

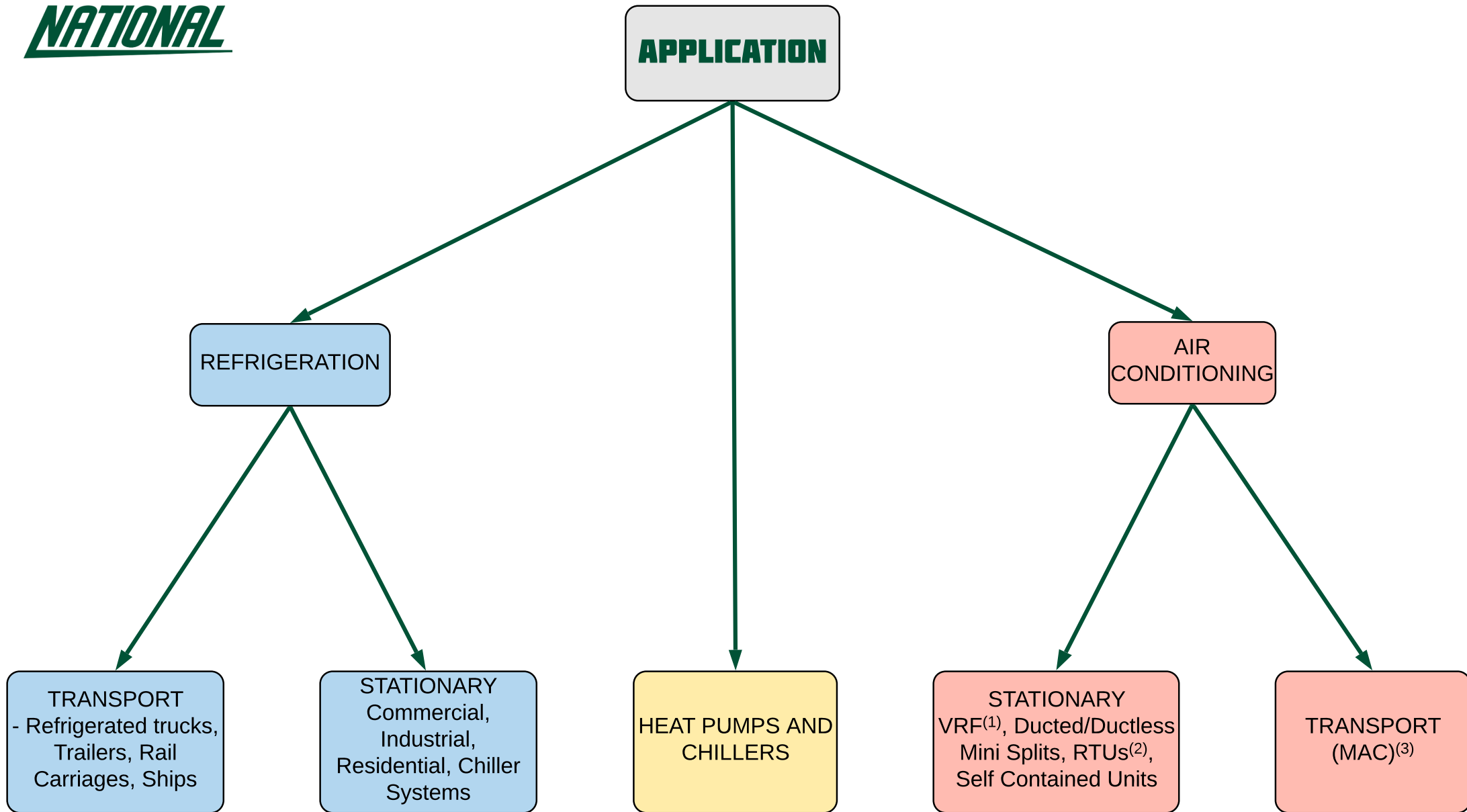


# **NATIONAL REFRIGERANTS**

## **A GENERAL GUIDE TO ALTERNATIVE LOWER GWP REFRIGERANTS**



***NATIONAL***



REFRIGERATION

AIR  
CONDITIONING

