ATMOsphere EUROPE
solutions for europe
natural refrigerants
16-17 March 2015 in Brussels

Refrigerant Emissions and Leakage-blended learning for alternative refrigerants in new equipment

safety, efficiency, reliability and containment

Bruxelles, 16th March 2015

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(www.area-eur.be)

AREA

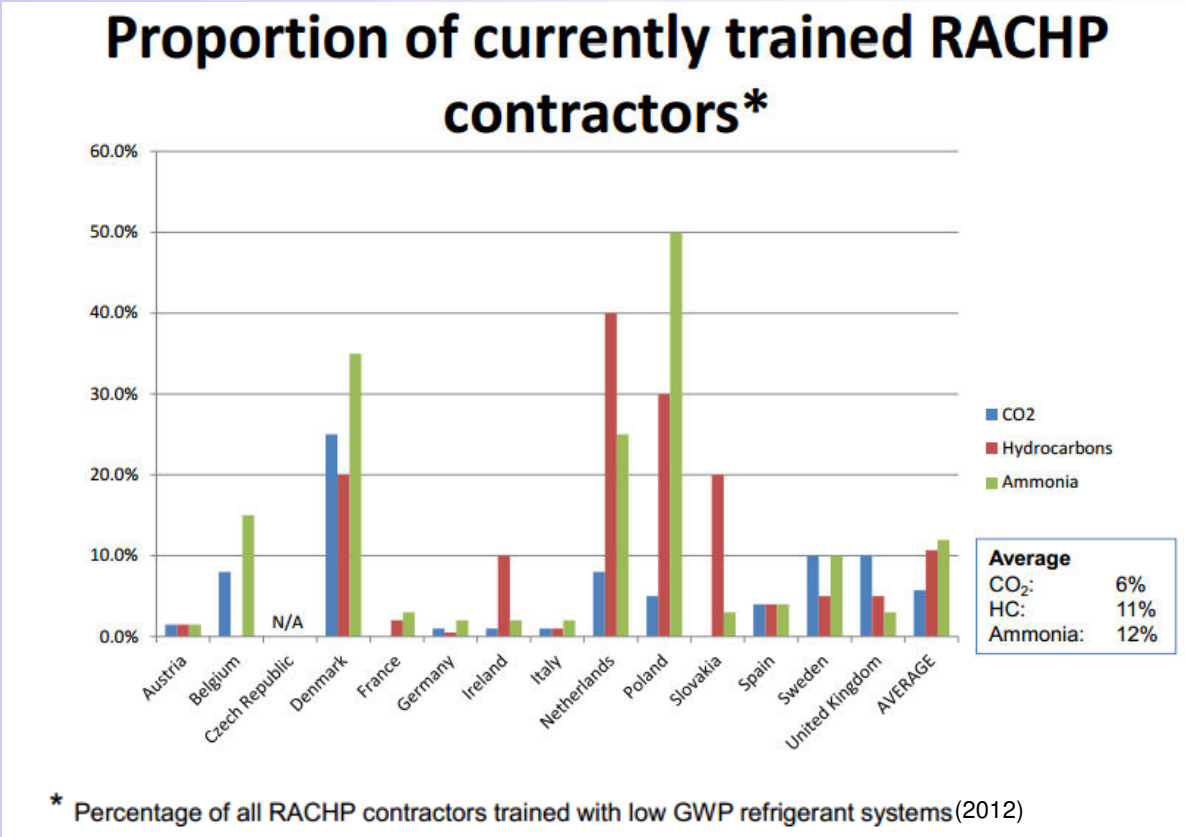
The indisputable voice of European RACHP contractors

- Funded in 1988 in Brussels, Belgium
- Represents RACHP contractors
- AREA in figures:
  - 20 national member associations
  - 17 countries from EU and beyond
  - > 13,000 companies (mainly SMEs)
  - +/- 110,000 work force
  - +/- € 23 bn annual turnover

Design, installation, maintenance and repair of all **Refrigeration, Air Conditioning and Heat Pumps** RACHP systems

Contractors' training with low GWP refrigerants: mind the gap!

