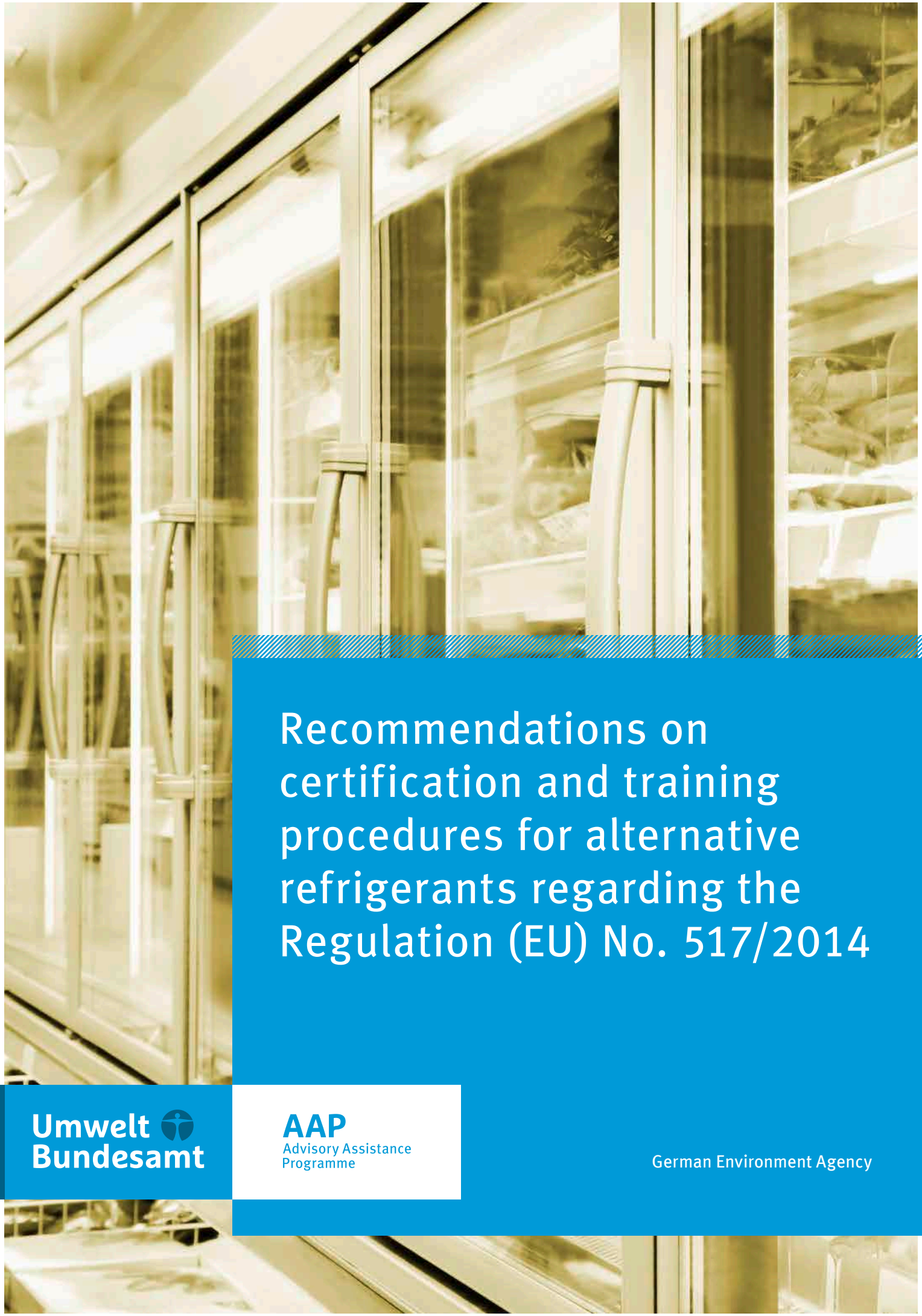

Recommendations on certification and training procedures for alternative refrigerants regarding the Regulation (EU) No. 517/2014

Umwelt Bundesamt

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Recommendations on certification and training procedures for alternative refrigerants regarding the Regulation (EU) No. 517/2014

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Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

