THE LINDE GROUP

Guide to updated EU f-gas regulation (517/2014).

Date July 2014

Contents.

Introduction.

This guide is focused on providing a technical analysis of the recently amended f-gas regulation (517/2004). It includes an analysis of the key changes versus the previous regulation (842/2006) and provides initial recommendations on actions necessary to comply with these changes.

Linde also provides a range of summary documents on the f-gas regulation that focus on how we can support you meet your environmental and legal obligations.

Background.

- Fluorinated greenhouse gases (f-gases) are a group of chemicals containing fluorine which includes HFCs, PFCs and SF_6.
  - The most common f-gases are hydrofluorocarbons (HFCs). These gases include R134a, R404A and R410A and are used in refrigeration and air conditioning, foam blowing and propellant applications. HFCs are ozone friendly, energy efficient refrigerants that are generally of low toxicity and non-flammable.
  - Other f-gases include perfluorocarbons (PFCs), which are often used in semiconductor applications, and sulfur hexafluoride (SF_6), which is commonly used in electrical switchgear.
- Most f-gases have a relatively high Global Warming Potential (GWP), and thus contribute to global warming if released to the atmosphere.

The European Union aims to reduce the environmental impact of fluorinated gases via regulation. The first f-gas regulation EC 842/2006 focused on reducing emissions mostly by preventing leaks in systems and enforcing responsible end-of-life recovery and destruction of these gases.

F-gas regulation update: key changes.

- The European Union has recently published an updated f-gas regulation (517/2014). This regulation will come into force from 1st January 2015, replacing the previous version (842/2006).
- Key changes include:
  - **Product and equipment bans:** Restrictions on the placing on the market (bans) of certain refrigeration and air conditioning equipment, foams and propellants using f-gases, and of SF_6 in small magnesium foundries.
  - **Service and maintenance bans:** Limits on the use of higher GWP gases, such as R404A and R507A, in existing refrigeration equipment from 2020.
  - **Cap and phase down:** Reductions on the placing on the market of f-gases via a cap and phase down on the supply of HFCs.
  - **Responsible supply:** Restrictions on the sale of f-gases to users that have the appropriate certification or have attended relevant training programmes.

Numerous additional changes include requirements for leakage control, checks and detection systems, end-of-life recovery, training and certification programmes, labelling and reporting.

Regulation structure.

Table 1: F-gas regulation articles and groups summary

Group	Article	Information included
Definitions	1: Subject matter	Regulation aims
	2: Definitions	Gas and equipment definitions
Containment	3: Prevention of emissions	Leakage control, certification
	4: Leak checks	Requirements for and frequency of leak checks
	5: Leakage detection systems	Requirements on the use of automated leak detection systems
	6: Record keeping	Requirements for operators and suppliers of equipment and f-gases
	7: Emissions from production	Destruction of HFC 23 produced as a by-product
	8: Recovery	End-of-life recovery of f-gases
	9: Producer responsibility	
	10: Training and certification	Training and certification programmes
Control of use	11: Restrictions on placing on the market	Product and equipment bans, responsible supply
	12: Labelling and product information	Labelling of equipment, gas containers, instruction manuals and advertising
	13: Control of use	Maintenance and service bans for refrigeration applications. Bans on the use of SF_6 in certain applications
	14: Pre-charging of equipment with HFCs	Pre-charged equipment to include HFCs accounted for within quotas
	15: Reduction of the quantity of HFCs placed on the market	Cap and phase down of HFCs on CO_2 equivalent (CO_2e) basis
	16–18: Quotas process	Allocation, registration and transfer of quotas
Reporting	19: Reporting	Annual reporting for producers, importers and exporters
	20: Collection of emissions data	Annual reporting for producers, importers and exporters
	21: Review	Possible future changes, reporting and monitoring of implementation success
	22–27: Delegation, procedures, penalties etc.	Procedures for the adoption of f-gas regulation

Product and equipment bans.

Regulation text

Article 11 (1):

- *The placing on the market of products and equipment listed in Annex III, with an exemption for military equipment, shall be prohibited …*
- *Table 2 shows the additional bans on top of those required in existing f-gas regulation 842/2006*

Article 13 (1) and (2) SF_6 Usage Bans:

- *The use of SF_6 in magnesium die-casting and in the recycling of magnesium die-casting alloys shall be prohibited. Installations using <850 kg per annum shall be prohibited from 1.1.2018.*
- *The use of SF_6 to fill vehicle tyres shall be prohibited.*

Table 2: Additional f-gas product and equipment bans – annex III

Ban type and number in text	Date
3. Fire protection equipment that contain HFC-23 (except critical use)	1.1.2016
10. Domestic refrigerators and freezers that contain HFCs with GWP of 150 or more	1.1.2015
11. Refrigerators and freezers for commercial use (hermetically sealed) that contain:	
– HFCs with GWP of 2500 or more	1.1.2020
– HFCs with GWP of 150 or more	1.1.2022
12. Stationary refrigeration equipment containing f-gases with GWP 2500 or more except equipment intended for applications designed to cool products to temperatures below –50 °C	1.1.2020
13. Multipack centralised refrigeration systems for commercial use with a rated capacity of 40 kW or more that contain, or whose functioning relies upon, f-gases with GWP 150 or more, except in the primary circuit of cascade systems where f-gases with a GWP of less than 1500 may be used.	1.1.2022
14. Movable room air conditioning equipment (hermetically sealed equipment which is movable between rooms by the end user) that contain HFCs with GWP of 150 or more	1.1.2020
15. Single split air conditioning systems containing less than 3 kg of f-gases, with GWP of 750 or more	1.1.2025
16. Foams that contain HFCs with GWP of 150 or more except when required to meet national safety standards:	
– Extruded polystyrene (XPS)	1.1.2020
– Other foams	1.1.2023
17. Technical aerosols that contain HFCs with GWP of 150 or more, except when required to meet national safety standards or when used for medical applications	1.1.2018

Linde comment and recommendation

The majority of the product and equipment bans impact refrigeration and air conditioning equipment, however there are some restrictions in fire suppression, foam blowing and aerosol propellant applications. There are also additional bans on the use of sulfur hexafluoride (SF_6) in magnesium die-casting.

Clarifications are being sought by industry regarding a few definitions, however in general the requirements are straightforward.

