UNEP

National Certification Schemes for Refrigeration and Air-conditioning Service Technicians

Examples of Strategies and Requirements for their Establishment and Operation

United Nations Environment Programme

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Executive Summary

It is expected that in the near future there will be a considerably higher uptake around the world, and particular in developing countries of 'alternative refrigerants', such as hydrocarbons, ammonia, carbon dioxide, unsaturated hydrofluorocarbons (HFCs) –or hydrofluoroolefins (HFOs) and HFOs mixtures. The refrigeration and air-conditioning industry will have to adapt to both the technical and safety issues concerning these refrigerants. In particular, many of the alternative refrigerants have specific characteristics regarding toxicity, flammability and high pressure which are different from those used previously such as chlorofluorocarbons (CFC) and hydrochlorofluorocarbons (HCFCs). During the installation, maintenance, repair and dismantling of refrigeration and air-conditioning equipment containing or relying of such alternatives, safety and technical issues need to be carefully evaluated and considered. Certification is the best practical method to verify the competence of personnel handling refrigerants and to ensure the correct installation, maintenance, repair and dismantling of a refrigeration, air-conditioning and heat pump systems. This is all the more important when servicing technicians have to deal with refrigerants with properties that they were previously not familiar with, particularly related to safety.

Certification is the means by which a person (or enterprise), as a result of training, education, external review and assessment, receives official approval of being able to competently complete a job or task. Certification can be a legal requirement or a measure undertaken voluntarily for professional advantage. Certification schemes which are mandatory by legislation have the advantage of providing a strong incentive for technicians and enterprises to comply.

Assessment for certification needs to be both practical and theoretical. In general servicing technicians tend to be more inclined towards practical components but the theory is important in order to fully understand the background and reasons for the particular methods and techniques. Training is undoubtedly important as the method to transfer knowledge to service technicians, but training alone does not verify the level of comprehension, competence and skills of a participant in a training programme. For example a certificate of participation given at the end of a training course cannot replace certification based on a comprehensive assessment of knowledge and skills.

Certification schemes often include training but the two phases are better being independent for the impartiality of the Certification itself. A third party should verify periodically and participate directly during the assessment process in order to confirm the validity of the procedures.

This publication aims to provide introductory information for institutions in developing countries to better understand the issue of certification in the field of refrigeration and air-conditioning, to assist in the creation of such certification and training schemes and to demonstrate to service technicians and enterprises why it is in their interest to participate. This guidance is provided through four main examples of existing certification schemes. It is intended for government officials, principally the National Ozone Units responsible for implementation of the Montreal Protocol on Substances that Deplete the Ozone Layer as well as those in various ministries (such as environment, education and labour) as well as Certification Bodies and relevant Industry Associations. The publication can also be of interest to the general public to better understand the importance of certification in ensuring the installation of safe and reliable equipment and provision of quality services through adherence to applicable standards. Certification is also an important element in customer protection and may prompt customers to put pressure on industry and the servicing sector to adopt appropriate certification. Certification in the refrigeration and air-conditioning sector can also act as an 'added value' for technicians to prove their competence and proficiency, particularly when they change employers or seek new jobs.

Contents


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Acronyms

A/C	Air-Conditioning
Article 5	Countries operating under Article 5 of the Montreal Protocol, (i.e. developing countries)
AREA	Air-Conditioning and Refrigeration European Association
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
CAP	Compliance Assistance Programme UNEP OzonAction
CEN	European Committee for Standardization
CFC	Chlorofluorocarbon
DTI	Department of Trade and Industry (Philippines)
EN	European Norm (Standard)
GHG	Greenhouse gas
GWP	Global warming potential
HCFC	Hydrochlorofluorocarbon
HC	Hydrocarbon
HFC	Hydrofluorocarbon
HFO	Hydrofluoroolefin, unsaturated HFCs with low GWP
HVAC&R	Heating, ventilation, air-conditioning and refrigeration
ISO	International Organization for Standardization
ODP	Ozone depleting potential
ODS	Ozone depleting substance
NOU	National Ozone Unit
RAC	Refrigeration and air-conditioning
RACCA	Refrigeration and Air-conditioning Contractors Association of Australia
RACHP	Refrigeration, Air-Conditioning and Heat Pump Equipment
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
UNFCCC	United Nations Framework Convention on Climate Change

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Foreword

Under the *Montreal Protocol on Substances that Deplete the Ozone Layer,* countries are in the process of phasing out the consumption (and production where appropriate) of hydrochlorofluorocarbons (HCFCs). UNEP OzonAction is providing assistance to over 100 developing countries to enable them to successfully comply with these commitments. Developing countries are faced with the particular challenge of selection of replacement technologies and alternatives. In order to effectively adopt low or zero global warming potential and non-ozone depleting substances there are a number of challenges and potential barriers to be overcome and frequently a lack of specialised experience in handling these alternatives.

There are some obvious questions that need to be asked. How can we be sure the technicians in the refrigeration and air-conditioning sector possess the necessary skills? Is the country ready and equipped to adopt 'alternative refrigerants', such as hydrocarbons, ammonia, carbon dioxide, or HFOs? Are the technicians trained to cope with the specific properties of refrigerants which may prevent the alternatives from being unconditionally adopted such as flammability, toxicity and high working pressures? Are they aware of the range of fluorinated alternatives which can range from those with extremely high GWPs to those with low or very low GWPs?

One way we can hope to start to answer these questions and be confident in the knowledge and skills of the servicing technicians is to ensure they are well trained and certified in the relevant areas. This way we can verify the competence of personnel handling refrigerants, performing installations and carrying out servicing.

By ensuring developing countries have well trained and certified technicians this will significantly contribute to the dual advantages of gaining climate and ozone benefits from the servicing sector.

We hope this UNEP OzonAction publication provides you a useful introduction to, and examples of, certification and the processes to be followed in establishing or enhancing a national certification system for refrigeration and serving sector practitioners. This publication is designed to provide a simple overview and examples to guide and assist in the design and implementation of certification schemes, both where training, certification, associations etc are already in place and where they are not and therefore need to be started from scratch.

Dr. Shamila Nair-Bedouelle,
Head, UNEP OzonAction

Introduction

The coming years will be important for the refrigeration, air-conditioning and heat pump sector and will bring important changes in technology as we know it, including:

- The total phase-out of HCFCs (such as R-22) in developed countries
- The progressive reduction of widely-used HCFCs in developing countries
- The increasing use of alternative refrigerants both in developed and developing countries (both natural and synthetic low GWP refrigerants)
- The phase-down of HFCs in some developed countries
- The ongoing discussions on a potential worldwide phase-down of high GWP HFCs

In developing countries the phasing out of HCFCs should lead to the increased adoption of alternative refrigerants / low GWP refrigerants. Many of these have flammable and/or toxic properties or operate at high pressures. Technicians may not be familiar with these as they are rather different from those used previously such as chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs). The installation, servicing, repair and dismantling of refrigeration and air-conditioning equipment operating with such refrigerants needs to be carefully evaluated and considered in the context of safety issues. It is therefore recommended that minimum requirements for training and certification of contractors handling low GWP refrigerants are adopted at the national level.

Training, which should be both theoretical and practical, is important since it is the only feasible method to transfer to the technicians and contractors the knowledge and skills to install, maintain and repair refrigeration and air-conditioning (RAC) systems which operate with alternative refrigerants considering both technical and safety issues.

What is Certification?

Certification is the means by which a person (or enterprise), as a result of training, education, external review and assessment, receives official approval of being able to competently complete a job or task. Certification can be a legal requirement or a measure undertaken voluntarily for professional advantage. Certification schemes which are mandatory by legislation have the advantage of providing a strong incentive for technicians and enterprises to comply.

Certification does not refer to the state of legally being able to practice or work in a profession. That is normally achieved by a licensing. Usually, licences are administered by a governmental entity primarily for public protection purposes and professional associations administer certification schemes. Licencing and certification are similar in that they both require the demonstration of a certain level of knowledge or ability.

In the context of refrigeration and air-conditioning servicing, certification is important in order to verify the competence of the personnel handling equipment and refrigerants to ensure best practice and prevent leakage of the refrigerants. This has the aim of preventing the environmental and safety issues due to emission of, for example:

CFCs, HCFCs	-	High GWP, ODS
HFCs	-	High GWP
HC	-	Flammable
Ammonia	-	Mildly Flammable and Toxic
CO_2	-	High Pressure, Suffocating, Odour-free
HFO	-	Mildly flammable

The competence of the personnel handling these refrigerants is important both from the environmental perspective (e,g. ozone depletion and climate change - CFCs, HCFCs, HFCs) and for safety reasons (HC, Ammonia, CO_2, HFO). It is therefore recommended that only Certified Technicians should be allowed to install, maintain, repair, recover, and dismantle RAC systems and to purchase refrigerant.

Certification covering the refrigeration and air-conditioning sector can include certification of personnel (e.g. servicing technicians, 'refrigeration craftsmen' etc.) and certification of enterprises or companies.

Importance of Training, Assessment & Certification

Certification is an important tool and essential in monitoring the labour market according to national qualification classification systems. Through legislation, this will have the effect of reducing refrigerant emissions, and increasing energy efficiency.

Servicing Technician - In terms of the servicing technician's (or contractor) perspective, in a market place with a high degree of competition, proof of the ability to deliver higher quality work and certification can be a distinct advantage.

Customer - In terms of the customer's perspective (which can include wholesalers, distributors, end users and consumers), particularly those with significant buying power, they can require environmentally friendly and energy efficient products and high quality services.

Training, assessment and certification can protect the interests of the customer through providing services according to applicable standards (including reliability and life-time of equipment, environmental impact, preventive maintenance). This can require the certification of the personnel and companies/workshops who handle air-conditioning, refrigeration and heat pump equipment. The customer can demand a particular level of quality in terms of equipment and servicing which can be guaranteed by appropriate certification.

Refrigeration Association -
Certification can also play an important role in the sustainability of the Refrigeration Associations, as it can be an important income stream both through the training and certification processes organised by the association. The Refrigeration Association's role in certification could include:

- Working alongside the government to set the certification rules, schemes and regulations
- Providing third party monitoring to ensure the regulation is implemented correctly
- A certification body that guarantees a high standard of certification
- A certification body that issues the certification and renews periodically
- A body that maintains the lists, registers and the records of certified technicians and companies

If it is possible to limit purchasing of refrigerants to only those technicians which hold the appropriate certification, this will limit expansion, to some extent, of the unregulated 'informal sector' and this should contribute to preventing bad practices(e.g. accidents, emissions), which are more common in the informal sector.

Types of Refrigeration Associations

Certification Institutions and Refrigeration Associations can be integrated or run jointly. In larger countries with potentially higher numbers of members, larger associations can be established with single categories of members (e.g. an association with members who are all service installers).

In smaller countries it is more feasible to have smaller associations with different categories of members with similar interests together (e.g. manufacturers and service installers).

In general, members of Refrigeration Associations could include:

- Service technicians and installers,
- Building engineers,
- Designers,
- Manufacturers
- Sales personnel

Some examples of Standards for Training and Certification

A 'Standard' is a formal document developed by experts to ensure a certain uniform level of products and services. There are a number of international and regional standards covering the certification of technicians and enterprises related to refrigeration and air-conditioning. These can be used to provide a framework, reference and examples for nationally-applicable requirements which could be adopted or used in establishing or improving certification systems. Standards are voluntary tools, they have no legal standing themselves unless adopted into national legislation. Standards are, in general, commercial products available for purchase. Some examples of regional and international standards for training and certification are provided below:

- EN 13313:2010 — Refrigerating systems and heat pumps – Competence of personnel
- EN 378:2008 — Refrigerating systems and heat pumps - Safety and environmental requirements
- ISO 5149:2014 — Mechanical refrigerating systems used for cooling and heating – Safety requirements
- ISO 817:2014 — Refrigerants – Designation and Safety Classification
- ISO 17024:2012 — Conformity assessment - General requirements for bodies operating certification of persons

For an introduction and simple overview of the relevant standards, please see: *International Standards in Refrigeration and Air-conditioning: An introduction to their role in the context of the HCFC phase-out in developing countries* (UNEP, 2014).

