs) as an intermediate alternative or in many cases directly to low global warming potential (GWP) alternatives, which entails a number of par-

1 https://www.thebetterindia.com/149420/iit-madras-develops-indias-first-green-supermarket-transcritical-refrigeration-system-eco-friendly/?fb=organic

adigmatic changes for the servicing sector. Low GWP alternatives can potentially improve the cooling performance and thus people's living and welfare, but at the same time, the transition may bear higher risks for the public and environment if not properly managed. A national quality infrastructure can effectively safeguard public safety and maintain positive economic effects on macro and micro level. In particular, it will strengthen India's ability to monitor direct and indirect emissions in the sector, adjust policies. Furthermore, India will benefit from significant mitigation effects of better quality operations. For example in the EU, with comparatively high equipment and competency standards, the introduction of competency based conformity requirements has reduced the overall energy consumption by 15% alone. In India, with far more dispersed sector practices, the effect could be even much larger. From all mitigation action, raising the sector competences to higher average levels requires the lowest investment, saves local resources, provides better income from suppliers to users and is most cost-effective.

In summary, the most important reasons for setting up a quality infrastructure in the Refrigeration and Air Conditioning (RAC) sector in India are:

- eliminating substantial risks (safety, environmental) for the public;
- improving overall safety, wealth and health for people;
- increasing efficient use of resources and safeguard sustainability of the common goods.

An institutional framework of public and private actors will ensure that products and services evidently meet defined requirements of established standardization, measurabilty, accreditation and conformity requested by Indian authorities or the market.

Figure 1: Overview of Policy Elements for building a quality infrastructure

Fundamental to such quality infrastructure is the existence and cooperation of national registers, standards-, inspection-, accreditation-, training- and certification

organizations/bodies. Furthermore, it is imperative for governments to play an active and continuous role in the establishment and sustainable operation of such networks.

With the required introduction of new alternative refrigerants to ODS and HFCs the specific challenges that needs to be taken care of, are:

- Flammability
- Toxicity
- High Pressure Systems
- Environmental impacts

The risks arising from these characteristics are dealt with throughout the value chain, especially during:

- Manufacturing
- Transport/storage/distribution
- Installation/commissioning
- Operation
- Maintenance/servicing/recovery/repair
- De-commissioning/recycling/disposal

The initial steps to implement such infrastructure require to

- clarify the institutional framework and identify where and how all RAC services can be formally registered;
- identify reforms or changes that could reverse this situation and include provisions for a step-by-step integration of the informal sector;
- support institutional context and capacity to implement required laws and regulations.

3. NATIONAL QUALIFICATION, CERTIFICATION AND COMPLIANCE SCHEME (Q2C) FOR BEST PRACTICE SERVICING

The described technical and behavioral challenges for establishing best practice in the servicing of low GWP refrigerants in a sustainable manner can be managed through **3 major elements**:

- **Qualification:** Creating sufficient national infrastructure of training and educational opportunities for servicing technicians and other personnel.

- **Certification:** Implementation of conformity requirements through national examination and certification schemes for personnel, institutions and products.
- **Compliance:** Managing compliance through incentives or regulation of training, certification, documentation procedures, testing, enforcement, registration of hazardous refrigerant users (ODS, HFC), monitoring and evaluation.

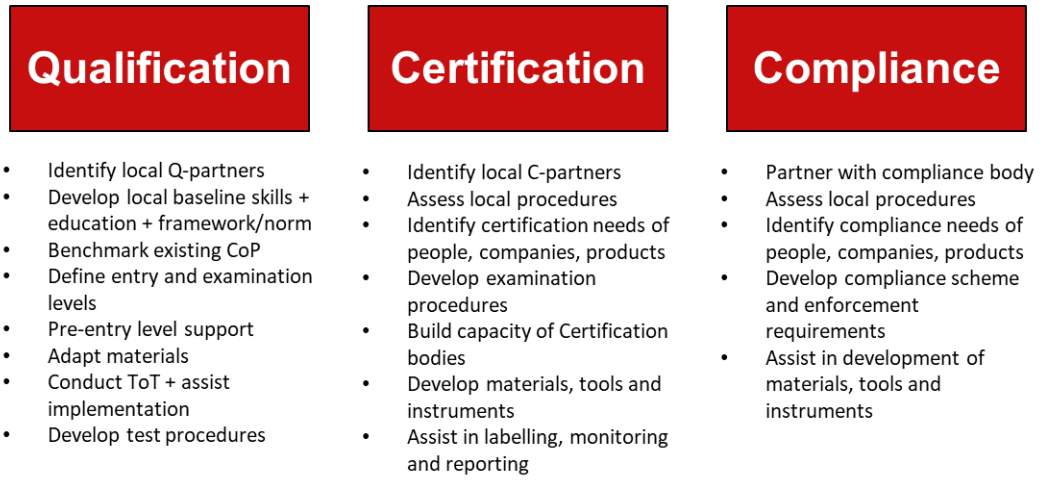

Figure 2: Three important pillars of the national quality infrastructure in the RAC sector

Who needs to be qualified and certified?

- Equipment's manufacturers/users must take reasonable steps to ensure that companies/persons responsible for the tasks mentioned in the bullet points below hold the necessary certificate.
- Persons, carrying out certain tasks on certain types of equipment, must be certified or qualified for: Installation, servicing, maintenance, repair, decommissioning, leakage checking, recovery
- Companies, but also self-employed contractors carrying out certain tasks on certain types of equipment for other parties must be certified for: R&R, installation, servicing, maintenance, repair, decommissioning

All assemblers, manufacturers and users must take reasonable steps to ascertain the conformity of installations, conversions, products and retrofits with national-/international standards and regulations, and the certification by a qualified person if required.

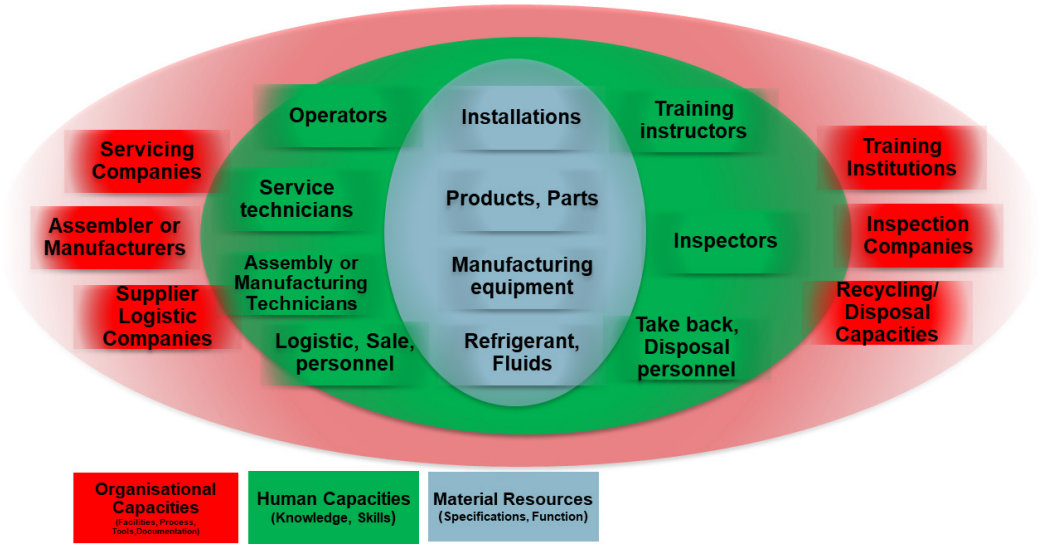

Figure 3: Selected certified institutional and individual stakeholders and material resources of a quality RAC infrastructure

4. ACTORS LANDSCAPE & OVERVIEW OF EXISTING TRAINING SERVICES IN THE MARKET

The roadmap to a national quality infrastructure involves the identification of institutions, organizations, individuals as part of

- a national qualification network facilitating country wide training of conformity requirements with good servicing practices (GSP) in the RAC sector;
- a national certification network facilitating country wide examination and certification of the conformity of RAC sector institutions, personnel and products;
- a governance structure facilitating a country wide process for compliance with the sector targets of the Indian government.

The implementation is proposed to follow a consecutive process, where the initial focus will be on complementing and upscaling qualification opportunities for service companies and personnel. In parallel to this activity relevant existing certification processes and products will need to be harmonized and gaps might need to be filled.

To enforce the qualification and certification processes, governmental institutions, such as the National Ozone Unit (NOU) resp. the Ozone Cell or the National Skill

Development Agency (NSDA), are gathering commercial data on trade, market enterprises and practices for monitoring and evaluation of compliance and policies impact.

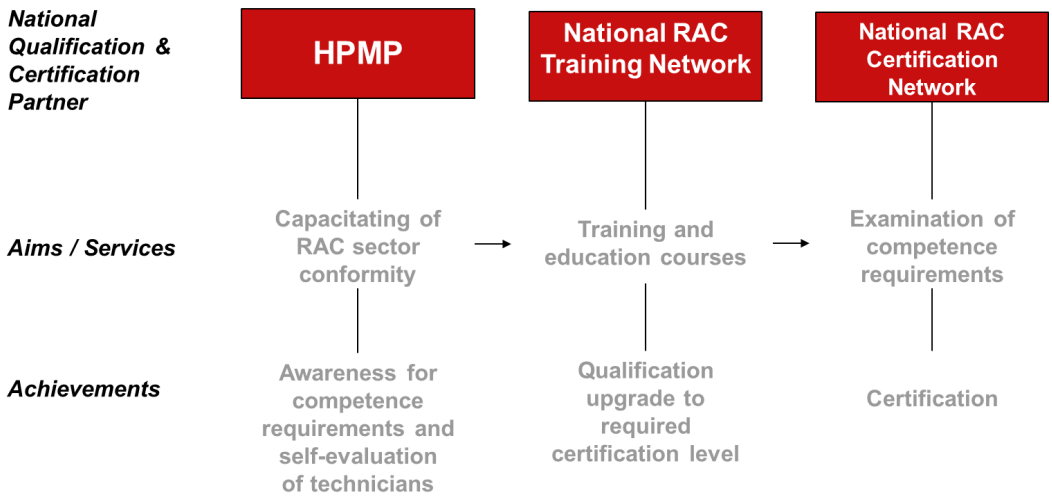

Figure 4: Overview of role of HPMP servicing activities and the national network on training and certification

The present actors landscape is far from being complete, but there is a vivid development of actors in the sector.

The Socitey of Heating, Refrigeration and Air Conditioning Engineers (ISHRAE) certifies heating, ventilation, air conditioning and refrigeration (HVAC&R) technicians and other professionals associated with the field. This will assure those employing the services of these professionals that they are dealing with persons of verified capability. The table below shows an overview of the selected actors in the national network of training providers.

Table 1 List of National Training Network[2]

Type of service	Duration	Syllabus	Required entry qualification	(Levels of) Certification	Compliance
Industrial Training Institutes (ITI)	24 months	Application & History of Refrigeration & Air-Conditioning, concepts of compressor, condenser, domestic air conditioning etc. problem solving in air conditioning & refrigeration[2]	Higher Secondary Under graduate Post graduate Engineering	National - Certified Refrigeration Technician	The National Accreditation Board for Certification Bodies (NABCB)
HPMP Servicing Sector	2 days	Good service practices and installation of Room Air-conditioners with HCFC – 22 and flammable refrigerants in the room air-conditioning sector and overview on certification levels and necessary skills for examinations	Practicing refrigeration technician (no formal education required)	Certificate of participation	Ministry of Environment, Forest and Climate Change (MoEFCC); Ozone Cell etc.
ISHRAE Institute of Excellence Training and Certification http://icp.ishrae.in/Details/ICP-AC-Service-Level-1/3	4 days	2 Modules (compulsory) - Customer service soft skills. Theory subjects covering AC systems, refrigeration cycle, refrigeration components and controls, oils, refrigerants, good installation practices, trouble shooting. AC plant maintenance, pressure testing, leak detection, vacuuming and practical demonstration	High school (12th grade) or ITI Working professional in any organization or independently	(IIE) – ISHRAE Certified Professional (ICP) AC service level 1	
ESSCI – Field Technicians: Air conditioner Training and Certification http://essc-india.org/assets/qp-consel-fieldtech-airconditioner11.pdf	240 to 480 hours	AC repair technicians, Install ACs, interact with customers to diagnose the problem and access possible causes. Rectify minor problems, replacing faulty modules for failed parts or recommends factory repair for bigger faults. Training is not mandatory. Offered courses: Informal Workshop (16h), Workshop "Recognition of prior Learning" (27h, incl. Exam) 240h Basic Installer Training > 400h full technicians course	Minimum: 8th Standard pass Maximum: ITI/Diploma (Electrical, Mechanical, RAC)	Electronics Sector Skills Council of India (ESSCI): - Installer - Professional (Oversees) According to UK certification	National Skill Development Corporation (NSDC)

2 http://www.tatti.in/trainings/air-conditioning-and-refrigeration

Kohinoor Technical Institute (KTI) Training and Certification	6-12 months	Fundamental of basic science, Tools and measuring instruments, AC and refrigerator systems parts, compressor study, control devices, condenser, cooling tower, lubrication, window AC and split AC, vacuuming and gas charging for R32 and R410A Fundamentals of basic science, Tools and measuring instruments, basic electricity and electronics, AC and refrigerator system parts, compressor study, control devices, condenser, evaporator, condenser, cooling tower, lubrication, window and split AC, air cooler, water cooler, deep freezer, plant visit etc.		Certificate course in AC and Refrigeration services (CAR) – 6 months Diploma course in AC and Refrigeration services (DAR) - 12 months	Affiliated to the National Skill Development Corporation (NSDC)
RAC company run institutes (e.g. Godrej, Panasonic, Samsung, Daikin, Voltas, etc.)	various	Enhancement of knowledge, skills and attitude in order to facilitate and fasten organizational growth. Partly includes workshop with practical training.			

5. IMPLEMENTING Q2C IN THE SERVICING SECTOR UNDER THE HPMP

Design of the Indian HPMP servicing sector instruments

The proposal is to introduce GSP workshops for service technician that is inclusive to any professional technician in the sector, independent from the educational background.

The concept includes a stepwise approach, where the workshop will provide orientation to technicians in view of GSPs and new refrigerants in order to enable them to evaluate their own skills and knowledge. Based on this self-evaluation these trainees can, in case they are well experienced and feel confident, either apply directly for an examination with an Indian institution (e.g. such as ESSCI) or they can apply for specific training courses provided by a number of local training providers that will leverage their skills and knowledge up to the required level for certification.

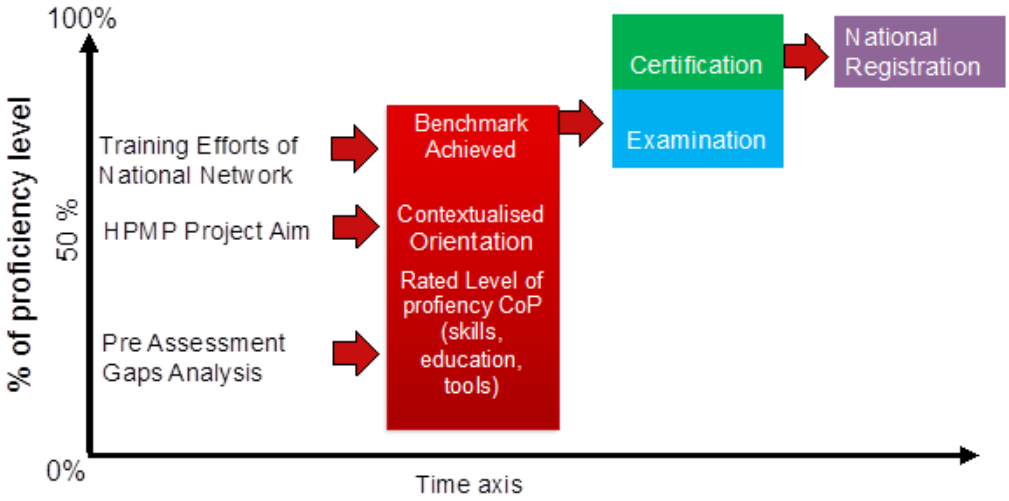

Figure 5: Overview proficiency level and role of the training network

Managing servicing sector qualification

Qualification systems need to ensure that personnel in public and private sector are able to acquire skills and knowledge for fulfilling relevant technical service according to agreed codes of practice. With such skills and knowledge they are qualified also for examination and certification, which represents an incentive for employment.

The leverage of sector competences incorporates a step wise process:

- Providing sector awareness and wide spread access for sector capacities to inform themselves on the required procedures, skills and knowledge to acquire various levels of certification;
- assessing and cluster the various training and entry level of trainees, rated by existing skills, education, experience and knowledge;
- enable participation of any institution with demonstrated experience in the field of training and encourage adaptation of their policies to national policies, standards and curricula;
- certified participation in such training functions as proof of the individual entry level qualification should enhance access to formal certification (EN 13313 could be used as a guiding rail).

Example: Entry Levels according to EN 13313 Annex A

All persons who demonstrate their practical and theoretical competence by being successfully assessed by an approved organisation should receive a certificate of competence:

a) Basic Appreciation (BA) Category I
   - Recognises importance of skill to business and society, and relevance to own job;
   - Interprets information on the skill for own tasks;
   - Knows where to obtain professional help in the skill.

b) Working Knowledge (WK) Category II
   - Assesses and diagnoses issues in the skill;
   - Provides reasoned challenges to specialists in the skill;
   - Supervises or directly works with practitioners of the skill.

c) Fully operational (FO) Category III
   - Performs all normal activities in the skill;
   - Resolves problems and makes improvement in the skill;
   - Applies and adapts best practice in the skill to local conditions.

d) Leading Edge (LE) Category IV
   - Able to create major innovations in the skill;
   - Creates best practice in the skill; Acts as a recognised reference point for the skill.

