**COMPATIBILITY OF R-245ca
WITH MOTOR MATERIALS
UNDER RETROFIT CONDITIONS**

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Review and Current Study

- What is R-245ca ?
- Motor Materials Compatibility Studies
 - New Materials with 11 Pure Refrigerants and 17 Refrigerant-Lubricant Combinations.
 - Materials Under Retrofit Conditions with R-12/R-134a, R-22/R-407C, R-502/R-404A and R-11/R-123.
 - Materials Under Retrofit Conditions with R-11/R-245ca and R-123/R-245ca

R-245ca 1995 Update

- Manufacturing Processes and Costs -Unknown
- Toxicity - Unknown
- Flammability - Yes
 - Flammable in Humid Air at Room Temperature.
 - Flammable at Higher Temperatures.
 - May Require Use of Blends and Not Pure R-245ca.
- Efficiency - Chiller Tests In Progress

Compatibility Studies

<u>New Motor Materials</u>	<u>Used Motor Materials</u>
Complete. Final Report May 1993	Retrofitted to Alternative Refrigerant and Lubricant.
Reported ASHRAE Journal August 1993	Exposed to Original Refrigerant and Oil for 20 Years.
Presented ASHRAE Meeting January 1993	

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Sequential Exposures

- Original Refrigerant & Mineral Oil for 500 Hours; then
- Alternative Refrigerant and Lubricant for 168, 336 and 500 Hours.
- 1000 Hours Exposure to Original Refrigerant & Mineral Oil as Control.
- Exposures at 127°C (260°F) and 300 psig except for R-11/R-123 at 100°C.

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Meets UL-2171 Requirements

UL-2171: "Field Conversion/Retrofit of Products to Change to an Alternative Refrigerant- Insulating Materials and Refrigerant Compatibility."

Conclusion

- **Most Materials Appear Compatible.**
- **Concerns**
 - **Embrittlement of PET Sheet Insulation & Sleeving.**
 - **Delamination of Aramid-PET-Aramid Sheet Insulation**
- **Effect of R-12, -22 & -502/Mineral Oil More Severe than Alternative Refrigerants/Lubricants.**

Varnish Results

Helical Coil Bond Strength.

**Increase from Unexposed Value of 27.4 lb After Exposure to R-245ca from Either R-11 or R-123.
Example:**

<u>Exposure</u>	<u>% Change from Unexposed</u>
R-123 500 Hr.	+12.5
R-245ca 168 Hr.	+18.6
R-245ca 336 Hr.	+13.9
R-245ca 500 Hr.	+6.3
R-123 1000 Hr.	+14.1

Refrigerants & Lubricants

<u>Original</u>		<u>Alternative</u>
CFC-11/Mineral Oil	→	HCFC-123/Mineral Oil
CFC-12/Mineral Oil	→	HFC-134a/Polyol Ester
R-502/Mineral Oil	→	R-404A/Polyol Ester
(CFC-115/HCFC-22)		(HFC-125/143a/134a)
HCFC-22/Mineral Oil	→	R-407C/Polyol Ester
		(HFC-32/125/134a)

Work in Progress

- **Re-evaluation of Sheet Insulation with R-12/R-134a and R-22/R-407C After Extensive Drying.**
- **Compatibility of Motor Materials with R-245ca After Retrofit from R-11 and R-123.**

Magnet Wire Results

- **Dielectric Strength: Increased About 15%.**
- **Burnout Time for R-11/245ca and R-123/R-245ca.**
 - Decreased <14% for Unvarnished Wire
 - Decreased <1.1% for Varnished Wire
 - Similar Decrease for Original Refrigerant Oil as R-245ca/Polyol Ester

R-11/245ca, a/al glass Wire, Varnished

<u>Exposure</u>	<u>Burnout</u>	<u>Dielectric</u>
Unexposed Value	751 sec	13.25 kV
<u>Percent Change from Unexposed</u>		
R-11 500 Hours	-1.8%	+12.9%
R-245ca 168 Hours	-0.9%	+14.0%
R-245ca 336 Hours	-0.2%	+10.5%
R-245ca 500 Hours	-1.0%	+12.6%
R-11 1000 Hours	-2.2%	+7.4%

Sheet Insulation

- Blistering of Aramid-PET-Aramid After Refrigerant Exposure and 127°C Air Bake.
- Other Five Sheet Insulation Materials Unaffected.

Condition of Sheet Insulation

R-11/Mineral Oil and R-245ca/Polyol Ester Exposures

<u>Exposure, 100°C</u>	<u>PET 1</u>	<u>PET 2</u>	<u>DMD</u>	<u>Aramid N-Mica</u>	<u>NMN</u>
R-11 500 Hours	ok	ok	ok	ok	ok
R-245ca 168 Hr.	ok	ok	ok	ok	ok
R-245ca 336 Hr.	ok	ok	ok	ok	ok
R-245ca 500 Hr.	ok	ok	ok	ok	ok
R-11 1000 Hr.	ok	ok	ok	ok	ok

Condition of Sheet Insulation

R-123/Mineral Oil and R-245ca/Polyol Ester Exposures

<u>Exposure, 100°C</u>	<u>PET 1</u>	<u>PET 2</u>	<u>DMD</u>	<u>Aramid N-Mica</u>	<u>NMN</u>
R-123 500 Hours	ok	ok	ok	ok	ok
R-245ca 168 Hr.	ok	ok	ok	ok	ok
R-245ca 336 Hr.	ok	ok	ok	ok	ok
R-245ca 500 Hr.	ok	ok	ok	ok	ok
R-123 1000 Hr.	ok	ok	ok	ok	ok

PET Sheet Insulation in R-123/R-245ca

<u>Exposure, 100°C</u>	<u>% Elongation</u>	<u>Dielectric</u>
Unexposed Value	134.8%	>14.1 kV
R-123 500 Hours	118%	>13.7
R-245ca 168 Hours	122%	>14.0
R-245ca 336 Hours	134%	>14.0
R-245ca 500 Hours	134%	>14.5
R-123 1000 Hours	118%	>14.5

Elastomer Volume Change in R-123/R-245ca

<u>Exposure, 100°C</u>	<u>Nitrile</u>	<u>Neoprene</u>
R-123 500 Hours	76.7%	34.1%
R-245ca 168 Hours	22.4%	-5.2%
R-245ca 336 Hours	20.4%	-5.3%
R-245ca 500 Hours	20.8%	-4.5%
R-123 1000 Hours	78.6%	32.9%

Tensile and Percent Elongation Are Satisfactory.

Elastomer Volume Change in R-11/R-245ca

<u>Exposure, 100°C</u>	<u>Nitrile</u>	<u>Neoprene</u>
R-11 500 Hours	14.2%	28.7%
R-245ca 168 Hours	17.4%	-1.5%
R-245ca 336 Hours	17.0%	-2.6%
R-245ca 500 Hours	16.5%	-1.8%
R-11 1000 Hours	13.4%	29.0%

Tensile and Percent Elongation Are Satisfactory.

Conclusion

- Most Materials Appear Compatible with R-245ca Under Retrofit Conditions.
- Concerns:
 - Blister of Aramid-PET-Aramid Sheet Insulation with R-11, R-123 and R-245ca.
 - Shrinkage of Neoprene Elastomers in R-245ca.
- Flammability, Toxicity, Efficiency and Cost of R-245ca and/or Blends Are Unresolved.