SOCIAL PROPERTY OF THE PROPERT	Application Factsheet: REFRIGERATORS AND F	REFRIGERATORS/FREEZERS		DR1	
Search Control of the	SECTOR	DOMESTIC REFRIGERATION	Sub-sector Sub-sector		
Society in control prints of the control pri		·		neingerators / recease	
Company and confidence and process of a control of the control of	Temperature range	DESCRIPTION OF THE REFREN			
Section Sect			Average charge by equipment (kg)	0.127	
Action of the control	Installed base		Defice yout house in France (A)	1 161 + /total and 2011)	
See the context of particular contests of the contests of particular contests of particular contests of the contests of particular contests of parti		87,500,000			
As a count of exispance of continues and process of the continues of the c		15			
And the state of t	in France :		Candy		
Section of the control partial condense of the specimen with process of the control partial condense of the specimen with process of the control partial condense of the specimen with process of the control partial condense of the specimen with process of the control partial condense of the control partial condense of the control partial condense of the control partial control partial condense of the control partial control par	Main owners of equipment	posen, brander agor, willipoor, Electrolax, Siemens, Indesic, Elebren	, candy		
Section of perfoliate controlling and the experiment under the perfoliation under the perfoliation and the perfoliation controlling and the perfoliation controlling and the perfoliation and the perf					
Control Principle Control Prin		Discharge temperature 8-10 K lower than R-12 Adapted to medium-temperature equipment, performance close to R-12 Good material compatibility			
Fig. 1997 Fig. 1		NF EN 60335-2-24 January 2010 specific rules for refrigeration equipr NF EN 378-2 on safety an environmental requirements for refrigeration	nent, ice cream machines and ice maker		
Case 1.1. (Colds) direct specimen I clean 1.2. (Case 2.2. (Case 2	in Europe :	EN 378 EN 60335-2-89 Regulation 643/2009/Ececo design requirements applicable to dome: 2006/95/EC directive relative to low tension tension 2004/108/EC directive relative to electromagnetic compatibility			
TECHNICAL ALTERNATIVES UNDER DEVELOPMENT Set States Fig. 19 Set State		Case 1: HC-600a direct system		Case 3:	
In Process Report of entire laboration and mining standards Report of the control of the Contr	· · ·				
Segretable regulations and central generalized partners. In Farror Center TWO Indicators to Instruction (see Instruction) per larger and Society (17 of the resolved in the Confidence of Instruction (18 of Instruction) (18 of	in France :				
Content of processing final institution of the processing of the	Applicable regulations and existing standards				
Supply petros than 1-1540 Apadiation Main barriors to the solution exposules Main barriors to the solution exposules For provided to the solution exposules For p	in Europe :	67/548/EEC directive related to the classification, packaging and labelling of hazardous substances ADR Regulation related to road transport of hazardous goods EN378 related to the safety of domestic equipments			
Main barriers to the solution expansion Main barriers to the solution expansion Centers promoting this technique implementation (Drigs in or mit, Impact on the Address)— Millionarian indicators El: Environmental Impact - GMVP 1 - Very low (1:0) 2 - Low (+150) 3 = Medium (< 750) 4 - High (750) 5 - Very logh (750) 5 - More limit (< 750) 4 - High (750) 5 - Very logh (750) 5 - More limit (< 750) 5 - Solicident 3 - Medium 6 - Unitariation (Drigs in or mit, Impact on the Address)— O: Cost of the solution (out of maintenance) 0 - Low 3 - Medium 6 - High Cost of the solution (out of maintenance) 0 - Low 3 - Medium 6 - High Cost of the solution (out of maintenance) 0 - Low 3 - Medium 6 - Unitariation (Drigs in or mit, Impact on the Address) Financial principle Technical Alternatives Under Development Cost 1: Cost 1: Cost 1: Cost 2: Cost 2: Cost 3: Cost 2: Cost 3: Cost 2: Cost 3: Cost 2: Cost 3: Cost 3: Cost 2: Cost 3: Cost 3: Cost 3: Cost 3: Cost 3: Cost 4: Cost 3: Cost 3: Cost 3: Cost 4: Cost 3: Cost 3: Cost 4: Cost 3: Cost 3: Cost 3: Cost 3: Cost 3: Cost 4: Cost 3: Cost 3: Cost 3: Cost 4: Cost 3: Cost					
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Context of permoting this technique implementation (Prop in or not, impact on the District, and Districts indicators Multicriteria indicators Multicriteria indicators 1 = New (100 (15.0) 2 = Low (15.0) 3 = Medium (2.75.0) 4 = High (17.05.0) 5 = Very Indiv (15.00), 6 = Satzemely high (12.00.0) EC. Energy Consumption 0 = Low 3 = Medium 6 = Ligh SS. Safety Risk 0 < Class A1 2 = A2L 4 = A2 and 82 6 = A3 and 83 CO. Cost of the solution (out of maintenance) Not 2 - New 1 = New 2 = New 3 = New 1 = New 3 = New 3 = New 3 = New 3 = New 1 = New 3 = New3		Flammable Low volumetric capacity High compression ratio Limited to low refrigeration capacity			
Well-Orderia Indicators Et Environmental Impact - GWP 1 - Very low (c10) 2 - Low (c150) 3 - Medium (c750) 4 - High (c750) 5 - Very high (c150) 3 - Medium (c750) 5 - Safety Risk 0 - Clas A1		Operation pressures lower than that of R-134a			
El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (<750) 5 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (<750) 5 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 5 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 6 = College of the Solution (out of maintenance) 0 = Low 3 = Medium 6 = High VE: Volumentic Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying Technical principle Techn		Discharge temperature lower than that of R-134a			
Technical principle Industrial availability Existence of demonstrators or operational prototypes Regulation and standard status en France: en Europe: GWP Energy efficiency Volumetric capacity Probable date of commercial availability Main barriers to the solution expansion Context promoting this technique implementation (Drop in or not, impact on the charge,) Multicriteria indicators EI: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High EE Case 1: Case 2: Case 3: Case 3: Case 3: Case 2: Case 3: Case 3: Case 3: Case 3: Case 2: Case 3: Case 2: Case 3: Case 4: Case 2: Case 3: Case 2: Case 3: Case 4: Case 2: Case 3: Case 4: Case 2: Case 3: Case 4: Case 2: Case 4: Case 4: Case 2: Case 4: Case	1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity	VC	VC	VC 3 EC SR	
Industrial availability Existence of demonstrators or operational prototypes Regulation and standard status en France: en Europe: GWP Energy efficiency Volumetric capacity Probable date of commercial availability Main barriers to the solution expansion Context promoting this technique implementation (Drop in or not, impact on the charge,) Multicriteria indicators El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High				Case 3:	
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SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO : Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV : Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC : Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	EI: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity	VC	VC 3 2 EC SR	VC	

SECTOR Usage / Standard application Cool and maintain food at below zero temperatures Temperature range 18°C DESCRIPTION OF THE REFI Refrigerant type commonly used / GWP R-134a GWP = 1370 A1 On the market, 5% in France and 20% in Europe Installed base, 88% in France and 54% in Europe Installed base in France: 3,015,000 in Europe: 23,100,800 Average equipment lifetime (years) Main providers of technologies in France: Brandt-Fagor in Europe: Bosch, Brandt-Fagor, Whirlpool, Electrolux, Siemens, Indesit, Liel Main owners of equipment in France: in Europe: Non toxic, non flammable, ODP = 0 R-12 replacement fluid Discharge temperature equipment, performance close Good material compatibility Type POE lubricant Specific applicable regulations and standards Decree n° 2011-764 of 28 June 2011 Art.3 related to the energy of Regulation 842/2006/CE EN 378 EN 60335-2-24 January 2010 specific rules for refrigeration ed Regulation 842/2006/CE EN 378 EN 60335-2-29 Regulation 643/2009/Ececo design requirements applicable to d 2006/95/EC directive relative to low tension tension	Refrigerant bank in France (t) Refrigerant bank in Europe (t) Sherr, Candy e to R-12 consumption of refrigeration equipment quipment, ice cream machines and ice maker eration systems and heat pumps omestic refrigerators	
Technical justification and particular conditions of the application with respect to the HFC type used Specific applicable regulations and standards DESCRIPTION OF THE REFI Refrigerant type commonly used / GWP R-134a GWP = 1370 A1 On the market, 5% in France and 20% in Europe installed base, 88% in France and 54% in Europe installed base. In France: 3,015,000 In Europe: 223,100,800 Average equipment lifetime (years) In France: Brandt-Fagor In Europe: Bosch, Brandt-Fagor, Whirlpool, Electrolux, Siemens, Indesit, Liet in Europe: Non toxic, non flammable, ODP = 0 R-12 replacement fluid Discharge temperature 8-10 K lower than R-12 Adapted to medium-temperature equipment, performance close Good material compatibility Type POE lubricant Specific applicable regulations and standards Decree n° 2011-764 of 28 June 2011 Art.3 related to the energy of the Signary of the Signary of the Signary of the Signary of the Refrigeration of the Refined to medium temperature equipment, performance close Good material compatibility Type POE lubricant Decree n° 2011-764 of 28 June 2011 Art.3 related to the energy of the Signary of the Signary of the Signary of the Refrigeration of the Refrigeration of the Signary of the Signary of the Signary of the Signary of the Refrigeration of the Signary of t	Refrigerant bank in France (t) Refrigerant bank in Europe (t) Poherr, Candy Per to R-12 Consumption of refrigeration equipment quipment, ice cream machines and ice maker eration systems and heat pumps Omestic refrigerators TECHNIQUES	2 408 t (total end 2011) 3,127 t (total EU27 end 2011)
Refrigerant type commonly used / GWP R-134a GWP = 1370 A1 On the market, 5% in France and 20% in Europe Installed base, 88% in France and 54% in Europe Installed base, 88%	Refrigerant bank in France (t) Refrigerant bank in Europe (t) Poherr, Candy Per to R-12 Consumption of refrigeration equipment quipment, ice cream machines and ice maker eration systems and heat pumps Omestic refrigerators TECHNIQUES	2 408 t (total end 2011) 3,127 t (total EU27 end 2011)
Data relative to the refrigerant used Installed base In France: In Europe:	Refrigerant bank in France (t) Refrigerant bank in Europe (t) Soherr, Candy Soherr, Candy Solution of the consumption of refrigeration equipment equipment, ice cream machines and ice maker eration systems and heat pumps Somestic refrigerators TECHNIQUES	3,127 t (total EU27 end 2011)
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Main owners of equipment in France: in Europe: Non toxic, non flammable, ODP = 0 R-12 replacement fluid Discharge temperature 8-10 K lower than R-12 Adapted to medium-temperature equipment, performance close Good material compatibility Type POE lubricant Specific applicable regulations and standards Decree n° 2011-764 of 28 June 2011 Art.3 related to the energy of NF EN 60335-2-24 January 2010 specific rules for refrigeration ed in France: NF EN 378-2 on safety an environmental requirements for refrigeration ed Regulation 842/2006/CE EN 378 EN 60335-2-89 Regulation 643/2009/Ececo design requirements applicable to de 2006/95/EC directive relative to low tension tension	to R-12 consumption of refrigeration equipment quipment, ice cream machines and ice maker eration systems and heat pumps omestic refrigerators TECHNIQUES	Case 3:
in Europe: Technical justification and particular conditions of the application with respect to the HFC type used Non toxic, non flammable, ODP = 0 R-12 replacement fluid Discharge temperature 8-10 K lower than R-12 Adapted to medium-temperature equipment, performance close Good material compatibility Type POE lubricant Specific applicable regulations and standards Decree n° 2011-764 of 28 June 2011 Art.3 related to the energy of NF EN 60335-2-24 January 2010 specific rules for refrigeration et NF EN 378-2 on safety an environmental requirements for refrigeration et Regulation 842/2006/CE EN 378 EN 60335-2-89 Regulation 643/2009/Ececo design requirements applicable to de 2006/95/EC directive relative to low tension tension	consumption of refrigeration equipment quipment, ice cream machines and ice maker eration systems and heat pumps omestic refrigerators TECHNIQUES	Case 3:
Discharge temperature 8-10 K lower than R-12 Adapted to medium-temperature equipment, performance close Good material compatibility Type POE lubricant Specific applicable regulations and standards Decree n° 2011-764 of 28 June 2011 Art.3 related to the energy of NF EN 60335-2-24 January 2010 specific rules for refrigeration en in France: NF EN 378-2 on safety an environmental requirements for refrigeration 842/2006/CE EN 378 EN 60335-2-89 Regulation 643/2009/Ececo design requirements applicable to de 2006/95/EC directive relative to low tension tension	consumption of refrigeration equipment quipment, ice cream machines and ice maker eration systems and heat pumps omestic refrigerators TECHNIQUES	Case 3:
Decree n° 2011-764 of 28 June 2011 Art.3 related to the energy of NF EN 60335-2-24 January 2010 specific rules for refrigeration ed in France: NF EN 378-2 on safety an environmental requirements for refrigeration 842/2006/CE EN 378 EN 60335-2-89 Regulation 643/2009/Ececo design requirements applicable to de 2006/95/EC directive relative to low tension tension	quipment, ice cream machines and ice maker eration systems and heat pumps omestic refrigerators TECHNIQUES	Case 3:
in France: NF EN 378-2 on safety an environmental requirements for refrigi Regulation 842/2006/CE EN 378 EN 60335-2-89 Regulation 643/2009/Ececo design requirements applicable to d 2006/95/EC directive relative to low tension tension	eration systems and heat pumps omestic refrigerators TECHNIQUES	Case 3:
EN 378 EN 60335-2-89 Regulation 643/2009/Ececo design requirements applicable to de 2006/95/EC directive relative to low tension tension	TECHNIQUES	Case 3:
in Europe : 2004/108/EC directive relative to electromagnetic compatibility		Case 3:
EXISTING ALTERNATIVE Case 1: HC-600a direct system		
Technical principle Vapor compression system Parc d'équipements en service		
in France : Significant installed based: 8,457,000 end in Europe : Significant installed based: 64,117,000 EU27 end 2012		
Applicable regulation and existing standards in France : Order TMD related to transport of hazardous goods		
67/548/EEC directive related to the classification, packaging and labelling of hazardous substances ADR Regulation related to road transport of hazardous goods EN378 related to the safety of domestic equipments		
GWP 4 Energy efficiency Slightly better than R-134a		
Volumetric capacity 40% lower than R-134a Availability Widely available		
Flammable Low volumetric capacity High compression ratio Limited to low refrigeration capacity 45% charge reduction compared to R-134a		
Context promoting this technique implementation (Drop in or not, impact on the charge,) Multicriteria indicators El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying		
ALTERNATIVES TECHNIQUES EN COL	JRS DE DEVELOPPEMENT	UÇ € SR
Case 1: Technical principle	Case 2:	Case 3:
Industrial availability Existence of demonstrators or operational prototypes		
Règlementation et état des normes en France :		
en Europe : GWP		
Energy efficiency Volumetric capacity		
Probable date of commercial availability Main barriers to the solution expansion		
Context promoting this technique implementation (Drop in or not, impact on the charge,) Multicriteria indicators		
El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 3 3 EC SR SC	VC 4 SR SR