Umwelt Bundesamt

HEAT

Öko-Recherche
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ATEX	ATmosphères EXplosibles
BFS	Bundesfachschule Kälte-Klima-Technik Maintal (School providing vocational education for refrigeration construction, part of the guild of refrigeration construction of Hesse-Thuringia and Baden-Wuerttemberg)
BIV	Bundesinnungsverband des Kälteanlagenbauerhandwerks (Guild association representing the interests of the refrigeration construction sector in Germany)
CO_2	Carbon dioxide: As refrigerant also called R744
CO_2 eq	Carbon dioxide equivalent
EN	European Standard
EU	European Union
HC	Hydrocarbon
HFC	Hydrofluorocarbon
IEI	Innung für Elektro- und Informationstechnik (Guild for electrical engineering and information technology, Stuttgart)
ISO	International Organization for Standardization
NH_3	Ammonia (anhydrous): As refrigerant also called R717
ODS	Ozone-depleting substance
TWK	Test- und Weiterbildungszentrum für Wärmepumpen und Kältetechnik (Testing and advanced vocational training center for heat pumps and refrigeration technology)
UBA	Umweltbundesamt (German Environment Agency)

1 Introduction

This paper is intended to provide a short overview on aspects regarding the certification of personnel and companies related to the EU F-gas Regulation. Points under discussion are the inclusion of information on the use of natural refrigerants and new developments, as well as the requirements for activities regarding refrigeration systems in trucks and trailers.

For this purpose, the certification system as implemented in Germany is outlined and possible content regarding natural refrigerants is presented. Conclusions are drawn and evaluated for their applicability to the Bulgarian context.

The ongoing discussion on the inclusion of the certification for persons working with refrigeration systems mounted on trucks and trailers into the current training and certification framework is summarized.

The Commission Regulation (EC) No. 303/2008, an implementing act dealing with certification requirements, has been repealed and replaced by the Commission Implementing Regulation (EU) No. 2015/2067[1], published on 17 November 2015. This document refers to the new regulation.

2 The certification system in Germany

2.1 Certification of personnel

In Germany, the Chamber of Crafts (Handwerkskammer) and the Chamber of Industry and Commerce (Industrie- und Handelskammer) are named as certification bodies according to Regulation (EU) No. 2015/2067. The craft guilds (Handwerksinnungen) are empowered by both chambers to administer exams and are also allowed to issue the respective certifications. Additionally, the competent authority in each state can accredit additional certification bodies. In total, there are currently more than 100 certification bodies in Germany.

The guild association representing the interests of the refrigeration construction sector in Germany (Bundesinnungsverband des Kälteanlagenbauerhandwerks, BIV) has issued a guideline for its member guilds defining the educational contents and exam format in order to fulfil Regulation (EU) No. 2015/2067. The guideline is implemented by vocational training institutes associated with the members of the BIV at state level, ensuring a certain standard and an equal level of education throughout Germany.

Individuals formally educated in refrigeration construction receive their certification after passing their final exam. This holds true for the following vocational educations: apprentice, master and state-certified technician.

Due to a lack of qualified and specialized personnel, technically trained individuals from other sectors are working in the RAC sector, too. Career changers have the possibility to gain certification by taking an exam.

[1] 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

Respective courses and exams are offered by the BIV-associated vocational training institutes as well as by other craft guilds or other chambers, often specifically tailored to the needs of career changers from the respective craft guild to refrigeration construction. Taking part in a course prior to taking the exam is not compulsory if practical experience of at least two years can be proven. Otherwise, taking part in the courses is a mandatory requirement in order to take the final exams.

Courses tailored to the preparation of certification exams are offered with slightly differing lengths and prerequisites. A common prerequisite is a completed vocational training in a mechanical/technical profession. Prior to the admission to a course, documents proving the fulfilment of the prerequisites need to be handed in and are verified. Regular attendance is compulsory and necessary to be admitted to take the exam. As an example, training courses that are offered by a vocational training institute under the BIV and those by a guild for electrical engineering and information technology are shown in Table 1. Depending on the certification category[2] and the experience of the trainee, course lengths vary between 2 and 30 days. Taking part in an exam without any course attendance is not possible under any circumstances for technicians from a non-specialized mechanical/technical profession.

