Guideline III: Training, qualification and certification for the introduction of climate-friendly cooling and heating technologies in Ukraine

In the framework of the project

"Capacity Building for the Innovative Application of Energy-Efficient and Climate-Friendly RACHP Technologies in Ukraine"

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List of Abbreviations

AC	Air Conditioner
BA	Basic Appreciation
CB	Certifying Body
CEN	European Committee for Standardization
CO_2	Carbon Dioxide
FO	Fully Operational
GWP	Global Warming Potential
HC	Hydrocarbons
HCFC	Hydrochlorofluorocarbons
HEI	Higher Educational Institution
HFC	Hydrofluorocarbons
HFO	Hydrofluoroolefins
IB	Independent Body
ISO	International Organization for Standardization
KPI	Kharkiv Polytechnic Institute
LCC	Life-Cycle-Costs
LE	Leading Edge
LULUCF	Land Use, Land Use Change and Forestry
MENR	Ministry of Ecology and Natural Resources Ukraine
MP	Montreal Protocol
NA	National Authority
NH_3	Ammonia
NUHT	National Academy of Food Technologies
ODS	Ozone-Depleting Substances
ONACHT	Odessa National Academy of Food Technologies
PFC	Perfluorinated compounds
RACHP	Refrigeration, Air Conditioning and Heat Pump
SF6	Sulfur hexafluoride
PU RAU	Public Union "Refrigerating Association of Ukraine"
TEWI	Total equivalent warming impact
UAS	Ukrainian Agency of Standardization
UNHPA	Ukrainian National Heat Pump Association
WK	Working Knowledge

1 Introduction

Fluorinated gases ("F-Gases") are extremely harmful greenhouse gases, with a global warming effect up to 23 000 times greater than carbon dioxide (CO_2). It is therefore important to make the necessary transition to F-gas free alternatives, especially in the Refrigeration, Air Conditioning and Heat Pump (RACHP) sector, which is one of the largest sources of F-gas emissions. This transition will require a phase-down of the use of hydrofluorocarbons (HFCs), improved monitoring and reporting, enhanced legal structures and standards, and increased national and local capacity.

As a signatory country to the Montreal Protocol (MP) and the Paris Agreement, Ukraine has committed itself to its greenhouse gas mitigation targets. The country is facing the need to update its national regulations concerning the use of HFCs. As a bordering country to the European Union, the Ukraine is also seeking to adopt regulations and standards which are relevant to the RACHP sector in Europe, including the Regulation (EU) No. 517/2014 for the phase-down of F-Gases.

Alternative technologies using low global warming potential (GWP) refrigerants such as ammonia (NH_3), CO_2 and hydrocarbons (HCs) are commercially available in Europe, cost-competitive in many applications and show better energy performance, often with lower life cycle cost, when compared to high GWP technologies. These natural refrigerants, however, have different or higher requirements with regards to safety issues. Either flammability (hydrocarbons, NH_3), toxicity (NH_3) or higher operating pressure (CO_2). Risks have been shown to be low if the equipment is handled properly by specifically trained technicians according to safety standards.

Thus, service technicians and engineers need to be equipped with the required knowledge and practical skills to install, operate, and maintain low GWP refrigerants safely to reduce refrigerant leakages, avoid accidents and environmental impacts. The specific characteristics of natural refrigerants have to be addressed with the formulation of newly and state of the art curricula for the RACHP sector and qualification and certification schemes based on international standards and regulations. To ensure safety, the trading and handling of refrigerants should be permitted only for qualified, certified, and registered companies and employees.

So far, the vocational education system in the Ukraine had been based on RACHP equipment with less or non-flammable HFC and HCFC refrigerants. Despite generally high training standards and a solid engineering know-how among RACHP technicians and engineers, the proper use of low GWP refrigerants in RACHP applications is not covered by current training curricula in the Ukraine.

This guideline is **part of a series of three consecutive guidelines** prepared for Ukrainian decision makers to promote climate friendly and energy efficient RACHP appliances in the country:

Guideline I: The regulatory framework for climate friendly and energy efficient alternatives in the refrigeration, air conditioning and heat pump (RACHP) sector in the Ukraine

Guideline II: Safety standards and regulations for manufacturers and operators of refrigeration, air conditioning and heat pump (RACHP) equipment in the Ukraine

Guideline III: Training, qualification and certification for the introduction of climate-friendly cooling and heating technologies in Ukraine

2 Purpose of this guideline

This guideline is developed to assist Ukrainian decision makers and stakeholders of the RACHP sector in preparing for the national implementation of the regulations on F-Gases in line with the Kigali Amendment to the Montreal Protocol and the EU F-Gas Regulation EU 517/2014, with an emphasis on low GWP alternatives.

This guideline is aimed at national **academic institutions**, **companies, and organizations offering education, training and certification** for the RACHP sector. It will provide information on the knowledge and skills requirements for personnel employed in the RACHP sector, as well as on training and certification practices based on European and international standards and regulations.

More specific, this guideline includes recommendations on:

- Setting up a training concept compliant with the F-Gas regulation and the European standard EN 13313:2010 for the qualification of RACHP personnel, and
- Establishing a transparent certification system for engineers and technicians in the RACHP sector, including specific information on the required institutional set-up

taking into consideration existing training and certification practices for RACHP personnel in the Ukraine.

3 Characteristics of future refrigerants

Following the phase out of the use of ozone depleting substances (ODS) as refrigerants in the Ukraine in line with the implementation of the Montreal Protocol, hydrofluorocarbons (HFCs) have been entering the market and are now dominantly used in RACHP equipment. They do not have an impact on the ozone layer (zero ozone depletion potential, ODP), but show a very high global warming potential (GWP). Therefore, there is a need to phase down HFCs as well. According to the Kigali Amendment[1] to the Montreal Protocol, the Ukraine as a "Group 1" country under Article 2 would need to achieve a first significant phase down step of HFCs by 2024.

