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12h July 2010

Assessment of the effectiveness of the EU F Gas Regulations in the UK based on experience of application by the stationary refrigeration, air conditioning and heat pump industry in the UK

EXECUTIVE SUMMARY

ACRIB has developed a detailed position paper reviewing F Gas Regulation in the UK and proposing measures to enhance the effectiveness of the regulation relevant to stationary refrigeration, air conditioning and heat pump sectors -in minimising emissions, based on experience to date with its implementation. It is to be endorsed by all ACRIB member organisations (AMDEA, ARC, BFFF, CIBSE, FETA, FSDF, HVCA, IOR).

This response is intended to confirm the UK industry evidence that improving containment works provided that there is sufficient support from UK Government in raising awareness of leakage issues and the effective encouragement of compliance. Government should be aware of the positive steps taken for example by retailers to both comply with the regulation via their contractors and to seek alternative solutions where feasible – all leading to a definite but unquantifiable reduction in emissions due to behaviour change.

This thorough analysis conducted in 2010 by ACRIB has identified that the single most significant barrier to effectiveness of the Regulation is the lack of visible enforcement, policing and mechanisms to guarantee compliance or report non compliance.

Whilst welcoming Governments emphasis on encouraging compliance and providing valuable advice on implementation though the F Gas Support service, industry now feels that it is time to make a shift towards improved enforcement to achieve the emissions reductions which are possible in the face of considerable investment by many elements of the industry in compliance.

ACRIB has concluded that the following steps are necessary within the UK to address this issue:

1. Public Awareness campaign focused on those with responsibility for equipment operation including information about enforcement activity and setting up of a reporting service which will target non-compliant operators, employers or personnel.

2. More active and high profile enforcement of operator legal obligations – particularly focused on record keeping and use of certified companies and individuals - under the Regulations and policing by relevant authorities.

3. The introduction of mandatory registration for individuals and public databases of members of company certification schemes in order to allow equipment operators to verify their own compliance with requirements and the compliance of companies and personnel they employ.

4. The placing of the onus for restricting handling of F gas refrigerants by uncertified personnel on the ***supplier*** of the refrigerant or equipment rather than the purchaser and the introduction of further restrictions on the sale of specific equipment/containers containing F gas refrigerant to uncertified personnel.

5. The compliance of all three company certification bodies must be actively monitored by Government to ensure equivalent standards are being maintained. Assurance that companies holding F Gas certificates meet all the criteria must be available by providing Company certification bodies with the authority to verify more pro-actively data provided by applicants.

6. UK Government (or an appointed) authority must take responsibility for ensuring training, assessment and certification standards are being maintained by the two bodies appointed to issue the individual F Gas certificates. This authority must have the powers to withdraw a body's certification rights if necessary.

A full and detailed commentary by ACRIB on the 13 points of the Review of the Regulation which will be carried out by the EU follows

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Detailed ACRIB Statement

Introduction

This ACRIB position paper proposes measures to enhance the effectiveness of the regulation relevant to stationary refrigeration, air conditioning and heat pump sectors -in minimising emissions, based on experience to date with its implementation. It is to be endorsed by all ACRIB member organisations (AMDEA, ARC, BFFF, CIBSE, FETA, FSDF, HVCA, IOR).

The recommendations in this paper should form the basis of the UK input to the EU review of the regulation due in July 2011 and will be circulated to The Commission, Oko recherche, AREA, EPEE, IIR and in the UK Defra and BIS.

It will also be made publicly available to the industry via trade publications and ACRIB websites.

Technical input

Input is based on comment and consultation from the Technical Committees of all ACRIB member organisations as well as those with specialist knowledge of training, key legislation developments, refrigerant supply, distribution and recycling, system design, installation, commissioning, service and maintenance, equipment production and distribution, and equipment use in commercial and industrial applications.

