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COMPATIBILITY OF REFRIGERANTS AND LUBRICANTS WITH MOTOR MATERIALS UNDER RETROFIT CONDITIONS

Final Report
Volume I

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FORMAT FOR THE FINAL REPORT

Because of the large scope of this project and the large amount of data recorded, the final report is divided into four volumes.

Volume I (148 pages) contains the abstract, introduction, significant results, conclusions, material identification, experimental procedures and summary data tables. This volume provides the results of the study and other information of interest to most readers. The other volumes are necessary only if the reader is interested in the individual data measurements rather than summaries or averages of the data sets.

Volume II (250 pages) contains the measurements from tests on the three high pressure refrigerant-lubricant combinations and their alternatives.

Original Refrigerant	Alternative Refrigerant	Exposure Temperature
R-12/Mineral Oil	R-134a/Polyol Ester	127°C (260°F)
R-22/Mineral Oil	R-407C/Polyol Ester	127°C (260°F)
R-502/Mineral Oil	R-404A/Polyol Ester	127°C (260°F)

Volume III (155 pages) contains the measurements from tests on the three low pressure refrigerant-lubricant combinations and their alternatives.

Original Refrigerant	Alternative Refrigerant	Exposure Temperature
R-11/Mineral Oil	R-123/Mineral Oil	100°C (212°F)
R-11/Mineral Oil	R-245ca/Polyol Ester	100°C (212°F)
R-123/Mineral Oil	R-245ca/Polyol Ester	100°C (212°F)

Volume IV (44 pages) contains the photographs of the motor materials after exposure to the six refrigerant-lubricant combinations and their alternatives.

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COMPATIBILITY OF REFRIGERANTS AND LUBRICANTS WITH MOTOR MATERIALS UNDER RETROFIT CONDITIONS

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ABSTRACT

Compatibility tests were conducted on motor materials to determine if exposure to the original refrigerant/mineral oil would affect compatibility of the motor materials after retrofit to the alternative refrigerant/lubricant. The motor materials were exposed at elevated temperature to the original refrigerant and mineral oil for 500 hours, followed by exposure to the alternative refrigerant and lubricant for 500 hours. Measurements were also taken after 168 and 336 hours. As a control, some samples were exposed to the original refrigerant/mineral oil for a total of 1000 hours. The original refrigerants and the alternatives tested for retrofit were as follows:

Original Refrigerant	Alternative Refrigerant	Exposure Temperature
R-12/Mineral Oil	R-134a/Polyol Ester	127°C (260°F)
R-22/Mineral Oil	R-407C/Polyol Ester	127°C (260°F)
R-502/Mineral Oil	R-404A/Polyol Ester	127°C (260°F)
R-11/Mineral Oil	R-123/Mineral Oil	100°C (212°F)
R-11/Mineral Oil	R-245ca/Polyol Ester	100°C (212°F)
R-123/Mineral Oil	R-245ca/Polyol Ester	100°C (212°F)

Most motor materials exposed to the alternative refrigerant and lubricant (after an initial exposure to the original refrigerant and mineral oil) were compatible with the alternative refrigerant and lubricant. The only concern was delamination and blistering of the sheet insulation containing Nomex, especially after removal of absorbed refrigerant. This was attributed to solution of the adhesive and not to the Nomex itself. Embrittlement of the polyethylene terephthalate (PET) found in Mylar and Melinex sheet and sleeving insulations was initially observed, but subsequent tests under dry conditions showed that embrittlement of the PET materials was caused by moisture present during the exposure.

Compatibility tests of elastomers with R-245ca, retrofitted from R-11 and R-123, showed that the nitrile was compatible with both R-11 and R-245ca, but not with R-123. The neoprene was unsatisfactory because of shrinkage in the R-245ca.

INTRODUCTION

A major concern in retrofitting air-conditioning and refrigeration equipment is the compatibility of the hermetic motors that have been operated with a CFC or HCFC refrigerant and mineral oil for years and after conversion will be operated with the alternative refrigerant and lubricant. That prior exposure may affect the compatibility with the retrofit refrigerant and lubricant. Compatibility tests on these old motor materials could be performed by two methods. The first method would require samples obtained from a motor that had operated in the original refrigerant for years, and perform compatibility tests on those materials. This method would be subject to a number of variables, including materials identification, exposure conditions over the years, unknown contamination and damage to materials on removal from an electric motor. The method actually used started with new motor materials which were then exposed to the original refrigerant/mineral oil, followed by exposure to alternative refrigerant/lubricant at elevated temperatures to simulate years of exposure to both refrigerants.

Underwriters Laboratories (UL) issued UL Standards 2171[1] covering compatibility of motor materials retrofitted to alternative refrigerants. That standard requires tests after sequential exposures to the original refrigerant/lubricant followed by the alternative refrigerant/lubricant to verify the compatibility of the motors. The work reported here was conducted in accordance with the requirements of UL Standard 2171. The tests were conducted on individual samples of motor materials and on motorettes as requested by UL. Previous UL test procedures used motorettes and UL desired that results on motorettes be compared with the results of tests on the individual motor materials.

To our knowledge compatibility tests of motor materials after sequential exposures to refrigerants and lubricants have not been previously conducted. The tests completed will determine if the sequential exposures are significant and will either support the need for the UL tests or will provide a basis for changing the UL requirement.

This work is an addition to the project recently completed in 1993 to determine the compatibility of currently used motor materials with alternative refrigerants and lubricants.[2] Because of interest in R-245ca as a possible retrofit replacement for R-11 and R-123 and the proposed ARTI/MCLR test of R-245ca in a R-11 chiller, R-245ca was included in the compatibility study.

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(1) UL Standards 2171, **Field Conversion/ Retrofit of Products to Change to an Alternative Refrigerant - Insulating Material and Refrigerant Compatibility,** Underwriters Laboratory, Sept.17,1993

(2) R.G. Doerr and S.A. Kujak, **Compatibility of Refrigerants and Lubricants with Motor Materials,** Final Report DOE/CE/23810-13, Air-Conditioning Refrigeration Technology Institute (ARTI) Database May 1993.

EXPERIMENTAL WORK

Motor Materials

The motor materials tested were the same motor materials tested in the prior MCLR program[2]. These materials have been used in hermetic motors since about 1973. A list of the materials tested is given below:

MAGNET WIRE INSULATION

- Polyester base with amide imide overcoat
- Esterimide base with amide imide overcoat
- Polyester base with amide imide overcoat[3] and epoxy saturated glass serving

VARNISHES

- Waterbase-epoxy-phenolic; Isopoxy 800
- Solvent-epoxy-phenolic; P.D. George 923
- Solvent-Epoxy; Sterling U-475EH[3]

SHEET INSULATION

- Polyethylene terephthalate (PET) film; Mylar
- Polyethylene terephthalate (PET) film, low oligomer; Melinex
- Polyethylene terephthalate (PET) composite; Dacron-Mylar-Dacron (DMD)
- Aramid fiber mat; Nomex 410
- Aramid fiber, mica mat; Nomex-Mica
- Aramid mat, Polyethylene terephthalate (PET) film composite; Nomex-Mylar-Nomex (NMN)

SPIRAL WRAPPED SLEEVING

- Polyethylene terephthalate (PET) film Mylar
- Aramid fiber mat, polyester film Nomex-Mylar

LEAD WIRE INSULATION

- Polyethylene terephthalate (PET) Composite; Dacron-Mylar-Dacron (DMD)
- Polyethylene terephthalate (PET), Fluoropolymer Composite; Dacron-Mylar-Teflon-Dacron (DMTD)

TIE CORD

- Polyester

ASSEMBLY TAPES

- Braided polyester, acrylic binder
- Polyester mats

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(3) The glass-served magnet wire with solvent-epoxy varnish, Sterling U-475, was tested only with exposures to R-11/mineral oil, R-123/mineral oil and R-245ca polyol ester, because this wire is used primarily in centrifugal applications.

Refrigerants And Lubricants

Equipment operating today with CFC's R-11, R-12 and R-502 (a HCFC-22/CFC-115 blend) and R-22 (an HCFC) are most likely to be retrofitted with alternative HCFC or HFC refrigerants. Polyolester lubricants for this study were randomly selected by a drawing at ARTI from a larger list of commercially available polyolesters.

Because of interest in R-245ca as a possible chlorine free replacement for R-11 or R-123, and a chiller test with R-245ca was planned on another ARTI MCLR project, the compatibility of motor materials with R-245ca after retrofit from R-11 or R-123 was also conducted. Solest 68 lubricant was used in the exposure tests with R-245ca in order to use the same lubricant planned for the chiller tests. The following refrigerants and lubricants were used in the study. Polyolester lubricants were dried to 50 ppm moisture or less before use. Mineral oils were dried to 30 ppm or less.

Original	Alternative
o CFC-11/mineral oil (Penreco Sontex 300 LT)	o HCFC-123/mineral oil (Penreco Sontex 300 LT)
o CFC-12/mineral oil (Suniso 3GS)	o HFC-134a (CPI Solest 68)
o R-502/mineral oil (Suniso 3GS)	o HFC-125/HFC-143a/HFC-134a R-404A (Castrol Icematic SW 32)
o HCFC-22/mineral oil (Suniso 3GS)	o HFC-32/HFC-125/HFC-134a R-407C (ICI Emkarate RL 32 H)
o CFC-11/mineral oil (Penrico Sontex 300 LT)	o HFC-245ca (CPI Solest 68)
o HCFC-123/mineral oil (Penrico Sontex 300 LT)	o HCFC-245ca (CPI Solest 68)

Compatibility Exposures

The compatibility exposures were based on the procedures previously used by Trane to determine the compatibility of current motor materials and were modified to comply with UL Standard 2171. The motor material samples were dried for 24 hours at 127°C (260°F) and placed in two-liter, stainless steel pressure vessels. The original lubricant (mineral oil) was added in sufficient

quantity to cover the materials, taking into consideration the thermal expansion of the lubricant and the solubility of the refrigerant. For the higher pressure refrigerants, (i.e. R-12, R-502, and R-22), refrigerant was added to provided a pressure of about 2109 kPa (300 psi) at 127°C (260°F). For the low pressure refrigerants (i.e. R-11, R-123 and R-245ca) the amount of refrigerant added was about 50% by weight. The ratio of refrigerant to lubricant ranged from approximately 20/80 for the high pressure refrigerants to 50/50 for R-11, R-123 and R-245ca depending on the solubility and pressure of the particular refrigerant/lubricant combination.

Samples were exposed to the original refrigerant and mineral oil for 500 hours at 127°C (260°F) for R-12, R-502 and R-22 or at 100°C(212°F) for R-11, R-123 and R-245ca; followed by exposure to the alternative refrigerant and lubricant for an additional 168, 336 and 500 hours at the same temperatures. Exposures were conducted at 100°C (212°F) to prevent thermal decomposition of the least stable refrigerant, R-11.

After exposure to the original refrigerant/mineral oil for 500 hours some of the samples were removed for evaluations according to the methods described in the next section. Results were used as a baseline for comparison with results on the samples after exposure to the retrofit refrigerant/lubricant. Other samples from the first exposure were divided into three pressure vessels and exposed to the retrofit refrigerant/lubricant at the elevated temperatures for an additional 168, 336 and 500 hours. In addition, exposures to the original refrigerant/mineral oil was continued on some samples for an additional 500 hours (1000 hours total).

Motorette samples were exposed at elevated temperatures to each combination of original refrigerant/mineral oil for 500 hours and to the alternative refrigerant/lubricant for an additional 168, 336 and 500 hours.

Evaluations

Motor Materials

Evaluations of the motor material samples and the motorettes were conducted prior to exposure and after the 500 and 1000 hour exposures to the original refrigerant/mineral oil, as well as after the 168, 336 and 500 hours of additional exposures to the alternative refrigerant/lubricant. In addition to evaluations immediately after exposure, the sheet insulation and varnished helical coils were evaluated after an additional 24 hour bake in air at 150°C (302°F) to determine the effect of refrigerant desorption.

The specific tests conducted on each motor material sample are described below and are summarized in Table 1. The numbers of samples tested are summarized in Table 2.

TABLE 1
SUMMARY OF SAMPLE EVALUATIONS

	Visual Inspection	Tensile Strength	% Elongation	Bond Strength	Dielectric Breakdown	Burnout Strength	Voltage Withstand
Magnet wire, Twisted Pairs	X				X	X	
Magnet wire, Twisted Pair-varnished	X				X	X	
Helical Coils	X			X			
Sheet Insulation	X	X	X		X		
Lead Wire	X				X		
Sleeving	X				X		
Tape or Tie Cord	X	X	X				
Motorettes	X						X

Varnish Bond Strength

Helical coils were prepared from magnet wire and were coated with an epoxy motor varnish and cured. The helical coils were exposed to refrigerant/lubricant and the bond strength was determined by measuring the force, applied at right angles to the coils, necessary to break the bond between the wire coils.

Magnet Wire

The primary tests for magnet wire insulation were the dielectric strength and burnout time. Both tests were run on twisted pairs - two sections of wire in close contact with one another by means of prescribed number of twists. The twisted pairs included both varnished or unvarnished magnet wire.

The dielectric strength was determined by ramping up the voltage potential between the two wires and recording the voltage at which the insulation failed and a spark traveled between the two wires. The burnout test used the same twisted pair type samples, but ramped up the current on the wires, causing internal heating. The recorded burnout time in seconds was the time and temperature at which the insulation failed and current leaked between the wires. The test measures the thermal resistance of the magnet wire insulation.

TABLE 2
NUMBER OF SAMPLES

Material	Sample Type	Unexposed Samples	Samples per Refrigerant	Total Samples for Unexposed + 6 refrigerants
Magnet Wire (3 Types	Twisted Pairs	30	100*	480
Magnet Wire Varnished	Twisted Pair	50	200*	800
Varnish (3 Types)	Helical Coils	50	200*	800
Sheet Insulation (6 Types)	Strips	18	180	1098
	Sheets	18	180	1098
Lead Wire Insulation	Strips	6	30	186
Sleeving (2 Types)	Strips	6	30	186
Tapes & Tie Cords (3 Types)	Strips	9	45	279
Motorettes		4	4*	20
Total Samples		191	969	4947

*For R-11, R-123 and R-245ca only 50 twisted pairs, 50 varnished twisted pairs, 50 helical coils and 2 motorettes were used per exposure; because only one varnish and one magnet wire were used.

Sheet Insulation
Sheet insulation was inspected for brittleness, blisters and delamination. Tensile strength, percent elongation and dielectric strength were also measured.

Lead Wire and Sleeve Insulation
Dielectric strength was measured on the lead wire and sleeving.

Tape or tie cord
Tensile strength and percent elongation were measured on the tape and tie cord.

Motorettes
Voltage withstand (600 volts for one minute applied between windings, windings & ground, and turn to turn) was measured on motorettes as specified in UL Standard 2171. The motorettes were also inspected for visual damage.

Lubricants

All lubricants were analyzed before and after exposures for changes in total acid number and other evidence of degradation.