Application Factsheet: Stand-alone display case	ses		CR1
SECTOR	COMMERCIAL REFRIGERATION	Sub-sector	Small stores
Usage / Standard application	Mini-markets, general food stores, vending machines	Jub-Sector	Sinan stores
Temperature range	-18 à +6°C		
Refrigerant type commonly used / GWP	DESCRIPTION OF THE REFREI	ICE SYSTEM Charge moyenne par équipement (kg)	1.23
Data relative to the refrigerant used	A1	enarge more me equipement (1.8)	1.60
Installed base	99% sur le marché et dans le parc en France et en Europe		
in France	406	Refrigerant bank in France (t):	498 t (total end 2011)
in Europe : Average equipment lifetime (years)	4,795,000 15	Refrigerant bank in Europe (t):	4,53 t (total EU27 end 2011)
Main providers of technologies			
in France in Europe	Foster Foster, Gamgo, Unifrigor, IGLOO, Hussmann, SARO, True, Randel, Fro	st Tech	
Main owners of equipment			
in France in Europe			
	Non toxic, non flammable, ODP = 0 R-12 replacement fluid		
Technical justification and particular conditions of the application with respect to	Discharge temperature 8-10 K lower than R-12 Adapted to medium-temperature equipment, performance close to R	-12	
the HFC type used	Good material compatibility		
Règlementations et normes spécifiques applicables	Type POE lubricant		
	NF EN 378 related to safety and environmental requirements of refrig		
in France	NF EN 60335-2-89 related so specific sagety rules for refrigeration equ	uipment of commercial use including a condensing unit or an integrate	ed or remote compressor
III France	Regulation 842/2006/CE		
	EN 441 for refrigerated display cases EN 378		
	EN 60335-2-89		
in Europe	EN 14276-1 and 14276-2		
	EXISTING ALTERNATIVE TE Case 1: HC-290	CHNIQUES Case 2:	Case 3:
Technical principle	Vapor compression, direct expansion	Last 2.	Cast 3.
Installed base			
in France in Europe	Significant: 8,457,000 end 2011 Significant: 64,117,000 EU27 end 2012		
Applicable regulation and existing standards in France			
in Europe	EN378		
GWP Energy efficiency	6 Slightly better thanR-134a		
Volumetric capacity	30% higher than R-134a		
Availability	Available Flammable and explosive		
Main barriers to the solution expansion	Limited to low refrigeration capacity		
	Service pressure similar to that of R-22 40% charge reduction vs. R-134a		
Context promoting this technique implementation (Drop in or not, impact on the	Adapted to higher ambient temperature (up to 43°C)		
charge,)	Compactness of equipment (compressor, heat exchangers, piping		
	Cost reduction		
Multicriteria indicators			
El: Environmental Impact - GWP	EI	EI	
1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500)	6	6	EI 6 🌣
EC: Energy Consumption	4	VC 3 FC	5
0 = Low 3 = Medium 6 = High	VC 3	VC 3	VC 3 EC
SR: Safety Risk 0 = Class A1	1		2
CO : Cost of the solution (out of maintenance)			
0 = Low 3 = Medium 6 = High AV : Availability		AV	
6 = Laboratory 3 = Field demonstration 0 = Industrial	AV	AV	
VC : Volumetric Capacity			AV
0 = Sufficient 3 = Medium 6 = Unsatisfying	со	со	
	ec e		co
	ALTERNATIVE TECHNIQUES UNDE		
Technical principle	Case 1: refrigerant blend GWP < 700 XP-10: R-134a/1234yf (44/56)	Case 2: R-1234yf	Case 3 : R-1234ze [E]
Technical principle Industrial availability	N-13a: R-134a/1234yf/1234ze (42/18/40) No	No	No
Existence of demonstrators or operational prototypes	Yes	NO Yes	Yes
Applicable regulation and status of standards in France			
in Europe	EN378	EN378	EN378
GWP	605 for XP-10, 579 for N-13a	4 COP -10% vs. R-134a	6
Energy efficiency	COP -5 at -10% vs. R-134a		COP -3 %
Volumetric capacity Probable date of commercial availability	-5% refrigeration capacity vs. R-134a XP-10 in 2013	-6 à -10% refrigeration capacity vs. R-134a In 2013, R-1234yf for MAC + RAC	-25% refrigerating capacity vs. R-134a 2015 en masse
Main barriers to the solution expansion	Slightly flammable A2L	Slightly flammable A2L	Slightly flammable A2L
Context promoting this technique implementation (Drop in or not, impact on the charge,)	Charge similar to that of R-134a	Charge similar to that of R-134a	Refrigerant charge similar to that of R-134a
Multicriteria indicators			
EI: Environmental Impact - GWP	EI 6 -	EI	EI 6 ←
1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750)	6	6	5
4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption	4	3	VC 3 EC
0 = Low 3 = Medium 6 = High	VC 3 EC	VC 3	2
SR: Safety Risk 0 = Class A1		2	
CO: Cost of the solution (out of maintenance)			
0 = Low 3 = Medium 6 = High			
AV : Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial			AV
VC : Volumetric Capacity	AV	AV	
0 = Sufficient 3 = Medium 6 = Unsatisfying			co
0 - Sufficient 3 - Medium 6 - Offsatisfying		\ i /	CO CO
0 – Sufficient 3 – Medium 6 – Onsatistynig	со		
0 – sunicient 3 – Medium 6 – Olisatisiying	СО	СО	
AFCE, UNICLIMA, ADEME Report: Alternatives to high-GWP HFCs in refrigeration and		со	

Application Factsheet: Condensing units for	commercial refrigeration		CR2
SECTOR	Commercial Refrigeration	Sub-sector Sub-sector	Small stores
Usage / Standard application Temperature range	Mini-markets, general food stores, bars and restaurants, butcheries -18 à +6 °C	s	
Refrigerant type commonly used / GWP	DESCRIPTION OF THE REFERE	NCE SYSTEM Average charge by equipment (kg)	1 to 5 kg
Data relative to the refrigerant used	A1 On the market, 100% in France and in Europe	[[] []	2.00.79
Parc d'équipements en service	In the installed base, 86.8% in France, 97.4% in Europe		
in France	285 3,331,100	Refrigerant bank in France (t): Refrigerant bank in Europe (t) :	2,086 t (total end 2011) 22,014 t (total EU27 end 2011)
Average equipment lifetime (years) Main providers of technologies	15		
in France in Europe Main owners of equipment	Tournus Sagi, Foster, Saro, Williams, Randell, Tecfrigo, Mafirol, Tournus, Iglo	oo, Hussmann	
in France in Europe			
Technical justification and particular conditions of the application with respect to the HFC type used	Non toxic, non flammable ODP = 0 Adapted to medium and low-temperature equipement Decrease of the energy consumption		
Regulations and applicable specific standards	NF EN 14276-1 et 14276-2 related to reservoirs and piping of equip	equipment of commercial use including a condensing unit or an integr	ated or remote compressor
in France	Regulation 842/2006/CE EN 441 for refrigerated display cases EN 378 EN 60335-2-89 EN 14276-1 and 14276-2		
in Europe	EXISTING ALTERNATIVE TE	CHNIQUES T	
	Case 1 : R-407A or R-407F direct expansion system (new and retrofit) R-407A - R-32/125/134a (20/40/40)	Case 2 :	Case 3:
Technical principle Installed base	R-407F - R-32/125/134a (30/30/60)		
in France in Europe	First cases in 2013 First cases in 2013		
Applicable regulations and existing standards in France			
in Europe GWP Energy efficiency	R-407A 2100 / R-407F 2060 Similar to R-404A at medium temperature		
Volumetric capacity Availability	Similar to R-404A at medium temperature Available		
Main barriers to the solution expansion	Environmental impact: GWP and hagh chargebecausze retrofit Uncertainty on the refrigerant price		
Context promoting this technique implementation (Drop in or not, impact on the charge,) Multicriteria indicators	Solutions available in retrofit		
El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 3 3 EC CO SR	VC 3 EC SR SC CO	VC 3 EC SR SC CO
	ALTERNATIVE TECHNIQUES UNDE Case 1: refrigerant blend GWP in the range of 300	R DEVELOPMENT Case 2: ARM-31a	Case 3:
Technical principle	ARM-30a : R-32/1234yf (29/71) L-40 : R-32/152a/1234yf/1234ze (40/10/20/30) D2Y-65 : R-32/1234yf (35/65) DR-7 : R-32/1234yf (36/64)	R-32/134a/1234yf (28/21/51)	
Industrial availability Existence of demonstrators or operational prototype	· ·	No Yes	
Regulation and status of standards in France in Europe	EN378	EN378	
GWP	ARM-30a: 210 L-40: 302 D2Y-65: 253 DR-7: 260	490	
Energy efficiency	L-ARM-30a: COP - 11% vs. R-404A L-40: COP - 14% vs. R-404A DR-7: COP + 7% vs. R-404A	COP +6% vs. R-404A	
Volumetric capacity	ARM-30a: - 19% vs. R-404A L-40: -17% vs. R-404A DR-7:+ 2% vs. R-404A	-9% vs. R-404A	
Probable date of commercial availability	2014 - 2015 ? Slightly flammable A2L	Chalden and the con-	
Main barriers to the solution expansion Context promoting this technique implementation (Drop in or not, impact on the	Uncertainty on the refrigerant price	Slightly flammable A2L	
Context promoting this technique implementation (Drop in or not, impact on the charge,) INVINITIENTEE INDICATORS	L-40: +5% charge vs. R-404A D2Y-65: -5% charge vs. R-404A	Charge similar to that of R-404A	
El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 3 3 EC EC SR CO	VC 3 2 EC SR	VC 4 SR SR
AFCE, UNICLIMA, ADEME Report: Alternatives to high-GWP HFCs in refrigeration an	d air-conditioning applications, 2013		

Fiche Application : Système centralisé à déte	nte directe ou indirecte en froid pos	itif seul	CR3		
SECTOR	Commercial refrigeration	Sub-sector	Supermarkets		
Usage / Standard application Temperature range	Supermarkets 0 à +6°C				
	DESCRIPTION OF THE REFERE R-404A GWP = 3700; R-507A GWP = 3800		300		
Refrigerant type commonly used / GWP Data relative to the refrigerant used	A1 On the market: 86% in France, 82% in Europe	Average charge by equipment (kg)	300		
Installed base in operation	In the installed base: 80% in France and 76% in Europe				
in France :	90% of the installed base 90% of the installed base	Refrigerant bank in France (t): Refrigerant bank in Europe (t) :	1,279 t (total end 2011) 20,24 t (total EU27 end 2011)		
Average equipment lifetime (years) Main providers of technologies	15				
in Europe :	Bonnet Névé, Synergies, Tournus Bonnet Névé, Costan, Frost trol, Koxka, Forgel, CoolPac, Synergies,	Mafirol, Frigomeccanica, Tournus, Enofrigo, Hussmann, Tecfrigo			
Main owners of equipment in France: Large supermarket chains in Europe: Large supermarket chains					
Technical justification and particular conditions of the application with respect to	Non toxic, non flammable				
the HFC type used	Adapted to medium and low-temperature equipement Decrease of the energy consumption				
Regulations and applicable specific standards in France:	NF EN 378 related to safety and environmental requirements of ref NF EN 60335-2-89 related so specific sagety rules for refrigeration of NF EN 14276-1 et 14276-2 related to reservoirs and piping of equip	equipment of commercial use including a condensing unit or an integr	rated or remote compressor		
	Regulation 842/2006/CE EN 441 for refrigerated display cases EN 378 EN 60335-2-89				
in Europe :	EN 14276-1 and 14276-2 EXISTING ALTERNATIVE TE	CHNIQUES			
	Case 1: R-134a + indirect system Heat transfer fluid	Case 2: R-744 transcritical	Case 3: R-407A or R-407F in direct expansion system (new and retrofit)		
Technical principle			R-407A - R-32/125/134a (20/40/40) R-407F - R-32/125/134a (30/30/60)		
Parc d'équipements en service in France :	50 Not communicated	4 under development Not communicated	First cases in2013 First cases in2013		
in Europe : Applicable regulations and existing standards in France :	Not communicated Regulation 842/2006/CE	Not communicated PED	First Cases IIIZU13		
in Europe :	Regulation 942/2000/CE Regulation 842/2006/CE 1370 / 1	1	R-407A 2100 / R-407F 2060		
Energy efficiency	At medium temperature, +5% vs. R-404A	Equivalent if not better than R-404A in clod climate, lower in south of Loire	Similar to R-404A at medium temperature		
Volumetric capacity Availability	-20 à -30% R-134a vs. R-404A Available	+10% vs. R-404A Available	Similar to R-404A at medium temperature Available		
Main barriers to the solution expansion	No barrier if designed for R-1234yf retrofit Lower HP	Low COP in transcritical, not adapted for hot climate High service pressure Cost +50% Good heat transfer properties, low pinch HX	Environmental impact: GWP and hagh chargebecausze retrofit Uncertainty on the refrigerant price		
Context promoting this technique implementation (Drop in or not, impact on the charge,) Multicriteria indicators	Possibility of retrofit R-134a/ R-1234yf or R-1234ze at medium tern depending on the evolution of regulation on flammables.		Solutions available in retrofit		
EI: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 4 SR SR CO	VC 4 3 EC EC SR	VC SR SC		
	ALTERNATIVE TECHNIQUES UNDE	R DEVELOPMENT			
	Case 1: Refrigerant blend GWP around 300 L-40: R-32/152a/1234yf/1234ze	Case 2: ARM-31a R-32/134a/1234yf (28/21/51)	Case 3:		
Technical principle Industrial availability	(40/10/20/30) D2Y-65: R-32/1234yf (35/65) DR-7: R-32/1234yf (36/64) ARM-30a: R-32/1234yf (29/71) No	No			
Existence of demonstrators or operational prototypes Regulation and status of standards	Yes	Yes			
in France : in Europe :	EN 378	EN 378			
GWP	ARM-30a : 210 L-40 : 302 D2Y-65 : 253 DR-7 : 260	490			
Energy efficiency with evaporation at 0°C	'ARM-30a : + 6 % vs. R-404A L-40 : COP + 5 % vs. R-404A DR-7 : COP + 7 % vs. R-404A	COP +6% vs. R-404A			
Volumetric capacity with evaporation at 0°C Probable date of commercial availability	ARM-30a : +4 % vs. R-404A L-40 : +2 % vs. R-404A DR-7 : +11 % vs. R-404A 2014- 2015 ?	-9% vs. R-404A			
Probable date of commercial availability Main barriers to the solution expansion	2014- 2015 ? Slightly flammable A2L Uncertainty on the refrigerant price	Slightly flammable A2L Uncertainty on the refrigerant price			
Context promoting this technique implementation (Drop in or not, impact on the	Drop in L-40: +5% charge vs. R404A	Charge similar to that of R-404A			
charge,) Intuitieriteria indicators	D2Y-65: -5% charge vs. R404A				
El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 3 3 EC SR SR	VC 4 SR SR	VC 3 3 EC SR SC		
AFCE, UNICLIMA, ADEME Report: Alternatives to high-GWP HFCs in refrigeration and	air-conditioning applications, 2013				