[2] There are four certification categories, allowing for different activities as defined in Reg. (EU) No. 2015/2067:
Category I: (a) leakage checking,(b) recovery, (c) installation, (d) repair, maintenance or servicing, (e) decommissioning,
Category II: (a) leakage checking without breaking into the refrigeration circuit, other activities (b), (c), (d), (e) on equipment containing less than 3 kg of F-gases (or 6 kg, if hermetically sealed),
Category III: (b) on equipment containing less than 3 kg of F-gases (or 6 kg, if hermetically sealed),
Category IV: (a) leakage checking without breaking into the refrigeration circuit

Table 1: Examples for training courses offered for skilled workers from other technical professions to obtain certification according to Regulation (EU) No. 2015/2067

Offering Institution	Target group	Prerequisite	Course duration	Certification category
BFS*	Skilled workers from other mechanical/ technical professions	Completed technical vocational training, e.g. electrician, plumber	15 days course (Module 1) 30 days course (Module 1 and 3)	Category II Category I
BFS*	Skilled workers	Successful completion of Module 1 and 3 before 7 April 2008	4 days	Category I
IEI**	Skilled workers from electrical engineering, plumber and metal-working professions	Master of their trade or at least two years of working experience as skilled worker	5 days	Category II
TWK***	Skilled workers from other mechanical/ technical professions	at least two years working experience as skilled worker in refrigeration construction	4 days	Category I
TWK***		Knowledge of refrigeration basics	2 days	Category IV

*BFS: Bundesfachschule Kälte-Klima-Technik Maintal (School providing vocational education for refrigeration construction, hosted by the guild of refrigeration construction of Hesse-Thuringia and Baden-Wuerttemberg)

**IEI: Innung für Elektro- und Informationstechnik (Guild for electrical engineering and information technology, Stuttgart)

***TWK: Test- und Weiterbildungszentrum für Wärmepumpen und Kältetechnik (Testing and advanced vocational training centre for heat pumps and refrigeration technology)

2.2 Training Content

The content of training courses offered has a strong emphasis on practical work. Usually, at least half of the lessons take place in the workshop where practical skills are developed. As an example, generic course content is outlined in the box below. Information on alternatives to hydrofluorocarbons (HFCs) have not been covered in detail in the past. This has to change, in order to comply with the new Regulation (EU) No. 2015/2067. Presently, many training centres offer separate theoretical and/or practical courses on topics such as flammable refrigerants or stationary refrigeration systems based on carbon dioxide (CO_2).

Content for certification category II:

Basic theory:

- Pressure-temperature correlation
- Setup and function of a refrigeration cycle
- Components of a refrigeration plant
- Environmentally sound handling of refrigerants

Laboratory:

- Setup and starting a refrigeration plant
- Simulation of air conditioning, medium and low temperature plants
- Measurement and interpretation of relevant technical parameters

Workshop:

- Setup and starting a refrigeration plant
- Piping, connection methods, leakage checks, leakage detection
- Adjustment, troubleshooting
- Proper disposal, taking out of service

Additional content for certification category I:

Theory:

- Extension of basic knowledge in thermodynamics, processes of cold production and components of a refrigeration plant
- Setup, function and effect of controlling devices

Laboratory:

- Examination of behaviour of controlling devices in a refrigeration cycle
- Evaporation pressure control, suction pressure control, condensation pressure control, hot gas bypass control

Workshop:

- Building a refrigeration plant with an extended control system
- Start-up
- Leakage detection, leakage check
- Adjustment of monitoring equipment
- Troubleshooting
- Disposal

Full attendance is essential to ensure a certain level of comprehension and competency before admitting the technicians to the final exam. The definition of clear prerequisites for admittance to the training courses, a compulsory minimum duration and mandatory attendance of the complete training course before the exam is desirable.

3 Changes driven by Regulation (EU) No. 2015/2067

The revision of Regulation (EC) No. 303/2008 was necessary to include provisions according to the new F-gas Regulation (EU) No. 517/2014[3]. These changes concern the proposed adaptation of charge sizes measured in kg to the newly introduced charge sizes measured in t CO_2 eq and the inclusion of knowledge on alternatives to F-gases and their safe handling (for suggestions on how to include this new content in the certification scheme, see chapter 4.2).

The activity "decommissioning" was explicitly added to the list of activities requiring certification.

