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Marketing Manager

June 26th 2014

F-Gas Regulation & R404A Alternatives

For Commercial Refrigeration

rac

Honeywell

European F-Gas Regulation

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INTENT...

To control emissions from fluorinated greenhouse gases (F-gases), the European Union has adopted the '**F-gas Regulation**' which covers all key applications in which F-gases are used.

HOW ....

- **Limiting** the amount of high GWP F-gases available to the market
- **Leak** Reduction / Prevention
- **Introducing Bans** on High GWP F-gases where alternatives are available

GOAL .....

To reduce F-gas emissions by **two-thirds** of today's levels by 2030.

Proposal for a

REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

on fluorinated greenhouse gases

2011
- F-gas Regulation Proposal European Parliament and Council

2011 /13
- Stakeholders & Government Negotiation / Lobbying Phase

May 2014
- F-gas Regulation Agreed / Officially published

Jan 2015
- F-gas 2015 Official Implementation

2030
- GOAL: Two thirds reduction in EU F-gas Emissions

Main Messages

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CHAPTER I – General Provisions

Objective of this Regulation: to protect the environment by reducing emissions of fluorinated greenhouse gases

CHAPTER II– Containment

Includes: Strict Guidelines on leak reduction, recovery for reclaim or destruction, training / certification and documentation

CHAPTER III – Placing on the Market & Control of Use

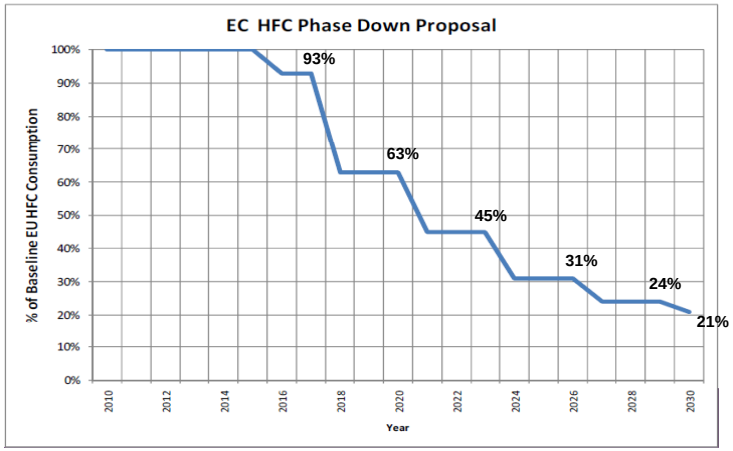
Focus On: Bans on High GWP HFC's by Date

Products and equipment		Date of prohibition
Fire protection equipment that contain HFC-23		1 January 2016
Domestic refrigerators and freezers that contain HFCs […] with GWP of 150 or more		1 January 2015
Refrigerators and freezers […] for commercial use (hermetically sealed systems)	that contain HFCs with GWP of 2500 or more	1 January 2020
	that contain HFCs with GWP of 150 or more	1 January 2022
Stationary refrigeration equipment, that contains, or that relies upon for its functioning HFCs with GWP of 2500 or more except equipment intended for application designed to cool products to temperatures below -50°C		1 January 2020
Multipack centralised refrigeration systems for commercial use with a capacity of 40kW or more that contain, or that rely upon for their functioning, fluorinated greenhouse gases with GWP of 150 or more, except in the primary refrigerant circuit of cascade systems where fluorinated greenhouse gases with a GWP of less than 1500 may be used		1 January 2022
Movable room air-conditioning appliances (hermetically sealed equipment which is movable between rooms by the end user) that contain HFCs with GWP of 150 or more		1 January 2020
Single split air-conditioning systems containing less than 3kg of fluorinated greenhouse gases, that contain, or that rely upon for their functioning, fluorinated greenhouse gases with GWP of 750 or more		1 January 2025
Foams that contain HFCs with GWP of 150 or more except when required to meet national safety standards	Extruded polystyrene (XPS)	1 January 2020
	Other foams	1 January 2023
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 January 2018

Note: 'HFCs' refers to blends, not individual components of blends

CHAPTER IV – Cap & Phase – Down for HFC's

Based On: The average quantity (Tonnes CO_2-eq) placed on the market in the period 2009 – 2012



CHAPTER V – Reporting

Only Affects: Producers / Importers / Exporters and destruction services

CHAPTER VI – Final Provisions

Details On: Review Clauses, Stakeholder Consultation Forum, Entry into Force....

Understand the Impact of F-gas for Your Business

New F-gas Regulation

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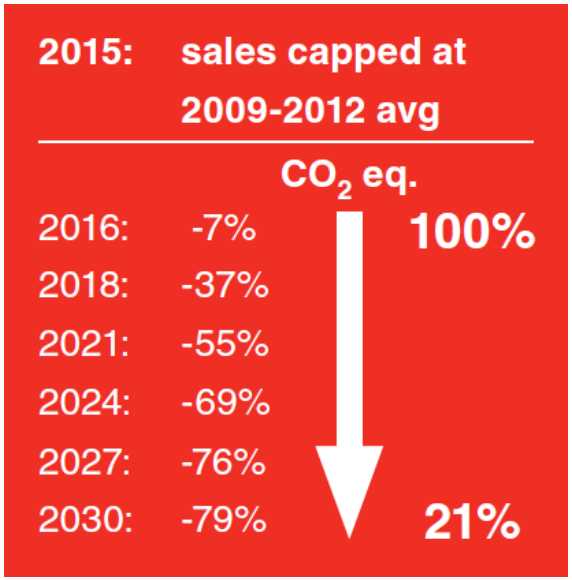
The original F-gas Regulation mainly targeting R-22 and adopted in 2006, is being replaced by a new Regulation which **applies** from 1st January 2015. This strengthens the existing measures and introduces a number of far-reaching changes....