The management of national training activities in the servicing sector under this HPMP includes following activities:

- Coordination with national sector stakeholders and supporting of national policy consolidation;
- Harmonization of national standards for training;
- Implementation of a 2 day workshop for 17,000 technicians until 2023;
- Assist other training institutes to upgrade training contents in line with national requirements through train the trainer and other assistance;
- to inform RAC technicians on essential state of the art Good Servicing Practices (GSPs).

Further action is required from the local partner:

- to create awareness about the importance of conformity of codes of practices;
- to provide orientation on the development of conformity requirements in the RAC sector, existing incentives and service providers for acquiring training and certification in India;
- drafting and dissemination of material for training trainers and technicians;
- harmonize training with the development of a first examination and certification scheme;
- support development of RAC sector documentation instruments for compliance requirements.

Managing servicing sector certification

Conformity assessment verifies that a process, product or service meets relevant technical standards and fulfils relevant requirements. Activities may include testing, surveillance, inspection, auditing, certification, accreditation, registration and documentation. A **specific certification process** needs to be accredited by an authorized body to conform with relevant international or national standards for independent verification procedures such as **ISO 17024**[3].

Accreditation is **validating the appropriateness** of the **structure** and **governance** of the certifying body, the characteristics of the certification programme, the information required to be available to applicants, and the periodic recertification initiatives of the certifying body. Furthermore, accreditation is facilitating **acceptance of the certification bodies** and their **certification schemes** and mutual recognition of personnel competences and services on national and international levels, which is important for importers and exporters of products and facilitates better services and products to users.

Typical barriers to the introduction of quality certification are:

- standards at various levels are not in line or even contradicting;
- standards are too general and are a barrier for innovative technologies;
- practices exist without existing standards;
- parts, components, products do not comply with necessary requirements;
- capacities in the manufacturing, assembly, operation, servicing, repair and

3 E.g. Personnel certification according to ISO 17024 requires
- Clear definition of what competences in terms of knowledge, skills and personal attributes are to be examined
- Examination must be independent and a valid test of "the demonstrated ability to apply knowledge, skills and attributes"

disposal are not adequately educated or skilled;

- users are not educated, aware or ignorant to the requirement for qualitative services;
- investors lack incentives to choose climate friendly solutions;
- there is no monitoring, control and enforcement for qualitative requirements.

For certificates to be reputable and **accepted** (e.g. by users, suppliers of parts and equipment), **accreditation of third party certification bodies** (although not strictly mandatory) is strongly recommended and remains an important aspect of the proposed activities.

The management of national certification activities in the servicing sector under GIZ implementation will include assistance for implementing the following national activities:

- Coordination with national sector stakeholders and supporting of national policy consolidation;
- Review and harmonization of national standards relevant for certification in the sector;
- Exemplary drafting and dissemination of material for training of trainers and technicians for Cat. I and/or III (details to be confirmed by national stakeholders), see Figure 5 on next page;
- Review existing requirements and procedures for examination and certification;
- Support further development and adaptation of certification schemes under participation of national sector experts;
- Coordinate with national accreditation boards and review or develop requirements for official accreditation scheme.

As described in chapter 2.1 governmental, non-governmental and private sector could facilitate a range of certificates covering basic installation, full range servicing and managing servicing with new refrigerants. For this, categories of certified personnel will need to be identified:

- Classify and distinguish category levels, e.g. low competence level such as semi-skilled workers or partially seasonal active or high level professionals actively planning and executing work tasks with different demands on complexity and severity.

- Generally four categories of certified personnel that have a different scope of authorized activities under the certification. These activities cover the particular sectors in which they may operate from original design to final dismantling and disposal.
- Categories two to four will have a similar level of competence to inspect: analyzing relevant data and parameters, make the correct diagnosis, identify abnormal functioning and/or leakage and use all measures specified within the competences criteria to prevent leakage and have, as soon as possible, any detected leakage repaired. Refrigerant handling is only permitted for the categories three and four. More detailed specification could be found in EN13313:2010 for example.

A certification scheme needs to be developed in view of the local context in line with international agreed standards.

Managing servicing sector compliance

At present there is no consistent enforcement of GSP standards in the sector, even the educational level of technicians has increased during the last 20 years. This is because of the current market characteristics like:

- little to no incentive to continue to acquire competence based training and certification;
- application of substandard practices is leading to emissions and consumption patterns;
- higher costs for resources and consequences of low quality service is lowering the return on investments for users;
- thus no incentive for users to invest in efficient equipment, because high efficiency depends on adequate maintenance and servicing practices and cannot be maintained at rated level if subject to substandard practices
- higher likeliness of catastrophic failures produces uncertain costs for loss of properties, health or in some cases life for investors and public;
- regulations on performance based requirements and containment practices fail to be enforced.

Managing compliance in the sector is of crucial importance, as it substantially influences effectiveness and impact of measures, e. g. reduced risks, environmental and economic benefits. A number of instruments can be used to monitor compliance with policies and system performance. Among this instruments are, among others:

- registration and certification of trading, manufacturing and servicing enterprises as carriers of hazardous waste;
- requirements for certificated competency to handle refrigerants, e.g. at least one certified technician per company;
- requirements to possess and use of purpose designed tools and refrigerant recovery equipment;
- operating auditable procedures and documentation for the proper control of refrigerants;
- evidence of conforming with all current legal requirements;
- proof of environmental awareness and refrigerant transactions with minimum emissions;
- accounting procedures for all refrigerant used and recovered;
- review and analyze with private industry representatives and relevant government organizations existing standards and regulations, identify gaps and needs for further development;
- unannounced inspection visits at companies and installations.

The collection of data and inspection of service operations needs to be sustainably institutionalized, either through governmental environmental/commercial organizations alone or shared implementation with non-governmental organisations (NGOs) such as trade associations. The data generated by this scheme will develop a number of additional benefits for policy making on energy consumption, most importantly data from consumers and their installed capacities. This could become the most valuable source of information when deciding on incentive scheme for redundant equipments and proposing performance standards on leakage and energy efficiency.

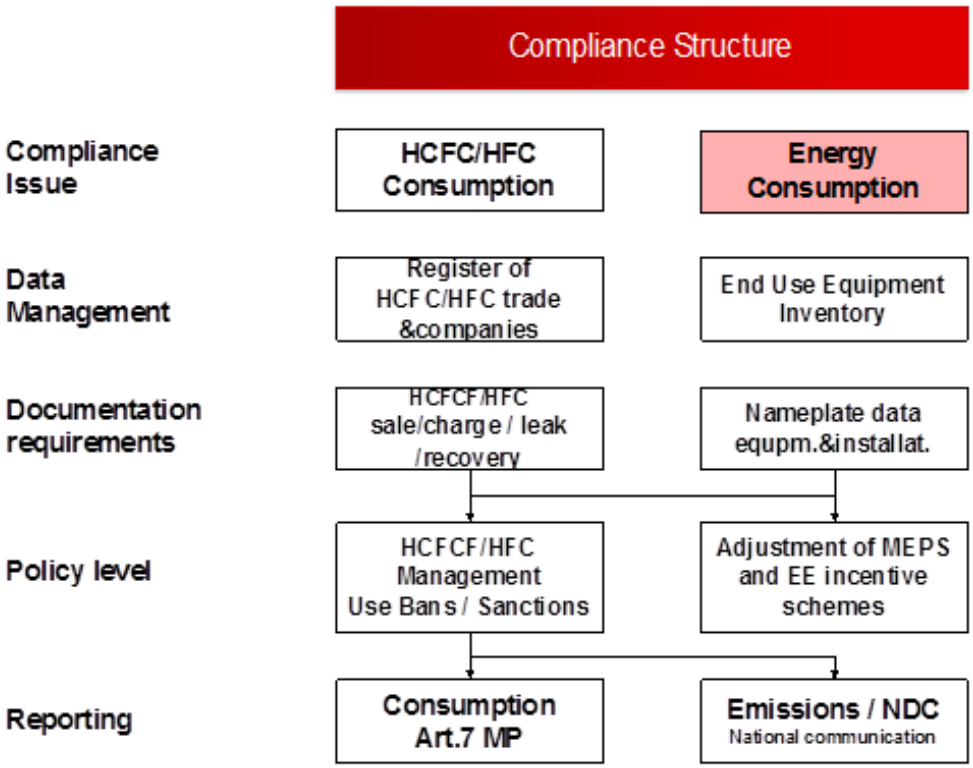

Figure 6: Overview on possible national compliance structure

Elements of controlling refrigerant emissions that are encouraged during servicing operations:

- Safe refrigerant handling and containment
- Documented leak inspection regimes
- Record keeping, labelling procedures
- Auditable refrigerant recovery
- Ongoing competence training, e.g. for innovative leak control measures or servicing of new refrigerants
- Monitor effectiveness of qualification and certification scheme of service and maintenance companies and its employees
- Monitor effectiveness of certification provided through local regional or international providers
- Evaluation of emission reduction effects and data processing for emission reporting

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INTERNATIONAL EXPERIENCE ON SETTING UP AND IMPLEMENTATION OF STANDARDS FOR SERVICING REFRIGERATION & AIR-CONDITIONING EQUIPMENT (EU STANDARD)

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ABSTRACT

Starting from EN13313 future ISO 22712, the industry groups are joining together to help provide information on the safe use of alternatives such as ammonia, hydrocarbon, carbon dioxide and low flammables though the REAL Alternatives learning programme. Resources developed as part of the project offer innovative blended learning - a mix of e-learning, face-to-face training materials, practical exercises, assessments, certification and an e-library of learning resources.

The free multi-lingual learning materials are available for individual development or use as classroom training materials. They include e-learning content, electronic tools, a comprehensive library gathered from existing resources. The e-library contains over 100 useful industry resources.

The project is co-funded by the EU LIFE Programme for environmental initiatives.

Key words: Standards in Training and Certification, EN13313, Leonardo da Vinci Project, Real Alternatives project.

1. INTRODUCTION

Standards, Legislations and Projects in EU (in chronological order)

1. EN13313 Refrigerating systems and heat pumps. Competence of personnel
   1.1. This European Standard defines the activities related to refrigerating circuits and the associated competence profiles and establishes procedures for assessing the competence of persons who carry out these activities.

1.2. The standards, legislations, projects are All linked together

2. Leonardo da Vinci EU project

2.1. 2005 - Refrigeration craftsman

AREA completed a Leonardo Da Vinci Project EUR/02/C/F/NT- 84604 (EC Agreement N° 2002-4549/001-001LE2X.). The project was carried out between December 2002 and November 2005. An enquiry involving approx. 350 craftsmen in 7 European countries was carried out in September 2003. The statistical analysis of the answers received was summarized in a report written by the Monitor Group.

2.2. The project finished with the establishment of an AREA portfolio of qualifications and skills needed to work in the field of refrigeration and air conditioning with excellent craftsmanship.

3. UE 517/2014 - UE 2067/2015 Fgas certification

3.1. Startining in 2008

3.2. A legislative obligation

3.3. Mandatory certification in competence for handling HFCs refrigerants

3.4. New version in 2015 including information on alternative refrigerants (HCs, NH3, CO2, HFOs etc…)

4. Real Alternatives EU project

4.1. The resources developed as part of the project offer innovative blended learning - a mix of e-learning, face-to-face training materials, practical exercises, assessments and an e-library of learning resources - the programme has brought together industry knowledge and expertise from across Europe about alternative refrigerants.

4.2. The free multi-lingual learning materials were launched in 2015 and are now available for individual development or use as classroom training materials. They include e-learning content, electronic tools, a comprehensive library gathered from existing resources. The e-library contains over 100 useful industry resources.

COMPETENCIES, QUALIFICATION, TRAINING AND CERTIFICATION

EN13313

The CEN: EN 13313:2010 Refrigerating systems and heat pumps is the standard future ISO 22712 which covers the following important items:

– competence of personnel • Specifies procedures for achieving and assessing the competence of persons who design, install, inspect, test and commission, maintain, repair and dispose of refrigerating systems and heat pumps with respect to health, safety, environmental protection, and energy conservation requirements • Requirements for training, assessment, and maintenance of competence • Certification set up in F-gas regulation is based on the requirements of this standard

Leonardo da Vinci EU project – The European Refrigeration Craftmen

Recommended General Structure

The National Authority is the governmental institution, for instance a Ministry or a National Agency, responsible for controlling the implementation of the overall certification scheme. The scheme should include a certifying body (or bodies) carrying out the functions of assessment and certification / registration of personnel and companies' working procedures and structure: the national authority has to recognise the competence of such a body in accordance with the relevant standards (for example EN 45012 and EN 45013 / ISO 17024). The Certification Bodies must have experience within the refrigeration sector and employ subject-competent specialists in refrigeration and airconditioning. An 'Advisory Committee of Experts' assists the National Authority and serves to define and update, as required, the criteria for certification (e.g. demands and terms of assessment, structures and terms of inspections). The members of the Advisory Committee can be experienced representatives of the government, refrigeration vocational education bodies / schools, certifying bodies and relevant trade associations (industry and end users).

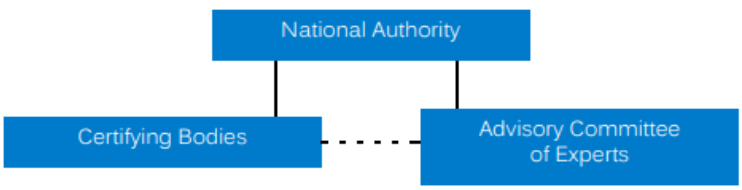

Figure 1 structure of the relevant bodies responsible for implementing a certification scheme

Requirements for the Certification of Personnel

Persons who are responsible for the installation, commissioning, inspection, testing, operation, maintenance, repair and de-commissioning of RAC systems and

their parts shall have the necessary training and knowledge (the relevant standards are for example, EN 378- 1/2/3/4 and EN 13313.) It is recommended that there are two (or more) categories of certified personnel that shall have a different scope of authorized activities under the certification criteria. Both should have the same level of competence to inspect, analyse relevant data and parameters, make diagnoses, identify abnormal functioning and/or leakage and use all measures specified in the relevant regulation to prevent leakage repair and detected leakage. Two proposed categories of certified personnel are 'Maintenance Technician' and 'Refrigeration Craftsman'. The Maintenance Technician is not authorized to break into the refrigerant circuit, while a Refrigeration Craftsman is. For example a Maintenance Technician is not permitted to connect gauges to a refrigeration system, if the Maintenance Technician needs to read pressures, permanent gauges connected to the system by a Refrigeration Craftsman. sector and employ subject-competent specialists in refrigeration and air conditioning. An 'Advisory Committee of Experts' assists the National Authority and serves to define and update, as required, the criteria for certification (e.g. demands and terms of assessment, structures and terms of inspections). The members of the Advisory Committee can be experienced representatives of the government, refrigeration vocational education bodies / schools, certifying bodies and relevant trade associations (industry and end users).

Refrigeration Craftsman The Refrigeration Craftsman is involved in installation, commissioning, inspection, testing, operation, maintenance, repair and decommissioning of new, repaired, working and redundant refrigeration systems, and their parts, used for refrigeration, air-conditioning and heat pump applications. The Refrigeration Craftsman works in accordance with the procedures of the certified company that employs him. The Refrigeration Craftsman shall have the necessary training and knowledge to achieve competence in wide range of relevant tasks. Certification procedure Proof of proficiency in the relevant tasks for Maintenance Technicians and Refrigeration Craftsmen must be tested by examination and/or assessment before certification in accordance with the standards EN 45013 / ISO 17024. Certification may be required to be reassessed at regular intervals. The Minimum requirements for certification and certification schemes for alternative Low GWP refrigerants has been listed in EN13313 for more details.

REAL Alternatives 4 LIFE Project

Financed by the EU's funding instrument for the environment and climate action, "the LIFE programme", the REAL Alternatives for LIFE project is an extension of the previous REAL Alternatives project.

As part of this funding programme, the European Commission is co-financing a consortium of European training centres and associations in partnership with the IIR to provide "Train the Trainer" sessions on low GWP refrigerants (Hydrocarbons, CO2, Ammonia, HFOs, R32) in order to ensure safe, efficient, reliable and cost-effective implementation.

The objective of the project is to develop new and update existing training material, as well as to introduce a range of practical exercises and assessments with an aim to standardising skills sets and requirements for handling low GWP refrigerants across the globe.

The project will promote the best practice in training in this field whilst equally increasing awareness, experience and knowledge at all levels by ensuring a presence at key national, EU and international meetings, conferences and events.

Confirming its international scope, initially it has been defined that it would be conducted in 13 languages and 15 countries which are involved in the project. Due to the large success now it has already been translated in 15 languages for 18 countries. More countries asked to join.

Figure 2 The project now reaches over 18 countries and 15 different languages with 200 teachers certified and qualified to issue training and certification under the real Alternatives scheme in their own country

Context and Objectives

It is a critical environmental objective for the refrigeration and air conditioning sectors to rapidly move to replace high GWP F-gas refrigerants with low GWP refrigerants to reduce the projected 70Mtonnes of C02 emissions from the sector by 2030. This project addresses knowledge, awareness and skills barriers to ensure a rapid and widespread adoption of low GWP alternative refrigerants throughout Europe by providing reliable, unbiased, consistent and up-to-date training materials linked to an extensive Train the Trainer programme.

- **Objective 1**

  To increase knowledge levels of the workforce (technicians working with traditional refrigerants) on the safe use of low GWP alternative refrigerants, carbon dioxide, ammonia and flammable hydrocarbons, and HFO blends. To be achieved through low-cost, accessible multilingual e-learning and a Train the Trainer programme.

- **Objective 2**

  To address inconsistencies in the skills levels across the EU in handling low GWP alternative refrigerants by providing training materials developed with input from a wide range of technical experts from 13 EU countries. To do so, the project will implement a collaborative approach to identify and share best practice knowledge across member states that could reach 85% of installers. The project will produce training resources that can be replicated throughout the EU by licencing of materials – ensuring long-term sustainability.

- **Objective 3**

  To overcome equipment user and distributor concerns over safety, reliability, containment, efficiency and standards compliance in low GWP refrigerant use by providing shared best practice experience, case studies of success stories and by carrying out a comprehensive awareness raising campaign across the EU.