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The Montreal Protocol Context

The Montreal Protocol

The *Montreal Protocol on Substances that Deplete the Ozone Layer* has been very successful in phasing out the production and consumption of some 100 ozone depleting substances, which include chlorofluorocarbons (CFCs), HCFCs, halons, methyl bromide, carbon tetrachloride and methyl chloroform.

As of today, the Parties to the Montreal Protocol have phased out about 98% of the consumption of ODS compared to pre-protocol levels. Under this treaty, developing countries (referred to as Article 5 countries) and developed countries have equal but differentiated responsibilities, but importantly, both groups of countries have binding, time-targeted and measurable commitments. In 2009, the Montreal Protocol became the first treaty to achieve universal ratification by all 197 United Nations Member States.

In 2007, at the 20th anniversary meeting of the Montreal Protocol, a historic decision was taken to accelerate the Montreal Protocol's phase-out schedule for the production and consumption of HCFCs. HCFCs, such as HCFC-22, which is widely used in the refrigeration and air-conditioning sector, are thus in the process of being phased-out in developing countries by 2030, with a small allowance for servicing thereafter. Please see Table below for details.

HCFCs were introduced in the 1990s as alternative chemicals to CFCs and added to the list of substances controlled by the Montreal Protocol. It was acknowledged at the time that these chemicals, with considerably lower ODPs, were transitional and their production and consumption were also to be phased out under the Montreal Protocol. Importantly, many HCFCs have high global warming potentials (of up to 2000 times that of carbon dioxide). Therefore, the HCFC phase-out will result not only in a significant reduction in ozone depletion but also in global warming, provided that low-GWP alternatives are adopted and ODS-reliant equipment is installed, maintained and serviced in a manner that prevents leakages and promotes maximum energy efficiency.

Schedule for Article 5 (developing) countries phase-out for production and consumption of HCFCs.

Deadline	Reduction step
By 2013	Freeze HCFC consumption at base level (average of 2009-2010)
By 2015	Reduction of HCFC consumption by 10%
By 2020	Reduction of HCFC consumption by 35%
By 2025	Reduction of HCFC consumption by 67.5%
By 2030	Total phase-out
2030 - 2040	2.5 % of baseline averaged over 10 years (2030-2040) allowed, if necessary, for servicing of refrigeration & air-conditioning equipment until 2040

HCFC Phase-Out

Through their commitments under the Montreal Protocol, developing countries in implementing the accelerated phase-out of HCFCs, require a shift to alternative technologies and refrigerants. This transition to ozone- and climate-friendly options is being financially and technically supported by the Montreal Protocol's Multilateral Fund, through the preparation and implementation of so called 'national HCFC Phase-out Management Plans' (HPMPs) for developing countries.

It is important to note that the Parties to the Montreal Protocol directed the Multilateral Fund, when providing this financial assistance, to focus on, *inter alia,* substitutes and alternatives that minimise other impacts on the environment, including on the climate, taking into account global warming potential, energy use and other relevant factors.

While the phase-out of HCFCs presents developing countries with a good opportunity to adopt ozone and climate-friendly technologies and policies, is not one without significant challenges.

Most of the refrigerants which were commonly used in the refrigeration and air-conditioning sectors, such as CFCs and HCFCs, have characteristics, both physical and chemical, which made them particularly suitable for refrigeration and air-conditioning applications. They possess particular thermodynamic characteristics that make them efficient refrigerants, but importantly these chemicals are generally non-flammable, non-toxic and relatively unreactive. Therefore in general, the refrigeration and air-conditioning systems that were designed to use CFCs and HCFCs and the approach taken by installers and servicing technicians did not place great

emphasis on safety issues due to the nature of the refrigerants used. With the completion of the phase-out of CFCs and the ongoing phase-out in the production and consumption of HCFCs under the Montreal Protocol, there is a need to adopt alternative non-ozone depleting alternatives. Some of these alternatives are similar in properties to the chemicals they replace (such as HFCs), but others (such as hydrocarbons) have characteristics that are considerably different. Many of the alternatives, especially those with lower GWP, demand a greater attention to safety than that required for 'ordinary' HCFC and hydrofluorocarbon (HFC) refrigerants. These alternatives can be flammable, have higher toxicity or operate at substantially higher pressures.

The role of the Servicing Sector in HPMPs

Many developing countries, particularly low volume consuming countries (LVCs), do not manufacture ozone depleting substances and their approved HPMPs place an important priority on achieving reductions in HCFC consumption through addressing the refrigeration servicing sector. It is therefore important that activities are prioritised that promote the reduction of emissions of HCFCs and other refrigerants and at the same time maximise energy efficiency.

While it could be expected that refrigerant leakage and increased energy efficiency could be achieved through purchase of more advanced technology and higher-quality components, significant reductions in direct emissions and indirect emissions (such as through energy efficiency gains) can be achieved through the best operation of a system, resulting from proper assembly, installation, charging and maintenance. Servicing of refrigeration equipment can have a measurable impact on indirect emissions. For a comprehensive overview please see: *Minimizing Adverse Climate Impact of HCFC Phase-Out in the Refrigeration Servicing Sector, (UNEP, April 2014).*

With the ambitious HCFC phase-out schedules for developing countries and the need to achieve both ozone and climate benefits from this phase-out, while at the same time addressing alternative refrigerants, many of which have characteristics that demand greater attention to safety, developing countries face both a great opportunity and a considerable challenge.

In developing counties therefore, particularly where the reductions in HCFC consumption is prioritised in the servicing sector, there is a great need to have refrigeration and servicing technicians who are well trained and skilled to enable the required efficiencies to be best attained. Certification of the relevant technicians and enterprises can go a long way in helping to achieve these goals.

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A Glimpse at Certification around the Globe

There are significant differences around the world in terms of the existence, modalities and levels of certification for technicians and enterprises involved in the installation and servicing of refrigeration and air-conditioning equipment. While a comprehensive overview and analysis of global certification schemes is beyond the scope of this publication, this short chapter provides a 'snapshot view' briefly summarising a number of existing certification schemes and highlighting some interesting features.

While in general, refrigeration and air-conditioning technician certification schemes are significantly more established and administered in developed countries, both at national and regional levels, there are a number of operational certification schemes in developing countries. The examples below highlight some of the features and characteristics of such schemes in both developed and developing countries. The proceeding chapters provide a selection of more specific examples including some describing implementation of national certification and training schemes and others providing some specific details of requirements and recommendations.

In Australia, technicians who operate refrigeration and air-conditioning equipment (as well as the automobile industry operating on mobile air-conditioning) are required to hold a *Refrigerant Handling License* and those that purchase (as well as possess and dispose of) refrigerants require a *Refrigerant Trading Authorization*. The system is administered by the *Australian Refrigeration Council Ltd.* on behalf of the Australian Government.

Interesting Highlight: *Administered by a private organisation.*

In China, the operation and monitoring of the certification systems for refrigerant servicing technicians is the responsibility of the Ministry of Human Resources and Social Security (MHRSS). The Foreign Economic Cooperation Office (FECO) / Ministry of Environmental Protection (MEP) recently completed a feasibility study on updating China's existing qualification authentication systems aiming to cover good practices during servicing and maintenance, as well as to cover how to handle the new generation of refrigerants which can be flammable, toxic or with higher working pressure. In consultation with MHRSS, FECO/ MEP signed an agreement with the Vocational Training and Qualification Certification Association of China in October 2013 for the study of the implementation of the current certification system, and later for the development of the certification syllabus

as well as the how to build the delivery capacity of various training institutes. Following consultation, it was noted that being aware of the presence of millions of servicing technicians and thousands of training and certification centres in China, the upgrading of the certification system has to be treated carefully with the aim of making the system feasible and sustainable. For servicing enterprises involved in industrial and commercial refrigeration and air-conditioning (ICR) equipment servicing, the China Refrigeration and Air-Conditioning Industry Association and China Association of Equipment Management have been jointly implementing a voluntary Qualification Certificate System for these servicing companies since 2006. As of August 2015, around 1400 servicing companies have been certified under this scheme, and it is well accepted by the refrigeration marketInteresting

Interesting Highlight: A number of different certification practices exist within China. Under one system, the technicians are encouraged to receive their qualification certificates before they are allowed to enter the refrigeration servicing sector as technicians. Under another system, the technicians are required to have compulsory certificates or called permit to be qualified to work in legally-defined, specialised sectors due to the nature of the safety concerns.

In the European Union (EU), there are several European standards and regulations that control certification, (see examples below), including the EU "F-Gas" Regulation No 517/2014. This regulation, which covers all 28 EU member states, includes specifications required for personnel covering a large variety to tasks and equipment related to the refrigeration and air-conditioning sector.

Interesting Highlight: *A regional regulation which is specifically implemented into relevant national legislation.*

In Japan refrigeration and air-conditioning technicians are required to hold a *Refrigeration Safety Manager Certificate*. This certification is required by law (*the High Pressure Gas Safety Act and the Refrigeration Safety Regulations*). The Japan Society of RAC Engineers also provides additional certification including certification focusing on refrigerant leak prevention.

Interesting Highlight: *There are three categories of certification (Refrigeration Safety Manager Certificate) depending on the equipment type and capacity.*

In Saint Lucia, technicians are required to complete and successfully pass a training and certification course entitled: 'Good Refrigeration and Air-conditioning Management Practices, Recovery, Recycling and Retrofitting and Alternative Technologies'. Candidates must have 3-5 years experience or have a certificate in refrigeration from a recognised institution. The course and assessment runs for six days with an examination and practical test. The fee for the course is $30. Successful certified technicians receive a certificate and an identification card. Unsuccessful technicians are issued only with a certificate of participation and are required to repeat the entire course and examination.

Interesting Highlight: *The recognised implementing body for the training and certification course and issuing the ID cards/certificates is the Saint Lucia National Ozone Unit (Ministry of Sustainable Development, Energy, Science and Technology).*

In South Africa there is a national standard (SANS 10147) which, *inter alia*, requires that refrigeration and air-conditioning technicians involved in servicing and handling of refrigerants have to be registered as being competent in their specific fields. The scheme is implemented by the South African Qualification & Certification Committee.

Interesting Highlight: *The national standard requiring registration is under the country's Occupational Health & Safety Act.*

In the USA, the Environmental Protection Agency (EPA) established a mandatory certification programme. Refrigeration and air-conditioning technicians are required to pass an EPA approved test implemented by an approved certifying organisation (if the technician is not under close and continual supervision from a certified technician). Some states and local jurisdictions have specific licensing and certification requirements. There also exists in the US a number of voluntary certification programmes.

Interesting Highlight: *The mandatory certification programme applies to the handling of CFCs and HCFCs and is likely to be extended to HFCs.*

In Zambia, the ODS control regulations, which are under the Environmental Management Act of 2011, apply to the servicing of refrigeration and air conditioners as well as people or institutions using controlled substances. The corresponding regulations include specific guidelines for technicians in the handling of ozone depleting substances including on forbidding venting and not retrofitting to HCFCs. They specify that certification is required for the servicing of products or technology that contains or uses ODS. If the technician is required to handle ODS, a request is made to the Zambia Environmental Management Agency with a certificate from the Vocational Training College which is overseen by the Government of the Republic of Zambia with assistance of GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit). If approved, a permit to handle refrigerants is issued.

Interesting Highlight: *The scheme relies on close cooperation between the National Ozone Unit, the Refrigeration and Air-conditioning Association of Zambia (RAAZ) and the Vocational Training Institutions.*

Permit to handle controlled ODS (Zambia)

Certification for Refrigeration and Air-conditioning Technician, Advanced (Zambia)

More information on certification systems and global examples can be found in: Qualification and Certification of Refrigeration Technicians, 28th Informatory Note on Refrigeration Technologies (September 2015) International Institute of Refrigeration (IIR). www.iifiir.org (membership required).

Example 1: Certification Programme for Technicians in Pacific Island Countries

For the Pacific Island Countries, the training and certification of refrigeration and air-conditioning servicing technicians is provided by the Australia Pacific Technical College (APTC).the Australia Pacific Technical College (APTC).

