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RICARDO

F-Gas Consultation Forum

Topic A:

Barriers to the uptake of low GWP alternatives to HFCs related to standards, codes and legislation

Preliminary findings of external study carried out for DG CLIMA

September 10th 2015, Brussels

Why are standards potential barriers?

- current HFCs have very high GWP
  - but all low GWP alternatives have characteristics that need to be addressed for safe use
- when there were numerous non-flammable / non-toxic HFCs available
  - easy to apply a conservative / simplistic approach to standards / legislation
  - standards committees could be overly cautious
    - bans are currently applied to certain applications even if risk level extremely low
- going forward we need to stop using high GWP HFCs
- some of the current standards / legislation make the transition difficult
  - the historic cautious approach creates unnecessary barriers
- in particular, the way flammability is dealt with creates barriers
  - for higher flammability fluids such as HC-290 and HC-600a
  - for lower flammability fluids such as HFOs, HFO/HFC blends and HFC-32

Growing concerns about barriers to HFC alternatives

- 16th European Conference on the latest Technologies in Refrigeration and Air Conditioning, Milan, June 2015
- Stephen Yurek, president of the US AHRI: "*Significant changes are required to achieve phase-down programmes already implemented in Europe and being introduced in the US and elsewhere. Most of the people in this room understand where we are going as we transition. The people who write the building and safety codes aren't here. There are the building inspectors, the fire marshalls, the insurance companies that we need to educate as well so that we can move forward in that process*".
- Andrea Voigt, Director of EPEE: "*We absolutely have to have the right frameworks in place. We have to have the installers able to handle all these different types of refrigerants. We have to have the right standards and the right building codes to make this all happen*".
- at Montreal Protocol OEWG 36, Paris, July 2015
  - GIZ side event on standards and IPR
  - UNEP OzonAction side event on safety issues

Where exactly are the barriers?

- codes, standards or legislation:
  - could restrict the uptake of low GWP alternatives to HFCs
  - could make it very difficult to achieve EU HFC phase-down targets
- possible barriers at 2 levels:
  - at EU level, related to international codes (e.g. EN 378) or EU Directives (e.g. ATEX)
  - at Member State level, related to national regulations or regional rules
- Topic A addresses these issues
  - provides an overview of standards, codes and legislation
  - provides an assessment of barriers at EU and Member States levels

Study Activities on barriers related to standards

- literature review
  - to identify relevant EU level standards / legislation
- Member States survey
  - to obtain information about national standards / legislation and produce an overview
- discussions with experts
- case studies
  - looking in more depth at countries with national standards
  - looking in more depth at EU and international standards / legislation
- this Consultation Forum
  - to identify any gaps in data and to test preliminary findings
- draft report due by October 2015

EU and international standards / legislation

examples for refrigeration, air-conditioning and heat pumps

Type	Reference	Comments
EU Directives	94/9/EC	ATEX 95 equipment directive, for products with flammable refrigerants
	99/92/EC	ATEX 137 workplace directive, for worker safety with flammable refrigerants
	97/23/EC	Pressure Equipment Directive
	14/35/EU	Low Voltage Directive
	2006/42/EC	Machinery Directive
EU Standards	EN 378 (2008)	Refrigerating systems and heat pumps – safety and environmental requirements
	IEC EN 60335-2-24	Safety requirements for household and similar electrical appliances
	IEC EN 60335-2-40	Safety requirements for electrical heat pumps, air conditioners, and dehumidifiers
	IEC EN 60335-2-89	Safety requirements for commercial refrigerating appliances
Inter-national Standards	ISO 5149	Refrigeration Safety and use; general equipment requirements
	ISO 817	System for numbering and classifying refrigerants , including 2L flammability

Using flammable refrigerants: ATEX Directives vs. EU Standards

- ATEX provides a general framework (mandatory)
  - allows an expert to address risks for a particular installation
  - this gives some flexibility (e.g. on assessment of allowable refrigerant charge)
  - but difficult and time consuming to use
- EN 378 and IEC standards (voluntary) provide prescriptive rules on using flammable refrigerants
  - simpler and quicker to use
  - but use of simplified assumptions encourages cautious approach
- many experts argue that the approach for higher flammability refrigerants (HCs) is too restrictive on maximum charge
- lower flammability refrigerants (e.g. HFOs) not yet recognised in EU standards
  - already recognised in ISO 5149