- **Objective 4**

  To support effective implementation of the EU F-Gas Regulation requirements for information to be made available by member states to installation operatives on low GWP alternative refrigerant technologies to support carbon emissions reduction in line with the Climate Change Policy, LIFE Climate actions in Governance and Information, and Climate Change Mitigation.

By the end of this project those employed in the sectors and users of cooling equipment across EU member states will have improved knowledge, skills and awareness of how to use low GWP refrigerants safely and minimise the environmental impact of systems. This will ensure the sector is prepared for a rapid and safe transition to climate friendly technologies in new refrigeration and air conditioning equipment and to adaptation of existing systems.

Table 3: Project Countries

Stakeholders' and Key Partners' Information		
UK/LSBU & IOR	Beneficiaries	LSBU – London South Bank University IOR – Institute of Refrigeration
Germany/IKKE		IKKE – Informationszentrum für Kälte-, Klima- und Energietechnik
Belgium/UCLL		UCLL – UC Leuven-Limburg
Italy/ATF		ATF – Associazione Tecnici del Freddo
Poland/Prozon		Prozon – The Foundation for climate protection
IIR/France		IIR – International Institute of Refrigeration
APIRAC/Portugal	Stakeholders	APIRAC – Portuguese Association for RAC Industry
CNI/Spain		CNI – National Confederation of RAC Installers
SCHKT/Czech Republic		SCHKT – Czech RAC Technical Group
SZCHKT/Slovakian Republic		SZCHKT – Slovakian RAC Technical Group
AGFR/Romania		AGFR – Romania General Association of Refrigeration
HRKT/Croatia		HRKT – Croatian Refrigeration air conditioning & heat pump association
SOSIAD/Turkey		SOSIAD – Turkish refrigeration and air conditioning

Current training provision for F-gas and Low GWP refrigerants

According to the European Commission report "on the availability of training for personnel regarding the safe handling of climate-friendly technologies replacing or reducing the use of fluorinated greenhouse gases" COM2016 748 final) of 2016 there were 40 F-gas trained technicians and 10 certified companies per a population of 100,000 people. These figures are compared to the actual figures established from the survey as presented in the Table 4 below.

Table 4: Certified Individuals & companies for working with F-Gas & Low GWP Refrigerants

Item No.	COUNTRIES	POPULATION	Estimated F-gas Trained Technicians as per 2016 EU Report	Actual F-gas Trained Technicians as per Our Needs Survey & Research	Low GWP Trained Technicians as per Our Needs Survey & Research	Estimated F-gas Certified Companies as per 2016 EU Report	Actual F-gas Certified Companies as per Our Needs Survey & Research	Low GWP Certified Companies as per Our Needs Survey & Research
1	UK	66,573,504	26,629	46,594	n/a	6,657	7,702	n/a
2	Poland	38,104,832	15,242	12,000	n/a	3,810	4,000	n/a
3	Belgium	11,498,519	4,599	3,000	200	1,150	350	n/a
4	Italy	60,656,000	24,262	80,000	1,000	6,066	45,000	n/a
5	Germany	82,293,457	32,917	35,000	n/a	8,229	10,000	n/a
6	Czech	10,625,250	4,250	3,000	n/a	1,063	n/a	n/a
7	Croatia	4,176,031	1,670	3,500	n/a	418	1,460	1460
8	Turkey	81,916,871	32,767	3,000	n/a	8,192	n/a	n/a
9	Spain	46,064,604	18,426	3,000	n/a	4,606	n/a	n/a
10	Slovakia	5,449,816	2,180	2,000	100	545	1,500	90
11	France	65,233,271	26,093	33,000	n/a	6,523	852	n/a
12	Portugal	10,457,295	4,182	n/a	n/a	n/a	n/a	n/a
13	Romania	19,580,634	7,832	6,000	n/a	1,958	n/a	n/a

Using this approach on the figures established during the survey that we conducted, to date there are 47 F-gas trained technicians and 9 certified companies per a population of 100,000 people. With exception of cases such as in the UK where training on Hydrocarbons, Ammonia, CO2 have been in place for a number of years now, in almost all the countries in which the survey was conducted, there were no reliable records of trained technicians and certified companies to competently implement low GWP refrigerants based systems.

The availability of existing training materials and development

The availability of training materials in each stakeholder country was investigated. There is a comprehensive list of resources covering more than 13 languages. Much of the material provided covers most of low GWP refrigerants and there are specific guides on R717, HCs and R744. There is limited training information on low GWP blends.

Percentage of workforce already trained on systems that use low GWP refrigerants Respondents were asked about the proportion of the workforce that was prepared to use low GWP refrigerants. Figure 5 below shows the results and illustrates the gap in training different levels of technical team members in range of low GWP refrigerants available.

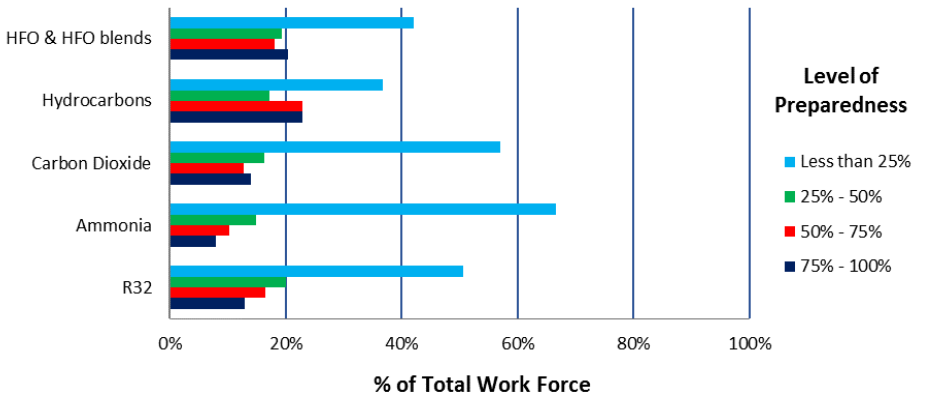

Figure 3: Percentage of workforce estimated to be trained on systems that use low GWP refrigerants

The survey results point towards low levels of capability for low GWP refrigerant systems as well as low capacity.

Importance of periodic and quality certification for technical team members

In this section survey respondents were asked to evaluate how important they thought it was for practicing technical team members to be periodically certified in training and examinations to test and demonstrate their knowledge in the latest use of Low GWP refrigerants. Figure 6 shows that an overwhelming majority - over 90% of respondents indicated that periodic and quality certification was essential or quite important.

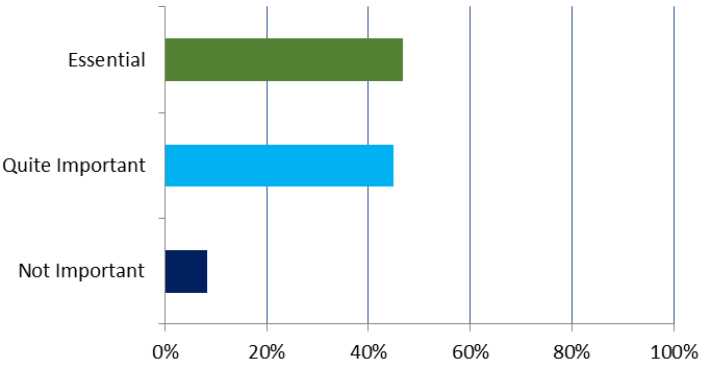

Figure 4: Importance of periodic & quality certification for technical team members

Other areas identified by most respondents about certification needs included:

- Mandatory training related to legislation as well as low GWP refrigerant use is needed
- Periodical retraining by traditional equipment manufacturers and distributors/ suppliers should be offered
- Aspects of design, manufacture, test, and commissioning should be included
- Safety design and pressure directives must be covered also.

In some circumstances regular retraining is carried out in order to ensure compliance and keep up with new technology. The table below gives an illustration of the type of additional retraining requirements related to a selection of countries and highlights the inconsistencies across the EU.

Baseline for CO2e emissions savings

The Climate impact baseline proposed in the project application (2016) was calculated to identify carbon savings based on average leakage rates of 30% for high GWP refrigerant systems (ICF Report December 2011), average GWP values of traditional refrigerants of 2,000 and 3500 and average volume of high GWP refrigerant being replaced with a low GWP alternative. **The project target at application stage was for potential CO2e savings with an initial 10% impact on the market by the end of the project was estimated at 7-12 Mt CO2e and a further 30% impact on the market within 3 years after the project end at 35-36 Mt CO_{2e}**

The Emissions reductions evaluation methodology and its assumptions are detailed in the table below. The estimations of potential impact calculated have been updated

based research carried out in this needs survey on the number of systems currently in place in the relevant countries using high GWP refrigerants which will need to be replaced, a reduction in leakage achieved by improved skills due to take up of the REAL Alternatives for LIFE programme, and the ability to raise awareness of the availability through training amongst 83% of installers across the project partners. The impacts of training will be long term and continue after the funded period as awareness and skills levels increase and training programmes are rolled out therefore it is difficult to make a detailed estimate at the outset of this project. However as performance indicators are measured and monitored during the project and after the funded period, and data collected on indicators below a reasonable assumption of the project impact on these targets can be estimated.

These assumptions were validated using the literature review and the survey results in 2017 as part of the needs research. This identified an increased estimate of total emissions in the stationery RACHP sector through leakage of high GWP refrigerants at 84.4 to 147.74Mt (See Columns C in table 7 below).

The potential carbon savings for this project were recalculated based on the same assumptions made in the project application for two scenarios of leakage reduction (shown in columns D), and the same assumptions that the training and awareness carried out by this project could have a 10% impact on the market by the end of the project (Columns E & G) and 30% impact three years after the project funding period when this training is fully embedded in the industry (Columns F & H). **This has identified an even greater carbon emissions saving potential assuming at the project end of at 8.4 - 14.8 Mt CO2e and 25.3 - 44.3Mt CO2e. within 3 years after the project has end.**

Table 7: Projected emissions -CO2e savings

A	B	C		D		E	F	G	H
Countries of Interest	Total Refrigerant Leakages (tonnes)	Emission through leakages (tonnes CO2e) - GWP2000	Emission through leakages (tonnes CO2e) - GWP3500	End project - Refrigerants Leakage - 10% Saving Scenarios (tonnes)	3 years after - Refrigerants Leakage - 30% Saving Scenarios (tonnes)	End project - 10% Saving Scenarios (tonnes CO2e) - GWP2000	3 years after - 30% Saving Scenarios (tonnes CO2e) - GWP2000	End project - 10% Saving Scenarios (tonnes CO2e) - GWP3500	3 years after - 30% Saving Scenarios (tonnes CO2e) - GWP3500
UK	2,873	5,746,566	10,056,491	287.3	861.9	574,657	1,723,970	1,005,649	3,016,947
France	2,609	5,218,493	9,132,362	260.9	782.7	521,849	1,565,548	913,236	2,739,709
Germany	3,292	6,583,263	11,520,711	329.2	987.6	658,326	1,974,979	1,152,071	3,456,213
Belgium	460	919,852	1,609,741	46	138	91,985	275,956	160,974	482,922
Italy	14,849	29,698,615	51,972,575	1484.9	4454.7	2,969,862	8,909,585	5,197,258	15,591,773
Spain	9,153	18,306,591	32,036,534	915.3	2745.9	1,830,659	5,491,977	3,203,653	9,610,960
Poland	1,422	2,843,477	4,976,085	142.2	426.6	284,348	853,043	497,609	1,492,826
Croatia	338	676,928	1,184,624	33.8	101.4	67,693	203,078	118,462	355,387
Czech Republic	73	145,717	255,006	7.3	21.9	14,572	43,715	25,501	76,502
Slovakia	36	71,534	125,185	3.6	10.8	7,153	21,460	12,519	37,556
Romania	130	259,385	453,925	13	39	25,939	77,816	45,393	136,178
Turkey	6,976	13,952,008	24,416,013	697.6	2092.8	1,395,201	4,185,602	2,441,601	7,324,804
Total Emissions (tonnes)	42,211	84,422,429	147,739,251	4,221	12,663	8,442,243	25,326,729	14,773,925	44,321,775

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HPMP PROJECT- UPSKILLING, ASSESSMENT AND CERTIFICATION OF RAC SERVICE TECHNICIANS UNDER THE NATIONAL SKILL QUALIFICATION FRAMEWORK (NSQF)

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The availability of skilled and certified manpower is the need of the hour across the ESDM sector and specifically the Air Conditioning and refrigeration Industry which is expanding at a very fast pace and requires certified technicians to handle the HPMP phase out as per the Montreal Protocol. The Electronics Sector Skills Council of India (ESSCI) has aligned its skilling capability to the industry requirements and is making an all-out effort in ensuring the industry requirements for skilled and certified AC technicians with relevant technical capabilities and thus giving a boost to the growth of the sector along with creating employment opportunities for the youth of the country.

The module developed by the Electronics Sector Skills Council of India (ESSCI) are as per the National Skill Qualification Framework, which has been promulgated by the government of India in December 2013 and supersedes all skill and vocational based programmes and certifications in the country and is now the ONLY certification based programme. Meaning all skill based training and certifications in the country will be only under the NSQF.

About National Skill Qualification Framework (NSQF) :

The National Skills Qualifications Framework (NSQF) organizes qualifications according to a series of levels of knowledge, skills and aptitude. These levels are defined in terms of learning outcomes which the learner must possess regardless of whether they were acquired through formal, non-formal or informal learning. In that sense, the NSQF is a quality assurance framework. It is, therefore, a nationally

integrated education and competency based skill framework that will provide for multiple pathways, horizontal as well as vertical, both within vocational education and vocational training , thus linking one level of learning to another higher level. This will enable a person to acquire desired competency levels, transit to the job market and, at an opportune time, return for acquiring additional skills to further upgrade their competencies.

The key elements of the NSQF provide:

- National principles for recognising skill proficiency and competencies at different levels leading to international equivalency
- Multiple entry and exit between vocational education, skill training, general education, technical education and job markets
- Progression pathways defined within skill qualification framework
- Opportunities to promote lifelong learning and skill development
- Partnership with industry/employers
- A transparent, accountable and credible mechanism for skill development across various sectors
- Increased potential for recognition of prior learning- RPL

The objectives of the NSQF are to provide a framework that:

- Accommodates the diversity of the Indian education and training systems
- Allows the development of a set of qualifications for each level, based on outcomes which are accepted across the nation
- Provides structure for development and maintenance of progression pathways which provide access to qualifications and assist people to move easily and readily between different education and training sectors and between those sectors and the labour market
- Gives individuals an option to progress through education and training and gain recognition for their prior learning and experiences
- Gives individuals an option to progress through education and training and gain recognition for their prior learning and experiences
- Supports and enhances the national and international mobility of persons with NSQF-compliant qualifications through increased recognition of the value and comparability of Indian qualifications

The Government of India vide its Gazette notification no. 8/6/2013-Invt dated 27th

December 2013 promulgated the National Skill Qualification Framework as the exclusive skill based framework, making all past certification frameworks redundant and making the NSQF as the only umbrella framework for all skill based qualification and certification in the country.

The Qualification and Certification under the NSQF are based on National Occupation Standards- NOS

The National Occupational Standards (NOS) specify the standard of performance an individual must achieve when carrying out a function in the workplace, together with the knowledge and understanding they need to meet a standard consistently.

Each NOS defines one key function in a job role. Each NOS must be a concise and readable document, usually consisting of no more than five or six pages (some are only one or two). In their essential form, NOS describe functions, standards of performance and knowledge / understanding.

A Qualification Pack (QP) is a set of NOS aligned to a job role. A QP is available for every job role in each industry sector. These drive both the creation of curriculum and assessments. Thus, the National Skills Qualification Framework (NSQF) theoretically makes it possible to drive competency based training for every job role in industry.

About the Electronics Sector Skills Council of India:

The National Policy on Skill Development and Entrepreneurship, 2015 laid out Skill India Mission, and envisaged the creation of Sector Skill Councils (SSCs) by NSDC. Priority sectors have been identified based on the skill gap analysis. The Electronics SSC is one of prominent SSC and have been mandated with the following functions:

- **Identification of skill development needs** including preparing a catalogue of types of skills, range and depth of skills to facilitate individuals to choose from them.
- Development of a sector skill development plan and maintaining skill inventory.
- **Determining skills/competency standards and qualifications** and getting them notified as per NSQF.
- **Standardization of affiliation, accreditation, examination and certification** process in accordance with NSQF as determined by NSQC.

- May also conduct skill-based **assessment and certification for QP /NOS aligned training** programmes.
- Participation in the setting up of affiliation, accreditation, examination and certification norms for their respective sectors.
- Plan and facilitate the execution of **Training of Trainers** along with NSDC and states.
- Promotion of academies of excellence.
- Paying particular attention to the skilling needs of ST/SC, differently-abled and minority groups.
- Ensuring that the persons trained and skilled in accordance with the norms laid down are assured of employment at decent wages.

Placements

The most critical outcome of skill training is employment, whether self or wage employment. To facilitate employment, Electronics Sector Skill Council have been encouraged to develop its own placement portal and mobile apps. These portals are linked to demand aggregation and are aimed at meeting the skill needs of the industry. The 360-degree interface of the portal connects candidates and training partners with recruitment firms & potential employers.

The Electronics Sector Skills Council of India is mandated to developing the structured mechanism under the NSQF in electronics sector and is leading the initiative across the sector with a special emphasis on the Air Conditioning and Refrigeration Industry.

Electronics Sector Skills Council of India (ESSCI) is a Not-for-Profit Organization, registered under the Indian Companies Act, 1956.The Council has been promoted by six Associations i.e. CEAMA, ELCINA, IESA (formerly ISA) , IPCA, MAIT & ELCOMA, with financial support by National Skill Development Corporation (NSDC).

The ESSCI's focus is on establishing an effective and efficient ecosystem for developing and imparting of outcome oriented skills for the Electronics Systems, Design and Manufacturing Industry (ESDM).