The service and maintenance bans will impact some users of SF_6, however the vast majority of industrial users have already transitioned to alternative technologies. Linde recommends the use of alternative methods of gas blanketing, including the use of HFCs and SO_2.

The restrictions and bans on the use of certain gases in new refrigeration and air conditioning equipment will lead to the need for OEMs to make changes to their equipment to ensure that it is suitable for use with lower GWP gases.

There are a wide number of potential alternative gases with lower GWP. These include HFCs, HFOs and natural refrigerants. Table 3 overleaf lists some of these. In certain cases, the changes to equipment designs in order to use a different gas will be minor (e.g. changing a system designed for R404A to operate with R407A), however in some cases they will involve major redesign of equipment, for example if designed to use a gas with substantially different physical properties.

The legislation provides limited scope for exemptions as detailed in Articles 11(2) and 11(3) (ecodesign, technical and safety exemptions).

Table 3: Some alternative gases available for each application

Ban type and number in text (additional bans on top of existing f-gas regulation 842/2006)	Commonly used gases and (GWP)	Possible alternatives* and (GWP)
3. Fire protection equipment that contain HFC-23 (except critical use)	R23 (14,800)	R227ea (3220)
10. Domestic refrigerators and freezers that contain HFCs with GWP of 150 or more	R134a (1430)	R600a (3) R1234yf (1)
11. Refrigerators and freezers for commercial use (hermetically sealed) that contain:		
HFCs with GWP of 2500 or more	R404A (3922) R507A (3985)	R407A (2107) R407C (1774) R407F (1825) R442A (1888) R449A (1397)
HFCs with GWP of 150 or more	R407A (2107) R407C (1774) R407F (1825) R442A (1888)	R290 (3) R600a (3) R1234yf (1)
12. Stationary refrigeration equipment containing f-gases with GWP 2500 or more except equipment intended for applications designed to cool products to temperatures below -50°C	R404A (3922) R507A (3985)	R407A (2107) R407C (1774) R407F (1825) R410A (2088) R442A (1888) R449A (1397) Future: HFO blends
13. Multipack centralised refrigeration systems for commercial use with a rated capacity of 40 kW or more that contain, or whose functioning relies upon, f-gases with GWP 150 or more except in the primary circuit of cascade systems where f-gases with GWP of less than 1500 may be used.	R404A (3922) R407 series (~1770–2100) R507A (3985)	R744 (1) R1234yf (4) Primary circuit: R134a (1430) R32 (675) Future HFO blends
14. Movable room air conditioning equipment (hermetically sealed equipment which is movable between rooms by the end user) that contain HFCs with GWP of 150 or more	R410A (2088)	R290 (3) Future: HFO blends
15. Single split air conditioning systems containing less than 3 kg of f-gases, with GWP of 750 or more	R407C (1774) R410A (2088)	R32 (675) R290 (3) Future: HFO blends
16. Foams that contain HFCs with GWP of 150 or more except when required to meet national safety standards: Extruded polystyrene (XPS)	HFC 134a (1430)	HFC 152a (124) HFO1234ze (7) DME (1) R600a (3) CO_2 (1)
Other foams	HFC 134a (1430) HFC 245fa (1030) HFC 365mfc (794) HFC 227ea (3220)	Pentanes (5) Methyl Formate (25) HFOs
17. Technical aerosols that contain HFCs with GWP 150 or more, except when required to meet national safety standards or when used for medical applications	HFC 134a (1430)	HFC 152a (124) Isobutane (3) N-Butane (4) Propane (3) DME (1)
Article 13: Magnesium die-casting using SF_6	SF_6 (22800)	HFC-134a (1430) SO_2 (0) Novec

*Alternative gases that may potentially be suitable for this application. Many alternatives are NOT simple retrofits; equipment or process design changes may be necessary.

Service and maintenance bans.

Regulation text

Article 13(3) Refrigeration Service Bans:
From 1 January 2020, the use of fluorinated greenhouse gases with a GWP of 2500 or more, to service or maintain refrigeration equipment with a charge size of 40 tonnes of CO_2 equivalent (CO_2e) or more, shall be prohibited.

This paragraph shall not apply to:

- *military equipment, or*
- *equipment intended for applications designed to cool products to temperatures below –50 °C*
- *until 1.1.2030: reclaimed or recycled f-gases providing they have been labelled in accordance with Article 12. Recycled gases may only be used by the undertaking which carried out the recovery … or the undertaking for which the recovery was carried out.*
- *refrigeration equipment for which received an exemption has been*

Table 4: Gases affected by service and maintenance bans

Refrigerant	GWP	Charge size threshold (40T CO_2e)	Comments
R23	14800	2.72 kg	Often used in applications below –50 °C (exempt)
R404A	3922	10.20 kg	
R422A - ISCEON® MO79	3143	12.73 kg	
R422D – ISCEON ® MO29	2729	14.66 kg	
R428A – RS52	3607	11.09 kg	
R434A – RS45	3245	12.33 kg	
R507	3985	10.04 kg	Sometimes used in applications below –50 °C (exempt)
R508B	13396	2.99 kg	Often used in applications below –50 °C (exempt)
ISCEON® MO89	3805	10.51 kg	Often used in applications below –50 °C (exempt)

Linde comment and recommendation

The refrigeration service and maintenance bans come into effect from 1.1.2020. They are targeted bans that only impact users of refrigeration equipment. (Other applications such as air conditioning or heat pumps are exempt.)

However, these bans will impact many operators of refrigeration equipment that use the refrigerant gases listed in table 4 above. It is also worth noting that the temperature and charge size thresholds create some challenges for some users in understanding whether or not they are exempt.

Therefore if a refrigeration system uses more than the minimum charge size of a refrigerant gas with GWP 2500 or more, and it doesn't have a temperature or process exemption, then it will be subject to the maintenance ban from 1.1.2020.

Many commercial refrigeration systems use R404A, which will be subject to the service and maintenance bans.

Options to consider

- **Continue:** Continue to use the existing equipment and gas until 2020, and then use reclaimed or recycled gas, if available, until 2030.
- **Convert:** Convert the equipment to run on a retrofit refrigerant gas with GWP less than 2500.
- **Replace:** Replace the refrigeration equipment with new, higher efficiency equipment that will also benefit from using lower GWP refrigerants.