Application factsheet: Direct or indirect centi	ralized systems (low and medium-te	mperatures)	CR4
SECTOR	Commercial refrigeration	Sub-sector	Supermarkets Large supermarkets
Usage / Standard application Temperature range	Supermarchés -18 à +6°C	NOT CVCTPA	
Refrigerant type commonly used / GWP	DESCRIPTION OF THE REFERE R-404A GWP = 3700; R-507A GWP = 3800 A1	Average charge by equipment (kg)	1000
	On the market: 86% in France, 94% in Europe In the installed base: 85% in France and 84% in Europe		
	95% of the installed base 90% of the installed base	Refrigerant bank in France (t): Refrigerant bank in Europe (t) :	1,780 t (total end 2011) 12,170 t (total EU27 end 2011)
Average equipment lifetime (years) Main providers of technologies	15		
	Bonnet Névé, Synergies, Tournus Bonnet Névé, Costan, Frost trol, Koxka, Forgel, CoolPac, Synergies,	Mafirol, Frigomeccanica, Tournus, Enofrigo, Hussmann, Tecfrigo	
in France :	Large chaines of supermarkets and large supermarkets Large chaines of supermarkets and large supermarkets		
Technical justification and particular conditions of the application with respect to the HFC type used	Non toxic, non flammable ODP = 0 Adapted to medium and low-temperature equipement Decrease of the energy consumption		
	NF EN 378 related to safety and environmental requirements of rel NF EN 60335-2-89 related so specific sagety rules for refrigeration of NF EN 14276-1 et 14276-2 related to reservoirs and piping of equip	equipment of commercial use including a condensing unit or an integr	rated or remote compressor
	Regulation 842/2006/CE EN 441 for refrigerated display cases EN 378 EN 60335-2-89		
in Europe :	EN 14276-1 and 14276-2 EXISTING ALTERNATIVE TE	CHNIQUES	
	Case 1: R-134a/CO _{2 cascade can be retrofitted i} n R-1234yf/CO ₂	Case 2: transcritical R-744	Case 3: R-407A or R-407F in direct expansion system (new and retrofit)
Technical principle Installed base in operation	Vapor compression	Vapor compression	R-407A - R-32/125/134a (20/40/40) R-407F - R-32/125/134a (30/30/60)
in France : in Europe :	450 Not communicated	3 1 000	First cases in2013 First cases in2013
Applicable regulations and existing standards in France: in Europe:	'Regulation 842/2006/CE 'Regulation 842/2006/CE	PED	
GWP	1370 / 1 then 4/1	1 Equivalent if not better than R-404A in clod climate, lower in south	R-407A 2100 / R-407F 2060
Energy efficiency Volumetric capacity	Good energy efficiency of "cascade" systems -20 à -30% vs. R-404A	of Loire +10% vs. R-404A	Similar to R-404A at medium temperature Similar to R-404A at medium temperature
Availability	Available Cost	Available Low COP in transcritical, not adapted to hot climates	Available Environmental impact: GWP and hagh chargebecausze
Main barriers to the solution expansion	Lower HP	High service pressure Cost +50% Good properties of heat transfer, low pinch HX	retrofit Uncertainty on the refrigerant price
Context promoting this technique implementation (Drop in or not, impact on the charge,) Multicriteria indicators	Retrofit possibility R-134a/ R-1234yf or R-1234ze at medium term depending on the evolutoin on flammable regulation.	Compactness	Solutions available in retrofit
El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 4 3 EC SR	VC 3 3 EEC SR CO	VC 3 EC SR CO
	ALTERNATIVE TECHNIQUES UNDE	I DEVELOPMENT	
	Case 1: refrigerant blend GWP around 300 L-40 : R-32/152a/1234yf/1234ze (40/10/20/30)	Case 2: ARM-31a R-32/134a/1234yf (28/21/51)	Case 3:
Technical principle	D2Y-65 : R-32/1234yf (35/65) DR-7 : R-32/1234yf (36/64) ARM-30a : R-32/1234yf (29/71)	No.	
Industrial availability Existence of demonstrators or operational prototypes Regulation and status of standards	No Yes	No Yes	
in France : in Europe :	EN 378	EN 378	
GWP	L-40: 302 D2Y-65: 253 DR-7: 260 ARM-30a: 210	490	
Energy efficiency at -30°C	L-40: COP - 14% vs. R-404A DR-7: COP + 7% vs. R-404A ARM-30a: COP - 11% vs. R-404A	COP +6% vs. R-404A	
Volumetric capacity at -30°C	L-40: -17% vs. R-404A DR-7:+ 2% vs. R-404A ARM-30a: - 19% vs. R-404A	-9% vs. R-404A	
Probable date of commercial availability Main barriers to the solution expansion	2014 - 2015 ? Slightly flammable A2L Uncertainty on the refrigerant price	Slightly flammable A2L Uncertainty on the refrigerant price	
Context promoting this technique implementation (Drop in or not, impact on the charge,)	L-40: +5% charge vs. R404A D2Y-65: -5% charge vs. R404A	Charge similar to that of R-404A	
El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 3 3 EC SR SC	6 5 4 2 2 2 1 1 0 0 3 3	VC 4 3 EC SR CO
AFCE, UNICLIMA, ADEME Report: Alternatives to high-GWP HFCs in refrigeration and	air-conditioning applications, 2013		

Application Factsheet: Self-contained AC units	(windows, through the wall or mova	ble)	SAC1
SECTOR	Air-to-air conditioning	Sub-sector	Domestic air conditioning
Usage / Standard application Temperature range	Movable, Windows 15 à 32°C	•	•
	DESCRIPTION OF THE REFERE		
Refrigerant type commonly used / GWP Data relative to the refrigerant used	R-410A GWP = 2100 A1 On the market 100% in France since 2001, in Funda since 2006	Average charge by equipment (kg)	0.482
Installed base in operation	On the market: 100% in France since 2001, in Europe since 2006 In the installed base: 96% in France and 88% in Europe		
in France : in Europe :	1,223,003 5,371,829	Refrigerant bank in France (t): Refrigerant bank in Europe (t) :	590 t (total end 2011) 2,689 t (total EU27 end 2011)
Average equipment lifetime (years) Main providers of technologies	10		
in Europe :	Airwell, Ciat, Technibel, Argo Carrier, Airwell, Ciat, Aermec, Technibel, ATA, Norcool, Alpatech, Arg	o, Electrolux, Delonghi, Whirlpool, Zenith	
Main owners of equipment in France: in Europe:			
	Non toxic, non flammable ODP = 0		
	Adapted to medium-temperature equipments Efficient and profitable system		
	NF EN 14511-4 related to the energy consumption of air conditioner		
1.11	NF EN 14825 related to the efficiency at partial load of air conditioned Directive ERP 2013 relative to the efficiency of stationary air condition		
in Europe :	EXISTING ALTERNATIVE TEC	CHNIQUES	
Technical principle	Case 1: R-290 replacing R-22 and not R-410A	Case 2:	Case 3:
installed base in operation in France :			
in Europe : Applicable regulatoins and existing standards			
in France : in Europe : GWP	EN378 6		
GWP Energy efficiency Volumetric capacity	6 COP higher than that of R-22 50% higher than that of R-22		
Availability	Available A3		
Main barriers to the solution expansion	Flammable and explosive Limited to low refrigeration capacity		
	Service pressures higher than that of R-600a 40% charge reduction vs. R-22		
Context promoting this technique implementation (Drop in or not, impact on the	Adapted to higher ambient temperature (up to 43°C) Compactness of equipment (compressor, heat exchangers, piping		
charge,)) Cost reduction		
Multicriteria indicators	Silent		
El: Environmental Impact - GWP	EI	EI	EI
1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption	6 5	6	6
0 = Low 3 = Medium 6 = High SR: Safety Risk	VC 3	VC 3 EC	VC 3 EC
0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO : Cost of the solution (out of maintenance)	2	2	1 1
0 = Low 3 = Medium 6 = High AV : Availability	0		
6 = Laboratory 3 = Field demonstration 0 = Industrial VC : Volumetric Capacity	AV		AV
0 = Sufficient 3 = Medium 6 = Unsatisfying		AV SR	
	со	CO	со
	ALTERNATIVE TECHNIQUES UNDE		Com 2
	Case 1: refrigerant blend GWP 500 L-41a : R-32/1234yf/1234ze (73/15/12) L-41b : R-32/1234ze (73/27)	Case 2 : refrigerant blend GWP 700 ARM-70 (R-32/134a/1234yf) (50/10/40)	Case 3 :
Technical principle	L-41D : K-32/1234ze (73/27) DR-5 : R-32/1234yf (72,5/27,5) ARM-70a : R-32/134a/1234yf (50/10/40)		
Industrial availability Existence of demonstrators or operational prototypes	No Yes	No Yes	
Regulation and status of standards in France:			
in Europe :	EN 378 L-41a et L-41b: 524 DR-5: 520	EN 378 R32: 716 R-32/134a: 749	
	DK-5: 520 ARM-70: 497 L-41a: COP similar to R-410A	R-32/152a: 687	
Energy efficiency	L-41b: COP -3 % vs. R-410A DR-5: COP slightly higher than R-410A	R-32: COP similar to R-410A and +3% in heating mode R-32/R-134a: COP -7% and similar to R-410A in heating mode R-32/R-152a: COP similar to R-410A and +8% in heating mode	
	ARM-70a: COP -3 % vs. R-410A L-41a: -5%		
Volumetric capacity	L-41b: -10 % DR-5: -3% ARM-70: -10 à -15% vs. R-410A	R-32: +2 to +8% vs. R-410A R-32/152a and R-32/134a: +5 to +10 % vs. R-410A	
Probable date of commercial availability	Slightly flammable A2L		
Main barriers to the solution expansion	L-41a : T discharge + 6 à +8 K L-41b : T discharge +12 K	Slightly flammable A2L R-32: T discharge at leat +25 K vs. R-410A	
	DR-5 : T discharge +4 K vs. R-410A ARM-70a : T discharge similar toR-410A	R-32/152a: T discharge +10 K vs. R-410A	
Context promoting this technique implementation (Drop in or not, impact on the	L-41a: charge +4% L-41b: charge -10%	R-32: charge - 20% vs. R-410A	
charge,) Multicriteria indicators	DR-5: charge -10% ARM-70a: similir to R-410A	R-32/152a: charge +3% vs. R-410A	
El: Environmental Impact - GWP			EI
1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500)	6	6 5	5
EC: Energy Consumption 0 = Low 3 = Medium 6 = High	VC 3 EC	4	VC 4
SR: Safety Risk 0 = Class A1	VC 3	6 3 2	2
CO : Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High			
AV : Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial			
VC : Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	AV	5	AV
	СО	4	СО
AFCE, UNICLIMA, ADEME Report: Alternatives to high-GWP HFCs in refrigeration and a	ir-conditioning applications, 2013		

Application factsheet: Splits and multi-splits (P	< 17.5 kW) R-410A		SAC2
		Sub-costor	Domestic air conditioning
SECTOR Usage / Standard application	France: Split, Multi-Split	Sub-sector	Non-residential air conditioning
Temperature range	Europe: Split < 5 kW, Ducted Split < 18 kW 15 à 32°C		
	DESCRIPTION OF THE REFERE		144
Refrigerant type commonly used / GWP	A1	Average charge by equipment (kg)	1.114
Data relative to the refrigerant used Installed base in operation	On ther market: 96% in France and 76% in Europe Oin the installed base: 57% in France and 54% in Europe		
in France : in Europe :	2,475,607 20,600,658	Refrigerant bank in France (t): Refrigerant bank in Europe (t) :	2,759 t (total end 2011) 22,475 t (total EU27 end 2011)
Average equipment lifetime (years) Main providers of technologies	15		
	Airwell, Ciat, Technibel Ciat, Technibel, Airwell, Aermec, Olimpia Splendid		
Main owners of technologies in France :			
in Europe :	Non toxic, non flammable		
Technical justification and particular conditions of the application with respect to the HFC type used Regulations and specific applicable standards	ODP = 0 Adapted to medium-temperature equipments Efficient and profitable system		
in France :	NF EN 14825 related to the efficiency at partial load of air conditioner NF EN 60335-2-89 related so specific sagety rules for refrigeration equ NF EN 14276-1 et 14276-2 related to reservoirs and piping of equipm	uipment of commercial use including a condensing unit or an integrate	ed or remote compressor
	Regulation 842/2006/CE EN 441 for refrigerated display cases EN 378 EN 60335-2-89		
in Europe :	EN 14276-1 and 14276-2 Directive ER-P 2013 relative to the efficiency of stationary air condition	oners≤ 12 kW	
	EXISTING ALTERNATIVE TE Case 1: R-290	CHNIQUES Case 2:	Case 3:
Technical principle Installed base in operation	Vapor compression, direct expansion		5505 5.
in France : in Europe :			
Règlementations applicables et normes existantes in France :			
in Europe :	EN 378 6		
Energy efficiency Volumetric capacity	Slightly lower than R-410A Lower than R-410A		
Availability Main barriers to the solution expansion	Available Flammable and explosive Limited to low refrigerating capacity, charge < 2.5 kg Lower HP		
Context promoting this technique implementation (Drop in or not, impact on the charge,)	40% charge reduction vs. R-134a Adapted to higher ambient temperature (up to 43°C) Compactness of equipement (compressor, heat exchangers, piping)		
Multicriteria indicators	Cost reduction		
El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 3 3 EC CO CO	VC 3 3 EC SR	VC 3 2 EC 3 SR CO
Technical principle	ALTERNATIVE TECHNIQUES UNDE Case 1: refrigerant blend GWP 500 L-41a: R-32/1234yf/1234ze (73/15/12) L-41b: R-32/1234ye (73/27) DR-5: R-32/1234yf (72,5/27,5) ARM-70a: R-32/1344/1234yf (50/10/40) No	R DEVELOPMENT Case 2: refrigerant blend GWP 700 R-32 R-32/134a (95/5) R-32/152a (95/5) Yes	Case 3:
Existence of demonstrators or operational prototypes Regulation and status of standards	Yes	Yes	
in France :	EN 378	EN 378	
GWP	L-41a et L-41b: 524 DR-5: 520 ARM-70: 497 L-41a: COP similar to R-410A L-41b: COP -3% vs. R-410A	R-32: 716 R-32/134a: 749 R-32/152a: 687 R-32: COP similar to R-410A	
Energy efficiency Volumetric capacity	DR-5: COP slightly higher than R-410A ARM-70a: COP -3% vs. R-410A L-41a: -5% L-41b: -10%	R-32/R-152a: COP slightly higher R-32: +2 à +8% vs. R-410A	
Probable date of commercial availability	DR-5: -3% ARM-70: -10 à -15% vs. R-410A	R-32/152a et R-32/134a: +5 à +10 % vs. R-410A	
Main barriers to the solution expansion	Slightly flammable A2L L-41a: Discharge temperature + 6 à +8 K L-41b: Discharge temperature +12 K DR-5: Discharge temperature +4 K vs. R-410A ARM-70a: Discharge temperature similar to R-410A	Slightly flammable A2L R-32: T discharge +15 K vs. R-410A	
Context promoting this technique implementation (Drop in or not, impact on the charge,)	L-41a: charge +4% L-41b: charge -10% DR-5: charge -10% ARM-70a: similar to R-410A	R-32: charge - 10% R-32/152a and R-32/134a: charge similar to R-410A	
Multicriteria indicators EI: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC SR SC	VC 3 3 EEC SR SC CO	VC 3 3 EC SR SR
AFCE, UNICLIMA, ADEME Report: Alternatives to high-GWP HFCs in refrigeration and		co	со