Most discussed was the manner of including activities regarding the servicing of refrigeration systems mounted on trucks and trailers in the certification scheme.

The new EU F-gas Regulation includes servicing of transport refrigeration systems in the list of activities that can only be conducted by certified personnel. Previously, there was no specific EU provision addressing the required competence for such servicing activities. Regulation (EU) No. 2015/2067 adds the refrigeration units mounted on trucks and trailers to the scope of activities, leaving requirements on skills and knowledge unchanged. A transition period until 1 July 2017 is granted for attaining certification for servicing and maintenance of refrigeration units of refrigerated trucks and trailers.

Overview of the discussion concerning the competences required for certification for the transport refrigeration sector

To some extent, different knowledge is required for servicing stationary and transport refrigeration systems. Transport refrigeration units comprise a special type of refrigeration systems, requiring special knowledge that is not part of the standard refrigeration construction education. On the other hand, not all skills and knowledge for dealing with stationary equipment are needed for servicing transport refrigeration units.

Technicians servicing transport refrigeration units are not always qualified to perform all activities on stationary refrigeration systems. Requiring all technicians to obtain the same qualification could have the following implications:

- Possibly disproportionate burden for service personnel of transport refrigeration units, especially for category I certification;
- Service personnel of transport refrigeration units would be allowed to service stationary refrigeration systems, but might lack the necessary practical experience.

Servicing transport refrigeration systems requires specific knowledge that is not necessary for stationary systems and might not be part of the standard refrigeration technician education. Also, the content of the EU F-gas certification does not cover any specific knowledge on transport refrigeration systems. Manufacturing companies usually provide a specific training for the transport refrigeration units independently of the certification acquired by technicians.

Companies undertaking servicing of transport refrigeration systems are not required to be certified at EU level. Consequently, it would be useful to demand a certain standard at a national level. This would require regulations stipulating that the necessary tools for servicing are available and that the technicians are properly equipped and educated.

[3] REGULATION (EU) No 517/2014 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006

In Germany, most of the personnel for transport refrigeration is already certified on the basis of the previous Regulation (EC) No. 303/2008. This is due to the fact that, for specific recovery tasks, a certification has been mandatory in Germany since 2008. The present national regulation was drafted because no specific EU regulation for transport refrigeration was available. In the future, more specific requirements for transport refrigeration at EU level would be useful.

4 Training concerning technologies for replacement and reduction of the use of F-gases and their safe handling

Regulation (EU) No. 517/2014 requires the inclusion of information on replacement technologies into the certification syllabus, as well as information on measures to reduce charge sizes of F-gas refrigerants. Table 2 shows the newly added examination content that is now part of the theoretical test.

Table 2: New examination content dealing with alternative refrigerants to F-gases as outlined in Annex I of Regulation (EU) No. 2015/2067

Section 1: Basic thermodynamics	
1.06: Know about the specific behaviour, physical parameters, solutions, systems, deviances of alternative refrigerants in the refrigeration cycle and components for their use	Relevant to all categories
Section 11: Information on relevant technologies to replace or to reduce the use of fluorinated greenhouse gases and their safe handling	
11.01: Know the relevant alternative technologies to replace or to reduce the use of fluorinated greenhouse gases and about their safe handling	Relevant to all categories
11.02: Know relevant system designs to reduce the charge size of fluorinated greenhouse gases and to increase energy efficiency	Relevant to categories I and II
11.03: Know relevant safety regulations and standards for the use, storage and transportation of flammable or toxic refrigerants or refrigerants requiring higher operating pressure	Relevant to categories I and II
11.04: Understand the respective advantages and disadvantages, notably in relation to energy efficiency, of alternative refrigerants according to the intended application and to the climate conditions of the different regions	Relevant to categories I and II

Replacement technologies to F-gases comprise the use of natural refrigerants such as hydrocarbons (HCs), ammonia (NH_3) and carbon dioxide (CO_2). Substance properties, like flammability, toxicity, or conditions of usage, like high pressure, require precautions in the systems design and in handling the refrigerants. Safety regulations and standards provide guidance on their safe use. More information on the use and application of natural refrigerants is provided in a separate document.[4]

[4] See the document "Recommendations to safety guidelines and standards for the use of natural refrigerants" also provided under project number 47535.