ESSCI's mandate comprises plethora of deliverables including development of curriculum, courses, information database, and delivery system. ESSCI is responsible

for standardization, accreditation and certification processes to enhance the employability of the Indian workforce globally. It envisions to enable a world class electronics manufacturing industry with an ecosystem for skill development and enhance employability of the large number of Indian human resource.

ESSCI strives to establish a structured mechanism under the National Skil Qualification Framework wherein ESSCI will facilitate & collaborate with NSDC in strengthening the existing vocational education system for skills development in electronics sector including the Air-Conditioning and the Refrigeration Industry & upgrade vocational training system leading to the national NSQF certification for the Air Conditioning industry to achieve global standards in manpower productivity and competencies

The Electronics Sector Skills Council of India has the following Vision, Mission and value for implementing the NSQF based skill development programme.

Vision: Electronics Sector Skills Council of India envisions to enable a world class electronics manufacturing industry with an ecosystem for skill development and enhance employability of the large number of Indian human resource.

Mission: To establish a structured mechanism wherein ESSCI will facilitate & collaborate with NSDC in strengthening the existing vocational education system for skills development in electronics sector & upgrade vocational training system for the industry to achieve global standards in manpower productivity.

Value: Setting up Labor Market Information System (LMIS) to assist planning and delivery of training. Develop a sector skill development plan for the Electronics Industry based on the National Policy on Electronics.

Development of National Occupational Standards (NOS) customized & implemented towards Indian Standards & Requirements and adopted by the Air Conditioning Industry

The approach of ESSCI is to build a robust eco system of partners and knowledge contributors leading to research and analysis and developing a training mechanism leading to accreditation and certification of trained resources

ESSCI has over 400 training partners having over 3200 training centres across the country, that are well equipped to undertake skill development across job roles in all segments of ESDM. ESSCI has 160 Qualification Packs (QPs). Out of these

over 200 training centres spread across the country are well equipped to undertake training in the Air Conditioning and Refrigeration job roles and have the required infrastructure, tools and training competence.
ESSCI has numerous credible Qualification Packs for the skill development in this segment and have been closely developed with the industry and after assessing the intrinsic demand for trained technical manpower in the industry in near future. Some of the Qualification Packs developed by the ESSCI for the Air Conditioning and Refrigeration Industry are:

QP NAME	QP Number	NSQF level
Field Technician - AC	ELE/Q3102	4
Field Technician – Refrigerator	ELE/Q3103	4
Field Engineer –RACW	ELE/Q3105	5
Functional Tester - RAC	ELE/Q3601	4
Safety Tester - RACWO	ELE/Q3605	3
Performance Tester -RACWO	ELE/Q3606	4
HVAC Technician	ELE/Q3112	4

About HCFC Phase Out Management Plan-HPMP:

The United Nations' major initiative on climate control has been the introduction of new refrigerants used in the refrigeration and air conditioning (RAC) Industry, the new refrigerants provide the necessary cooling while protecting the ozone layer from depletion. In the beginning, Chlorofluorocarbons (CFCs) were rarely used for refrigeration until the synthesis methods, developed in the 1950s, reduced their cost. However, the market dominance of CFCs was questioned in the 1980s when concerns were raised about their ozone depleting potential.

Following legislative regulations on ozone depleting CFCs and hydro chlorofluorocarbons (HCFCs), substitute refrigerants like perfluorocarbons (FCs) and hydrofluorocarbons (HFCs) also came under criticism. They are currently subject to prohibition discussions due to their harmful effect on the climate. In 1997, FCs and HFCs were included in the Kyoto Protocol to the Framework Convention on Climate Change. In 2006, the European Union adopted a regulation on fluorinated greenhouse gases, which stipulates the use of FCs and HFCs with the intention of reducing their emissions. The provisions do not affect climate-neutral refrigerants.

To support the initiative of reducing their emissions, the Electronics Sector Skills Council of India (ESSCI), a body under the Ministry of Skill Development and Entrepreneurship, participated in a workshop held in Agra in June for the United

Nations Ozone officers from different countries. ESSCI has always taken a keen interest in the HCFC Phase-out Management Plan (HPMP) to reduce the country's carbon foot print.

Training Needs for the Air Conditioning technicians and Certifications:

To enhance its efforts, ESSCI was nominated by Ministry of Environment, Forest and Climate Control and Ministry of Skill Development and Entrepreneurship to participate in the 'Ozone2Climate Technology Road Show and Industry Round Table 2017' held in the Maldives from August 14-16 and shared its views on the subject.

In its way forward, ESSCI, which is an apex body for skill development and certification in the electronics sector, with the support of Ministry of Environment, Forest and Climate Controls interacted with the stake holders of the UN HCFC phase out action plan and develop 'Qualification Packs in Air Conditioning' with a Pan-India training ecosystem.

SKILL TRAINING OF RAC SERVICE TECHNICIANS UNDER PRADHAN MANTRI KAUSHAL VIKAS YOJANA (PMKVY 2.0) RPL Type 3

The Ministry of Environment Forest and Climate Change (MoEFCC) and Ministry of Skill Development and Entrepreneurship (MSDE) have agreed to jointly undertake upskilling and certification of 100,000 refrigeration and air-conditioning (RAC) service technicians on good servicing practices and knowledge of alternative refrigerants to ozone-depleting chemicals. The project is funded under the Skill India Mission - Pradhan Mantri Kaushal Vikas Yojana (PMKVY).

Need for the Project:

India has been witnessing high growth in the air-conditioning (AC) market, which is expected to grow fivefold by 2030 from the existing stock of 35 million. Refrigerants used in ACs are either Ozone Depleting Substances (ODS) or have extremely high global warming potential (GWP). Refrigerants leak out of ACs during normal operation and due to poor servicing practices by AC service technicians, causing adverse impacts to the environment.

Of the 200,000 estimated technicians in the country, the majority are semi or unskilled. Given that around 50% of refrigerant consumption is happening in the servicing sector, training of technicians on proper servicing practices to reduce leak-

ages can have significant environmental benefits. This training would also benefit technicians since the training would include safety practices and would increase their employability within the formal sector.

Salient Features of the Project:

Project jointly proposed by the Ozone Cell, Ministry of Environment Forests and Climate Change (MoEFCC) and the Electronic Sector Skill Council of India (ESSCI).

Updation of National Occupation Standards, training material and post-training resources in line with Montreal Protocol;

Training of trainers to build a pool of qualified trainers;

1. Training of 100,000 technicians on good service practices and safety practices and Technician assessment and certification as per the National Skill Qualification Framework.

Project Outcomes:

1. Better awareness of safety and environmental practices in RAC servicing by technicians;
2. Reduced consumption of refrigerants among trained technicians;
3. Increased number of certified technicians who can seek employment in the formal sector.

Proposed Timeline:

All 100,000 technicians to be trained in one (1) year (excluding months of Apr, May and June due to this being the peak season for technicians).

Benefits to the AC Technician:

1. Up Skilling on Industry Best Practices, Optimum use of R22, Alternate Refrigerants including 5 Practical Training
2. Assessment and Government of India Certificate with Skill India logo, MSDE Logo, MOEF&CC logo, NSDC & ESSCI logo
3. Certificate incorporated with Personal Accidental Insurance of Rs. 2L for 3 years
4. Rs. 500 Direct Bank Transfer to AC Technician Accounts

5. Rs. 500 worth kit of Candidate Handbook, Mobile Application, T-Shirt, Cap, Note pad, Pen, etc.
6. Opportunity to upgrade their Skills to improve Working standards / Productivity and hence Customer Satisfaction
7. Regular Technical updates through Mobile application
8. Field level Doubts Clarifications through interaction Mobile Application by ESSCI Subject Matter Experts / Industry Experts
9. Improve Consumer Confident and Customer satisfaction to get Social Respect like Ola / Uber Drivers
10. Helps to get Organized sector jobs from unorganized jobs and improves on Carrier development
11. Positive influence on the livelihoods of technicians

Benefits to the Employer:

1. Talent Acquisition for Doing Right at the First Time
2. Productivity improvement
3. Helps to get Organized sector jobs from unorganized jobs and improves on Carrier development

Each training course is for 3 days, including hands-on practical training and assessment at training centres across the country (112 training centres). Each batch would comprise of 18-20 technicians.

The following topics are broadly covered in the training and upskilling during the course and post completion the assessment leading to NSQF certification is undertaken.

The objectives of this session is to:

1. Provide training to trainers in QP Field Technician - Air Conditioner.
2. To enable the trainers with skills for furthering quality based trainings
3. To enable the trainers to help the government in bridging the skill gap in the window and split air conditioner domain

The following are covered in the training and upskilling module:

1. Impact of refrigerants on the environment- OZONE LAYER
2. Commonly used refrigerants for Window and Split Air-Conditioners

3. Basics of air conditioning – Cooling Philosophy
4. Introduction to tools
5. Introduction to clamp meter
6. Copper tube operations
7. Types of Circuits- Basic., Series., Parallel.
8. Refrigerants and Lubricants- Types and Handling
9. Testing of Parts – Compressor Fixed Speed, sensors, capacitor, electric parts,
10. Practical Sessions : leak testing, evacuation, gas charging, Safety while handling Nitrogen, Evacuation and Gas charging, Refrigerant recovery system, Trouble shooting- Split and Window AC, Safety, First Aid

After the training and upskilling, The Assessment and Certification process is undertaken by the ESSCI though the nominated Assessor.

The following is the Assessment and Certification process followed by the Electronics Sector Skills Council of India are as per the RPL guidelines and broadly we follow the process enumerated below:

Assessment is one of the most important activities of the skills value chain and the National Skills Policy of 2009, specifies 'Quality Assured Assessment of Learners' to ensure that assessment is based on national standards (competencies) and uses valid and reliable assessment methods.

The PMKVY mandates Project Implementing Agencies (PIAs) to follow the stipulated Assessment and certification process as laid down in the manual and undertaken by the Sector Skill Council

The Assessments will be based on the relevant QP here on the Field Technician Air-Conditioner- ELE/Q/3102 as selected for the HPMP RPL Certification programme.

Each candidate will be assessed for Knowledge, Skills, Behaviour and Aptitude and the assessor, nominated by the ESSCI will undertake the Assessment based on the Question Bank provided by the Electronics Sector Skills Council of India and on the assessment criterion weightage, also provided by the ESCCI.

Principles of Assessment :

Purpose of Assessment

Assessments play a major role in continuous improvement of student learning.

The assessment is done in a transparent manner with latest process and the results are declared by the ESSCI and uploaded on the SDMS, the master certification portal of NSDC where the certificate is generated and handed over to the candidate.


QUALITY
CONCEPTS


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CAPACITY BUILDING OF TECHNICIANS FOR INSTALLATION AND SERVICING OF ROOM AIR-CONDITIONERS WITH REFERENCE TO A3 REFRIGERANT.

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ABSTRACT

The Air Conditioning market in India presents a fragmented scenario with more than 25 players from all over the world. After sales and service plays an important role in AC business, service support significantly influences purchase decision of a customer. The AC service industry in India is divided into Organized and Unorganized sector. Lack of trained Technicians and no formal certification process for appointing a technician leads to gaps in servicing of RAC equipment. This gap becomes more critical with advances in newer refrigerants and refrigeration technology.
The ASHRAE standards define A3 refrigerants as highly flammable refrigerants. Hydro carbon refrigerants like propane and isobutane fall under this category. The use of these refrigerants for commercial and domestic equipment entails necessary design and service adaptability. Manufacturers have implemented appropriate design measures to ensure optimum performance. Challenge lies in the Servicing sector where equipments are taken care by Service technicians who are responsible for installation, maintenance and repairs of these units. This paper is intended to focus on capacity building challenges related to use of A3 refrigerants.

1. INTRODUCTION

The air conditioner market has the following main stakeholders

1. Original Equipment Manufacturer.
2. Customer
3. Company Authorized Service Providers (Technician)
4. Local Repair workshops / Free-lance technicians.
5. Online Consumer service providers. (Aggregators)

Extreme weather conditions, energy regulations, rising power tariffs, awareness of environmental impact due to refrigerants are necessitating innovation in refrigeration technology. Customers demand products which are low cost, very Efficient and environment friendly. Air Conditioners using Hydrocarbon refrigerants can deliver these expectations.

More and more people in India including those in Tier 2 towns and cities own air conditioners in their homes and in offices. Increase in usage has accelerated the demand for skilled service Technicians they are required to install air conditioning systems, test them for proper functioning, perform repairs, maintain equipment and make routine adjustments to maximize operational efficiency. Many are also expected to sell service contracts and accessories to build long-term relationships with their clients. Given their role and growing need for such expertise, it is imperative to build their knowledge and skills this is to ensure

- Proper safety measures are understood and adopted.
- Ensure Optimum performance from the equipment.
- Use of environment friendly refrigerants (create awareness for ODP and GWP)
- Build capability to handle complex electronically controlled units
- Explore possibility of retrofitting equipment containing CFC, HCFC and HFC with alternate refrigerants in case of breakdowns or failure.

The qualities of a competent technician include a variety of interesting characteristics. With advancement in Technology, good technicians must be able to adapt to change and embrace it. Technician plays a crucial role when handling customer complaints and providing after sales services. Frequently it is the technician who is helping the client by answering a myriad of concerns or questions. In many cases a Technician helps the customer select appropriate model and tonnage depending up on the usage pattern. Need of the hour is to have a tech savvy, skilled and knowledgeable Service Technician. Continuous development of the technician skills and capabilities is of prime importance.

A3 refrigerants have low GWP it is likely that we will see more equipment that relies on the use of A3 refrigerants. Due to safety concerns mildly flammable A2L refrigerants are also likely to be implemented in replacement to A1 refrigerants.

Additional research efforts are ongoing in the field of refrigerants some flammable refrigerants are already in use like ammonia in industrial applications and hydrocarbons in household refrigerators, recently R290 & R32 are gaining popularity in domestic air conditioning and heat pump applications.

A3 refrigerant use need technicians to be well versed and knowledgeable about Transport, Handling and Usage precautions to be taken for these refrigerants This paper is intendeds to acclimatize readers on the current challenges existing in market and future solutions for A3 refrigerant usage.

2. HISTORY OF REFRIGERANTS

"And the world is burning; June 2019 was the hottest month in human history, and air conditioning is undoubtedly a factor in that. Hydrofluorocarbons, the refrigerants used in a/c units, are far more potent greenhouse gases than carbon dioxide or methane."Refer: "https://www.theguardian.com/commentisfree/2019/aug/11/ditch-your-air-conditioning-youll-be-fine" by Franklin Schneider on Sunday 11 August 2019.

Refrigeration and air-conditioning provide many benefits to society by maintaining the temperature of living spaces, preservation of food and temperature control of industrial processes. The continuous technological developments in refrigeration system is gaining much attention all over the world as the weather pattern throughout the world is changing and we are facing extreme temperatures in summer and winter. Refrigeration and air-conditioning applications affect the environment in terms of ozone depletion and global warming caused by the emission of refrigerants. Efficiency of product also determines the energy consumption. Regulation agencies are working on harmful refrigerants by phasing out and replacing them with environment friendly and more efficient alternatives of refrigerants. In many countries the focus is on reducing emissions by selecting suitable refrigerants, equipment design maintenance and inspection processes, etc. Selection of appropriate refrigerant alternatives has also been an important issue for both HVAC (heating, ventilation and air-conditioning) and automobile industries. The global warming potential (GWP) of most of hydrofluorocarbons (HFCs) is very high. It is therefore necessary to find an eco-friendly alternative for refrigerants in order to protect the environment. It should also be safe and economical in term of the existing system, design and installation procedure and reduce greenhouse gas (GHG) emissions and protect the ozone layer.

First-generation refrigerants (1830–1930)

In the time period between 1830 and 1930 when the refrigeration system was evolving, ammonia, carbon dioxide, Sulphur dioxide, ethers, hydrocarbons and air were used as refrigerants. These were classified as first generation refrigerants. The selection of refrigerants in the first-generation was based on availability and

whatever worked in those days. These refrigerants had high flammability, toxicity and reactivity.

Second-generation refrigerants (1931–1990)

In 1930, a safer class of refrigerants became available with chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) being classified as second-generation of refrigerants. The focus of these refrigerants was on reduced toxicity and flammability. Due to their special characteristics, such as stability, inflammability, non-toxicity and good material compatibility, CFCs and HCFCs were produced and consumed on a large scale, particularly in developed countries. In 1987, the Montreal Protocol was designed as a framework to protect the ozone layer by phasing out the refrigerants which are responsible for ozone depletion. This created the need for finding alternate refrigerant.

Third-generation refrigerants (1990–2010)

The initial step of the Montreal Protocol was to switch over from CFCs to HCFCs. But due to high ODP of HCFC, subsequently a range of HFCs and their derivatives or blends was developed to meet the specifications of refrigeration applications. Attention was given on reduced emissions of refrigerants during service and disposal. This class of refrigerants was considered as third generation.

Thus, the current scenario requires industry to use refrigerant that are ecofriendly in terms of Ozone Depletion Potential and Global Warming Potential. Now, the search for new alternative refrigerants which can replace the conventional CFC and HFC refrigerants, without compensating the performance of the systems has become a challenge. The natural refrigerants like CO2, NH3 and hydrocarbons have zero ODP and very low GWP which are the long-term replacements to CFCs and HFCs. The natural refrigerants failed back in those days, due to the problems of toxicity and flammability. The present-day technology can easily handle such problems. Thus, the use of natural refrigerants (hydrocarbons) could be the best possible solution to stop the environmental destruction caused by the conventional CFC and HFC refrigerants.