Cap and phase down.

Regulation text

Article 15: *"The Commission shall ensure that the quantity of HFCs that producers and importers are entitled to place on the market does not exceed a maximum quantity for the year in question as calculated in accordance with Annex V."*

Article 14: *"From 1 January 2017 refrigeration, air conditioning and heat pump equipment charged with hydrofluorocarbons shall not be placed on the market unless hydrofluorocarbons charged into the equipment are accounted for within the quota system … "*

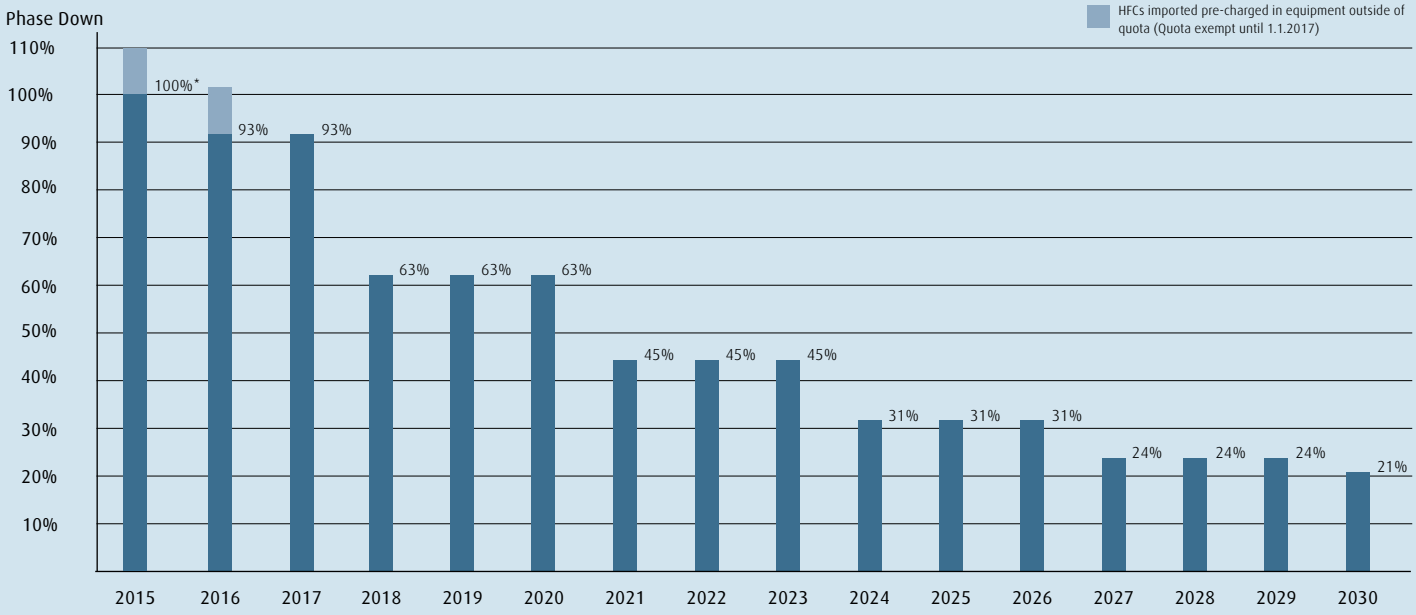
Linde comment and recommendation

Summary

The cap and phase down only impacts the supply of HFCs, not PFCs or SF_6. This part of the regulation does not ban the sale of any particular HFC. Instead, starting in 2015, the cap and phase down will limit the total supply of HFCs across the EU based on the total tonnes carbon dioxide (CO_2) equivalent (CO_2e).

The regulation will initially target the supply of bulk HFCs, but from 2017, as detailed in Article 14 and on page 14 overleaf, it will also impact the supply of equipment containing HFCs. This will effectively reduce the supply of HFCs available for other applications by 10 % from that date.

Diagram 1: HFC phase down schedule (CO_2e basis, in %)



* 100% = Average of 2009–2012

Table 5 and Diagram 1 highlight the phase down schedule. During the phase down there are some major reductions, such as in 2018. By 2030, the supply of HFCs will have reduced to 21% of 2009–2012 baseline CO_2e.

Linde believes that there is a potential risk of supply shortages and associated cost increases. Therefore this section of the report will analyse the implications further.

GWP and CO_2 Equivalents (CO_2e)

Each HFC gas has a different Global Warming Potential (GWP) as detailed in table 6. All GWP figures are compared to that of the most common greenhouse gas.

The total weight of gas used multiplied by its GWP gives the total CO_2 equivalent (CO_2e) for that system. By way of example, 10 kg of R134a will have a CO_2e of 14,300 kg CO_2e (14.3 tonnes CO_2e).

As can be seen in table 6, the same weight of R404A will use almost twice as much quota as R407A. Therefore if all R404A customers moved to R407A, it would effectively halve the CO_2e of their demand.

To meet the needs of the legislation either the total quantity of gases sold in kg needs to rbe reduced, or the average GWP of the gases needs to be reduced, or – and most likely – a combination of both will need to occur.

Table 5: Annex V: Quantities

2009–2012 average	2015	2016–17	2018–20	2021–23	2024–26	2027–29	2030
Baseline (100 %)	100%	93%	63%	45%	31%	24%	21%

Table 6: Global warming potential of some HFC gases

Gas	R134a	R404A	R407A	R407C	R410A	R422D	R427A	R438A	R507	R744 (CO_2)
GWP	1430	3922	2107	1774	2088	2729	2138	2265	3985	1

Table 7: Supply and demand changes of HFCs

Supply changes	Demand changes
Supply reduction:	Demand reduction:
– Cap and phase down: reduction to 21% of 2009–2012 base	– Product and equipment bans
	– 2020 service and maintenance bans
	– MAC directive
	– Leak control
	– Refrigerant recovery and reclamation
	– Use of lower GWP gases
	Demand increase (effective)
	– Equipment containing HFCs will require HFC quota from 2017*
	– Economic growth

Balancing supply and demand – risk of shortages

Currently the supply of HFCs exceeds market demand. However,the cap and phase down restrictions on supply will change that situation. The cap and phase down will reduce supply, and therefore there is a need for demand to decline at a similar rate. If market demand remains at the same level as in the period 2009–2012, or if for any reason the initial baseline is too low, then there will be product shortages, and associated cost rises.