The Review of the Regulation

The F Gas Regulation states that within 5 years of the Regulation coming into force (by 4th July 2011) the EU Commission will produce a report based on experience of application of Regulation. This report will take the form of a 13 part assessment and evaluation process, reflected below.

1. Assessment of impact on emissions and projected emissions plus cost effectiveness.

Government and voluntary industry initiatives such as the IOR REAL Zero campaign, ACRIB individual registration and REFCOM Voluntary company scheme are demonstrating that the F Gas Regulation is being effective in reducing leakage. However we believe it is too early to be able to fully assess the impact of such initiatives within the timescale of the mandatory EC Regulation Review period.

1.1 The UK industry supports containment as the most effective route to reducing emissions based on the potential impact of the training, certification and leak checking elements of the Regulation which were specified by the Commission less than 3 years ago.

1.2 It may be too early to assess the impact of these initiatives. The review was originally scheduled to take place 5 years after implementation, but the delay in specifying training and leak testing regulations and the introduction of interim extension arrangements, as well as the accelerating switch over from HCFC refrigerants, mean that current quantitative data on HFC refrigerant use may not yet accurately reflect what is an increasingly positive impact on emissions reductions.

1.3 Training take up has been somewhat slower than anticipated with an estimated 5,000 out of a potential 40,000 individuals certified to the new standard in the UK. Company Registration has been effective with an estimated 4,500 registered – although the vast majority hold interim qualifications and certification. We believe the recession has had a large part to play in this.

1.4 Strong support from a variety of Industry with a range of initiatives is maximising the future impact of the Regulation. These include:

- The Institute of Refrigeration REAL Zero programme of voluntary equipment inspections, proactive recommendations for improvement, guidance on design, leak check and service issues and supplementary training programmes.
- Voluntary company registration to a level higher than that required by the regulation with the industry-led REFCOM scheme.
- End user initiatives (from supermarkets) providing emissions reduction data reported to F Gas Support
- Numerous conference, workshops and events organised by trade associations and professional institutes to raise awareness of requirements and impact of emissions reduction
- Helpful practical publications eg ACRIB guidance notes and FAQs, BRA Guide to Emissions Reduction, BRA Commercial Code of Practice Part 10 on emissions reduction, IOR Code of Practice for the Minimisation of Emissions (revised January 2010)

1.5 Europe wide initiatives have also been prepared to share experiences and achievements:

- REAL Skills Europe (Leonardo Vocational Skills Programme) has been set up with partners from six member states to build on the learning from the UK REAL Zero initiative)
- The International Institute of Refrigeration has set up an international working party on the Mitigation of Greenhouse Gas Emissions from Refrigeration Equipment (1st meeting in Stokholm June 2010),
- Promotion within Europe and specifically in UK of CETIM (France) information on leakage reduction techniques.

UK specific comments

1.6 The lack of enforcement by Regulators is the single biggest barrier to compliance by system operators as well those responsible for the installation, service and maintenance of equipment. No information has been made public about inspections carried out or enforcement activities. This may have encouraged non-compliance amongst some equipment owners and a small proportion of the contracting industry responsible for installation, service and maintenance activities.

1.7 Enforcement bodies within the Local Authorities have not placed a sufficiently high profile on compliance with these Regulations and UK industry would support a move to working with the Environment Agency because of their current links with the sector in the enforcement of Hazardous Waste Regulations.

1.8 Compliance is also undermined by low levels of awareness amongst equipment owners in certain sectors such as Building Owners, Facilities Managers, and Industrial Process Equipment operators. The "risk-based" approach adopted by DEFRA targeting the largest emitters such as supermarkets and industrial sites must be extended to cover all sectors, instead of focusing exclusively on producers and a small number of responsible retailers.

2. Assess whether additional F-Gases should be added.

ACRIB does not believe this to be necessary at this stage.

2.1 ACRIB would not support the extension of the regulation to cover additional F gases whilst it is still in the implementation assessment stage. It has been demonstrated eg by the voluntary introduction of safe refrigerant handling qualifications (eg City and Guilds 2078 some 20 years ago) does have a positive impact on the reduction of emissions of **all** refrigerant types.