In the RACHP sector, alternatives to HFCs can be natural refrigerants such as hydrocarbons (HC), ammonia (NH_3) or Carbon Dioxide (CO_2). The specific safety properties of these refrigerants are visualised in Table 1 below. It can be seen that especially propane and ammonia need to be handled properly following specific safety precautions.

To ensure safety, these specifics need to be part of the RACHP personnel's education. That is why several international and European standards including requirements for RACHP workers stipulate specific competence requirements for those workers actually handling (natural) refrigerants (see next Chapter).

[1] The Ukraine still lacks ratification and implementation of the Kigali Amendment (see Guideline 1 on Regulations).

Table 1: Safety properties of refrigerants

	HFC			"Natural" refrigerants		
	R-32	**R-410A**	**R-134a**	**R-290**	**R-717**	**R-744**
Name of refrigerant	difluoromethane	blend: 50% of R32 and 50% of R125 pentafluoroethane	tetrafluoroethane	propane	ammonia	carbon dioxide
GWP[2]	677	1725	1300	3	0	1
ISO 817 safety Classification[3]	A2L – lower toxicity and lower flammability	A1 – lower toxicity and non-flammable	A1 – lower toxicity and non-flammable	A3 – lower toxicity and higher flammability	B2L – higher toxicity and lower flammability	A1 – lower toxicity and non-flammable

Source: own compilation

4 Qualification and certification in the RACHP sector at an international level and particularly in the European Union

The following section provides an overview of the qualification and certification standards, regulations and practices in European countries. There are several normative and regulative references for the definition of competences of personnel in the RACHP sector.

The most relevant standards and regulations are listed below and referenced in the following paragraphs:

- European Regulation No 517/2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006 (F-Gas Regulation)
  - Commission Implementing Regulation (EU) 2015/2067 "certification of companies and natural persons according to (EU) 517/2014"
- EN13313:2010 on "Refrigerating systems and heat pumps – Competence of personnel"
  - (An ISO standard (ISO/DIS22712:2018 Refrigerating systems and heat pumps — Competence of personnel) is currently under development with reference to EN 133313; the scope is principally the same but more actual and applicable (see below).)
- EN ISO/IEC 17024: Conformity assessment – General requirements for bodies operating certification of persons
- EN 378-1-4: Refrigerating systems and heat pumps – Safety and environmental requirements:
  - EN 378-1:2016: Refrigerating systems and heat pumps – Safety and environmental requirements –Part 1: Basic requirements, definitions, classification and selection criteria
  - EN 378-2:2016: Refrigerating systems and heat pumps – Safety and environmental requirements –Part 2: Design, construction, testing, marking and documentation
  - EN 378-3:2016: Refrigerating systems and heat pumps – Safety and environmental requirements – Part 3: Installation site and personal protection

[2] IPCC Assessment Report 2014 (The GWP assigns a value to the amount of heat trapped by a certain mass of a gas relative to the amount of heat trapped by a similar mass of carbon dioxide over a specific period of time (e.g. 100 years).

[3] ISO 817:2014 provides a system for assigning a safety classification to refrigerants based on toxicity and flammability data, and a means of determining the refrigerant concentration limit.

- EN 378-4:2016+A1:2019: Refrigerating systems and heat pumps – Safety and environmental requirements – Part 4: Operation, maintenance, repair and recovery (EN 378 refers in a broad range to ISO 5149 1-4[4])
- ISO 13585-2012 – Brazing- Qualification test of brazers and brazing operators
- EN 50110 - Operation of electrical installations – Part 1: General requirements

The SE Ukrainian Agency of Standardization (UAS) (previously called Ukrainian SE "UkrNDNC" Ukrainian Research and Training Center of Standardization, Certification and Quality) is a member body of the International Organization for Standardization (ISO), which allows the Ukraine to get involved in standard development by joining the specific Technical Committees and allows and facilitates national adoption and implementation. The UAS is also a Companion Standardisation Body to the European Committee for Standardization (CEN), which provides the Ukraine access to CEN standards and allows the adoption of EN standards without restrictions.

The following paragraphs will provide an overview about the relevant requirements and rules of these regulations and standards. While EN13131/ ISO/DIS22712 is applicable for fluorinated and non-fluorinated gases (natural refrigerants), the F-Gas Regulation only applies for f-gases. Processes and requirements for the qualification of personnel can, however, be adopted for natural refrigerants.

4.1 European F-Gas Regulation: EU 517/2014

The F-Gas Regulation **EU 517/2014 – Regulation on fluorinated greenhouse gases** has the aim of reducing the F-Gas consumption in the European Union considerably until 2050.[5] The regulation restricts the amount of refrigerant put on the market, but also applies to persons carrying out installation, servicing, maintenance and repair of RACHP equipment.

Regulated is the use of HFCs, perfluorinated compounds (PFC)s, and sulfur hexafluoride (SF6), which all contribute to climate change if emitted to the atmosphere. It does not address natural refrigerants. But since some HFCs are also flammable (e.g. R-32 is classified as A2L, see Table 1) the processes for qualification and certification are applicable. The competence requirements should be complemented by the requirements specified in EN 13313 (or ISO/DIS22712).

4.1.1 Qualification and certification

Training, certification and registration in accordance to the F-gas regulation is common practice in Europe since many years with a very high number of certified technicians. The F-Gas Regulation requires all personnel and companies to have a certification proving their ability to install, maintain, service and recover systems using "F-gases" (as outlined in Table 2) with the aim of reducing refrigerant emissions. For example, the technician entrusted with checking or repairing the equipment's F-gas circuits must have the relevant F-gas certificate or training for that type of equipment.