SIGNIFICANT RESULTS

Visual observations

The magnet wire insulations, varnishes, lead wire insulators, tapes and tie cords were not adversely affected by either exposure to the old refrigerant and mineral oil or to the alternative refrigerant and lubricant. All motorettes maintained electrical integrity.

Sheet Insulations Exposed to R-22/R-407C, R-12/R-134a, and R-502/R-404A.
Degradation of certain sheet insulation materials and sleeving was observed after the 500 and 1000 hour exposures to R-22, R-12, and R-502. Results are summarized in Table 3. Polyethylene terephthalate (PET) found in the Mylar and Melinex sheet insulations and sleeving became brittle after the 1000 hour exposure to the original refrigerant/mineral oil. Blisters and delamination were noted in the Nomex-Mylar-Nomex (NMN) sheet insulations. After the 1000 hour exposures the Mylar layer in the NMN and Dacron-Mylar-Dacron (DMD) was very brittle. In some cases the PET from the sleeving exposed to R-22 was embrittled to the extent that samples could not be removed from the pressure vessel without breaking.

TABLE 3. VISUAL OBSERVATIONS OF SHEET INSULATION

R-22/Mineral Oil and R-407C/Polyol Ester

	Mylar	Melinex	DMD	Nomex	N-Mica	NMN
R-22 500 Hours	ok	ok	ok	ok	ok	Blister
R-407C 168 Hr.	ok	ok	ok	ok	ok	Blister & Delaminate
R-407C 336 Hr.	ok	ok	ok	ok	ok	Blister & Delaminate
R-407C 500 Hr.	ok	ok	ok	ok	ok	Blister & Delaminate
R-22 1000 Hr.	Brittle	Brittle	Brittle Mylar Layer	ok	ok	Severe Blister & Delaminate

R-12/Mineral Oil and R-134a/Polyol Ester

	Mylar	Melinex	DMD	Nomex	N-Mica	NMN
R-12 500 Hours	ok	ok	ok	ok	ok	Slight Blister
R-134a 168 Hr.	ok	ok	ok	ok	ok	Slight Blister
R-134a 336 Hr.	ok	ok	ok	ok	ok	Blister & Delaminate
R-134a 500 Hr.	ok	ok	ok	ok	ok	Blister & Delaminate
R-12 1000 Hr.	Brittle	Brittle	Delam-inate	ok	ok	Severe Blister & Delaminate

R-502/Mineral Oil and R-404A/Polyol Ester

	Mylar	Melinex	DMD	Nomex	N-Mica	NMN
R-502 500 Hours	ok	ok	ok	ok	ok	Slight Blister
R-404A 168 Hr.	ok	ok	ok	ok	ok	Blister & Delaminate
R-404A 336 Hr.	ok	ok	ok	ok	ok	Blister & Delaminate
R-404A 500 Hr.	ok	ok	ok	ok	ok	Blister & Delaminate
R-502 1000 Hr.	Brittle	Brittle	Delam-inate	ok	ok	Severe Blister & Delaminate

Embrittlement of the PET materials was observed after the 127°C (260°F) exposure to R-22/mineral oil and various refrigerants with alkyl benzene lubricants in the original study on the **Compatibility of Refrigerants and lubricants with Motor Materials.**[2] Embrittlement was also observed and recorded as a decrease in percent elongation as high as 96% after exposure to nitrogen gas at the same temperature, suggesting that temperature, as well as moisture, affects the flexibility of the PET materials. Blistering or pockets of delamination in the NMN were also observed in the original study after exposure to R-22/mineral oil and to other alternative refrigerants and lubricants.

A sample of Mylar MO that was embrittled after 1000 hours exposure to R-12/mineral oil was sent to Dr.Charles C. Walker of DuPont Circleville Research Laboratory for analysis. Based on his analysis showiing reduced intrinsic viscosity compared to new Mylar, he concluded that the embrittlement was caused by substantial chain cleavage through hydrolysis, rather than by thermal breakdown. A copy of his report is attached as Appendix E.

Exposure of the PET and Nomex sheet insulation to R-407C/ICI Emkarate RL32H, R-134a/Solest 68 and R-404A/Castrol Icematic SW32 (following the R-22, R-12, and R-502 exposures with mineral oil, respectively) suggested that degradation was less after exposure to the alternatives. Comparison of these sheet insulations and sleevings after 500 hour exposures in the alternative refrigerant/lubricant and after the 1000 total hour exposures in the old refrigerant/mineral oil again indicated that degradation after exposure to the alternative refrigerant/lubricant was less severe. Motorettes with Nomex sheet insulation retained electrical integrity and there was no indication of blisters or delamination in the motorette system. The insulation materials used in the motorette are protected with varnish.

Exposure of Sheet Insulation Under Dry Conditions

Exposures of the sheet insulation to R-12/R-134a and R-22/R-407C and lubricants were repeated under dry conditions. Extra care was taken to insure that all materials were dried. The mineral oil was dried to 9.7 ppm, and motor materials were dried overnight at 127°C (260°F) and for an additional four hours at 145-160°C (293-320°F). Extra care was taken to avoid moisture during the evaluations and in between exposures. Sheet insulations, which became embrittled after the first exposures, remained flexible after exposures under extra dry conditions. Therefore, embrittlement of the polyester sheet insulation can be attributed to moisture.

Blisters and pockets of delamination of the Nomex composite materials still occurred under the dry conditions. Complete delamination was not observed. The observations for R-22/R-407C are summarized in Table 4. Blisters

occurred in both the Nomex and Nomex-Mylar-Nomex materials, and were more prevalent in the R-407C than in the R-22.

Exposure to R-12/R-134a was not as severe. No blisters were produced on the Nomex and the Nomex-Mylar-Nomex exhibited only slight blisters after the 168, 336 and 500 hour exposures to R-134a, but not after the after the 500 and 1000 hour exposures to R-12 . Under dry conditions, blistering of the Nomex composite sheet material is more prevalent in the alternative refrigerant than after exposure to the original R-22 or R-12 and mineral oil.

The cause of the blistering is due to absorbed refrigerant in between the layers of Nomex attempting to escape as a vapor. The polyester adhesive absorbed refrigerant under pressure, and pressure was produced between the Nomex layers as the refrigerant vaporized. Use of an alternative adhesive may have prevented the blister formation.

TABLE 4. VISUAL OBSERVATIONS OF SHEET INSULATION AFTER DRY EXPOSURE TO R-22/R-407C

Dry R-22/Mineral Oil and R-407C/Polyol Ester

	Mylar	Melinex	DMD	Nomex	N-Mica	NMN
R-22 500 Hours	ok	ok	ok	ok	ok	ok
R-407C 168 Hr.	ok	ok	ok	ok	ok	Blister
R-407C 336 Hr.	ok	ok	ok	ok	ok	Blister
R-407C 500 Hr.	ok	ok	ok	ok	ok	Blister
R-22 1000 Hr.	ok	ok	ok	ok	ok	Slight Blister

Dry R-22/Mineral Oil and R-407C/Polyol Ester + 127° Bake

	Mylar	Melinex	DMD	Nomex	N-Mica	NMN
R-22 500 Hours	ok	ok	ok	ok	ok	Blister
R-407C 168 Hr.	ok	ok	ok	Blister	ok	Blister
R-407C 336 Hr.	ok	ok	ok	Blister	ok	Blister
R-407C 500 Hr.	ok	ok	ok	Blister	ok	Severe Blister
R-22 1000 Hr.	ok	ok	ok	ok	ok	Blister

R-11/R-123 Retrofit Exposures

Tests showed that all motor materials were in good condition after exposure to R-11/mineral oil for 500 hours followed by exposure to R-123/mineral oil for 168, 336, and 500 hours at 100°C (212°F). Materials evaluated at the end of the 500 hour R-123/mineral oil were compared to the same materials exposed to R-11/mineral oil for an additional 500 hours (1000 hours total). The

Dacron-Mylar-Dacron (DMD) and Permacel tape darkened slightly in the R-123 but were even darker after exposure to R-11/mineral oil. The Mylar sheet insulation and sleeving were still flexible and the Nomex materials showed no signs of blistering or delamination. The NMN sheet insulation was satisfactory after the exposure to refrigerant and lubricant but blistered after the 127°C (260°F) air bake. Motorettes maintained electrical integrity. However, separation of the Sterling U475 varnish from the metal surfaces of the motorettes was observed after exposure to R-123/mineral oil for 336 and 500 hours. Varnish remained intact on all electrical insulation materials. Additional tests of the same varnish on motorettes exposed to R-11/R-245ca and R-123/R-245ca showed that the varnish remained intact on motorette metal surfaces. The separation of the Sterling U475 varnish from metal surfaces may have been influenced by the condition of the metal surface or surface contamination before application of the varnish.

R-11/R-245ca and R-123/R-245ca Retrofit Tests

All motor materials exposured to R-11/R-245ca and R-123/R-245ca remained in good condition. The Nomex-Mylar-Nomex (NMN) sheet insulation did not have any blisters after the retrofit exposure. Blisters were produced in the NMN after the subsequent 24 hour exposure to air at 127°C (260°F). The motorettes exposed to R-11 for 500 hours showed corrosion on the bolts, but not on other metal surfaces.

TABLE 5. VISUAL OBSERVATIONS OF SHEET INSULATION EXPOSED TO R-245ca

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

	Mylar	Melinex	DMD	Nomex	N-Mica	NMN
R-11 500 Hours	ok	ok	ok	ok	ok	ok
R-245ca 168 Hr.	ok	ok	ok	ok	ok	ok
R-245ca 336 Hr.	ok	ok	ok	ok	ok	ok
R-245ca 500 Hr.	ok	ok	ok	ok	ok	ok
R-11 1000 Hr.	ok	ok	ok	ok	ok	ok

R-11/Mineral Oil and R-245ca/Polyol Ester + 127° Bake

	Mylar	Melinex	DMD	Nomex	N-Mica	NMN
R-11 500 Hours	ok	ok	ok	ok	ok	Blister
R-245ca 168 Hr.	ok	ok	ok	ok	ok	Blister
R-245ca 336 Hr.	ok	ok	ok	ok	ok	Blister
R-245ca 500 Hr.	ok	ok	ok	ok	ok	Blister
R-11 1000 Hr.	ok	ok	ok	ok	ok	Blister

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

	Mylar	Melinex	DMD	Nomex	N-Mica	NMN
R-123 500 Hr.	ok	ok	ok	ok	ok	ok
R-245ca 168 Hr.	ok	ok	ok	ok	ok	ok
R-245ca 336 Hr.	ok	ok	ok	ok	ok	ok
R-245ca 500 Hr.	ok	ok	ok	ok	ok	ok
R-123 1000 Hr.	ok	ok	ok	ok	ok	ok

R-123/Mineral Oil and R-245ca/Polyol Ester + 127° Bake

	Mylar	Melinex	DMD	Nomex	N-Mica	NMN
R-123 500 Hr.	ok	ok	ok	ok	ok	Blister
R-245ca 168 Hr.	ok	ok	ok	ok	ok	Blister
R-245ca 336 Hr.	ok	ok	ok	ok	ok	Blister
R-245ca 500 Hr.	ok	ok	ok	ok	ok	Blister
R-123 1000 Hr.	ok	ok	ok	ok	ok	Blister

Electrical And Mechanical Property Measurements.

Varnish

Helical coil bond strengths on coils made from both types of magnet wires and coated with Isopoxy 800 varnish were not reduced after the three high pressure refrigerant/lubricant exposures under retrofit conditions. The bond strengths of coils coated with P.D. George 923 varnish were reduced about 20% for magnet wire B (ester imide with amide imide overcoat) and 50% for magnet wire A (polyester with amide imide overcoat) after exposure to all three high pressure refrigerants/lubricants retrofit combinations. Bond strength decrease was similar in the original refrigerant/mineral oil as in the alternative refrigerant/lubricant, suggesting that compatibility problems are not anticipated.

The bond strength of Sterling U475 varnish on magnet wire C (glass served) was not appreciably decreased by exposure to R-11 or R-123/mineral oil. Exposures for 168, 336 and 500 hours produced no significant trend, above experimental scatter, in any of the four refrigerant/lubricant retrofit exposures. Exposure to R-245ca/polyol ester after either R-11 or R-123/mineral oil caused an increase in the varnish bond strength suggesting that compatibility with the varnish should not be a concern.

Weight changes in the varnish varied from -9.6% for R-502 and Isopoxy 800 to +14.4% for R-123 with Sterling U475 varnish. Volume changes varied from -12.4% for R-502 and -12.5% for R-404A with Isopoxy 800 to +8.2% for R-123 and Sterling U475 Varnish. The Isopoxy 800 usually loses weight due to

extraction and Sterling U475 varnish absorbs R-123. Absorption of refrigerant is usually less in refrigerant/lubricant mixtures than in pure refrigerant.

Magnet Wire

After the R-12/R-134a exposure, dielectric strength increased for the unvarnished magnet wires and for magnet wire A. (polyester with amide imide overcoat) The dielectric strength of magnet wire B (ester imide with amide imide overcoat) decreased slightly for both Isopoxy 800 and P.D. George 923 varnishes. The burnout time decreased for both unvarnished and varnished magnet wires with values as high as -66% in R-12. Burnout time decrease was always greater for the R-12/mineral oil than for the R-134a/polyol ester. There were no trends observed over experimental deviation for the 168, 333 and 500 hour exposures.

For R-502/R-404A exposures, the dielectric strength usually increased except for a slight decrease for magnet wire B with the P.D. George 923 varnish. Burnout times decreased for all exposures ranging from -5.4% to -44.3%. Burnouts usually decreased about -25% and the decrease was greater for the R-502/mineral oil than the R-404A/polyol ester lubricant. No trends were indicated as a function of the length of exposure.

For R-22/R407C dielectric strength increased after exposure except for a slight decrease for magnet wire B with the P.D. George 923 varnish. Burnout times decreased about -25% and the burnout time decreases were usually greater in the R-22 mineral oil than the R-407C. No trends over time were observed.

Exposure to R-11/R-123 decreased the burnout time of magnet wire C (glass served) only slightly and actually increased the dielectric strength. For the R-11/R-245ca and the R-123/R-245ca retrofit exposures, the dielectric strength of the magnet wire increased about 10-15% and the burnout time decreased only about 1%.

Lead Wire

The dielectric strength of the Dacron-Mylar-Teflon-Dacron (DMTD) lead wire insulation increased after exposure under retrofit conditions while that of the DMD lead insulation was decreased, but to a lesser extent than observed after the 1000 hour exposure to the original refrigerant/mineral oil.

Sleeving

The sleeving material retained dielectric strength, but the PET insulation became brittle especially after the R-12 and R-22 mineral oil exposures. The brittleness was probably due to hydrolysis caused by small amounts of water present during the exposures. A crack in the brittle insulation could allow the spark to pass through during the dielectric test, but this was not observed. The Nomex-Mylar sheet insulation retained dielectric strength in all cases and embrittlement of the Mylar layer left the Nomex intact.