Some parts of the f-gas regulation will lower the market demand, as indicated in table 7 above. The product and equipment bans and the service and maintenance bans are the most notable areas of impact. In addition, improved containment – such as reducing system leakage – as well as the recovery and reclamation of used refrigerants have the potential to reduce demand for virgin gas. Finally, the EU MAC directive will restrict the use of R134a in mobile air conditioning systems installed in new car platforms.

However, from 2017, the supply of equipment imported into the EU that contains HFCs will also be managed via the quota system. Companies that manufacture equipment containing HFCs to be imported into the EU will be required either to purchase HFCs from within the EU, or ensure that they have access to quota for the equivalent amount of gas as contained within their equipment. This effectively will increase the demand for HFCs from the quota system, further necessitating a reduction in demand elsewhere.Then in 2018, there is a large reduction in supply quota from 93% to 63% of baseline.

Therefore without industry action, there is a real risk that the reduction in supply of HFCs will outpace the net reduction in demand. This would lead to potential supply shortages and associated cost increases.

Implications for Industry

Consequently, there will be a need for other sectors to reduce their CO_2e demand by using lower volumes of gas, or using lower GWP gases. This will increase the need for users to convert their systems to use lower GWP refrigerant gases, or replace their systems with ones that use lower GWP HFCs, HFOs or natural refrigerants.

There are already a number of lower GWP refrigerant gases available – both for new and existing refrigeration and air conditioning equipment – and further low GWP gases will be launched over the coming years. We would expect these low GWP gases to become increasingly cost competitive, as high GWP gases suffer potential supply shortages and associated cost increases.

Responsible supply.

Regulation text

Article 10(1): *Member States shall ... establish or adapt certification programmes including evaluation processes. Member States shall ensure that training is available for natural persons carrying out the following tasks:*

(a) installation, servicing, maintenance, repair or decommissioning of the equipment listed in points (a) to (f) of Article 4(2)
(b) leak checks of the equipment referred to in points (a) to (e) of Article 4(2) ...
(c) recovery of f-gases as provided for in Article 8(1)

Article 10(2): *Member States shall ensure that training programmes for natural persons recovering f-gases from air-conditioning equipment in motor vehicles falling within the scope of Directive 2006/40/EC are available ...*

Article 11(4): *For the purposes of carrying out the installation, servicing, maintenance or repair of the equipment that contains fluorinated greenhouse gases or whose functioning relies upon those gases for which certification or attestation is required in Articles 10, f-gases shall only be sold to and purchased by undertakings that hold relevant [f-gas] certificates or attestations in accordance with Article 10 or undertakings that employ persons holding a certificate or training attestation in accordance of Article 10 (2) and (5).*

Linde comment and recommendation

The previous f-gas regulation demanded that competent and/or certified people or businesses used f-gases. The newly revised f-gas regulation will put an increased responsibility on refrigerant distributors to ensure that f-gases required for specific applications are sold only to people or businesses that hold the relevant certification or who have attended accredited training programmes.

The previous f-gas regulation provided a requirement for training programmes to be set up in Member States. The updated regulation has widened the scope of the training to include new sectors and/or training requirements. Table 8 provides preliminary analysis of the areas where certification or training attestations will be required.

The exact details on how this requirement will be managed are still to be determined and will vary slightly by Member State. In many countries this will lead to a change in business processes. In some cases this may lead to a requirement to request information on f-gas certification prior to supply. Refrigerant distributors will need to work closely with customers to minimise any disruption.

These requirements highlight an increased focus on ensuring that users of f-gases are trained and/or certified.

It is critically important to ensure that your business has the correct knowledge, training and certification required under this regulation, so that you are entitled to purchase f-gases as well as carry out the servicing and maintenance of the systems that utilise these gases.

Table 8: Preliminary analysis of certification or training requirements

Sector	Current EU regulation
Stationary refrigeration, air conditioning and heat pump equipment	303/2008
Refrigeration units of refrigerated trucks and trailers	Regulation to be defined
Stationary fire protection systems and fire extinguishers	304/2008
High voltage switchgear	305/2008
Equipment containing f-gas solvents	306/2008
Air conditioning systems in motor vehicles	307/2008

Leakage: leak checks and leak detection.

Regulation text

Article 4: Leak Checks

Operators of the following equipment:
a) stationary refrigeration equipment
b) stationary air conditioning equipment
c) stationary heat pumps
d) stationary fire protection equipment
e) refrigeration units of refrigerated trucks and trailers
f) electrical switchgear
g) organic rankine cycles

that contains f-gases in quantities of 5 tonnes CO_2e or more and not contained in foams shall ensure that the equipment is checked for leaks.

Except for:

- *hermetically sealed equipment that contains f-gases in quantities of less than 10 tonnes CO_2e, provided the equipment is labelled as hermetically sealed*
- *electrical switchgear with tested leakage of less than 0.1% per year and labelled accordingly*
- *electrical switchgear equipped with a pressure or density monitoring device*
- *electrical switchgear that contains less than 6 kg f-gases*
- *until 31.12.2016: equipment containing less than 3 kg f-gases, or hermetically sealed equipment (labelled) containing less than 6 kg f-gases.*

Table 9: Article 4: Leak check frequency

F-gas system contents	Leak check frequency (No leak detection system installed)	Leak check frequency (Leak detection system installed)
500 tonnes CO_2e or more	*At least once every 3 months*	*At least once every 6 months*
50 to 499.99 tonnes CO_2e	*At least once every 6 months*	*At least once every 12 months*
5 to 49.99 tonnes CO_2e	*At least once every 12 months*	*At least once every 24 months*

Table 10: Article 5: leak detection systems

Equipment group	Leak detection system needs	Leak detection system check frequency
a) Stationary refrigeration equipment	*Operators of equipment containing f-gases in quantities of 500 tonnes CO_2e or more shall ensure that this equipment is provided with a leak detection system that shall alert the operator or a service company of any leakage*	*At least once every 12 months to ensure proper functioning*
b) Stationary air conditioning equipment		
c) Stationary heat pumps		
d) Stationary fire protection equipment		
e) Refrigeration units of refrigerated trucks and trailers	*No requirements*	*No requirements*
f) Electrical switchgear	*Operators of equipment containing f-gases in quantities of 500 tonnes CO_2e or more and installed after 1 January 2017 shall ensure that this equipment is provided with a leak detection system that shall alert the operator or a service company of any leakage*	*At least once every 6 years to ensure proper functioning*
g) Organic Rankine cycles		*At least once every 12 months to ensure proper functioning*

Linde comment and recommendation

The most obvious change to the requirements on leak checks and leak detection systems is a move from kg thresholds to CO_2e thresholds.