[4] ISO 5149-1:2014 Refrigerating systems and heat pumps — Safety and environmental requirements — Part 1: Definitions, classification and selection criteria; ISO 5149-2:2014 Refrigerating systems and heat pumps — Safety and environmental requirements — Part 2: Design, construction, testing, marking and documentation; ISO 5149-3:2014 Refrigerating systems and heat pumps — Safety and environmental requirements — Part 3: Installation site; ISO 5149-4:2014 Refrigerating systems and heat pumps — Safety and environmental requirements — Part 4: Operation, maintenance, repair and recovery

[5] Ozone depleting substances (ODS such as HCFCs) are still regulated by the ODS Regulation 1005/2009, which remains unchanged and sets out the obligations with regard to ODS and equipment containing ODS.

Table 2: Activities that require a certificate

Activity	Explanation	Certified personnel	Certified company
Installation	joining two or more pieces of equipment or circuits containing or designed to contain F-gases irrespective of the need to charge the system after assembly (this includes joining gas carrying conductors to complete a circuit, with the intention to assemble a system at the place of operation)	x	x
Maintenance or servicing	all activities that entail breaking into the circuits containing or designed to contain F-gases, excluding recovery and checks for leakage: supplying the system with F-gases, removing one or more pieces of circuit or equipment, reassembling two or more pieces of circuit or equipment, repairing leaks	x	x
Leak checks[6]	the examination of the equipment for leaks of F-gases	x	
Recovery of F-gases	collection and storage of F-gases from equipment during maintenance, servicing and prior to disposal	x	

Source: own compilation based on EU 2015[7]

The operator is responsible for making arrangements so that the above described activities are done by certified personnel.

The personnel certification is obtained after a theoretical and practical assessment. The following topics are defined as necessary competences for a qualified RACHP technician to be included in the training and examination programs (according to Art. 10 of the F-Gas Regulation and Annex I of the Implementing Regulation (EU) 2015/2067[8] pursuant to the F-Gas regulation):

- Sufficient knowledge and practical expertise of:
  - applicable regulation and technical standards; emission prevention; recovery of fluorinated GHG, and safe handling of equipment; more specifically:
- Basic knowledge of thermodynamics (theory of refrigeration systems, ISO standards, function of the main components, etc.) and practical expertise on environmental-friendly handling of the system and refrigerants;
- Basic knowledge of the environmental impact of refrigerants (climate change, GWP), corresponding environmental regulations and the relevant provisions of the F-Gas Regulation and its implementing acts;
- Practical experience in leakage checking;
- Practical expertise and knowledge about putting into operation and maintenance of compressors, condensers, evaporators, thermostatic expansion valves, and piping;
- Technical knowledge on relevant technologies to replace or to reduce the use of f-gases and their safe handling.

[6] of applications containing more or equal to 5t CO2-eq of F-gases (more than 10t CO_2-eq if hermetically sealed and labelled as such)

[7] European Union (2015): Information for technical personnel and companies working with equipment containing fluorinated greenhouse gases https://ec.europa.eu/clima/sites/clima/files/f-gas/docs/technical_personnel_brochure_en.pdf

[8] Commission Implementing Regulation (EU) 2015/2067 of 17 November 2015 establishing, pursuant to Regulation (EU) No 517/2014 of the European Parliament and of the Council, minimum requirements and the conditions for mutual recognition for the certification of natural persons as regards stationary refrigeration, air conditioning and heat pump equipment, and refrigeration units of refrigerated trucks and trailers, containing fluorinated greenhouse gases and for the certification of companies as regards stationary refrigeration, air conditioning and heat pump equipment, containing fluorinated greenhouse gases

4.1.2 Levels of certification

Commission Implementing Regulation 2015/2067[9] pursuant to Regulation No 517/2014 sets out minimum qualifications for personnel on stationary refrigeration, air-conditioning and heat pump equipment and refrigeration units of refrigerated trucks and trailers systems that contain or are designed to contain F-gases. This Regulation stipulates four different levels of certification for stationary systems, which depend – similar to EN 13313 – on the extend technicians are handling refrigerants, but also on the refrigerant charge size (see Table 3). For example, with a Category I certificate personnel is allowed to work on any systems containing 3 kg or more of an F-gas whereas technicians with a Category IV certificate may only undertake leak checking.

Table 3: Levels of certification in the F-Gas regulation[10]

	Category	Key Activities & Competences	Allowed Refrigerant Volume
Increasing level of competencies ↑	Category I (highest)	All refrigerant handling activities: installation, maintenance and servicing, repair, decommissioning, leak checking and refrigerant recovery.	Work on any systems containing 3 kg or more of an F-gas
	Category II	Refrigerant recovery, installation, maintenance and servicing; leak checking provided that it does not entail breaking into the refrigeration circuit containing F-gases	Work on systems containing less than 3 kg of F-gases (or less than 6 kg for systems that are hermetically sealed)
	Category III	Refrigerant recovery	Do refrigerant recovery on systems containing less than 3 kg of F-gases (or less than 6 kg for systems that are hermetically sealed)
	Category IV (lowest)	Leak checks	Do leak checks on any plant provided that it does not entail breaking into the refrigeration circuit containing F-gases

Source: Own compilation based on Regulation (EU) No 517/2014 and Implementing Regulation (EU) 2015/2067[11]

The first two category certificates enable personnel to carry out almost all tasks of the RACHP cycle. Operation of the equipment, however, is only permitted to personnel that gained a category IV certificate, while the recovery of the refrigerant can only be done by technicians that own a category 3 certification. The design of refrigeration systems is usually not part of a refrigeration technician, but the task of engineers.

[9] establishing, pursuant to Regulation (EU) No 517/2014 of the European Parliament and of the Council, minimum requirements and the conditions for mutual recognition for the certification of natural persons as regards stationary refrigeration, air conditioning and heat pump equipment, and refrigeration units of refrigerated trucks and trailers, containing fluorinated greenhouse gases and for the certification of companies as regards stationary refrigeration, air conditioning and heat pump equipment, containing fluorinated greenhouse gases

[10] Note that the categories are not linked to the categories of EN 13313. Annex C of EN 13313, however, provides an overview of how the different activities relevant for RACHP technicians as defined in the standard relates to the certification categories of the F-Gas Regulation.