3. Evaluate Training & Certification Programmes.

The mechanisms to ensure compliance with these requirements were found to be weak.
There is a high risk of significant non-compliance and slow take up which could lead to wholesale non compliance after 4th July 2011. This could be addressed through the introduction of mandatory databases of certified companies and registration of individuals which equipment operators can access immediately ie on line or the issuing of personal ID cards.
An independent audit or overview by Government or an independent 3rd party needs to be introduced to ensure standards of compliance by certification bodies for companies and individuals.

3.1 The Commission must clarify that where the regulation specified Individual and Company certification requirements, this was understood to mean that member states **must** provide publicly accessible central registers for both individuals and companies holding certificates.

3.2 There is widespread support for such a database amongst companies and individuals (as evidenced by levels of support for voluntary schemes). This is a necessary tool for equipment owners to verify compliance in employing companies or individuals to operate on their equipment. A database is likely to gain higher levels of compliance within the sector.

3.3 In addition we would call for the Commission to provide a publicly searchable database of all member state acceptable F Gas certificates to encourage freedom of movement of companies/individuals across member state borders and provide a means for equipment operators and employers to verify compliance.

UK specific comments

3.4 *At this stage it is clear that slow take up of individual certification and full company certification will lead to a last minute rush coming up to the July 2011 deadline. (Only 285 of the 5714 individuals registered on the voluntary ACRIB scheme have a 2079/J11 qualification. Only 330 of the 3700 companies certified by REFCOM have achieved their Full F Gas Certification)* In this case there is likely to be insufficient supply of training courses and administration capacity for the schemes and therefore widescale non compliance post July 2011 is foreseeable. ACRIB recommends that a high profile awareness campaign amongst equipment operators, personnel who install, service or maintain systems, consultants and distributors is necessary by Government over the next 12 months.

3.5 A lack of awareness amongst the majority of equipment owners continues to undermine compliance of this aspect of the regulation.

3.4 The UK Government should be providing a means for equipment owners to verify that individuals or companies working on their equipment comply with these requirements. A national register of individuals holding certificates is a necessary tool to ensure compliance with Regulation and all company registration schemes should have a publicly searchable database of members. The need for a means of communicating direct to certified employers and individuals on changes to F Gas and ODS Regulations provides further support for national registers.

3.7 Full compliance with the pursuant regulations on Training and Certification and on Leak Checking by the bodies named in the UK legislation is necessary to ensure the effectiveness of these training programmes in delivering the skills to individuals to contain refrigerant. There exists no independent means of verifying or challenging the quality of the delivery of these programmes. It is proposed that the UK Government must take a more active role in this independent verification for both companies and individual certification to ensure equally rigorous standards and equivalence. Furthermore it is noted that the pursuant regulation has provision for both Awarding bodies and Evaluation bodies, and that the current named providers fulfil both roles. Industry recommends that UK Government ensure that the Evaluation body is independent of the Certification body with rights to withdraw certification rights for any awarding bodies that do not come up to standard. A national training specialist body such as the Sector Skills Council, Summit Skills would be well placed to fulfil such a role. SummitSkills also publish the national occupational standards and National Vocation Qualification standards.

3.7 Summitskills sampled 21 employers of 1056 engineers on costs of F Gas Training in 2009. This shows an average training time invested of 23 working hours per person and a training cost per employee of £595. This is in addition to salary, travel, accommodation costs and the loss of revenue from engineers not engaged in business activity. The gross cost is therefore substantially higher – estimated at 3 to 4 times this amount. The impact on those businesses who are complying at the expense of those who do not comply due to lack of enforcement, at a time of economic recession must be taken into account.

4. Assess the need for new emission control standards

4.1 The UK industry does not believe there is a need for new emission control standards or that these would be effective.