Previously, the thresholds for determining the frequency of leak checks were at 3, 30 and 300 kg of f-gases. The new thresholds are at 5, 50 and 500 tonnes CO_2e. Therefore the charge size thresholds will vary by refrigerant gas and respective GWP as detailed in table 11. This will lead to some systems being categorised differently. Operators of systems using gases with GWP >1666 may find that they need to carry out more frequent leak checks, and those with systems using gases with GWP <1666 may find that they can carry out less frequent checks. It should be noted that most systems will continue to have the same requirements.

Other changes include the broadening of the requirements for leak checks to include the refrigeration units of refrigerated trucks and trailers, electrical switchgear and organic Rankine cycles.

Additionally, the users of electrical switchgear and organic Rankine cycles with larger systems (greater than 500 tonnes CO_2e) will also be expected to install leak detection systems.

Finally, users with leakage detection systems will be allowed to carry out less frequent leak checks.

Table 11*: Common HFC and charge size groups

Refrigerant	Other names	GWP	Leak detection: 5 tonnes CO_2e threshold equivalent weight (kg)	Leak detection: 50 tonnes CO_2e threshold equivalent weight (kg)	Leak detection: 500 tonnes CO_2e threshold equivalent weight (kg)
23		14800	0.3	3.4	34
32		675	7.4	74.1	741
134a		1430	3.5	35.0	350
404A	SUVA HP62, Forane FX70	3922	1.3	12.7	127
407A	Klea 60	2107	2.4	23.7	237
407C	Klea 66, Suva 9000	1774	2.8	28.2	282
407F	Performax LT	1825	2.7	27.4	274
410A	Genetron AZ-20	2088	2.4	23.9	239
417A	ISCEON MO59	2346	2.1	21.3	213
422A	ISCEON MO79	3143	1.6	15.9	159
422D	ISCEON MO29	2729	1.8	18.3	183
423A	ISCEON 39TC	2280	2.2	21.9	219
424A	RS-44	2440	2.0	20.5	205
427A	Forane FX100	2138	2.3	23.4	234
428A	RS-52	3607	1.4	13.9	139
434A	RS-45	3245	1.5	15.4	154
438A	ISCEON MO99	2265	2.2	22.1	221
442A	RS-50	1888	2.6	26.5	265
507A	Genetron AZ-50	3985	1.3	12.5	125
508B	SUVA 95	13396	0.4	3.7	37
MO89	ISCEON MO89	3805	1.3	13.1	131

*SUVA, Forane, Klea, Gentron, Performax, ISCEON are all trademarks or their respective companies

Labelling.

Regulation text

Article 12: *"Products and equipment that contain fluorinated greenhouse gases, or whose functioning relies upon fluorinated greenhouse gases, shall not be placed on the market unless they are labelled."*

Additional Labelling Requirements
Article 12(6): *"Reclaimed or recycled fluorinated greenhouse gases shall be labelled with an indication that the substance has been reclaimed or recycled, information on the batch number and the name and address of the reclamation or recycling facility."*

Articles 12(7 to 12): *Special use gases (for destruction, export, military equipment, semiconductor manufacture, feedstock and metered dose inhalers) must also be labelled for use only for that specific purpose.*

Article 12(14): *The Commission may, by means of implementing acts, determine the format of the labels referred to in paragraph 1 and paragraphs 4 to 12 and may repeal acts adopted pursuant to Article 7(3) of Regulation (EC) No 842/2006.*

Table 12: Article 12: Labelling requirements

Product / Equipment Type	Key Labelling Requirements
Paragraph 1 *a) Refrigeration equipment* *b) Air conditioning equipment* *c) Heat pumps* *d) Fire protection equipment* *e) Electrical switchgear* *f) Aerosol dispensers (with the exception of metered dose inhalers)* *g) All f-gas containers (cylinders / drums)* *h) F-gas solvents* *i) Organic Rankine cycles*	• *A reference that the product contains fluorinated greenhouse gases or that its functioning relies upon such gases* *The accepted industry designation of the f-gas, or if no such designation is available, the chemical name* *As of 1.1.2017, the quantity expressed in weight and CO_2 equivalent of fluorinated greenhouse gases contained in the product or equipment.* *Specific labelling requirements for hermetically sealed and low leakage switchgear* *Labels shall be clearly readable and indelible and shall be placed either adjacent to the service ports for charging or recovering the f-gas, or on the part of the product or equipment that contains the gas*
Paragraph 5 *Foams and pre-blended polyols*	• *Information that the foam contains fluorinated greenhouse gases. In the case of foam boards, this information shall be clearly and indelibly stated on the boards.* *The name of the fluorinated greenhouse gas using the accepted industry designation, or if no such designation is available, the chemical name*

Linde comment and recommendation

Many of the labelling requirements remain the same as in the previous f-gas regulation 842/2006 and the associated labelling articles (e.g. 1494/2007). However there are a few notable differences.

Firstly, from 2017, products and equipment will need to carry more information on the CO_2e of the f-gas contained within the system. This will mean making changes to the labelling on systems, including when a retrofit is undertaken. However, this is a relatively straightforward task once the gas in use has been identified and the charge size is known. In both cases, we expect the Commission to update the previous labelling legislation to meet these new requirements, as stated in Article 12(14).

Implications: continue, convert or replace.

Choice available

Greater corporate environmental responsibility is already leading to increased momentum to utilise lower GWP refrigerant gases. However, the f-gas regulation creates an additional push driven by product and equipment bans and service and maintenance bans, combined with potential supply shortages and cost increases arising from the cap and phase down.

Users of refrigerants have a number of options available to them:

- **Continue** using the same gas
- **Convert** to another lower GWP gas
- **Replace** their system with a new installation that can use a lower GWP gas.