Contents regarding the changes in system designs for charge size reduction and energy efficiency improvement are largely independent from the refrigerant used. Refrigerant charge size can be effectively reduced by changing from direct expansion system to secondary loop or distributed systems (e.g. in supermarkets). Due to stringent charge size restrictions such systems became more popular, especially in northern EU member states. Lower charge size can also be obtained by reducing the internal volume of the refrigeration system via e.g. small channel heat exchangers or optimized liquid-lines.

Several training institutes in Germany offer training courses focusing on handling and operating natural refrigerants. Those courses usually include theoretical and practical work and last between 2 and 5 days.

The courses' contents comprise special characteristics of natural refrigerants that differ from F-gases, such as flammability (HCs, NH_3), high pressure (CO_2) and toxicity (NH_3), which have implications on the handling of the refrigerant and on the system design. Relevant standards are covered as well. Additional courses on the planning and structuring of refrigeration systems elaborate on the use of the physical properties of natural refrigerants for energy-efficient plant designs.

Examining the minimum content of the exam for certification as laid out in Regulation (EU) No. 2015/2067, only about 10 % of the category I exam might cover alternatives and design optimization and only as theoretical questions. Therefore, more than one day of course content does not seem adequate in the context of certification preparation. Nevertheless, it is an opportunity to disseminate knowledge on alternatives among service technicians.

In the light of decreasing amounts of available F-gases on the EU market and, therefore, increasing importance of the application of alternatives, a more elaborate training should be considered.

4.1 Suggestions on the design of an update course, including an overview of selected suitable training courses in the EU

A modular system with teaching units subsequently linked might be the best way to address the needs of different trainee groups. Depending on prior knowledge and experience, as well as the category of certification, certain aspects could be covered in more depth. The three modules presented below are tailored to the required content of Regulation (EU) No. 2015/2067.

Parts of the information presented in the following subchapters have been retrieved from the e-learning modules of the REAL Alternatives platform[5]. The modules are accessible free of charge after registration and provide in-depth information on the use of alternatives to F-gases. Translating the modules into Bulgarian might be an option to provide a starting point for courses on the handling of alternative refrigerants.

[5] www.realalternatives.eu

4.1.1 Module 1: Relevant alternative refrigerants and their properties

A basic overview of relevant alternative refrigerants and their properties, especially safety measures, can be given within a two hour lecture. Their goal is to raise awareness for the aspect. The lecture could contain the following content:

Table 3: Alternatives to F-gases and their properties

	Inhalation	Flammability	Operating Pressure
CO_2 (R744)	non-toxic (asphyxiant accumulates and re-places air when not vented properly)	non-flammable gas	very high pressure
HCs (R290, R600a, R1270)	non-toxic (asphyxiant accumulates and re-places air when not vented properly)	extremly flammable gas	lower to similar pressure compared to R404A
NH_3 (R717)	toxic if inhaled	flammable gas	lower pressure compared to R404A

When using the above described substances as refrigerants, specific safety measures have to be taken, e.g.:

Table 4: Safety measures

	Work area	Equipment	Recovery / disposal
CO_2 (R744)	very well ventilated	suitable for very high pressure	vented
HCs (R290, R600a, R1270)	very well ventilated and free from ignition sources	free from ignition sources	vented in low amounts (< 150 g), otherwise recovered
NH_3 (R717)	very well ventilated and free from ignition sources	suitable for R717 (corrosive!) and free from ignition sources	recovered

For leakage tests it has to be ensured that the method used is safe and appropriate for the refrigerant in question.

It has to be emphasized that such a short general lecture can certainly not enable service technicians undertaking service activities on natural refrigerants systems. Proper practical training is needed prior to working on natural refrigerants systems.

4.1.2 Module 2: System design for charge reduction and energy efficiency

Information on system design for charge reduction and energy efficiency is certainly intended for personnel that are proficient in refrigeration construction, preferably already engaged in system design. The length of the training depends on the objective and can be a short introduction of about half a day to several days of in-depth analysis, exercises and feedback. Possible content could cover secondary refrigerant systems, optimization of heat exchangers, liquid lines, optimal charge for energy efficiency and the influence of climatic conditions on energy efficiency. A comparison between the characteristics of different refrigerants may aid the understanding and illustrate the suitability of individual refrigerants for selected applications.