The Most Important Change

- Introduction of the Phase-Down
- Largest Impact on the Com Refrigeration Industry
- Reduction in volume of CO_2-eq. of HFC's placed on the market. (Targeting R-404A / 507)
- Quota allocated to producers / importers (based on 2009 /12)
- EXPECTED RESULT:
  - Force industry towards using lower GWP refrigerants
  - Reduce refrigerant leaks in systems
  - Reduce the environmental impact of our industry
  - Reduce F-gas emissions by 2/3 of 2009/12 baseline



Phase-Down of HFC's will have the Greatest Impact

Control of Use

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New Installation Bans*

(only main bans affecting Refrigeration shown here)

Domestic refrigerators and freezers using HFC's >150 GWP

New Commercial Refrigerators / Freezers (hermetically sealed systems) >2500 GWP

Stationary Refrigeration Equipment requiring HFC >2500 GWP

Centralised multipack systems >40kW capacity using HFC >150 GWP / except primary circuit (not distributed) of cascade system where <1500 GWP is acceptable

New Commercial Refrigerators / Freezers (hermetically sealed systems) >150 GWP

2015 → 2016 → 2017 → 2018 → 2019 → 2020 → 2022 → 2025 → 2028 → 2030

R-22 Total Ban

RAC & H/Pump equip. pre-charged with F-gases must be included in a registered Quota system beginning 2017

Virgin F-gases >2500 GWP for servicing ref equip. With charge size of >40 T CO_2-eq (~10kg R404A)

Recycled and reclaimed F-gases with >2500 GWP for servicing ref equip with a charge size of >40 T CO_2-eq

Exemptions include Military equipment and refrigeration applications below -50 Deg C

Maintenance & Service Bans*

(only those affecting Refrigeration shown here)

Genetron Performax® LT F-Gas Ready Honeywell

NOTE: R407F (<1825 GWP) repl. for R404A - can be used for servicing without end date (beyond 2030...)

*Note – This document is not a comprehensive collection of all the 2015 F-gas bans

A Time of Change

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- Today >85% Commercial Refrigeration in EU uses R404A / R507
- F-gas Regulation will restrict availability of these High GWP refrigerants
- Low GWP alternatives to R404A already well proven / available
- Industry already in a New Age – increased understanding on .....
  - Glide
  - Flammability
  - System Pressure

  .....and affect on system design / specification / installation / service.
- Education / Information is Key!
- Leak prevention must be a major focus for your business
- Phase Down will change the 'value' of HFC's (kg to CO_2-eq)
- HFO / HFO Blends provide industry with longer term solutions
- Business must adapt to meet the new F-gas Regulations....

Solstice® ze Refrigerant F-Gas Ready Honeywell

F-gas Regulations will Challenge our Industry ➡ Opportunities

Important Links for More Information

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Honeywell European Website

Honeywell Refrigerants European Website

Honeywell One Pager on F-gas Regulation

European Commission Website

Climate Action Website

Download Full F-gas Regulation (all languages)

EPEE Website (incl video)

EPEE F-gas Regulation Update

EPEE
European Partnership for Energy and the Environment

EFCTC Website - F-gas Implementation

EFCTC - Figaroo

figaroo
» F-Gas Implementation
» Download the logbook

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Low GWP Refrigerants

June 26, 2014

Technical aspects of R404A retrofitting

Commercial Refrigeration

Honeywell

Agenda

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- Comparative Assessment of R404A alternatives in existing systems or new built (15')
- Technical considerations for a successful retrofit (10')
  - Glide
  - Tdischarge
  - Fractionation
- Questions & Answers (10')

Selecting the Right Refrigerant (Cycle Analysis)

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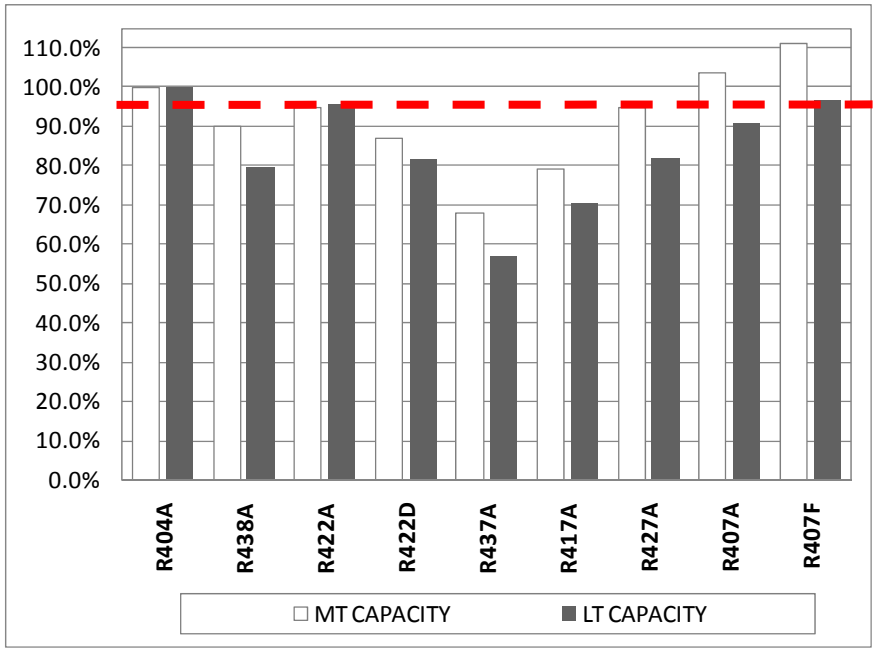
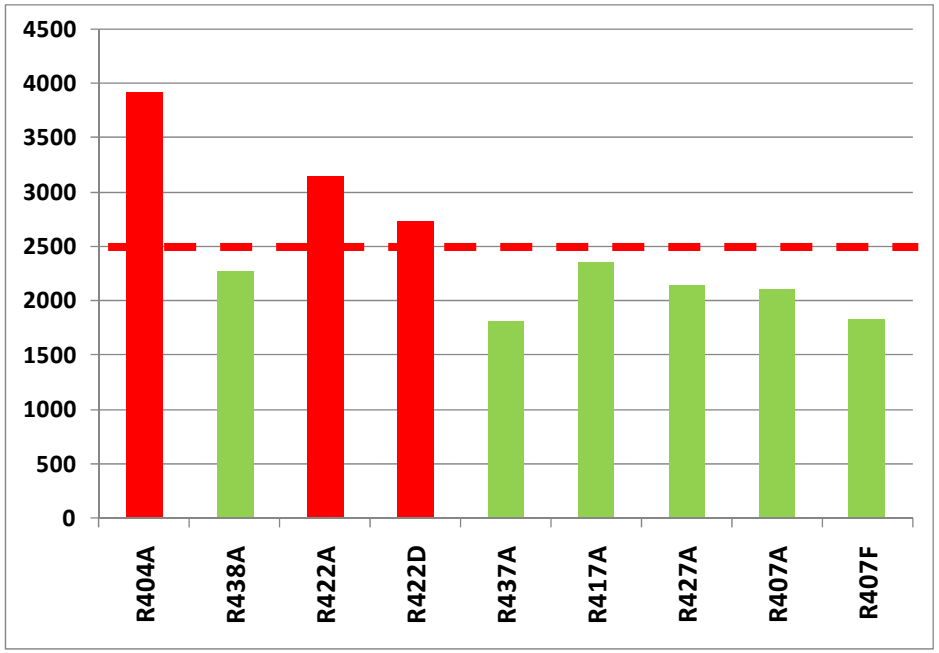
Main commercially available products: 2 selection criteria