The best solution will vary depending on the user's specific requirements, however some general guidance is provided overleaf.

Continue

Many users are able to continue using their current refrigeration system with existing gases for a number of reasons.

Table 13 provides a summary of the most common reasons for continuing to operate refrigeration equipment.

Some of these examples have very low risk for the customer – such as cases where equipment is already using long-term replacement gases such as natural refrigerants and HFOs. However, other actions, such as relying on reclaimed or recycled HFCs, relies on the availability of these gases.

Table 13: Potential reasons for a user to continue using a refrigeration system with existing gas.

Example system and/or customer group	Impacted by 2020 service and maintenance ban	Impacted by cap and phase down	Comments
(i) System not containing an HFC. (e.g. R744)	No	No	No legal requirement to change gas.
(ii) System containing an HFC, but with a full process exemption as defined in Article 15(2) (e.g. military use)			User can continue with low risk.
(iii) System containing an HFC with GWP < 2500 (e.g. R134a, R407A)	No	Yes	No legal requirement to change gas.
(iv) Non-refrigeration equipment containing an HFC with GWP 2500 or more.			User can continue with medium risk (some risk of HFC supply shortages or cost increases in the future)
(v) Refrigeration equipment containing an HFC with GWP 2500 or more that has received an exemption from the service and maintenance ban (e.g. due to size or process temperature)			
(vi) Refrigeration system containing an HFC with GWP 2500 or more (e.g. R404A) that does not meet any requirements of service and maintenance ban exemptions.	Yes	Yes	User plans to replace or retrofit the equipment prior to 2020 but will continue to operate "as-is" at present.
			User plans to use reclaimed or recycled HFCs post 2020 to maintain their system.
			The level of risk will depend on the availability of reclaimed gas. An especially high risk strategy for gases other than R404A and R507

Convert: (retrofit)

Immediate focus: 2020 refrigeration maintenance ban

The most immediate reason to consider retrofitting a refrigeration system is to meet the obligations of the service and maintenance ban that impacts gases with GWP 2500 and above. Therefore this review will focus on those gases.

In many cases, especially for the most common installations using R404A, R507 or R422D, it is possible to convert your equipment to use another gas.

Retrofit gases that are commercially available today will allow you to meet the requirements of the service and maintenance ban. These retrofit gases generally have a GWP of between 1700 and 2400.

Future challenges: cap and phase down

Linde notes that the cap and phase down will severely restrict supply of HFCs in the future, reaching just 21% of the baseline by 2030.

It is possible that the currently available retrofit gases may not provide enough CO_2e savings to fully meet the requirements of the cap and phase down. Therefore whilst they meet the requirements of the 2020 service and maintenance ban, they may not be the final solution to meet all aspects of the f-gas regulation.

It is also very likely that HFCs with GWP less than 2500 will need to be retrofitted with lower GWP gases where possible. Therefore further retrofits using HFO blends, or replacement of equipment to use lower GWP gases such as HFOs or natural refrigerants may be required in the longer term.

Refrigerant manufacturers are working to commercialise lower GWP retrofit gases that will provide the benefit of avoiding the risk of having to carry out a second retrofit in the future.

R404A systems

For many R404A systems, the changes will be very minor as the retrofit replacement blends R407A, R407F (Genetron® Performax™ LT) and R442A (RS-50) have similar thermodynamic properties, share many of the same HFC components, and are designed to use the same lubricants. The retrofit of a system from R404A to another HFC such as R407A is a simpler procedure than historical HCFC-to-HFC retrofits (such as R22 retrofits).

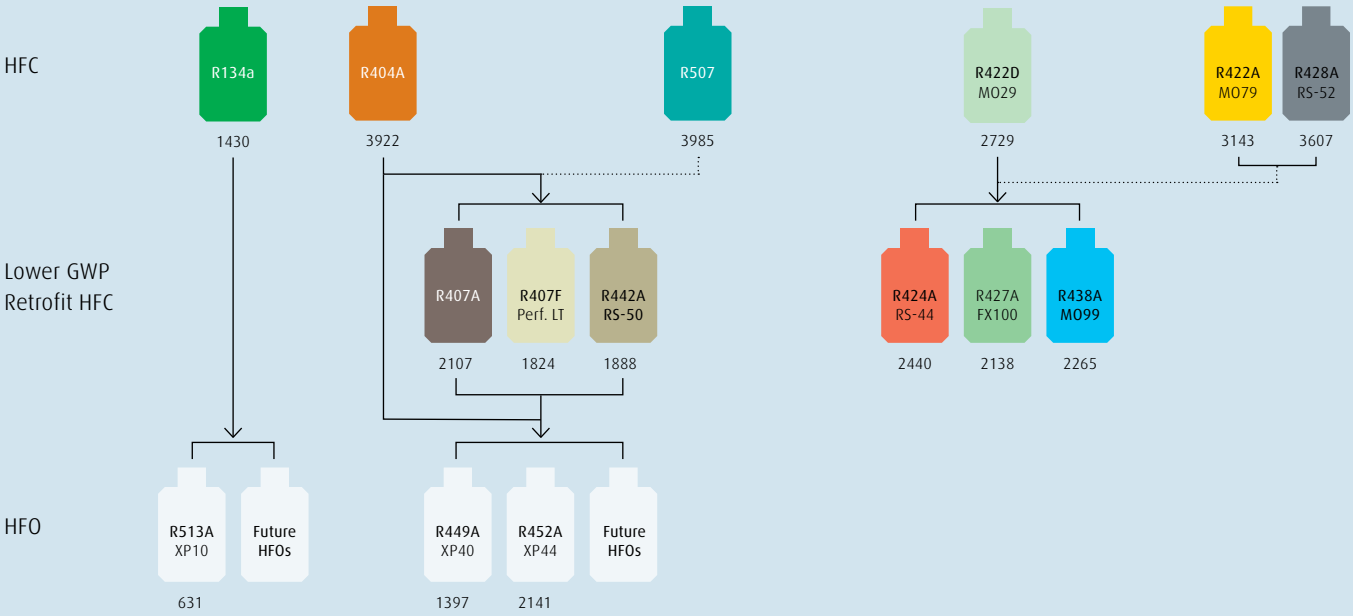
Linde notes however that the cap and phase down will severely restrict supply of HFCs in the future. It is possible that the currently available R404A retrofit gases may not provide enough CO_2e savings to fully meet the long-term requirements of the cap and phase down.