APTC is an Australian Government initiative which was announced at the Pacific Islands Forum in October 2006. The APTC is funded by the Australian Government and managed through the Department of Foreign Affairs and Trade - Australia Aid. The APTC was designed as a centre of training excellence to build skills and qualifications. APTC has campuses in five countries: Fiji, Papua New Guinea, Samoa, the Solomon Islands and Vanuatu.

The Samoa campus provides training and certification in refrigeration and air-conditioning.

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Certificate III Refrigeration and Air-Conditioning

The Certificate III in Engineering - Mechanical Trade (Refrigeration & Air-Conditioning) course is designed to offer students in these Pacific Island Countries the opportunity to further develop their skills and experience within the refrigeration and air-conditioning industry and obtain an Australian qualification. The Australian Government subsidises the cost of the course including materials and consumables.

The Certificate III in Engineering - Mechanical Trade (Refrigeration & Air-Conditioning) develops the skills needed to work as a qualified refrigeration and air-conditioning technician. The programme is designed to provide refrigeration and air-conditioning training in:

- Installation
- Servicing
- Repairs

Course duration depends upon the previous skills possessed by students. In general courses are full-time and take over 20 weeks to complete.

Course Content

The Certificate III in Engineering - Mechanical Trade (Refrigeration & Air-Conditioning) will cover the following units of competency:

- Perform engineering measurements
- Undertake manual handling,
- Perform computations
- Perform electrical/electronic measurement
- Apply principles of OHS in the work environment
- Perform emergency first aid
- Plan to undertake a routine task
- Use hand tools
- Plan a complete activity
- Use power tools/hand held operations
- Apply quality systems
- Shut down and isolate machines/ equipment
- Apply quality procedures
- Install pipework and pipework assemblies
- Organise and communicate information
- Dismantle, replace and assemble engineering components
- Work with others in a manufacturing, engineering or related environment
- Service and repair domestic and light commercial refrigeration and air-conditioning equipment
- Interact with computing technology
- Test, recover, evacuate and charge refrigeration systems
- Assist in the provision of on the job training
- Participate in environmentally

sustainable work practices
- Maintain and repair commercial and/or industrial refrigeration and/or air-conditioning controls
- Maintain and repair commercial air-conditioning systems and components
- Perform brazing and/or silver soldering
- Maintain and repair central air handling systems
- Interpret technical drawing
- Service and repair commercial refrigeration
- Install refrigeration and air-conditioning plant and equipment
- Maintain, repair/replace and adjust refrigerant flow controls and associated equipment
- Disconnect/reconnect fixed wired equipment up to 1000Vac/1500Vdc
- Fault find/repair electrical equipment/components up to 1000Vac/1500Vdc
- Terminate and connect electrical wiring

Entry Requirements

- Prospective Pacific Island students for the certification course are required to be currently employed in the refrigeration and air-conditioning industry and/or hold a local qualification.
- The programme is also offered to graduates of local Technical Vocational Education & Training programmes with limited or no work experience.
- Applicants need to complete literacy and numeracy assessments an entry level knowledge and skills assessment.

Scholarships

The scholarship programme provides for the possibility of financial assistance to Pacific Islanders for full or partial scholarship assistance.

Example 2: Certification Programme for Technicians in Malaysia

Malaysia has conducted training and certification of refrigeration and air-conditioning servicing technicians since 2007 and training of technicians in the mobile air-conditioning sector (MAC) since 2004. This training was carried out under the Malaysia's National CFC Phase-Out Plan (NCFCP). The technician certification programme is implemented in line with the requirements under the *Environmental Quality Act (Refrigerant Management*) of 1999.

The objectives of the training programme are to educate and to certify qualified and competent technicians to carry out good practices in the refrigeration and air-conditioning servicing sector. A training manual for technicians on *Good Practices in Refrigeration and Air-Conditioning Sector* was published and is to be used during the training courses.

Initially the training for refrigeration and air-conditioning servicing technicians was organised by 29 Authorised Training Centres (ATCs) throughout the country. However, more recently, to enable the country to effectively achieve its

commitments to the Montreal Protocol under the first stage of national HCFC Phase-Out Management Plan (*Stage 1 HPMP*), which runs from 2012 to 2016, the number of ATCs was increased to 41. Of these, 30 ATCs are hosted in government institutes and 11 are in the private sector. All ATCs were provided with at least one recovery and recycling machine setup and with basic tools to run the programme. A few training courses for master-trainers including a regional master trainer programme were conducted for the ATCs.

The ATCs were appointed by the Department of Environment (DOE) through cooperation with the private sector, particularly the refrigeration and air-conditioning service workshops and with the Malaysian Government through the Manpower Department, the Ministry of Youth and Sports and the Ministry of Rural and Regional Development.

To date more than 4000 technicians were certified by the Malaysian the Department of Environment under this programme.

Theoretical examination

Practical examination

Example 3: Training and Certification in the Former Yugoslav Republic of Macedonia

The legal basis for the Training and Certification scheme in the Former Yugoslav Republic of Macedonia is the Law on Environment (amended in March 2014). The provision on exam performance on certification/ licensing will enter into force from the 1st of January, 2016. The Ministry of Environment and Physical Planning will establish and maintain an official register of issued, withdrawn and extended licenses.

Article 22-b of the amended Law on Environment designates that a 'legal and/or natural person' who manages refrigerants should posses a licence for refrigerant management including equipment containing refrigerants. The licences will be issued in categories depending on the refrigerant types, procedure applied for the equipment servicing and installation and the manner of recovery and recycling. The article also stipulates the following:

- Minimum conditions to be met by the persons applying for a licence
- Conditions to be met by the persons applying for the examination
- Method of a certificate issuance
- Method of training performance
- Specifications of development, verification and conducting of assessment examination

Licensed 'legal or natural persons' are defined as those that meet the following conditions:

Legal person:

- Posses space and equipment for handling of refrigerants and equipment containing refrigerants
- Have at least one employee who has passed the exam for handling refrigerants and/or products containing refrigerants

Natural person:

- Posses space and equipment for handling of refrigerants and equipment containing refrigerants
- Holds registration in accordance with the Law on Trade Companies
- Has passed the examination for handling refrigerants and/or products containing refrigerants.

Examination

The following conditions should be met by persons applying for the examination for handling refrigerants and/or products containing refrigerants:

- Persons are Macedonian citizens
- Persons having vocational secondary school or university diploma
- Persons having certificate of completion of training for the handling of refrigerants

The examination will be divided in two parts: a theoretical part, with an electronic written test, and a practical part, with practical example exercises and related questions. The questions for the theoretical and practical examples are prepared by experts and/or professors with at least five years of experience in the field of refrigeration and air-conditioning. A *Commission*, comprising Ministry of Environment and Physical Planning representatives nominated by the Minister of Environment and experienced professionals and university professors having at least 10 years experience in the field of refrigeration and air-conditioning, will verify the sets of questions.

Licenses

The Licenses are to be issued by the Minister of Environment and Physical Planning. Licenses are valid for five years, with the possibility for extension of additional five years. The license will be issued in several categories. The categories depend on the refrigerant type and procedures that are applied for installation and servicing of the equipment, including the manner of refrigerant collection, recovery and recycling.

Training

To date, refrigeration and air-conditioning technician training has been performed by the Ministry of Environment and Physical Planning/Ozone Unit. According to the new amended Law on Environment, the training will be performed by the authorised persons/ institutions authorised by the Ministry. They shall meet the following criteria :

- Possess equipment for practical training
- Develop a programme for training on proper refrigerants handling, servicing, recovery, recycling
- Employ at least one person with university diploma and five years of

experience in the field of handling of refrigerants and equipment containing refrigerants.
- The programme is approved by the four-member Commission established for this purpose
- Following an on-site visit the Minister of Environment and Physical Planning authorises perform the training activities to be performed.

The 'Rulebook' on the nature and content of the training programme on proper refrigerant handling, servicing, recovery and recycling. It also specifies it also specifies the conditions to be met by the authorised persons that perform training. This provides the scope of the training as well as the manner of organisation of the training. The general topics to be covered by the training programme are as follows:

1. Introduction
   - Ozone layer, chemistry of ozone layer depletion
   - Refrigerants impact to the global warming
2. Basic refrigeration elements
   - Introduction
   - Refrigerants characteristics
   - Cooling cycle
3. Good servicing practice
   - System vacuuming
   - System filling
4. Refrigerant recovery and recycling
   - Safe refrigerants handling
   - Recovery and recycling equipment
   - Methods for refrigerants recovery
   - Methods for refrigerants recycling
5. Alternatives to the existing refrigerants and technologies
   - Retrofitting procedures

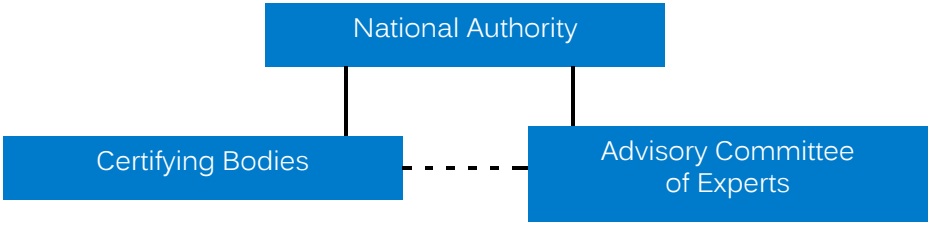
The 'Rulebook' also contains a list of the equipment as a minimum required for servicing of equipment, recovery and recycling of the refrigerants:
- Manifold with pressure gauge for high and low pressure and contolling valves (high and low pressure valves, vacuum pump valve and valve for connecting the refrigerant cylinder or recovery machine) complete with hoses with ball valves
- Vacuum pump
- Recovery machine for evacuation of refrigerant
- Refrigerant recovery cylinder with valves for liquid and vapour phase
- Electronic scale
- Small demonstration cooling system including cooling compressor, service valve on the suction and discharge side, oil separator, refrigerant condenser, refrigerant receiver, filter - dryer, refrigerant sight glass with moisture indicator, solenoid valve, refrigerant evaporator, service connection, drop eliminator, brazing equipment - oxygen and acetylene cylinder complete with pressure reducers, hoses and torch, nitrogen cylinder complete with pressure reducer and adapt connection for refrigerant hoses.

Test rig for training

Example 4: Requirements for Training and Certification -Example of Implementation in the EU

This section is an example guideline based on that used for implementation in the European Union to establish a certification scheme, outlining the main general recommended requirements.

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 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).

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 authorised 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.

Maintenance Technician

The Maintenance Technician is employed/contracted by the operator/ owner of a refrigeration system and is involved in operation, maintenance and leakage control of the operator's working refrigeration system used for refrigeration, air-conditioning and heat-pump applications. The Maintenance Technician works in accordance with the procedures of the operator's company that employs him.

The Maintenance Technician shall have the necessary training and knowledge to achieve competence for a number of tasks including technical reports, monitoring and fault finding. The full range of these tasks are indicated in Annex I.

Refrigeration Craftsman

The Refrigeration Craftsman is involved in installation, commissioning, inspection, testing, operation, maintenance, repair and de-commissioning 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. These are indicated in Annex I.

Certification procedure

Proof of proficiency in the relevant tasks for Maintenance Technicians and Refrigeration Craftsmen (as detailed in Annex I) 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.

See Annex III - Minimum requirements for certification and certification schemes for alternative Low GWP refrigerants for more details.

Requirements for the Certification of Companies

Some countries offer certification for companies. A company/workshop seeking certification should fulfil the following requirements:
The company:

- Has to officially state its commitment to comply with the obligations of the relevant Regulation,
- Has to have at least one person with a valid certificate to assess the competence corresponding to the activities carried out and a current list of the certified personnel shall be supplied.
- Has the necessary equipment and tools to ensure, in particular, the safe handling of refrigerants (see Annex 2 for an informative list)
- Has the necessary refrigerant control administration and documentation system; a refrigerant register shall be supplied,
- Has the necessary work procedures, leakage control, testing, recovery, data collection, log books of equipment serviced, work reports, etc.
- No company shall be eligible for certification without having in full time employment, one or more Refrigeration Craftsmen.