	ystèmes VRV and Roofops R-410A		SAC3	
SECTOR	Air-to-air air conditioning	Sun-sector	Non-residential air conditioning Commercial air conditioning	
Jsage / Standard application Temperature range	15 à 32°C			
Refrigerant type commonly used / GWP		NCE SYSTEM Average charge by equipment (kg)	9.547	
Data relative to the refrigerant used	A1 Sur le marché, 98 % en France, 56 % en Europe			
Parc d'équipements en service	Dans la parc, 31 % en France et 38 % en Europe			
in France in Europe		Refrigerant bank in France (t): Refrigerant bank in Europe (t):	686 t (total end 2011) 56,370 t (total EU27 end 2011)	
Average equipment lifetime (years) Main providers of technologies	15		25,2	
in France	: Airwell, Ciat, Trane	anice.		
Main owners of technologies	: Ciat, Trane, Lennox, York, Climaveneta, Aermec, Emat, Airwell, Solare	nics		
in France in Europe				
echnical justification and particular conditions of the application with respect to	Non toxic, non flammable ODP = 0			
he HFC type used	Adapted to medium-temperature equipments Efficient and profitable system	Adapted to medium-temperature equipments		
Regulations and specific applicable standards	NF EN 60335-2-89 related so specific sagety rules for refrigeration equipment of commercial use including a condensing unit or an integrated or remote compressor			
	NF EN 14276-1 et 14276-2 related to reservoirs and piping of equipm NF EN 14825 related to the efficiency at partial load of air conditione	nent under pressure for refrigeration systems and heat pumps		
in France	:			
	Regulation 842/2006/CE Directive 2010/31/EU on energy efficiency in buildings			
	EN 378 EN 60335-2-89			
in Europe	EN 14276-1 and 14276-2	CHIMICIES		
	EXISTING ALTERNATIVE TEC	Case 2:	Case 3:	
echnical principle Parc d'équipements en service				
in France in Europe				
Applicable regulations and existing standards in France				
in Europe				
NP energy efficiency				
/olumetric capacity Availability				
Main barriers to the solution expansion Context promoting this technique implementation (Drop in or not, impact on the				
Multicriteria indicators				
El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High ER: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 4 3 3 EC SR SR	VC 3 3 EC SR CO	VC 4 3 EC CO SR	
	ALTERNATIVE TECHNIQUES UNDE	R DEVELOPMENT		
	Case 1: refrigerant blend GWP 500 L-41a: R-32/1234yf/1234ze (73/15/12)	Case 2: refrigerant blend GWP 700 R-32	Case 3:	
echnical principle	L-41b: R-32/1234ze (73/27) DR-5: R-32/1234yf (72,5/27,5)	R-32/134a (95/5) R-32/152a (95/5)		
Industrial availabilit	ARM-70a: R-32/134a/1234yf (50/10/40) y No	Yes		
Existence of demonstrators or operational prototype Regulation and status of standards		Yes		
in France		EN 279		
in Europe	L-41a et L-41b: 524	EN 378 R-32: 716		
SWP	DR-5: 520 ARM-70: 497	R-32/134a: 749 R-32/152a: 687		
inergy efficiency	L-41a: COP similar to R-410A L-41b: COP -3% vs. R-410A	R-32: COP similar to R-410A		
	DR-5: COP slightly higher than R-410A ARM-70a: COP -3% vs. R-410A	R-32/R-152a: COP slightly higher		
/olumetric canacity	L-41a: -5% L-41b: -10%	R-32: +2 à +8% vs. R-410A		
/olumetric capacity	DR-5: -3% ARM-70: -10 à -15% vs. R-410A	R-32/152a et R-32/134a: +5 à +10 % vs. R-410A		
Probable date of commercial availability	Slightly flammable A2L			
Main barriers to the solution expansion	L-41a: Discharge temperature + 6 à +8 K L-41b: Discharge temperature +12 K	Slightly flammable A2L		
viani barriers to the solution expansion	DR-5: Discharge temperature +4 K vs. R-410A	R-32: T discharge +15 K vs. R-410A		
	ARM-70a: Discharge temperature similar to R-410A L-41a: charge +4%			
Context promoting this technique implementation (Drop in or not, impact on the charge, \ldots)	L-41b: charge -10% DR-5: charge -10%	R-32: charge - 10% R-32/152a and R-32/134a: charge similar to R-410A		
	ARM-70a: similar to R-410A	N-32/1328 and N-32/1348. Charge similar to N-410A		
Multicriteria indicators El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High GR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial //C: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 4 3 3 EC SR	VC 3 4 SR	VC 3 3 EC SR	

Application factsheet: Air-to-water heat pump	using R-410A		HP1
	-	L	
	Residential heat pumps	Sub-sector	Domestic air contidioning and heating
Usage / Standard application	15 à 32°C		
Temperature range	DESCRIPTION OF THE REFEREI	 NCE SYSTEM	
Refrigerant type commonly used / GWP	R-410A GWP = 2100 A1	Average charge by equipment (kg)	3;47
	On the market: 80% in France and i en Europe In the installed base: 72% in France and 65% in Europe		
Installed base in operation in France :		Defice want hand in France (A)	1,188 t (total end 2011)
in Europe :	1,781,006	Refrigerant bank in France (t): Refrigerant bank in Europe (t) :	4,390 t (total EU27 end 2011)
Average equipment lifetime (years) Main providers of technologies	15		
in Europe :	Technibel, Ciat, Atlantic Technibel, Viessmann, Ciat, Atlantic, Stiebel eltron, Dimplex		
Main owners of technologies in France :			
in Europe :	Non toxic, non flammable		
Technical justification and particular conditions of the application with respect to the HFC type used	ODP = 0 Adapted to medium-temperature equipments		
Regulations and specific applicable standards	Efficient and profitable system		
	NF EN 378 related to safety and environmental requirements of refri NF 414 related to HP performance	gerations systems and heat pumps	
	NF EN 14825 related to the efficiency at partial load of air conditione EN 378 on safety and environmental requirements of refrigeration sy		
in Europe :	EN 378 on Safety and environmental requirements of refrigeration sy EN 14825 relative to partial load energy efficiency of air-conditioners		
carope .	EXISTING ALTERNATIVE TEC	1	
Technical principle	Case 1: R-290 replacing R-22	Case 2:	Case 3:
Installed base in operation in France :			
in Europe : Applicable regulations and existing standards			
in France : in Europe :	EN 378		
GWP	6 COP equivalent to that of R-22		
Energy efficiency Volumetric capacity	10% lower than that of R-22		
Availability Main barriers to the solution expansion	Available Flammable and explosive		
	Limited to low refrigeration capacity Adapted to higher ambient temperature (up to 43°C)		
Context promoting this technique implementation (Drop in or not, impact on the	Compactness of equipement (compressor, heat exchangers, piping)		
	Cost reduction		
Multicriteria indicators			
EI: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750)	EI 6 ✓	EI	EI
4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500)	5	5	5
EC: Energy Consumption 0 = Low 3 = Medium 6 = High	VC 3 EC	VC 3 EC	VC 3 EC
SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3		2	
CO : Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High			
AV : Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial			AV
VC : Volumetric Capacity	AV	AV	
0 = Sufficient 3 = Medium 6 = Unsatisfying			со
	со	co	
	ALTERNATIVE TECHNIQUES UNDER	R DEVELOPMENT	
	Case 1: refrigerant blend GWP 500 D2Y-60: R-32/1234yf (40/60)	Case 2: refrigerant blend GWP 700 ARM-70 (R-32/134a/1234yf) (50/10/40)	Case 3 :
Technical principle	L-41a: R-32/1234yf/1234ze (73/15/12) DR-5: R-32/1234yf (72,5/27,5)		
Industrial availability	ARM-70: R-32/134a/1234yf (50/10/40) No	No	
Existence of demonstrators or operational prototypes Regulation and status of standards	Yes	Yes	
in France : in Europe :	EN 378	EN 378	
	D2Y-60: 289 L-41a: 524	R32: 716	
GWP	L-41a. 524 DR-5: 520 ARM-70: 497	R-32/134a: 749 R-32/152a: 687	
Enormy officionary		R-32: COP similar to R-410A and +3% in heating mode	
Energy efficiency	COP similar to R-410A for the four candidates	R-32/R-134a: COP -7% and similar to R-410A in heating mode R-32/R-152a: COP similar to R-410A and +8% in heating mode	
Volumetric capacity	D2Y-60: -15 à -20% L-41a: -5 à -10%	R-32: +2 à +8% vs. R-410A	
	DR-5: -3% vs. R-410A ARM-70: - 10% vs. R-410A	R-32/R-152a and R-32/R-134a: +5 à +10 % vs. R-410A	
Probable date of commercial availability	Slightly flammable A2L	611116	
Main barriers to the solution expansion	D2Y-60: Discharge temperature lower than that of R-410A L-41a: Discharge temperature +7 Kand similar to R-410A in heating	Slightly flammable A2L R-32: Discharge temperature at leats +15 K vs R-410A	
	mode	R-32/152a: Discharge temperature +10 K vs R-410A	
Context promoting this technique implementation (Drop in or not, impact on the charge,)	D2Y-60: charge similar to R-410A L-41a: charge -10%	R-32: charge - 20% vs. R-410A R-32/152a: charge +3% vs. R-410A	
Multicriteria indicators	L-41a. Gildige -1U/0	1. J2/ 132a. Citai ge +3/0 V3. N*41UA	
El: Environmental Impact - GWP	EI		EI
1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750)	6 5	6 El	6
4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption	4	5	VC 3 EC
0 = Low 3 = Medium 6 = High SR: Safety Risk	VC 3	VC 3	2
0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO : Cost of the solution (out of maintenance)			
0 = Low 3 = Medium 6 = High AV : Availability			
6 = Laboratory 3 = Field demonstration 0 = Industrial			AV
VC : Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	AV	AV	
	co	СО	со
ACCE LINICIANA ADEME Booosts Albamatism to histocuration of the CHOICE CO.	ir conditioning applications 2012		
AFCE, UNICLIMA, ADEME Report: Alternatives to high-GWP HFCs in refrigeration and a	m-conditioning applications, 2013		

Application factsheet: Hydronic ground-source	e heat pump using R-410A		HP2
SECTOR	Residential heat pumps	Sub-sector Sub-sector	Domestic air contidioning and heating
Usage / Standard application Temperature range	15 at 32°C		
	DESCRIPTION OF THE REFERE		
Refrigerant type commonly used / GWP	R-410A GWP = 2100 A1	Average charge by equipment (kg)	2.446
Data relative to the refrigerant used	Sur le marché, 80% en France and en Europe Dans le parc, 49% en France and 83% en Europe		
Installed base in operation in France:	13	Refrigerant bank in France (t):	32 t (total end 2011)
in Europe: Average equipment lifetime (years)		Refrigerant bank in Europe (t):	1,310 t (total EU27 end 2011)
Main providers of technologies	Ciat, Heliotherm, Géothermie, France PAC		
in Europe:	Heliotherm, Erset, Enalsa, Géothermie, Ciat, Dimplex, Stiebel eltron,	Sofath, Visseman, Vaillant, France PAC	
Main owners of technologies in France:			
in Europe: Technical justification and particular conditions of the application with respect to the HFC type used	Non toxic, non flammable ODP = 0 Adapted to medium-temperature equipments		
Regulations and specific applicable standards	Efficient and profitable system		
	NF EN 378 related to safety and environmental requirements of refri	igerations systems and heat pumps	
in France:	Directive ER-P 2013 relative to the efficiency of stationary air conditi	oners ≤ 12 kW	
in Europe:			
	ALTERNATIVES TECHNIQUES Case 1:	Case 2:	Case 3:
Technical principle Installed base in operation			
in France:			
Applicable regulations and existing standards			
in France: in Europe:			
GWP Energy efficiency			
Volumetric capacity Availability			
Main barriers to the solution expansion			
Context promoting this technique implementation (Drop in or not, impact on the			
charge,) Multicriteria indicators			
El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 3 3 EC SR SCO	VC 4 3 EC SR SC CO	VC SR SR CO
	ALTERNATIVE TECHNIQUES UNDE Case 1: refrigerant blend GWP 500 L-41a: R-32/1234vf/1234ze (73/15/12)	Case 2: refrigerant blend GWP 700	Case 3:
Technical principle	DR-5: R-32/1234yf (72,5/27,5) ARM-70a: R-32/134a/1234yf (50/10/40)	R-32 R-32/134a (95/5) R-32/152a (95/5)	
Industrial availability Existence of demonstrators or operational prototypes	No Yes	No Yes	
Applicable regulations and existing standards in France:	163	163	
in Europe:	EN378	EN378	
GWP	4L-41a: 524 DR-5: 520	R32: 716 R-32/134a: 749	
Energy efficiency	ARM-70: 497 L-41a: COP similar to R-410A DR-5: COP +3% in heating mode ARM-70a: COP +2% in heating mode	R-32/152a: 687 R-32: COP similar to R-410A and +3% in heating mode R-32/134a: COP -7% and similar to R-410A in heating mode R-32/152a: COP similar to R-410A and +8% in heating mode	
	L-41a: -5 to -10%	222.22	
Volumetric capacity	DR-5: -3% vs. R-410A ARM-70: -10 to -15% vs. R-410A	R-32: +2 to +8% vs. R-410A R-32/152a and R-32/134a: +5 to +10% vs. R-410A	
Probable date of commercial availability		Clightly flammable A21	
Main barriers to the solution expansion	Slightly flammable A2L L-41a: Discharge temperature + 6 to +8 K DR-5: Discharge temperature +4 K vs. R-410A ARM-70a: Discharge temperature similar to R-410A	Slightly flammable A2L R-32: Discharge temperature at least +25 K vs R-410A R-32/134a: Discharge temperature +105 K in heating mode vs. R- 410A R-32/152a: Discharge temperature +10 K vs. R-410A	
Context promoting this technique implementation (Drop in or not, impact on the	L-41a: charge +4%	R-32: charge -20%	
context promoting this technique implementation (Drop in or not, impact on the charge,)	DR-5: charge -10% ARM-70a: similar to -R410A	R-32/134a: charge similar to R-410A R-32/152a: charge +3% vs. R-410A	
Multicriteria indicators			
El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 3 EC SR	VC 4 4 SR SR	VC 3 EC SR
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Application factsheet: MAC systems			MAC1
SECTOR	Mobile air conditioning	Sub-sector	Cars, vans and industrial vehicles
Usage / Standard application	Woone an conditioning		
Temperature range	15 à 32°C		
Refrigerant type commonly used / GWP	DESCRIPTION OF THE REFEREI	NCE SYSTÈME Average charge by equipment (kg)	0;64
Data relative to the refrigerant used	A1		
Parc d'équipements en service	100% sur le marché et dans le parc en France et en Europe		
in France:	23,088,712 160,251,625	Refrigerant bank in France (t)	
in Europe: Average equipment lifetime (years)	9	Refrigerant bank in Europe (t):	100,947 t (total EU27 end 2011)
Main providers of technologies in France:			
in Europe: Main owners of technologies			
in France:			
Technical justification and particular conditions of the application with respect to the HFC type used	Non toxic, non flammable, ODP = 0 Adapted to medium-temperature equipments Good material compatibility Lubricant POE type		
Regulations and specific applicable standards in France:	Decree 2007-737 related to certain refrigerants ued in refrigeration	and air-conditioning equipement	
	Regulation 842/2006/CE and 307/2008 qualifications required for handling certain fluorinate		
in Europe:	EXISTING ALTERNATIVE TE		
	Case 1: R-1234yf	Case 2:	Case 3:
Technical principle Installed base in operation			
in France:			
in Europe: Regulations and specific applicable standards			
in France: in Europe:	EN 378		
GWP Energy efficiency	4 COP similar to R-134a		
Volumetric capacity	Similar to R-134a		
Availability	2013 Slightly flammable A2L		
Main barriers to the solution expansion	not Drop in ΔP higher in the evaporator charge +5% vs. R-134a		
Context promoting this technique implementation (Drop in or not, impact on the charge,) Multicriteria indicators	Discharge temperature -8 to -10 K		
El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 4 3 EC SR SC	VC 3 2 EC SR	VC 4 3 EC 2 1 1 0 SR
	ALTERNATIVES TECHNIQUES EN COURS	S DE DEVELOPPEMENT	
Technical principle	Case 1:	Case 2:	Case 3:
Industrial availability Existence of demonstrators or operational prototypes			
Regulation and status of standards in France:			T
in Europe:			
GWP Energy efficiency Volumetric capacity Probable date of commercial availability			
Main barriers to the solution expansion			
Context promoting this technique implementation (Drop in or not, impact on the charge,) Multicriteria indicators			
El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 3 3 EC SR SC	VC 3 3 EC SR SC CO	VC