TRANSPORT  
- Refrigerated trucks,  
Trailers, Rail  
Carriages, Ships

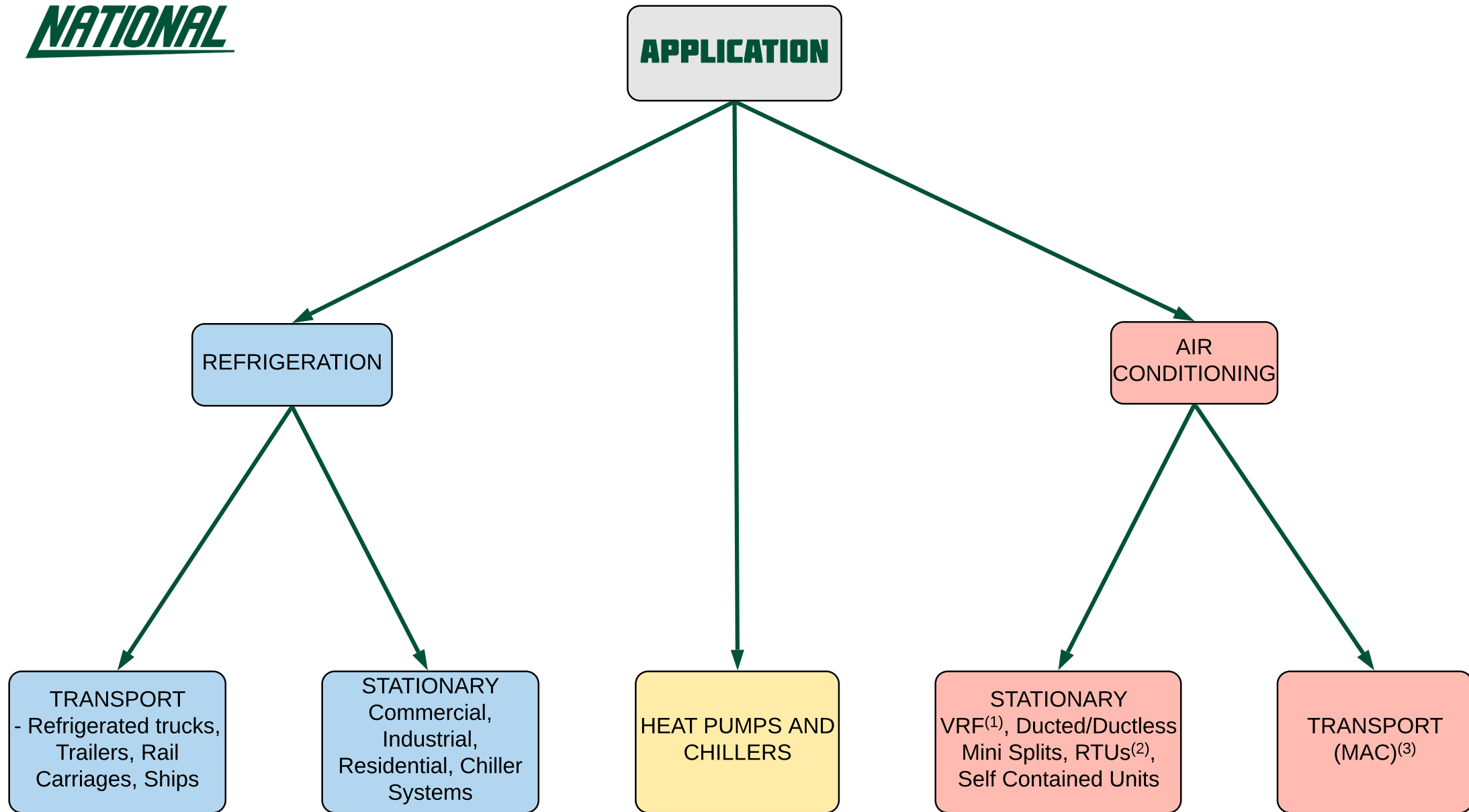
STATIONARY  
Commercial,  
Industrial,  
Residential, Chiller  
Systems