In EUROPE,
the use of HFCs is legislatively decreased (by 79% by 2030) and consequently the use of alternative refrigerants is pushed, there will probably be a gap between training offer and training needs resulting in a shortage of trained contractors



AREA position on training and certification of LOW GWP refrigerants

- The phase-down of HFCs will lead to a higher use of alternative refrigerants / low GWP refrigerants. Low GWP refrigerants have issues on safety, flammability, toxicity and high pressure which will need to be properly considered when handling those refrigerants.

AREA recommend to worldwide and European decision-makers and industry minimum requirements for training and certification of contractors handling low GWP refrigerants.

(1) Minimum Requirements listed for the Specific module HC – NH_3 – CO_2

	HC	NH_3	CO_2
BASIC THERMODYNAMICS AND PHYSICS			
Thermodynamic properties of Low GWP refrigerant: temperature, pressure, density, thermal capacity, p/h diagram	T	T	T
Differences between Low GWP refrigerants and HFCs	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	----------
Specific components for that refrigerant in the refrigeration cycle	T	T	T
Material compatibility	----------	T	T
Oil compatibility, requirements and oil return	T	T	T

From AREA Guidance
www.area-eur.be

(2) Minimum Requirements listed for the Specific module HC – NH_3 – CO_2

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

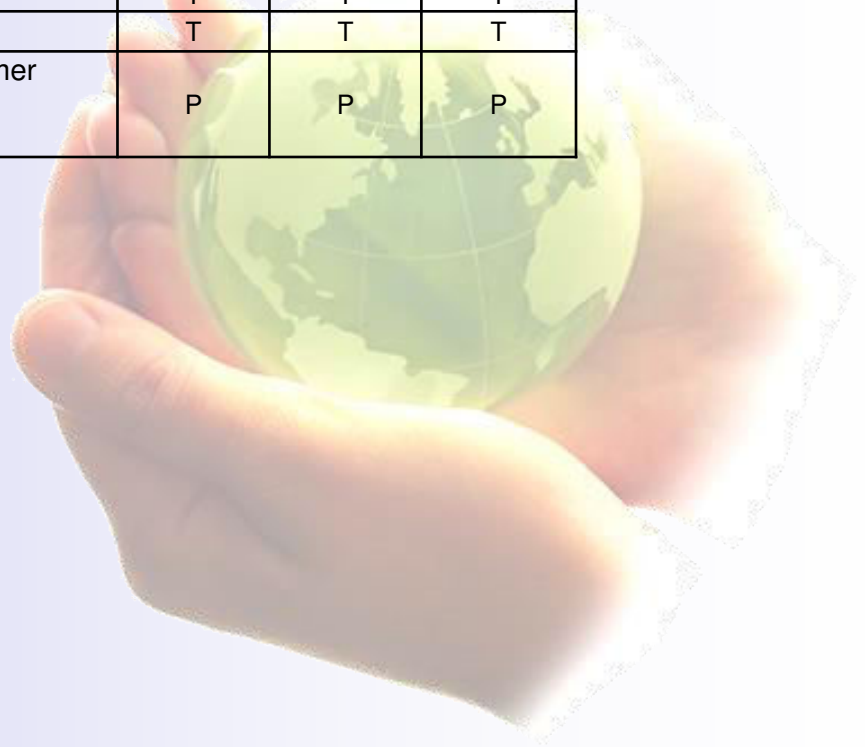
[1] All practical trainings should include theoretical training
[2] City and Guilds, Level 2 and Level 3 Refrigeration and Air Conditioning CPD Pathways, March 2012 v1.0
[3] It is normally accepted to vent hydrocarbons with low charges (please refer to national legislation)
[4] It is normally accepted to vent CO2 (please refer to national legislation)