SECTION Children Compared to Children	Application factsheet: Centrifugal chillers - R-:	134a (Pfrigo > 350 kW)		CH1
Secretary of the control of the cont		-		0.17
STATE Common Co		Chillers	Sub-sector	Centrifugal chillers
The case 121 Annual Properties of Section (Control of Section (Con	Temperature range	2 à 10°C		
And the control contro	Refrigerant type commonly used / GWP			Ω 3 kg/kW
Section of the control of the contro		A1		0.5 Ng/ NVV
A THE PROPERTY OF THE PROPERTY		100% on the market in France and in Europe, 81% in France and 94%	in Europe in the installed base	
Comparison of minimum terror supports December De	in France			
A TRANSPORT OF TOWN CONTROL OF THE PROPERTY OF	Average equipment lifetime (years)		reingerant bank in Europe (t):	9,000 t (total E027 end 2011)
Signature continuous production and particular uniforms of the application to continuous production and particular uniforms of the application to continuous production and particular uniforms of the application of the appl	in France			
Section performs on primary continues of the spirituria with registry and the spirituria with regis		Ciat, Trane, Carrier, Lennox, Heatcraft, Stulz, GWK, Sorema, Eurodifro	iid, Olaer, AEC, Frigofluid, Wesper, MTA, Thermal care, Mokon, Euroklii	nat, J& E hall
Search products and product contributed the application with received and office of the contributed of the c				
Section of the control paper (1997) Section of the control paper (the HFC type used	Discharge temperature 8 to 10 K lower than that of R-12 Adapted to medium-temperature equipments, efficiency close to tha Good material compatibility	t of R-12	
To 1972 The Total Control of Con	Regulations and specific applicable standards			
Cost 18 32Mort [1] Cost 21 Cos		ISO 3744 acoustic power EN 14511 COP efficiency NFC 15-100 relative to the connecting and operation of electrical equ		
Simulated beautiful respectation. Comparison of a similar generation. Comparison of a similar generatio		1		Case 3:
Activation particularly and existing standards in Infrarect Infra				
Automatic principles Automatic principle Automati	in France			
Section Sect	Applicable regulations and existing standards			
R.1224x1 COP - 78.	in Europe			
Somewhate (apachy) January 1992 Main barrers to the colorido capacitation (1992) in or not, impact on the Chappe sinches to the Ch				
Suit-of-framewhise A2L Charge unimine the scholarse implementations (trops in or not impact on the Charge) It fundamental impact GWP It fundamental	Volumetric capacity			
ALTERNATIVE TECHNIQUES UNDER DEVELOPMENT Concept Annual Process of the Substitution of Substi				
Enricemental impacts (SUP 1 - New (New (Cot (D) 2 - New (Cot (D) 2 - New (Cot (D) 3 - N		Charge similar to that of R-134a		
Technical principle R:134a/1234yr (44/56) R:134a/1234yr (44/56) R:134a/1234yr (14/56) R	1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity	VC 3 3 EC SR	VC	VC 3 2 EC SR
Technical principle R-134a/1234yt (7/11/82) R-134a/1234yt (7/11/82) R-134a/1234yt (7/11/82) R-134a/1234yt (7/11/82) R-134a/1234yt (7/11/82) R-134a/1234yt (4/4/56) N-13is: R-134a/1234yt (4/3/58) N-13is: R-134a/1234yt (4/3)s N-13is: R-134a/1234yt (4/3is)s N-13is: R-134a/1234yt (4/3is)s N-13is: R-134a/1234yt (4/3is)s N-13is: R-134a/1				
Existence of demonstrators or operational prototypes Regulation and status of standards In France: EN 378 GWP In Europe: EN 378 GWP COP -3 to -7% vs. R-134a COP -4% vs. R-134a COP -5 to -7% vs. R-134a COP -4% vs. R-134a COP -4				N-13a: R-134a/1234yf/1234ze (42/18/40)
in France: In France: EN 378	Existence of demonstrators or operational prototypes	Yes	Yes	Yes
Energy efficiency COP -3 to -7% vs. R-134a COP -4% vs. R-134a N-13a: -10% N-13a: -10% N-13a: -10% N-13b: -12% vs. R-134a Similar to that of R-134a Similar to that of R-134a N-13a: -10% N-13b: -12% vs. R-134a Context promoting this technique implementation (Drop in or not, impact on the charge) ARM-42a: charge -5% vs. R-134a Charge -3% vs. R-134a	in France	EN 378	EN 378	
Volumetric capacity Similar to that of R-134a Similar to that of R-134a N-13a: -10% N-13b: -12% vs. R-134a Probable date of commercial availability Main barriers to the solution expansion Context promoting this technique implementation (Drop in or not, impact on the charge) Multicriteria indicators El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = class A1 2 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity Similar to that of R-134a A1 A2 AA Silphty flammable A2L ARM-42a: charge -5% vs. R-134a Charge -3% vs. R-134a	GWP	114	605	
Probable date of commercial availability Main barriers to the solution expansion Context promoting this technique implementation (Drop in or not, impact on the charge,) All Context promoting this technique implementation (Drop in or not, impact on the charge,) All Context promoting this technique implementation (Drop in or not, impact on the charge,) All Context promoting this technique implementation (Drop in or not, impact on the charge -3% vs. R-134a ARM-42a: charge -5% vs. R-134a Charge -3% vs. R-134				N-13a: -10%
Context promoting this technique implementation (Drop in or not, impact on the charge,) ARM-42a: charge -5% vs. R-134a Charge -3% v		60 Lu 6	CP List O	
Charge,) Multicriteria indicators El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity	Context promoting this technique implementation (Drop in or not, impact on the			
1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity	Multicriteria indicators			
	1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity	VC	VC 4 3 EC SR	VC 3 EC SR

Application factsheet: Low-capacity volumetr	ic chillers - R-410A (P < 150 kW)		CH2
			CHZ
	Chillers	Sub-sector	Volumetric chillers
Usage / Standard application Temperature range	2 to 10°C		
	DESCRIPTION OF THE REFEREI	NCE SYSTEM	
Refrigerant type commonly used / GWP	R-410A GWP = 2100 A1	Average charge by equipment (kg)	0.3 kg/kW
· · · · · · · · · · · · · · · · · · ·	On the market: 71% in France		
Installed base in operation	On the installed base: 35% in France		
in France: in Europe:	19 Not communicated	Refrigerant bank in France (t): Refrigerant bank in Europe (t):	137 t (total end 2011) Not communicated
Average equipment lifetime (years) Main providers of technologies	15		
	Ciat, Trane, Airwell Ciat, Trane, Carrier, Lennox, Heatcraft, Stulz, GWK, Sorema, Furodifr	oid, Olaer, AEC, Frigofluid, Wesper, MTA, Thermal care, Mokon, Eurokli	mat. I& F hall
Main owners of technologies in France:			
in Europe:	New training and florescelle, ODD, 0		
Technical justification and particular conditions of the application with respect to	Non toxic, non flammable, ODP = 0 Adapted to medium-temperature equipments		
the HFC type used	Lubricant POE type		
Regulations and specific applicable standards in France:			
	EN 378 ISO 3744 acoustic power		
	EN 14511 COP efficiency		
in Europe:	NFC 15-100 relative to the connecting and operation of electrical equ	lipment in buildings	
	EXISTING ALTERNATIVE TEC	1	
Technical principle	Case 1: R-290 replacing R-22 Vapor compression	Case 2:	Case 3:
Installed base in operation in France:			
in Europe: Applicable regulations and existing standards			
in France:	FN378		
	EN378 ATEX regulation 99/92/CE		
GWP Energy efficiency	6 Slightly lower than that of R-410A		
Volumetric capacity Availability	- 30% vs. R-410A Available		
Main barriers to the solution expansion	Flammable (A3) Limitation due to the refrigerant charge		
·	Additional cost linked to ATEX Adapted to higher ambient temperature (up to 43°C)		
Context promoting this technique implementation (Drop in or not, impact on the	Adapted to higher difficient temperature (up to 45 c)		
charge,)			
Multicriteria indicators			
El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750)	EI 6	EI	EI 6
4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption	5	6	5
0 = Low 3 = Medium 6 = High SR: Safety Risk	VC 3 EC	VC 3 EC	VC 3 EC
0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance)	2	2	2
0 = Low 3 = Medium 6 = High			
AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial			AV
VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	AV	AV	AV
	со		со
		со	
	ALTERNATIVE TECHNIQUES UNDER		0.12
	Case 1: refrigerant blend GWP 500 DR-5: R-32/1234yf (72,5/27,5)	Case 2: R-32	Case 3:
Technical principle	ARM-70a: -R32/134a/1234yf (50/10/40) L-41a: R-32/1234yf/1234ze (73/15/12)		
	L-41b: R-32/1234ze (73/27) HPR1D: R-32/744/1234ze (60/6/34)		
Industrial availability Existence of demonstrators or operational prototypes	No Yes	No Yes	
Regulation and status of standards in France:			
in Europe:	EN 378 DR-5: 520, ARM-70a: 497, L-41a and L-41b: 524	EN 378	
GWP	HPR1D: 432	716	
Energy efficiency	L-41a and L-41b: +3% DR-5: +3%	Similar to R-410A	
	ARM-70a: +6% HPR-1D: -8% vs. R-410A		
Volumetric canacity	L-41a: -3%; L-41b: -5% ARM-70a: -10%	-100/	
Volumetric capacity	DR-5: similar to R-410A HPR-1D: -8%	+10%	
Probable date of commercial availability		T discharge at least > 25 K vs. R-410A	
Main barriers to the solution expansion	Slightly flammable A2L	Slightly flammable A2L	
Context promoting this technique implementation (Drop in or not, impact on the	Drop in L41a et L41b: charge -12%		
charge,)	ARM-70a: charge - 4% DR-5: charge -8%	R-32: charge -20%	
Multicriteria indicators	HPR1D: charge -4%		
EI: Environmental Impact - GWP	EI	EI	EI
1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750)	6	6	6
4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption	5	5	4
0 = Low 3 = Medium 6 = High SR: Safety Risk	VC 3	VC 3	VC 3
0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance)	2	2	1
0 = Low 3 = Medium 6 = High			
AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial			
VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	AV	AV	AV
v - Summent 3 - Medium v - Offsatisfying			
	со	со	со
AFCE, UNICLIMA, ADEME Report: Alternatives to high-GWP HFCs in refrigeration and a	ir-conditioning applications, 2013		