3. RAC TECHNOLOGY EVOLUTION

The air conditioner has evolved a lot in last 5 years from fixed speed air conditioner to variable speed inverter air conditioner. The high power consuming noisy window air conditioners are been replaced with sleek and low power consuming inverter

technology. The overall product with respect to refrigeration cycle has also witnessed changes such as,

Technology 5 to 10 years back	Change in Technology
Fixed speed air conditioners only	Variable inverter air conditioners
Refrigerant used HCFC (R22) or CFC (R12)	Refrigerant used HFC (R410a and R32) or HC (R290 or R600a)
Capillary used as a traditional device for expansion of the refrigerant.	Electronic Expansion Valve or Capillary used for expansion of the refrigerant.
Reciprocating compressor and single rotary compressor used.	Twin rotary compressor with inverter technology.
Copper condenser	Aluminium condenser with larger surface area for improved heat exchange resulting in higher efficiency.
AC motors for blower and condenser	BLDC motors for blower and condenser
Controlled by infra-red remote control.	Can be controlled by remote control and smart phone.

The air conditioner star labelling program has been able to improve the power efficiency to a large extent. The Government of India led Energy Efficiency Service Limited agency are aggressively promoting the replacement of fixed speed air conditioner with inverter air conditioner. The AC industry along with GOI are planning to further cut down the power consumption by restricting the AC remote setting to 24 deg Celsius.

4. AC MARKET IN INDIA

At around 5 million units, India is the second-fastest room air conditioners (RAC) market in the world among large economies. While the split AC segment accounts for 83% of the market, window AC forms 15% and multi split is 2%. However, India has the lowest AC penetration among the top 10 RAC markets. Lifestyle changes and improving an increasing per capita income of earning population has also help increase the market. Various efforts like revised wages act and steps to empower the agricultural sector have increased the buying capacity of people even in Tier 2 cities. The product penetration has also been aided by extreme temperatures experienced in summer seasons.

5. TECHNICIAN'S BACKGROUND AND AVAILABILITY:

Currently the RAC industry recruits' technicians who have preliminary education till 10th or 12th many are also either dropouts of school or could not afford formal education, else belonged from a region which lacked resources with respect to school and colleges. This work force is inclined towards vocational learnings. These youngsters have no proper technical background and need exhaustive trainings on basics of electronics and latest mechanical refrigeration system.

1. Organized sources of recruiting technicians are
   - Government ITI
   - Private ITI
   - Vocational Training schools.
   - Training institute setup by Industry.

2. Unorganized Sources of recruiting Technicians are,
   - Fresher appointed by Service Providers who gain experience by on job training helped by seniors.
   - Multi skilled appliance technicians migrating to RAC products.

Choosing a career as an AC Technician in India is not as lucrative as other trades. Renumeration earned is not fixed, also AC business in India is seasonal and does not ensure reliable source of income throughout the year. Hence a technician necessarily needs to be multi skilled in all RAC products. As most of the technicians work on contract it does not ensure minimum wages as per regulations.

Though the above scenario is true for freshers and lesser experienced technicians, air conditioning industry has seen highest attrition rates in recent times due to increase in demand. There has been an exponential rise due to newer applications like mobile towers, AC showrooms, AC sales counters, chain stores and malls. There is a huge requirement of skilled manpower in hospitality industry, and cold chain for food preservation. Middle East countries like Saudi Arabia, UAE etc. are also lucrative employment options for RAC technicians. The entry of online consumer service also helps many skilled technicians earn additional income throughout the year.

The entry level technician after an experience of one or two years aspires to earn more through above options leading to higher attrition amongst organized Service Providers.

6. TRAINING PROCESS AND SKILL LEVELS:

Completion of secondary school is usually required for entry in any trade certification program. A formal certification program can be for a period of maximum two years (ITI course) and minimum three months from private vocational training providers. Curriculum for such courses is not regulated and may vary from institute to institute. Even trained and certified technicians from some institute lack awareness on latest technology and present product line up. Currently awareness about Certification Courses in Refrigeration and Air conditioning needs to be emphasized. The new work force joining the industry must be familiar with basics of electrical connections and safety related to RAC products. They should also have knowledge and practical experience on latest industry technology. In many of the up-country locations, villages and cities young candidates work along with Senior Technician (Buddy Technician). The hierarchy of a Service Provider normally consist of Helper, Junior Technician, Senior Technician and Supervisor / Owner. Practical learning happens at customer location when handling live complaints along with Buddy technician. This is a very rudimentary way of training and does not ensure developing expertise in the technician as his exposure is limited.

We need to create more awareness about certification courses available in refrigeration and air-conditioning. The courses should concentrate equally on practical learnings and theoretical sessions. To gain relevant experience and get exposure to the required skills apprentice ship program through Industry partners can also be explored. Industry should give first preference to Certified technician's. We should also formulate a process to routinely update technicians on latest technology and market trends. It is essential to note that the above applies to both organized and unorganized RAC service technicians.

7. EXPECTATION FROM RAC TECHNICIAN (SCOPE OF WORK):

Workers in this field install and maintain the heating and air-conditioning systems that control the temperature, humidity and total air quality in residential, commercial, industrial and other buildings by precisely following blueprints, design specifications and manufacturers' instructions.

They need knowledge of electrical components and systems since heating, air-conditioning and refrigeration systems consist of many mechanical, electrical and electronic components such as motors, compressors, pumps, fans, thermostats and switches.

Field technicians work with a variety of precision measuring tools needed measure parameters such as refrigerant pressures and air flow in duct systems. Voltmeters, pressure gauges, manometers and other testing devices are used in analyzing system performance. When servicing installed equipment, they must also use extreme care to conserve, recover and recycle the chlorofluorocarbon (CFC) refrigerants used in the refrigeration and air-conditioning systems. (Presently recovery and recycling of refrigerants not prevalent in India)

Refrigeration and air conditioning mechanics perform some or all of the following duties:

- Read and interpret blueprints, drawings circuit diagram or other specifications
- Measure and lay out reference points for installation
- Assemble and install refrigeration or air conditioning components such as motors, controls, gauges, valves, circulating pumps, condensers, humidifiers, evaporators and compressors using hand and power tools
- Measure and cut piping, and connect piping using welding and brazing equipment
- Install, troubleshoot and overhaul entire heating, ventilation, air handling, refrigeration and air conditioning systems
- Start-up system and test for leaks using testing devices
- Recharge system with refrigerant, check and test regulators, calibrate system and perform routine maintenance or servicing
- Repair and replace parts and components for entire refrigeration, air conditioning, ventilation or heat pump systems
- May install, maintain and repair equipment in refrigerated trucks used to transport food or medical supplies
- May prepare work estimates for clients.

AC Field Technicians job is an after sales job for installing and providing support to the buyers. He installs the air conditioner and in case of break down interacts with customers to diagnose the problem and assess possible causes. Once the root causes have been identified, he rectifies the problems by replacing faulty modules for failed parts or recommends factory repairs for bigger faults. The AC Technician work is one of the toughest kind as he is on the field and travels through the day from one customer's premise to another.

8. CHALLENGES IN MEETING A3 REQUIREMENT:

➢ SAFE USE OF REFRIGERANT. USE OF PPE

There are three main aspects to consider when dealing with A3 refrigerants:

- Ensuring the system is leak-tight, and refrigeration system joints are sufficiently robust during the useful life of the equipment.
- Ensuring the safety of equipment that uses or comes into contact with flammable atmospheres
- Protection of workers that may encounter flammable atmospheres in the workplace

The responsibility for the leak-tightness and the general safety of equipment lies with the manufacturer/producer and/or installer of the equipment. Equipment must be designed and constructed such that emissions and thus the creation of a flammable atmosphere is, practically impossible during use. This may be achieved through leak-tight design, ventilation and certain protective systems. Locations where a flammable atmosphere may be created, those responsible for the positioning or installation of the equipment must ensure that ignition of that flammable atmosphere is not possible, for example, eliminate of potential sources of ignition through design changes. The use of personal protective equipment is also very essential for personal safety.

➢ USE OF PROPER TOOLS AND EQUIPMENT.

The tools and equipment used for A3 refrigerant are same that are used for HCFC refrigerants. Appropriate gas leak detectors should be used to monitor the air in the work area. A dry-powder or CO2 fire extinguisher must be available at the location. A suitable ventilation fan should be used when working inside confined spaces or rooms Refrigerant recovery units should be rated for use of A3 refrigerants. Refrigerant charging in sealed system should be done by weight only.

➢ FOLLOWING SOP FOR INSTALLATION.

The technician installing equipment with A3 refrigerant should be trained. The technician should always carefully read the installation and/or service manual that is provided by the manufacturer, so that they are aware of any special requirements associated with the equipment under

consideration. The following precautions should be taken before working on the refrigerant circuit:

- Room size must be referred to guidelines mentioned in EN 378 Standards in which air conditioner is to be installed. (Rough thumb rule)
- Installation checklist should be duly filled in for every customer location.
- All staff and others working in the local area must be instructed on the nature of the work being carried out.
- The area around the workspace must be sectioned off.
- Before carrying out any work on a refrigerating system or associated equipment, it is essential to ensure that the immediate area is suitable for working safely – as it is deemed a temporary flammable zone – and the appropriate precautions are in place.
- Obtain permit for hot work (if required).
- Working within confined spaces should be avoided. A suitable ventilation fan should be used when working inside, if there is insufficient natural ventilation, or when working in a confined space.
- No flammable materials are stored in the work area.
- No ignition sources are present anywhere in the work area.
- Suitable fire extinguishing equipment (CO2 or dry-powder type) is available within the immediate area.
- The work area is properly ventilated before working on the refrigerant circuit or before brazing or handling electrics.
- Venting of refrigerant should be safely dispersed and preferably expel it externally to the outside atmosphere.
- Suitable flammable gas detectors are present and operating to warn workers of a dangerous concentration of refrigerants and that the gas detection equipment being used is non-sparking, adequately sealed or intrinsically safe.
- All maintenance staff have been instructed
- Erect appropriate signage, including “no smoking” and “do not enter the area” signs
- All appropriate and necessary tools and equipment are available.
- It is essential that the technician is completely familiar with the equipment and all its detail like equipment location and installation blue print.

- The technician must be familiar with the equipments purpose and operation
- The equipment should, whenever possible, be isolated from the electricity supply
- Ensure that all refrigerant handling and mechanical handling equipment is available
- All necessary personal protective equipment is available and being used correctly

➢ ACCURATE FAULT DIAGNOSIS AND REPAIR.

The equipment fault should be accurately diagnosed by the technician. While brazing or welding a refrigeration system, especially to change parts, all the refrigerant must be recovered from the system, using the appropriate procedures. The technician should ensure the system is leak tight before recharging refrigerant into the system. The suitable leak detector should be used to leak checks before switching ON the equipment.

➢ TRANSPORT OF REFRIGERANT.

HC refrigerants are available in a range of cylinder sizes, both refillable and non-refillable, depending upon the manufacturer. Most refillable cylinders are equipped with pressure relief valves, and some cylinders employ special (unique) cylinder connections in order to differentiate them from other refrigerant cylinders, thereby reducing the possibility of mixing cylinder types. The following include general refrigerant cylinder safe handling guidelines:

- Do not remove or obscure official labelling on a cylinder.
- Always refit the valve cap when the cylinder is not in use.
- Check the condition of the thread and ensure it is clean and not damaged.
- Do not expose cylinders to direct sources of heat such as steam or electric radiators.
- Do not repair or modify cylinders or cylinder valves.
- Always use a proper trolley for moving cylinders even for a short distance – never roll cylinders along the ground.
- Take precautions to avoid oil, water and foreign matter entering the cylinder.

- If it is necessary to warm the cylinder, use only warm water or air, not naked flames or radiant heaters, the temperature of the water or air must not exceed 40°C.
- Always weigh the cylinder to check if it is empty – its pressure is not an accurate indication of the amount of refrigerant that remains in the cylinder.
- Use only dedicated recovery cylinders for the recovery of HC refrigerant
- Always check that the cylinder is not beyond its mandatory safety check or pressure test date.
- Ensure that the cylinder is not being used for a refrigerant that it is not intended to be used for.

The above precautions are necessary due to flammable nature of A3 gasses. Flammability is a property of a mixture in which a flame is capable of self-propagating for a certain distance. Flammability of a refrigerant is its ability to burn or ignite, causing fire or combustion. The degree of difficulty required to cause the combustion of a substance is quantified through fire testing and dependent on several parameters discussed below. The combustion of any substance depends on the upper and lower flammability limits and the supplied energy for ignition. The consequences of the flammability event depend on the burning velocity, heat released and byproducts of combustion.

Mixtures of refrigerant and air will burn only if the fuel concentration lies within well-defined lower and upper bounds determined experimentally referred to as flammability limits.

Lower flammability limit (LFL, % by volume or g/m3) is the minimum concentration of the refrigerant that can propagate a flame through a homogeneous mixture of the refrigerant and air under the specified test conditions at 23.0 °C and 101.3 kPa [1]. At a concentration in air lower than the LFL, gas mixtures are too weak to burn. Propane(R290) gas has an LFL of 2%. If the atmosphere has less than 2% Propane, combustion cannot occur even if a source of ignition is present.

Upper flammability limit (UFL) is the highest concentration of a gas or a vapor in air capable of producing a flash of fire in presence of an ignition source (arc, flame, heat). Concentrations higher than UFL are “too rich” to burn. Propane(R290) gas has a UFL of 10%.

9. CAPACITY REQUIRMENT FOR A3 REFRIGERANT WITH RESPECT TO SERVICE PROCESS

Application	Technical Requirement
Installation	Safety training for general handling of A3 refrigerant.
	Correct use of tools and equipment.
	Ensure appropriate room size for relevant capacity of air conditioner.
	The place where equipment is kept should not have any sources of ignition nearby.
	All the sources of ignition if unavoidable should be oriented in such a manner that the flames do not spread beyond the affected area.
	Guidelines mentioned by the manufacturer should be referred when selecting the air conditioner capacity for a given room size.
	In case of air conditioner charge size should not exceed the specification, limit prescribed by the manufacturer
	Use of Personal Protective Equipment is must for example safety harness for installation of outdoor unit at height.
	In case refrigerant is to be vented out of the equipment. The same should be vented out directly into the outside atmosphere.
Preventive Maintenance Service	Safety training for general handling of A3 refrigerant.
	Technician should check for loose connection inside the unit and fix the same firmly if found loose.
	Checking of all the mechanical joints between the copper pipes for refrigerant leaks should be part of the check list during routine maintenance.
	Wet service and Dry service of the A3 refrigerant air conditioner are similar to HCFC / HFC / CFC products.
	All the electrical contacts in the equipment should be firmly tightened during the routine maintenance visit.

Tools	The tools should be inspected after periodic intervals for proper functioning.
	The gauges and meters used for recording various parameters like voltage, current, pressure and temperature etc. should calibrated every year.
	Adequate signages and warning boards should be carried along during the repair or installation activity at customer location.
	Whenever work at site is interrupted and carry forwarded, proper Lock Out and Tag Out procedure should be followed at customer location.
Repair of sealed system and compressor replacement	Safety training for general handling of A3 refrigerant.
	Before carrying out the brazing activity all the refrigerant in the system should be recovered using appropriate recovery unit suitable for A3 refrigerant.
	In case refrigerant is to be vented out of the equipment. The same should be vented out directly into the outside atmosphere.
	Technician should be careful during brazing and avoid direct exposure of the flame towards any wire and cables present inside the cabinet.
	1. Venting of HC (with piercing pliers and long pipe outside workplace) 2. Removal of left over refrigerant (with 2 stage vacuum pump) 3. Open the brazed joints 4. Replace parts (compressor, drier/filter etc.) 5. Brazing joints (with recommended filler materials & flux) 6. Leak detection (with leak detector or soap solution) 7. Evacuation (with 2 stage vacuum pump – up to 300 microns) 8. Refrigerant charging by weight (digital weighing scale) 9. Sealing process tube 10. Final inspection (performance)

TABLE FOR REFRIGERANT CLASSIFICATION:

Refrigerant Group	Refrigerant example	ODP	GWP	Atmo-spheric lifetime (years)	Flamma-bility	ASHRAE safety des-ignation
CFCs	R11, R12, R115	0.6-1	4750-14400	45-1700	Non-flam-mable	A1
HCFCs	R22, R141b, R124	0.2-0.11	400-1800	1-20	Non-flam-mable	A1
HFCs	R407C, R32, R134a	0	140-11700	1-300	Non-flam-mable	A1
HFOs	R1234yf, R1234ze,					
R1234yz	0	<0-12	-	Flam-mable	A3	
Natural Re-frigerants	R744, R717,					
HC (R290, R600, R600a)	0	0	Few days	Flam-mable	A3	

Table 1

10. CRITICALITY OF USING CORRECT TOOLS AND EQUIPMENT:

Having the right tool is imperative to successful completion of the task at hand. In addition, the right tools allow technician to complete their task efficiently. The tools required for hydrocarbons are same as the ones required for HCFC's. The working pressure of both the refrigerant being same allows use of same tools.

Service equipment

- Electronic leak detector (suitable for HCs)
- Soapy water (or leak detection spray cans)
- Refrigerant cylinders (R290, R600a, etc,)
- Refrigerant recovery cylinder
- Nitrogen (oxygen-free, dry nitrogen) cylinder
- Vacuum pump and vacuum gauge
- Refrigerant recovery machine (suitable for use with HCs)

- Venting hose
- Scales/electronic balance
- Gauge manifolds and hoses
- Hand tools including adjustable spanners, pliers, valve keys, screw driver etc

Protective equipment

- Fire extinguisher
- Gloves
- Helmet
- Safety shoes
- Goggles
- Safety belt and safety harness

11. PRODUCT COMPLEXITY:

The A3 category refrigerant are compatible with mineral oil used in HCFC equipments. This is an added advantage during in case there is need for retrofitting of equipment's using HC. The power consumption of hydrocarbons is less than the HCFC family refrigerants due to the physical and chemical properties. The air cooled (air conditioner with Aluminum condenser) variable speed inverter AC along with electronic expansion valve can deliver highest ISEER using A3 refrigerants with respect to current energy rating table. Products using A3 refrigerants does not require large scale changes in the manufacturing process or component design. The operating pressure of A3 refrigerant are very much similar to HCFC range. Charge quantity of the refrigerant is also comparatively less in units having A3 refrigerant gases. Products with A3 refrigerant are similar to HCFC range of products and do not have any additional complexity.