Sheet Insulation

The sheet insulation materials were most affected by exposures to the refrigerant/lubricants under retrofit conditions. Embrittlement of the PET material and delamination of the DMD or NMN had an effect on the tensile strength and percent elongation. The dielectric strengths were not affected. In most of the dielectric tests, the spark traveled around the 2 x 3 inch samples rather than through the material. Dielectric strengths were recorded as greater than the recorded voltage (>_kV), rather than percent change.

Exposure of the sheet insulations to R-502/R-404A resulted in embrittlement of the PET materials and delamination of the NMN composite. Embrittlement was most pronounced after the 1000 hour exposure to R-502/mineral oil. After the 500 hour exposure to R-404A/polyol ester lubricant, the sheet insulation was still flexible but showed a decrease in the percent elongation suggesting that it had become more brittle. Tensile strength of the PET decreased by about 20% after the R-404A exposure . Dielectric strengths of all sheet insulations were not decreased and in most cases actually increased. In some cases there appeared to be a trend of decreasing percent elongation with exposure time, but experimental deviation predominated in at least half of the data sets.

Exposure of sheet insulation to R-22/R-407C resulted in embrittlement of the PET materials and delamination of the NMN. This had an effect on the tensile strength and percent elongation. Exposure to R-22/mineral oil for 1000 hours caused embrittlement of the PET to the extent that tensile strength and percent elongation of the PET material could not be determined. Results at the other conditions showed decreased tensile strengths and percent elongations with increased time of exposure. For example the tensile strength of Mylar film decreased -28.2%, -31.3% and -32.5% from 168, 336 and 500 hours exposure to R-407C, and percent elongation decreased -38.2%, -71.9% and -84.3%, respectively. The DMD which is the fiber-film-fiber form of PET showed similar behavior. With other sheet insulation materials the effect of time on tensile strength and elongation was inconclusive. Dielectric strength was unaffected.

Exposure of sheet insulation to R-12/R-134a showed similar results to that of R-22/R-407C. The Mylar and Melinex tensile strength and percent elongation decreased with time of exposure and was most severe after 1000 hours in R-12/mineral oil. The dielectric strength usually increased after exposure to refrigerant lubricant.

The exposure of sheet insulation to R-22/R-407C and R-12/R-134a was repeated to determine if extra care in drying would prevent embrittlement of the PET materials and blistering of the NMN. Care was taken to dry materials both before and in between the exposures. Results showed that embrittlement of the PET materials was prevented, but blistering of the NMN still occurred. Tensile strength of the Mylar was decreased about 30% after all R-22/R-407C exposures while percent elongation was decreased about 95% for all R-22/R-

407C exposures There was very little change in results with increacing exposure times. Dielectric strength was maintained for all types of sheet insulation tested. Results with R-12/R-134a were about the same as with R-22/R-407C

In the R-11 to R-123 retrofit scenario, the lubricant remained the same, namely mineral oil. A small amount of moisture in mineral oil had a greater effect on hydrolysis of PET materials than larger amounts of moisture in polyol ester lubricant due to solvolysis of the water by the ester lubricant. The PET sheet insulation appeared satisfactory after the 1000 hour exposure to R-11 or R-11/R-123 but the percent elongation was severely reduced, especially after the 24 hour bake. Tensile strength was reduced by only 25% for the same materials. There was no evidence of delamination and dielectric strength was retained. There was a trend toward increased embrittlement, and decreased tensile strength as the exposure to R-123 increased from 168 to 326 to 500 hours.

Exposure to R-245ca polyol ester after exposure to either R-11 or R-123 mineral oil resulted in blisters in the NMN after the 127°C bake, but little embrittlement of the PET sheet insulation. Percent elongation actually increased slightly from the 118% in R-123 to 134% (same as the unexposed value) in R-245ca. The dielectric remained the same.

Tapes and Tie Cords

The heat shrinkable braided polyester tape showed about -20% decrease in tensile strength and +3 to -57% decrease in elongation after exposure to the alternative refrigerant/polyol ester. There was a greater decrease after exposure to the old refrigerant mineral oil for 1000 hours: -39.4% for R-22, -78.7% for R-12 and -82.7% for R-502. The braided polyester tape with acrylic binder and polyester tie cords showed less decrease in tensile strength and percent elongation than the heat shrinkable braided polyester tape after exposure. In most cases, the percent elongation actually increased after the exposures.

Motorettes

All motorettes passed the voltage withstand test (600 volts for one minute applied between windings, windings & ground, and turn to turn) after exposure to all combinations of the original refrigerant/mineral oil followed by the alternative refrigerant/lubricant.

Elastomers

The R-245ca retrofit exposure included elastomers. This was done in anticipation of an ARTI/MCLR performance test of R-245ca in a R-11 chiller. Elastomers included a nitrile and a neoprene. Evaluations consisted of change in weight, volume, durometer, tensile and elongation. Results are summarized in Appendix H. The nitrile is compatible with both R-11 and R-245ca but not R-

123. The neoprene formulation resulted in about 5% shrinkage in R-245ca and is not recommended.

Lubricant Analysis

Total acid numbers of the POE lubricants increased with increasing time of exposure. Acid numbers were highest for R-404A/Castrol Icematic SW 32, lowest for R-134a/CPI Solest 68 and intermediate for R-407C/ICI Emkarate RL 32 H. Data is tabulated in Appendix C.

CONCLUSION

Most of the motor materials, appeared to be compatible with the alternative refrigerants and lubricants after retrofit from the original refrigerant and mineral oil, The major concern was delamination and blistering of the Nomex-Mylar-Nomex composite sheet insulation . The embrittlement observed in the polyethylene terephthalate (PET) insulation materials found in the Mylar, Melinex and Dacron-Mylar-Dacron was thought to be due to hydrolysis from moisture present in the insulation and in the lubricant during the compatibility exposures. Tests were repeated with very dry PET insulation and lubricants. Embrittlement was not observed.

Elastomers were tested with R-245ca plyol ester after exposure to either R-11 or R-123 and mineral oil. The nitrile was compatible with R-11 and R-245ca, but not R-123. The neoprene was not recommended for use with R-245ca because of shrinkage.

Electrical insulation materials were either unaffected or affected by the old refrigerant/mineral oil to a to a similar or greater extent than by the alternative refrigerant and lubricant. These motor materials have an excellent history of reliability in R-22, R-12, R-502, R-11 AND R-123, and should offer equal or superior reliability with the alternative refrigerants and lubricants. The compatibility of each motor material with the six retrofit refrigerant-lubricant combinations is summarized in Table 6:

Table 6

MOTOR MATERIALS COMPATIBILITY CHART

MOTOR MATERIAL	Refrigerant-Lubricant Exposure		
	R-12 to R-134a	R-22 to R-407C	R-502 to R-404A
Magnet Wires			
-Modified polyester overcoated with polyamide imide	Compatibile	Compatibile	Compatibile
-Modified polyester overcoated with polyamide imide and epoxy saturated glass	Compatibile	Compatibile	Compatibile
-Polyester imide overcoated with polyamide imide	Compatibile	Compatibile	Compatibile
Varnishes			
U-475 EH	Compatibile	Compatibile	Compatibile
No. 923	Compatibile	Compatibile	Compatibile
Isopoxy 800	Compatibile	Compatibile	Compatibile
Sheet Insulations			
Nomex/Mylar/Nomex	Concern*	Concern*	Concern*
Dacron/Mylar/Dacron	Compatibile	Compatibile	Compatibile
Mylar	Compatibile	Compatibile	Compatibile
Nomex	Compatibile	Compatibile	Compatibile
Nomex Mica	Compatibile	Compatibile	Compatibile
Melinex	Compatibile	Compatibile	Compatibile
Sleeving Insulations			
Nomex	Compatibile	Compatibile	Compatibile
Mylar	Compatibile	Compatibile	Compatibile
Nomex/Mylar	Compatibile	Compatibile	Compatibile
Tapes			
Heat Cleaned Glass	Compatibile	Compatibile	Compatibile
Heat Shrinkable Polyester	Compatibile	Compatibile	Compatibile
Lead Wire Insulation			
Dacron/Mylar/Dacron	Compatibile	Compatibile	Compatibile
Dacron/Mylar/Teflon/Dacron	Compatibile	Compatibile	Compatibile
Tie Cord			
Polyester	Compatibile	Compatibile	Compatibile

*·A concern about the compatibility of the Nomex-Mylar-Nomex sheet insulation was raised when pockets of delamination appeared between the Nomex and the Mylar sheet insulations. These pockets appeared after the 127°C (260°F) exposure plus a 24 hour air bake at 260°F(127°C).

MOTOR MATERIALS COMPATIBILITY CHART

MOTOR MATERIAL	Refrigerant-Lubricant Exposure		
	R-11 to R-123	R-11 to R-245ca	R-123 to R-245ca
Magnet Wires			
-Modified polyester overcoated with polyamide imide	Compatibile	Compatibile	Compatibile
-Modified polyester overcoated with polyamide imide and epoxy saturated glass	Compatibile	Compatibile	Compatibile
-Polyester imide overcoated with polyamide imide	Compatibile	Compatibile	Compatibile
Varnishes			
U-475 EH	Compatibile	Compatibile	Compatibile
No. 923	Compatibile	Compatibile	Compatibile
Isopoxy 800	Compatibile	Compatibile	Compatibile
Sheet Insulations			
Nomex/Mylar/Nomex	**Concern***	**Concern***	**Concern***
Dacron/Mylar/Dacron	Compatibile	Compatibile	Compatibile
Mylar	Compatibile	Compatibile	Compatibile
Nomex	Compatibile	Compatibile	Compatibile
Nomex Mica	Compatibile	Compatibile	Compatibile
Melinex	Compatibile	Compatibile	Compatibile
Sleeving Insulations			
Nomex	Compatibile	Compatibile	Compatibile
Mylar	Compatibile	Compatibile	Compatibile
Nomex/Mylar	Compatibile	Compatibile	Compatibile
Tapes			
Heat Cleaned Glass	Compatibile	Compatibile	Compatibile
Heat Shrinkable Polyester	Compatibile	Compatibile	Compatibile
Lead Wire Insulation			
Dacron/Mylar/Dacron	Compatibile	Compatibile	Compatibile
Dacron/Mylar/Teflon/Dacron	Compatibile	Compatibile	Compatibile
Tie Cord			
Polyester	Compatibile	Compatibile	Compatibile

*A concern about the compatibility of the Nomex/Mylar/Nomex sheet insulation was raised when pockets of delamination appeared between the Nomex and the Mylar sheet insulations. These pockets appeared after the 100°C exposure plus a 24 hour air bake at 260°F(127°C).

COMPLIANCE WITH AGREEMENT

All work performed during this project was in full compliance with the requirements of the original contract or as amended during the course of this project.

PRINCIPAL INVESTIGATOR EFFORT

Robert Doerr devoted 842 hours (about 28% of his available work hours) on this program since the beginning of the project. Todd Waite and other technicians devoted 1894 hours (about 65% of Todd's available work hours) on this program since the beginning of the project.

Appendix A

Materials Identification

MATERIAL IDENTIFICATION

Magnet Wires

-Phelps Dodge, Armored Poly-Thermaleze 2000

Basecoat (BC):	THEIC Polyester
Topcoat (TC):	PD-amideimide
Glasscoat (GC):	none
Coat Construction:	5 coats-BC/2 coats-TC
Wire Size	18 gauge

-Phelps Dodge, Armored Poly-Thermaleze Daglass 2000

Basecoat (BC):	THEIC Polyester
Topcoat (TP):	PD-amideimide
Glasscoat (GC):	Dacron/glass/epoxy
Coat Construction:	5 coats-BC/2 coats-TC/2 coats-GC
Wire Size	18 gauge

-Phelps Dodge/Schenectady Chemical; Polyester imide overcoated with polyamide imide

Basecoat:	THEIC Esterimide
Topcoat:	PD-Amideimide
Glasscoat:	none
Coat Construction:	5 coats-BC/2 coats-TC
Wire Size:	18 gauge

Varnishes

-Sterling U-475EH, Solvent-Based Epoxy
-P.D. George No. 923, Solvent-Based Phenolic Epoxy
-Schenectady Chemical Co., Isopoxy 800, Water Borne Epoxy

Sheet Insulations

-Westinghouse, Nomex/Mylar/Nomex

Description:	Nomex 410/Mylar Film/Nomex 410 Sheet insulation
Composite Thickness:	0.020 inches
Thickness Breakdown:	0.005 inches Nomex/0.010 inches Mylar/0.005 inches Nomex
Polyester Adhesive	

-Westinghouse, Pyrolam 100 Dacron/Mylar/Dacron

Description:	Dacron/Mylar Film/Dacron Sheet insulation
Composite Thickness:	0.020 inches
Thickness Breakdown:	0.005 inches Nomex/0.010 inches Mylar/0.005 inches Nomex
Polyester Adhesive	

-DuPont, Mylar MO

Description:	Mylar 900 MO Sheet Insulation
Nominal Thickness:	0.009 inches

-DuPont, Nomex/Mica 418

Description:	Nomex/Mica 418 Sheet Insulation
Nominal Thickness:	0.008 inches

-ICI, Melinex 228

Description:	Melinex 228 Sheet Insulation
Nominal Thickness:	0.009 inches

Spiral Wrapped Sheet Insulations

-A.O. Smith, Mylar

Description:	Spirally wound Mylar electrical insulation sleeving
Sleeving Composites:	Mylar
Sleeving Thickness:	0.006 inches

-A.O. Smith, Nomex/Mylar

Description:	Spirally wound Mylar and Nomex electrical insulation sleeving
Sleeving Composites:	Mylar outside/Nomex inside
Sleeving Thickness:	0.005 inches

Lead Wires

-A.O. Smith, Dacron/Mylar/Dacron

Description:	A brand of Dacron thread over the bare copper wire, then a wrap of Mylar tape half lapped, then a final braid of Dacron thread.
Sleeving Composites:	Dacron outside/Mylar 1 mil middle/Dacron over wire

-A.O. Smith, Dacron/Mylar/Teflon/Dacron

Description:	A brand of Dacron thread over the bare copper wire, a wrap of Teflon tape half lapped, then a layer of Mylar half lapped, then a final braid of Dacron thread.
Sleeving Composites:	Dacron outside/Mylar 1 mil middle/Teflon tape/Dacron over wire

Tapes

-Electrolock Inc., Heat Shrinkable Braided Polyester

Description:	Heat Shrinkable Polyester Woven Tape
Width:	0.75 inches
Thickness:	0.005 inches

-Essex Insulation, Permacel P247 glass/acrylic

Description:	Permacel P-247 Electrical Insulating Tape
Composites:	Polyester file reinforced with glass filaments

Tie Cord

-Ludlow Textiles, Polyester Tie Cord

Description:	A 4-ply soft, polyester tie cord on 1000 Denier polyester fiber twisted and cabled at 8.0 "Z" x 5.0 "S".