Application factsheet: Medium-capacity volume	netric chillers - R-410A (150 kW < P < 8	800 kW)	СНЗ
SECTOR		<u> </u>	Volumetric chillers
Usage / Standard application		<u> </u>	
Temperature range	2 à 10°C DESCRIPTION OF THE REFEREI	NCE SYSTEM	
Refrigerant type commonly used / GWP	R-410A GWP = 2100 A1	Average charge by equipment (kg)	0.3 kg/kW
Data relative to the refrigerant used	On the market: 54% en France and 23% en Europe In the installed base: 21% en France and 11% en Europe		
Installed base in operation in France:		Refrigerant bank in France (t):	635 t (total end 2011)
in Europe:		Refrigerant bank in Europe (t):	4,200 t (total EU27 end 2011)
Main providers of technologies	Ciat, Trane, Airwell		
		oid, Olaer, AEC, Frigofluid, Wesper, MTA, Thermal care, Mokon, Eurokl	imat, J& E hall
in France: in Europe:			
the HFC type used	Non toxic, non flammable ODP = 0 Adapted to medium-temperature equipments Efficient and profitable system		
Regulations and specific applicable standards in France:			
	EN 378 ISO 3744 acoustic power EN 14511 COP efficiency		
in Europe:	NFC 15-100 relative to the connecting and operation of electrical equ		
	EXISTING ALTERNATIVE TEC Case 1: R-290	Case 2: R-717	Case 3:
Technical principle Installed base in operation	Vapor compression	Vapor compression	
in France: in Europe:			
Applicable regulations and existing standards in France:		Ammonia regulation	
in Europe:	EN 378 ATEX regulation 99/92/CE	EN 378	
GWP	6	0 COD +3% vs B-/10A	
Energy efficiency Volumetric capacity	Slightly lower than R-410A -30% vs. R-410A	COP +8% vs. R-410A +25% vs.n R-410A	
Availability	Available Flammable (A3)	Available	
	Limitation due to the refrigerant charge Additional cost linked to ATEX	B2 Cost (investment and safety) higher than that of R-410A	
Context promoting this technique implementation (Drop in or not, impact on the charge,)	Adapted to higher ambient temperature (up to 43°C)	Higher energy efficiency that R-410A system Mature technology	
Multicriteria indicators El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 3 3 EC SR SC CO	VC 3 2 EC SR	VC 3 3 EC 2 1 O SR
	ALTERNATIVE TECHNIQUES UNDE	CO R DEVELOPMENT	
	Case 1: refrigerant blend GWP < 500 DR-5: R-32/1234yf (72,5/27,5)	Case 2: R-32	
Technical principle	ARM-70a: R-32/134a/1234yf (50/10/40) L-41a: R-32/1234yf/1234ze (73/15/12) L-41b: R-32/1234ze (73/27) HPR1D: R-32/744/1234ze (60/6/34)		
	Non toxic, non flammable ODP = 0	No	
Industrial availability	Adapted to medium-temperature equipments Efficient and profitable system		
Existence of demonstrators or operational prototypes Regulation and status of standards in France:	Yes	Yes	
in Europe:	EN 378 DR-5: 520, ARM-70a: 497, L-41a and L-41b: 524	EN 378	
GWP	DK-5: 520, AKM-703: 497, L-41a and L-41b: 524 HPR1D: 432 L-41a and L-41b: +3%	716	
Energy efficiency	DR-5: +3% ARM-70a: +6% HPR-1D: -8% vs. R-410A	Similar to R-410A	
Volumetric capacity	L-41a: -3%; L-41b: -5% ARM-70a: -10% DR-5: similar to R-410A HPR-1D: -8%	+10% vs. R-410A	
Probable date of commercial availability Main barriers to the solution expansion	Slightly flammable A2L	T discharge at least +25 K vs. R-410A Slightly flammable A2L	
Context promoting this technique implementation (Drop in or not, impact on the charge,)	L41a and L41b: charge -12% ARM-70a: charge - 4% DR-5: charge -8% HPR1D: charge -4%	R-32: charge -20%	
Multicriteria indicators EI: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	HPR1D: charge -4%	VC 3 2 EC SR	VC 3 3 EEC SR SR
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Application factsheet: High-capacity volume	tric chillers (screw compressors)		CH4
SECTOR	Chillers	Sub-sector	Volumetric chillers
Usage / Standard application Temperature range	2 à 10°C		
	DESCRIPTION OF THE REFER		
Refrigerant type commonly used / GWP	R-134a GWP = 1370 A1	Average charge by equipment (kg)	0.3 kg/kW
Data relative to the refrigerant used	On the market: 26% in France In the installed base: 6% in France		
Installed base in operation in France:	2	Refrigerant bank in France (t):	300 t (total end 2011)
in Europe: Average equipment lifetime (years)	Not communicated 20	Refrigerant bank in Europe (t):	Not communicated
Main providers of technologies	le i z		
	Ciat, Trane, Airwell Ciat, Trane, Carrier, Lennox, Heatcraft, Stulz, GWK, Sorema, Eurodifi	roid, Olaer, AEC, Frigofluid, Wesper, MTA, Thermal care, Mokon, Euro	klimat, J& E hall
Main owners of technologies in France:			
in Europe:			
Technical justification and particular conditions of the application with respect to the HFC type used	Non toxic, non flammable ODP = 0 Adapted to medium-temperature equipments		
Regulations and specific applicable standards	Lubricant POE type		
in France:	EN 378		
in Europe	ISO 3744 acoustic power EN 14511 COP efficiency NFC 15-100 relative to the connecting and operation of electrical ec		
	EXISTING ALTERNATIVE TE		Case 3: R-717
Technical principle	Case 1: R-1234ze [E]	Case 2: R-1234yf	Case 5: R-/1/
Installed base in operation in France:			Yes
in Europe:			Yes
Applicable regulations and existing standards in France:			
in Europe:	EN 378 6	EN 378 4	EN 378 0
Energy efficiency	COP - 3% vs. R-134a	COP similar to R-134a	COP + 10% vs. R-134a
Volumetric capacity Availability	-25% vs. R-134a 2013	-5% vs R-134a 2015	+ 30% vs.R-134a Available
Main barriers to the solution expansion	Slightly flammable A2L	Slightly flammable A2L	B2
Context promoting this technique implementation (Drop in or not, impact on the charge,) Multicriteria indicators	Charge similar to R-134a	Charge similar to R-134a	Mature technonlogy
El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk	VC 3 EC	VC 3 EC	6 EI VC 3 2 EC
0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	AV SR	AV SR	AV SR
	ALTERNATIVE TECHNIQUES UNIO		
	ALTERNATIVE TECHNIQUES UND Case 1: ARM-42a	ER DEVELOPMENT Case 2: XP-10	Case 3: GWP <700
Technical principle	DR-5: R-32/1234yf (72,5/27,5) ARM-70a: -R32/134a/1234yf (50/10/40) L-41a: R-32/1234yf/1234ze (73/27) L-41b: R-32/1234ze (73/27) HPR1D: R-32/744/1234ze (60/6/34)		DR-7: R32/1234yf (36/64) L-20: R-32/152a/1234ze (45/20/35)
Industrial availability Existence of demonstrators or operational prototypes	? Yes	? Yes	? Yes
Regulation and status of standards in France:			
in Europe:	EN 378	EN 378	EN378
GWP Energy efficiency	114 COP -3 to -7% vs. R-134a	605 COP -4% vs. R-134a	604 COP similar to R-134a
Volumetric capacity	Similar to R-134a	Similar to R-134a	N-13a: -10% vs. R-134a N-13b: -12% vs. R-134a
Probable date of commercial availability Main barriers to the solution expansion	Slightly flammable A2L	Slightly flammable A2L	A1
Context promoting this technique implementation (Drop in or not, impact on the charge,)	Charge -5% vs. R-134a	Charge -3% vs. R-134a	Charge -3% vs. R-134a
El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity	VC	VC 3 3 EC SR	VC 3 3 EC SR
0 = Sufficient 3 = Medium 6 = Unsatisfying AFCE, UNICLIMA, ADEME Report: Alternatives to high-GWP HFCs in refrigeration and	СО	CO	co co

SECURE Section of the process of th	Application factsheet: Medium-temperature	direct expansion systems using R-404	4A	FP1
## Company of the Com				
Approximate production of the control of the contro	SECTOR	Refrigeration in food processes	Sub-sectors Sub-sectors	Warehouses Beer and wine industries
April			lions cases can be observed, depending on the industry:	Sparling beverages
Magneting control of the second control of t	Usage / Standard application	- warehouse, product storage at +4°C		
Discrete Control Contr		- industrial air conditioning		
And the second process of the control of the contro	Temperature range		NCE SYSTEM	
Section of the properties of the control of the con	Refrigerant type commonly used / GWP		Average charge by equipment (kg)	
Service of the control of the contro				
Section of the findings Section of the findin	in France in Europe	Not communicated		
Section of the control of the contro	Main providers of technologies			
The State of the Control of the Cont	in Europe			
The control of the co	in Europe	Nestlé, Bell, Danone, etc. Interviewed groups are: Bel (30% milk ind	ustry France), LDC (Leader poultry, pre-cooked dishes) and Bonduelle	(world leader for vegetables)
Control Cont	the HFC type used		trofit easiness, no temperature glide of R-404A, drop-in possible	
School State of the control of the c		NF EN 60335-2-89 related so specific sagety rules for refrigeration e	equipment of commercial use including a condensing unit or an integ	rated or remote compressor
Section (1997) Section (1997)		EN 378		
Construction of control of the contr	in factors			
State of the company	in Europe			Case 3: R-407A or R-407F in naw and in retrofit
Significant processing and sections of the control	Technical principle			R-407A - R-32/125/134a (20/40/40)
Seption for extraction and various partnership. Prince Prince	in France			First installations in 2012
The state of the s	Applicable regulations and existing standards			
Telescent and international property of the Park State of the Control of the Cont	in Europe	-	Regulation 842/2006/CE	Regulation 842/2006/CE
ATTENATIVE TECHNOLIS UNDER DEVILOPMENT Coat a final analysis of the section registering registering the section registering r	Energy efficiency		Lower than that of R-404A	Similar to medium temperature
Secretary growding this business implementation (flows in an article personness appliess) Leading growding this business implementation (flows in an article personness appliess) Leading growding this business implementation (flows in an article personness appliess) Leading growding and personness appliess (Leading and personness appliess) Leading growding and personness appliess (Leading and personness appliess) Leading growding and personness appliess (Leading and personness appliess) Leading growding and personness appliess (Leading and personness appliess) Leading growding and personness appliess (Leading and personness appliess) Leading growding and personness appliess (Leading and personness appliess) Leading growding and personness appliess (Leading and personness appliess) Leading growding and personness appliess (Leading and personness appliess) Leading growding and personness appliess (Leading and personness appliess) Leading growding and personness appliess (Leading and personness appliess) Leading growding and personness appliess (Leading and personness appliess) Leading growding and personness appliess (Leading applies) Leading growding appliess (Leading appliess) Leading growding appliess (Leading applies) Leading growding appliess (Leading appliess) Leading growding appliess (Leading appliess) Leading growding appliess (Leading appliess) Leading growding appliess	Volumetric capacity	Similar	30% lower than that of R-404A	
Souther providing the Editingue Implementation (Diop in or set, impact on the Canada C	Main barriers to the solution expansion		GWP within the scope of the F-Gas evaolution at medium term.	GWP relatively high.
15 Control Control of Principle - Control of Principle - Medican (CVP) and State (CVP) (CV		Lasting solution regardless of the F-Gas evolution. Similar or higher energy efficiency than the R-404A reference	depending on the flammable regulation evolution. Design characteristics in the specifications (lower refrigerating capacity of R-134a)	Both refrigerant blends are adapted to R-404A retrofit
Case 2: Retrofit by HFO-HFC blends, dightly flammable, GWP around 1300	1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity	VC 3 3 EC SR	VC 3 2 EC SR	VC 3 EC SR
Technical principle Technical		ALTERNATIVE TECHNIQUES UNDE	l R DEVELOPMENT	
Technical principle IND-HIC Dienois (R-32/123-94) or R-32/125/33/123-94) or R-32/125/33/123-94 or R-32/125/33-94 or R-32/12		around 250		Case 3:
Regulation and status of standards In France Flammable regulations (no A2L standard) F-Gas	Technical principle	HFO-HFC blends (R-32/1234yf or		
Regulation and status of standards In France Flammable regulations (no A2L standard) F-Gas In Europee Flammable regulations (no A2L standard) F-Gas D2Y 65: 253 DX-7: 260 DX-		No	No - communications of refrigerant producers not dedicated to	
GWP Context promoting this technique implementation (Drop in or not, impact on the Garge, and Multicriteria indicators El: Environmental Impact - GWP L - Wild Multicriteria indicators El: Environmental Impact - GWP L - Wild Multicriteria indicators El: Environmental Impact - GWP L - A33 and B33 CO: Cost of the solution (out of maintenance) O = Low 3 = Medium 6 = High AV: Availability AV: Availability AV: Availability AV: Availability AV: Volumentic 1, 1500, 6 = Extremely high (>2500) EC: Context Pask O = Class A1 Z = A21 L = A2 and B2 G = A3 and B3 CO: Cost of the solution (out of maintenance) O = Low 3 = Medium 6 = High AV: Availability AV: Availability AV: Volumentic (Capacity) AV: Volumentic (Capacity) AV: Volumentic (Capacity) AV: Columentic (Capacity) AV: Availability AV: Availa	Regulation and status of standards			
Energy efficiency Good performances of blends compared to R-404A, variations depending on proposed refrigerants (L-40, D-R7, ARM-30) Volumetric capacity Probable date of commercial availability A2L Temperature glide from 2 à 4 K Context promoting this technique implementation (Drop in or not, impact on the charge,) Multicriteria indicators El: Environmental impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial Vol. Volumetric (capacity) ARM-30: 210 Good performances to blends compared to R-404A, variations depending on proposed refrigerants (N-40, D-R7, ARM-30) Good performances of blends compared to R-404A, variations depending on proposed refrigerants (N-40, D-R7, ARM-30) Good performances of blends compared to R-404A, variations depending on proposed refrigerants (N-40, D-R7, ARM-30) Fremperature glide from 2 à 4 K Temperature glide from 2 à 4 K Performances similar to R-404A Drop in (to be confirmed) less costly El: Environmental impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial Vc. Volumetric capacity AVE: Volumetric capacity AVE: Volumetric capacity From 1 = Very low (<10)		Flammable regulations (no A2L standard) L-40: 302		
Energy efficiency Good performances of blends compared to R-404A, variations depending on proposed refrigerants (L-40, D-R7, ARM-30) Wolumetric capacity Main barriers to the solution expansion A2L Temperature glide from 2 à 4 K Context promoting this technique implementation (Drop in or not, impact on the darage,) Multicriteria indicators El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium 6 = High SR: Safety Risk 0 = Class A1	GWP	DR-7: 260	1300 à 1400	
Volumetric capacity Probable date of commercial availability A2L Temperature glide from 2 à 4 K Context promoting this technique implementation (Drop in or not, impact on the charge,) Multicriteria indicators El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium 6 = High CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AC: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity A2L Lack of durability High charge because of retrofit Temperature glide from 2 to 4 K A1 Performances similar to R-404A Drop in (to be confirmed) less costly El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (<750) 5 = Very high (<1500), 6 = Extremely high (<2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High AC: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity AV. Volumetric Capacity A2L Lack of durability High charge because of retrofit Temperature glide from 2 to 4 K A1 A2L Lack of durability High charge because of retrofit Temperature glide from 2 to 4 K A1 AC I Ferformances similar to R-404A Drop in (to be confirmed) less costly B1 B1 B1 B1 B1 B1 B1 B1 B1 B	Energy efficiency	Good performances of blends compared to R-404A, variations		
Main barriers to the solution expansion A2L Temperature glide from 2 à 4 K Context promoting this technique implementation (Drop in or not, impact on the charge,) Context promoting this technique implementation (Drop in or not, impact on the charge,) Drop-in R-404A or R-22 GWP low enough Drop-in R-404A or R-22 GWP low enough Drop-in R-404A Drop in (to be confirmed) less costly Multicriteria indicators El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity		(אוים (אב דו פוווא אינוים פאר אינוים (אוים לאביים אינוים לאביים אינוים לאביים אינוים א	בריוווא בנייום עד זון בריוונים בייים ביים בייים בייים בייים בייים בייים בייים בייים בייים בייים	
Context promoting this technique implementation (Drop in or not, impact on the charge,) Drop-in R-404A or R-22 GWP low enough Multicriteria indicators El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity			High charge because of retrofit	
1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity	charge,)		A1 Performances similar to R-404A	
co co	EI: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity	VC	VC	0 5 4 3 2 2 1 1 0 SR