[11] Commission Implementing Regulation (EU) 2015/2067 of 17 November 2015 establishing, pursuant to Regulation (EU) No 517/2014 of the European Parliament and of the Council, minimum requirements and the conditions for mutual recognition for the certification of natural persons as regards stationary refrigeration, air conditioning and heat pump equipment, and refrigeration units of refrigerated trucks and trailers, containing fluorinated greenhouse gases and for the certification of companies as regards stationary refrigeration, air conditioning and heat pump equipment, containing fluorinated greenhouse gases

4.1.3 Certification of companies

For the purpose of design, installation, maintenance, service or repair of equipment that contains or requires F-gases, F-gases may only be sold and purchased to and from companies that are certified and/or have certified personnel. Companies that collect, transport or supplies F-gases exclusively do not need a certificate.

A certification of a company is issued by the competent local authority upon request. An application with the following information should be submitted in writing to the authority.

- Name and location of the company (each site individually)
- Description of the activities of the company
- Certificates of the personnel
- Technical equipment / equipment list
- Statement of sufficient certified personnel

Company certificates can also be issued by a certification body in another Member State of the European Union and are mutually recognized.

4.1.4 Institutional set-up for a certification scheme

Commission Implementing Regulation (EU) 2015/2067 of 17 November 2015 establishing, pursuant to Regulation (EU) No 517/2014, minimum requirements and the conditions for mutual recognition for the certification of natural persons as regards RACHP equipment, European countries must establish a Certification and an Evaluation Body:

The **Certification Body** (CB) shall establish procedures to issue and withdraw certificates to natural persons or companies involved in one or more of the activities referred to in Table 2 and Table 3 and maintain records that allow verifying the status of a certified person or company.

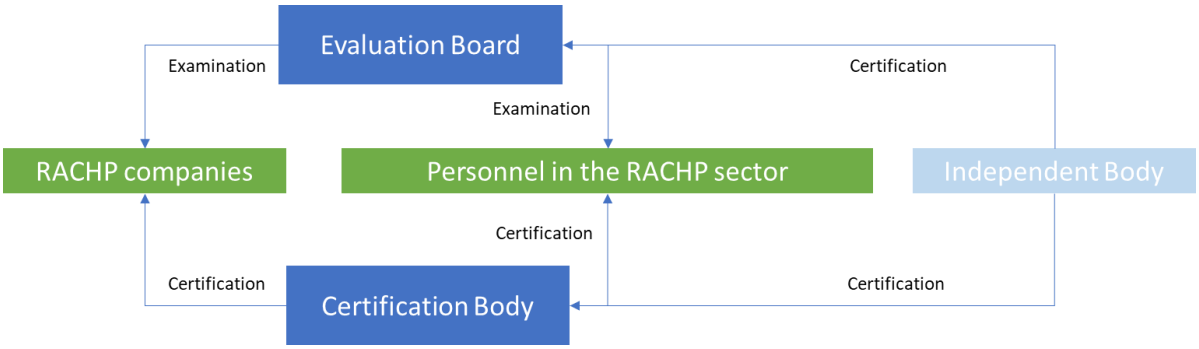
The **Evaluation Body** (EB) shall organise examinations for the natural persons in a manner which ensures that the minimum skills and knowledge set out in Annex I of (EU) 2015/2067 are covered. The examiners must have an appropriate competence in the field to be examined. The evaluation body also has to establish reporting and documentation procedures to keep record of the individual and overall results of the evaluation.

The Evaluation Body and the Certification Body can be the same institution.

Experiences in other countries have shown that these bodies are not always sufficient to ensure a transparent and effective certification system. That is why some countries additionally established an **Independent Body (IB)** to certify the EB and the CB and their practices according to official standards. Its role is to ensure that qualification standards (curricula) and evaluation and certification practices are in line with national regulations and standards and examiners are competent to test and certify the RACHP sector personnel and behave ethically. The establishment of an IB is, however, not part of the requirements of the F-Gas Regulation.

Figure 1 illustrates a possible institutional setup for a certification scheme in line with the F-Gas regulation.

Figure 1: Institutional set-up of a certification scheme for the RACHP sector



Source: Own compilation

Besides personnel working in the RACHP sector, **companies** that employ certificated technicians for the activities requiring certification, must be registered at the NA and are then permitted to purchase and sell refrigerants and fluids (lubricants, secondary refrigerants, etc.). The company must secure that the necessary equipment, tools and procedures are available to the ersonnel engaged in activities for which certification is required.

It might be advisable to appoint a **National Authority (NA)** within a governmental institution that has the overall responsibility for the implementation of the qualification and certification scheme in line with already existing national technical standards, environmental regulations, occupational health and safety decrees and existing RACHP educational decrees.

4.2 European Standard EN 13313:2010 "Refrigerating systems and heat pumps - Competence of personnel"

In the European standard **EN 13313:2010 – Refrigerating systems and heat pumps – Competence of personnel** competences are described, used as a basis for national training and apprenticeship programs in Europe. The following paragraphs provide an overview of the scope and level of competences determined by the standard.

It should be noted, however, that EN13313 is already from 2010. The draft ISO standard **ISO/DIS 22712:2018 Refrigerating systems and heat pumps — Competence of personnel** (which is based on EN13313) is more up-to-date and provides a more practical approach to the skills assessment process and more precise examples of the knowledge and skills to be assessed. ISO/DIS22712:2018 also contains some specific examples for evaluation criteria for workers handling flammable refrigerants.[12] For the Ukraine, in order to develop assessment criteria and certification processes for RACHP personnel, it is therefore recommended to take both standards, the European and the international draft standard as the basis.