Motorettes

-Wire Type A, Polyester with Amide Imide Overcoat
P.D. George 923 Solvent Based Phenolic Epoxy Varnish
Mild Steel Frame
Nomex Slot Liner
Polyester Tie Cord
Nomex Sleeving

-Wire Type B, Ester Imide with Amide Imide Overcost
P.D. George 923 Solvent Based Phenolic Epoxy Varnish
Mild Steel Frame
Nomex Slot Liner
Polyester Tie Cord
Nomex Sleeving

-Wire Type C, Polyester with Amide Imide Overcoat and Dacron-Glass Serving
Sterling 475 Solvent Based Epoxy Varnish
Mild Steel Frame
Dacron-Mylar-Dacron Slot Liner
Polyester Tie Cord
Nomex Sleeving

Elastomers

-Neoprene, Wynn's Precision Formula 2347
Temperature Range -50°F to +275°F.

-Nitrile, Wynn's Precision Formula 8307
Temperature Range -40°F to +250°F.

Title	Table I Samples for Freon Testing at Trane		
Product	18 H APTz	18 H APTz	18 H APTz S Dg
Run Number	APTz# 5418	APTz#5421	P - 2574
Sample Number	X - 7975	X - 7987	X - 7974
Basecoat	THEIC Polyester	THEIC Esterimide	THEIC Polyester
Basecoat Supplier	Phelps Dodge	Schenectady Chem.	Phelps Dodge
Topcoat	PD - amideimide	PD - amideimide	PD - amideimide
Glasscoat	none	none	Dacron/glass/epoxy
Coat Construction	5 coats-BC/2 coats-TC	5 coats-BC/2 coats-TC	5-BC/2-TC/1-GC
DIMENSIONS			
Overall Diameter	.0433 - .0436	.0432 - .0434	.0480 - .0485
Bare Diameter	.0403 - .0404	.0402 - .0403	.0400 - .0401
Insulation Build	.0030 - .0032	.0030 - .0031	.0080 - .0084
FLEXIBILITY			
Elongation	36%	40%	35%
Mandrel Flex	BP 1xOK	32% 1xOK	BP no craks
Snap	OK	OK	3x no cracks
Snap flex	1xOK	3xOK	
Springback 1 7/8" 4 Oz	52 °	54°	
Unidirectional Scrape Load = 1000 gms	1650 gms	1536 gms	
THERMAL PROPERTIES			
Heat Shock			
1/2 hr @220 C 20% 3x	Pass	Pass	Pass
NEMA Cutthru C	386 °C	385 °C	
ELECTRICAL PROPERTIES			
Dielectric Breakdown	15,800 v	14,053 v	10,817 v
Df 240 C 400Hz	0.17	0.04	
HVC 3000 v DC	0 faults/100 ft	0 faults/100 ft	
MICROSCOPIC ANALYSIS			
Percent Topcoat	23%	26%	
Percent Basecoat	77%	74%	
Overall Concentricity	1.5:1	1.2:1	

djb 12/9/92

Appendix B

Experimental Procedure

EXPERIMENTAL PROCEDURES

Evaluation of Motor Materials

Exposed and unexposed motor materials were evaluated by the following methods:

Magnet Wires

The three types of magnet wire were tested, both alone and in combination with three varnishes. Tests conducted on the magnet wire measured burnout strength and dielectric strength.

Appearance
The magnet wire samples after an exposure were checked against unexposed samples of the same type to see if there was a visible change.

Twisted Pair Fabrication

Film Coated Magnet Wire

Film coated magnet wires were fabricated into twisted pairs using:

Motorized Dielectric Twist Specimen Fabricator(MW-3)
From: A/Z-Tech Inc.
A Division of Indiana Institute of Technology
Fort Wayne, Indiana 46803

Served Magnet Wire

Served magnet wire was fabricated into twisted pairs using:

Motorized Wire Twist Fabricator(MW-3B)
From: A/Z-Tech Inc.
A Division of Indiana Institute of Technology
Fort Wayne, Indiana 46803

Burnout Strength (Twisted Pairs Only)
The Twisted pairs after an exposure were checked for burnout strength using:

Test instrument used: Wire Burnout Tester
from: A/Z-Tech Inc.
A Division of Indiana Institute of Technology
Fort Wayne, Indiana 46803

Method: ASTM D-1676, "Standard Test Method for Film-Insulated Magnet Wire" Sections 13 to 21.

Dielectric Strength(Twisted Pairs Only)
The twisted pairs after an exposure were checked for dielectric strength using:

Test instrument used: Automatic Dielectric Breakdown Tester, 20 KV (MW-2)
From: A/Z-Tech Inc.
A Division of Indiana Institute of Technology
Fort Wayne, Indiana 46803

Method: ASTM D-1676 "Standard Test Method for Film-Insulated Magnet Wire", Sections 69 to 75.

Varnishes

Three types of varnishes were tested, separately in the form of varnish disks and as coating on helical coils of the three types of magnet wire. Tests conducted on the varnishes measured weight change, flexibility and varnish bond strength. Procedures for the dipping of the magnet wire materials and the cure times used for each varnish for the varnish coated magnet wire materials and varnish disks are included in this section.

Weight Change
1. The varnish disks were weighed before the exposure without the I.D. tag to the nearest 0.0001 grams.
2. The varnish disks were weighed after the exposure without the I.D. tag to the nearest 0.0001 grams.
3. The difference in 1 and 2 is the weight change.

Appearance
The varnish disks after an exposure were compared with unexposed varnish disks of the same type to see if there was a visible change in their appearance.

Flexibility
The varnish disks after an exposure were checked against unexposed varnish disks of the same type to see if there was a change in the flexibility.

Bond Strength (Helical Coils)
The Helical Coils after exposure are checked for bond strength using ASTM D-2519.

Curing Procedure for Varnish Disks
A selected weight of liquid varnish was placed in a tarred aluminum weighing dish to give a cured disk that was approximately 0.05 inches thick. The varnish was cured according to the suppliers recommendation, except that a step cure was often used to avoid solvent bubbles. Table 1 gives the varnish weight, step cure, final cure and percent solids

		Step Cure		Final Cure		
Varnish	Weight	Hours	Temp.	Hours	Temp.	Solids
U-475EH	4.0	4	121°C(250°F)	4	163°F(325°F)	63%
923	4.0	24	100°C(212°F)	4	163°F(325°F)	50%
800	6.0	24	100°C(212°F)	6	149°C(300°F)	32%

Varnishing and Curing Procedure for Magnet Wire Materials
Helical coils(HC), and twisted pairs(TP) were made from each of the three magnet wires. The varnish dip and bake process for the three varnishes used in the project were as follows:

-The HC and TP were preheated to 175°C(350°F) for 2 hours prior to varnishing.
-HC and TP were cooled to approximately 93°C(200°F).
-Sets of hot HC and TP were dipped into the varnish and removed at a rate of 4 inches per minute.
-HC and TP were allowed to drip until no further dripping was noticed. The helical coils were inspected to make certain they were not plugged with varnish.
-Sets of HC and TP, were suspended in an oven for a step cure of 2 hours at 100°C(212°F).
-Oven temperature was then increased to 163°C(325°F) and samples were cured an additional ten hours.
-Invert the HC and TP.
-Again the HC and TP were heated to 163°C(325°F) and cooled to approximately 93°C(200°F).
-The samples were inverted and dipped a second time into the varnish and removed at a rate of 4 inches per minute.
-The HC and TP were allowed to drip until no further dripping was noticed. The helical coils were inspected to make certain they were not plugged with varnish.
-Sets of coils were suspended in an oven for a step cure of 2 hours at 100°C(212°F).
-The oven temperature was increased to 163°C(325°F) and samples cured an additional 10 hours.

Sheet Insulations

The six types of sheet insulation were evaluated for appearance, tensile strength, percent elongation and dielectric strength.

Appearance
The sheet insulations after an exposure were compared with unexposed sheet insulations of the same type to see if there was a visible change.

Tensile Strength
The sheet insulations were tested for tensile strength using the following procedure:

ASTM D-882 "Tensile Properties of Thin Plastic Sheeting.

Test parameters used for each sheet insulation:

Sheet Insulation type	Initial Head Distance(in)	Rate(in/min)
Nomex/Mylar/Nomex	4.0	2.0
Dacron/Mylar/Dacron	2.0	20.0
Mylar MO	2.0	20.0
Nomex 410	4.0	2.0
Nomex-Mica 418	4.0	2.0
Melinex 228	2.0	20.0

Sample size
1/2in x6 in

Percent(%) Elongation
The percent(%) elongation was determined by the change in head distance from the original preset value and converted to a percent.

Dielectric Strength
The sheet insulations after an exposure were checked for dielectric strength using:

ASTM D-149 "Dielectric Breakdown Voltage"

Sample size
1-1/2in x 3 in

Spiral Wrapped Sleeving Insulations

The two types of spiral wrapped sleeving insulations were evaluated for dielectric change and appearance change after exposure.

Appearance
The spiral wrapped sleeving insulations after an exposure were compared with unexposed spiral wrapped sleeving insulations of the same type to see if there was a visible change.

Dielectric strength
Dielectric strength was determined by inserting a metal cylinder (attached to one lead wire) inside the sleeving and measuring the dielectric strength through the sleeving to a wrapping of aluminum foil attached to the other lead. The sleeving was measured for dielectric strength using the following procedure.

-A 1/2 inch by 1 inch piece of aluminum foil was cut.
-A 4 " piece of copper wire was attached to one end of the aluminum foil.
-The aluminum foil was wrapped around the center of the sleeving.
-The copper wire was connected to one pole of the dielectric tester
-A metal cylinder was attached to the other lead wire and inserted inside the sleeving.
-Voltage was applied at 500 volts/second until a dielectric breakdown of the insulation occurred.
-Breakdown voltage to the nearest 0.01 Kilovolt(kV) was recorded.
-A new piece of aluminum foil was used for each lead wire.

Tapes

The three types of tapes were evaluated for appearance change, break load strength and percent(%) elongation.

Appearance
The tapes after an exposure were compared with unexposed tapes of the same type to see if there was a visible change.

Break Load
The tapes were tested for break load using the following procedure:

ASTM D-882 "Tensile Properties of Thin plastic Sheeting".
*The same procedure was followed as for the sheet insulation, but the break load(lbs.) that was achieved was recorded instead of calculating a tensile strength.

Parameters for each Tapes:

Tape type	Head Distance(in)	Rate(in/min)
Polyester	2.0	2.0
Permacel	2.0	2.0

Sample Size
6 inches

Percent(%) Elongation
The percent(%) elongation was determined by change in the head distance from the original preset value and converted to percent change.

Tie Cord

The polyester tie cord was evaluated for appearance change, break load strength and percent(%) elongation.

Appearance
The tie cords after an exposure were compared with unexposed tie cords of the same type to see if there was a visible change.

Break Load
The tie cords were tested for break load using the following procedure:

ASTM D-882 "Tensile Properties of Thin plastic Sheeting.
*The same procedure was followed as for the sheet insulation, but the break load(lbs.) that was achieved was recorded instead of calculating a tensile strength.

Parameters for each Tapes:

Tie Cord type	Initial Head Distance(in)	Rate(in/min)
Polyester Tie Cord	4.0	2.0

Sample Size
6 inches

Percent(%) Elongation
The percent(%) elongation was determined by the change in head distance from the original preset value and converted to a percent change.

Lead Wire

The lead wires were evaluated for appearance change and dielectric strength.

Appearance

The lead wires after an exposure were compared with unexposed lead wire of the same type to see if there was a visible change.

Dielectric Strength

The lead wires were checked for dielectric strength using the following procedure.

-A 1/2 inch by 1 inch piece of aluminum foil was cut.
-A 4 " piece of copper wire was attached to one end of the aluminum foil.
-The aluminum foil was wrapped around the center of the lead wire.
-The copper wire was connected to one pole of the dielectric tester and the lead wire to the other pole.
-Voltage was applied at 500 volts/second until a dielectric breakdown of the insulation occurred.
-Breakdown voltage to the nearest 0.01 Kilovolt(kV) was recorded.
-A new piece of aluminum foil was used for each lead wire.

Other Procedures

Procedures listed in this section include Exposure Setup, which includes procedures to load materials into the Parr bombs, chargie of the Parr bombs with refrigerant and/or lubricant, and procedures for analysis of oil samples.

Exposure Setup

Loading of Pressure Vessels with Motor Materials.

Five 2000 ml type 316 stainless steel pressure vessels were used to hold all the motor material samples needed for each refrigerant-lubricant exposure. For exposures to the original refrigerant/mineral oil and alternative refrigerant/lubricant, the samples were loaded into five vessels as stated below.

2000 ml Pressure Vessel	Original Refrigerant/ Mineral Oil	Alternative refrigerant
#1	Motorettes Tape, Tie cords Lead Wire	Motorettes
#2	Helical Coils 3 Sheet Insulations	All materials 168 Hours
#3	Helical Coils 3 Sheet Insulations	All materials 336 Hours
#4	Twisted Pairs	All materials 500 Hours
#5	Motorettes Sleeving Varnish Disks	Motorettes

Charging of the Pressure Vessels with Refrigerant and/or Lubricant

Refrigerant-Lubricant Exposures

The motor materials were placed in each appropriate pressure vessel and lubricant was poured over the materials until the materials were almost covered. The vessels was sealed and evacuated for 30 minutes. Next, an appropriate amount of refrigerant was placed in the vessel to give a refrigerant pressure of greater than 2109 kPa(300 psi). After the bombs were heated for 24 hours the pressure was measured. If the pressure was greater than 2109 kPa(300 psi), refrigerant was removed until the pressure was 2109 kPa(300 psi). If it was less than 2109 kPa(300 psi), the vessel was charged with more refrigerant. The vessels were checked again at 48 hour, 168 hour, 336 hours and 500 hours and adjusted to maintain a pressure of 2109 kPa(300 psi).

Oil Analysis

The two analyses that were performed on all lubricants during the project were acid number and moisture. Each procedure is listed below:

Acid Number

Acid numbers of an oil were determined by the procedure given in ASTM D-974 " Acid and Base Number by Color-Indicator Titration".

Moisture

Moisture in lubricant was evaluated by injecting a known amount of lubricant into a Fisher Scientific Coulometer K-F Titrimeter Model 447. After the water was titrated, the moisture in the lubricant was calculated in parts per million.