The certified company/workshop is involved in installation, commissioning, inspection, testing, operation, maintenance, repair and de-commissioning of any new, repaired, working or redundant refrigeration systems, and their parts, used for refrigeration, air-conditioning and heat-pump applications. The certified company will be eligible to take delivery of refrigerant.

Where a certified Refrigeration Craftsman is self-employed, he/she is the legal entity responsible for his/her activities and will have to be certified as such.

Where a maintenance department of an operator company or subsidiary of a larger operator corporation carries out the tasks detailed above and employs Refrigeration Craftsmen, that department/subsidiary shall apply for certification and comply with all the criteria detailed above. The certification shall apply to the department/subsidiary only and not to the parent company. Where an operator, operator company or in-house maintenance department employs certified Maintenance Technicians to carry out the non-intrusive maintenance tasks and authorised leakage checking, but employs no Refrigeration Craftsmen, this company shall become registered on an operator company register to be held by the national Certifying Bodies. The operator company shall not be entitled to take delivery of refrigerant.

Certification provides formal recognition of the company's competence; a company is certified as long as it continues to demonstrate that its competence is maintained.

After a certificate has been issued, the Certifying Bodies shall inspect the company on a regular basis to ensure the certificate can be renewed following a successful visit and report of the Certifying Body's inspector. The auditing will concentrate on competence of personnel, inspection of equipment, equipment calibrating, review of management system, records, relevant documentation and compliance with the work procedures.

The Certifying Bodies will issue requirements and procedures to be followed by companies that are not complying with any of the criteria.

When the Certifying Body declines to renew the certification after an audit, due to non-compliance with the criteria, the company concerned has to file a new application.

Similarly the operator, operator company or in-house maintenance department registered on the operator company register will be audited by the Certified Bodies before the renewal of its registration.

Table 1: Summary of certification

	Installation, servicing, maintenance	Repair	Decommissioning	Leakage checking	Recovery
Stationary Refrigeration, Air-Conditioning and Heat Pump equipment					
Refrigerated trucks & trailers					
Air-conditioning in road vehicles Directive 2006/40					 *
Air-conditioning in road vehicles (outside Directive 2006/40)					 **

 Personnel

 Company

* Personnel must be appropriately qualified (i.e. hold at least a training attestation)
** Personnel must be appropriately qualified, no formal training attestation required

Example 5: Requirements on Training and Certification in the Philippines

Assessment and Certification in the Philippines is provided through the Technical Education and Skills Development Authority (TESDA) as mandated by law. In early 2000 the inclusion of the Montreal Protocol issues were integrated in the Training standards and in the assessment and certification of the Heating, Ventilation, Air-Conditioning and Refrigeration Sector.

The specifications and definitions are as follows:

Certified Technician - a technician who has successfully completed and passed the competency assessment given by TESDA (or an accredited institution) and holds a current TESDA-issued certificate.

National Certificate (NC) – a document issued to individuals who have achieved all the required units of competency of a national qualification defined under the promulgated Training Regulations.

National Certification II (NC II) - a technician certification wherein workers at this level prescribed range of functions involving known routines and procedures, where clearly identified choices and limited complexity applies. Work involves some accountability for the quality of outputs while applications at this level may involve individual responsibility or autonomy or working with others as part of a team or group.

The RAC SERVICING (DomRAC) NC II Qualification consists of competencies that a person must achieve to enable him/her to install, service, maintain, troubleshoot and repair domestic air-conditioning and refrigeration units.

National Certification III (NC III) - Package Type Air-Conditioning (PACU)/ Commercial Refrigeration (CRE) is a technician certification wherein workers on this level perform a wide range of skilled operations at a high level of competence involving known routines and procedures. The work context involves some complexity in the extent and choice of options available, understanding the work processes, equipment to and material to be used.

Applications at this level may involve individual responsibility or autonomy and/or may involve some responsibility for others. Participation in teams including team or group coordination may be involved.

RAC SERVICING (ComRAC) NC III Qualification consists of competencies that a person must achieve to enable him/her to install, service, maintain, troubleshoot and repair as well as to perform start-up, testing and commissioning of Package Type Air-Conditioning Unit (PACU)/Commercial Refrigeration Equipment (CRE).

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Assessment and Certification of Technicians

To attain the National Qualification of RAC servicing, the candidate must demonstrate compliance covering all units of competency of a particular qualification. Successful candidates shall be awarded a National Certificate signed by the TESDA Director General and will be included in the Registry of Certified Workers.

The Registry of Certified Workers will:

- Provide information on the pool of Certified workers for certain occupations nationwide
- Facilitate verification of the certification status of workers
- Assessment focuses of the core units of competency.

The following are qualified to apply for assessment and certification:

- Graduates of formal, non-formal and informal training, including enterprise-based training programmes ;
- Experienced workers (wage employed or self-employed)

The guidelines on assessment and certification are based on the "Procedures Manual on Assessment and Certification" and "Guidelines on the Implementation of the Philippines TVET [Technical Vocational Education and Training] Qualification and Certification System".

Example of assessment instruction for RAC Servicing (DomRAC) NC II

The qualification of RAC Servicing (DomRAC) NC II (TESDA) may be attained through demonstration of competence through a project-type assessment covering all required units of the qualification.

Assessment shall focus on the core units of competency. The basic and common units shall be integrated or assessed concurrently with the core units.

The following are qualified to apply for assessment and certification:

- Graduates of formal, non-formal and informal including enterprise based training programmes
- Experienced Workers (wage employed or self-employed)

Units of Competency covered:

- Install Domestic Refrigeration and Air – Conditioning (DomRAC) Units
- Service and maintain domestic

refrigeration and air-conditioning (DomRAC) units
- Troubleshoot and repair domestic refrigeration and air-conditioning (DomRAC) systems

SPECIFIC INSTRUCTIONS FOR THE CANDIDATE

(see Annex VI for the relevant modules used during the examination)

1. Given the necessary materials, instruments, tools and equipment candidates are required to perform the following tasks within six (6) hours in accordance with set performance criteria:
- Troubleshoot window-type air-conditioner
- Troubleshoot domestic refrigerator
- Recover and recycle refrigerant in window-type air-conditioning and refrigeration systems
- Repair and replace defective window-type air-conditioning and domestic refrigeration systems and its accessories
- Perform leak testing, vacuuming and dehydration
- Perform charging system
- Perform testing and commissioning

2. The assessment is based on the units of competency in the Training Regulations and the Evidence Plan and will focus on the evidence listed below:
- Demonstration/Observation with Oral Questioning (see Annex VII Example of a 'Rating Sheet' (Philippines))

3. Final assessment shall be the responsibility of the Accredited Assessor.

4. At the end of the assessment, the assessor shall give the candidates feedback on performance. The feedback will indicate whether the candidates are:
- Competent
- Not yet competent

The qualification of RAC Servicing (Package Type Air-Conditioning (PACU)/ Commercial Refrigeration (CRE) NC III follow the same scheme of NC II, described above.

Example 6: Minimum Requirements for Contractor Training & Certification in Low GWP Refrigerants in Europe

The increasing uptake of 'alternative refrigerants', such as hydrocarbons, ammonia, carbon dioxide, unsaturated HFCs –or HFOs- and HFOs mixtures can present additional specific challenges. The refrigeration and air-conditioning industry will have to adapt to both the technical and safety issues concerning these refrigerants. In particular, many of the alternative refrigerants have specific characteristics regarding toxicity, flammability and high pressure which are different from those used previously such as chlorofluorocarbons (CFC) and hydrochlorofluorocarbons (HCFCs). During the installation, maintenance, repair and dismantling of refrigeration and air-conditioning equipment containing or relying of such alternatives, safety and technical issues need to be carefully evaluated and considered. Certification is the best practical method to verify the competence of personnel handling refrigerants and to ensure the correct installation, maintenance, repair and dismantling of a refrigeration, air-conditioning and heat pump systems. This is all the more important when servicing technicians have to deal with refrigerants with properties that they were previously not familiar with, particularly related to safety.

Minimum requirements for training and training facilities

Training is important and it is the only effective method to transfer to the contractor the knowledge to install, maintain and repair RACHP systems containing low GWP refrigerants considering both the technical and safety issues. Additional training may be required to achieve the mandatory certification. Training should be both theoretical and practical.

For the training facilities the Air-conditioning and Refrigeration European Association (AREA) suggests that test rigs, equipment and components related to each specific alternative refrigerant are recommended to simulate best practices. Please refer to the Annex IV p.76 for more details.

Table. 3: Characteristics of alternatives to ODS

Refrigerant	Natural Refrigerants			Synthetic HFCs	
	HCs	Ammonia	CO_2	Saturated HFCs	Unsaturated HFCs (HFOs)
GWP (100 years)	++	++	++	--*	++
Flammability	--	-	++	++*	-
Toxicity	++	--	+	++	++
Pressure	+	+	--	+	+
Availability	+	+	+	++*	--
Familiarity	+	+	-	++	-

* This refers to conventional, widely used HFCs such as R-134a, R-404A, R-407A, R-410A, etc. Some saturated HFCs such as R-161 and R-152a have low GWPs, are flammable, and may not be as easily available as the common HFCs.

++ - very positive
+ - positive
- - negative
-- - very negative

Example 7: Considerations for Practical Assessments in Europe

Assessments: Practical Organisation Issues

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

- Maximum 20-25 candidates per class dependent on number of assessors
- Assessor/s should be independent and not involved in the training of the candidates (also refer to international standards)
- Multiple choice tests, between 30 and 45 questions for 60-90 minutes duration (Sample questions are provided in Annex V)
- Book, only specific technical tools such as calculator and pressure-temperature comparator allowed
- No mobile phones or cameras
- No copying or communication between candidates
- Speaking to the assessor for clarification (e.g. many candidates use different words and vocabulary to identify the same concept)
- Theoretical assessment: Pass mark above 60%
- Laboratory should be properly equipped for performing the practical tests (see Annex IV)
- Practical assessment: Pass achieved only if candidate proves competence in performing main RAC service technicians activities effectively
  - Thermodynamic parameters reading gauges and devices, temperature, pressure, sub-cooling, superheating,
  - Parameters interpretation, troubleshooting
  - Perform a leak test
  - Vacuum, charge, recovery with minimum emissions
  - System Logbook reading, understanding and competition
  - Brazing leak tight joints

Assessor Qualification and Competence

- Assessors and Trainers should hold an appropriate certificate
- Assessors should have many years of experience in the field
- Assessors should be experienced in trainee evaluation
- Please see International Standards as ISO 17024 for more details
- In order to endorse the value of the scheme and guarantee the sustainability of the certification, standards must be kept high and therefore not all candidates will pass the examination

Certificate Layout

Certificates which provide the 'proof' of certification in the competence in handling refrigerants and performing the required services can be a traditional paper document or an identity card sized document.
The certificate should include the following:

- Name of the person (company) holding the certificate, with all the necessary personal data to unequivocally determine an individual
- The dates of validity of the certificate
- The certification body issuing the certificate
- The standard, regulation under which the certificate has been issued
- A unique registration number

Examples of documents proving certification has been achieved (Italy)

It is important to note that a training course where a Participation Certificate is issued at the end without a written, oral or practical assessment which proves the ability of the service technician or the quality of the company, is ***not*** certification.

Promotion of Certification of RAC Service Technicians

The following actions may help ensure successful establishment and operation of national certification schemes:

- Certification should be made compulsory by law for every technician who is handling refrigerants
- Certification should be necessary to buy refrigerants and refrigerant-containing equipment
- Certification should be properly and publicly advertised at all levels (end-users, service companies, manufacturers, government institutions) as an added value to guarantee professionalism

Possible barriers before and after the certification should be considered, such as technicians potentially seeing certification as an added cost or 'tax' to enter the sector, or that the process may appear to be too bureaucratic to warrant engaging with.