(3) Minimum Requirements listed for the Specific module HC – NH_3 – CO_2

	HC	NH_3	CO_2
HEALTH AND SAFETY REQUIREMENTS			
Safe system shutdown and isolation [2]	P	P	P
Extinguish a fire, identify the appropriate fire extinguisher	P	P	----------
First aid care treatment for frostbite	P	P	P
First aid due to fire burn	P	P	----------
First aid suffocation due to breathing problems	----------	P	P
Safety issues related to high pressures	----------	----------	P
Calculate LFL (confined space)	T	T	----------
Calculate confined space for asphyxiation (heavier than air)	T	----------	T
Check that Health and Safety rules in the refrigeration system location are respected (emergency exits, fire alarms, leak detectors…)	T	T	T
Correct use of Personal Protective Equipment	P	P	P

(4) Minimum Requirements listed for the Specific module HC – NH_3 – CO_2

	HC	NH_3	CO_2
REGULATIONS AND STANDARDS			
Knowledge of European and National Regulations and standards	T	T	T
Storage of the refrigerant	T	T	T
Transport of the refrigerant	T	T	T
Describe the process for handing over system to costumer completing and passing on appropriate commissioning documentation[2]	P	P	P



Use the right Equipment

- ***Characteristic: Flammable proof***
- Leak detector
- Recovery unit

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Co-financed by
Lifelong Learning Programme

We are proud to have among our stakeholders **the European Commission DG Clima & UNEP Ozone Action**

Sharing best practice across Europe for an INDEPENDENT training and education in Alternative Refrigerants

Institute of Refrigeration

London South Bank University

Associazione Tecnici del Freddo, Italy

Limburg Catholic University College

Foundation for the Protection of the Ozone Layer, Poland

Informationszentrum für Kälte- Klima- und Energietechnik gGmbH

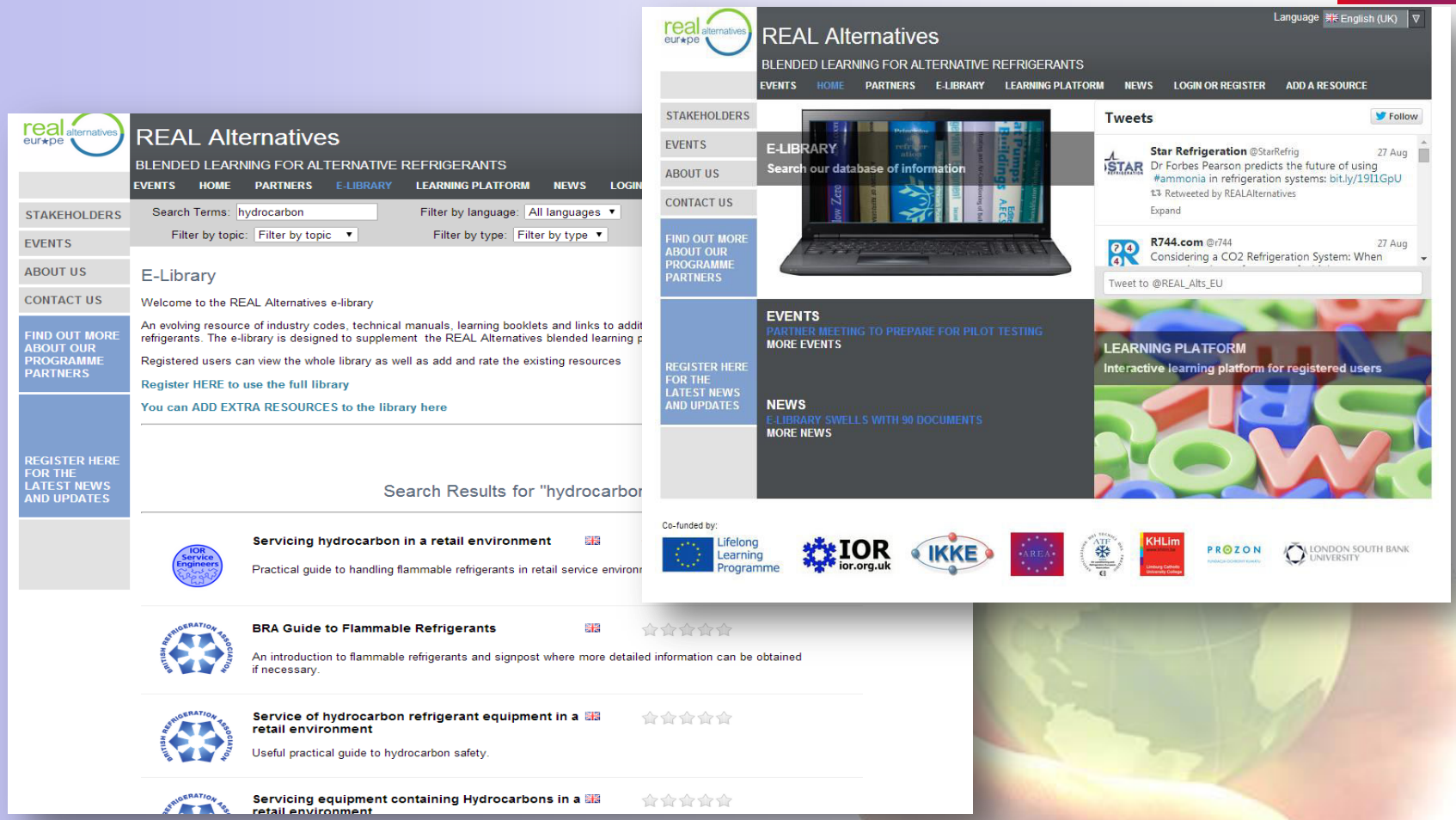
Air Conditioning and Refrigeration European Association