Criteria 1: minimum 95% R404 (MT or LT) Capacity



Criteria 2: GWP < 2500



R407F is the best capacity provider with lowest GWP for supermarket applications

R407F (Genetron Performax® LT)

Honeywell

- Developed for use in low and medium-temperature commercial refrigeration applications
- Proven for retro-fit of R-22 and R-404A

- ASHRAE **R-407F**
- **GWP = 1825**
- **A1** ASHRAE safety rating
- EPA SNAP approved
- Reach registered
- 100% Zero ozone depleting

Blend of
R-32 / R-125 / R-134a
30% / 30% / 40%

R407F is the Lowest GWP HFC for Supermarket Applications*

* Commercially Available

Independent Measured Performance Comparison

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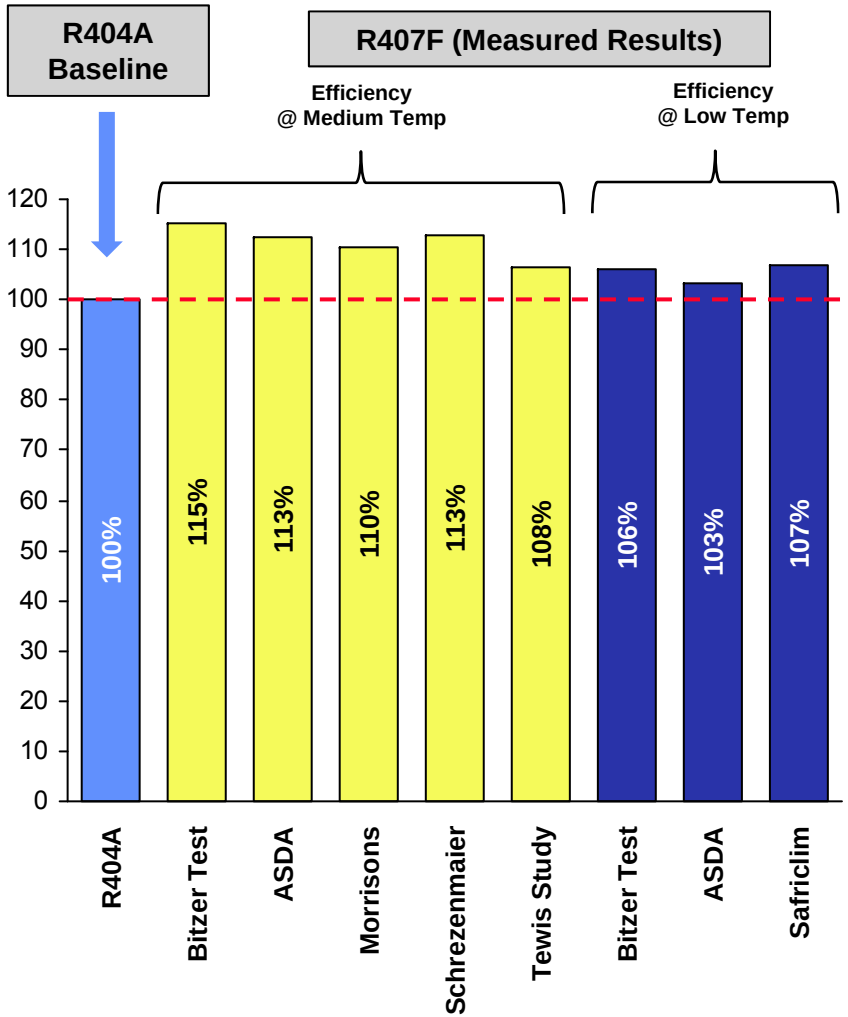

Efficiency comparisons
(Independent verification)

- Important improvements in MT applications ~ 10%
  - Climate / system specific / optimisation during retro-fit
- Still large improvements at LT conditions ~ 6%
- Clear overall improvement in Energy Efficiency shown by R407F