4.1.3 Module 3: Safety regulations and standards for the use of flammable, toxic or high pressure refrigerants

The target group for safety regulations and standards are individuals proficient in refrigeration construction, preferably involved in system planning and design already. The length of lectures can vary between two hours for a general overview and several days going into detail with exercise in applying the standards to specific cases. Standards to be covered should include the following:

- Standard EN 378, which is a so-called horizontal standard, covers most refrigeration applications, as well as heat pumps and air conditioning systems. It consists of four parts and contains guidance on topics like charge limits, high pressure protection, requirements for machinery rooms, refrigerant detectors, repair of systems using flammable refrigerants, competence of personnel working on systems using flammable refrigerants, etc.
- ISO 817 defines numbering and safety classification of refrigerants.
- The pressure equipment directive 2014/68/EC6 sets standards for design, testing and fabrication of pressure equipment in general, which exceeds 1 litre of volume and more than 0.5 bar above atmospheric pressure. These parameters also apply to refrigeration systems.

For flammable refrigerants, legal requirements for controlling protective systems intended for use in potentially explosive atmospheres, commonly called ATmosphères EXplosibles (ATEX), apply:

- ATEX 95 (94/9/EC): design of equipment and protective systems for use in potentially explosive atmospheres
- ATEX 137 (99/92/EC): minimum requirements for safety and health protection of workers working in potentially explosive atmospheres, e.g. service technicians working on hydrocarbon systems.

Additionally, several standards provide guidance on the use of flammable refrigerants.

- The standard series IEC 60335: “Household and similar appliances – Safety” contains several parts that define system requirements, testing methods and application of systems using flammable refrigerants.
- The standard series EN 60079 provides guidance on the use of equipment in explosive atmospheres and contains categorization of flammable gases, classification of equipment, zones, leakage simulation testing, sources of ignition, wiring, labelling, etc.

[6] DIRECTIVE 2014/68/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 May 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment (recast)

4.2 Suggestion to link the renewal of certification to the completion of a course covering new developments in the use of alternative refrigerants

In Bulgaria, certification according to Regulation (EU) No. 2015/2067 has to be renewed after five years. Presently, the only prerequisite is sufficient working experience during the last five years to obtain renewal of certification. A course on alternatives to F-gases, could be made a requirement for certification renewal to ensure that the personnel's knowledge is up to date.

For category III and IV certification, a two hour module would be sufficient, covering the basics of the safe handling of natural refrigerants as outlined in chapter 4.1.1.

Content for category I and II certification could be presented during a day's workshop, focusing on advantages and challenges when using natural refrigerants, including introducing state-of-the-art measures to reduce charge sizes and to improve energy efficiency (for a possible outline see chapters 4.1.2 and 4.1.3).

These topics are part of the syllabus of the F-gas certification. The goal of such courses is to raise awareness for the special handling requirements of natural refrigerants, as well as their advantages. These courses are not sufficient to enable technicians to work safely with natural refrigerants. For this purpose, training institutes in Germany favour a one week course including intensive practical training in a workshop.

4.3 First steps towards a comprehensive training system on the safe use of natural refrigerants

Setting up a training course on the safe use of natural refrigerants is not mandatory under the F-gas certification according to Regulation (EU) No. 2015/2067. Nevertheless, the subsequent phase-down of F-gases leads to an increased demand for alternative technologies and, thus, for qualified technicians who can install and maintain these technologies.

In Germany, courses on the safe handling of natural refrigerants are offered by several institutions. Usually a company sends their technicians for the training and bears the costs. Increased demand for equipment using natural refrigerants leads to a higher willingness of companies to get their staff trained. Usually, full attendance is a prerequisite for admission to any final exam.

In order to develop a course structure for Bulgaria, it is recommended to start with a train-the-trainer programme. Sending designated trainers to follow, e.g. a natural refrigerants training course offered in Germany, could safe considerable time and money otherwise spend for the development of the course curriculum.

At the same time, measures that give clear signals to the market that alternative refrigerants are politically favoured such as green public procurement could positively influence the readiness of companies to invest in the training of their technicians. Chapter 6 of the guidance document "Recommendations to safety guidelines and standards for the use of natural refrigerants" provides starting points for such measures.