Member State Survey

- sent to F-Gas contact points in all 28 Member States
- responses received from 24 countries
  - representing around 95% of EU population
  - non-responders: Greece, Hungary, Luxembourg, Slovakia
- key question in survey:
  - list any national or regional codes, standards and legislation that could restrict the use of refrigerants beyond the requirements in EU Directives and safety standards
- foams
  - none of the responders highlighted any national codes or legislation that would be a barrier to use of low GWP alternatives in foams
- refrigeration, air-conditioning and heat pumps (RACHP)
  - a significant majority of countries (17 out of 24) said they had no national codes or legislation that would be an extra barrier to use of low GWP alternatives in RACHP

EU Countries with barriers at national level

- the 7 countries that reported some national legislation that may create barriers are:
  - Austria
  - Belgium
  - France
  - Germany
  - Italy
  - Spain
  - Sweden
- some are only minor barriers, but in certain countries there is a ban that affects certain low GWP refrigerants, especially in buildings with public access

Example 1: Italy

- a number of Ministerial Decrees affecting various public access buildings including:
  - hotels, shopping malls, hospitals, schools, offices, airports
- wording relating to refrigerants in each Decree is similar
- specifically affects air-conditioning (central and localised)
  - does not apply to refrigeration or heating-only heat pumps
- requirements for air-conditioning systems:
  - refrigerants must be non-flammable and non-toxic
  - chillers that use ammonia can be used in indirect systems
- barriers created
  - no split air-conditioning with flammable refrigerants
  - no chillers with flammable refrigerants
    - ammonia is allowed
- rules are not the responsibility of the Environment Ministry
  - makes it more difficult to get the legislation changed

Example 2: France

- Decree of 25 June 1980 approving the general provisions of the safety regulation against the risks of fire and panic in public buildings including:
  - hotels, restaurants and bars, shops and shopping malls
  - hospitals, schools, offices, museums, libraries, conference and entertainment facilities
- Article CH 35 (amended July 2003) affects air-conditioning
- barriers created similar to those in Italy
  - no split air-conditioning with flammable refrigerants
  - no chillers with flammable refrigerants
    - ammonia is allowed
- several references made to EN 378
  - but no version referred to (Decree in 2003, so available version is 378:2000)
  - important to harmonise national regulations with latest versions of standards
    - but this can take several years to achieve

Example 3: Germany (1)

- German response refers to a number of pieces on national / regional legislation that must be considered
- however, in most situations these are not extra barriers
  - e.g. the use of HCs in Germany is less restricted than in EN 378 / IEC standards
  - some end users specify use of EU level standards, so HCs still constrained
- interesting study carried out in Germany, published in December 2014
  - development of a strategy for increased use of hydrocarbon refrigerants
- investigation of 4 possible HC applications
  - split air-conditioning, domestic heat pumps, refrigerated trucks, chillers
- useful discussion about
  - product liability issues for OEMs and component manufacturers
  - difference between rules in standards and “state-of-the-art”

Example 3: Germany (2)

- German study identified various important barriers in standards at EU level e.g.
  - formula for maximum charge
  - evaluation of leakage quantity / leakage rate
  - allowance for risk mitigation e.g. ventilation, shut-off valves
- interesting distinction in types of barriers to HCs:
  - for split air-conditioning: standards
  - for domestic heat pumps: lack of awareness / acceptance in market
- some recommendations from German study:
  - Green Public Procurement of chillers
  - changes to standards
  - review and clarification of product liability laws
  - independent and objective consulting centre for hydrocarbon refrigerants

Example 4: Spain

- Spanish response refers to Royal Decree 138/2011
  - this sets detailed safety standards for refrigeration applications
- the requirements for higher flammability refrigerants are similar to EN 378
  - but only sealed systems in public access areas
- the requirements for lower flammability refrigerants are quite restrictive
  - 2.5 kg charge limit
  - must be a sealed system

Example 5: Sweden

- Swedish Work Environment Authority
- treats all refrigerants as either flammable or non-flammable
  - all treated as “higher flammability”
  - no distinction made for lower flammability refrigerants
- hydrocarbons allowed in appropriate circumstances e.g.
  - <0.15 kg in domestic refrigerators
  - HC chillers in open air / special machinery rooms
  - but risk assessment required – can be costly / time consuming
- pressure must be applied to Work Environment Authority to change current rules