5. Evaluate effectiveness of containment measures.

The effectiveness of containment of smaller systems (under 3kg or 6kg hermetic) has been curtailed by their exclusion from the scope of the complete package of F Gas containment requirements. An estimated 220,000 items are sold a year (based on 2008 figures from BRSIA for through the wall, moveable and split sales) which are likely to be under 3kg charge and therefore be out of scope of leak checking and record keeping requirements. These types of commercial equipment are installed in pubs, restaurants, small shops and offices in the UK and contain on average less than 3 kg of F Gas refrigerant. This represents significant potential total emissions. Reducing this limit to 100grams will ensure that only white goods or those in a domestic environment are excluded from the full range of containment measures.

By placing the onus on the purchaser of refrigerant rather than the supplier the regulation's effectiveness in restricting the installation, service and maintenance of equipment containing or designed to contain F Gas refrigerant to only certified companies and personnel is being undermined. Equipment continues to be marketed for example to the DIY and Heat Pump market without restriction. The onus should be placed on the supply chain.

5.1 Classification of Hermetically Sealed Equipment - This definition is not helpful and should be removed because it causes confusion as to what equipment may fall within scope of different requirements. The definition provided should apply to factory sealed systems only.

5.2 Certification Categories. In practice category 3 is not proving to be effective. The Category 3 for recovery only allows a limit of recovery of 3kg/6kg yet there are many operatives whose work involves recovery only and who need to recover a much larger quantity regularly but do not need a category 1 qualification to install service or maintain. It is recommended that the limit of 3kg/6kg in this category be removed ie no limit to the weight of refrigerant that can be recovered.

5.3 The introduction of different requirements for equipment containing less than 3kg (6kg hermetic) has led to much misunderstanding and confusion as to what equipment/activity comes within scope of the regulation. It should be noted that some specialist installers believe they are completely out of scope of all aspects of the regulation because they work on smaller equipment which does not require a leak test (ie they believe they do not need qualifications to do installation, service or maintenance work on equipment containing or designed to contain refrigerant). In practice the Category 2 qualification is mainly similar in content and training as the Category 1 and is therefore unnecessary and impractical. The charge size means that many small commercial air conditioning systems in shops and offices come out of scope of the leak checking requirements as 3kg (6kg hermetic) is actually a relatively large system. If this limit is designed to ensure that domestic refrigerating appliances are outside of scope of certain obligations then a limit of up to 100grams would be more than sufficient. (ie up to 100g for Category 2 : 100grams or more for Category 1)

5.4 Fixed leak detectors. The value of this requirement could be questioned as a containment measure as it fails to take into account the diversity of applications eg in certain applications for example where the majority of system is outside.

5.5. Specialist containers of F gas refrigerant continue to be widely available and supplied without any environmental warnings or awareness or requirement for certification. These small containers lead to direct venting of their contents in refrigeration applications ie for Topping up of leaking air conditioning of cars using R134a for the DIY market and Plumbers pipe freezing sprays. These products should be clearly brought within scope of the regulation.

UK specific comments

5.6. Purchasing of refrigerant - the UK Regulations put the onus on the purchaser of the refrigerant to ensure that they are compliant before they take delivery of refrigerant. This is a barrier to effective compliance. UK industry believes that the authority to restrict supply of refrigerant by suppliers ie wholesalers, retailers etc is the only way to prevent uncertified and unscrupulous persons from obtaining refrigerant.

5.7 There is confusion in the F Gas Support guidance which indicates that equipment containing or designed to contain less than 3kg (6kg hermetic) does not need to be installed by a qualified person. (see RAC 5 sections 3 and 5)

6. Assess/propose modifications to the reporting requirements.

No comment

7. Assess best environmental practices concerning prevention and minimisation of emissions.

Many positive steps (as detailed below) have been taken for example by retailers and voluntary initiatives by UK industry to both comply with the regulation, improve system containment and seek alternative solutions where feasible – all leading to a definite but unquantifiable reduction in emissions due to behaviour change.