Appendix C

Lubricant Acid Numbers

R22 AND 3GS OIL/A.C. 9000 AND ICI EMKARATE RL 32

	ACID CONTENT*	
	before	after
500 HOURS R22 #1	0.009	0.036
500 HOURS R22 #2	0.009	0.009
500 HOURS R22 #3	0.009	0.013
500 HOURS R22 #4	0.009	0.012
500 HOURS R22 #5	0.009	0.014
1000 HOURS R22	0.009	0.017
168 HOURS A.C. 9000	0.009	0.098
336 HOURS A.C. 9000	0.009	0.253
500 HOURS A.C. 9000	0.009	0.495

* Acid content is measured in mg KOH/ gm oil
#1 Denotes 2 motoretts tiecords and tapes
#2 Denotes helical coils and sheet insulation
#3 Denotes helical coils and sheet insulation
#4 Denotes twisted pairs
#5 Denotes 2 motoretts and disks

R-12 AND 3GS/ R-134a AND CPI SOLEST 68

	ACID CONTENT*	
	before	after
500 HOURS R12 #1	0.009	0.033
500 HOURS R12 #2	0.009	0.004
500 HOURS R12 #3	0.009	0.003
500 HOURS R12 #4	0.009	0.012
500 HOURS R12 #5	0.009	0.021
1000 HOURS R12	0.009	0.017
168 HOURS R-134a	0.029	0.061
336 HOURS R134a	0.029	0.072
500 HOURS R134a	0.029	0.109

* Acid content is measured in mg KOH/ gm oil
#1 Denotes 2 motoretts tiecords and tapes
#2 Denotes helical coils and sheet insulation
#3 Denotes helical coils and sheet insulation
#4 Denotes twisted pairs
#5 Denotes 2 motoretts and disks

R-502 AND 3GS/ HP-62 AND CASTROL ICEMATIC SW 32

	ACID CONTENT*	
	before	after
500 HOURS R502 #1	0.009	0.050
500 HOURS R502 #2	0.009	0.010
500 HOURS R502 #3	0.009	0.004
500 HOURS R502 #4	0.009	0.005
500 HOURS R502 #5	0.009	0.017
1000 HOURS R502	0.009	0.021
168 HOURS HP62	0.098	1.011
336 HOURS HP62	0.098	1.291
500 HOURS HP62	0.098	1.455

* Acid content is measured in mg KOH/ gm oil
#1 Denotes 2 motoretts tiecords and tapes
#2 Denotes helical coils and sheet insulation
#3 Denotes helical coils and sheet insulation
#4 Denotes twisted pairs
#5 Denotes 2 motoretts and disks

R-11 AND PENRICO SONTEX 300 LT/R-123 AND PENRICO SONTEX 300 LT

	ACID CONTENT*	
	before	after
500 HOURS R11 #1	0.002	0.011
500 HOURS R11 #2	0.002	0.014
500 HOURS R11 #3	0.002	0.000
1000 HOURS R11	0.002	0.071
168 HOURS R123	0.002	0.017
336 HOURS R123	0.002	0.005
500 HOURS R123	0.002	0.034

* Acid content is measured in mg KOH/ gm oil
#1 Denotes motoretts
#2 Denotes helical coils and sheet insulation
#3 Denotes twisted pairs and sheet insulation

R-11 AND PENRICO SONTEX 300 LT/R-245ca AND SOLEST 68

	ACID CONTENT*	
	before	after
500 HOURS R11 #1	0.002	0.022
500 HOURS R11 #2	0.002	0.017
500 HOURS R11 #3	0.002	0.006
1000 HOURS R11	0.002	0.018
168 HOURS R245ca	0.002	0.041
336 HOURS R245ca	0.002	0.035
500 HOURS R245ca	0.002	0.048

* Acid content is measured in mg KOH/ gm oil
#1 Denotes motoretts
#2 Denotes helical coils and sheet insulation
#3 Denotes twisted pairs and sheet insulation

R-123 AND PENRICO SONTEX 300 LT/R-245ca AND SOLEST 68

	ACID CONTENT*	
	before	after
500 HOURS R123 #1	0.002	0.013
500 HOURS R123 #2	0.002	0.01
500 HOURS R123 #3	0.002	0.036
1000 HOURS R123	0.002	0.025
168 HOURS R245ca	0.002	0.019
336 HOURS R245ca	0.002	0.027
500 HOURS R245ca	0.002	0.032

* Acid content is measured in mg KOH/ gm oil
#1 Denotes motoretts
#2 Denotes helical coils and sheet insulation
#3 Denotes twisted pairs and sheet insulation

Appendix D

Summary Data Tables, High Pressure Refrigerants

EXPLANATION OF THE SUMMARY DATA TABLES

Physical and electrical property measurements were determined on replicate (3-5) samples of motor materials and entered into the original data tables. The original data tables are included in Volumes II and III of the final report. An average was taken of the replicate data and expressed as a percent change from the measurements taken on unexposed materials. This comparison of data for exposed and unexposed samples is presented as the summary data tables.

The summary data tables are divided according to the type of motor material tested, and further divided according to the six refrigerant retrofit exposures . The data, expressed as percent change from unexposed, is presented in a two-section box, as shown below.

Results for R-11 / R-123 retrofit

	Varnish Type
	Sterling U-475
Unexposed Bond Strength	27.4 lbs.

Exposure With:	**% Change from Unexposed**	
R-11 500 HRS. @ 212 F	-6.3%	******
R-123 168 HRS. @ 212 F	******	-11.9%
R-123 336 HRS. @ 212 F	******	15.0%
R-123 500 HRS. @ 212 F	******	-3.2%
R-11 1000 HRS. @ 212 F	-22.6%	******

The left section of the box contains data for the original refrigerant/mineral oil at 500 and 1000 hours and the right section of the box contains data for the retrofit refrigerant/lubricant at 168, 336, and 500 hours. The ****** signifies that data was not determined for the exposures indicated.

The refrigerant retrofit combinations R-22/R-407C, R-12/R-134a and R-502/R-404A exposures used two magnet wires (designated as **A.** & **B.**) in combination with two varnishes. Separate pages are necessary for each magnet wire type and two sets of data boxes are used for the two varnishes. In contrast, the R-11/R-123, R-11/R-245ca, and R-123/R-245ca exposures used only one magnet wire (designated as **C.**) and one varnish.

Varnish Weight and Volume Changes

Results for R-12 / R-134a retrofit

Isopoxy-800

Exposure With:	% Change from Unexposed Weight		Volume	
R-12 500 HRS. @ 260 F	-4.3%	******	-7.0%	******
R-134a 168 HRS. @ 260 F	******	-5.7%	******	-8.2%
R-134a 336 HRS. @ 260 F	******	-5.9%	******	-8.1%
R-134a 500 HRS. @ 260 F	******	-6.2%	******	-8.6%
R-12 1000 HRS. @ 260 F	-3.2%	******	-6.0%	******

R-134a exposures are in addition to an initial 500 hr. R-12 exposure

Results for R-12 / R-134a retrofit

P. D. George 923

Exposure With:	% Change from Unexposed Weight		Volume	
R-12 500 HRS. @ 260 F	1.5%	******	-3.8%	******
R-134a 168 HRS. @ 260 F	******	1.7%	******	-0.3%
R-134a 336 HRS. @ 260 F	******	1.5%	******	-0.4%
R-134a 500 HRS. @ 260 F	******	1.4%	******	-0.5%
R-12 1000 HRS. @ 260 F	1.7%	******	-0.2%	******

R-134a exposures are in addition to an initial 500 hr. R-12 exposure

Varnish Weight and Volume Changes

Results for R-22 / R407C retrofit

Isopoxy-800

Exposure With:	% Change from Unexposed Weight		Volume	
R-22 500 HRS. @ 260 F	4.6%	******	1.0%	******
R-407C 168 HRS. @ 260 F	******	-7.6%	******	-2.7%
R-407C 336 HRS. @ 260 F	******	-1.4%	******	-3.0%
R-407C 500 HRS. @ 260 F	******	-2.1%	******	-4.0%
R-22 1000 HRS. @ 260 F	5.8%	******	1.2%	******

R-407C exposures are in addition to an initial 500 hr. R-22 exposure

Results for R-22 / R-407C retrofit

P. D. George 923

Exposure With:	% Change from Unexposed Weight		Volume	
R-22 500 HRS. @ 260 F	5.4%	******	3.0%	******
R-407C 168 HRS. @ 260 F	******	1.7%	******	0.9%
R-407C 336 HRS. @ 260 F	******	1.2%	******	0.5%
R-407C 500 HRS. @ 260 F	******	1.0%	******	0.4%
R-22 1000 HRS. @ 260 F	6.4%	******	4.1%	******

R-407C exposures are in addition to an initial 500 hr. R-22 exposure

Varnish Weight and Volume Changes

Results for R-502 / R-404A retrofit

Isopoxy-800

Exposure With:	% Change from Unexposed Weight		Volume	
R-502 500 HRS. @ 260 F	-9.0%	******	-11.0%	******
R-404A 168 HRS. @ 260 F	******	-10.6%	******	-12.1%
R-404A 336 HRS. @ 260 F	******	-11.0%	******	-12.5%
R-404A 500 HRS. @ 260 F	******	-11.0%	******	-12.5%
R-502 1000 HRS. @ 260 F	-9.6%	******	-12.4%	******

A-404A exposures are in addition to an initial 500 hr. R-502 exposure

Results for R-502 / R-404A retrofit

P. D. George 923

Exposure With:	% Change from Unexposed Weight		Volume	
R-502 500 HRS. @ 260 F	-1.2%	******	-2.6%	******
R-404A 168 HRS. @ 260 F	******	-4.1%	******	-4.9%
R-404A 336 HRS. @ 260 F	******	-4.4%	******	-5.2%
R-404A 500 HRS. @ 260 F	******	-4.3%	******	-4.8%
R-502 1000 HRS. @ 260 F	0.2%	******	-1.8%	******

R-404A exposures are in addition to an initial 500 hr. R-502 exposure

Varnish Coated on Magnet Wire A
(Polyester base with amide imide overcoat)

	Varnish Type	Varnish Type
	Isopoxy 800	P. D. George 923
Unexposed Bond Strength	57.3 lbs.	66.6 lbs.

Exposure With:	% Change from Unexposed		% Change from Unexposed	
R-12 500 HRS. @ 260 F	-5.8%	******	-58.2%	******
R-134a 168 HRS. @ 260 F	******	-4.0%	******	-56.2%
R-134a 336 HRS. @ 260 F	******	19.3%	******	-53.8%
R-134a 500 HRS. @ 260 F	******	3.5%	******	-50.5%
R-12 1000 HRS. @ 260 F	10.4%	******	-57.6%	******

	Varnish Type	Varnish Type
	Isopoxy 800	P. D. George 923
Unexposed Bond Strength	57.3 lbs.	66.6 lbs.

Exposure With:	% Change from Unexposed		% Change from Unexposed	
R-12 500 HRS. @ 260 F	4.2%	******	-51.1%	******
R-134a 168 HRS. @ 260 F	******	30.3%	******	-34.3%
R-134a 336 HRS. @ 260 F	******	-13.6%	******	-57.4%
R-134a 500 HRS. @ 260 F	******	2.9%	******	-44.7%
R-12 1000 HRS. @ 260 F	8.9%	******	-28.4%	******

R-134a exposures are in addition to an initial 500 hr. R-12 exposure

Varnish Coated on Magnet Wire B
(Esterimide base with amide imide overcoat)

Results for R-12 / R-134a retrofit

	Varnish Type	Varnish Type
	Isopoxy 800	P. D. George 923
Unexposed Bond Strength	57.3 lbs.	66.6 lbs.

Exposure With:	% Change from Unexposed		% Change from Unexposed	
R-12 500 HRS. @ 260 F	-4.8%	******	-29.4%	******
R-134a 168 HRS. @ 260 F	******	-4.5%	******	-23.0%
R-134a 336 HRS. @ 260 F	******	19.3%	******	-17.0%
R-134a 500 HRS. @ 260 F	******	-11.9%	******	-48.7%
R-12 1000 HRS. @ 260 F	-4.0%	******	-56.7%	******

	Varnish Type	Varnish Type
	Isopoxy 800	P. D. George 923
Unexposed Bond Strength	57.3 lbs.	66.6 lbs.

Exposure With:	% Change from Unexposed		% Change from Unexposed	
R-12 500 HRS. @ 260 F	-4.7%	******	-7.1%	******
R-134a 168 HRS. @ 260 F	******	6.3%	******	0.9%
R-134a 336 HRS. @ 260 F	******	-32.3%	******	-21.2%
R-134a 500 HRS. @ 260 F	******	0.8%	******	-3.5%
R-12 1000 HRS. @ 260 F	31.3%	******	1.5%	******

R-134a exposures are in addition to an initial 500 hr. R-12 exposure

Varnish Coated on Magnet Wire A
(Polyester base with amide imide overcoat)

Results for R-22 / R-407C retrofit

	Varnish Type	Varnish Type
	Isopoxy 800	P. D. George 923
Unexposed Bond Strength	57.3 lbs.	66.6 lbs.

Exposure With:	% Change from Unexposed		% Change from Unexposed	
R-22 500 HRS. @ 260 F	-8.4%	******	-57.5%	******
R-407C 168 HRS. @ 260 F	******	15.5%	******	-55.3%
R-407C 336 HRS. @ 260 F	******	3.5%	******	-54.1%
R-407C 500 HRS. @ 260 F	******	0.2%	******	-51.1%
R-22 1000 HRS. @ 260 F	3.4%	******	-58.1%	******

	Varnish Type	Varnish Type
	Isopoxy 800	P. D. George 923
Unexposed Bond Strength	57.3 lbs.	66.6 lbs.

Exposure With:	% Change from Unexposed		% Change from Unexposed	
R-22 500 HRS. @ 260 F	2.0%	******	-50.9%	******
R-407C 168 HRS. @ 260 F	******	-6.9%	******	-45.8%
R-407C 336 HRS. @ 260 F	******	26.3%	******	-13.7%
R-407C 500 HRS. @ 260 F	******	-11.7%	******	-43.2%
R-22 1000 HRS. @ 260 F	19.8%	******	-40.8%	******

R-407C exposures are in addition to an initial 500 hr. R-22 exposure

Varnish Coated on Magnet Wire B

(Esterimide base with amide imide overcoat)
Results for R-22 / R-407C retrofit

	Varnish Type	Varnish Type
	Isopoxy 800	P. D. George 923
Unexposed Bond Strength	57.3 lbs.	66.6 lbs.

Exposure With:	% Change from Unexposed		% Change from Unexposed	
R-22 500 HRS. @ 260 F	-5.6%	******	-24.1%	******
R-407C 168 HRS. @ 260 F	******	24.0%	******	-12.1%
R-407C 336 HRS. @ 260 F	******	3.3%	******	-26.8%
R-407C 500 HRS. @ 260 F	******	9.3%	******	-15.0%
R-22 1000 HRS. @ 260 F	-1.7%	******	-39.7%	******

	Varnish Type	Varnish Type
	Isopoxy 800	P. D. George 923
Unexposed Bond Strength	57.3 lbs.	66.6 lbs.