4.2.1 Scope & addressees of the standard

EN 13313:2010 includes competences and assessment requirements regarding the refrigeration circuit and is independent of the refrigerant or charge size of the equipment. The standard itself is not mandatory, but several EU Directives require qualified personnel for certain tasks, which can be complied with by applying EN 13313 to their qualification.

[12] Annex A of ISO/ DIS 22712:2018 together with section B.2.3.3 provide concrete examples for defining assessment criteria based on the fields of competences in EN13313 (outlined in Table 5 of this publication). Tables F.1 to F.6 give an example of personnel carrying out circuit maintenance and removing refrigerant specifically on pre-charged self-contained systems containing a flammable refrigerant.

The standard covers activities along the entire refrigeration circuit of refrigeration and air conditioning equipment[13] and defines the associated competence profiles and establishes procedures for assessing the competence of personnel to carry out these activities.

The competences regarding electrical activities are usually covered in national regulations. If not covered by national regulations, a minimum of these competences is listed in Annex B of EN 13313 (see Annex 1 of this guideline). Since electrical installations and troubleshooting may incorporate about 50 percent of the daily regular work tasks of a RACHP professional these competences have to be considered in general training activities and assessments.

EN 13313:2010 defines qualification requirements for persons responsible for the following work tasks in the following six generic fields of competences (as outlined in Table 4).

Table 4: Fields of competences and work tasks in EN 13313:2010

Work tasks	Fields of competences					
1 Design 2 Pre-assembling 3 Installation 4 Putting into operation 5 Commissioning 6 Operating 7 In-service Inspection 8 Leakage checking 9 General Maintenance 10 Refrigerant circuit Maintenance 11 Decommissioning 12 Removing Refrigerant 13 Dismantling 14 Disposal	**I) Basic thermodynamics** (units, terminology, log p. h-diagrams, refrigeration system, …)	**II) Components and tests of refrigeration systems** (refrigeration circuit, heat pump installation, compressors and other components, filling of refrigerants, vacuum testing…)	**III) Piping, joints and valves**	**IV) Safety equipment** (control of temperature, pressure relief, detectors, valves, ….)	**V) Fluids** (refrigeration properties, heat transfer medium, toxicity, flammability, recovery, recycling, disposal, …)	**VI) Commu-nication** (information and reporting to customer about condition of equipment, safety, …)

Source: Own compilation

Companies working in the RACHP sector shall be certified by a recognized national organization, which automatically means registration. To be certified and registered, companies shall have trained personnel (with refrigeration certification), and adequate minimum equipment to enable the competent persons to carry out their work.

[13] The standard does not apply to persons carrying out work on self-contained refrigerating systems as defined in EN 378-1 from the initial design of the product to the complete manufacture of the product, provided the process is controlled and the methods used are checked by an organisation or individual responsible for the compliance with statutory requirements on health, safety and environment.

4.2.2 Levels of competencies

Not every employed RACHP technician needs to have the same level of job competences and for this purpose, EN 13313:2010 includes **four competence levels of certified personnel (see below)** that have a different scope of certified and authorized activities (see Table 5). These activities cover the different activities in which the personnel may operate, from original design to final dismantling and disposal.

Table 5: Levels of competences according to EN 13313:2010 and related potential educational and pre-qualification levels

	According to EN 13313:10			Interpretation	
	Competence level	**Key competences**	**Activities**	**Job level**	**Pre-qualification**
Increasing level of requirements & competencies ↓	**Basic Appreciation, BA**	Install RACHP components (Split AC units); brazing of copper tubing	Execution of rooting of refrigerant pipe work, drainpipes, preparation works	Semi-Skilled Worker	Brazing certification according to ISO 13585:2012. Minimum of 1 year on the job experience
	Working Knowledge, WK	Work that does not require breaking into the refrigeration circuit	Operation, maintenance and leakage control, Support installation	Maintenance Technician	2 years on the job experience
	Fully Operational, FO	Handle refrigerants and fluids (lubricants, secondary refrigerants, etc.)	Installation, commissioning, inspection, testing, operation, maintenance, repair, decommissioning and disposal of refrigeration systems and their parts	Refrigeration Craftsman	3,5 years on the job experience
	Leading Edge, LE	Design and construction of refrigeration systems; purchase and handling of refrigerants and fluids	Compliance design according to all valid standards and norms and responsibility for the sufficiency and accuracy of the system documentation and labelling	Refrigeration Engineer	University degree, ideally with several years of on the job experience

Source: Own compilation

For a detailed description of the competence assessment methods, the subjects to be assessed and the level of expertise as defined for four different levels of work competences (BA, WK, FO, LE) it is recommended to refer to Annex A of EN 13313:2010 and ISO/DIS 22712:2018.

It is important to stress that refrigerant handling is only permitted for personnel within the categories "Refrigeration Craftsman" (FO) and "Refrigeration Engineer" (LE). Besides, personnel within categories Maintenance Technician (WK), FO and LE will have the same level of competence to inspect, analyse relevant data and parameters, make the correct diagnosis, identify abnormal functioning and/or leakage

and use all measures specified within the competences criteria to prevent leakage and have, as soon as possible, any detected leakage repaired.

Note that the different levels of work competences (BA, WK, FO, LE) of EN 13313 are not linked to the four levels of certification as stipulated in the F-Gas Regulation. Annex C of EN 13313, however, provides an overview of how the different activities relevant for RACHP technicians as defined in the standard relates to the certification categories of the F-Gas Regulation (see Table 6).