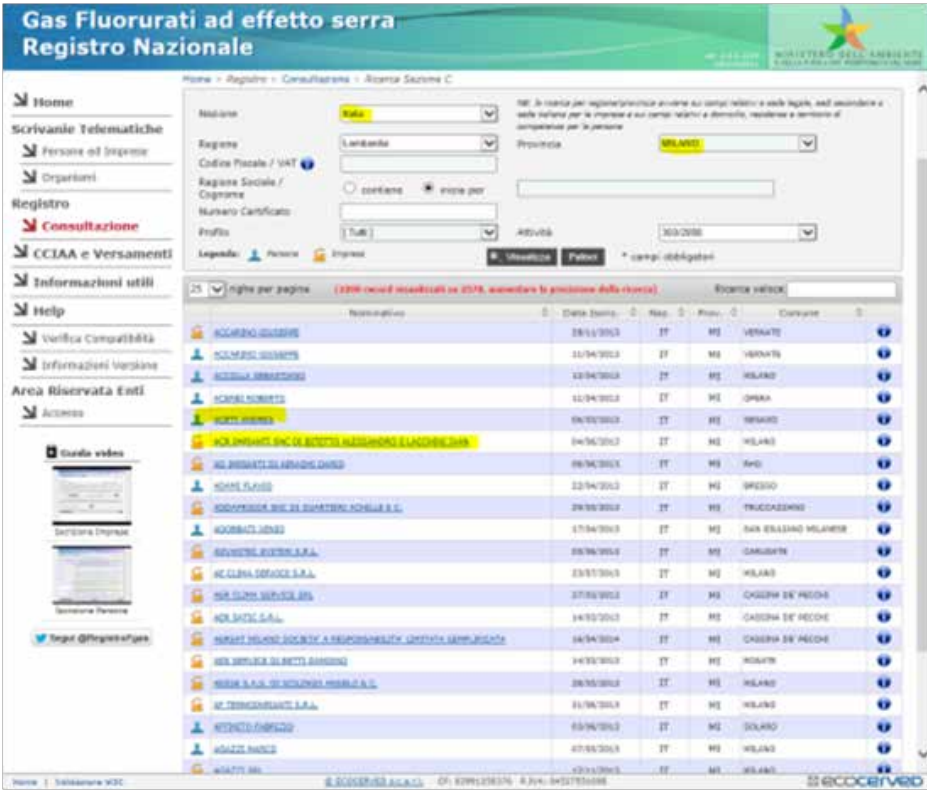
Monitoring the Results of the Certification

Monitoring systems consists of putting in place several requirements within the National Certification Scheme, these can include:

- A register of certified personnel and companies publically available online (recommended) or held by a national authority
- Regulation that only certified personnel and companies can purchase refrigerants and refrigerant containing equipment
- Regulation that only certified personnel and companies can install, repair, maintain, recover and dismantle RAC systems
- A register with the quantity of purchased and recovered refrigerants (both at a certified personnel or company level and from at the distributors) available to the authorities
- Refrigeration System Logbook containing relevant historical data of the installation, maintenance and repair available for each system (a threshold to avoid small systems, such as domestic refrigeration and air-conditioning, could be evaluated)

The above allows the checking and monitoring of the whole sector ensuring the Service Technician and the company performing competently and prevents loopholes in the certification system. Penalties should be considered to prevent infringements of the law.

It is interesting to note how certification for refrigeration and air-conditioning service technicians differs between countries in terms of the numbers of certified personnel. In Italy, for example, there are currently about 45 000 certified refrigeration and air-conditioning service technicians, in Germany and the United Kingdom 25 000 and 32 000 respectively. In Australia the number of certified technicians is around 55 000 but this includes automotive mechanics. By contrast, in the Philippines there are around 3000 certified refrigeration and air-conditioning service technicians.



Example of a national register (Italy)

Certification Costs

Certification costs vary greatly between countries - even between developed countries - as they depend on:

- Paperwork required for certification
- Registration procedure for public listings
- Organizational aspects of assessments
- Validation, confirmation procedures of the assessment from a third party

Certification normally has to be renewed periodically, preferably every 5-10 years due to technological changes in components, equipment, refrigerants, standards and regulations.

Below are some examples of prices for the certification of personnel for a single service technician.

Installer certification cost (approx. in US$ equivalent)

Australia	$ 900
Belgium	$1,400
Czech Republic	$200-300
Finland	$0 to $3,500 depending on training needs
France	$2,300-3,400
Germany	$60 for those who already hold a master craftsman's diploma or certificate of apprenticeship in air-condition technology.
Hungary	$200 up to $2,300 depending on categories and former level of certification
Ireland	Between $1,600 and $2,300
Italy	$600-700
Philippines	$30
Portugal	$850
Romania	$170
Saint Lucia	$30
Slovakia	$90+90 (training + exam and certification)
Spain	$2,300
Sweden	$800-2,900

Note: some countries include training in the certification, the costs above are for certification only for the majority of countries. Ideally, certification and training costs should be left separate.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Concluding Remarks

As has been briefly illustrated in this booklet through the examples above, both the structure and mode of establishment of certification schemes can vary between countries and regions. Establishment of certification schemes through legislation entail the government, usually the Ministry of Environment or Labour, having the commitment and willingness to do so. This will normally require cooperation with for example the Ministry of Environment, Ozone or Climate Change offices as well as cooperation on safety and labour issues, for example with the Ministry of Labour, Health and Safety or Commerce offices. Certification schemes which are mandatory by legislation have the advantage of providing a strong incentive for technicians and enterprises to comply with the necessary requirements.

Manufacturers also have a particular interest in ensuring properly skilled service technicians to provide the best product and avoid high warranty costs. The larger manufacturers which can have well established structures would be in a better to position to set up, or contribute to the set up and running of a certification scheme. The service technicians themselves in general also want to show themselves to be skilled and to prove their excellence, which is best achieved by certification.

Iit is recommended that only Certified Technicians are be allowed to install, maintain, repair, recover, dismantle RAC systems containing refrigerants and importantly that only certified technicians are permitted to purchase refrigerants. Such a measure will limit the development and expansion of the informal sector and this should contribute to preventing poor practice which in general is more common in the informal sector. The ‘Further Reading’ section and Annexes to this document provide the reader with some more detailed and specific information on the requirements of establishing a new certification scheme or to improve or update the current scheme.

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.

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UNEP. Minimizing Adverse Climate Impact of HCFC Phase-Out in the Refrigeration Servicing Sector, 9 April 2014. (document: UNEP/OzL.Pro/ExCom/72/42) available from: http://www.multilateralfund.org

Further reading

(EC) No 303/2008 of 2 April 2008 minimum requirements and the conditions for mutual recognition for the certification of companies and personnel as regards stationary refrigeration, air-conditioning and heat pump equipment containing certain fluorinated greenhouse gases

US EPA technician certification programme http://www.epa.gov/Ozone/title6/608/608fact.html

NATEX North American Technician Excellence www.natex.org

RACCA Refrigeration and Air-conditioning Contractors' Association Australia – ARC certification http://racca.asn.au/featured/slide-3-tab

IIR International Institute of Refrigeration www.iifiir.org

GIZ Green Cooling Technologies https://www.green-cooling-initiative.org/study-download/

Centro Studi Galileo Training and certification provider www.centrogalileo.it

Business Edge Ltd Training and certification provider UK www.businessedgeltd.co.uk

Air-conditioning and Refrigeration European Association AREA www.area-eur.be

Annex I

Competence of the Maintenance Technician and the Refrigeration Craftsman – Assessment Criteria

Annex 1 provides more information on the required professional qualifications and skills to work in the field of refrigeration, the result of the 3-year Leonardo Project EUR/02/C/F/NT-84604 "The Refrigeration Craftsman" (2002-2005)

The European Refrigeration Craftsman

A detailed European survey (347 questions) was organised : 355 refrigeration and air-conditioning craftsmen from 7 representative countries (DE, ES, FR, HU, NL, SE, UK) have answered a questionnaire designed to make an inventory of the tasks performed by the basic refrigeration craftsman in Europe; the questions addressed 328 activities classified in 17 chapters.

A thorough statistical analysis of the answers received was reviewed by international refrigeration experts to specify the profile of the "European refrigeration craftsman".

Annex 1 provides a list of activities that the European refrigeration craftsman has to be capable of performing - on which to prove adequate competence.

It should be used as the objective to be reached by the National RAC (refrigeration & air-conditioning – and heat pump) VET (vocational education & training) programmes.

Maintenance Technician – competence marked with (**O**)

Refrigeration Craftsmen – competence marked with (**X** + **O**)

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Job Competence		Common Activities for the Service Technician						
1.1 Basic Thermodynamics Description The "CERTIFIED PERSON" is capable of giving a theoretical explanation about a basic compression refrigerating system		Pre-assembly	Installation	Technical Reports	Commissioning	Monitoring	Fault Finding	Dismantling
Criteria		1	2	3	4	5	6	7
1.1.1	Know the basic ISO standard units as for temperature, pressure, mass, density, energy			O	X	O	O	
1.1.2	Understand basic refrigeration terms as: Superheat, High Side, Heat of Compression, Enthalpy, Refrigeration Effect, Low Side, Sub-cooling, Vapor Quality, Saturated Suction			O	X	O	O	
1.1.3	Describe the lines of a Log P/h chart of a refrigerant			O	X	O	O	
1.1.4	Use the saturation tables of a refrigerant			O	X	O	O	
1.1.5	Draw a diagram of a single compression refrigeration cycle			O	X	O	O	
1.1.6	Describe the operation and function of the main components			O	X	O	O	
1.1.7	Describe also the operation and function of the following components used in a refrigeration system:							
1.1.8	- Valves (ball valves, diaphragms, globe valves, relief valves)	X	X	O	X	O	O	
1.1.9	- Temperature and Pressure Controls	X	X	O	X	O	O	
1.1.10	- Sight Glasses and Moisture Indicators	X	X	O	X	O	O	
1.1.11	- Defrost Controls	X	X	O	X	O	O	
1.1.12	- System Protectors	X	X	O	X	O	O	
1.1.13	- Measuring Devices as manifold thermometer		X	O	X	O	O	
1.1.14	- Oil Control Systems	X	X	O	X	O	O	
1.1.15	- Receivers	X	X	O	X	O	O	
1.1.16	- Liquid and Oil Separators	X	X	O	X	O	O	
Results	A theoretical report explaining the functioning of a refrigeration system to the client/end user. A detailed report about the operation of the refrigeration system with conclusions/recommendations.							

Job Competence		Groups of Activities						
2.1 Component: Compressor Description The CERTIFIED PERSON is capable of installing, putting into operation and carrying out the maintenance of reciprocating, screw and scroll compressors, single and two stage		Pre-assembly	Installation	Technical Reports	Commissioning	Monitoring	Fault Finding	Dismantling
Criteria		1	2	3	4	5	6	7
2.1.1	Explain the function of the compressor in the system	X	X	O	X	O	O	X
2.1.2	Explain the functioning of the compressor	X	X	O	X	O	O	
2.1.3	Explain the lubricating system of the compressor		X	O	X	O	O	
2.1.4	Explain the capacity control of the compressor		X	O	X	O	O	
2.1.5	Install the above mentioned different kinds of compressors incl. control and safety equipment	X	X				X	
2.1.6	Adjust the safety and control switches	X	X	O	X	O	O	
2.1.7	Adjust the suction and discharge valves	X	X	O	X	O	O	
2.1.8	Check the oil return system	X	X	O	X	O	O	
2.1.9	Start up and shut down the compressor(s)	X	X	O	X	O	O	X
2.1.10	Make measurements during operation of compressor		X	O	X	O	O	
2.1.11	Check the good working condition of the compressor		X	O	X	O	O	
2.1.12	Write a report about the condition of the compressor		X	O	X	O	O	
2.1.13	Take the decision to repair the compressor			O	X	O	O	
2.1.14	Take the decision to replace the compressor			O	X	O	O	
Results	A perfectly working compressor contributes to a low energy consumption and a reliable performance as planned for the client.							