HEAT PUMPS AND  
CHILLERS

STATIONARY  
VRF<sup>(1)</sup>, Ducted/Ductless  
Mini Splits, RTUs<sup>(2)</sup>,  
Self Contained Units

TRANSPORT  
(MAC)<sup>(3)</sup>

***NATIONAL***



## TRANSPORT AIR CONDITIONING



Legacy/Current (GWP <sup>(4)</sup> , Class)	R134A (1430, A1)			
Alternative	R1234yf (Solstice yf)	R1234yf (Opteon yf)	R513A (Opteon XP10)	R744 (Carbon Dioxide)
Manufacturer	Honeywell	Chemours	Chemours	National
GWP (ipcc AR4)	4	4	631	1
Safety Class	A2L	A2L	A1	A1
System	MAC	MAC	MAC	MAC
Equipment Type	New	New	New / Retrofit	New
Oil	PAG <sup>(6)</sup> / POE <sup>(7)</sup>	PAG / POE	POE	POE
Capacity	Similar (+/- 5%)	Similar (+/- 5%)	Similar	Better
Efficiency	Similar (+/- 5%)	Similar (+/- 5%)	Similar	Similar to Worse
Compressor	Depends on required system capacity, compatibility and design			
Comments	Adopted by MAC industry.	New Thermostatic Expansion Valve (TXV) <sup>(8)</sup>	Non flammable replacement	High Pressure and Low Critical Temp

**TRANSPORT  
AIR  
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# STATIONARY AIR CONDITIONING



Legacy/Current (GWP, Class)	R410A (2088, A1)					R407C (1774, A1)	R22 (1810, A1)	R134a (1430, A1)	
Alternative	R447A (Solstice L41)	R452B (Solstice L41y, Opteon XL55)	R454B (Opteon XL41)	R32	R466A (Solstice N41)	R444B (Solstice L20)	R438A (Freon MO99) (ISCEON MO99)	R513A (Opteon XP10)	R1234yf (Opteon XL10) (Solstice yf)
<b>Manufacturer</b>	Honeywell	Honeywell	Chemours	National	Honeywell	Honeywell	Chemours	Chemours	Chemours Honeywell
<b>GWP (ipcc AR4)</b>	582	698	466	675	733	295 *	2264	631	4
<b>Safety Class</b>	A2L	A2L	A2L	A2L	A1	A2L	A1	A1	A2L
<b>System</b>	A/C <sup>(9)</sup>	Residential & Light Commercial	A/C	Residential and light a/c small splits	VRF Systems	A/C	DX <sup>(10)</sup> Systems	Vending Machines	Domestic
<b>Equipment type</b>	New	New	New	New	New	New	Retrofit	New / Retrofit	New
<b>Oil</b>	POE	POE	POE	PAG	PAG / POE	POE	POE, AB <sup>(11)</sup> , MO <sup>(12)</sup>	POE	PAG / POE
<b>Capacity</b>	7 - 10% Lower	Similar	Similar	5% compressor downsize	95 to 100% match	vs R22: 95% vs R407C: Similar	5-10% less	Similar	Similar
<b>Efficiency</b>	1 - 3% Higher	1 - 3% Higher	1 - 3% Higher	Near drop in (+1-2%)	Close match, 5% increase in higher ambients	vs R22: 95% vs R407C: 1- 3% higher	Similar	Similar	5% less
<b>Compressor</b>	Determined by the required system capacity and material compatibility during the design phase								
<b>Comment</b>	Works well at higher ambient, Lower pressure fluid. Codes and regs apply	Standards, codes and regulations for flammability apply	Standards, codes and regulations for flammability apply	Up to 10% in electricity saving, High discharge temp.	Need to replace condensing unit for retrofit	Works well in warm climates, Standards, codes and regulations apply	Designed as a 'drop-in' replacement, change elastomeric seals and gaskets	Non Flammable replacement	Standards, codes and regulations for flammability apply