Impact of EU Standards and National Legislation: Ammonia (R-717)

- ammonia characteristics: toxic and lower flammability (B2 in EN 378:2008)
- widely used for many years in industrial distributed systems and large chillers
- industrial distributed systems
  - compressors, vessels and condensers in special machinery rooms / outdoors
  - coolers and low pressure pipework in occupied factory areas with authorised access
  - unlimited ammonia charge can be allowed in EN 378:2008
- water chillers usually located in machinery rooms or outdoors
  - EN 378:2008 allows unrestricted ammonia charge in most circumstances
    - some exceptions apply, e.g. machinery room is below ground level
  - most national legislation also allows use of ammonia (150 kg restriction in France)
- ammonia Codes of Practice (e.g. UK IOR) well respected and widely used
- **→ no major barriers related to ammonia standards / legislation identified by industry experts**

Impact of EU Standards and National Legislation: CO_2 (R-744)

- CO_2 characteristics: non-flammable and non-toxic (A1)
  - operates at high pressure
- used widely in supermarket systems and water heating heat pumps
  - significant potential in many other areas
  - e.g. industrial cooling, condensing units, bottle coolers, data centres
- experience with CO_2 more limited than ammonia – few systems before 2010
  - but there has been rapid uptake and successful implementation under EN 378:2008

→ **no major barriers related to standards / legislation identified by industry experts**

  - some issues e.g. pressure relief valve requirements; risk management rule

Impact of EU Standards and National Legislation: Flammable refrigerants

- two main groups of flammable refrigerants under consideration

- hydrocarbons (HCs): higher flammability, non-toxic
  - most common are propane (R-290), iso-butane (R-600a) and propylene (R-1270)
  - widely used in domestic refrigerators and freezers for over 15 years
  - significant and fast growing use in small hermetic commercial refrigeration
  - some use for chillers and industrial systems
  - small split air-conditioning systems being introduced (e.g. in China)

- HFOs, HFC-32, certain HFO / HFC blends: lower flammability, non-toxic
  - only recently introduced (2 – 3 years max; many still under development)
  - various potential markets e.g. split air-conditioning, chillers, condensing units

→ **industry experts identify standards / legislation as a major barrier for flammables both at EU and national levels**

Impact of EU Standards and National Legislation: Foam blowing agents

- no standard / legislative barriers identified for foams in Member State survey
- foam situation quite different to refrigeration
  - flammability significantly affected by foam matrix, not just by blowing agent
  - adopting new blowing agents requires long term insulation performance testing
- historically, significant use of CFCs and HCFCs, replaced under Ozone Regulations
  - flammable blowing agents (e.g. HCs and DME) widely adopted as ODS alternatives
  - for some applications non-flammable HFCs adopted
  - in many cases choice made on financial grounds (e.g. HFCs for low volume factories)
- options to replace HFCs include:
  - non-flammable HFOs, lower flammability HFOs, higher flammability HCs

→ **no major barriers related to standards / legislation identified by industry experts**

  - although testing new products for compliance with standards takes time

Understanding safe use of flammable refrigerants (1)

- older RACHP standards / legislation use a simplistic approach to flammability and allowable charge sizes
- some simply refer to flammable / non-flammable e.g.:
  - Italian and French Decrees that ban all flammables in certain applications
- this approach was historically appropriate
  - plenty of non-flammable refrigerants available
- introduction of HFC phase down changes this situation
  - flammable refrigerants required to meet phase-down targets
  - better understanding of safe charge limits needs to be established / applied
  - many different stakeholders need to address this
    - e.g. fire regulators; insurance

Understanding safe use of flammable refrigerants (2)

- significant differences in the degree of flammability of different refrigerants
  - these are already partially recognised in EN 378:2008 flammability categories

1	2	3
Non-flammable	Flammable	Higher flammability

- ISO 5149 has introduced a new lower flammability category
  - based on fluids with low burning velocity

1	2L	2	3
Non-flammable	Lower flammability	Flammable	Higher flammability

Understanding safe use of flammable refrigerants (3)