Job Competence		Groups of Activities						
2.2 Component: Condenser Description The CERTIFIED PERSON is capable of installing, putting into operation and carrying out the maintenance of air cooled and water cooled condensers.		Pre-assembly	Installation	Technical Reports	Commissioning	Monitoring	Fault Finding	Dismantling
Criteria		1	2	3	4	5	6	7
2.2.1	Explain the function of the compressor in the system	X	X	O	X	O	O	X
2.2.2	Explain the functioning of the compressor	X	X	O	X	O	O	
2.2.3	Explain the lubricating system of the compressor		X	O	X	O	O	
2.2.4	Explain the capacity control of the compressor	X	X				X	
2.2.5	Install the above mentioned different kinds of compressors incl. control and safety equipment	X	X	O	X	O	O	
2.2.6	Adjust the safety and control switches	X	X	O	X	O	O	
2.2.7	Adjust the suction and discharge valves		X	X	X	X	X	
2.2.8	Check the oil return system		X	O	X	O	O	X
2.2.9	Start up and shut down the compressor(s)		X	O	X	O	O	
2.2.10	Make measurements during operation of compressor		X	O	X	O	O	
2.2.11	Check the good working condition of the compressor			O	X	O	O	
2.2.12	Write a report about the condition of the compressor			O	X	O	O	
2.2.13	Take the decision to repair the compressor			O	X	O	O	
2.2.14	Take the decision to replace the compressor			O	X	O	O	
Results	A perfectly working condenser contributes to a low energy consumption and a minimum of heat load to the environment.							

Job Competence		Groups of Activities						
2.3 Component: Evaporator Description The CERTIFIED PERSON is capable of installing, putting into operation and carrying out the maintenance of air cooled and liquid cooled evaporators.		Pre-assembly	Installation	Technical Reports	Commissioning	Monitoring	Fault Finding	Dismantling
Criteria		1	2	3	4	5	6	7
2.3.1	Explain the function of the evaporator in the system	X	X	O	X	O	O	X
2.3.2	Explain the working of the evaporator	X	X	O	X	O	O	
2.3.3	Explain the several ways of defrosting the evaporator			O	X	O	O	
2.3.4	Adjust an evaporating pressure control of the evaporator		X	O	X	O	O	
2.3.5	Install the above mentioned different kinds of compressors incl. control and safety equipment	X	X				X	
2.3.6	Adjust the safety and control switches	X	X	O	X	O	O	
2.3.7	Check the liquid and suction pipelines in the correct position	X	X	O	X	O	O	
2.3.8	Check the hot gas defrost pipeline	X	X	O	X	O	O	
2.3.9	Adjust evaporation pressure regulation valve		X	O	X	O	O	
2.3.10	Start up and shut down all kinds of evaporators		X	O	X	O	O	X
2.3.11	Make measurements during operation of the refrigeration system		X	O	X	O	O	
2.3.12	Check the good working condition of the evaporator		X	O	X	O	O	
2.3.13	Check the surface of the evaporator			O	X	O	O	
2.3.14	Write a report about the condition of the evaporator			O	X	O	O	
2.3.15	Take the decision to repair a part of the evaporator			O	X	O	O	
2.3.16	Take the decision to replace the evaporator			O	X	O	O	
Results	A perfectly working evaporator contributes to a low energy consumption and a reliable performance as planned for the client							

Job Competence		Groups of Activities						
2.3 Expansion valve & other components Description The CERTIFIED PERSON is capable of installing, putting into operation and servicing Thermostatic Expansion Valves (TEV) and other components.		Pre-assembly	Installation	Technical Reports	Commissioning	Monitoring	Fault Finding	Dismantling
Criteria		1	2	3	4	5	6	7
2.4.1	Explain the function of a TEV in the system	X	X	O	X	O	O	X
2.4.2	Explain the working of a TEV in the system	X	X	O	X	O	O	
2.4.3	Explain the functioning of different kinds of expansion regulators		X	O	X	O	O	
2.4.4	Install all kind of components in a RAC system, as valves, receivers, separators, etc	X	X				X	
2.4.5	Adjust a mechanical and electronic TEV		X	O	X	O	O	
2.4.6	Adjust mechanical and electronic thermostats	X	X	O	X	O	O	
2.4.7	Adjust mechanical and electronic pressure limiters	X	X	O	X	O	O	
2.4.8	Check the functioning of an oil separator	X	X	O	X	O	O	
2.4.9	Check (level) a liquid receiver	X	X	O	X	O	O	
2.4.10	Check a sight glass and the condition of the refrigerant	X	X	O	X	O	O	
2.4.11	Check the condition of a filter dryer	X	X	O	X	O	O	
2.4.12	Check the functioning of a solenoid valve	X	X	O	X	O	O	
2.4.13	Check the gland of a stop valve	X	X	O	X	O	O	
2.4.14	Adjust a pressure regulated valve	X	X	O	X	O	O	
2.4.15	Write a report about the condition of these components		X	O	X	O	O	
2.4.16	Take the decision to repair part of these components			O	X	O	O	
2.4.17	Take the decision to replace components			O	X	O	O	
Results	A perfectly working TEV and other components contribute to a low energy consumption and a good performance as planned for the client. A perfectly fitted and adjusted component contributes to the optimal working of the system.							

Job Competence		Groups of Activities					
3.1 Piping Description The CERTIFIED PERSON is capable of building a leak tight piping system in a refrigeration installation.		Pre-assembly	Installation	Technical Reports	Commission-	Monitoring	Fault Finding
Criteria		1	2	3	4	5	6
3.1.1	Work with copper tubes from a diameter of ¼" (6mm) till 7/8" (28mm) and from 1"3/8 (35 mm) till 2"1/8 (54 mm).	X	X				X
3.1.2	In particular in the following ways:						
3.1.3	- flared joints diameter of ¼"(6mm) till 3/4" (18mm)	X	X				X
3.1.4	- bends of copper tubes diameter of ¼"(6mm) till 3/4" (18mm).	X	X				X
3.1.5	- fixed connections by hard soldering diameter ¼" (6mm) till 7/8" (28mm) and from 1"3/8 (35 mm) till 2"1/8 (54 mm).	X	X				X
3.1.6	Make hard soldering joints for the following connections:						
3.1.7	• copper-copper	X	X				X
3.1.8	• copper-steel	X	X				X
3.1.9	• copper-brass	X	X				X
3.1.10	Install valves in the correct position	X	X				X
3.1.11	Install flexible insulation	X	X	X	X	X	X
3.1.12	Check the condition of insulation	X	X	X	X	X	O
3.1.13	Make / check pipe- and component supports	X	X	X	X	X	O
3.1.14	Perform a strength pressure test	X	X	X	X	X	
3.1.15	Perform a tightness test		X	X	X	X	X
3.1.16	Perform a functional test	X	X	O	X	O	O
3.1.17	Perform a conformity test of the complete installation		X	O	X	O	
Results	Safe and environmentally friendly refrigeration piping system without leakage by starting up and during operation						

Job Competence		Groups of Activities						
4.1 Electrical Description The CERTIFIED PERSON is capable of installing the electrical cabling and wiring of a refrigeration system.		Pre-assembly	Installation	Technical Reports	Commissioning	Monitoring	Fault Finding	Dismantling
Criteria		1	2	3	4	5	6	7
4.1.1	Explain the use of different kinds of cables and wires	X	X				O	
4.1.2	Explain the use of different kinds of classified connections	X	X					
4.1.3	Explain the use of different kinds of classified IP	X	X				O	
4.1.4	Explain the different kinds of safety fuses and switches		X		X	O	O	
4.1.5	Install electrical equipment and motors		X			X	X	
4.1.6	Install cables in the cable routes	X	X				X	
4.1.7	Make the wiring of a switch panel	X	X		X		O	
4.1.8	Connect the power supply at the main switch panel		X		X		O	
4.1.9	Connect a single or three phase motor		X		X		O	
4.1.10	Connect other electrical components	X	X		X		O	
4.1.11	Check the electrical safety according to the EU and National regulations			O	X	O	O	
4.1.12	Check the power consumption of a motor			O	X	O	O	
4.1.13	Measure the electrical equipment and cabling		X	O	X	O	O	
4.1.14	Adjust the electrical safety switches			O	X	O	O	
4.1.15	Adjust the electrical equipment			O	X	O	O	
4.1.16	Check the rotation direction of a motor			O	X	O	O	
4.1.17	Take the decision to repair an electrical component			O	X	O	O	
4.1.18	Take the decision to replace an electrical component			O	X	O	O	
4.1.19	Write a report about the electrical equipment			O	X	O	O	
Results	A safe environment for the client and his personnel							
	A reliable electrical system							

Job Competence		Groups of Activities					
5.1 Measurements and Analysis Description The CERTIFIED PERSON is capable of measuring and analyzing physical data, and of making a correct diagnosis.		Pre-assembly	Installation	Technical Reports	Commissioning	Monitoring	Fault Finding
Criteria		1	2	3	4	5	6
5.1.1	Use a manometer set			X	X	X	X
5.1.2	Use a thermometer			O	X	O	O
5.1.3	Use a Torr gauge			O	X	X	X
5.1.4	Use scales to weigh refrigerant		X	X	X	X	X
5.1.5	Use an airflow meter			O	X	O	O
5.1.6	Use an acid test kit to check an oil sample			X	X	X	X
5.1.7	Use a recovery set			X	X		X
5.1.8	Handle a refrigerant cylinder			X	X		X
5.1.9	Drain oil out of a system			X	X		X
5.1.10	Use a multi-meter for measuring Volt/Amp/ Ohm			O	X	O	O
5.1.11	Use an electronic leak detection device			O	X	O	O
5.1.12	Use a vacuum pump			X	X		O
5.1.13	Place the data in a Log P/h diagram			O	X	O	O
5.1.14	Place the data in a h/x diagram			O	X	O	O
5.1.15	Use product information			O	X	O	O
5.1.16	Use a computer programme to control the system			O	X	O	O
5.1.17	Write a report based on the results of the measurements and draw the correct conclusions			O	X	O	O
Results	Correct information about the condition of the system at the time of measuring / checking, properly recorded, to allow historical review and future reference						

Job Competence		Groups of Activities						
6.1 Communications Description The CERTIFIED PERSON is capable of informing a client about the working procedures and the use of the refrigeration system.		Pre-assembly	Installation	Technical Reports	Commissioning	Monitoring	Fault Finding	Dismantling
Criteria		1	2	3	4	5	6	7
6.1.1	Arrange an appointment with the client		X		X	X	X	X
6.1.2	Properly inform the client about the process of operation of the refrigeration system		X		X	O	O	X
6.1.3	Consider the client's requests		X	O	X	O	O	X
6.1.4	Advise the client about maintenance planning			O	X	O	O	
6.1.5	Advise the client on saving energy		X	O	X	O	O	
6.1.6	Make the client aware of environmental issues		X	O	X	O	O	X
6.1.7	Advise the client on safety issues		X	O	X	O	O	
6.1.8	Process client complaints			O	X	O	O	
6.1.9	Advise the client with regard to shutting down the refrigeration system			O	X	O	O	X
6.1.10	Advise the client whether a new system, or the repair of components, is required			O	X	O	O	
6.1.11	Explain to the client the work procedures		X	O	X	O	O	
6.1.12	Explain to the client the content of a report		X	O	X	O	O	
Results	The client has received the necessary information about the system installed, at different times of its life cycle, and understands the performance that he can expect in the future.							

Job Competence		Groups of Activities						
7.1 Environmental and safety regulations Description The CERTIFIED PERSON is capable of handling the refrigeration system in a way that there is no loss of refrigerant and its operation is safe.		Pre-assembly	Installation	Technical Reports	Commissioning	Monitoring	Fault Finding	Dismantling
Criteria		1	2	3	4	5	6	7
7.1.1	Be aware and understand the environmental and safety regulations	X	X	O	X	O	O	X
7.1.2	Carry out a pressure test to check the strength of the system	X	X					
7.1.3	Carry out a pressure test to check the tightness of the system		X		X		O	
7.1.4	Evacuate the system to a level 270 Pa		X		X		O	
7.1.5	Fill the system with refrigerant without loss of refrigerant		X		X		X	
7.1.6	Control the charge of refrigerant			O	X	O	O	X
7.1.7	Make a visual inspection of the whole system especially the joints		X	O	X	O	O	
7.1.8	Make a leak test of the system			O	X	O	O	
7.1.9	Fill in the data in the logbook			O	X	O	O	
7.1.10	Fill in the certificate of the pressure test			X	X		X	
7.1.11	Fill in the certificate of the evacuation test			X	X		X	
7.1.12	Fill in the certificate of the tighness/ leak test			X	X	X	X	
7.1.13	Fill in a report with starting up figures			O	X		O	
7.1.14	Fill in a report with operational figures			O	X	O	O	
7.1.15	Fill in the report about the refrigerant used			X	X		X	
7.1.16	Fill in the document for removing contaminated refrigerant			X			X	X
7.1.17	Fill in the report about the refrigerant removed out of a system			X			X	X
7.1.18	Fill in a report of dismantling of the system			X			X	X

Results

Strict minimum emission of refrigerant

The environmental auditors can monitor the history of the system.