Exposure With:	% Change from Unexposed		% Change from Unexposed	
R-22 500 HRS. @ 260 F	-15.2%	******	-13.1%	******
R-407C 168 HRS. @ 260 F	******	-1.0%	******	-10.5%
R-407C 336 HRS. @ 260 F	******	16.4%	******	1.0%
R-407C 500 HRS. @ 260 F	******	-9.2%	******	-8.5%
R-22 1000 HRS. @ 260 F	20.9%	******	-12.9%	******

R-407C exposures are in addition to an initial 500 hr. R-22 exposure

Varnish Coated on Magnet Wire A
(Polyester base with amide imide overcoat)

Results for R-502 / R-404A retrofit

	Varnish Type	Varnish Type
	Isopoxy 800	P. D. George 923
Unexposed Bond Strength	57.3 lbs.	66.6 lbs.

Exposure With:	% Change from Unexposed		% Change from Unexposed	
R-502 500 HRS. @ 260 F	-13.4%	******	-53.4%	******
R-404A 168 HRS. @ 260 F	******	0.1%	******	-51.5%
R-404A 336 HRS. @ 260 F	******	27.0%	******	-44.1%
R-404A 500 HRS. @ 260 F	******	6.2%	******	-48.9%
R-502 1000 HRS. @ 260 F	-2.6%	******	-53.9%	******

	Varnish Type	Varnish Type
	Isopoxy 800	P. D. George 923
Unexposed Bond Strength	57.3 lbs.	66.6 lbs.

Exposure With:	% Change from Unexposed		% Change from Unexposed	
R-502 500 HRS. @ 260 F	-0.5%	******	-26.4%	******
R-404A 168 HRS. @ 260 F	******	-8.8%	******	-39.4%
R-404A 336 HRS. @ 260 F	******	6.1%	******	-38.4%
R-404A 500 HRS. @ 260 F	******	2.5%	******	-40.6%
R-502 1000 HRS. @ 260 F	6.7%	******	-45.7%	******

R-404A exposures are in addition to an initial 500 hr. R-502 exposure

Varnish Coated on Magnet Wire B
(Esterimide base with amide imide overcoat)

Results for R-502 / R-404A retrofit

	Varnish Type		Varnish Type	
	Isopoxy 800		P. D. George 923	
Unexposed Bond Strength	57.3 lbs.		66.6 lbs.	
Exposure With:	% Change from Unexposed		% Change from Unexposed	
R-502 500 HRS. @ 260 F	4.8%	******	-7.5%	******
R-404A 168 HRS. @ 260 F	******	-2.7%	******	-28.9%
R-404A 336 HRS. @ 260 F	******	30.0%	******	-11.8%
R-404A 500 HRS. @ 260 F	******	1.8%	******	-20.0%
R-502 1000 HRS. @ 260 F	-3.2%	******	-12.2%	******

	Varnish Type		Varnish Type	
	Isopoxy 800		P. D. George 923	
Unexposed Bond Strength	57.3 lbs.		66.6 lbs.	
Exposure With:	% Change from Unexposed		% Change from Unexposed	
R-502 500 HRS. @ 260 F	11.6%	******	-23.5%	******
R-404A 168 HRS. @ 260 F	******	9.4%	******	-14.2%
R-404A 336 HRS. @ 260 F	******	3.8%	******	-28.5%
R-404A 500 HRS. @ 260 F	******	11.3%	******	-10.5%
R-502 1000 HRS. @ 260 F	16.8%	******	-11.4%	******

R-404A exposures are in addition to an initial 500 hr. R-502 exposure

Varnish Coated on Magnet Wire A
(Polyester base with amide imide overcoat)

Results for R-12 / R-134a retrofit

	Varnish Type
	none
Unexposed Burnout	555 sec.

Exposure With:	% Change from Unexposed	
R-12 500 HRS. @ 260 F	-51.9%	******
R-134a 168 HRS. @ 260 F	******	-28.9%
R-134a 336 HRS. @ 260 F	******	-11.6%
R-134a 500 HRS. @ 260 F	******	-10.0%
R-12 1000 HRS. @ 260 F	-45.0%	******

	Varnish Type
	none
Unexposed Dielectric Strength	15.25 kv.

Exposure With:	% Change from Unexposed	
R-12 500 HRS. @ 260 F	10.2%	******
R-134a 168 HRS. @ 260 F	******	2.7%
R-134a 336 HRS. @ 260 F	******	9.6%
R-134a 500 HRS. @ 260 F	******	-2.6%
R-12 1000 HRS. @ 260 F	7.3%	******

R-134a exposures are in addition to an initial 500 hr. R-12 exposure

Varnish Coated on Magnet Wire B
(Esterimide base with amide imide overcoat)

Results for R-12 / R-134a retrofit

	Varnish Type
	none
Unexposed Burnout	584 sec.

Exposure With:	% Change from Unexposed	
R-12 500 HRS. @ 260 F	-65.7%	******
R-134a 168 HRS. @ 260 F	******	-36.4%
R-134a 336 HRS. @ 260 F	******	-22.2%
R-134a 500 HRS. @ 260 F	******	-16.7%
R-12 1000 HRS. @ 260 F	-59.2%	******

	Varnish Type
	none
Unexposed Dielectric Strength	13.43 kv.

Exposure With:	% Change from Unexposed	
R-12 500 HRS. @ 260 F	29.7%	******
R-134a 168 HRS. @ 260 F	******	24.8%
R-134a 336 HRS. @ 260 F	******	21.1%
R-134a 500 HRS. @ 260 F	******	26.2%
R-12 1000 HRS. @ 260 F	29.8%	******

R-134a exposures are in addition to an initial 500 hr. R-12 exposure

Varnish Coated on Magnet Wire A
(Polyester base with amide imide overcoat)

Results for R-12 / R-134a retrofit

	Varnish Type	Varnish Type
	Isopoxy 800	P. D. George 923
Unexposed Burnout	536 sec.	612 sec.

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 260 F	-40.1%	******	-51.1%	******
R-134a 168 HRS. @ 260 F	******	-18.4%	******	-30.1%
R-134a 336 HRS. @ 260 F	******	2.8%	******	-18.0%
R-134a 500 HRS. @ 260 F	******	5.9%	******	-4.4%
R-12 1000 HRS. @ 260 F	-15.2%	******	-43.1%	******

	Varnish Type	Varnish Type
	Isopoxy 800	P. D. George 923
Unexposed Dielectric Strength	15.98 kv.	17.01 kv.

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 260 F	16.1%	******	14.9%	******
R-134a 168 HRS. @ 260 F	******	12.6%	******	15.6%
R-134a 336 HRS. @ 260 F	******	14.2%	******	11.8%
R-134a 500 HRS. @ 260 F	******	13.9%	******	13.8%
R-12 1000 HRS. @ 260 F	15.2%	******	17.1%	******

R-134a exposures are in addition to an initial 500 hr. R-12 exposure

Varnish Coated on Magnet Wire B
(Esterimide base with amide imide overcoat)

Results for R-12 / R-134a retrofit

	Varnish Type	Varnish Type
	Isopoxy 800	P. D. George 923
Unexposed Burnout	543 sec.	554 sec.

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 260 F	-56.6%	******	-55.5%	******
R-134a 168 HRS. @ 260 F	******	-5.3%	******	-52.0%
R-134a 336 HRS. @ 260 F	******	-38.7%	******	-0.4%
R-134a 500 HRS. @ 260 F	******	5.1%	******	7.5%
R-12 1000 HRS. @ 260 F	-50.8%	******	-45.1%	******

	Varnish Type	Varnish Type
	Isopoxy 800	P. D. George 923
Unexposed Dielectric Strength	18.88 kv.	19.79 kv.

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 260 F	0.0%	******	-0.1%	******
R-134a 168 HRS. @ 260 F	******	5.7%	******	1.0%
R-134a 336 HRS. @ 260 F	******	-2.0%	******	-0.6%
R-134a 500 HRS. @ 260 F	******	-6.4%	******	-3.0%
R-12 1000 HRS. @ 260 F	3.0%	******	-1.2%	******

R-134a exposures are in addition to an initial 500 hr. R-12 exposure

Varnish Coated on Magnet Wire A
(Polyester base with amide imide overcoat)

Results for R-502 / R-404A retrofit

	Varnish Type
	none
Unexposed Burnout	555 sec.

Exposure With:	% Change from Unexposed	
R-502 500 HRS. @ 260 F	-20.0%	******
R-404A 168 HRS. @ 260 F	******	-26.1%
R-404A 336 HRS. @ 260 F	******	-22.5%
R-404A 500 HRS. @ 260 F	******	-26.0%
R-502 1000 HRS. @ 260 F	-33.6%	******

	Varnish Type
	none
Unexposed Dielectric Strength	15.25 kv.

Exposure With:	% Change from Unexposed	
R-502 500 HRS. @ 260 F	-13.1%	******
R-404A 168 HRS. @ 260 F	******	10.6%
R-404A 336 HRS. @ 260 F	******	14.7%
R-404A 500 HRS. @ 260 F	******	8.3%
R-502 1000 HRS. @ 260 F	10.3%	******

R-404A exposures are in addition to an initial 500 hr. R-502 exposure

Varnish Coated on Magnet Wire A
(Polyester base with amide imide overcoat)

Results for R-502 / R-404A retrofit

	Varnish Type	Varnish Type
	Isopoxy 800	P. D. George 923
Unexposed Burnout	536 sec.	612 sec.

Exposure With:	% change from unexposed		% change from unexposed	
R-502 500 HRS. @ 260 F	-28.1%	******	-30.5%	******
R-404A 168 HRS. @ 260 F	******	-29.2%	******	-16.3%
R-404A 336 HRS. @ 260 F	******	-30.1%	******	-23.4%
R-404A 500 HRS. @ 260 F	******	-29.8%	******	-23.7%
R-502 1000 HRS. @ 260 F	-22.3%	******	-44.3%	******

	Varnish Type	Varnish Type
	Isopoxy 800	P. D. George 923
Unexposed Dielectric Strength	15.98 kv.	17.01 kv.

Exposure With:	% change from unexposed		% change from unexposed	
R-502 500 HRS. @ 260 F	19.6%	******	15.4%	******
R-404A 168 HRS. @ 260 F	******	19.6%	******	13.7%
R-404A 336 HRS. @ 260 F	******	17.3%	******	12.5%
R-404A 500 HRS. @ 260 F	******	10.0%	******	14.8%
R-502 1000 HRS. @ 260 F	2.9%	******	9.2%	******

R-404A exposures are in addition to an initial 500 hr. R-502 exposure

Varnish Coated on Magnet Wire B
(Esterimide base with amide imide overcoat)

Results for R-502 / R-404A retrofit

	Varnish Type
	none
Unexposed Burnout	584 sec.

Exposure With:	% Change from Unexposed	
R-502 500 HRS. @ 260 F	-8.7%	******
R-404A 168 HRS. @ 260 F	******	-39.8%
R-404A 336 HRS. @ 260 F	******	-26.9%
R-404A 500 HRS. @ 260 F	******	-26.9%
R-502 1000 HRS. @ 260 F	-40.5%	******

	Varnish Type
	none
Unexposed Dielectric Strength	13.43 kV

Exposure With:	% Change from Unexposed	
R-502 500 HRS. @ 260 F	17.6%	******
R-404A 168 HRS. @ 260 F	******	16.0%
R-404A 336 HRS. @ 260 F	******	13.1%
R-404A 500 HRS. @ 260 F	******	16.3%
R-502 1000 HRS. @ 260 F	10.7%	******

R-404A exposures are in addition to an initial 500 hr. R-502 exposure

Varnish Coated on Magnet Wire B
(Esterimide base with amide imide overcoat)

Results for R-502 / R-404A retrofit

	Varnish Type		Varnish Type	
	Isopoxy 800		P. D. George 923	
Unexposed Burnout	543 sec.		554 sec.	
Exposure With:	% change from unexposed		% change from unexposed	
R-502 500 HRS. @ 260 F	-42.2%	******	-14.2%	******
R-404A 168 HRS. @ 260 F	******	-39.9%	******	-5.4%
R-404A 336 HRS. @ 260 F	******	-29.9%	******	-32.2%
R-404A 500 HRS. @ 260 F	******	-33.3%	******	-14.3%
R-502 1000 HRS. @ 260 F	-13.1%	******	-26.0%	******

	Varnish Type		Varnish Type	
	Isopoxy 800		P. D. George 923	
Unexposed Dielectric Strength	18.88 kv.		19.78 kv.	
Exposure With:	% change from unexposed		% change from unexposed	
R-502 500 HRS. @ 260 F	3.4%	******	-9.8%	******
R-404A 168 HRS. @ 260 F	******	3.6%	******	0.1%
R-404A 336 HRS. @ 260 F	******	-5.2%	******	-14.7%
R-404A 500 HRS. @ 260 F	******	-2.0%	******	-1.1%
R-502 1000 HRS. @ 260 F	1.1%	******	-9.3%	******

R-404A exposures are in addition to an initial 500 hr. R-502 exposure

Varnish Coated on Magnet Wire A
(Polyester base with amide imide overcoat)

Results for R-22 / R-407C retrofit

	Varnish Type
	none
Unexposed Burnout	555 sec.

Exposure With:	% Change from Unexposed	
R-22 500 HRS. @ 260 F	-41.4%	******
R-407C 168 HRS. @ 260 F	******	-25.5%
R-407C 336 HRS. @ 260 F	******	-10.9%
R-407C 500 HRS. @ 260 F	******	-15.9%
R-22 1000 HRS. @ 260 F	-33.7%	******

	Varnish Type
	none
Unexposed Dielectric Strength	15.25 kv.

Exposure With:	% Change from Unexposed	
R-22 500 HRS. @ 260 F	1.0%	******
R-407C 168 HRS. @ 260 F	******	38.4%
R-407C 336 HRS. @ 260 F	******	7.4%
R-407C 500 HRS. @ 260 F	******	0.6%
R-22 1000 HRS. @ 260 F	15.5%	******

R-407C exposures are in addition to an initial 500 hr. R-22 exposure

Varnish Coated on Magnet Wire B
(Esterimide base with amide imide overcoat)

Results for R-22 / R-407C retrofit

	Varnish Type
	none
Unexposed Burnout	584 sec.

Exposure With:	% Change from Unexposed	
R-22 500 HRS. @ 260 F	-45.7%	******
R-407C 168 HRS. @ 260 F	******	-40.7%
R-407C 336 HRS. @ 260 F	******	-53.5%
R-407C 500 HRS. @ 260 F	******	-20.1%
R-22 1000 HRS. @ 260 F	-59.1%	******

	Varnish Type
	none
Unexposed Dielectric Strength	13.4 lbs.