Considerable reduction in operational / running costs

Full Stores Comparison: ASDA / WALMART

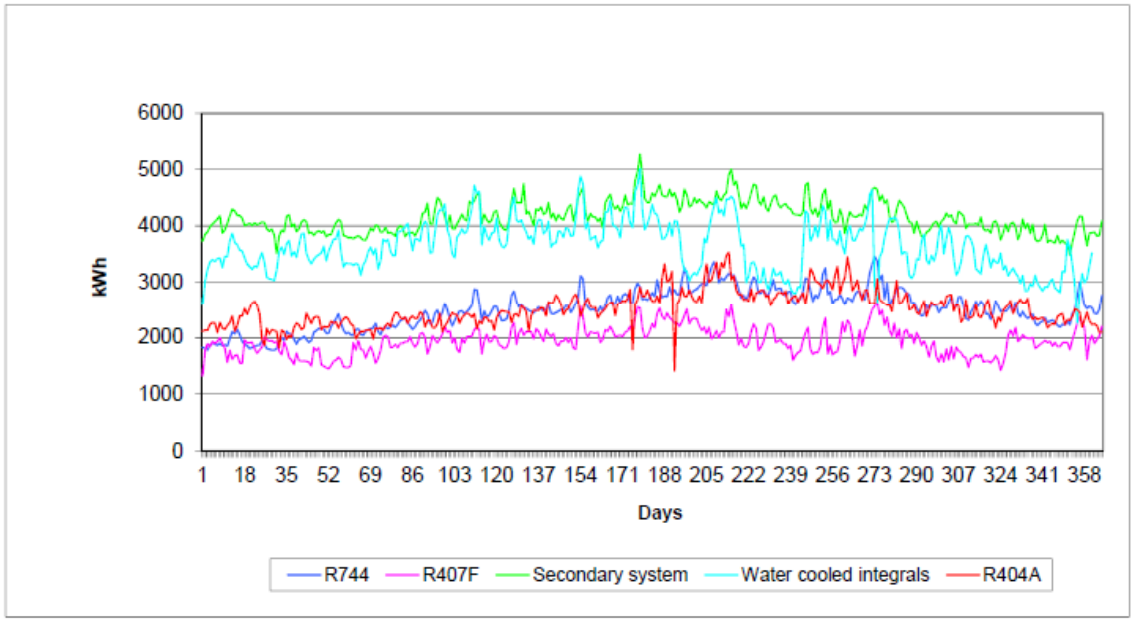

Figure 2 – 2011 Annual energy consumption.

	R407F system	R404A system	R744 system	Secondary system	Water cooled integrals
Total energy consumption in 2011 (kWh)	710,983	919,413	916,831	1,520,700	1,315,531
Life Time TEWI (Tonnes CO2)	6,055	17,669	6,893	11,433	10,027

Figure 1 – Energy consumption and environmental impact summary.

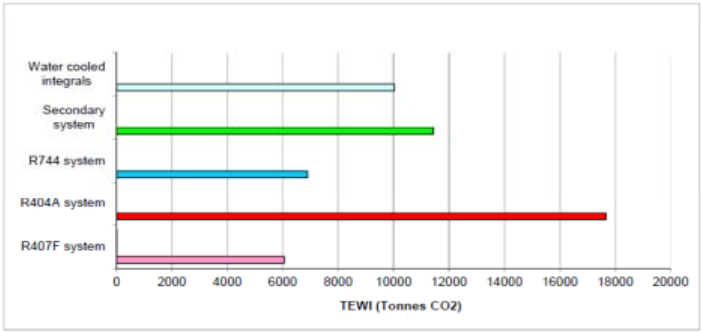

Figure 3 – 2011 Environmental Impact.

*** R404A data from 2005**

**** Ref – www.ior.org.uk *(Evaluation of available Refrigeration Systems in the Retail Sector – by James Bailey & Brian Churchyard, 4th Oct. 2012)***

- Lowest Electricity consumption and lowest CO2 emissions for R407F under UK climate.
- Extract from Conclusions *'this paper identifies that irrespective of a retailer's refrigeration strategy it is possible to greatly reduce emissions by retrofitting systems operating on R404A / R22 with Performax® LT'*

R407F: Lowest CO2 Emissions and Best Financial Choice for a Supermarket

Supermarket Store Trials – Savings R407F vs. R404A

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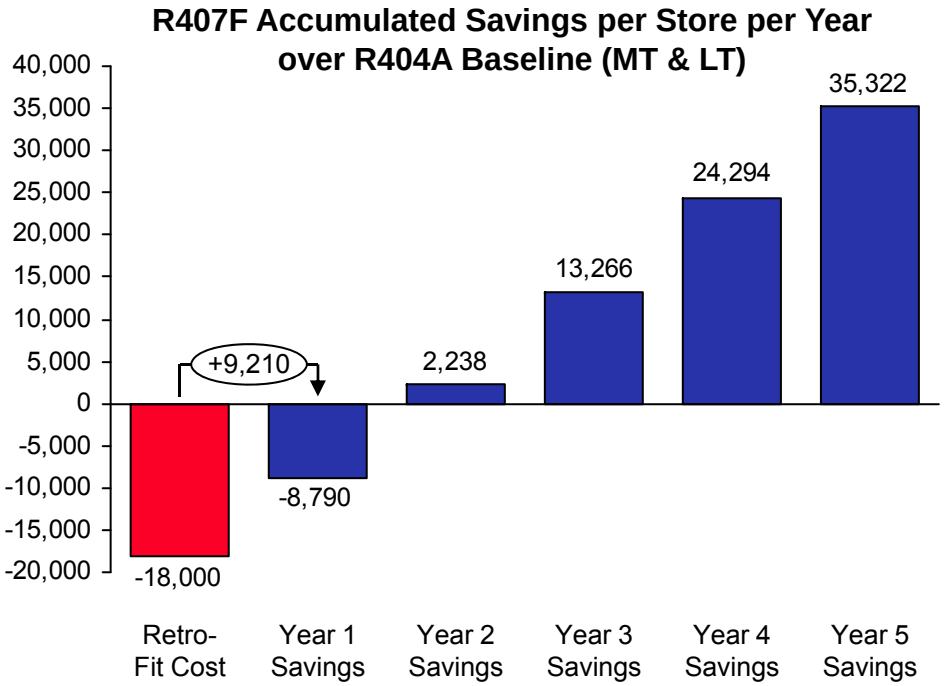
Extrapolated from 1 Year trial