- the rules for maximum charge need to be carefully reconsidered
  - standards are considered too restrictive for flammable refrigerants
- technology can allow safe use of flammables in a wider range of applications
  - use of risk management techniques
    - e.g. ventilation and shut off valves triggered by leak detectors
  - use of more resilient and appropriate components
- standards writers in a difficult position
  - insufficient practical data available
  - a very cautious approach is often adopted in the absence of better evidence

→ many industry experts express concerns that current standards do not maximise the safe envelope of use for flammable refrigerants

Calculation of maximum allowable charge (1)

- EN 378:2008 has complex matrix of allowable charge for all refrigerants, depending on
  - location and type of refrigeration equipment
  - type of occupancy (public access; supervised access; authorised access)
  - refrigerant safety group (e.g. A1, A3 etc.)
- different calculations for human comfort cooling and for other applications
- calculations take into account
  - flammability characteristics of each specific refrigerant (LFL)
  - room volume (and for human comfort, height of evaporator)
- there is some provision to take “risk management” into account
  - e.g. ventilation or other measures to limit concentration level of leaked refrigerant
  - but currently these only apply to non-flammable refrigerants

Calculation of maximum allowable charge (2)

- maximum charge can vary across and within standards
- Example 1: hydrocarbons in EN 378:2008 and IEC EN 60335-2-89
  - small retail refrigeration equipment in area with public access
  - EN 378: up to 1.5 kg may be allowed depending on room volume
  - EN 60335-2-89 ignores room volume – maximum charge = 0.15 kg
- Example 2: Within EN 378, hydrocarbons for human comfort or other refrigeration

Example calculations for HC-290 (propane), Room 5m * 10m * 2.5m					
Human Comfort					Other refrigeration
Evap height	0.6	1.1	1.8	2.2	
Max kg	0.18	0.33	0.53	0.65	0.95

Plans to update EN 378

- latest version of update is out for consultation
  - revision may be agreed by 2016
- possible changes of relevance:
  - inclusion of lower flammability category, harmonised with ISO 5149
  - introduction of risk management measures to allow larger charges
    - for non-flammable and lower flammability refrigerants
- other changes being considered, but possibly not in this revision
  - possible merging human comfort and other application charge calculations
  - possible inclusion of hydrocarbons in refrigerants in risk management approach
  - test procedure for leak amount
  - evaluation of below ground constraints for hydrocarbon charge
  - possible improved harmonisation with ATEX