Usage / Standard application Temperature range Refrigerant type commonly used / GWP Data relative to the refrigerant used Installed base in operation In France: In Europe: Average equipment lifetime (years) Wain providers of technologies In France: In Europe: Main owners of technologies	-18 à +6°C DESCRIPTION OF THE REFEREI R-404A GWP = 3700 R-125/143a/134a (44/52/4) A1 Not communicated Not communicated Not communicated 30 years Johnson Control, Clauger, GEA Mattal	Sub-sector Sub-sector	Meat industry Slaughterhouses Frozen food Pre-cooked dishes Warehouses Very variable depending on the production level. Up to 3 t
Usage / Standard application Temperature range Refrigerant type commonly used / GWP Data relative to the refrigerant used Installed base in operation In France: In Europe: Average equipment lifetime (years) Wain providers of technologies In France: In Europe: Wain owners of technologies	-18 à +6°C DESCRIPTION OF THE REFEREI R-404A GWP = 3700 R-125/143a/134a (44/52/4) A1 Not communicated Not communicated Not communicated 30 years Johnson Control, Clauger, GEA Mattal Nestlé, Bell, Danone, etc. Interviewed groups are: Bel (30% milk indu	Sub-sector NCE SYSTEM Average charge by equipment (kg) Refrigerant bank in France (t):	Frozen food Pre-cooked dishes Warehouses
Refrigerant type commonly used / GWP Data relative to the refrigerant used Installed base in operation In France: In Europe: Average equipment lifetime (years) Main providers of technologies In France: In Europe: Wain owners of technologies In France: In Europe: In France: In France: In France: In France: In France:	DESCRIPTION OF THE REFEREI R-404A GWP = 3700 R-125/143a/134a (44/52/4) A1 Not communicated Not communicated 30 years Johnson Control, Clauger, GEA Mattal Nestlé, Bell, Danone, etc. Interviewed groups are: Bel (30% milk indu	Average charge by equipment (kg) Refrigerant bank in France (t):	Very variable depending on the production level. Up to 3 t
Refrigerant type commonly used / GWP Data relative to the refrigerant used Installed base in operation In France: In Europe: Average equipment lifetime (years) Main providers of technologies In France: In Europe: Main owners of technologies In France: In F	DESCRIPTION OF THE REFEREI R-404A GWP = 3700 R-125/143a/134a (44/52/4) A1 Not communicated Not communicated 30 years Johnson Control, Clauger, GEA Mattal Nestlé, Bell, Danone, etc. Interviewed groups are: Bel (30% milk indu	Average charge by equipment (kg) Refrigerant bank in France (t):	Very variable depending on the production level. Up to 3 t
nstalled base in operation in France: in Europe: Average equipment lifetime (years) Main providers of technologies in France: in Europe: Main owners of technologies Main owners of technologies in France: in France:	R-404A GWP = 3700 R-125/143a/134a (44/52/4) A1 Not communicated Not communicated 30 years Johnson Control, Clauger, GEA Mattal Nestlé, Bell, Danone, etc. Interviewed groups are: Bel (30% milk indu	Average charge by equipment (kg) Refrigerant bank in France (t):	Very variable depending on the production level. Up to 3 t
nstalled base in operation in France: in Europe: Average equipment lifetime (years) Main providers of technologies in France: in Europe: Main owners of technologies Main owners of technologies in France: in France:	R-125/143a/134a (44/52/4) A1 Not communicated Not communicated 30 years Johnson Control, Clauger, GEA Mattal Nestlé, Bell, Danone, etc. Interviewed groups are: Bel (30% milk indu	Refrigerant bank in France (t):	Very variable depending on the production level. Up to 3 t
nstalled base in operation in France: in Europe: Average equipment lifetime (years) Main providers of technologies in France: in Europe: Main owners of technologies in France: in Europe:	Not communicated Not communicated 30 years Johnson Control, Clauger, GEA Mattal Nestlé, Bell, Danone, etc. Interviewed groups are: Bel (30% milk indi		
in France: in Europe: Average equipment lifetime (years) Main providers of technologies in France: in Europe: Wain owners of technologies in France:	Not communicated 30 years Johnson Control, Clauger, GEA Mattal Nestlé, Bell, Danone, etc. Interviewed groups are: Bel (30% milk indu		
Average equipment lifetime (years) Main providers of technologies in France: in Europe: Main owners of technologies in France:	30 years Johnson Control, Clauger, GEA Mattal Nestlé, Bell, Danone, etc. Interviewed groups are: Bel (30% milk indu	nenigerant bank in europe (t).	
in France: in Europe: Main owners of technologies in France:	Nestlé, Bell, Danone, etc. Interviewed groups are: Bel (30% milk indi		13,000 t (total illustry E027 ellu 2012)
in France:	Johnson Control, Clauger, GEA Mattal	ustry France), LDC (Leader poultry, pre-cooked dishes) and Bonduelle	(world leader for vegetables)
in Europe:			
Fechnical justification and particular conditions of the application with respect to the HFC type used	Evolution of old R-22 installations: compatibility of components, ret	rofit easiness, no temperature glide of R-404A, drop-in possible	
	Regulation 842/2006/EC		
in Europe:	Regulation 842/2006/EC EXISTING ALTERNATIVE TEC	CHNIQUES	
	Case 1: Cascade system R-717/CO ₂	Case 2: Cascade system R-134a/ CO ₂ can be retrofitted in R-	Case 3: Booster system R-717/R-717
Technical principle	Unchanged. Vapor compression	1234yf/CO ₂ Unchanged. Vapor compression	Unchanged. Vapor compression
nstalled base in operation in France:	Strong growth of the installed base, first installations in 2010	Strong growth of the installed base, first installations in 2010	First installations in 2012
in Europe: Applicable regulations and existing standards in France:	Strong growth of the installed base, first installations in 2010 Ammonia regulation	Strong growth of the installed base, first installations in 2010 Regulation 842/2006/EC	First installations in 2012 Ammonia regulation
in France: in Europe: SWP	Ammonia regulation 0/1	Regulation 842/2006/EC Regulation 842/2006/EC 1370 / 1	Ammonia regulation 0/0
Energy efficiency	Energy consumption reduction of cascade systems compared to direct systems, and better energy efficiency of ammonia and CO ₂ ,	Better energy efficiency of cascade systems,	Good energy efficiency of ammonia. Booster systems allow energy consumption reduction compared to simple direct systems.
of the state of th	Immediate	Immediate	Immediate
Vain barriers to the solution expansion	Toxic and moderately flammable (B2L). Cost (investment and safety) higher,up to 50%, than R-404A installation	R-134a GWP within the scope of Regulation 842/2006/EC evolution in the medium term	
Context promoting this technique implementation (Drop in or not, impact on the charge,)	Flexibility of the ammonia regulation Lasting solution regardless of the Regulation 842/2006/EC evolution. Similar or higher energy efficiency than the R-404A reference system.	Possible retrofit: R-134a/ R-1234yf or R-1234ze at medium term depending on the flammable regulation evolution. Design characteristics in the specifications (lower refrigerating capacity of R-134a) Cost similar to that of R-404A installation, except further retrofit,	Flexibility of the ammonia regulation Lasting solution regardless of the F-Gas evolution. Similar or higher energy efficiency than the R-404A reference system.
Multicriteria indicators El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 3 2 EC SR	VC 4 4 SR	VC 4 3 EC SR SR
	ALTERNATIVE TECHNIQUES UNDER	R DEVELOPMENT Case 2: Retrofit by a non-flammable blend, GWP around	Existing Case 4: R-407A or R-407F in new and in
	GWP around 250 Unchanged. Vapor compression.	1300 Unchanged. Vapor compression.	retrofit
Fechnical principle Industrial availability	Olicianges, vapor Coningession. HFO-HFC blends (R-32/1234yf or R-32/152a/1234yf/1234ze) No	HFO-HFC blends (R-32/125/134a/1234yf and possibly R-1234ze) No	R-407A - R-32/125/134a (20/40/40) R-407F - R-32/125/134a (30/30/60) No
Existence of demonstrators or operational prototypes Regulation and status of standards	No but AHRI tests for other applications	No-communications of refrigerant producers not dedicated to food process	First installations in 2012
regulation and status of standards in France: in Europe:	Flammable regulations (no A2L standard) Flammable regulations (no A2L standard)	Regulation 842/2006/CE Regulation 842/2006/CE	Regulation 842/2006/CE Regulation 842/2006/CE
GWP	about 200 Good performances of blends compared to R-404A, variations depending on proposed refrigerants (L-40, DR-7, ARM-30)	1300 to 1400 Good performances of blends compared to R-404A, variations depending on proposed refrigerants (N-40, DR-33, ARM-32)	R-407A 2100 / R-407F 2060 Similar to medium temperature
Volumetric capacity Probable date of commercial availability			Similar Immediate
Main barriers to the solution expansion	A2L Temperature glide from 2 à 4 K Uncertainty on the refrigreant price	Lack of durability High charge because of retrofit Temperature glide from 2 to 4 K Uncertainty on the refrigreant price	GWP relatively high.
Context promoting this technique implementation (Drop in or not, impact on the charge,) VIUITICITIETIA INGICATORS	Drop-in R-404A or R-22 GWP low enough	A1 Performances similar to R-404A Drop in (to be confirmed) less costly	Both refrigerant blends are adapted to R-404A retrofit
El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 4 SR SR	VC SR SR	VC SR SR

Application factshoots Madium tomporature i	ndirect system using P 404A		ED3
Application factsheet: Medium-temperature i	ndirect system using R-404A		FP3
SECTOR	Refrigeration in food processes	Sub-sectors	Milk tanks Milk industry Chocolate industry Warehouses Beer and wine industries Sparking beverages
Usage / Standard application	03.486		
Temperature range	0 à +4°C DESCRIPTION OF THE REFEREN	ICT CVCTFNA	
Refrigerant type commonly used / GWP	DESCRIPTION OF THE REPEREN	Average charge by equipment (kg)	
Renigerant type commonly used 7 GWF	R-404A GWP = 3700 R-125/ 143a/ 134a (44/52/4)	Average charge by equipment (kg)	Very variable depending on the production level. Up to 3 t
Data relative to the refrigerant used	A1		
Installed base in operation in France	Not communicated	Refrigerant bank in France (t):	2,500 t (total agri end 2011)
in Europe		Refrigerant bank in France (t).	15,000 t (total industry EU27 end 2012)
Average equipment lifetime (years) Main providers of technologies	30 years		
in France	Johnson Control, Clauger, GEA Mattal, Diatec, Synergies, Tecnal		
Main owners of technologies	Diatec, Packo, Synergies, Tecnal, DIMA		
in France in Europe	Johnson Control, Clauger, GEA Mattal Nestlé, Bell, Danone, etc. Interviewed groups are: Bel (30% milk indus	the France) LDC (Leader poultry, pre-cooked disher) and Renduelle (v	world loader for vegetables)
Technical justification and particular conditions of the application with respect to	Adaptedto medium and low-temperature equipments	try France), EDC (Leader pourry, pre-cooked distres) and bonduene (v	volid leader for vegetables)
FC type used Evolution of old R-22 installations: compatibility of components, retrofit easiness, no temperature glide of R-404A, drop-in possible ations and specific applicable standards			
in France		uipment of commercial use including a condensing unit or an integrate	ed or remote compressor
in Europe			
	EXISTING ALTERNATIVE TEC	· ·	
Technical principle	Case 1: R-717 + indirect system with HTF (MPG or CO ₂ or other) Unchanged. Vapor compression	Case 2: R-134a + indirect system with HTF (MPG or CO2 or other) Unchanged. Vapor compression	No retrofit solution
Installed base in operation in France		Not communicated	
in Europe Applicable regulations and existing standards	Not communicated	Not communicated	
in France	Ammonia regulation	Regulation 842/2006/CE	
in Europe.	0	Regulation 842/2006/CE 1370	
	Similar to the reference system	Lower than R-404A	
Energy efficiency			
Volumetric capacity Availability	Similar Immediate	Lower than R-404A Immediate	
Main barriers to the solution expansion	Toxic and moderately flammable (B2L). Cost (investment and safety) higher,up to 50%, than R-404A installation	GWP within the scope of the F-Gas evaolution at medium term.	
Context promoting this technique implementation (Drop in or not, impact on the charge,)	Flexibility of the ammonia regulation Lasting solution (Regulation 842/2006/CE) Energy efficiency similar to R-404A. High cost of the shell-and-tube heat exchanger plu cost due to the necessary insulation of the circuit and pumps installation.	Possible retrofit R-134a/ R-1234yf or R-1234ze on the medium term High cost of the shell-and-tube heat exchanger plu cost due to the necessary insulation of the circuit and pumps installation.	
El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	OCO ECC	VC 3 3 EC SR SC CO	VC 4 3 EC SR SR
	ALTERNATIVE TECHNIQUES UNDER		
Technical principle	Case 1:	Case 2:	Case 3:
Industrial availability			
Existence of demonstrators or operational prototypes Regulation and status of standards			
in France in Europe:			
GWP			
Energy efficiency Volumetric capacity			
Probable date of commercial availability Main barriers to the solution expansion			
Context promoting this technique implementation (Drop in or not, impact on the			
charge,)			
Multicriteria indicators			
EI: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 3 3 EC SR	VC 3 EC SR	VC 3 2 EC SR
AFCE, UNICLIMA, ADEME Report: Alternatives to high-GWP HFCs in refrigeration and	co air-conditioning applications, 2013	со	со

Application factsheet: Low-temperature flood	ed evaporator operating with R-404A		FP4
			Meat industry
SECTOR	Refrigeration in food processes	Sub-sectors	Slaughterhouses Frozen food Pre-cooked dishes Warehouses
Usage / Standard application Temperature range	-18 à +6°C		
Temperature range	DESCRIPTION OF THE REFEREI	NCE SYSTEM	
Refrigerant type commonly used / GWP	R-404A GWP = 3700	Average charge by equipment (kg)	Very variable depending on the production level. Up to 3 t
Data relative to the refrigerant used	R-125/ 143a/ 134a (44/52/4) A1		
Installed base in operation in France:	Not communicated	Refrigerant bank in France (t):	
Average equipment lifetime (years)	Not communicated 30 years	Refrigerant bank in Europe (t):	15,000 t (total industry EU27 end 2012)
	Johnson Control, Clauger, GEA Mattal, Diatec, Synergies, Tecnal		
Main owners of technologies	Diatec, Packo, Synergies, Tecnal, DIMA		
in France:		stry France), LDC (Leader poultry, pre-cooked dishes) and Bonduelle (v	world leader for vegetables)
Technical justification and particular conditions of the application with respect to the HFC type used	Evolution of old R-22 installations: compatibility of components, retr	ofit easiness, no temperature glide of R-404A, drop-in possible	
Regulations and specific applicable standards	NF EN 378-2 related to safety and environmental requirements of re NF EN 60335-2-89 related so specific sagety rules for refrigeration eq NF EN 14276-1 et 14276-2 related to reservoirs and piping of equipm	uipment of commercial use including a condensing unit or an integrat	ed or remote compressor
in France:	Regulation 842/2006/EC EN 378		
	EN 60335-2-89 EN 14276-1 et 14276-2		
in Europe:	EXISTING ALTERNATIVE TEC	CHNIQUES	
Technical principle	Case 1: R-717 + indirect system with HTF (MPG or CO ₂ or Temper)	Case 2: R-134a + indirect system with HTF (MPG or CO ₂ or Temper)	No retrofit solution
Parc d'équipements en service in France:	Not communicated	Not communicated	
in Europe: Applicable regulations and existing standards	Not communicated	Not communicated	
in France: in Europe: GWP	Ammonia regulation 0	Regulation 842/2006/CE Regulation 842/2006/CE 1370	
GWP	U Similar to the reference system	Lower than R-404A	
Energy efficiency Volumetric capacity	Similar Countries of the Percentile System	Lower than R-404A	
Availability	Immediate	Immediate	
Main barriers to the solution expansion	Toxic and moderately flammable (B2L). Cost (investment and safety) higher,up to 50%, than R-404A installation	GWP within the scope of the F-Gas evaolution at medium term.	
Context promoting this technique implementation (Drop in or not, impact on the charge,)	Flexibility of the ammonia regulation Lasting solution (Regulation 842/2006/CE) Energy efficiency similar to R-404A. High cost of the shell-and-tube heat exchanger plu cost due to the necessary insulation of the circuit and pumps installation.	Possible retrofit R-134a/ R-1234yf or R-1234ze on the medium term High cost of the shell-and-tube heat exchanger plu cost due to the necessary insulation of the circuit and pumps installation.	
Multicriteria indicators EI: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 3 3 EC SR SR	VC 3 3 EC SR	VC 3 3 EC SR
	ALTERNATIVE TECHNIQUES UNDER		
Technical principle	Case 1:	Case 2:	Case 3:
Industrial availability Existence of demonstrators or operational prototypes Regulation and status of standards			
in France:			
GWP Energy efficiency			
Volumetric capacity Probable date of commercial availability			
Main barriers to the solution expansion Context promoting this technique implementation (Drop in or not, impact on the charge,)			
El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 3 3 EC SR SR	VC 3 3 EC SR SC CO	VC