Annual Comparison	Usage (kg's)	R407F Savings/kg over R404A (€)	R407F Accumulated Savings over R404A
Year 1	996	9.25	9210
Year 2	130	84.90	20238
Year 3	130	84.90	31266
Year 4	130	84.90	42295
Year 5	130	84.90	53323
Total 5 Years	1516	35.19	53323

- Combination of cost for retro-fit / refrigerant / leaks and energy consumed
- Typical Supermarket Example:
  - Cost of retro-fit pay back inside 2 years
  - Total Estate of 500 stores over 5 years
    - Estimate savings R407F = **€26.6M**
    - Cost to Retro-Fit = **€9M**
    - Estimate net savings = **€17.7M**
- **Direct money saving for new build!**

Leak Rate @ 15%/annum
Cost of Energy @ €0.14/kWh

R407F Provides Very Short Payback or Direct Money Savings

R407F Case Studies

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- Case: Saucisson Storage
- Application: Food Process / Storage
- Location: Macon, France
- Trial: Direct R404A v R407F
- Compressor: GEA Bock
- Contractor: Safriclim
- Result: Energy Benefit of 7%

- Case: Biedronka Stores
- Application: Supermarket
- Location: Warsaw, Poland
- Trial: Retro-Fit R404A with R407F
- Compressor: Bitzer
- Contractor: n/a
- Result: Energy Benefit of 15%

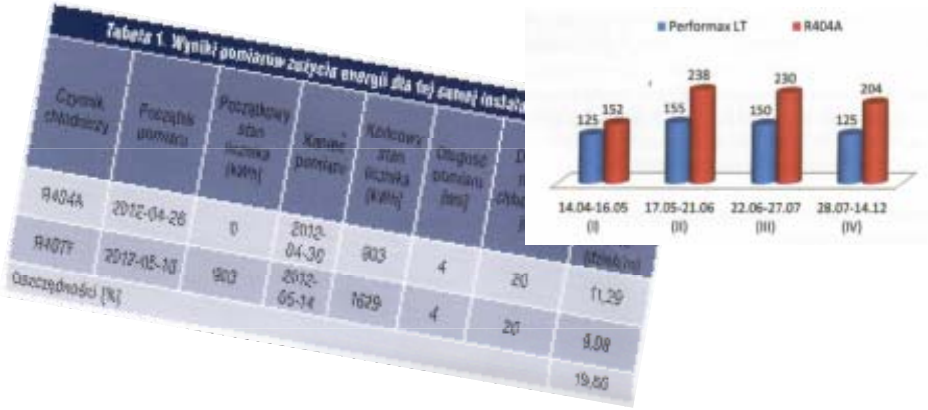


Tabela 1. Wyniki pomiarów zużycia energii dla tej samej instal

Czynnik chłodniczy	Początek pomiaru	Początkowy stan licznika [kWh]	Koniec pomiaru	Końcowy stan licznika [kWh]	Długość pomiaru [dni]		
R404A	2012-04-26	0	2012-04-30	903	4	20	11,29
R407F	2012-05-10	903	2012-05-14	1629	4	20	9,09
Oszczędności [%]							19,60

In Summary
In any of the systems tested were not any additional adjustment-all parameters set IE. for R404A refrigerant. It is the turn of ny plus the use of R407F as a wildcard R404A-there is no need for laborious adjustment expansion valves (thermostatic). The results of the research allow for the formulation of the condusion that using new refrigerants GenetronPerformax LT-R407F, you can add space investment in refrigeration installation to improve its energy efficiency, lower tdal cost of ownership and causes ić to environmental protection through reducing carbon dioxide emissions

Compressor Qualification – June 2014

Honeywell

COMPRESSOR APPROVAL for Performax® LT (R407F)

Compressor Manufacturers Update on R407F Qualification

BRANDS	Qualified for use on Performax® LT (R407F)	Included in Selection Software
Copeland Scroll / EMERSON Climate Technologies	Qualified & Released	**Yes** Current Ver. Select 7.7
Bitzer	Qualified & Released	**Yes** Currently on-line Version
BOCK COMPRESSORS	Qualified & Released	**Yes**
frascold	Qualified & Released	**Yes**
DORIN	Qualified & Released	**Yes**
Tecumseh	Medium Temp Qualified. Low Temp excluded	Next Release
Maneurop RECIPROCATING COMPRESSORS	Final Testing - Expect Full approval in Summer 2014	
embraco	Testing - Not qualified for LT Hermetics	Samples Only

4GE-23Y

Op. Frequency: 50 Hz

MT conditions

to =	-10°C
tc =	45°C
Δtoh =	10 K
Δtuc =	0 K

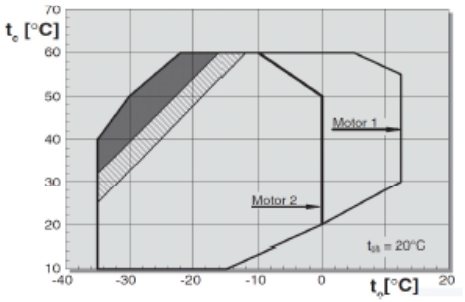
Refrigerant(i)	R404A	R407A	R407F
Evaporator capacity [kW]	41,053	39,281	42,994
Power input [kW]	20,13[illegible]	17,404	18,281
COPo [-]	2,03[illegible]	2,257	2,352
COPo_R(i)/COPo_R404A [%]	100,0%	110,7%	115,4%
Tdisch (°C)	73[illegible]	86.8	90.9

LT conditions

to =	-35°C
tc =	40°C
Δtoh =	10 K
Δtuc =	0 K

Refrigerant(i)	R404A	R407A	R407F
Evaporator capacity [kW]	12,[illegible]22	9,974	11,218
Power input [kW]	10,[illegible]4	8,199	8,671
COPo [-]	1,22[illegible]	1,217	1,294
COPo_R(i)/COPo_R404A [%]	100,0%	99,7%	106,0%
Tdisch (°C)	81.5	115.2	122.5

R407F 4VES-7Y .. 6FE-50Y ③, ④



t_o Evaporating temperature (°C)
t_{oh} Suction gas temperature (°C)
Δt_{oh} Suction gas superheat (K)
t_c Condensing temperature (°C)
Additional cooling or max. 0°C suction gas temperature
Additional cooling or limited suction gas temperature according to <20 K suction gas superheat

③ Evaporating and condensing temperatures are based on dew point conditions (saturated vapour)

④ Lower evaporating temperatures are possible with CIC® operation. Selection upon request.

