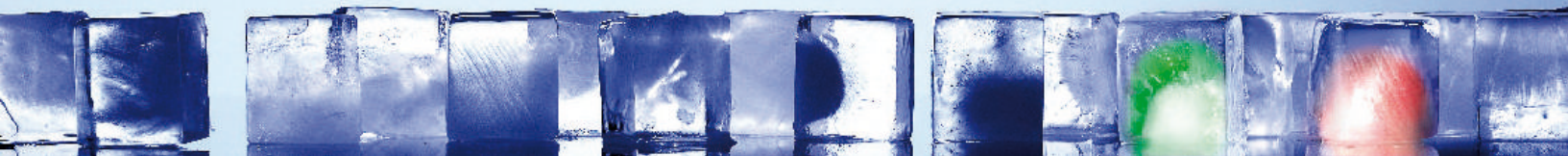


F-GAS

New Refrigerants & Selecting Capital Equipment

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Refrigerants for Capital Equipment Selections

Fluorinated gases (F-gases) are a family of man-made chemicals that are very powerful greenhouse gases. Emission of even a small quantity of an F-Gas to the atmosphere is harmful to the environment. Most F-Gases are between 1,000 and 20,000 more powerful than CO₂ in terms of GWP (Global Warming Potential).

The F-Gas Regulations EU 517/2014 took effect on 1st January 2015 and now, commonly used HFC's such as R404A are no longer viable as long term refrigerant choices due to their high GWP. At the same time, uncertainty still surrounds the new generation of lower GWP refrigerants being introduced on the market.

The purpose of this document is to give some background and guideline information on the lower GWP refrigerants which are now commercially available and widely accepted as the candidates to replace R404A in the immediate future. This information should provide some clarity when it comes to selecting refrigeration Capital Equipment.

Until recently, the accepted default refrigerant for almost all applications was R404A, due to its ability to be applied to high, medium and low temperature applications without special considerations to equipment or system design. Replacement refrigerants such as R407A/F and R448A / R449A which have a lower GWP, offer a practical alternative but also present some problems of their own in trying to match all the necessary requirements of such a versatile refrigerant.

With availability of equipment restricted to certain models, or compressor types / sizes, and special consideration needed for their use on low temperature applications, the following pages show the refrigeration equipment currently approved as suitable for the various refrigerants on offer.

Key point - It is recommended that new systems are installed with alternative refrigerants to R404A where possible.

F-Gas

The use of fluorinated greenhouse gases with a **GWP >2500** to service or maintain refrigeration equipment with a charge size of 40 tonnes of CO₂ equivalent or more shall be prohibited from **1st January 2020**.

The charge size equivalent to 40 tonnes CO₂ is shown in the table below.

Typical Application	Refrigerant	GWP	Equivalent to 40 tonnes CO ₂
HT/MT	R134a	1430	27.97kg
MT/LT	R404A	3922	10.20kg
HT/AC	R407C	1600	25.00kg
MT/LT	R407A	2107	18.98kg
MT/LT	R407F	1825	21.92kg
HT/AC	R410A	2088	19.16kg
AC	R417A	2346	17.05kg
MT/LT	R422A	3143	12.73kg
MT/LT	R422D	2729	14.66kg
MT/LT	R434A	3245	12.33kg
MT/LT	R448A	1387	28.48kg
MT/LT	R449A	1397	28.63kg
MT/LT	R452A	2140	18.69kg
AC	R32	675	59.26kg
MT/LT	CO ₂	1	40,000kg

The F-Gas Regulations (EU 517/2014) introduced a phase-down mechanism which implements a gradually declining cap on the total placement of bulk HFCs (in tonnes of CO₂ equivalent) on the market in the EU.

Year	Phase-down percentage
2015	100%
2016-17	93%
2018-20	63%
2021-23	45%
2024-26	31%
2027-29	24%
2030	21%

Capital Equipment Selections

Based on the capital equipment currently stocked in the UK, the following tables provide an overview of equipment approved for use with lower GWP alternatives.