Exposure With:	% Change from Unexposed	
R-22 500 HRS. @ 260 F	27.2%	******
R-407C 168 HRS. @ 260 F	******	19.5%
R-407C 336 HRS. @ 260 F	******	6.5%
R-407C 500 HRS. @ 260 F	******	25.3%
R-22 1000 HRS. @ 260 F	26.9%	******

R-407C exposures are in addition to an initial 500 hr. R-22 exposure

Varnish Coated on Magnet Wire A
(Polyester base with amide imide overcoat)

Results for R-22 / R-407C retrofit

	Varnish Type		Varnish Type	
	Isopoxy 800		P. D. George 923	
Unexposed Burnout	543 sec.		554 sec.	
Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 260 F	-26.2%	******	-22.9%	******
R-407C 168 HRS. @ 260 F	******	-25.5%	******	-28.5%
R-407C 336 HRS. @ 260 F	******	-34.8%	******	-29.0%
R-407C 500 HRS. @ 260 F	******	-27.4%	******	-28.5%
R-22 1000 HRS. @ 260 F	-26.0%	******	-34.1%	******

	Varnish Type		Varnish Type	
	Isopoxy 800		P. D. George 923	
Unexposed Dielectric Strength	15.98 kv.		17.01 kv.	
Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 260 F	20.8%	******	10.8%	******
R-407C 168 HRS. @ 260 F	******	21.2%	******	11.7%
R-407C 336 HRS. @ 260 F	******	20.4%	******	8.9%
R-407C 500 HRS. @ 260 F	******	13.1%	******	10.3%
R-22 1000 HRS. @ 260 F	14.1%	******	14.4%	******

R-407C exposures are in addition to an initial 500 hr. R-22 exposure

Varnish Coated on Magnet Wire B

(Esterimide base with amide imide overcoat)
Results for R-22 / R-407C retrofit

	Varnish Type	Varnish Type
	Isopoxy 800	P. D. George 923
Unexposed Burnout	543 sec.	554 sec.

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 260 F	-32.2%	******	-34.8%	******
R-407C 168 HRS. @ 260 F	******	-37.5%	******	-25.3%
R-407C 336 HRS. @ 260 F	******	-44.4%	******	-23.8%
R-407C 500 HRS. @ 260 F	******	-39.4%	******	-29.1%
R-22 1000 HRS. @ 260 F	-46.6%	******	-45.8%	******

	Varnish Type	Varnish Type
	Isopoxy 800	P. D. George 923
Unexposed Dielectric Strength	18.88 kv.	19.78 kv.

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 260 F	-0.8%	******	-2.5%	******
R-407C 168 HRS. @ 260 F	******	-2.7%	******	-0.7%
R-407C 336 HRS. @ 260 F	******	-3.1%	******	-4.3%
R-407C 500 HRS. @ 260 F	******	4.2%	******	-5.0%
R-22 1000 HRS. @ 260 F	-13.3%	******	-0.4%	******

R-407C exposures are in addition to an initial 500 hr. R-22 exposure

Results for R-12 / R-134a retrofit

	type
	DMD
Unexposed Dielectric Strength	9.77 KV.

Exposure With:	% Change from Unexposed	
R-12 500 HRS. @ 212 F	-13.8%	******
R-134a 168 HRS. @ 212 F	******	-14.9%
R-133a 336 HRS. @ 212 F	******	-67.6%
R-134a 500 HRS. @ 212 F	******	-31.2%
R-12 500 HRS. @ 212 F	-81.9%	******

	type
	DMTD
Unexposed Dielectric Strength	10.16 kv.

Exposure With:	% Change from Unexposed	
R-12 500 HRS. @ 212 F	10.8%	******
R-134a 168 HRS. @ 212 F	******	69.9%
R-133a 336 HRS. @ 212 F	******	24.7%
R-134a 500 HRS. @ 212 F	******	25.0%
R-12 500 HRS. @ 212 F	25.9%	******

R-134a exposures are in addition to an initial 500 hr. R-12 exposure

DMD denotes Dacron Mylar Dacron lead wire material

DMTD denoted Dacron Mylar Teflon Dacron lead wire material

Results for R-22 / R-407C retrofit

	type
	DMD
Unexposed Dielectric Strength	9.77 KV.

Exposure With:	% Change from Unexposed	
R-22 500 HRS. @ 212 F	-6.4%	******
R-407C 168 HRS. @ 212 F	******	-7.2%
R-407C 336 HRS. @ 212 F	******	61.9%
R-407C 500 HRS. @ 212 F	******	-10.1%
R-22 500 HRS. @ 212 F	-38.2%	******

	type
	DMTD
Unexposed Dielectric Strength	10.16 kv.

Exposure With:	% Change from Unexposed	
R-22 500 HRS. @ 212 F	36.0%	******
R-407C 168 HRS. @ 212 F	******	39.0%
R-407C 336 HRS. @ 212 F	******	88.9%
R-407C 500 HRS. @ 212 F	******	37.0%
R-22 500 HRS. @ 212 F	17.9%	******

R-407C exposures are in addition to an initial 500 hr. R-22 exposure
DMD denotes Dacron Mylar Dacron lead wire material
DMTD denoted Dacron Mylar Teflon Dacron lead wire material

Results for R-502 / R-404A retrofit

	type
	DMD
Unexposed Dielectric Strength	9.77 KV.

Exposure With:	% Change from Unexposed	
R-502 500 HRS. @ 212 F	2.5%	******
R-404A 168 HRS. @ 212 F	******	-13.0%
R-404A 336 HRS. @ 212 F	******	-7.4%
R-404A 500 HRS. @ 212 F	******	-26.3%
R-502 500 HRS. @ 212 F	-75.5%	******

	type
	DMTD
Unexposed Dielectric Strength	10.16 kv.

Exposure With:	% Change from Unexposed	
R-502 500 HRS. @ 212 F	43.8%	******
R-404A 168 HRS. @ 212 F	******	51.5%
R-404A 336 HRS. @ 212 F	******	35.2%
R-404A 500 HRS. @ 212 F	******	31.0%
R-502 500 HRS. @ 212 F	6.4%	******

R-404A exposures are in addition to an initial 500 hr. R-502 exposure
DMD denotes Dacron Mylar Dacron lead wire material
DMTD denoted Dacron Mylar Teflon Dacron lead wire material

Results for R-12 / R-134a retrofit

	Sleeving type
	PET
Unexposed Dielectric Strength	>17.60

Exposure With:	Dielectric Strength	
R-12 500 HRS. @ 212 F	brittle	******
R-134a 168 HRS. @ 212 F	******	brittle
R-134a 336 HRS. @ 212 F	******	brittle
R-134a 500 HRS. @ 212 F	******	brittle
R-12 1000 HRS. @ 212 F	brittle	******

	Sleeving type
	Nomex- PET
Unexposed Dielectric Strength	>12.12

Exposure With:	Dielectric Strength	
R-12 500 HRS. @ 212 F	5.64	******
R-134a 168 HRS. @ 212 F	******	>9.68
R-134a 336 HRS. @ 212 F	******	7.96
R-134a 500 HRS. @ 212 F	******	6.35
R-12 1000 HRS. @ 212 F	4.26	******

R-134a exposures are in addition to an initial 500 hr. R-12 exposure

Results for R-22 / R-407C retrofit

	Sleeving type
	PET
Unexposed Dielectric Strength	>17.60

Exposure With:	Dielectric Strength	
R-22 500 HRS. @ 212 F	>16.33	******
R-407C 168 HRS. @ 212 F	******	>19.99
R-407C 336 HRS. @ 212 F	******	brittle
R-407C 500 HRS. @ 212 F	******	>14.62
R-22 1000 HRS. @ 212 F	brittle	******

	Sleeving type
	Nomex- PET
Unexposed Dielectric Strength	>12.12

Exposure With:	Dielectric Strength	
R-22 500 HRS. @ 212 F	>16.84	******
R-407C 168 HRS. @ 212 F	******	>15.12
R-407C 336 HRS. @ 212 F	******	>15.83
R-407C 500 HRS. @ 212 F	******	>11.88
R-22 1000 HRS. @ 212 F	8.18	******

AC 9000 exposures are in addition to an initial 500 hr. R-22 exposure

Results for R-502 / R-404C retrofit

	Sleeving type
	PET
Unexposed Dielectric Strength	>17.60

Exposure With:	Dielectric Strength	
R-502 500 HRS. @ 212 F	>17.19	******
R-404C 168 HRS. @ 212 F	******	>17.19
R-404C 336 HRS. @ 212 F	******	>17.32
R-404C 500 HRS. @ 212 F	******	>16.10
R-502 1000 HRS. @ 212 F	>13.02	******

	Sleeving type
	Nomex- PET
Unexposed Dielectric Strength	>12.12

Exposure With:	Dielectric Strength	
R-502 500 HRS. @ 212 F	>12.21	******
R-404C 168 HRS. @ 212 F	******	>12.21
R-404C 336 HRS. @ 212 F	******	>10.81
R-404C 500 HRS. @ 212 F	******	10.80
R-502 1000 HRS. @ 212 F	6.04	******

R-404C exposures are in addition to an initial 500 hr. R-502 exposure

Results for R-12 / R-134a retrofit

Polyester film

	Tensile strength	Elongation
Unexposed	22.5 ksi	134.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	-21.5%	******	-10.6%	******
R-134a 168 HRS. @ 212 F	******	-25.4%	******	-25.5%
R-134a 336 HRS. @ 212 F	******	-30.4%	******	-75.7%
R-134a 500 HRS. @ 212 F	******	-35.2%	******	-81.8%
R-12 1000 HRS. @ 212 F	brittle	******	brittle	******

	Dielectric strength
Unexposed	14.10 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	>14.12	******
R-134a 168 HRS. @ 212 F	******	>13.83
R-134a 336 HRS. @ 212 F	******	>14.42
R-134a 500 HRS. @ 212 F	******	>14.14
R-12 1000 HRS. @ 212 F	>14.37	******

Polyester film (24 hour air bake)

	Tensile strength	Elongation
Unexposed	22.5 ksi	134.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	brittle	******	brittle	******
R-134a 168 HRS. @ 212 F	******	brittle	******	brittle
R-134a 336 HRS. @ 212 F	******	brittle	******	brittle
R-134a 500 HRS. @ 212 F	******	brittle	******	brittle
R-12 1000 HRS. @ 212 F	brittle	******	brittle	******

	Dielectric strength
Unexposed	>14.10 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	>14.16	******
R-134a 168 HRS. @ 212 F	******	>14.63
R-134a 336 HRS. @ 212 F	******	>13.00
R-134a 500 HRS. @ 212 F	******	>14.46
R-12 1000 HRS. @ 212 F	>14.64	******

R-134a exposures are in addition to an initial 500 hour R-12

Sheet Insulation

Results for R-12 / R-134a retrofit

Polyester film low oligomer

	Tensile strength	Elongation
Unexposed	19.1 ksi	142.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	-14.9%	******	-26.6%	******
R-134a 168 HRS. @ 212 F	******	-16.9%	******	-25.3%
R-134a 336 HRS. @ 212 F	******	-15.1%	******	-94.8%
R-134a 500 HRS. @ 212 F	******	-16.0%	******	-93.8%
R-12 1000 HRS. @ 212 F	brittle	******	britte	******

	Dielectric strength
Unexposed	>14.60 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	>14.74	******
R-134a 168 HRS. @ 212 F	******	>14.46
R-134a 336 HRS. @ 212 F	******	>14.67
R-134a 500 HRS. @ 212 F	******	>14.27
R-12 1000 HRS. @ 212 F	>14.33	******

Polyester film low oligomer (24 hour air bake)

	Tensile strength	Elongation
Unexposed	19.1 ksi	147.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	brittle	******	brittle	******
R-134a 168 HRS. @ 212 F	******	brittle	******	brittle
R-134a 336 HRS. @ 212 F	******	brittle	******	brittle
R-134a 500 HRS. @ 212 F	******	brittle	******	brittle
R-12 1000 HRS. @ 212 F	brittle	******	britte	******

	Dielectric strength
Unexposed	>14.60 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	>14.03	******
R-134a 168 HRS. @ 212 F	******	>15.22
R-134a 336 HRS. @ 212 F	******	>14.59
R-134a 500 HRS. @ 212 F	******	>14.86
R-12 1000 HRS. @ 212 F	>14.64	******

R-134a exposures are in addition to an initial 500 hour R-12

Results for R-12 / R-134a retrofit

Dacron Mylar Dacron

	Tensile strength	Elongation
Unexposed	13.4 ksi	29.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	-1.9%	******	-15.2%	******
R-134a 168 HRS. @ 212 F	******	-10.4%	******	13.1%
R-134a 336 HRS. @ 212 F	******	-12.7%	******	-20.5%
R-134a 500 HRS. @ 212 F	******	-15.1%	******	14.8%
R-12 1000 HRS. @ 212 F	brittle	******	brittle	******

	Dielectric strength
Unexposed	>18.56 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	>17.13	******
R-134a 168 HRS. @ 212 F	******	>17.64
R-134a 336 HRS. @ 212 F	******	>17.47
R-134a 500 HRS. @ 212 F	******	>19.60
R-12 1000 HRS. @ 212 F	>19.46	******

Dacron Mylar Dacron (24 hour air bake)

	Tensile strength	Elongation
Unexposed	13.4 ksi	29.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	-86.9%	******	-95.5%	******
R-134a 168 HRS. @ 212 F	******	brittle	******	brittle
R-134a 336 HRS. @ 212 F	******	brittle	******	brittle
R-134a 500 HRS. @ 212 F	******	brittle	******	brittle
R-12 1000 HRS. @ 212 F	brittle	******	brittle	******

	Dielectric strength
Unexposed	>18.56 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	>17.60	******
R-134a 168 HRS. @ 212 F	******	>13.87
R-134a 336 HRS. @ 212 F	******	>15.33
R-134a 500 HRS. @ 212 F	******	>16.14
R-12 1000 HRS. @ 212 F	>14.62	******

R-134a exposures are in addition to an initial 500 hour R-12

Sheet Insulation

Results for R-12 / R-134a retrofit

Nomex

	Tensile strength	Elongation
Unexposed	18.1 ksi	16.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	-7.0%	******	-20.5%	******
R-134a 168 HRS. @ 212 F	******	2.8%	******	-7.2%
R-134a 336 HRS. @ 212 F	******	0.0%	******	-52.8%
R-134a 500 HRS. @ 212 F	******	-6.0%	******	-25.6%
R-12 1000 HRS. @ 212 F	-7.9%	******	-29.2%	******

	Dielectric strength
Unexposed	10.29 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	13.82	******
R-134a 168 HRS. @ 212 F	******	13.79
R-134a 336 HRS. @ 212 F	******	13.96
R-134a 500 HRS. @ 212 F	******	13.28
R-12 1000 HRS. @ 212 F	13.33	******

Nomex (24 hour air bake)

	Tensile strength	Elongation
Unexposed	18.1 ksi	16.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	7.7%	******	-41.0%	******
R-134a 168 HRS. @ 212 F	******	5.9%	******	-39.0%
R-134a 336 HRS. @ 212 F	******	3.9%	******	-20.5%
R-134a 500 HRS. @ 212 F	******	-3.2%	******	-43.6%
R-12 1000 HRS. @ 212 F	6.4%	******	-23.1%	******

	Dielectric strength
Unexposed	10.29 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	11.49	******
R-134a 168 HRS. @ 212 F	******	11.25
R-134a 336 HRS. @ 212 F	******	10.84
R-134a 500 HRS. @ 212 F	******	10.34
R-12 1000 HRS. @ 212 F	9.80	******