## TRANSPORT REFRIGERATION



Legacy / Current (GWP, Class)	R-404A (3922, A1)				R-134a (1430, A1)
Alternative	R-448A (Solstice N40)	R-452A (Opteon XP44)	R-454C (Opteon XL20,	R-454A (Opteon XL40)	R513A (Opteon XP10)
<b>Manufacturer</b>	Honeywell	Chemours	Chemours	Chemours	Chemours
<b>GWP (ipcc AR4)</b>	1386	2140	148 *	238 *	631
<b>Safety Class</b>	A1	A1	A2L	A2L	A1
<b>System</b>	Direct Expansion	Refrigerated trucks and trailers	Suited for hermetically-sealed systems.	Positive displacement, DX Low temp and Med temp commercial and industrial	Container Refrigeration
<b>Equipment Type</b>	New Retrofit	New Retrofit	New	New	New Retrofit
<b>Oil</b>	POE	POE	POE	POE	POE
<b>Capacity</b>	Similar	Close match	Higher Cooling	Higher cooling	Similar
<b>Efficiency</b>	+1 to +4% Higher	Equivalent	Improved	Improved	Equivalent
<b>Compressor</b>	Determined by the required system capacity and material compatibility during the design phase				
<b>Comment</b>	Higher discharge temp in Low Temperature applications	Lower GWP interim non flammable replacement.	<150 GWP F-gas regulation limit for commercial refrigeration hermetic systems (2022). Follow applicable codes	Can be safely used by following the applicable codes and standards.	Very low GWP, long term replacement
<b>Status</b>	Available for Sampling Commercial	Commercial	Commercial	Commercial	Commercial

## STATIONARY REFRIGERATION



Legacy/Current (GWP, Class)	R404A (3922, A1), R22 (1810, A1), R507 (3985, A1)							R134A (1430, A1)		
Alternative	R407F (Performax LT)	R448A (Solstice N40)	R455A (Solstice L40X)	R452A	R454A (Opteon XL40)	R449A (Opteon XP40)	R454C (Opteon XL20)	R1234ze (Solstice ze)	R450A (Solstice N13)	R513A (Opteon XP10)
<b>Manufacturer</b>	Honeywell	Honeywell	Honeywell	Honeywell Chemours	Chemours	Chemours	Chemours	Honeywell	Honeywell	Chemours
<b>GWP (ipcc AR4)</b>	1825	1386	145 *	2140	238*	1397	148	7	601	631
<b>Safety Class</b>	A1	A1	A2L	A1	A2L	A1	A2L	A2L	A1	A1
<b>System</b>	DX	DX Low temp & Medium temp	SCCU <sup>(13)</sup>	Low Temp & Medium Temp	Low temp & Medium temp	Low temp & Medium temp	Low temp & Medium temp	DX Med temp CO <sub>2</sub> <sup>(14)</sup> Cascade	DX Med temp CO <sub>2</sub> Cascade	HT <sup>(15)</sup> , MT <sup>(16)</sup> Water chillers
<b>Equipment Type</b>	New / Retrofit	New / Retrofit	New	New / Retrofit	New	New / Retrofit	New	New	New / Retrofit	New,Retrofit
<b>Oil</b>	POE	POE	POE	POE	POE	POE	POE	POE	POE	POE
<b>Capacity</b>	Similar	Similar	4% Lower	Close match	Superior performance	Similar	-12 to -9%	20 -25% Lower	8-10% Lower	Similar
<b>Efficiency</b>	5 to 10% Higher	5 to 10% Higher	+3 to +6% (LT) <sup>(17)</sup> +10% (MT)	Exhibit efficiency gain	Superior performance	Lower Energy Consumption	+5 to 11% COP <sup>(18)</sup>	1 - 5% Higher	Similar	Similar
<b>Compressor</b>	Determined by the required system capacity and material compatibility during the design phase									
<b>Comment</b>	No TXV change. Higher discharge temp in Low Temperature applications	No TXV change. Good compressor envelope coverage	Same discharge Temp in Low Temp applications. Follow applicable codes and standards	Low Temperature: Closest match and low discharge temp. Interim replacement	Can be safely used by following the applicable codes and standards.	Excellent performance match & lower energy consumption	Allows much higher charge sizes. Can be safely used by following the applicable codes and standards.	Outdoor / ATEX Compliance, Supermarkets and other Medium Temperature applications	Wider operating envelope. Works well at higher ambient. Flooded evaporator OK	No Glide