R407F is Qualified in All Major Compressor Brands and Technologies

Agenda

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- Comparative Assessment of R404A alternatives in existing systems or new built (15')
- Technical considerations for a successful retrofit (10')
  - Glide
  - Tdischarge
  - Fractionation
- Questions & Answers (10')

Typical Supermarket System / Glide Influence

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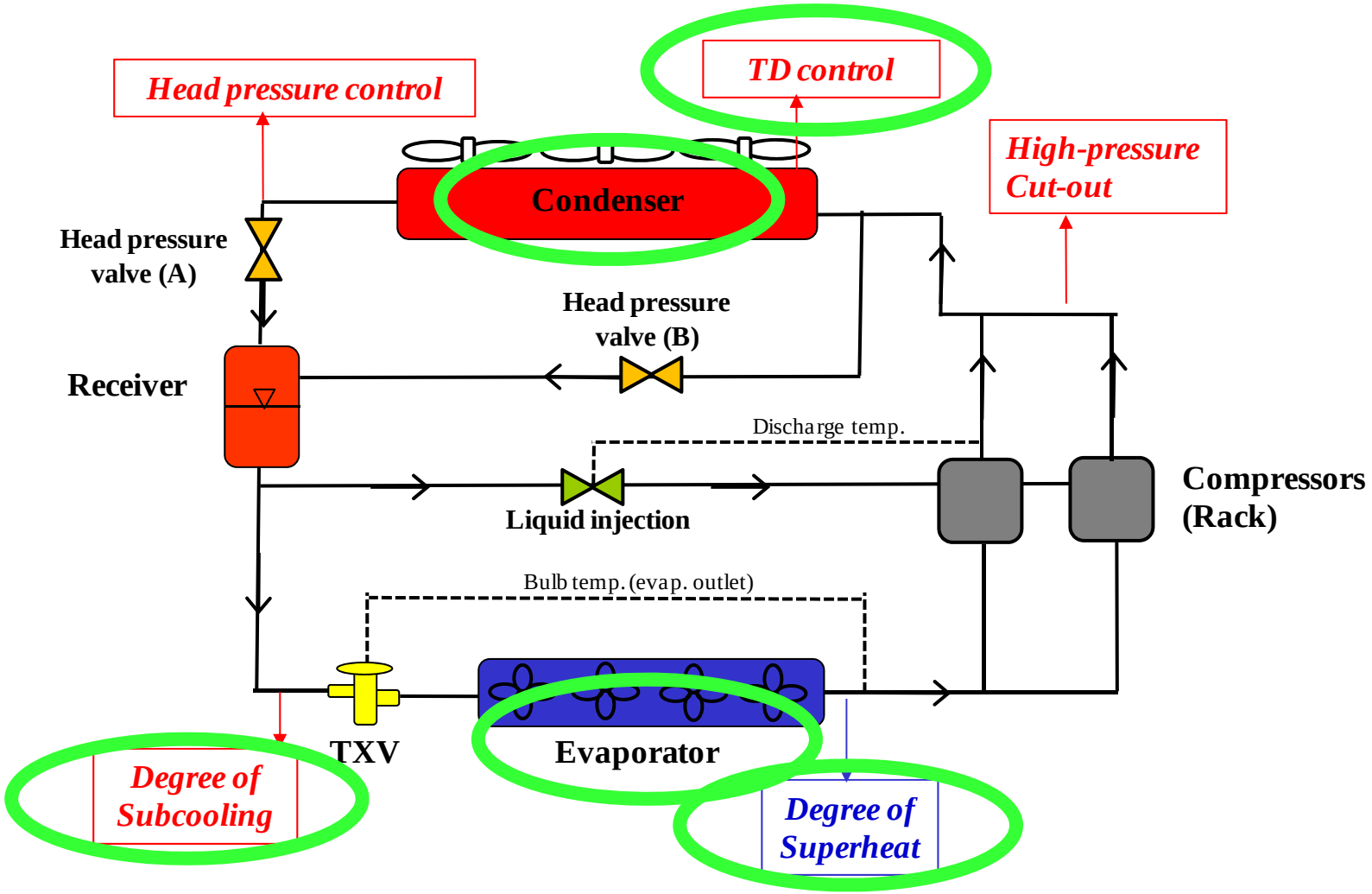