Annex II

Equipment and tools for the Maintenance Technician and the Refrigeration Craftsman

Equipment and tools of the certified personnel to be supplied by his employer	MT	RC
Manifold		X
Vacuum Gauge or Vacuum Meter		X
Temperature meter	X	X
Portable leak detector	X	X
Refrigerant weight Scale		X
Vacuum pump		X
Recovery set		X
Nitrogen pressure regulator		X
Recycling cylinder		X

Figure 4 Recovery cylinder labelling

© Bacharach Inc

© testolimited.com

© INFICON

Refrigerant gas detectors for hydrocarbon refrigerants (left), ammonia (centre) and carbon dioxide (right)

© Mastercool

Electronic manifold gauge set that can be used with flammable refrigerants, ammonia and high pressure refrigerants (up to 50 bar)

© panimpex.com

Manifold gauge set for use with carbon dioxide (up to 160 bar)

© cm-green

© RDA-eng.com

Refrigerant recover machines for hydrocarbons (left) and all flammable refrigerants except ammonia (right)

Refrigerant recovery cylinder

© Howe Corporation - Chicago, Illinois USA
Ammonia recovery pump set

Example of protective suit for Ammonia

For more information on equipment and tools please see: *Safe Use of HCFC Alternatives in Refrigeration and Air-Conditioning - An overview for developing countries.* (UNEP,2015)

Annex III

Minimum Requirements for Certification and Certification Schemes for Alternative Low GWP Refrigerants

Each candidate who wants to handle alternative refrigerants should hold a certificate which assessed to the requirements of 303/08 and should take part in an assessment specifically for the alternative refrigerant he/she wants to handle.

The table below lists the minimum competences which the candidate should have to obtain the certification specific to each alternative refrigerant.

Minimum Requirements listed for the specific module HC – NH_3 – CO_2 – HFO

	HC	NH_3	CO_2	HFO
BASIC THERMODYNAMICS AND PHYSICS				
Thermodynamic properties of low GWP refrigerant: temperature, pressure, density, thermal capacity, p/h diagram	T	T	T	T
Differences between low GWP refrigerants and HFCs	T	T	T	T
Toxicity characteristics, grades and limits for the human body	--	T	T	--
Characteristic of flammability of the substances, velocity of propagation, LFL, UFL, occupancy	T	T	--	T
Specific components for that refrigerant in the refrigeration cycle	T	T	T	T
Material compatibility		T	T[1]	
Oil compatibility, requirements and oil return	T	T	T	T
REGULATIONS AND STANDARDS				
Knowledge of European and national regulations and standards	T	T	T	T
Storage of the refrigerant	T	T	T	T
Transport of the refrigerant	T	T	T	T
Describe the process for handing over system to customer, completing and passing on appropriate commissioning documentation[6]	P	P	P	P

T= theoretical / P= practical

[1] For high pressures
[2] All practical trainings should include theoretical training
[3] City and Guilds, Level 2 and Level 3 Refrigeration and Air-conditioning CPD Pathways, March 2012 v1.0
[4] It is normally accepted to vent hydrocarbons with low charges (please refer to national legislation)
[5] It is normally accepted to vent CO_2 (please refer to national legislation)

	HC	NH_3	CO_2	HFO
GOOD PRACTICE[2]				
Identify typical application of low GWP refrigerant RAC systems6 (refer to AREA: Low GWP Refrigerants Guidance)	P	P	P	P
State and identify the commonly used refrigerants' designation[3]	P	P	P	P
State the requirements for safely labelling low GWP refrigerant RAC systems[6]	P	P	P	P
Select appropriate tools, equipment and PPE for work on low GWP RAC systems[6]	P	P	P	P
Recovery of the refrigerant	P	P[4]	P[5]	P
Venting the refrigerant in a safe way (according to national legislation)	P	P	P	P
Calculate the safe fill weight for the recovery cylinder (density difference between HFCs and low GWP refrigerants) [6]	P	P	P	P
Leak check direct assessment with the correct equipment	P	P	P	P
Make vacuum of the refrigerant preventing moisture in the system and without refrigerant emissions	P	P	P	P
Make charge of the refrigerant with no emission relief	P	P	P	P
Make a connection without brazing with alternative connections	P	P	P	P
Check the correct functioning of the safety ventilation system		P	P	
Check the correct functioning of the safety system controls	P	P	P	P

	HC	NH_3	CO_2	HFO
HEALTH AND SAFETY REQUIREMENTS				
Safe system shutdown and isolation [6]	P	P	P	P
Extinguish a fire, identify the appropriate fire extinguisher	P	P	--	P
First aid treatment for frostbite	P	P	P	P
First aid treatment for fire burn	P	P	--	P
First aid treatment for suffocation due to breathing problems	--	P	P	--
Safety issues related to high pressures	--	--	P	--
Calculate LFL (confined space)	T	T	--	T
Calculate confined space risk for asphyxiation (heavier than air)	--	--	T	--
Check that Health and Safety rules in the refrigeration system location are respected (emergency exits, fire alarms, leak detectors…)	T	T	T	T
Correct use of Personal Protective Equipment	P	P	P	P

Annex IV

Training Recommendations

Following are the course details specific to each low GWP refrigerant; the duration of the training is decided by the the European Union Member State.

Hydrocarbons

Course details

- Thermodynamic characteristic of Hydrocarbons as refrigerant - p/h diagram
- Specific components for Hydrocarbons
- Electronic components suitable for flammable refrigerants
- Refrigeration and Air-conditioning applications with HC
- Recovery or Venting Hydrocarbons
- Vacuum-Charging procedures
- Leak testing
- Mechanical/compression joint connections – avoid brazing
- Flammability and safety issues, first aid
- Conversion HCFC – HFC systems into HC
- National and European regulations and standards
- Transport and storage requirements
- Logbook

Necessary equipment and components (minimum)

- Test Rig equipped with Pressure Gauges, sight glasses in key points, service valves for connections, temperature well - thermowell (Domestic/Commercial refrigerator or small packaged portable air-conditioning unit)
- Mechanical/compression joint tool and connectors
- Nitrogen Regulator - Cylinder of High Purity Nitrogen
- Electronic Weighing Platform
- Hydrocarbon Cylinder
- Electronic or analogue Vacuum gauge
- Manifold set - Hoses with ball valves
- Vacuum Pumps and Hose

- Electronic Leak Detector (suit HC)
- Proprietary Leak Spray
- Temperature meter
- Ammeter
- Tools, Pipe Cutters, Pipe Deburring Tool, Pipework Expanders, Hacksaws, Brazing Rods
- Flaring Tool
- Personal protective equipment

Ammonia

Course details

- Thermodynamic characteristic of Ammonia as refrigerant - p/h diagram
- Specific components for Ammonia
- Compatibility with other materials, oil return and miscibility with water
- Refrigeration and Air-conditioning applications with NH_3
- Recovery of Ammonia
- Vacuum-Charging procedures
- Leak testing
- Flammability, Toxicity and safety issues, first aid
- National and European Regulations and standards
- Transport and storage requirements
- Logbook

Necessary equipment and components (minimum)

- Test Rig equipped with Pressure Gauges, sight glasses in key points, service valves for connections, temperature well - thermowell (industrial refrigerator)
- Nitrogen Regulator - Cylinder of High Purity Nitrogen
- Electronic Weighing Platform
- Ammonia Cylinder
- Electronic or analogue Vacuum gauge
- Manifold set - Hoses with ball valves
- Vacuum Pumps and Hose
- Recovery unit
- Electronic Leak Detector
- Proprietary Leak Spray
- Temperature meter
- Ammeter
- Tools
- Personal protective equipment

Carbon Dioxide

Course details

- Thermodynamic characteristic of carbon dioxide as refrigerant - p/h diagram
- Subcritical and Transcritical operations
- Specific components for carbon dioxide
- Refrigeration and Air-conditioning applications with CO_2
- Recovery or venting of CO_2
- Vacuum-Charging procedures
- Leak testing
- High pressures and safety issues, first aid
- National and European Regulations and standards
- Transport and storage requirements
- Logbook

Necessary equipment and components (minimum)

- Test Rig equipped with Pressure Gauges, sight glasses in key points, service valves for connections, temperature well - thermowell (Cascade System)
- Nitrogen Regulator - Cylinder of High Purity Nitrogen
- Electronic Weighing Platform
- CO_2 Cylinder
- Electronic or analogue Vacuum gauge
- Manifold set - Hoses with ball valves
- Vacuum Pumps and Hose
- Recovery unit
- Electronic Leak Detector (to suit CO_2)
- Proprietary Leak Spray
- Temperature meter
- Ammeter
- Tools, Pipe Cutters, Pipe Deburring Tool, Pipework Expanders, Hacksaws, Brazing Rods
- Personal protective equipment

HFOs

Course details

- Thermodynamic characteristic of HFOs as refrigerant - p/h diagram
- Specific components for HFOs
- Electronic components suitable for A2L mildly flammable refrigerants
- Refrigeration and Air-conditioning applications with HFOs
- Recovery HFOs
- Vacuum-Charging procedures
- Leak testing
- Mechanical/compression joint connections
- Flammability and safety issues, first aid
- Conversion HCFC – HFC systems into HFOs
- National and European regulations and standards
- Transport and storage requirements
- Logbook

Necessary equipment and components (minimum)

- Test Rig equipped with Pressure Gauges, sight glasses in key points, service valves for connections, temperature well - thermowell (Domestic/Commercial refrigerator or small packaged portable air-conditioning unit)
- Mechanical/compression joint tool and connectors
- Nitrogen Regulator - Cylinder of High Purity Nitrogen
- Electronic Weighing Platform
- Hydrocarbon Cylinder
- Electronic or analogue Vacuum gauge
- Manifold set - Hoses with ball valves
- Vacuum Pumps and Hose
- Electronic Leak Detector (suit A2L mildly flammable refrigerants)
- Proprietary Leak Spray
- Temperature meter
- Ammeter
- Tools, Pipe Cutters, Pipe Deburring Tool, Pipework Expanders, Hacksaws, Brazing Rods
- Flaring Tool
- Personal protective equipment

Annex V

Sample Questions for the Theoretical Assessment of the Certification
(Real Alternatives Project, 2015)

1. The hazards of R32 include:

a. High flammability

b. Mild flammability

c. High toxicity

d. Mild toxicity

2. What is the maximum charge of R290 that can be used on a supermarket shop floor (occupancy category A)

a. It cannot be used in this application

b. 150 g

c. 1.5 kg

d. There is no limit

3. What is the pressure of R744 in a system which is at standstill in an ambient temperature of 20°C?

a. 4.9 bar g

b. 7.4 bar g

c. 55 bar g

d. 72.8 bar g

4. What is the approximate displacement required for a compressor operating on R600a compared to one operating on R134a to give the same cooling capacity?

a. The same

b. Two times

c. Seven times

d. Half

5. According to the latest European F Gas regulation (EU517/2014) how frequently must an R1234ze system with a charge of 300kg and a fixed leak detection system.

a. It does not need to be leak tested

b. Once per year

c. Twice per year

d. Four times per year

6. Which refrigerant can be detected by the use of litmus paper?

a. R32

b. R744

c. R290

d. R717

7. When working with R1270 what is the recommended radius around the work area that should be free from sources of ignition?

a. 0.3 m

b. 1 m

c. 3 m

d. 10 m

8. What is the usual method for removing R744 from a system?

a. It is vented

b. It is recovered using a high pressure recovery machine

c. It is pumped into high pressure cylinders

d. The system is pumped down

Annex VI

Sample Modules for the Activities of the Practical Assessment and for the Results of the Certification (TESDA)

Form AC 24/0108

Competency Assessment Results Summary (CARS)