12. GODREJ EXPERIENCE WITH HC:

1. AC with R290 introduction:

   Godrej introduced air conditioner with R290 (Propane) in year 2012 and till date has more than 2 lac happy customers. Godrej is the first company to introduce air conditioner with R290 in India. During Installation, Service and Repair of the equipment containing A3 refrigerants. utmost care and safety guidelines are adhered.

2. Installation methodology:
    a. Godrej has adopted policy of free installation for customers who buy equipment with A3 refrigerants.
    b. The installation, service and repair of the equipment is done by technicians who have been trained on A3 refrigerants. The trained technicians are competent enough to answer queries of customer regarding A3 refrigerants.
    c. The trained technicians use correct tools and equipment during installation, service and repair of the equipment and strictly follow the SOP laid by the company.

3. Technician Support:
    1. Every product launched by company has a Service Manual, which contains technical details about the product.
    2. Technician carry installation checklist which is to be filled after every air conditioner installation and duly signed by customer.
    3. Godrej through its vast Training Setup ensures proper flow of communication and technical bulletins regarding existing and new product to every technician.
    4. Specification of the product are also shared with technician as and when required.

4. Training of the Trainers:
    1. Training Content is prepared by HO trainers dedicated for every product category, emphasizing on critical requirements which need to be looked up on.
    2. Practical training on working product jigs which can simulate field scenario to the technician and help them understand complexity of the product. This has helped us in strengthening technician's troubleshooting techniques and pinpoint root cause of the breakdown.
    3. Trainings are regularly carried out for all technicians at local branch center.
    4. GIZ had extended support to Godrej for Training the Trainers on handling of A3 refrigerant.

13. SUMMARY

Capacity enhancement of technician for A3 refrigerants necessarily needs to focus on safe transport, handling and usage of the gas. Due importance needs to be given to training and certification process of the Technician. Products using A3 refrigerants does not have any additional complexity or require any specialization. A3 (HC) refrigerants can prove to be ideal substitutes for HFC, HCFC and CFC as they have "zero" ODP and very low GWP, they also meet the energy efficiency requirements without significant design changes in the product.

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WHY CERTIFY TECHNICIANS? ENSURING SUSTAINABILITY, SAFETY AND SUCCESS FOR INDIA'S GROWING RAC SERVICING SECTOR

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ABSTRACT

As the demand for space cooling in buildings in India increases, with RACs alone anticipated to grow eleven times over the next twenty years, so too will the need to service refrigerant-based air conditioning units. India's energy efficiency enhancements, phase-out of ozone depleting substances (ODS), and transitions to low-global warming potential (GWP) refrigerants present a unique trifecta of regulatory requirements on air-conditioners (ACs); and necessitates that service technicians be trained and certified to ensure personnel safety and well-being, as well as, optimize environmental gains that are easily lost from incorrect AC installations, and good servicing practices (GSPs) not being followed as part of maintenance protocols. In order to transform India's informal and un-trained servicing sector, into one that is trained, certified, and has better access to job- and social-security through formalization, this paper highlights three key issues that must be assiduously addressed:

(i) Certification must be incentivized and made mandatory over time;

(ii) Trainings must be standardized to reflect a minimum need to create certifiable technicians; and finally

(iii) Consumer awareness must be targeted so as to induce a surge in demand for certified and qualified technicians.

Key words: servicing sector, skilling, training and certification, air conditioning

1. INTRODUCTION

India's residential air-conditioner (RAC) servicing sector is currently estimated at two lakh technicians (Ozone Cell 2017). The RAC servicing sector is expected to grow rapidly with increasing penetration of ACs among Indian households (Ozone Cell 2019). While more service technicians are required for proper and regular maintenance of ACs, given the price sensitivity of Indian consumers, the demand for service technicians is likely to be met by under-trained/ un-trained technicians (Ozone Cell 2019; Sridhar and Chaturvedi 2017). As noted in the India Cooling Action Plan (ICAP), launched in March 2019, insufficient training among servicing technicians not only has implications on proper functioning of the AC but also on the environmental impact of the AC during its operational lifetime.

The RAC servicing sector holds a significant position in addressing thermal comfort needs in India as it contributes to: (i) enhancing cooling efficiency of in-use cooling equipment; (ii) reducing refrigerant consumption; and (iii) reducing direct and indirect greenhouse gas emissions. Regular servicing of RACs wherein proper functioning of components, filter cleaning and sufficient levels of refrigerant gas are checked, ensures efficient cooling performance of the AC. Additionally, the operational lifetime refrigerant gas emissions of RACs, estimated at 10 per cent, can increase substantially in old units with corroding copper coils (Kaushik 2018) and other leak points (Chaturvedi et al. 2015). Further, venting of refrigerant gas during servicing is noted to contribute to operational life emissions of the AC units (Chaturvedi et al. 2015)— regular checks and awareness on proper refrigerant handling for RAC units can reduce their operational life emissions significantly. To this end, Sridhar and Chaturvedi (2017) report that adherence to good servicing practices (GSPs), use of proper tools during servicing and regular servicing can reduce the service sector's[1] current refrigerant consumption of 40 per cent of the total refrigerant consumption, substantially (Ozone Cell 2017) .

With rising incomes and rapid urbanization in India, ownership of RAC units is proliferating; average ACs per household increased from 1.2 in 2001 to 1.7 as of 2015 (Sachar, Goenka, and Kumar 2018). Consequently, in the past decade alone, RAC penetration has reportedly risen from 4 percent to almost 9 percent (Sharma and Shah 2017; Ozone Cell 2019). Cooling demand for buildings, as a consequence, is estimated to grow eleven times over the next two decades (Ozone Cell 2019). Rapid increase in AC units, and subsequent demand for service technicians is a challenge already being faced by the industry.[2] Some industry associates indi-

1 Includes residential, commercial and mobile air-conditioning sectors.

2 Based on interviews with experts from the servicing sector for Bhasin et al. (2019)

cated that high demand for service technicians, especially at the start of the summer season, is an important factor contributing to non-compliance of GSPs, and to the influx of untrained technicians to service ACs.[3]

Adherence of GSPs is further contingent on training received by a technician, in addition to knowledge displayed by the consumer (Sridhar and Chaturvedi 2017). Owing to the criticality of trainings for service technicians, stage I of Hydrochlorofluorocarbon (HCFC) Phase-out Management Plan (HPMP I) conducted workshops and training sessions across twelve Indian states to create awareness on GSPs (as summarised by Sridhar and Chaturvedi (2017)). The on-going HPMP II proposed institutional strengthening activities for training and a certification programme as a key requirement for the service sector (Ozone Cell 2017). The ICAP (2019) further recognises the informal nature of the service sector and the role of training and certification in formalising the sector. In response to the growing need for training and certification, the authors of this paper aim to propose a framework to formalise India's servicing sector in the remainder of this paper.

2. CURRENT LANDSCAPE OF THE RAC SERVICING SECTOR

The RAC servicing sector in India is estimated to grow tremendously in response to growing demand for room ACs. From the 90s, India has successfully implemented three stages of refrigerant transition: chlorofluorocarbon phaseout; HPMP stage I to meet the HCFC freeze in 2013 and 10 percent phaseout in 2015; and the ongoing HPMP stage II enabling a complete phaseout of HCFCs 141b and 22 in all applications (Ozone Cell 2019). In line with these transitions, and technological overhauls that they mandate, the Government of India has simultaneously invested in trainings and workshops to facilitate the required upgradation along refrigeration and air conditioning supply chains, with a specific focus on the servicing sector. These capacity additions in the RAC workforces have often been realised with the support of various stakeholders – both national and international.

So far, these training and skilling programmes have been limited in their direct outreach, in terms of the numbers of immediate beneficiaries. Training programmes during HPMP I reportedly trained 6 per cent of the total technicians in India, between 2008 and 2015 (Ozone Cell 2017). However, HPMP II, launched in 2017, committed to a target of training and certifying one lakh technicians by 2020 under the 'Recognition of Prior Learning (RPL)' scheme.[4] Given the current estimates of two lakh techni-

3 Based on interviews with experts from the servicing sector for Bhasin et al. (2019)

4 'Recognition of Prior Learning (RPL)' instituted under a memorandum of understanding between the Ministry of Environment, Forest and Climate Change and Ministry of Skill Development and Entrepreneurship in 2018 is a country-wide programme that aims to train and certify experienced air conditioning and refrigeration service technicians. This programme is designed and executed by the Electronics Sector Skill Council of India (ESSCI).

cians, achieving this target would have re-trained and certified about 50 percent of the technicians in India's servicing sector. It is important to note that this programme has been designed to specifically target experienced service technicians; a critical need as pointed out by Sridhar and Chaturvedi (2017), as increasing years of experience did not necessarily result in corresponding higher knowledge among experienced technicians. Moreover, this re-training is a response to creating a service-sector readiness for the impending transition away from hydrofluorocarbons (HFCs) that India agreed to as a part of the Kigali Amendment to the Montreal Protocol.

India has committed to phase-down high-GWP refrigerants, primarily HFCs, after its freeze date of 2028. While the timeline for HFC phase-down for the RAC sector is not determined, as a consequence of various refrigerant transitions, it is likely that at any given point at least two different types of refrigerant gases will be used by RAC units (see Kumar et al. 2018 for projections up to 2027). For example, in the current market, HCFC, HFCs and HC refrigerants are used in RAC units sold across India (Kumar et al. 2018).

Servicing practices and refrigerant handling processes vary for each gas type; necessitating technician awareness on easy recognition of the refrigerant gas in use in specific units, and then implementing the appropriate refrigerant handling and management process. Servicing of RACs is a critical issue as refrigerant emissions have an adverse impact on the environment[5] as well as due to the hazard that exposure to refrigerants poses to service technicians. As India aims to completely phase-out ODS gases in the next decade, transitioning to non-ODS, low-GWP refrigerant gases for RAC units service sector skilling are important considerations. (See table 1) Therefore, training programmes will need to incorporate proper handling of the variety of refrigerants, in addition to GSPs.

Table 1: HPMP stage II and HFC phase-down schedule for India under Montreal Protocol

Timeline	HPMP stage II	HFC phase-down
Baseline year	2009 and 2010	2024, 2025 and 2026
Baseline calculation	Average production/ consumption of HCFCs in 2009 and 2010	Average production/ consumption of HFCs in 2024, 2025 and 2026
		Plus 65 per cent of HCFCs baseline production/ consumption

Reduction steps				
Freeze	2013		2028	
Step 1	2015	10 per cent	2032	10 per cent
Step 2	2020	35 per cent	2037	20 per cent
Step 3	2025	67.5 per cent	2042	30 per cent
Step 4	2030	97.5 per cent*	2047	85 per cent

Source: based on Ozone Cell (2017); OzonAction (2016)

**allowing annual average of 2.5 per cent between 2030 to 2040 for servicing*

It is also essential to note the various channels of training available for service technicians and the resultant types of skills these technicians possess. As summarised in ICAP (2019), there are four major channels, namely:

(i) Government of India instituted trainings designed and executed by the Ministry of Skill Development and Entrepreneurship;

(ii) Government of India instituted trainings designed and executed through international support;

(iii) Private companies and industry association led training programmes;

(iv) Engineering degrees and Diploma programmes.

While channels (i), (ii) and (iii) provide opportunities for re-skilling and vocational training to technicians, channel (iv) provides possibilities for a professional career as a service engineer. The level of skill obtained from these programmes is also reflected in their duration. While (i), (ii) and (iii) are typically two days to a week-long programmes, an engineering degree takes four years and a diploma programmes offered by Industrial Training Institutes (ITIs) are about three years long. Regardless of the range of training programmes available, a large number of technicians reportedly do not undergo formal training, instead learn on the job from a senior service personnel (Ozone Cell 2019).

The criticality of training is further illustrated by Sridhar and Chaturvedi's (2017) finding that technicians' training has a clear effect on their adherence to GSPs. An additional factor noted to have an impact on compliance with GSPs during RAC servicing was the awareness displayed by the consumer on refrigerants (Sridhar and Chaturvedi 2017). Additionally, during focus group discussion (FGD) with service sector personnel on training (Sridhar and Chaturvedi 2017) and one-on-one meetings with industry stakeholders to understand their challenges in transitioning

to low-GWP refrigerants (Bhasin et al 2019), it was found that awareness related to environmental impacts of refrigerants was often attributed to workshops and training sessions held during ODS phase-out and HPMP stage I.

Despite the relative success of the Montreal Protocol in India with specific focus on service sector training, as part of HPMP I and II, the informal nature of the sector continues to persist. The informal or unorganised sector (includes all sectors of employment) in India, is reported to contribute to about 50 per cent of the country's GDP (National Statistical Commision 2012). The National Statistical Commission (2012) further stated that India's economic growth is accompanied by increasing informalisation wherein informal labour is also extending to formal and organised sector enterprises. This presence of an informal sector in India, where regulations and government incentives are less likely to reach, presents a unique challenge. While training of service technicians will provide the skillset required to be able to join the formal workforce, certification can be used as a mechanism to achieve this. The ICAP goes one step further to establish the need for a universal certification system to tackle: (i) Lack of compliance to GSPs leading to refrigerant emissions and low cooling efficiency; and (ii) Need for enhancing livelihoods and social security of service sector personnel. .

However, the ground reality is far from achieving this long term ambition of the Government of India set out in its ICAP. During an FGD[6] with twenty entry- and mid-level service technicians, while the value of certification was acknowledged by many, few possessed any form of certification. This further points at economics of obtaining training and certification, especially, given that AC servicing is not restricted to a season but is a year-round occupation (Sridhar and Chaturvedi 2017). Additionally, several technicians added that while certification is desirable, they did not view it as a means to prepare them for employment. Theoretical nature of training programmes and the associated test required for certification held lower significance to technicians in comparison to training they received on the job. Therefore, other factors such as incentives for certification such as health insurance and social security benefits may provide the necessary impetus. Additionally, consumer demand for certified service technicians may encourage many more service technicians to pursue certification.

Bearing in mind challenges highlighted above, and the critical need for a comprehensive training and certification landscape in India, formalisation of the servicing sector could be achieved with concrete addressal of the following:

6 The FGD was conducted on 20th June 2018 by CEEW researchers with participation from twenty service sector technicians. Transcript available on request.

(i) Standardisation of training to reflect a minimum need to create certifiable technicians;

(ii) Certification should offer incentives to the technicians, and made mandatory over time; and finally

(iii) Consumer awareness should be a focus to increase demand for skilled and certified technicians.

3. ENABLING THE CREATION OF A UNIVERSAL CERTIFICATION SYSTEM FOR RAC TECHNICIANS IN INDIA

As highlighted above, India has a few ongoing schemes for trainings and certification, but none that systematically addresses the creation of a uniform certification scheme for all RAC servicing technicians- employed in formal or informal enterprises, existing technicians and those who will join the workforce as technicians as demand-led jobs increase. OzonAction, the central Secretariat within the international regime tackling refrigerant transitions, notes that

"For those countries or enterprises wishing to establish a new certification scheme, it is heartening to recognise that one is not starting from scratch and that there are many schemes around the world both in developed and developing countries that can provide guidance, inspiration and examples of the various approaches and methods that can be followed." OzonAction (2015)

In recognition of global best practices that India may benefit from, some key lessons arising from nations in the European Union (Schwarz et al. 2011) have been identified in the ICAP as follows (Ozone Cell 2019):

- Separation of training and certification.
- Establishing a uniform training curriculum executed by a country-wide network of training centres.
- Feedback mechanism to check the efficacy of the certification programme and make improvements.
- Awareness drives for consumers and companies on the importance of certified technicians.
- Introduce different certification levels – allowing technicians to earn certification for varying skills levels (e.g. installation only, refrigerant handling, system repairs etc).

Other global best practices, highlighted by OzonAction (2015), include:

- Establishing a private organisation to administer the certification system as done by the Australian Refrigeration Council Ltd in Australia.
- Mandating the need for certification of technicians to handle specific type of refrigerants such as ODSs as done in the USA and Zambia.
- In Saint Lucia, passing the certification examination awards the technician certification and an ID card. However, unsuccessful technicians are, instead, issued a participation certificate and are required to re-take the training and examination.
- Different categories of certification can be awarded depending on the equipment type and capacity, as done in Japan. Further, Japan also awards certification focusing on leak prevention.

In learning from these best practices as India aims to develop and implement a universal certification scheme, the following key aspects will be critical to its success:

3.1. Certification must be incentivized and made mandatory over time

The informal nature of the service sector and lack of certified technicians in the current market could be addressed by providing incentives to the service technicians as part of a voluntary scheme to initiate a successful universal certification system within India. As an example, the RPL scheme offers a cash award of INR 500 per technician for obtaining the certificate (NSDC, 2016). A further step can be taken by integrating schemes like Pradhan Mantri Jan Arogya Yojna with certification thereby providing health and accident insurance to service technicians and their family members. Given that, Ayushman Bharat already recognises 'repair workers/ mechanics/ electricians' eligible (FP staff 2019), certification could be added as an additional criterion for securing accidental insurance under the scheme. The use of incentives would create the necessary 'push' required to encourage more technicians to acquire certification.

Given the range of steps, infrastructure and investments involved in establishing a successful system, it is important to reiterate that the certification system must be introduced as a voluntary scheme at first. It is also essential to note that the certification system if introduced in a gradual manner, moving from a voluntary scheme to a mandate, will encourage more service sector personnel to benefit from the system, as the infrastructure and institutional blueprint for certification

develops over time. This will also prevent cases of technicians being forced out of the profession due to lack of certification institutions, at worst; or a likely heavy backlash if a mandate is imposed without adequate provisions for such certification within India.