7.1 Legislators must consider the positive impact being achieved through new long term industry initiatives indicated in 1.4 & 1.5. The findings of such projects will help to inform future practice and should be recognised or where necessary adopted.

7.2 Recognition must also be given to industry dissemination initiatives such as: the frigaroo website, EPEE briefings, the CETIM leakage guides. Also note that manufacturers, distributors, wholesalers actively conduct installer training to support awareness and expertise within the sector

7.3 Research carried out in the UK and published in an IOR paper identifies that the lack of verification that system operator F gas records are being kept and lack of interrogation of these records by the operator is a major weakness which limits the extent to which practices are being improved. We recommend that greater emphasis is placed on such record keeping with either mandatory lodgement of F gas records or representative sampling of records and public reporting of results.

7.4 UK wide industry initiatives are pressing for greater compliance with environmental legislation ie the CIBSE led "Non Compliance Costs" campaign focusing on F Gas Regulations and Building Regulations of which ACRIB, IOR, HVCA are all members.

UK specific comments

7.5 UK Government must introduce powers for Company certification bodies to randomly audit companies on the register and a requirement to audit a percentage of the members, in accordance with the powers identified in the regulation.

7.6 Effectiveness of implementation across the whole property estate in the UK, where HFC products may be in use, has been undermined by the risk based approach which focuses on a few enforcement visits to four or five large supermarkets and which have not been made public. Therefore the average equipment owners and contractors may believe there is no implementation and refuse to pay for the

additional services required to ensure compliance under the regulation. We would support any moves to work more closely with the Environment Agency rather than Local Authorities on compliance and inspection.

8. **Summarise development of technology regarding foams.** (no comment from acrib)

9. **Assess if alternatives to sulphur hexafluoride in sand casting is feasible.** (no comment from acrib)

10. Assess if inclusion of further products and equipment containing F-Gases is technically feasible & cost effective, taking account of energy efficiency.

Unacceptably high levels of emissions from the following sources should be taken into account:
1. sales of pre-charged air conditioning equipment to uncertified personnel; installation, service and maintenance of such equipment by uncertified personnel;
2. continued availability of Car Air conditioning top up equipment designed for and supplied to uncertified personnel through retail outlets, and pipe freezing spray cans for plumbers.

10.1 Inclusion of pre-charged equipment for small air conditioning installation

The supply of pre-charged systems, particularly the small to medium, split or multi-split type air conditioners allows non-certified personnel to take delivery of and install systems containing fluorinated gases. This undoubtedly leads to poorer quality installations with inadequate or no leak tightness testing taking place, inadequate or no evacuation of pipework and an increase in leakage and loss of refrigerant charge. By only supplying systems with a holding charge of OFN (oxygen free nitrogen) the system would be useless to anyone without the necessary qualifications to allow them to take delivery of the relevant refrigerant. The refrigerant charge would also be reduced in this way as only the charge sufficient to make the system work efficiently would be charged at the time of commissioning. At present many split system air conditioning units are supplied with sufficient refrigerant in them for a 30 metre pipe run between indoor and outdoor units when, in many cases, the pipe run will be much less than that which the factory charge allows.

10.2 Clarification of handling requirements for pre-charged heat pumps for domestic heating and cooling

The definition of pre-charged heat pumps needs to be clarified here. A split type domestic air to water heat pump would be classed as pre-charged as the entire refrigerant charge would be contained in the outdoor section. However the system would need to be installed on site with refrigerant pipes between indoor and outdoor to complete the refrigerant circuit necessary for the heat transfer to occur. However if the system is the "monoblock" type there would be no need for any refrigerant work on site and the installing operative would simply be placing a unit on site ready to be connected to the electrical supply and the flow and return heating water pipes. If we are talking about the first type then there would need to be full compliance with the F Gas Regulation to enable an operative to legally install the unit. However, when servicing this type of equipment, whether it is the split or monoblock type, full compliance with the F Gas Regulation would be necessary to prevent accidental loss of refrigerant charge by non-qualified personnel. This is also the case for end of life when the fluorinated gases will need to be removed by qualified personnel.