Glide management educational presentation can be found here

Glide Should be Considered for Main System Settings

Main Influencer: Compressor

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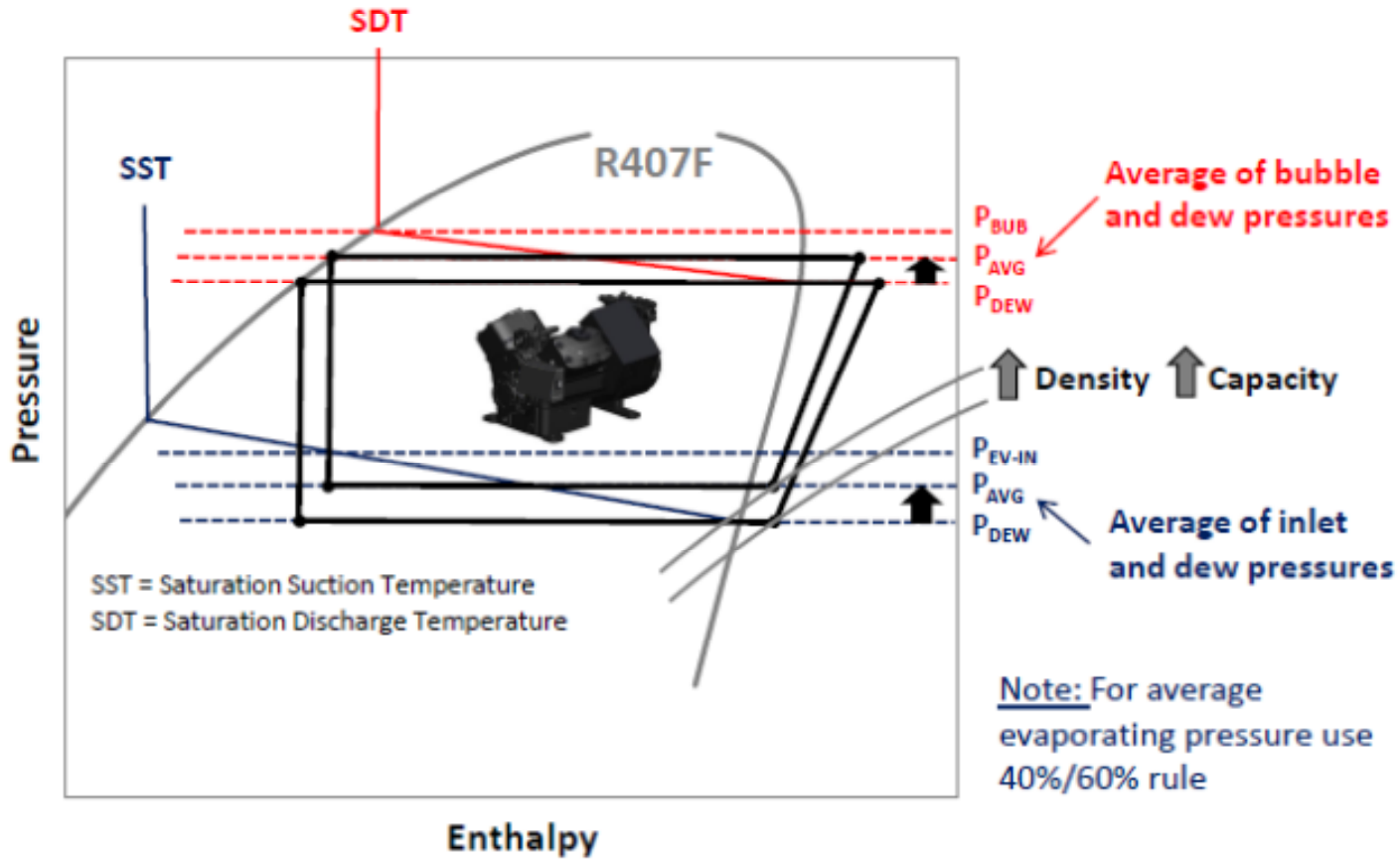

- Average pressure reflects the natural response of the blends in the heat exchangers.
- Evaporating pressure increase is a source of COP and Capacity gain with reduction of Tdisch.
- In Compressors softwares 'Mid-Point' option should be selected for appropriate selection.

Average Pressures Should be Used vs. Dew Pressures

Compressor Performance: Glide Influence

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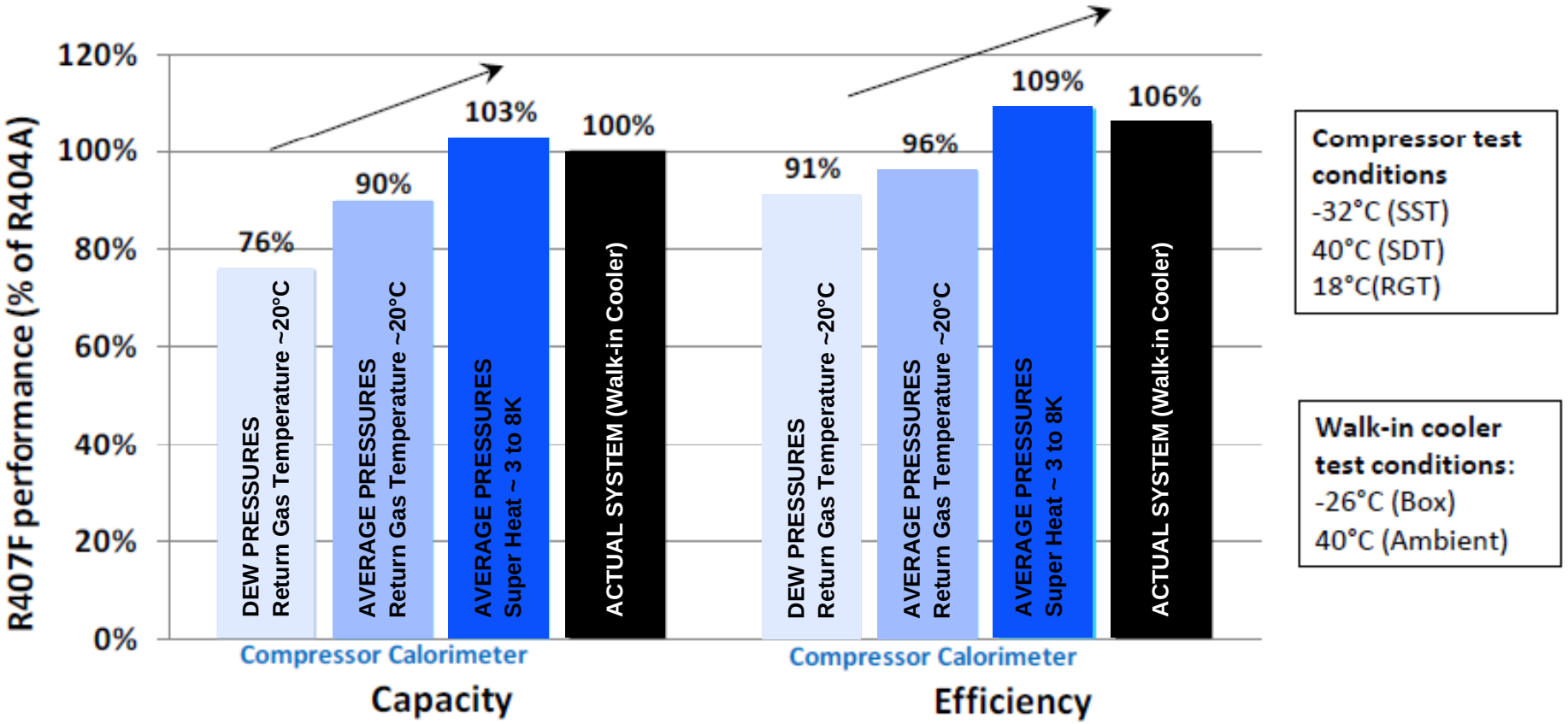