Evaporators / Condensers							
	R404A	R407A	R407F	R448A	R449A	R452A	CO ₂
Application	MT/LT	MT/LT	MT/LT	MT/LT	MT/LT	MT/LT	MT/LT
GWP Potential	3922	2107	1825	1387	1397	2140	1
Lu-Ve Coolers	✓	✓	✓	✓	✓	✓*	✓
Lu-Ve Condensers	✓	✓	✓	✓	✓		
Searle Coolers	✓	✓	✓	✓	✓		✓
Searle Condensers	✓	✓	✓	✓	✓		
Friga Bohn Coolers	✓	✓	✓	✓	✓	✓	✓
Friga Bohn Condensers	✓	✓	✓	✓	✓	✓	

*Capacity tables tbc

Condensing Units												
	R404A	R407A		R407F		R448A		R449A		R452A		CO ₂
Application	MT/LT	MT	LT	MT	LT	MT	LT	MT	LT	MT	LT	MT/LT
GWP Potential	3922	2107		1825		1387		1397		2140		1
Danfoss Optyma New Generation	✓	✓		✓		✓		✓			✓	
Danfoss Optyma Slim	✓	✓		✓		✓		✓			✓	
Bitzer LHE	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Bitzer Ecostar	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Copeland MC	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Copeland Stream	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Copeland ZX	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Tecumseh / L'Unite	✓							✓	✓	✓	✓	
Frascold	✓	✓	✓	✓	✓	✓		✓				
Embraco	✓									✓	✓	
Cubo Light	✓	✓	✓	✓	✓	✓	✓	✓	✓			
SCM Frigo/ Starcold	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓
Cubo2 Smart												✓

Expansion Valves							
	R404A	R407A	R407F	R448A	R449A	R452A	CO ₂
Application	MT/LT	MT/LT	MT/LT	MT/LT	MT/LT	MT/LT	MT/LT
GWP Potential	3922	2107	1825	1387	1397	2140	1
Danfoss TEV	✓	✓	✓	✓*	✓*	✓*	
Danfoss AKV	✓	✓	✓	✓	✓	✓	✓
Danfoss ETS	✓	✓	✓	✓	✓		✓
Carel E*V	✓	✓	✓	✓	✓	✓	✓

*TE2

F-Gas - What Should We Be Saying?

- Recommend that **new systems** are installed with alternative refrigerants to R404A where possible.
- For **new** systems, recommend the use of refrigerants with a lower GWP than R404A.
- For **existing** systems, suggest retrofitting to one of the lower GWP alternatives.
- Reduce leakage in existing systems to the absolute minimum.
- Ensure any R404A is recovered for further use.
- There is no single R404A replacement for all applications. The most appropriate alternative will depend on the type of application and availability of suitable equipment and controls.

General Replacement Guide

R404A & R-407A/C/F Replacements*

Product Name	ASHRAE#	Applications ²	Safety Class ³
Opteon™ XP40	R449A	LT, MT, AC	A1
Solstice N40	R448A	LT, MT	A1
Opteon™ XP44	R452A	LT, MT, TR	A1
Opteon™ XL40	R454A	LT, MT, AC, HP	A2L
Opteon™ XL20	R454C	LT, MT, AC	A2L

R410A Replacements*

Product Name	ASHRAE#	Applications ²	Safety Class ³
Opteon™ XL41	R454B	AC, HP	A2L
Opteon™ XL55	R452B	AC, HP	A2L

R134a Replacements*

Product Name	ASHRAE#	Applications ²	Safety Class ³
Opteon™ XL10	HFO-1234yf	MT,	A2L
Opteon™ XP10	R513A	MT	A1

R22 Replacements*

Product Name	ASHRAE#	Applications ²	Safety Class ³
Opteon™ XP40	R449A	LT, MT, AC	A1
Solstice N40	R448A	LT, MT	A1
Opteon™ XL20	R454C	LT, MT, AC	A2L
Freon™ MO99	R438A	AC	A1

R123 & R245fa Replacements*

Product Name	ASHRAE#	Applications ²	Safety Class ³
Opteon™ MZ	HFO-1336mzz(Z)	HP, WHR	A1
Opteon™ XP30	R514A	AC	B1

Equipment Type Compatible Oil⁴

New, Retrofit	POE
New Retrofit	POE
New, Retrofit	POE
New	POE
New	POE

R404A Retrofit Recommendation:

LT/MT: R449A (XP40), R448A (N40): Excellent performance match & lower energy consumption with 64 % lower GWP.