10.3 Restriction of sale of DIY equipment aimed at the domestic/small commercial installation market and car air conditioning

All equipment containing fluorinated gases should be covered in the scope of the Regulation except where the charge is so small as to be negligible (e.g. domestic fridge freezers). Small air conditioning systems not of the monoblock or portable type sold through DIY outlets should only be installed by qualified personnel. Therefore, no equipment should be supplied to consumers, installers or companies who are not properly qualified as specified in Article 4. This practice of selling to non qualified personnel is not confined to DIY retailers though as it is possible to buy equipment, tubing and all ancillary products associated with an air conditioning installation from some wholesalers with no checks carried out as to the qualifications or competence of the individual who is taking supply. Therefore, the onus needs to be placed on the supplier to prove competence of the purchaser via website lists, etc. This would also satisfactorily address 10.1.

DIY canisters of R134a designed for car air conditioning and sold through automotive spare parts wholesalers should be outlawed. They are sold as a top up canister to enable car owners to knowingly top up a leaking air conditioning system.

10.4 Freezing pipe spray using R134a for plumbing purposes
This should be treated the same as the top up canisters for car air conditioning systems. These freeze spray kits are designed to empty all of the charge of R134a into a non-sealed loose fitting sleeve which covers the pipe. The refrigerant is, therefore, deliberately leaked and emitted to atmosphere.

11. Assess if the Regulations provisions concerning global warming potential of F-Gases should be amended taking account of technological and scientific developments and need to respect industrial product planning timescales.

Evidence is beginning to become available to prove that high levels of refrigerant containment are possible and that leak tight systems that do not leak operate at high levels of efficiency therefore reducing the total direct and indirect global warming impact of systems.

The skills and infrastructure to support the widescale adoption of F Gas–alternative refrigerants are not yet available.

11.1 Industry is supportive of measures to achieve containment of refrigerants within the framework of policy. The Institute of Refrigeration Guidance note on Refrigerant Selection and System Design issued earlier this year gives a much fuller picture. (see appendix 1)

11.2 ACRIB further highlights the need for increased Government support for funding of training to improve skills in the use of F gas alternative refrigerants in the future as the availability and suitability of this technology increases in the long term in the light of current industry investment and prioritisation on F Gas training.

12. Assess need for further action in light of existing and new international commitments regarding reduction of greenhouse gas emissions.

In the absence of an internationally binding agreement on greenhouse gas emissions measures relevant to this sector, the EC should not impose new restrictions which might disadvantage EC international trade and competitiveness.

13. **Where necessary will make appropriate proposals for revision of relevant provisions of Regulation.**

- Article 3 "Containment" lower limit under item 2 (a) to be reduced from 3kg (6kg hermetic) to 100gm
- Article 5 "Training and Certification" should be amended to include the provision for mandatory databases of certified companies and registration of individuals
- Article 5 "Training and Certification" should be amended to include provision to make member states responsible for ensuring standards of compliance by certification bodies for companies and individuals.
- Article 5.1 "Training and Certification" should be revised to make it clear that equipment containing or designed to contain F Gas refrigerants may not be **supplied** to persons or companies who do not hold a certificate, rather than "take delivery of"
- Article 9 "placing on the market bans" Annex II to be amended to include Pipe freezing sprays, Containers/aerosols designed for topping up of car air conditioning, and RACHP equipment which is pre-charged with F Gas Refrigerants.
- Article 11 "Promotion of alternatives" should place an obligation on member states to take into account current levels and to develop the necessary skills and infrastructure to support the widescale adoption of alternatives.