Table 6: Work tasks according to EN13313 and certification categories according to F-Gas Regulation

Work tasks/Categories accord. to F-gas regulation	1	2	3	4
Design				
Pre-assembling	x	x		
Installation	x	x		
Putting into operation	x	x		
Commissioning	x	x		
Operating				x
In-service Inspection	x	x		
Leakage checking	x	x		x
General Maintenance	x	x		x
Refrigerant circuit Maintenance	x	x		
Decommissioning	x	x		
Removing Refrigerant	x	x	x	
Dismantling	x	x	x	

Source: Table C.1 EN13313

The following box provides a brief description of the mechatronics apprenticeship for refrigeration in Germany. A mechatronic technician for refrigeration is equipped with the knowledge and skills as required for the competence level "Fully Operational" (FO) according to EN 13313 and category I according to the F-Gas Regulation as well as with additional brazing and electrical competences. With the obtainment of the certificate the mechatronic technician for refrigeration is allowed to break into the refrigerant circuit and handle all related tasks, including the installing, commissioning, inspection, testing, operation, maintenance, repair, decommissioning and disposal of the refrigeration systems and their parts. The apprenticeship consists of company- and school-based learning.

Box 1: National example: the mechatronics apprenticeship for refrigeration in Germany

Undergoing a mechatronics apprenticeship for a refrigeration technician in Germany lasts 3 years and 6 months and does not require specific pre-qualifications. The educational content is based on:

- EN 13313:2010 – Refrigerating systems and heat pumps – Competence of personnel Category III, refrigeration craftsmen (FO)
- EN 50110 - Operation of electrical installations – Part 1: General requirements
- ISO 13585-2012 - Brazing - Qualification test of brazers and brazing operators
- further qualification according to F-Gas Regulation (category I)

The apprenticeship is characterised by a combination of company-based and school-based learning. Apprentices spend approximately 70% of their educational time in the company for practical training. The relevant theoretical knowledge is acquired at part-time public vocational schools. The training

regulations and curricula have a nationwide validity and are worked out and regularly modified by professional experts. Trainers in the companies have to pass successfully the trainer aptitude examination. The training at the companies is supplemented by an inter-company training, provided by the training centres of the chambers or professional associations, focussing on those learning outcomes, which cannot be imparted by all companies. At the end of the apprenticeship students have to successfully pass a final exam, conducted by the chambers on the basis of federal standards. Members of the examination committee are experienced practitioners from the companies as well as teachers from vocational schools (and are independent from the chambers). The chamber certificate has a high reputation on the labour market – and in society in Germany.

See also: http://www.berufe.tv/apprenticed-professions/electrical-trades/industrial-electrical-worker-trades/mechatronics-engineer-refrigeration-technology-m-f/

5 Brief description of the knowledge and skills development in the RACHP sector in the Ukraine

The following paragraphs provide a brief summary of the status-quo in the Ukraine with regards to current training programs and certification practices in the RACHP sector. The information stems from the Public Union "Refrigerating Association of Ukraine".

5.1 Current training and qualification programs

There are two types of training and qualification programs offered in the RACHP sector in the Ukraine:

- Trainings for technicians and engineers are mainly held by representatives of **foreign companies,** such as manufacturers of equipment and technologies (Danfoss, Güntner, Bitzer, etc.) in the form of seminars, webinars and training marathons. In their training, manufacturers usually present the options of their equipment and solutions for the transition to environmentally friendly refrigerants. These trainings are conducted by specialized engineers and specialists of these companies.
- In addition, there is a general training for specialists of refrigeration systems and air conditioning equipment, which is conducted with students in **17 educational institutions:** five higher educational institutions (HEIs) and 12 colleges. Among those are the Odessa National Academy of Food Technologies (ONACHT) and its member, the Institute of Refrigeration, Cryotechnology and Eco-Energy, the National Academy of Kharkiv Polytechnic Institute (KPI), the Dnepropetrovsk Installation College of Building Technology and Architecture, and the National Academy of Food Technologies (NUHT) in Kiev. There is currently very little exchange between them.

While these institutions do not offer special courses or trainings for technicians who will work with refrigerants, the concept of refrigerants and their properties is usually included into the general training program for students, but it does not have an in-depth character and only conveys theoretical knowledge without practical training. The training is conducted by teachers of these educational institutions, usually having a specialized or closely connected educational background. Sometimes, at universities, trainers have a technical sciences background and are associate professors or professors of sciences.

In addition, some of these institutions offer short-term training courses. But as public institutions, it is difficult for them to implement these courses commercially and motivate teachers. Moreover, the material and technical base of the educational institutions is insufficient. These trainings are not connected to an official certificate of their completion. Those who can provide such a certificate (universities and colleges)

are dependent on hours and programs that are approved centrally. Short-term courses can usually only be conducted by private companies, but they, on the contrary, do not provide a publicly accredited certificate.

5.2 Current training contents

The topics included in trainings range from the Montreal Protocol to modern retrofit and energy-efficient technologies. In the university programs, information about different types of installations, equipment and its components, refrigerants and its physical properties, their application and use, is usually provided in each discipline/area of study, including the discipline of Labor Protection and Safety Technology. Rarely students are provided with information on European standards and regulations for natural and flammable refrigerants.

Almost every training session contains references to classifications of refrigerants based on international standards referring to their flammability and toxicity (A1, A2 A3, B1…), but theoretical knowledge on safe handling of natural refrigerants is mostly not covered in the programs. This is due to the lack of standards in the Ukraine. Moreover, if such theory is taught, it is not accompanied by practical classes on handling flammable refrigerants. This is also a result of missing standards, accompanied by the lack of facilities and equipment required for training with natural refrigerants (lack of physical capacities of the educational institutions and the companies which work in the RACHP market). Trainings on refrigerators and air conditioners usually do not include installations based on R600a and R290. Thus, the practical skills on the safe handling of natural flammable refrigerants are not taught to training participants.

On the contrary, energy efficiency issues are well covered in the training programs and seminars.

Heat pumps are usually covered under the programs for refrigeration systems and air conditioning equipment. There are a few educational institutions that provide study courses for renewable energy technologies that include heat pumps.

The content of the training programs is regulated by the Ministry of Education and Science of Ukraine. The Ministry is currently being reorganized and in the process of implementing the dual education system (ongoing). The government, however, has not involved employers in this process (together with representatives of the Chambers of Commerce and Industry and employers' associations), which has led to a situation that study contents do not necessarily meet the demand and people are not adequately equipped with knowledge and skills after their education, but have to attain competencies on the job.