Table 14: Overview of HFCs impacted by service and maintenance ban and potential retrofit alternatives

R-number	Other names	GWP	Retrofit replacement gas	GWP	Comments
R23		14800	None available		Often used for applications below –50 °C (therefore exempted)
R404A		3922	R407A	2107	Generally a straightforward retrofit. New HFO blends soon to be commercialised that offer lower GWP long-term retrofit solutions.
			R407F Performax™ LT	1825	
			R442A – RS-50	1888	
			R449A – Opteon® XP40	1397	
			Other HFO blends		
R422A	ISCEON® MO79	3143	R438A – ISCEON® MO99*	2265	No simple solution, consult your equipment or refrigerant supplier for assistance. (Replacement gases may suffer from lower capacity at low temperatures and discharge temperature/mass flow challenges)
			R427A – Forane® 427A*	2138	
R422D	ISCEON® MO29	2729	R438A – ISCEON® MO99	2265	Generally a straightforward retrofit
			R427A – Forane® 427A	2138	
R428A	RS-52	3607	R442A – RS-50	1825	No simple solution, consult your equipment or refrigerant supplier for assistance
			R407F	1888	
			R438A – ISCEON® MO99*	2265	
			R427A – Forane® 427A*	2138	
R434A	RS-45	3245	Retrofit replacement under development.		Continue to use R434A in the short-term.
R507		3985	R407A	2107	Retrofit solutions not suitable in all applications, especially in low temperature or flooded systems. If in doubt contact your refrigerant supplier.
			R407F – Performax™ LT	1825	
			R442A – RS52	1888	
R508B		13396	None available		Often used for applications below –50 °C (therefore exempted)
MO89	ISCEON® MO89	3805	None available		Often used for applications below –50 °C (therefore exempted)

F-gas regulation: regulation details

Customer options: continue, convert, replace
common HFCs and retrofit alternatives (with respective GWP)



R507 Systems

Some R507 systems can use the same retrofit gases as with R404A systems – i.e. R407A, R407F or R442A. However, this is not true for all systems. Therefore we recommend further analysis on a case by case basis.

HCFC Retrofit gases

R422D (Isceon® MO29) is the most popular HCFC retrofit gas within the European Union. Unfortunately, however, it has a GWP of 2729 and therefore is impacted by the service and maintenance bans. The most obvious retrofit solution is to change to R438A (Isceon® MO99).

This is a simple change in most circumstances. In some cases, alternative gases such as R427A (Forane® 427A) and R424A (RS-44) may also provide a suitable solution.

Other HCFC retrofit gases that are impacted by the service and maintenance bans include R422A, R428A and R434A. These gases are often chosen for applications where other retrofit gases are not suitable. In some cases these may be replaced by gases such as R438A, R427A or R424A, however their suitability will depend on the equipment setup and cooling requirements. More detail is provided in table 14.

Other HFC gases

The cap and phase down will restrict the supply of all HFCs, and therefore it is likely that it will be necessary to retrofit systems with gases with a GWP less than 2500 in the future.

Refrigerant manufacturers are developing HFO blends suitable for retrofitting other HFCs, most notably R410A and R134a systems. We expect these gases to be commercially available during the next few years.

Recovery and reclamation

The regulation also prohibits the intentional release of f-gases into the atmosphere. Therefore it is critical to ensure the correct end of life recovery of the old refrigerant gas during the retrofit process.

This recovered gas can then be recycled, reclaimed or destroyed. When recovering gas, Linde strongly recommends to use separate cylinders or drums per gas to avoid creating “cocktails“ of gases of unknown constituency as this creates additional challenges during the refrigerant recovery and reclamation process and may lead to additional costs for the user.

General advice

In all cases, when replacing a gas with a retrofit alternative, Linde recommends recovering the original refrigerant charge, and replacing it with a full charge of the replacement gas. We do not recommend “topping up” as this will create mixtures of unknown composition which may have unpredictable consequences. “Topping up” also creates challenges in adhering to other aspects of the f-gas regulation, such as labelling requirements and end-of-life recovery and reclamation.

Finally, there will be some cases where the retrofit solution will not be immediately obvious. In these cases, we would recommend referring to the equipment supplier for further support. In some circumstances it may be more economical to replace the system in its entirety.

Replace

New, highly efficient refrigeration and air conditioning technologies are becoming available that are designed to operate using low GWP refrigerant gases. These provide both energy efficiency and environmental benefits.

Therefore it can make good economic sense to replace your existing system. This is especially true if your current system was originally designed to use HCFCs, such as R22, and as such is already relatively old, or if it is operating using one of the refrigerant gases where no obvious retrofit solution is available.

There is a wide range of refrigerant gases available with lower GWP. These include HFCs, HFOs and a wide range of natural refrigerants including R744, R717 and hydrocarbon refrigerants. Some of the most common gases are summarised in Table 15.

Whilst offering potential environmental benefits, many of the lower GWP gases have other physical properties that need to be managed safely. The most common difference is in the flammability of the gas, with many low GWP gases either being rated A2L (mildly flammable) or A3 (highly flammable).

Many of these gases are only suitable for new installations that are specifically designed to utilise them and may be restricted in certain applications – e.g. as defined under EN 378. They are not suitable for retrofitting existing HFC systems.