Plans to update IEC EN 60335-2-40 and 60335-2-89

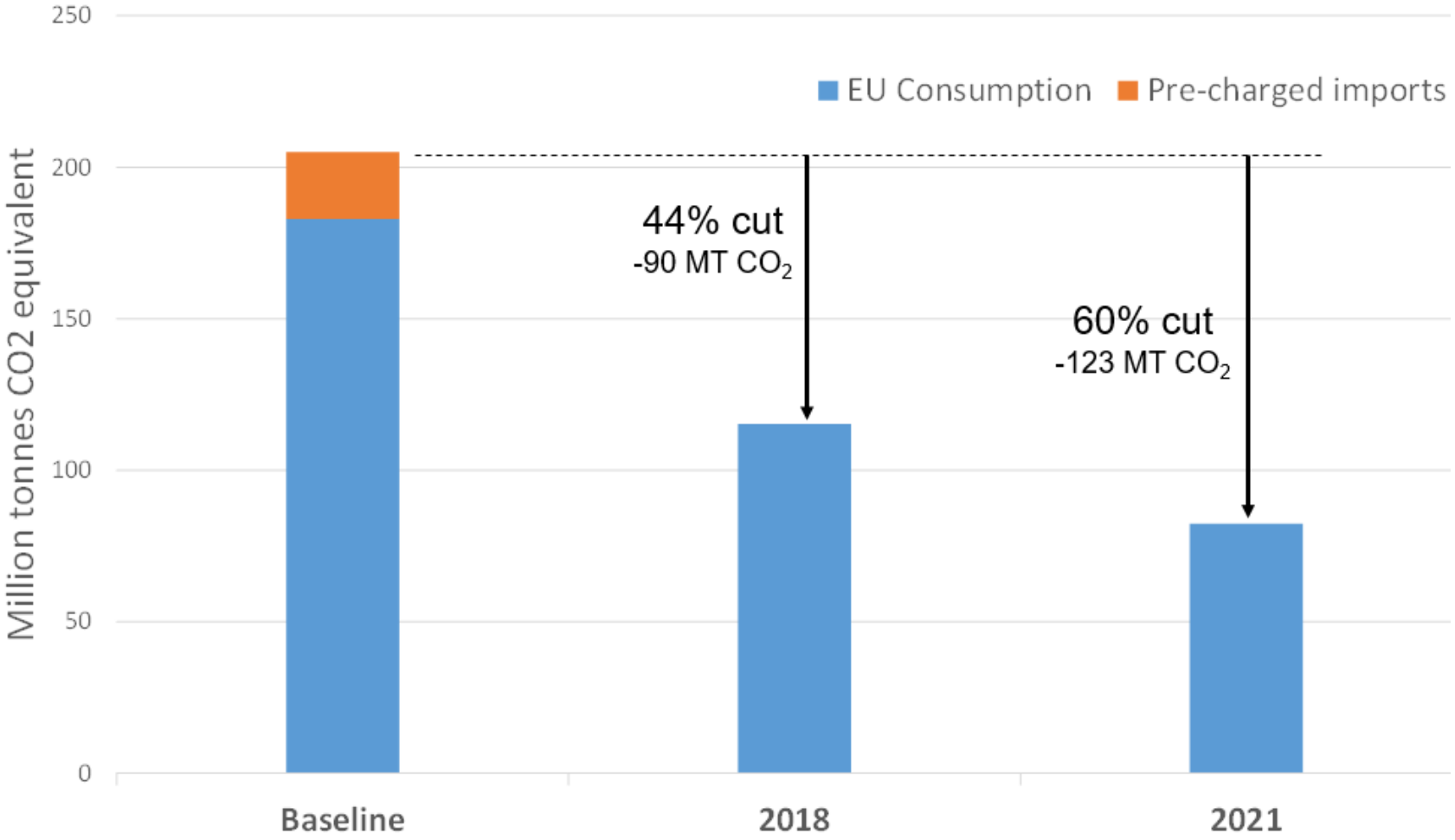
- these standards may also be revised, possibly by 2017
- 60335-2-40: electrical heat pumps, air conditioners, and dehumidifiers
  - charge rules similar to EN 378 human comfort calculations
  - changes being considered:
    - inclusion of lower flammability category
    - inclusion of risk management measures to allow greater hydrocarbon charge
- 60335-2-89: commercial refrigeration appliances
  - includes 0.15 kg charge restriction on any flammable refrigerant
  - changes being considered: higher hydrocarbon charges (e.g. 0.3, 0.5 or 1.0 kg)
    - with measures for greater system resilience, ventilation and room size warning

Other Standards and Directives that may be relevant

- Ecodesign Directive
  - do energy efficiency requirements create unfair burdens? E.g.
    - Hydrocarbons in Split AC
    - CO2 in hot water heatpumps

Action is required urgently

- changing standards and legislation is a slow process
- but the impact of the EU HFC phase-down becomes very significant within 3 years
  - major cuts occur in 2018 and 2021



What needs to be done to standards / legislation ?

- interim conclusions based on survey responses, literature review and expert comments
- ammonia: little change required
  - ammonia standards are well-established and appropriate for industrial refrigeration and for most chiller applications
- CO_2: little change required
  - as CO_2 is non-flammable, current standards do not create major barriers
- hydrocarbons (higher flammability)
  - **urgent changes required at both EU and Member State levels**
  - current maximum charge limits considered unfairly restrictive and often not based on evidence or taking technological progress into account
- HFOs, HFO/HFC blends, HFC-32 (lower flammability)
  - **urgent changes required at both EU and Member State levels**
  - 2L category is new in ISO 5149 – needs harmonisation in EU?
  - more data needed to understand safe limits for 2L refrigerant charge

Concluding Comments on Standards and Legislation

- comprehensive information on EU and national standards / legislation collected
  - via Member States survey
  - from literature review and discussions with experts
- for ammonia and CO_2 there are few major barriers
  - these refrigerants are well established based on current standards
- for flammable refrigerants the barriers are very significant
  - there are barriers for all Member States due to EU standards
  - there are extra barriers in some Member States due to national legislation
- the barriers to flammables will affect the implementation of the HFC phase-down
- changing the current standards is a slow and difficult process
  - action is needed urgently because of the scale of HFC cuts by 2018