www.realalternatives.eu

REAL Alternatives blended learning resources:

- flexible learning programmes for use by individuals, companies or training providers.
- multi-lingual website
- interactive e-learning in five languages (*more countries interested to translate it*)
- searchable e-library with over FREE 100 downloads you can add to
- tracking spreadsheets, report formats and other tools
- standard on-line tests and controlled assessment papers with optional certification
- opportunities for stakeholders to contribute and update the materials and resources
- downloadable guides and training booklets

Website and e-library already available
E-LEARNING LAUNCH on 19 MARCH 2015



www.realalternatives.eu

How you can get involved

- become a stakeholder
- add technical material to the e-library now
- **sign up technicians for the FREE e-learning courses when launched starting from the 19th MARCH 2015**
- **register to deliver classroom training courses or certification using these materials as an employer or training provider**
- register for updates at the website, follow us on twitter
- translate in other languages
- spread the word…

Module 1 - Introduction to Alternative Refrigerants

Introduction
- Introduction
- Basic Properties
- Application

Refrigerants
- R744
- R290 R1270 R600a
- R32
- R1234ze
- R717

Safety
- Classification
- Flammability
- Toxicity
- Higher Pressures

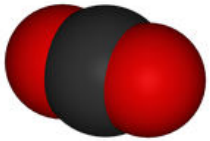
Restriction on use
- Maximum Charge Size
- Direct Expansion Systems
- Indirect Systems
- Comfort cooling/heating

Examples
- Eg.1 - Non Comfort

R744 (Carbon Dioxide, CO_2) WP = 1

Properties

R744 has high operating pressures, a low critical temperature (31°C) and a high triple point. Its volumetric cooling capacity is between 5 and 8 times that of HFCs, reducing the required compressor displacement and pipe size. Its properties have an effect on how the system is designed and operates, especially in high ambient temperatures. It has a high discharge temperature, necessitating two stage compression for low temperature systems. The document highlighted below has detailed information on how these properties effect the application of R744.