Table 15: Refrigerant Gases with GWP 2500 or less

R-Number	Other names	GWP	GWP band	ASHRAE rating	Replacement for	Comments
R717	Ammonia	0	Low	B2	R134a	New equipment only, not a retrofit gas
R744	Carbon dioxide	1	Low	A1	R134a , R404A	New equipment only, not a retrofit gas
R1270	Propene, propylene	2	Low	A3	R22,R404A, R410A	New equipment only, not a retrofit gas
R290	Propane	3	Low	A3	R22,R404A, R410A	New equipment only, not a retrofit gas
R600a	Isobutane	3	Low	A3	R134a	New equipment only, not a retrofit gas
R1234yf	DuPont™ Opteon® YF Solstice™ yf	4	Low	A2L	R134a	New equipment only, not a retrofit gas
R1234ze(E)	Solstice™ ze	7	Low	A2L	R134a	New equipment only, not a retrofit gas
R513A*	DuPont™ Opteon® XP10	631	Medium	TBC (A1)	R134a	Suitable as a retrofit gas in existing equipment. (Estimated to be commercially available during 2015)
R32		675	Medium	A2L	R410A	New equipment only. Not a retrofit gas
R449A	DuPont™ Opteon® XP40	1397	Medium	TBC (A1)	R404A	Suitable as a retrofit gas in existing equipment. (Estimated to be commercially available during 2014)
R407C		1774	Medium	A1	R22	Suitable as a retrofit gas in existing equipment – oil change necessary.
R407F	Genetron® Performax™ LT	1825	Medium	A1	R404A (R507*, R22*)	Suitable as a retrofit gas in existing equipment *May be suitable in some retrofit applications
R442A	RS-50	1888	Medium	A1	R404A (R507*, R22*)	Suitable as a retrofit gas in existing equipment *May be suitable in some retrofit applications
R410A		2088	Medium	A1	R22	New equipment only, not a retrofit gas
R407A		2107	Medium	A1	R404A (R507*, R22*)	Suitable as a retrofit gas in existing equipment *May be suitable in some retrofit applications
R427A	Forane® 427A	2138	Medium	A1	R22 and R22 retrofit blends – R422D, R422A*, R428A*	Suitable as a retrofit gas in existing equipment – oil change necessary (no flush) *May be suitable in some retrofit applications
R452A*	DuPont™ Opteon® XP44	2141	Medium	TBC (A1)	R404A	Suitable as a retrofit gas in existing equipment. (Estimated to be commercially available during 2015)
R438A	DuPont™ ISCEON® MO99	2265	Medium	A1	R22 and R22 retrofit blends – R422D, R422A*, R428A*	Suitable as a retrofit gas in existing equipment *May be suitable in some retrofit applications
R423A	DuPont™ ISCEON® 39TC	2280	Medium	A1	R12	Suitable as a retrofit gas in existing equipment
R417A	DuPont™ ISCEON® MO59	2346	Medium	A1	R22 and R22 retrofit blends	Suitable as a retrofit gas in existing equipment
R424A	RS-44	2440	Medium	A1	R22 and R22 retrofit blends	Suitable as a retrofit gas in existing equipment

*Pending ASHRAE final approval

Appendix.

For further information on how Linde can help you meet your environmental and legislative challenges, please contact your local Linde supplier.

Alternatively visit www.linde-gas.com/fgas

Further reading

New f-gas regulation 517/2014
http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:JOL_2014_150_R_0008

European Commission f-gas Policy
http://ec.europa.eu/clima/policies/f-gas

EU MAC Directive EN
http://ec.europa.eu/enterprise/sectors/automotive/environment/macs/index_en.html

Table 16: F-gases and alternatives: GWP

Product number	Other names	Gas type	GWP
23	trifluoromethane (fluoroform)	HFC	14800
32	difluoromethane	HFC	675
116	hexafluoroethane (perfluoroethane)	PFC	12200
134a	1,1,1,2-tetrafluoroethane	HFC	1430
152a	1,2-difluoroethane	HFC	124
170	Ethane	Natural/not-in-kind	6
218	octafluoropropane (perfluoropropane)	PFC	8830
227ea	1,1,1,2,3,3,3-heptafluoropropane	HFC	3220
236fa	1,1,1,3,3,3-hexafluoropropane	HFC	9810
245fa	1,1,1,3,3-pentafluoropropane	HFC	1030
290	Propane	Natural/not-in-kind	3
365mfc	1,1,1,3,3-pentafluorobutane	HFC	794
404A	SUVA® HP62, Forane® FX70	HFC	3922
407A	Klea® 60	HFC	2107
407C	Klea® 66, Suva® 9000	HFC	1774
407F	Genetron® Performax™ LT	HFC	1825
410A	Genetron® AZ-20	HFC	2088
417A	ISCEON® MO59	HFC	2346
422A	ISCEON® MO79	HFC	3143
422D	ISCEON® MO29	HFC	2729
423A	ISCEON® 39TC®	HFC	2280
426A	RS-44	HFC	2440
426A	RS-24	HFC	1508
427A	Forane® FX100	HFC	2138
428A	RS-52	HFC	3607
434A	RS-45	HFC	3245
438A	ISCEON® MO99	HFC	2265
442A	RS-50	HFC	1888
449A	Opteon® XP40	HFO/HFC blend	1397
452A*	Opteon® XP44	HFO/HFC blend	2141
507A	Genetron® AZ-50	HFC	3985
508B	SUVA® 95	HFC	13396
513A*	Opteon® XP10	HFO/HFC blend	631
600	Butane	Natural/not-in-kind	4
600a	Isobutane	Natural/not-in-kind	3
601	Pentane	Natural/not-in-kind	5
601a	Isopentane	Natural/not-in-kind	5
611	Methyl Formate	Natural/not-in-kind	25
717	Ammonia	Natural/not-in-kind	0
744	Carbon Dioxide	Natural/not-in-kind	1
1234yf	Opteon® YF, Solstice™ YF	HFO	4
1234ze	Solstice™ ZE	HFO	7
1270	Propene/Propylene	Natural/not-in-kind	2
E-170	Dimethylether (DME)	Natural/not-in-kind	1
MO89	ISCEON® MO89	HFC	3805
SF_6	Sulfur Hexafluoride	Other f-gas	22800

*Pending ASHRAE final approval

Getting ahead through innovation.

With its innovative concepts, Linde is playing a pioneering role in the global market. As a technology leader, it is our task to constantly raise the bar. Traditionally driven by entrepreneurship, we are working steadily on new high-quality products and innovative processes.

Linde offers more. We create added value, clearly discernible competitive advantages, and greater profitability.
Each concept is tailored specifically to meet our customers' requirements – offering standardised as well as customised solutions. This applies to all industries and all companies regardless of their size.

If you want to keep pace with tomorrow's competition, you need a partner by your side for whom top quality, process optimisation, and enhanced productivity are part of daily business. However, we define partnership not merely as being there for you but being with you. After all, joint activities form the core of commercial success.

Linde – Ideas become solutions.

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