Application factsheet: Direct-drive unit using	R-404A in medium and low-temperatu	re systems	RT1
SECTOR	I	Sub-sector	Direct drive
	Transport of perishable goods for different classes of temperatures (find deliveries, these vehicles are equipped with oversized refrigeration un	resh, frozen). Small-size vehicles, they are used for local delivery of fo	od of pharmaceutical products. The use needing multiple
Usage / Standard application	vehicles (small vans and refrigerated vans). [+ 12 °C et 0 °C] (classe A ATP) et [+ 12 °C et - 10 °C] (classe B ATP) et		ing of doors. In 2011, the French production was of 6,852
Temperature range	DESCRIPTION OF THE REFEREN	ICE SYSTEM	
Refrigerant type commonly used / GWP Data relative to the refrigerant used	R-404A GWP = 3700 A1, R-404A represents 92% of the global market of refrigerated transp	Average charge by equipment (kg)	1.63
Installed base in operation	A1, N-404A Tepresents 32.8 of the global market of reingerated transp	Juli	
in France in Europe		Refrigerant bank in France (t): Refrigerant bank in Europe (t):	78.24 652
Average equipment lifetime (years) Main providers of technologies	10 years		
	Carrier transicold (US), Thermoking, (US), Carrier transicold (US), Thermoking, (US), Frigoblock (DE)		
Main owners of technologies in France			
in Europe Technical justification and particular conditions of the application with respect to	Refrigerants well adapted to the range of temperatures (especially for	r low-temperature refrigeration) down to -20°C in foodSince the inst	called base includes 30% of multi-temperature vehicles, this
the HFC type used Regulations and specific applicable standards	refrigerant is used for vehicles adapted to transportation of fresh produced to transportation of tran	ducts.	
	 Rural code (Article 231-59) on characteristics of vehicles for the tran Environment Code applicable to refrigerants 	sport of perishable goods	
in France	- Order of 2 June 2008, ATP Agreement -NF EN 378		
in Europe	Local regulations not harmonized in Europe		
	EXISTING ALTERNATIVE TEC Case 1: Eutectic cold source	HNIQUES Case 2: R-407A or R-407F in new and in retrofit	Case 3 :
	Installed in an insulated vehicle, a cold source called Eutectic		
Technical principle	consisting of an aqueous solution previously frozen which allows delivery of refrigeration during transport. Cooler principle. The	R-407A - R-32/125/134a (20/40/40) R-407F - R-32/125/134a (30/30/60)	
	implementation of eutectic involves the use of a fixed refrigeration system which itself contains a HFC and compression technology		
Installed base in operation in France		First installations in 2013	
in France in Europe Applicable regulations and existing standards		First installations in 2013 First installations in 2013	
in France in Europe			
GWP	0 (if one forgets the time forthe eutectic plates to reach the defined temperature)	R-407A 2100 / R-407F 2060	
Energy efficiency Volumetric capacity	Sufficient	Similar to R-404A for medium-temperature systems Similar to R-404A for medium-temperature systems	
Availability	Immediate - Increase the vehicle weight and decrease the useful load	Immediate	
Main barriers to the solution expansion	- Difficult to reconcile with the desire to expand the park of electrical equipment for urban logistics	GWP relatively high.	
	- Does not solve the issue of cold storage that needs a cold room to lower the temperature	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
Context promoting this technique implementation (Drop in or not, impact on the charge,)	Technologie dedicated mainly to low-temperature refrigeration (ice)	Solutions available in retrofit	
Multicriteria indicators			
El: Environmental Impact - GWP	EI	EI	FI
1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500)	6 5	6	6 5
EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk	VC 3 EC	VC 3 EC	VC 3 EC
0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance)	2	2	2
0 = Low 3 = Medium 6 = High AV: Availability			
6 = Laboratory 3 = Field demonstration 0 = Industrial			
VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	AV	AV	AV
			co
	со	со	CO
	ALTERNATIVE TECHNIQUES UNDER	DEVELOPMENT	
	Case 1: Refrigerant blend GWP around 300 L-40: R-32/152a/1234yf/1234ze	Case 2 :	Case 3 :
Technical principle	(40/10/20/30) D2Y-65: R-32/1234yf (35/65)		
	DR-7: R-32/1234yf (36/64) ARM-30a: R-32/1234yf (29/71)		
Industrial availabilit Existence of demonstrators or operational prototypes	Non		
Regulation and status of standards in France			
in Europe	EN 378 L-40: 302		
	D2Y-65: 253 DR-7: 260		
GWP	ARM-30a: 210 L-40: COP - 14% vs. R-404A		
Energy efficiency	DR-7: COP + 7% vs. R-404A ARM-30a: COP - 11% vs. R-404A		
	L-40: -17% vs. R-404A DR-7:+ 2% vs. R-404A		
Volumetric capacity Probable date of commercial availability	ARM-30a: - 19% vs. R-404A		
Main barriers to the solution expansion	Slightly flammable A2L Uncertainty on the refrigerant price		
Contact promoting this technique involumentation (Development			
Context promoting this technique implementation (Drop in or not, impact on the charge,)	L-40 : +5% charge vs. R-404A D2Y-65: -5% charge vs. R-404A		
Multicriteria indicators			
El: Environmental Impact - GWP	EI	EI	EI
1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500)	6	6 5	6 5
EC: Energy Consumption 0 = Low 3 = Medium 6 = High	3 4	4	4
SR: Safety Risk 0 = Class A1	VC 3	VC 3	VC 3 EC
CO: Cost of the solution (out of maintenance)		1	1
0 = Low 3 = Medium 6 = High AV: Availability		0	0
6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity	AV		
0 = Sufficient 3 = Medium 6 = Unsatisfying	AV SK	AV	AV
	со	co	co
AFCE, UNICLIMA, ADEME Report: Alternatives to high-GWP HFCs in refrigeration and	air-conditioning applications 2013		

	Sub-sectors resh, frozen). Multi-temperature transport. Self-powered units are off an stores. In 2012, the French production represented 5,062 vehicles (Self-powered units ten used to equip large vehicles (> 12 t) and semi-trailers for
long distance transport and delivery of large and medium-surface urb [+ 12°C et 0°C] (class A ATP) and [+ 12°C and - 10°C] (class B ATP) and DESCRIPTION OF THE REFEREN		en used to equip large vehicles (> 12 t) and semi-trailers for
	NCE SYSTEM Average charge by equipment (kg)	6.4
A1, R-404A represents 92% of the global market of refrigerated trans	port	
73 600	Refrigerant bank in France (t): Refrigerant bank in Europe (t):	
10 years		
Carrier transicold (US), Thermoking, (US), Carrier transicold (US), Thermoking, (US), Frigoblock (DE)		
Stef, STG, Delanchy, Staf, Olano Stef		
		alled base includes 30% of multi-temperature vehicles, this
- Environment Code applicable to refrigerants - Order of 2 June 2008, ATP Agreement NF EN 378	sport of perishable goods	
 EC labeling due to the Directiveon noise of refrigerating units PIEK Protocole (noise of refrigerating units) CEN standards: EN 16440-1, -2, -3, 4 (PC 413) 		
		Case 2: R-407A or R-407F in new and in retrofit
The principle is based on the direct expansion of liquid nitrogen. Cold produced by the expansion of liquid nitrogen is transferred directly to the air to be cooled (that of the refrigerated vehicle	The principle is based on an open primary circuit with direct expansion of liquid nitrogen and a heat exchanger installed in the vehicle compartment. The compartment is qeuipped with forced	R-407A - R-32/125/134a (20/40/40) R-407F - R-32/125/134a (30/30/60)
Not communicated	Not communicated	First installations in 2013
Not communicated	Not communicated	First installations in 2013
Recommendation from the social security because of safety problems of personnel in charge of deliveries: in operation, air of the refrigerated vehicle compartment is replaced by nitrogen. Human intervention can begin only once the iar in the compartment is renewed, hence the setting of safety devices locking the doors.		
0 - Low energy consumption for a low ΔT - High energy consumption for significant ΔT	- Low energy consumption for a low ΔT - High energy consumption for significant ΔT	R-407A 2100 / R-407F 2060 Similar to R-404A for medium-temperature systems
Available - Aditional costs linked to the development and safety devices	Available - Lack of a network for the distribution of liquid nitrogen	Similar to R-404A for medium-temperature systems Immediate
- Lack of a network for the distribution of liquid nitrogen - Safety aspects of persons for urban deliveries - Limited autonomy for high ambient temperatures. Cannot be adapted on an existing compartment by standard replacement (chassis, case modification)	- Safety of persons for deliveries in closed sas - Limited autonomy for high ambient temperatures. Cannot be adapted on an existing compartment by standard replacement (chassis, case modification)	GWP relatively high.
- Silent technologie - No moving parts (robustness limiting the maintenance) - Low energy consumption for low ΔT - Good efficiency at partial load - Rapid decrease in temperature - Low maintenance cost - Adapted to urban logistic	- Silent technologie - No moving parts (robustness limiting the maintenance) - Low energy consumption for low ΔT - Good efficiency at partial load - Rapid decrease in temperature - Low maintenance cost	Solutions available in retrofit
VC 3 3 2 EC CO	6 1 2 2 2 1 1 1 3 3	VC SR SC
ALTERNATIVE TECHNIQUES UNDER	R DEVELOPMENT	
Case 1: CO ₂ compression unit Same as compression unit	Case 2: refrigerant blend GWP around 300 L-40: R-32/152a/1234yf/1234ze	
	(40/10/20/30) DR-7: R-32/1234yf (36/64) ARM 202: B-32/1324yf (79/71)	
No No	ARM-30a: K-32/1234yt (29//1) No Yes	
···	- ***	
	EN 378 ARM-30a: 210	
1	L-40: 302 DR-7: 260	
+5% energy consumption vs. R-404A and losses of efficiencies at high outdoor temperatures	'ARM-30a : + 6% vs. R-404A L-40: COP + 5% vs. R-404A DR-7: COP + 7% vs. R-404A	
+10% vs. R-404A	ARM-30a : +4 % vs. R-404A L-40 : +2 % vs. R-404A	
Development cost of components, training of maintenance operators	DR-7 : +11 % vs. R-404A Slightly flammable A2L Uncertainty on the refrigerant price	
Successful experience for containers for very variable ambient temperatures. A1 refrigerant.	L-40: +5% charge vs. R404A	
VC 4 3 3 EC SR	VC SR	VC 3 2 EC SR
	Stef, STG, Delanchy, Staf, Olano Stef Refrigerants well adapted to the range of temperatures (especially for refrigerant is used for vehicles adapted to transportation of fresh pro- Pural code (Article 231-59) on characteristics of vehicles for the transportation of the pro- Pural code (Article 231-59) on characteristics of vehicles for the transportation of the pro- Pural code (Article 231-59) on characteristics of vehicles for the transportation of the pro- Pural code (Article 231-59) on characteristics of vehicles for the transportation of the properties of personnel in Characteristics of the properties of personnel in charge of deliveries: in operation, air of the refrigerated vehicle compartment is replaced by nitrogen. Not communicated Not communicated Not communicated Not communicated Not communicated Not communicated or the properties of the properties of personnel in charge of deliveries: in operation, air of the refrigerated vehicle compartment is replaced by nitrogen. Proposed of the properties of the properties of personnel in charge of deliveries: in operation, air of the refrigerated vehicle compartment is replaced by nitrogen. Auditional costs inked to the development and safety devices locking the doors. Auditional costs linked to the development and safety devices - Lack of a network for the distribution of liquid nitrogen. Safety aspects of persons for urban deliveries. Linked autonomy for high ambient temperatures. Cannot be adapted on an existing compartment by standard replacement (chassis, case month for the distribution of liquid nitrogen. Safety aspects of persons for urban deliveries. Linked autonomy for high ambient temperatures. Alternative for experiment of the properties of the prop	DOC. STOC. Detainly, 264, Class And TRANATIVE TECHNIQUES UNder DEVELOPMENT AND CONTRIBUTION STATES AND CONTRIBUTION OF THE PROPERTY OF THE P

Application factsheet: Self-powered units for	containers		RT3
SECTOR	Refrigerated transport	Sub-sector	Containers
Usage / Standard application	electrically-driven; equipement allow, on port terminals, on ships and refrigerated sea containers, of which 85% use R-134a and 15% R-404,	ea containers (20-feet or 40-feet) are equipped with an insulated comp I on some road chassis, to power these units during the transport durat A. The large majority of transported goods are fresh and not frozen, wh	cion. The installed base is estimated at 1.1 million of
Temperature range	[+12°C et 0°C] (class A ATP) and [+12°C et -10°C] (class B ATP) and [+ DESCRIPTION OF THE REFEREN		
Refrigerant type commonly used / GWP	R-134a GWP = 1370	Average charge by equipment (kg)	4 to 4.9 kg for 20-ft containers
Data relative to the refrigerant used Installed base in operation			
in France in Europe		Refrigerant bank in France (t): Refrigerant bank in Europe (t):	
Average equipment lifetime (years) Main providers of technologies	14 years		
in France	: Carrier transicold (US),Thermoking, (US)		
in Europe Main owners of technologies	:: Carrier transicold (US), Thermoking, (US)		
in France in Europe	: CMA CGM,		
Technical justification and particular conditions of the application with respect to the HFC type used Regulations and specific applicable standards	R-134A is well adapted to transportation of fresh products		
in France	- Norme ISO 1496-2 specification and tests of containers with therma - ATP, if used within multi-modal transport	l characteristics	
in Europe			
	EXISTING ALTERNATIVE TEC	HNIQUES Case 2: R-407A or R-407F in new and in retrofit	Case 3:
	CO ₂ unit with Scroll or reciprocating compressor and air or water	R-407A - R-32/125/134a (20/40/40)	Case 3:
Technical principle	condensers	R-407F - R-32/125/134a (30/30/60)	
Installed base in operation in France	:: Not communicated	First installations in 2013	
in Europe	:: Not communicated	First installations in 2013	
Applicable regulations and existing standards in France			
in Europe GWP		R-407A 2100 / R-407F 2060	
Energy efficiency	COP (Tamb=38°C, Tint=-18°C) of R-12 units was of 0.73 in the 90s, 1.1 for R-134a units in 2008. Significant developments have been made in design of fans and scroll compressors in order to increase the efficiency of CO ₂ units.	Similar to R-404A for medium-temperature systems	
Volumetric capacity	Sufficient Recently available. The NaturaLINE series has been launched	Similar to R-404A for medium-temperature systems	
Availability	officially at the Intermodal Salon early October 2013,	Immediate	
Main barriers to the solution expansion	Development cost of components, training of maintenance operators	GWP relatively high.	
Context promoting this technique implementation (Drop in or not, impact on the charge, \dots)	Low-GWP refrigerant. A1	Solutions available in retrofit	
El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (<750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 3 3 EC SR SC CO	VC 3 2 EC SR SC	VC 3 EC SR SC CO
	ALTERNATIVE TECHNIQUES UNDER	DEVELOPMENT	
Technical principle	cas 1 :	cas 2 :	cas 3 :
Industrial availabilit			
Existence of demonstrators or operational prototype Regulation and status of standards			
in France in Europe			
GWP Energy efficiency			
Volumetric capacity			
Probable date of commercial availability Main barriers to the solution expansion			
Context promoting this technique implementation (Drop in or not, impact on the charge,)			
Multicriteria indicators El: Environmental Impact - GWP 1 = Very low (<10) 2 = Low (<150) 3 = Medium (< 750) 4 = High (>750) 5 = Very high (>1500), 6 = Extremely high (>2500) EC: Energy Consumption 0 = Low 3 = Medium 6 = High SR: Safety Risk 0 = Class A1 2 = A2L 4 = A2 and B2 6 = A3 and B3 CO: Cost of the solution (out of maintenance) 0 = Low 3 = Medium 6 = High AV: Availability 6 = Laboratory 3 = Field demonstration 0 = Industrial VC: Volumetric Capacity 0 = Sufficient 3 = Medium 6 = Unsatisfying	VC 3 3 EC SR	VC 3 3 EC EC SR	VC 3 3 EC SR