3.2. Trainings must be standardized to reflect a minimum need to create certifiable technicians

In order to train to become a RAC service technician any one of the four channels mentioned in Section 2 can be followed. These training programmes cater to entry-level as well as experienced technicians. Training programmes such as Ecological Refrigeration (ECOFRIG) and the National CFC Consumption Phase-out Plan (NCCoPP) have reported to have trained about 20,000 RAC technicians on GSPs (Ozone Cell 2019). Under the HPMP stage I, trained over 11,000 technicians with an emphasis on refrigerant management (Ozone Cell 2019). Stage II of HPMP proposed to train around 17,000 technicians (Ozone Cell 2019). Additionally, the RPL programme instituted under HPMP II aims to train and certify one lakh technicians by 2020 (UNI 2018). Relatively longer, more specialised courses such as those offered by ITIs in India, reportedly train 12,000 service personnel annually (Ozone Cell 2017).

Sridhar and Chaturvedi (2017) reported that about 50 per cent of the formal sector technicians and close to 30 per cent of the informal sector technicians had undergone some form of training. They further found that authorised service centres (formal sector enterprises) required technicians to have an ITI or polytechnic degree (Sridhar and Chaturvedi 2017). However, to train technicians for new technologies, most manufacturers had short courses and focused training for technicians (Sridhar and Chaturvedi 2017; Bhasin et al. 2019).

The non-standardised training system has contributed to cases where non-trained technicians handling AC units with no adherence to GSPs. This in turn has resulted in price per service being driven low, thereby providing no apparent advantage of training or no motivation to follow GSPs (Ozone Cell 2019; Sridhar and Chaturvedi 2017).

Addressing these issues in the sector, standardisation of training could be achieved as follows (also see Ozone Cell 2019):

- Establishing sufficient capacity for training. Similar to the EU model, a network of training centres should be established across the country.

- Training should cater to different levels of skills in terms of sectors and experience of the service personnel, among other aspects.
- Given the influx of new technology in response to refrigerant transition, greater participation of industry stakeholder should be encouraged in developing the curriculum for training and delivering the training to service technicians.
- A further consideration should be made for the language in which training is provided. Syllabus and training should be made available in regional languages for greater accessibility.

3.3. Consumer awareness must be targeted so as to reflect a surge in demand for certified and qualified technicians

A final measure to be taken in establishing a country-wide training and certification mechanism for RAC service technicians is consumer awareness. Sridhar and Chaturvedi (2017) found that consumer awareness on refrigerant gas had a direct bearing on technician's adherence to GSPs. According to Sridhar and Chaturvedi (2017):

"if customers have knowledge about refrigerants, then service technicians are more than twice as likely to not follow poor practices."

The ICAP (2019) further notes,

"The key objectives of the policy actions for the service sector fall under the purview of developmental and environmental goals. Five main stakeholders of the service sector make contributions at various capacities for achieving this transition: service technicians, industry, government, civil society, and customers. Depending on their role in the life-cycle of the equipment, each stakeholder has a different role to play. The government would facilitate the transition through policies, regulations, incentive schemes etc., while the industry would play an important role in increasing access to social security, training and certification for technicians. Service technicians and customers are responsible for field-level implementation of regular and appropriate servicing and maintenance practices. Feedback from service technicians and customers would be central to creating policy actions. Civil society plays an important role in advisory and research capacities." (Ozone Cell 2017)

The means for consumer awareness is further highlighted by Bhasin et al. 2019,

"Stakeholders[7] suggested products labelling systems that indicate environmental performance or 'goodness'. Awareness building must also be included in larger training programmes for retail suppliers and sales teams."

Thus, consumer awareness plays a critical role in establishing the 'pull' required to increase the demand for trained and certified technicians. Service sector personnel often compete with un-trained technicians thereby driving down the price per service; noted as the 'problem of lemons' in Ozone Cell (2019). Technicians often refrain from adhering to GSPs less so due to lack of knowledge, rather because of lack of awareness displayed by the consumer (Sridhar and Chaturvedi 2017). In the current landscape, therefore, training and certification offers no apparent advantage for service technicians. Through consumer awareness drives, the aim is to create a demand for qualified and certified service technicians. The following guidelines could be used in designing a consumer awareness drive:

- Monetary gains offered by well serviced RAC units should be highlighted. This could be in terms of the money saved in electricity bills or in terms of refrigerant gas by preventing leak and venting. As noted by the success of Bureau of Energy Efficiency's awareness campaign on energy efficiency and star labelling (Market Xcel 2015), monetary savings may provide the necessary motivation to employ well-trained/ certified technicians.
- A recent analysis by CEEW (2019, unpublished), finds that online media is the least used source of information by households to employ service technicians for their ACs (see Figure 1). Majority of the respondents showed a preference for recommendations from friends/ family and retailers to find technicians for servicing their ACs (see Figure 1). Additionally, in determining AC purchase, print media and television advertisements were the most preferred by consumers (see Figure 2). Based on this, print media and television advertisements could be employed to create awareness on certification. Further, retailers could be used as a medium to recommend certified technicians to consumers.

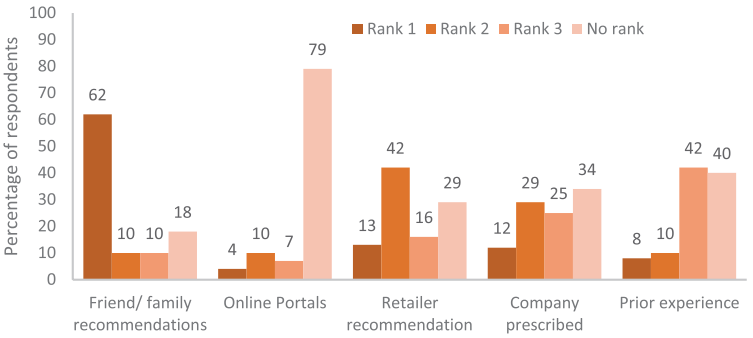

Figure 1: Sources of information used to select a service technician

Source: CEEW analysis 2019

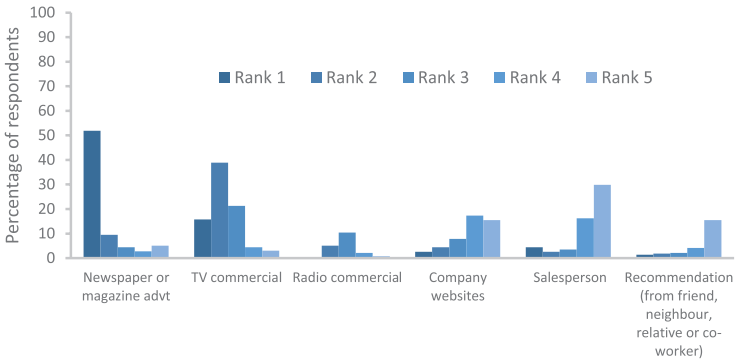

Figure 2: Sources of information used to make decisions on AC purchase

Source: CEEW analysis (2019)

- As indicated in ICAP (2019), public procurement of certified RAC service technicians by the Government of India, will create jobs for technicians as well as awareness on the importance of certified technicians among consumers.
- Bhasin et al. (2019) report the need for labels to help identify refrigerants used in RACs and help identify differences between units. This would not only inform consumers of the refrigerant gas used in the RAC unit, but also help the technician follow the correct procedures for refrigerant handling.

4. CONCLUSIONS

The Indian RAC servicing sector is expected to see a tremendous growth in the coming decades. This growth not only increases the number of jobs in the sector but also presents an opportunity to formalise it through training and certification. The informal nature of the sector, and the safety hazard posed by the occupation necessitates an emphasis on workplace safety measures as well as social security benefits for service sector personnel. To address this, the authors of this paper propose a three-step approach:

1. Certification should be incentivised at first and mandated over time;
2. Training must be standardised to reflect a minimum need to create certifiable technicians; and finally,
3. Consumer awareness must be targeted so as to reflect a surge in demand for certified and qualified technicians.

In addressing the need for formalising the RAC servicing sector through the aforementioned approach, not only will India be able to meet its international commitment to phase-down ODS and high-GWP refrigerants, but also achieve domestic developmental goals of job creation and up-skilling.

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INSIGHTS OF CAPACITY BUILDING NEEDS AND THEIR SIGNIFICANCE FOR PROFESSIONAL MODULES FOR CERTIFICATION VIZ: REFRIGERANT RECOVERY, RECYCLING AND RECLAMATION

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MANAGEMENT OF REFRIGERANT BANKS

Addressing emissions of halogenated refrigerants through minimizing leaks and emissions from old refrigeration and air conditioning appliances containing chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) or hydrofluorocarbons (HFCs) has been identified as one of the most cost-effective climate change solutions. In particular, in countries with large urban areas - like India - the mitigation potential is substantial and the efforts which need to be undertaken are manageable in comparison to the climate benefits which can be earned ("low hanging fruit").

The Montreal Protocol has successfully phased out the production and use of CFCs and is on track to phase out HCFCs by 2030. However, these substances are still present in 'banks': for example, as refrigerants in old appliances that are either still in use or abandoned, as blowing agents in building and appliance foam, or in storage cylinders after collection. If no measures are taken, these banks will be emitted to the atmosphere.

The annual emissions from the global ODS bank is estimated to be around 1.5 Gt CO2eq which is equal to the annual emissions of more than 440 coal power plants. In 2017, GIZ published a study[1] with country-level estimates of global banks of ozone depleting substances, also providing some data on HFCs. For India, ODS banks were estimated at almost 88 kt of ODS, using a top-down approach based on

1 GIZ (2017) - Global banks of ozone depleting substances - A country-level estimate

reported data until 2014. The refrigeration and air-conditioning sector accounts for approximately 42 kt ODS, in the order of 75 Mt CO2eq assuming a predominant presence of HCFC-22. This figure does not reflect the full potential of the sector to mitigate climate change, since it does not include the increasing quantities of HFCs. Furthermore, the methodology applied does not fully capture the quantities imported in pre-charged equipment. It can be assumed that in particular the HFC banks in this sector increased significantly.

The presence of substantial quantities of CFCs in equipment reaching its end of lifetime in the coming years offers a window of opportunity to reduce the pressure on the stratospheric ozone layer and at the same time to contribute to climate change mitigation, due to the extremely high global warming potential of CFCs.

The servicing sector is key for seizing the mitigation potential: The recovery of the refrigerants during servicing or decommissioning is the crucial first step for the management of banks. The collection of used refrigerant enables either their destruction in case of unwanted and contaminated substances or their reuse, reducing the need for new refrigerants. The recycling, i.e. reuse without re-distillation (reclamation), requires specific knowledge and skills of the servicing person to ensure the correct cleaning of the recovered fluids, which is essential to ensure proper functioning of the equipment.

RELEVANCE OF THE SERVICING SECTOR FOR THE MANAGEMENT OF REFRIGERANT BANKS

In the EU, the importance of well-informed and trained service personnel is reflected in the minimum requirements for the certification of persons installing and servicing stationary refrigeration, air conditioning and heat pump equipment.[2] They need to know about the environmental impact of refrigerants and corresponding environmental regulations, have a basic knowledge of the EU and international climate change policy, of the concept of Global Warming Potential (GWP) and about the use of other substances than fluorinated greenhouse gases as refrigerants. Knowledge of requirements and procedures for handling, reusing, reclaiming, storage and transportation of contaminated refrigerant and oils is explicitly mentioned. Furthermore, the certified person has to demonstrate comprehensive practical skills that are necessary to carry out recovery and recycling of refrigerants.

THE REGULATORY AND INFRASTRUCTURAL FRAMEWORK

Even a well-trained service person, aware about the environmental necessity of avoiding emissions of refrigerants and the economic benefits of reusing them, cannot act accordingly if there is no functioning recycling and destruction infrastructure. Furthermore, the existence of a supporting regulatory framework facilitates a broader uptake of good management practices.

Neither the Montreal Protocol nor any other international agreement regulates the management and destruction of existing ODS and HFC banks. It is therefore each country's own responsibility to establish a successful ODS and HFC bank management scheme to handle this important source of emissions.

Based on the experiences made in other countries, five key elements of good ODS and HFC bank management are:

1. Well informed and trained service personnel
2. An effective collection mechanism
3. A suitable set of policy measures
4. A sustainable financing mechanism
5. A functioning recycling and destruction infrastructure

Before being able to take appropriate actions within these four processes local data needs to be collected in order to assess the amount of substances potentially available for management and define priority areas for ODS and HFC bank management and supportive policy measures.

VOCATIONAL TRAINING SYSTEM FOR REFRIGERATION & AIR CONDITIONING SERVICING TRADE IN INDIA

Mr. Deepankar Mallick , Deputy Director General,
Directorate General of Training (DGT),
Ministry of Skill Development & Entrepreneurship

Major functions of the DGT are:

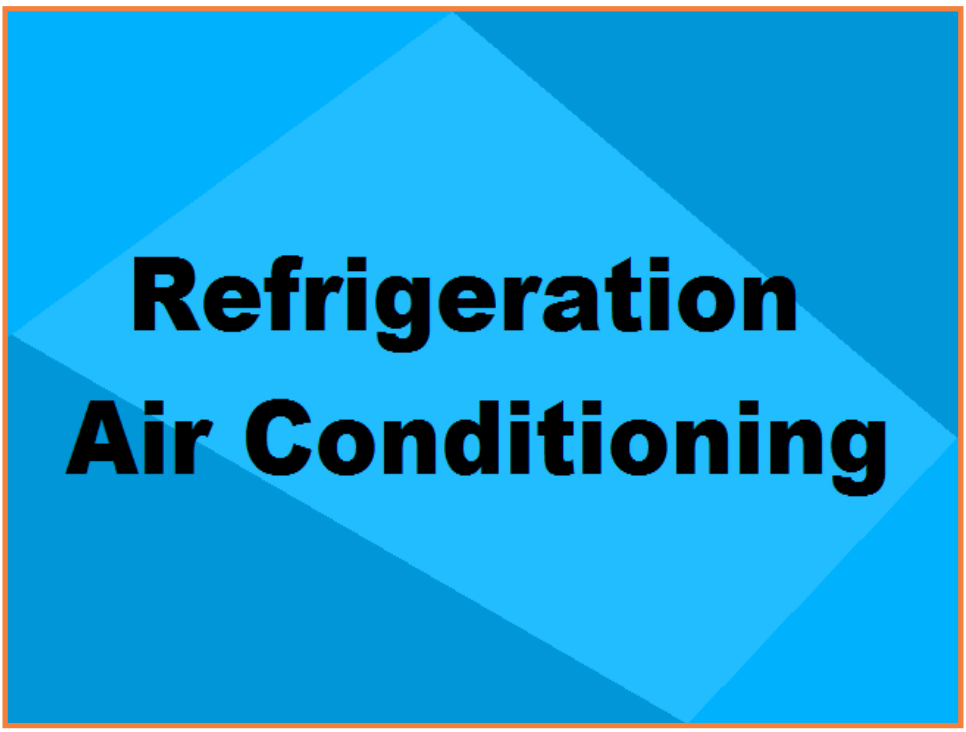
- To frame overall policies, norms and standards for vocational training.
- To diversify, update and expand training facilities in terms of craftsmen and crafts instructor training.
- To organize and conduct specialized training and research at the specially established training Institutes.
- To implement, regulate and increase the scope of training of apprentices under the Apprentices Act, 1961.
- To organize vocational training programmes for women.
- To provide vocational guidance and employment counselling.

SCHEMES OF TRAINING

- **Craftsmen Training Scheme (CTS)**
- **Flexi MOU**
- **Dual System of Training**
- **AVTS**
- **Apprenticeship Training Scheme (ATS)**

SCHEMES OF TRAINING OF TRAINERS

- **Craft Instructor Training Scheme (CITS).**
  - Training of Craft Instructors is the mandated responsibility of DGT and It has been operational since the inception of the Craftsmen Training Scheme (CTS).
  - Comprehensive training both in skills and training methodology is imparted to the instructor trainees to make them conversant with techniques of transferring hands-on skills, to train skilled manpower for the industry.



Vocational Training System For Refrigeration and Air Conditioning.

- Govt ITI - 765 Nos
  - Training Capacity - 47086 per annum
- Pvt ITI - 238 Nos
  - Training Capacity - 14872 per annum

Institutes conducting Instructor Training - RAC

- NSTI, Calicut, Kerala.
  - Training Capacity – 100 per annum
- NSTI, Howrah, Kolkata.
  - Training Capacity - 25 per annum
- ITOT, Lucknow, UP.
  - Training capacity -100 per annum

TRAINING OF TRAINERS (ToT)FOR RAC INSTRUCTORS

- With the tie up of DGT & GIZ – Prokilima on behalf of Government of Germany and in close cooperation with Ozone cell in the Ministry of Environment Forest and Climate change (MoEF & CC) conducted ToT of HPMP stage 1 for Instructors at
- NSTI KOLKATTA
- NSTI HYDERABAD
- NSTI CALICUT

Thank you

INTERNATIONAL SCENARIO FOR CERTIFICATION OF RAC SERVICING PERSONNEL

Ole Reinholdt Nielsen , Chief, Montreal Protocol Division,
Environment Department,
United Nations Industrial Development Organization (UNIDO)
Email : O.Nielsen@unido.org

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INDUSTRIAL DEVELOPMENT ORGANIZATION

SUSTAINABLE DEVELOPMENT GOAL 9
INDUSTRY, INNOVATION AND INFRASTRUCTURE

Outline

- Brief intro;
- Challenges for service sector;
- Lessons learnt from last 25 years;
- Approaches for certification;
- Thoughts

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Intro

- UNIDO's mandate: Create prosperity through inclusive and sustainable industrial development (SDG 9);
- Technical cooperation if fields of trade and innovation, agro business; energy; and environment.
- Environment department handles industrial resource efficiency and compliance issues in relation to Stockholm and Minamata Conventions as well as Montreal Protocol.