5.3 Standards and legislation regarding training and skills development

There are no standards for training in the Ukrainian regulations, but there are professional standards for some types of professions related to refrigeration and air conditioning for different job levels in place: basic worker, mechanic and bachelor, master. Some of these standards, however, are outdated, some professions are also outdated and there is no mechatronics profession, for example in refrigeration. These general standards for the level of working professions and standards for bachelors and masters are often written without extensive discussion with employers and usually written by representatives of the education system only.

The law on the use of ozone-depleting gases and fluorinated greenhouse gases is still under consideration in the Ukrainian Parliament, which includes sections setting out procedures for training and accreditation of trainers (without references to standards).

Many standards, which have been in force since the Soviet Union, have been abolished, and often not yet been replaced with new ones. Therefore, some companies apply European standards, but without a legal force.

5.4 Current certification practices

There is no certification practice in place that provides permits to work with ozone-depleting substances and F-gases in the Ukraine. Training certificates are issued by training organizers and state diplomas on completion of the full cycle of trainings for students by vocational schools, colleges and HEIs.

In addition, there are a few private educational institutions at manufacturing companies, which have started the process of training and certification. Some companies train employees for themselves and sometimes also for others, but the certificates are not approved and recognized by the state.

Compliance is not controlled in the Ukraine. Training certificates, diplomas, etc. are not mandatory and usually depreciated in the labor market. That is why most personnel in the RACHP sector in the Ukraine does not have any specialized education but is trained at the workplace.

Seminars and trainings are usually financed by the organizers and co-financed by the participants. Diplomas are financed by the government as well as by students themselves (and their parents). Educational institutions in the Ukraine usually have very small financial capacities.

Certificates are not categorized in any way, but the diplomas differ according to the institution that issued it:

- the diploma of vocational schools gives a working profession,
- the college diploma gives a profession of a specialist, junior specialist and bachelor, and
- the diploma of universities gives a bachelor's and master's degree.

6 Recommendations for the knowledge and skills development in the RACHP sector in the Ukraine

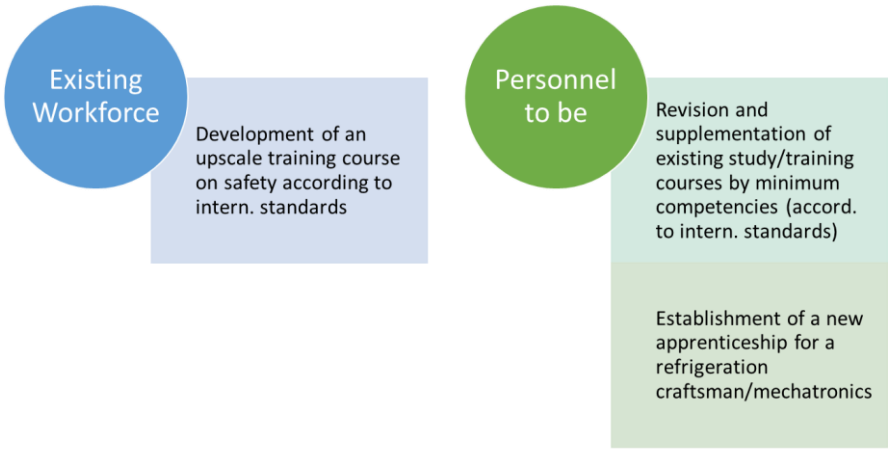
The brief review of the Ukrainian regulations and practices on knowledge and skills development in the RACHP sector has shown that the Ukrainian educational system is currently in a transition phase from the former Soviet Union system towards standards, regulations and educational concepts that are more in line with those in the European Union. The situation provides a chance for the government to consider the past experiences gathered in European countries and implement best practice policies and standards right from the beginning.

The following paragraphs provide some general recommendations with regards to training and certification for the Ukrainian RACHP sector, which would enable the country to introduce more climate friendly heating and cooling technologies and, at the same time, adopt state of the art rules and procedures established in the European RACHP sector as laid out in EN 13313 and the F-gas regulation.

Efforts should be followed up at two different levels (as outlined in Figure 2 below):

- Setting up an upscaling training course for the existing workforce (targeting technicians in the RACHP sector) that include additional safety aspects of alternative refrigerants, and
- Revision of the existing educational system, particularly curricula and certification schemes to ensure that RACHP personnel to-be will be fully equipped with the necessary knowledge and skills compliant with EU regulations and standards.

Figure 2: Approach to tackle current educational challenges in the RACHP sector



Source: own compilation

Against this background it is recommended to conduct an **in-depth analysis of the existing knowledge and skills providers**, including the above mentioned HEIs and colleges, public and private institutions in the Ukraine to examine their study/training programs and current curricula (incl. theoretical and practical contents), their equipment and facilities for training, as well as their resources (financial and human resources). The information would need to be compared against the competence requirements according to EN13313 and the F-gas regulation aiming at identifying important gaps.