- Selecting Dew pressure is misleading vs. Capacity and COP system results.
- Very high superheat has negative impact on refrigerants cycle.
- Appropriate system settings is a key to Capacity and Electricity consumption.

Average Pressures and Controlled SH are Key Factors

Fractionation: Nominal vs. Circulating Composition

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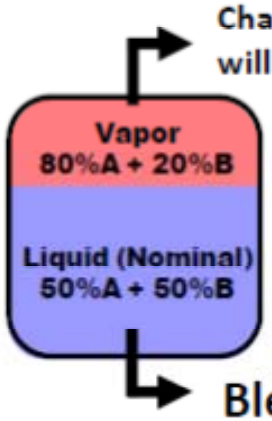
Fractionation is the change in the circulating (system) composition relative to the nominal composition. There are two main sources of fractionation:

1) Refrigerant Charging

a) From Liquid-port: do not cause fractionation

b) From Vapor-port: will cause fractionation



Blends should always be charged from liquid port!

2) Leak Events:

2.1) System ON:

a) Liquid-line leaks: do not cause fractionation if there is liquid seal

b) Vapor-line leaks: do not cause fractionation (suction or discharge lines)

c) Two-phase leaks: in middle of evaporator or condenser could cause mild fractionation

2.2) System OFF

a) Liquid: will not cause fractionation

b) Vapor: may cause mild fractionation

Leakage: Several Worst Case Scenario Leaks (30% each)

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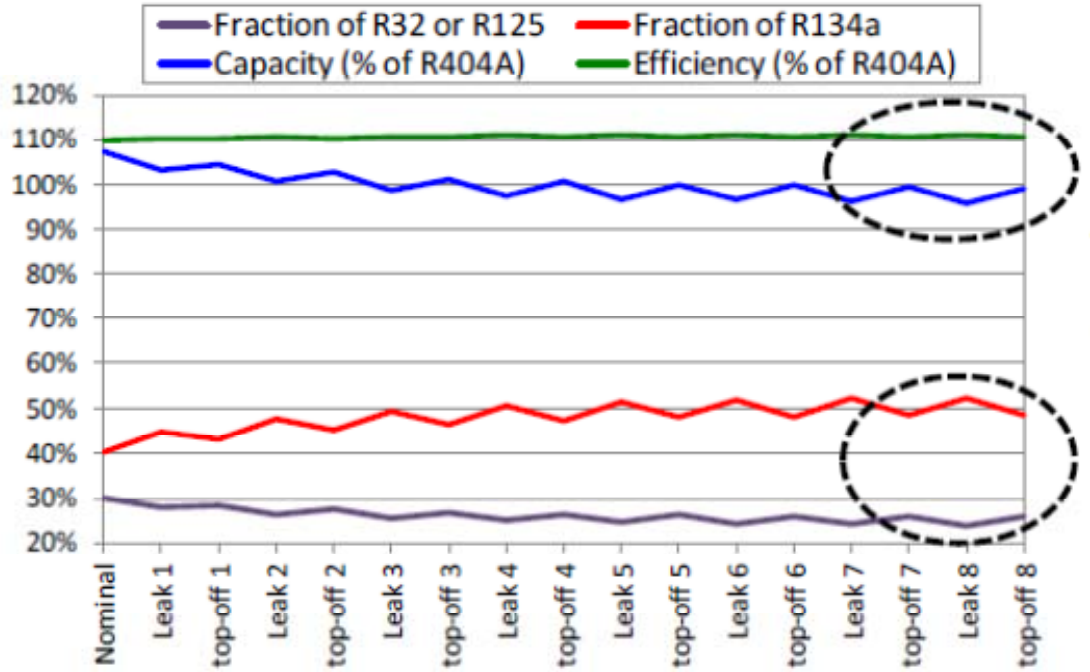

After several leak/top-off events, composition and performance would become stable

1) **Using experimental data we estimated the impact of 8 consecutive "two-phase" (worst case scenario) leaks of 30% of the total charge each, followed by top-offs.**

2) **After the 8th leak/top-off event:**
   - Changes in composition due to leaks would be compensated by the top-offs, so the blend composition would remain stable
   - Capacity would remain nearly unchanged and still a match of R404A
   - Superior efficiency of R407F would be maintained

R407F Maintains High COP and Capacity for Worst Case Leakage

Technical Conclusion

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- When compared to R404A – R407F provides .....
  - Energy Improvements (up to 15%)
  - Carbon Benefits (on GWP -53.5% and TEWI -66%)
  - Capacity Improvements
  - Life Cycle Cost Benefits / Engineer 'Friendly'
  - 'Future proof' complies with F-Gas regulation post 2030 and minimizes HFC taxes where applied
- Simple to retro-fit R404A (glide!)
  - Same TX valve
  - Remove R404A / Evacuate / Change Drier / Liquid Charge with R407F
  - Optimise System / TX Valve settings for R407F (Super Heat)
  - Check Operation ..... Save Energy!
- Widely available through a multi-channel distribution network

Genetron Performax® LT F-Gas Ready

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Performax LT can be used for servicing without end date.
R404A will be banned.

Genetron Performax® LT (R407F) – The 'First Choice' Solution

Thank you! Questions?

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