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Intro

- Montreal Protocol Division implements ODS and HFC phase-out projects in around 70 countries;
- Activities comprise:
  - Industry conversions;
  - Activities in relation to service sector – primarily investments;
  - Institutional strengthening projects;
  - Enabling activities for Kigali amendment; and
  - Technology demonstration projects

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Kigali amendment

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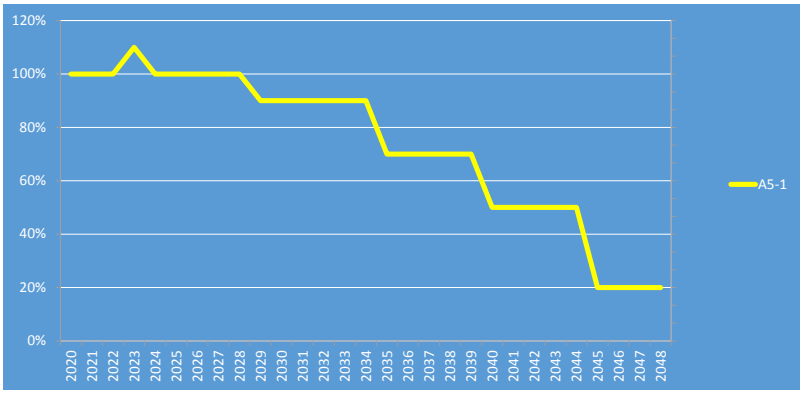
Regulatory certainty – HFC phase-down



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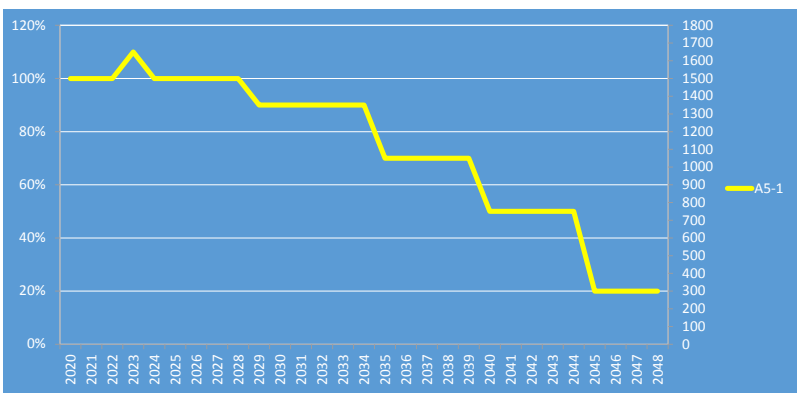
Regulatory certainty – HFC phase-down



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Challenge 1

- Low(er) GWP refrigerants are flammable (except a few natural refrigerants); (toxic or with excess pressure).

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Challenge 2

- All synthetic refrigerants are harmful to the environment:
  - Ozone depletion; or
  - Global warming
- Retrofit from HCFC/HFC to flammable is in general not advisable.

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Possible solutions

- Extensive capacity building in handling flammable refrigerants; and in parallel
- Focus on containment and EOL of products containing synthetic refrigerants

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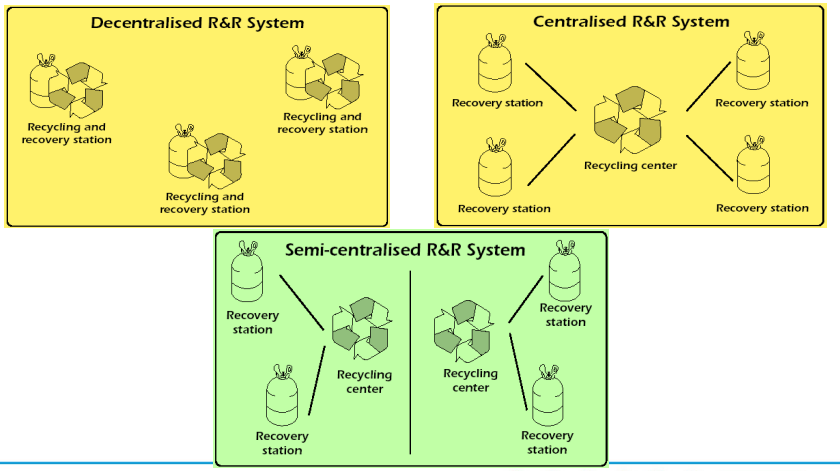
Lessons learnt - training

- Refrigeration servicing is universal;
- Training of refrigeration servicing personnel during last 25 years;
- Based on UNEP's "Good Practices in Refrigeration" (1991):
  - 5 days course;
  - Good for raising awareness on ozone depletion but possibly lightweight in terms of practical training; however
  - Challenges in 1990'ies were completely different than now

Lessons learnt – containment



Definitions

- **Recycling**: To reduce contaminants in used refrigerants by separating oil, removing non-condensable gasses and using devices such as filter-driers to reduce moisture, acidity and particulate matter *(comment: to unspecified level)*
- **Reclaim**: To reprocess used refrigerant to new product specifications, and verify by chemical analysis of the refrigerant that new product specifications have been met *(comment: e.g. ARI 700)*
- **Contaminants**:
  - Oil, water, acid, NCG, particulate matter; and
  - Other refrigerants.

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Required purity levels

- European Standard EN 378-4:
  - Re-use of refrigerant after recycling: Same or similar system;
  - Re-use of refrigerant after reclaim: Any system.

- Centralized approach will require reclaim operation

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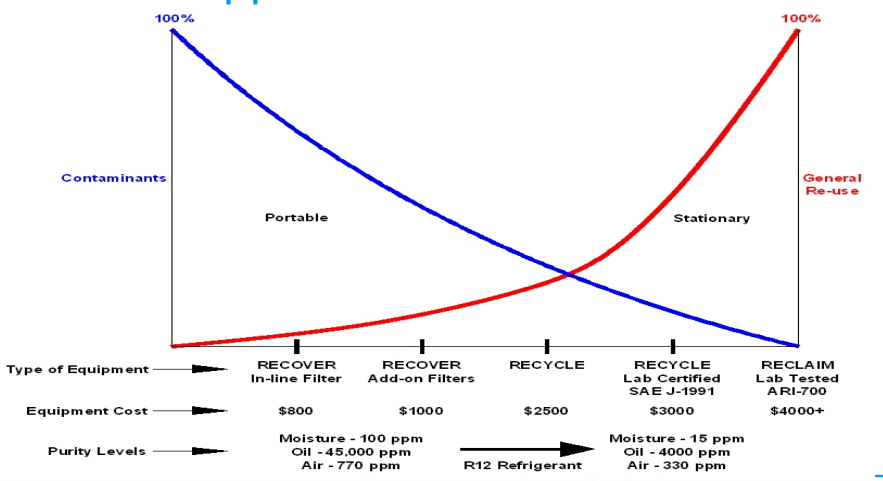
Re-use opportunities



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Training during CFC phase-out

- Extensive training by few international consultants (in recipient countries);
- No or minor follow-up;
- R&R part perceived not being successful.

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MP inclusion of HCFC's

- Typically BAU applied in terms of R&R by requirement to handle HCFC in addition to CFC;
- Big mistake……

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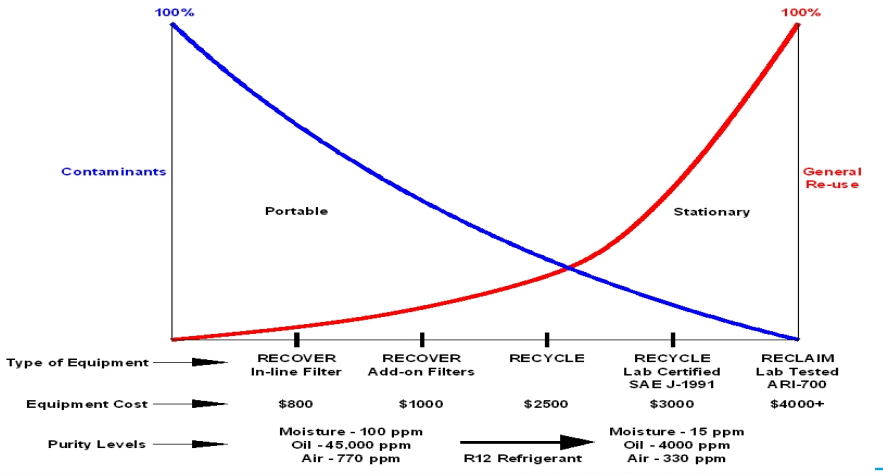
Re-use opportunities



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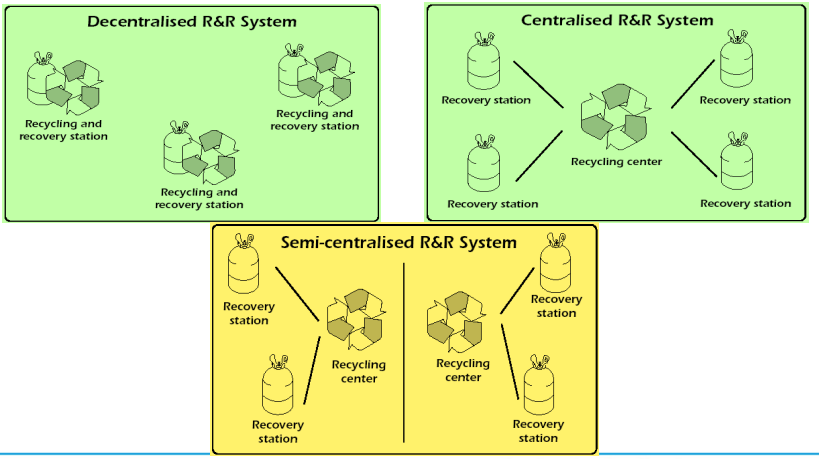
Recycling ???

Lessons learnt – R&R



External filter module

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Reclaim center

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Recovery and re-use

- UNIDO is implementing such schemes now and selection of reclaim center host(s) based on call for interest and presentation of business plan;
- Results will be available in a few years.

- Recovery of synthetic refrigerants should be mandatory and proper methods integrated into the education of refrigeration servicing personnel.

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Recent training approaches

- Train-the-trainer concept, e.g.:
  - GIZ Cool Training;
  - Institute Galileo
- UNEP partnerships; e.g.:
  - RDL
- Industry based training; e.g.:
  - Danfoss web training or CO2 container

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Recent training approaches

- Given our mandate, UNIDO is typically utilizing existing structures; however

- HOPE Project ?

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Recent training approaches

- Given our mandate, UNIDO is typically utilizing existing structures; however
- HOPE Project ?
- House Of PropanE

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Change of mindset

- Refrigeration servicing personnel and equipment owners should consider refrigerant as an asset; not as a consumable

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Thoughts

- Presence and in particular future requires a set of minimum skills of refrigeration servicing personnel:
  - To ensure safe operation; and
  - To ensure that initial energy efficiency is maintained.
- Learning by doing is no longer an option;
- Curricula of vocational schools needs to be updated;

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Thoughts

- Refrigeration servicing personnel needs to be registered and preferably also certified;
- Framework needs to be developed to ensure that only registered technicians perform work on refrigerating systems:
  - Legislation in place;
  - Enforcement through possibly voluntarily actions among industry stakeholders (producers and importers)

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Thoughts

- Potential future additional funding from MLF to include certification with focus on energy efficiency

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Thank you

Contact

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TRAINING OF SERVICE TECHNICIANS FOR INSTALLATION , COMMISSIONING & SERVICING OF RESIDENTIAL & COMMERCIAL AIR-CONDITIONING SYSTEMS

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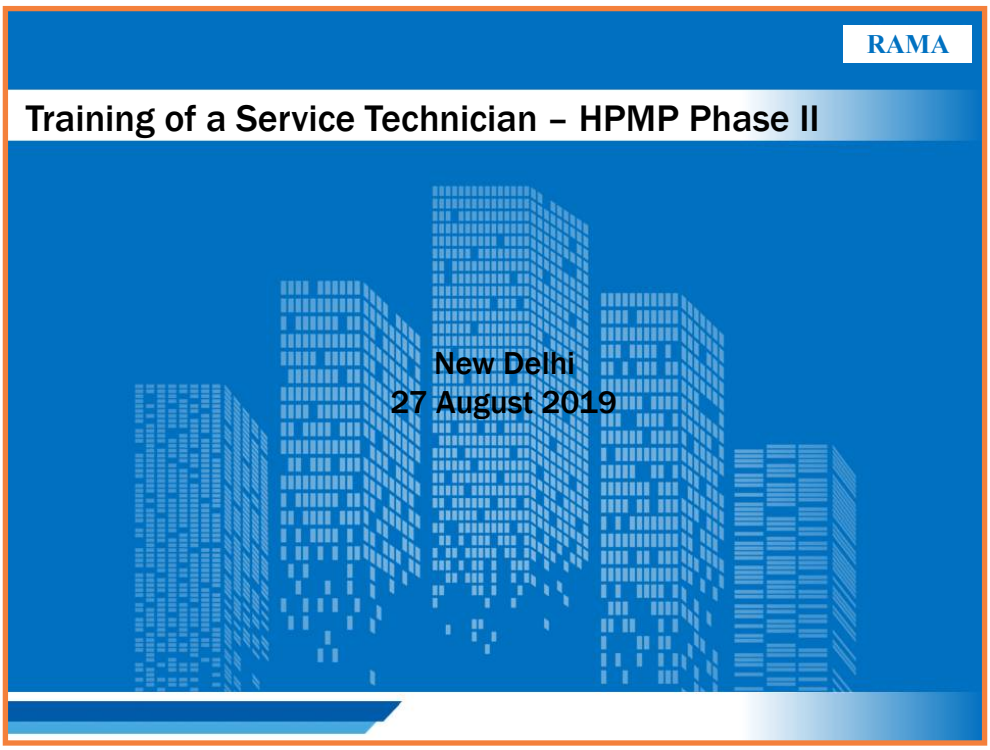


RAMA

Service Technician – Customer Perspective

- Appearance
- Punctuality
- Politeness
- Use of Appropriate Tools
- Safety at Work
- Quality Practice
- First time correct Diagnosis
- Timely Resolution
- Communicate with Clarity
- Tech-savvy Approach
- Field Service Report
- Customer Feedback

RAMA

Technology Trends in HVAC

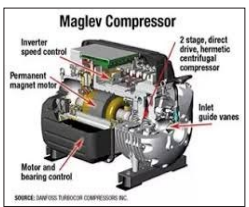
Advance Electronics

Home Automation

Mobile Application

New Refrigerants

VRF Systems



Compressor Technology

RAMA

Training Infrastructure - OEM

- State of the art training centre
- Demo of equipment functioning
- Expert Trainers - Function wise
- Simulation of Electrical & Electronics - Fault Diagnosis
- Training on Wheels

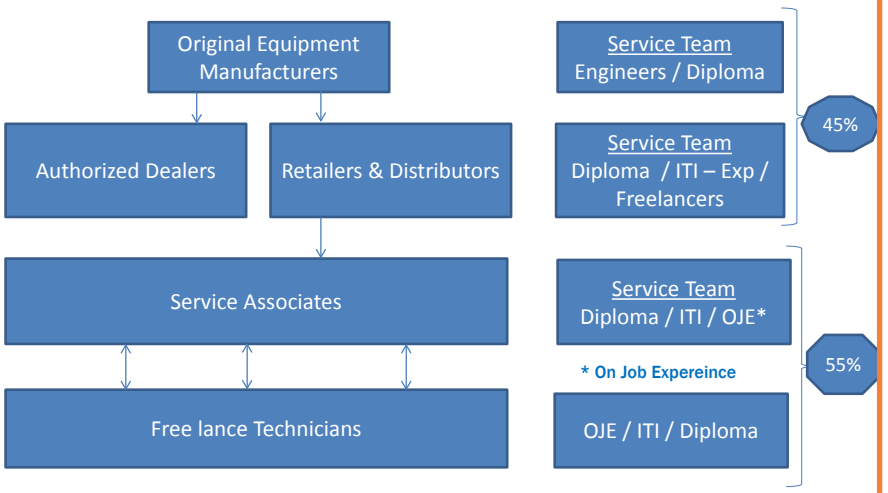
RAMA

Certification Programmes

- OEM Certification - Product wise & Function wise Certification programme
- ISHRAE - ISHRAE Certified Professional (ICP) & ISHRAE Institute of Excellence (IIE)
- Electronic Sector Skill Council of India (ESSCI) - Qualification Packs
- Refrigeration & Airconditioning Service Sector Society
- GIZ - HCFC Phase out Management plan

RAMA

Eco system - Service Sector



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RAMA

Technicians for Installation

- New AC's Installed in a year (Retail) - 70 Lakhs
- 5% replacement of the existing 390 L of AC's in residential segment - 20 Lakhs
- Thus the total AC Installation in a year - 90 Lakhs
- Assuming 02 installation / day - 45 Lakhs Crew days (02 per Crew)
  - 90 Lakhs Mandays
- In 08 Months - 37500 Installers

Growth 2019 – 2025 :

- Room Airconditioner - CAGR 12%
- Ducted System - CAGR 5%
- VRF System - CAGR 15%
- Chilled Water System - CAGR 10%

Source : RAMA & BSRIA

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RAMA

Technicians for Servicing – Residential / Retail Segment

Assumption : (a) 390 Lakhs of units are serviced every year in a span of 08 months.
(b) 04 Customers are serviced in a day by a service crew of 02 members.

- The total AC serviced in a year - 390 Lakhs
- Assuming 04 service / day - 97 Lakhs Crew days (02 per Crew)
- In 08 Months - 40,416 Mandays
- 100% of units - 01 Service per Unit / year - ~ 80,000 Technicians
- 50% of units are done 02 Service / year - ~ 40,000 Technicians
- 25% of units are serviced 04 times / year - ~ 40,000 Technicians
- Breakdown of AC's - 01 call / unit / year - ~ 40,000 Technicians
- Total Technicians required for servicing - ~ 2,00, 000 Technicians

Source : RAMA

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RAMA

Challenges & way forward

- The training & certification program are mostly theoretical → Hands on Training
- Non-uniform Content across various training → Standard Training Curriculum with current trends & technology
- Currently available in Tier 1 to Tier 3 Towns → Larger Reach (5454 Taluks)
- Attracting Un-Organized sector (Freelancer) → What is in it for me ?
- Identification of Training Partners
- Delivery Mechanism - Classroom → Flexible timing / Short modules / AV
- Customer Acceptability → Educating Customer & Licence for Refrigerants Usage
- Employability of Freelance technicians in Organized service sector - Bridging the gap

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Thank you