Candidate Name:			
Assessor Name:			
Title of Qualification/ Cluster of Units of Competency:	RAC SERVICING NC II		
Assessment Center:		**Date of Assessment:**	

The performance of the candidate in the following unit(s) of competency and corresponding assessment methods		**Satisfactory**	**Not Satisfactory**
Unit of Competency	Assessment Method		

Note: Satisfactory Performance shall only be given to candidate who demonstrated successfully all the competencies identified in the above-named Qualification/Cluster of Units of Competency

Recommendation	❑ For issuance of NC/COC (indicate title/s of COC, if Full Qualification is not met)	❑ For submission of Additional documents Specify:	❑ For re-assessment (pls. specify)
Did the candidate overall performance meet the required evidences/standards?		❑ Yes	❑ No
OVERALL EVALUATION	❑ **Competent**	❑ **Not Yet Competent**	
General Comments [Strengths/Improvements needed]			

Candidate signature:		Date:	
Assessor signature:		Date:	
Assessment Center Manager signature		Date:	

CANDIDATE'S COPY (Please present this form when you claim your NC/COC)

COMPETENCY ASSESSMENT RESULTS SUMMARY

Name of Candidate:		Date Issued:	
Name of Assessment Center:		Date of Assessment:	
Assessment Results:	❑ Competent	❑ Not Yet Competent	
Recommendation:	❑ For issuance of NC/COC (indicate title/s of COC, if Full Qualification is not met)	❑ For submission of Additional documents Specify:	❑ For re-assessment (pls. specify)
Assessed by:	Name and Signature	Attested by:	Name and Signature
Date:		Date:	

NATIONAL ASSESSMENT FOR RAC SERVICING (DomRac) NC II

INSPECTION/OPERATION LOG REPORT

(Note: Fill-out ONLY the items that are applicable to the job performed - Troubleshoot and Repair Domestic Refrigeration and Air-conditioning Systems)

Candidate's Name:					
Assessor's Name:					
Unit Capacity:			Model:		
Type:	( ) Direct Expansion		( ) Chilled Water	( ) Cooled Water	
FCU MODEL			FCU	L1	
FCU SERIAL NO.			Motor	L2	
FCU MOTOR FLA			Actual Load	L3	
ACCU Model			ACCU	L1	
ACCU Serial No.			Fan Motor	L2	
ACCU Fan Motor FLA			Actual Load	L3	
Compressor Model			COMPRESSOR	L1	
Compressor Serial No.			FLA	L2	
Compressor LRA			Actual Load	L3	
Compressor Located At:	EVAPORATOR ( )		CONDENSER ( )		
Suction Pressure		Compressor Suction Pipe Temp:			
Discharge Pressure		Compressor Discharge Pipe Temp:			
Field Piping Approx.:		Compressor head Temp:			
Length:		Outdoor Suction Air Temp:			
Suction Line Pipe Size:		Outdoor Discharge Air Temp:			
Discharge Line Pipe Size:		Outdoor Air Temp. Difference:			
Liquid Line Pipe Size:		Indoor Suction Air Temp:			
Breaker / Fuse Size:		Indoor Discharge Air Temp:			
Wire Size Used:		Indoor Air Temp. Difference:			
Line Voltage:		Additional Refrigerant Charge:			
CONTROLS:	BRAND:	WORKING		SETTING:	
Oil Pressure Switch				Factory Set ( ) psig ( )	
High Pressure Switch				_____ psig	
Low Pressure Switch				Factory Set ( ) Cut in Cut out	
Water Flow Switch					
Crank Case Heater					
Thermostat				_____ F _____ C	
REMARKS:					

Candidate Signature:	Date:

Annex VII

Example of a 'Rating Sheet' (Philippines)

Rating Sheet for Demonstration with Oral Questioning			
Candidate's Name:			
Assessor's Name:			
During the demonstration of skills, did the candidate:	**YES**	**NO**	**N/A**
- Assess site conditions and installation requirements according to manufacturer's specification and prevailing codes and ordinances* - Determine tools, equipment and materials needed for installation according to site condition and site installation requirements - Report survey result in accordance with enterprise policies and procedures - Perform roughing-in activities in accordance with the Philippines Electrical Codes provisions - Select electrical cabling and wiring devices of correct load carrying capacity and installs safely in line with manufacturer's instructions - Install power wiring in accordance with applicable Philippines Electrical Codes provisions - Test electrical circuits in accordance with applicable PEC provisions - Prepare unit and equipment/components based on work procedures - Install bracket, hangers and frames in accordance with manufacturer's recommendation and/or RAC Code of Practice - Position and level unit in line with manufacturer's instructions and/or RAC Code of Practice - install sealing materials to ensure an air tight seal around the unit in line with manufacturer's instructions and/or RAC Code of Practice - install condensate drain in accordance with manufacturer's recommendation and/or RAC Code of Practice - Employ safe manual handling techniques in line with enterprise OH&S procedures - Exercise in line with enterprise policy			

- Measure voltage and current according to unit power requirements - Measure Air temperature and velocity based on unit specifications - Check sounds and vibration based on unit specifications - Accomplish service report in line with enterprise policies and procedures. - Identify and remove air filter following standard procedures - Check filter for damage and replaces if required in line with standard operating procedures - Clean air filter using the correct tools and cleaning procedures - Replace filter in accordance with filter specifications - Select tools in dismantling the evaporator/ condensing unit as per standard operating procedures - Use high pressure washer in cleaning evaporator/ condensing coil based on established procedures - Straighten evaporator/condenser coil fins in accordance with service procedure - Use cleaning agent or non-corrosive chemical in cleaning and maintaining evaporator/ condensing coil, fins and other body accessories as per standard operating procedures - Maintain fan motor in line with manufacturer's instructions. - Service and maintain fan blades and blower in line with manufacturer's instructions. - Check and service fan motor terminals in line with manufacturer's instructions. - Check and service fan motor mounting in line with manufacturer's instructions. - Use proper instrument in checking power supply and diagnosing electrical control - Repair and report loose connections/wirings in line with SOP - Check plugs and outlets in line with standard operating procedures - Check grounding in line with standard operating procedures - Report all defects and problems encountered in line with enterprise policies and procedures. - Report observation and recommendation properly in line with enterprise policies and procedures. - Interpret appropriate wiring diagrams, charts and manuals in line with the job requirements - Select appropriate materials, tools and equipment are based on job requirements - Check power supply to ensure compliance with nameplate rating and/or manufacturer's specifications - Select appropriate PPE and used in line with job requirements			

- Test components following manufacturer's manual, RAC Code of Practice and/or enterprise troubleshooting policy - Diagnose faults/problems with components are in line with manufacturer's manual, RAC Code of Practice and/or enterprise troubleshooting policy - Take remedial action to overcome faults/problems in line manufacturer's manual, RAC Code of Practice and/or enterprise troubleshooting policy - Complete work safely in line with workplace safety guidelines - Complete report on testing procedure, including faults and minor repair, in line with manufacturer's manual, RAC Code of Practice and/or enterprise troubleshooting policy - Observe safe working practices throughout the task as per enterprise procedure - Select suitable tools and equipment and used based on job requirement - Perform optimum recovery of refrigerant in line with RAC Code of Practice - Perform refrigerants recovery/recycling according to manufacturer's recommendations and RAC Code of Practice - Perform retrofitting based on RAC Code of Practice - Test unit in line with troubleshooting procedures - Prepare report on repair and testing of unit in line with enterprise procedures			

The candidate should answer the following questions:	**YES**	**NO**	
1. What would you do if the condenser fan motor has burnt out? 2. What would you do if the evaporator of a refrigerator is not freezing? 3. Explain briefly the vapour compression refrigeration cycle. 4. How do you determine if the capacitor is defective? 5. How do you avoid overheating of electrical wiring of the equipment? 6. What are the specified procedures or steps in servicing ceased hermetic motor compressor? 7. Why is it important to prepare a report after repairing the unit? 8. What would you use as a guide when repairing air-conditioning or refrigeration units? Why? 9. What causes the partial cooling of an air-conditioning unit evaporator? 10. What would you do if unnecessary noise is heard after servicing and starting up the unit? 11. Give at least 2 indicators that a unit is functioning and running efficiently. 12. Why is it important to wear appropriate PPE when repairing air-conditioning or refrigeration units?			

13. What safety precaution must you take when removing a window air-conditioning unit? 14. What would you do if the refrigerator body has gone to ground? 15. What is the importance of labelling the refrigerant cylinder with recovered/recycled refrigerant? 16. What would you do if you charged a unit with the wrong refrigerant? 17. How would you prevent the condenser and evaporator fins from corrosion? 18. What would you do to optimize recovery of the refrigerant? 19. What does Republic Act 6969 state? 20. What would you do if there is ice on the evaporator of an aircon-ditioning unit? 21. What causes the motor compressor of a refrigerator to run continuously? 22. What would you do if the recovery/recycling machine fails during the recovery/recycling process? 23. How do you dispose used refrigerant and oil?			

The candidate's underpinning knowledge was: Satisfactory Not Satisfactory

Feedback to candidate:
The candidate's overall performance was: Satisfactory Not Satisfactory

Candidate's Signature: Date:

Assessor's Signature: Date:

About the UNEP DTIE OzonAction Programme

Under the Montreal Protocol on Substances that Deplete the Ozone Layer, countries worldwide are taking specific, time-targeted actions to reduce and eliminate the production and consumption of man-made chemicals that destroy the stratospheric ozone layer, Earth's protective shield.

The objective of the Montreal Protocol is to phase out ozone depleting substances (ODS), which include CFCs, halons, methyl bromide, carbon tetrachloride, methyl chloroform, and HCFCs. One hundred ninety seven governments have joined this multilateral environmental agreement and are taking action.

The UNEP DTIE OzonAction Branch assists developing countries and countries with economies in transition (CEITs) to enable them to achieve and sustain compliance with the Montreal Protocol. With our programme's assistance, countries are able to make informed decisions about alternative technologies, ozone-friendly policies and enforcement activities.

OzonAction has two main areas of work:

- Assisting developing countries in UNEP's capacity as an Implementing Agency of the Multilateral Fund for the Implementation of the Montreal Protocol, through a Compliance Assistance Programme (CAP).
- Specific partnerships with bilateral agencies and Governments.

UNEP's partnerships under the Montreal Protocol contribute to the realisation of the Millennium Development Goals and implementation of the Bali Strategic Plan.

For more information

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About the UNEP Division of Technology, Industry and Economics

The UNEP Division of Technology, Industry and Economics (DTIE) helps governments, local authorities and decision-makers in business and industry to develop and implement policies and practices focusing on sustainable development.

The Division works to promote:

> sustainable consumption and production,
> the efficient use of renewable energy,
> adequate management of chemicals,
> the integration of environmental costs in development policies.

The Office of the Director, located in Paris, coordinates activities through:

> The International Environmental Technology Centre - IETC (Osaka, Shiga), which implements integrated waste, water and disaster management programmes, focusing in particular on Asia.

> Sustainable Consumption and Production (Paris), which promotes sustainable consumption and production patterns to contribute to human development through global markets.

> Chemicals (Geneva), which promotes sustainable development by catalysing global actions and building national capacities for the sound management of chemicals and the improvement of chemicals safety worldwide.

> Energy (Paris), which fosters energy and transport policies for sustainable development and encourages investment in renewable energy and energy efficiency.

> OzonAction (Paris), which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition to ensure implementation of the Montreal Protocol.

> Economics and Trade (Geneva), which helps countries to integrate environmental considerations into economic and trade policies, and works with the finance sector to incorporate sustainable development policies.

UNEP DTIE activities focus on raising awareness, improving the transfer of knowledge and information, fostering technological cooperation and partnerships, and implementing international conventions and agreements.

For more information
see **www.unep.org**

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Multilateral Fund
for the Implementation of the Montreal Protocol

This publication provides a simple overview and examples of the design and implementation of certification schemes for technicians and enterprises in the refrigeration and air-conditioning servicing sector.

Certification is important in order to verify the competence of personnel handling equipment and refrigerants, including installation, maintenance, repair and recovery and dismantling, to ensure safe use, best practice and leakage prevention.

DTI/1925/PA