Since there is currently no mechatronics profession for refrigeration in the Ukraine and no specific training program (apprenticeship) for a refrigeration craftsman in place, it could be considered to **develop a new mechatronics apprenticeship for refrigeration based on the German apprenticeship program**, which is in line with the European standards and regulations. This could be done **as part of the Ukraine's recent introduction of the dual educational system.**

It is further recommended to **establish an interdisciplinary Working Group or a Community of Practice**, consisting of representatives of the existing training institutions with a strong RACHP sector background and the respective associations in the Ukraine that convenes regularly (e.g. virtually) to develop a strategy that addresses both aforementioned target groups (current and future personnel) and develop minimum competences for RACHP personnel in the Ukraine, as well as assessment and examination criteria. At a later stage, this Group could serve as an advisory board (as described in section 4.3) The following issues would need to be taken up:

- A precondition for the definition of minimum competences and the development of new training programs and certification schemes is the recognition and **adoption of training and skills standards** in the Ukraine. The Ukraine may develop own standards (more coherent with the Ukrainian conditions) or adopt the relevant international standards (e.g. EN13313).
- As natural refrigerants are characterised by a higher toxicity or flammability than HFCs, careful handling of these substances must be ensured. **Vocational education and training curricula** in the Ukraine should be **compared to and supplemented by the essential content of the F-Gas Regulation and the competencies laid out in EN 13313:2010 and ISO/DIS22712:2018.** For that purpose, it would be helpful if these standards and regulations were officially translated into the Ukrainian or Russian language (e.g. by the Ukrainian Agency of Standardization). Annex A Table A1 and Annex C Table C2 of EN13313 provide a detailed composition of tasks and

competencies for four different competence levels (basic worker, maintenance technician, refrigerant craftsman, and refrigeration engineer). In addition, in Annex 1 of the Commission Implementing Regulation (EU) 2015/2067 minimum requirements for the certification of RACHP personnel are defined. In addition to these occupations, the competences of RACHP personnel should cover electrical activities to a refrigerating system, based on national regulations or the list in Annex B of ED 13313:2010).

- All persons carrying out these activities in the RACHP sector should have to demonstrate their practical (skills) and theoretical (knowledge) competence and must be successfully assessed by an approved Certifying Body that will award a certificate of competence according to the determined minimum requirements (and standards). Thus, it **would be necessary that the Ukraine establishes a Certifying Body and an Evaluation Board**that assess individuals and issue and award certificates. The associations (e.g. the Public Union "Refrigerating Association of Ukraine" and Ukrainian National Heat Pump Association) or one of the existing educational institution with a strong background in RACHP technologies or a newly founded institution could serve as a Certifying Body in the Ukraine. The associations, representing employers in the RACHP sector, could ensure that the knowledge and skills taught are in line with the private sector needs and increase appreciation of such certificates in the private sector. The Certifying Body should also set up a procedure to document the results of examinations of individuals and establish a national registry.
- A **strategy** would be needed **for the establishment of new training centers.** Ideally, in all major cities of the Ukraine under the auspices of the associations and with the participation of educational institutions that are members of the association, there would be highly professional training centers.
- It should be discussed amongst the Working Group **which public institution could take the role of the independent body** to certify and supervise the Certifying Body and their practices according to official standards and ensure that qualification standards (curricula) are in line with national regulations and the CB and certification practices (Board of Examiners) are competent to test and certify the RACHP sector personnel.
- As outlined above, it is recommended that certification goes beyond the regular diploma currently offered in the Ukraine, but **recognizes dual forms of education (mixture of company-based and school based training) and privately operated training centers** as well (provided that they comply with training standards).
- Since not every employed RACHP worker needs to have the same level of job competences it is further recommended **to classify and distinguish the level of minimum competences** e.g. for semi-skilled workers, perhaps partially seasonal active only and with lower competence level, from these professionals actively planning and executing work tasks with different demands on complexity and severity. Since the competence categories according to the F-gas regulation do not cover all activities, the **four categories as laid out in EN 13313:2010 can be used.** It is recommended that competence certificates should be valid for four (4) years, starting with issuing the diploma.
- Since the current training programs in the Ukraine lack practical training, they should be revised with the aim to significantly **increase the practical parts of the training**, in line with the requirements laid out in EN13313 and the F-gas regulation.
- Training facilities would need to be equipped with **minimum necessary equipment and tools** (including sufficient consumables) for the training. Equipment and tools should be provided for mechanical works, electric, refrigeration and brazing (for an example list, please refer to Annex 2).

7 Annex

Annex 1: Electrical activities to a refrigerating system as of Annex B of EN 13313:2010

Minimum competences to be included in training activities related to the electrical system
• Explain the use of different kinds of cables and wires; • Explain the use of different kinds of classified connections; • Explain the use of different kinds of classified IP; • Explain the different kinds of safety fuses and switches; • Install electrical equipment and motors; • Lay cables in the cable routes; • Do the wiring of a switch panel; • Connect the power supply at the main switch panel; • Connect a single and/or three phase motors; • Connect the electrical components; • Connect and adjust electronic control components • Check the electrical safety according to the national/international regulations; • Check the power consumption of a motor; • Measure the electrical equipment and cabling; • Adjust the electrical safety switches; • Adjust the electrical equipment; • Take the decision to repair an electrical component; • Earthing and insulation resistance control; • Write a report about the electrical equipment.

Annex 2: Technical equipment and appliances necessary for persons carrying out activities of Category I of the F-Gas Regulation

TOOLS, TECHNICAL EQUIPMENT, APPLIANCES	
- manometer battery with hoses	- absolute pressure meter (0-150mbar)
- electronic scale, resolution 5-10g	- recycling bottle for disposal
- vacuum pump (double stage P_{END} 2-4*10-4 mbar)	- refrigerant cylinders, fittings/connections
- suction equipment	- piercing valves
- soldering equipment, brazing solder	- lead-sealing pliers with seals
- refrigerator oil	- fin comb
- inspection mirror	- measurement equipment (multi-functional)
- flaring tool	- bending jig (Ø 6-22mm)
- refrigeration ratchet	- nitrogen cylinder

- tubing cutter (3-16 mm and 3-30 mmm)	- deburrer
- pressure reducer for N_2 (P_{MAX} 50bar)	- leak detector spray
- leak detector (5g/a)	- thermometer digital
- clip-on measuring equipment	- body protection
- filling hoses	- assembly-filling-and testing units
- ball valves	- 4-port manometer batteries
- acid tester	- tools (screwdriver, socket spanner, open-end spanner, …)
- dynamometric key	-

Source: own compilation based on the application form for companies according to Art. 6 of (EU) 2015/2067 Bayrisches Landesamt für Umwelt