CO_2 molecule

Usage

R744 is used in the following system types:

- Pumped secondary – where R744 is the secondary fluid cooled by a primary system. R744 is a volatile secondary which, coupled with the high capacity and density, reduces the required pump power compared to other secondary fluids such as glycol.
- Cascade – where the heat rejected by the condensing R744 is absorbed by the evaporating refrigerant in a separate high stage system. In these systems the R744 operates below the critical point and the high side pressure is generally below 40 bar g. The high stage system can be R744 (see below), or it can be HFC, HC, HFO or R717.
- Transcritical systems – where the R744 heat is rejected to ambient air and at ambient temperatures above approximately 21°C the R744 will be above the critical point (31°C) – i.e. it will be transcritical. The R744 does not condense – it remains a super critical fluid until its pressure is reduced to below the critical pressure (72.8 bar g).The high side pressure is typically 90 bar g when transcritical.

Currently (2014) R744 has been used in several thousand retail systems and in industrial systems in Europe. It is starting to be used in heat pumps and in integral systems. Some examples of R744 are shown below:

The application of R744 has required additional skills for design engineers and service technicians, and availability of new components.

This video gives an introduction to carbon dioxide properties when used in refrigeration

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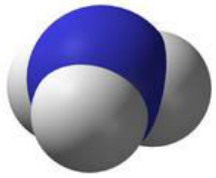
Examples
- Eg.1 - Non Comfort

R717 (Ammonia, NH_3) GWP = 0

Properties

R717 has a relatively high saturation temperature at atmospheric pressure, is highly toxic, mildly flammable and has a pungent odour.

It can be smelt at concentrations of just 3mg/m^3 so it is evident at levels much lower than those which are hazardous (the ATEL / ODL is 350 mg/m^3). It is the only commonly used refrigerant which is lighter than air which means that dispersion of any leaked refrigerant takes place quickly.



NH_3 molecule

R717 also operates with very high discharge temperatures. Single stage compression can therefore normally be used above -10°C evaporating temperature. Below this, two stage compression with interstage cooling is required.

The high toxicity limits the application of R717 to very low charge systems or industrial systems (i.e. systems in areas which are not accessible by the general public). This typically includes distribution cold stores and food processing plants, usually using secondary systems where R717 is the primary refrigerant.

Some examples of Ammonia packaged systems are shown below:

Ammonia corrodes copper so steel pipe work and open drive compressors are used. It is also immiscible with conventional mineral oils, making oil rectification an additional requirement of the refrigeration systems. The use of steel pipe, open drive compressors and oil rectification impact on the capital cost of an ammonia installation.

The video below shows an example of an adsorption ammonia system used in a building services application

Module 4 - Guidance on the Maintenance and Repair for Alternative Refrigerant Systems

Introduction
Hazards
Service Procedures
Flammable Refrigerants
Safety
Equipment
Leak Testing
Recovery and Evacuation
Brazing
Charging and Replacement
R744
Safety
Equipment
Leak Detection
Disposal
Evacuation and Charging
Isolating Replacing
R717

The safe working environment and PPE

Flammable Refrigerants

This section covers the safe handling of:

- Hydrocarbons (R600a, R290, R1270);
- R32 (also refer to the section on F Gases);
- R1234ze (also refer to the section on F Gases);
- R717 (also refer to the section on R717).

The safe working environment and PPE

The safe working environment and PPE When you work with flammable refrigerants the area must:

- Be well ventilated
- Have no source of ignition within 3 m (a typical safe area when working on flammable refrigerant systems).

If necessary introduce forced ventilation using a suitable fan assembly. This has an Ex rated fan motor and a 5m cable which enables it to be switched on outside the safe work area.

Figure 1, suitable ventilation fan

When carrying out invasive work, or if a leak is suspected, check and monitor the work area using an HC detector.

It is important that the detector cannot be zeroed out to background flammable refrigerant levels and alarms at 20% of the lower flammability level.

The photo shows suitable detectors for HCs.

Figure 2, flammable gas detectors

You should also have a fire extinguisher to hand.

This should either be a dry power type with a capacity of at least 2 kg, or an equivalent sized CO_2 type.

Figure 3 (left), dry powder fire extinguisher
Figure 4 (right), CO_2 fire extinguisher

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