**HEAT PUMPS  
AND  
CHILLERS**



Legacy/Current (GWP, Class)	Boilers, Fossil Fuels, Electric Heaters,	R404A (3922, A1)	R410A (2088, A1)			R134a (1430, A1)				R123 (77, B1)	
Alternative	HFO1233zd (Solstice zd)	R454A (Opteon XL40)	R452B (Opteon XL55)	R454B (Opteon XL41)	R447A (Solstice L41)	R1234yf (Solstice yf)	HFO1234ze (Solstice ze)	R450A (Solstice N13)	R513A (Opteon XP10)	HFO1233zd (Solstice zd)	R1336mzz(Z) Opteon MZ
<b>Manufacturer</b>	Honeywell	Chemours	Chemours	Chemours	Honeywell	Honeywell	Honeywell	Honeywell	Chemours	Honeywell	Chemours
<b>GWP (ipcc AR4)</b>	4	239	698	466	582	4	6	601	631	4	2
<b>Safety Class</b>	A1	A2L	A2L	A2L	A2L	A2L	A2L	A1	A1	A1	A1
<b>System</b>	High Temp Heat Pumps	Heat Pumps	Heat Pumps, H2O Chillers	Heat Pumps, Chillers	Heat Pumps	Med & High Pressure Chillers	Heat Pumps & Chillers	Med & High Pressure Chillers	Med Temp Water Chillers	Low Pressure Centrifugal Chillers	High Temp Heat Pumps
<b>Equipment Type</b>	New	New	New	New	New	New	New	New Retrofit	New Retrofit	New	New
<b>Oil</b>	POE	POE	POE	POE	POE	POE	POE	POE	POE	POE	POE
<b>Capacity</b>	Better than R123	Higher	Match	Similar	7-10% Lower	Similar	20-25% Lower	8-10% Lower	Close Match	40-45% Higher	-
<b>Efficiency</b>	Similar to R123	Improved	Higher	Improved	1 to 3% Higher	5% Less	1 to 5% Higher	1-3% Higher	Close Match	Similar	-
<b>Compressor</b>	Determined by the required system capacity and material compatibility during the design phase										
<b>Comment</b>	Higher capacity range	Much higher charge sizes compared to other flammables	Design compatibility and reduced compressor discharge temp.	Flammability Standards, codes and regulations apply	Works well at higher ambient, Lower pressure fluid	Service equipment and system components not interchangeable	Higher oil solubility, mildly flammable at temp >30C	Wider operating Envelope, better at higher ambient	Negligible glide. Commercially available.	Higher capacity range	Used as a working fluid for high temp heat pump applications.

Note:

- (1) VRF - Variable Refrigerant Flow
- (2) RTUs - Roof Top Units
- (3) MAC - Mobile Air Conditioning
- (4) GWP - Global Warming Potential
- (5) AR4 - Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Report
- (6) PAG - Polyalkylene Glycol
- (7) POE - Polyol Ester
- (8) TXV - Thermostatic Expansion Valve
- (9) A/C - Air Conditioning
- (10) DX - Direct Expansion
- (11) AB - Alkylbenzene
- (12) MO - Mineral Oil
- (13) SCCU - Self Contained Condensing Units
- (14) CO<sub>2</sub> - Carbon Dioxide
- (15) HT - High Temperature
- (16) MT - Medium Temperature
- (17) LT - Low Temperature
- (18) COP - Coefficient of Performance

Refrigerator:  $COP = \text{Desired Output/Required Input} = \text{Cooling Effect/Work Input} = \frac{Q_L}{W_{net,in}}$

Heat Pump:  $COP = \text{Desired Output/Required Input} = \text{Heating Effect/Work Input} = \frac{Q_H}{W_{net,in}}$

\* Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report