LT: R452 (XP44) : Closest match & low discharge temperature with 45 % lower GWP.

Equipment Type Compatible Oil⁴

New	POE
New	POE

R410A Retrofit Recommendation:

Retrofit needs to respect mild flammability (modifications might be necessary):

R454B (XL41) : Lowest GWP (-78 % vs. 410A)
R452B (XL55): Closest match to R410A

Equipment Type Compatible Oil⁴

New	POE
New, Retrofit	POE

R134a Retrofit Recommendation:

R513A (XP10) : Excellent performance match with 56 % lower GWP vs. R134a.

Equipment Type Compatible Oil⁴

New, Retrofit	POE
New Retrofit	POE
New	POE
Retrofit	MO, AB POE

R22 Retrofit Recommendation:

LT/MT R449A (XP40), R448A (N40): Excellent performance match & lower discharge temperature vs. R22 with 27 % lower GWP.

AC: R438A (MO99): Closest MO compatible performance match to R22 in A/C.

Equipment Type Compatible Oil⁴

New	POE
New, Retrofit	POE

² LT=Low Temperature, MT= Medium Temperature, A/C=Air Conditioning, Auto = Automotive Air Conditioning, TR = Transport, HP = Heat Pump, WHR = Waste-Heat Recovery

³ Safety Class according to ASHRAE Standard 34 and ISO 817

⁴ MO=Mineral Oil, AB=Alkylbenzene, POE=Polyol Ester

An Introduction to R32 for use in Refrigeration and Air Conditioning

To meet the requirements of the F-Gas regulation phase down process, it will be necessary to make use of refrigerants with much lower GWPs. This means that the RAC industry will need to begin to use the new A2L refrigerants as part of this process, as the effects of the HFC phase down begin to bite.

R32 (an HFC classified as A2L) is now being promoted as the alternative to R410A in new air conditioning systems, due to its similarity in performance to R410A. There are millions of systems operating on R32 in Japan and already hundreds in the UK.

A feature of A2L products such as R32 is that they exhibit lower flammability however, there is no reason why these new refrigerants cannot be used safely in a wide range of applications, providing guidance and regulations are observed, and good practice is used. Due to their lower flammability, A2L refrigerants are intended for use in equipment specifically designed for these products.

A2L refrigerants are already in use in a variety of applications. For instance, from 1st January 2017, all new cars produced in Europe contain a refrigerant with a GWP of less than 150 in their A/C system. The product of choice is HFO R1234yf. There are currently over 12.5m cars on European roads using this refrigerant and this is expected to rise to 29m by the end of 2017.

Currently, only the manufacturers of our A/C split systems are marketing R32 equipment but we do know that refrigerant and refrigeration equipment manufacturers are also trialling R32 and A2L HFO blends as replacements for R404A type applications.

Practical Aspects of Using A2L Refrigerants

All technicians that carry out work on stationary RAC systems must hold an F-Gas handling certificate. Existing certificates issued in accordance with the 2006 EU F-Gas Regulation remain valid, in accordance with the conditions under which they were originally issued.

Service Equipment

Many of the service tools used for current non-flammable (A1) refrigerants can be used for servicing A2L refrigerants. However, some service equipment, due to the electrical components and motors, should be specifically designed for use with lower flammability A2L refrigerants (e.g. R32, R1234yf etc.). Equally, tools such as manifolds, leak detectors and reclaim devices need to be compatible for use with A2L refrigerants. Flare connections and pipework, as well as pressure testing requirements, remain the same. Providing the required risk assessments have been made beforehand, installation of an A2L system should be no more difficult than an A1 system. A2L service items are available from all Beijer Ref companies.