*Appendix 1- **Refrigerant Selection and System Design (IOR Guidance Note 18 issued April 2009)***

The Institute of Refrigeration has compiled this guidance note to provide non-partisan advice on the effects of refrigerant choice and system design on the carbon footprint of a refrigerating system. Two effects are considered: the direct global warming potential of the refrigerant selected and the climate change effect of energy use by the system. The direct effect is measured as a "global warming potential" (GWP), usually against a reference of the potential of carbon dioxide over a 100 year period. Strategies for the reduction of carbon footprint include designing more efficient systems, minimising sources of leakage through the selection of more robust system components, reducing the quantity of refrigerant required to operate the system in order to mitigate the effect of a large leak and substituting refrigerants with a high GWP for those with a lower potential. These include ammonia, hydrocarbons, carbon dioxide, some low-GWP HFCs and hydrofluoroolefins.

There are many situations where the direct substitution of a hydrofluorocarbon (HFC) with a "natural" refrigerant is not reasonably practicable, either due to toxicity or flammability or high pressure. In such cases it would be possible to minimise HFC charge, or even eliminate it, by using a secondary fluid but this would tend to make the alternative system more expensive and less efficient. Rather than promoting a total ban of HFCs a more appropriate course would be to advocate a policy of "responsible use" of fluorocarbons in order to ensure that the climate effects of refrigerant emissions are minimised. A responsible refrigerant policy would place a high emphasis on the elimination of leak sources, the efficiency of the overall system and the life cycle cost of ownership.

Energy Efficiency and Refrigerant Selection

Energy Efficiency of refrigeration systems is governed by the laws of physics and by practicality. Practicality embraces cost, cycle, legislative requirements, refrigerant choice and maintenance. Efficiency is not only dependent on choice of refrigerant but also on good design, selection of an appropriate system and good maintenance. Selection of the refrigerant demonstrating highest efficiency in an appropriate system is unlikely to improve system efficiency by more than 10% over efficiency of an optimized system using an HFC refrigerant. Some "natural" refrigerants such as carbon dioxide may result in reduced system efficiency unless they are integrated into a heat recovery system. At current levels of knowledge and expertise, practicality often leads to a choice of HFCs for good efficiency to be realistically achieved and maintained. In some applications, ammonia, carbon dioxide or hydrocarbons would be the preferred choice, but these refrigerants are not suitable for all applications. Good efficiency is vital to minimize emissions of greenhouse gases.
The practicality element will change as costs and design changes associated with HFC use evolve, and more components, experience and skills for ammonia, HCs and CO2 are developed. This can be expected to reduce the applications that require HFCs, but not eliminate them in the foreseeable future. Examples of highly practical HFC applications include split A/C systems, and in particular VRF combined cooling/heating systems.
Arbitrary constraints on how designers can specify systems (such as bans on the use of specific refrigerant fluids) could result in less efficient systems being installed and will not drive the industry along the path of lowest GHG emissions.

To obtain 'good efficiency' attention needs to be given to the following steps:
1) Avoid refrigeration / reduce the cooling load. This is the most important first step – there is no point designing an efficient system if the load was unnecessary!
2) Get the overall system design right (e.g. best cycle, splitting loads at different temperatures onto different suction levels, etc. etc)
3) Get the control philosophy right (don't forget the "off-design" operating conditions which are much more common than the peak "design point", avoid head pressure control, avoid partly loaded compressors, avoid fixed speed auxiliaries like pumps and fans, etc. etc.)
4) Optimise individual components for efficiency (e.g. how big should heat exchangers be, which compressor has best efficiency etc.)
5) Operate and maintain the plant for best efficiency.

Mistakes in any of the above can change the efficiency of a plant by large amounts (e.g. 20% to 50%). Where does refrigerant selection fit in? It can either be thought of as a system design issue or a "component optimisation". The impact of the refrigerant on efficiency is likely to be less than 5%, assuming all other design parameters are optimized.

The key message is that refrigerant choice matters, but many other design issues matter much more.