Flammability References

Refrigerants are classified according to their flammability and toxicity. “A” classification indicates low toxicity (“B” is high toxicity). The numbers 1, 2 or 3 following the A or B indicate the degree of flammability. The safety groups A1, A2 and A3 are explained in the tables below.

Safety Classification	Lower Flammability level, % in air by	Heat of combustion, J/kg	Flame Propagation
A1	No flame propagation when tested at 60°C and 101.3kPa		
A2, lower flammability	>3.5	<19,000	Exhibit flame propagation when tested at 60°C and 101.3kPa
A2L, lower flammability, proposed sub classification	>3.5	<19,000	Exhibit flame propagation when tested at 60°C and 101.3kPa and have a maximum burning velocity of $\leq 10\text{cm/s}$ when tested at 23°C and 101.3kPa.
A3, higher flammability	≥ 3.5	<19,000	Exhibit flame propagation when tested at 60°C and 101.3kPa

Tonnes CO₂ Equivalent

The use of fluorinated greenhouse gases with a GWP > 2500 to service or maintain refrigeration equipment with a charge size of 40 tonnes of CO₂ equivalent or more shall be prohibited from 1st January 2020. This provision shall not apply to military equipment or equipment intended for applications designed to cool products to temperatures below -50°C.

Calculation to work out the Tonnes CO₂ Equivalent:

Mass (in kg) of system charge x GWP Potential divided by 1000 = tonnes CO₂ equivalent (kg)

Leak Checks

From the 1st January 2015, operators of equipment that contain fluorinated greenhouse gases in quantities of 5 tonnes of CO₂ equivalent or more and not contained in foams shall ensure that the equipment is checked for leaks. This applies to operators of stationary refrigeration equipment, stationary air conditioning equipment, stationary heat pumps, stationary fire protection equipment, refrigeration units of refrigerated trucks and trailers and organic Rankine cycles.

Tonnes CO ₂ Equivalent charge weight (kg)	Frequency of Inspection	Frequency if leak detection equipment is fitted	Leak detection equipment mandatory
≥5 and ≤50	Every 12 months	Every 24 months	No
≥50 and ≤500	Every 6 months	Every 12 months	No
≤500	Every 3 months	Every 6 months	Yes
Hermetic systems ≤10	None	None	No

Labelling

From the 1st January 2017, RAC equipment placed on the market containing F-Gases shall be labelled with a reference that the equipment contains fluorinated greenhouse gases, the name of the refrigerant, the quantity of gas expressed in kg and its CO₂ equivalent along with its GWP value of the refrigerant

Typical indicative labelling for a system containing 8kg of R407A might be as follows:

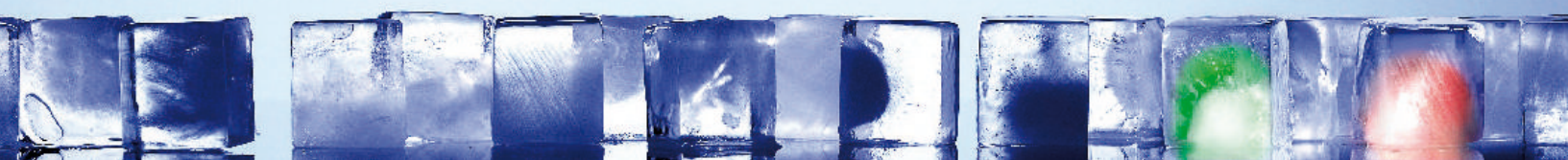
Contains fluorinated greenhouse gases
Refrigerant: R407A
R407A GWP value = 2107
System charge weight = 8kg
System CO₂ equivalent charge weight = 16.86 tonnes

UK Code:
FGASLABEL2

Notes

A series of horizontal dashed lines for writing notes.

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