R-134a exposures are in addition to an initial 500 hour R-12

Results for R-12 / R-134a retrofit

Nomex Mica

	Tensile strength	Elongation
Unexposed	7.1 ksi	1.9%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	-19.8%	******	30.2%	******
R-134a 168 HRS. @ 212 F	******	-15.3%	******	64.9%
R-134a 336 HRS. @ 212 F	******	-3.3%	******	56.3%
R-134a 500 HRS. @ 212 F	******	-20.1%	******	51.9%
R-12 1000 HRS. @ 212 F	-20.7%	******	30.2%	******

	Dielectric strength
Unexposed	11.39 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	12.72	******
R-134a 168 HRS. @ 212 F	******	12.39
R-134a 336 HRS. @ 212 F	******	12.05
R-134a 500 HRS. @ 212 F	******	11.06
R-12 1000 HRS. @ 212 F	12.70	******

Nomex Mica (24 hour air bake)

	Tensile strength	Elongation
Unexposed	7.1 ksi	1.9%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	2.8%	******	-65.3%	******
R-134a 168 HRS. @ 212 F	******	-3.6%	******	-47.9%
R-134a 336 HRS. @ 212 F	******	4.6%	******	-30.6%
R-134a 500 HRS. @ 212 F	******	-0.7%	******	-21.9%
R-12 1000 HRS. @ 212 F	3.5%	******	-17.5%	******

	Dielectric strength
Unexposed	11.39 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	11.14	******
R-134a 168 HRS. @ 212 F	******	12.72
R-134a 336 HRS. @ 212 F	******	11.30
R-134a 500 HRS. @ 212 F	******	11.89
R-12 1000 HRS. @ 212 F	11.72	******

R-134a exposures are in addition to an initial 500 hour R-12

Sheet Insulation

Results for R-12 / R-134a retrofit

Nomex Mylar Nomex

	Tensile strength	Elongation
Unexposed	17.1 ksi	25.5%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	-5.2%	******	-22.2%	******
R-134a 168 HRS. @ 212 F	******	3.2%	******	-54.6%
R-134a 336 HRS. @ 212 F	******	2.5%	******	-61.1%
R-134a 500 HRS. @ 212 F	******	-6.7%	******	-68.6%
R-12 1000 HRS. @ 212 F	-51.5%	******	-72.2%	******

	Dielectric strength
Unexposed	>17.76 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	>18.55	******
R-134a 168 HRS. @ 212 F	******	>18.61
R-134a 336 HRS. @ 212 F	******	>19.06
R-134a 500 HRS. @ 212 F	******	>19.73
R-12 1000 HRS. @ 212 F	>17.58	******

Nomex Mylar Nomex (24 hour air bake)

	Tensile strength	Elongation
Unexposed	17.1 ksi	25.5%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	-54.2%	******	-76.5%	******
R-134a 168 HRS. @ 212 F	******	-62.6%	******	-85.0%
R-134a 336 HRS. @ 212 F	******	brittle	******	brittle
R-134a 500 HRS. @ 212 F	******	brittle	******	brittle
R-12 1000 HRS. @ 212 F	brittle	******	brittle	******

	Dielectric strength
Unexposed	>17.76 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	>16.54	******
R-134a 168 HRS. @ 212 F	******	>19.48
R-134a 336 HRS. @ 212 F	******	>17.35
R-134a 500 HRS. @ 212 F	******	>19.03
R-12 1000 HRS. @ 212 F	>15.81	******

R-134a exposures are in addition to an initial 500 hour R-12

Results for R-22 / R-407C retrofit

Polyester film

	Tensile strength	Elongation
Unexposed	22.5 ksi	134.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	-25.2%	******	1.0%	******
R-407C 168 HRS. @ 212 F	******	-28.2%	******	-38.2%
R-407C 336 HRS. @ 212 F	******	-31.3%	******	-71.9%
R-407C 500 HRS. @ 212 F	******	-32.5%	******	-84.3%
R-22 1000 HRS. @ 212 F	brittle	******	brittle	******

	Dielectric strength
Unexposed	>14.10 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	>14.41	******
R-407C 168 HRS. @ 212 F	******	>14.36
R-407C 336 HRS. @ 212 F	******	>14.22
R-407C 500 HRS. @ 212 F	******	>14.42
R-22 1000 HRS. @ 212 F	>14.04	******

Polyester film (24 hour air bake)

	Tensile strength	Elongation
Unexposed	22.5 ksi	134.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	brittle	******	brittle	******
R-407C 168 HRS. @ 212 F	******	brittle	******	brittle
R-407C 336 HRS. @ 212 F	******	brittle	******	brittle
R-407C 500 HRS. @ 212 F	******	brittle	******	brittle
R-22 1000 HRS. @ 212 F	brittle	******	britte	******

	Dielectric strength
Unexposed	>14.10 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	>13.18	******
R-407C 168 HRS. @ 212 F	******	>14.59
R-407C 336 HRS. @ 212 F	******	>13.24
R-407C 500 HRS. @ 212 F	******	>12.53
R-22 1000 HRS. @ 212 F	brittle	******

R-407C exposures are in addition to an initial 500 hour R-22 exposure

Results for R-22 / R-407C retrofit

Polyester film low oligomer

	Tensile strength	Elongation
Unexposed	19.1 ksi	142.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	-13.2%	******	-25.2%	******
R-407C 168 HRS. @ 212 F	******	-13.8%	******	-1.2%
R-407C 336 HRS. @ 212 F	******	-18.3%	******	-56.9%
R-407C 500 HRS. @ 212 F	******	-18.1%	******	-95.1%
R-22 1000 HRS. @ 212 F	brittle	******	brittle	******

	Dielectric strength
Unexposed	>14.60 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	>14.84	******
R-407C 168 HRS. @ 212 F	******	>14.51
R-407C 336 HRS. @ 212 F	******	>14.59
R-407C 500 HRS. @ 212 F	******	>15.15
R-22 1000 HRS. @ 212 F	>14.82	******

Polyester film low oligomer (24 hour air bake)

	Tensile strength	Elongation
Unexposed	19.1 ksi	142.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	brittle	******	brittle	******
R-407C 168 HRS. @ 212 F	******	brittle	******	brittle
R-407C 336 HRS. @ 212 F	******	brittle	******	brittle
R-407C 500 HRS. @ 212 F	******	brittle	******	brittle
R-22 1000 HRS. @ 212 F	brittle	******	brittle	******

	Dielectric strength
Unexposed	>14.60 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	>14.45	******
R-407C 168 HRS. @ 212 F	******	>15.24
R-407C 336 HRS. @ 212 F	******	>14.35
R-407C 500 HRS. @ 212 F	******	>13.61
R-22 1000 HRS. @ 212 F	brittle	******

R-407C exposures are in addition to an initial 500 hour R-22 exposure

Sheet Insulation

Results for R-22 / R-407C retrofit

Dacron Mylar Dacron

	Tensile strength	Elongation
Unexposed	13.4 ksi	29.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	-8.7%	******	-14.8%	******
R-407C 168 HRS. @ 212 F	******	-11.2%	******	50.6%
R-407C 336 HRS. @ 212 F	******	-14.2%	******	15.4%
R-407C 500 HRS. @ 212 F	******	-30.9%	******	30.7%
R-22 1000 HRS. @ 212 F	-80.4%	******	-93.8%	******

	Dielectric strength
Unexposed	>18.56 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	>16.46	******
R-407C 168 HRS. @ 212 F	******	>17.73
R-407C 336 HRS. @ 212 F	******	>19.99
R-407C 500 HRS. @ 212 F	******	>19.48
R-22 1000 HRS. @ 212 F	>18.76	******

Dacron Mylar Dacron (24 hour air bake)

	Tensile strength	Elongation
Unexposed	13.4 ksi	29.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	brittle	******	brittle	******
R-407C 168 HRS. @ 212 F	******	brittle	******	brittle
R-407C 336 HRS. @ 212 F	******	brittle	******	brittle
R-407C 500 HRS. @ 212 F	******	brittle	******	brittle
R-22 1000 HRS. @ 212 F	brittle	******	brittle	******

	Dielectric strength
Unexposed	>18.56 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	>14.75	******
R-407C 168 HRS. @ 212 F	******	>16.38
R-407C 336 HRS. @ 212 F	******	>16.77
R-407C 500 HRS. @ 212 F	******	>12.53
R-22 1000 HRS. @ 212 F	4.75	******

R-407C exposures are in addition to an initial 500 hour R-22 exposure

Sheet Insulation

Results for R-22 / R-407C retrofit

Nomex

	Tensile strength	Elongation
Unexposed	18.1 ksi	16.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	-8.2%	******	-19.0%	******
R-407C 168 HRS. @ 212 F	******	-3.0%	******	-54.4%
R-407C 336 HRS. @ 212 F	******	-9.8%	******	-21.5%
R-407C 500 HRS. @ 212 F	******	-8.1%	******	-59.0%
R-22 1000 HRS. @ 212 F	-13.6%	******	-47.7%	******

	Dielectric strength
Unexposed	10.24 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	13.70	******
R-407C 168 HRS. @ 212 F	******	14.84
R-407C 336 HRS. @ 212 F	******	13.10
R-407C 500 HRS. @ 212 F	******	12.62
R-22 1000 HRS. @ 212 F	13.80	******

Nomex (24 hour air bake)

	Tensile strength	Elongation
Unexposed	18.1 ksi	16.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	6.3%	******	-76.9%	******
R-407C 168 HRS. @ 212 F	******	-1.4%	******	-66.2%
R-407C 336 HRS. @ 212 F	******	-2.3%	******	-41.5%
R-407C 500 HRS. @ 212 F	******	-9.2%	******	-56.4%
R-22 1000 HRS. @ 212 F	-13.7%	******	-69.7%	******

	Dielectric strength
Unexposed	10.24 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	9.97	******
R-407C 168 HRS. @ 212 F	******	12.09
R-407C 336 HRS. @ 212 F	******	10.41
R-407C 500 HRS. @ 212 F	******	11.44
R-22 1000 HRS. @ 212 F	10.81	******

R-407C exposures are in addition to an initial 500 hour R-22 exposure

Sheet Insulation

Results for R-22 / R-407C retrofit

Nomex Mica

	Tensile strength	Elongation
Unexposed	7.1 ksi	1.9%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	-18.0%	******	4.2%	******
R-407C 168 HRS. @ 212 F	******	-9.3%	******	-17.5%
R-407C 336 HRS. @ 212 F	******	-20.6%	******	8.5%
R-407C 500 HRS. @ 212 F	******	-18.6%	******	-26.2%
R-22 1000 HRS. @ 212 F	-15.3%	******	-17.5%	******

	Dielectric strength
Unexposed	11.39 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	>13.80	******
R-407C 168 HRS. @ 212 F	******	12.47
R-407C 336 HRS. @ 212 F	******	12.69
R-407C 500 HRS. @ 212 F	******	11.89
R-22 1000 HRS. @ 212 F	13.24	******

Nomex Mica (24 hour air bake)

	Tensile strength	Elongation
Unexposed	7.1 ksi	1.9%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	-1.1%	******	-65.3%	******
R-407C 168 HRS. @ 212 F	******	-1.0%	******	-56.6%
R-407C 336 HRS. @ 212 F	******	-0.1%	******	-47.9%
R-407C 500 HRS. @ 212 F	******	-6.9%	******	-47.9%
R-22 1000 HRS. @ 212 F	-15.2%	******	-56.6%	******

	Dielectric strength
Unexposed	11.39 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	10.39	******
R-407C 168 HRS. @ 212 F	******	13.19
R-407C 336 HRS. @ 212 F	******	12.45
R-407C 500 HRS. @ 212 F	******	12.20
R-22 1000 HRS. @ 212 F	8.29	******

R-407C exposures are in addition to an initial 500 hour R-22 exposure

Results for R-22 / R-407C retrofit

Nomex Mylar Nomex

	Tensile strength	Elongation
Unexposed	17.1 ksi	25.5%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	-15.0%	******	-40.2%	******
R-407C 168 HRS. @ 212 F	******	-25.8%	******	-74.8%
R-407C 336 HRS. @ 212 F	******	-54.1%	******	-94.1%
R-407C 500 HRS. @ 212 F	******	-60.1%	******	-79.4%
R-22 1000 HRS. @ 212 F	-53.3%	******	-92.2%	******

	Dielectric strength
Unexposed	>17.76 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	>19.65	******
R-407C 168 HRS. @ 212 F	******	>19.53
R-407C 336 HRS. @ 212 F	******	>19.95
R-407C 500 HRS. @ 212 F	******	>19.50
R-22 1000 HRS. @ 212 F	>17.17	******

Nomex Mylar Nomex (24 hour air bake)

	Tensile strength	Elongation
Unexposed	17.1 ksi	25.5%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	-49.3%	******	-86.9%	******
R-407C 168 HRS. @ 212 F	******	-53.1%	******	-69.6%
R-407C 336 HRS. @ 212 F	******	-49.6%	******	-68.0%
R-407C 500 HRS. @ 212 F	******	delamination	******	delamination
R-22 1000 HRS. @ 212 F	delamination	******	delamination	******

	Dielectric strength
Unexposed	>17.76 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	>14.04	******
R-407C 168 HRS. @ 212 F	******	>19.85
R-407C 336 HRS. @ 212 F	******	>16.38
R-407C 500 HRS. @ 212 F	******	>16.34
R-22 1000 HRS. @ 212 F	>19.08	******

R-407C exposures are in addition to an initial 500 hour R-22 exposure

Sheet Insulation

Results for R-502 / R-404A retrofit

Polyester film

	Tensile strength	Elongation
Unexposed	22.5 ksi	134.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-502 500 HRS. @ 212 F	-26.3%	******	-45.9%	******
R-404A 168 HRS. @ 212 F	******	-20.8%	******	-50.8%
R-404A 336 HRS. @ 212 F	******	-13.5%	******	-94.6%
R-404A 500 HRS. @ 212 F	******	-12.1%	******	-95.1%
R-502 1000 HRS. @ 212 F	brittle	******	brittle	******

	Dielectric strength
Unexposed	>14.10 kv

Exposure With:	recorded dielectric strength	
R-502 500 HRS. @ 212 F	>14.50	******
R-404A 168 HRS. @ 212 F	******	>14.50
R-404A 336 HRS. @ 212 F	******	>14.48
R-404A 500 HRS. @ 212 F	******	>14.43
R-502 1000 HRS. @ 212 F	>14.42	******

Polyester film (24 hour air bake)

	Tensile strength	Elongation
Unexposed	22.5 ksi	134.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-502 500 HRS. @ 212 F	-21.2%	******	-26.6%	******
R-404A 168 HRS. @ 212 F	******	-17.8%	******	-36.1%
R-404A 336 HRS. @ 212 F	******	-20.4%	******	-59.5%
R-404A 500 HRS. @ 212 F	******	-19.7%	******	-94.4%
R-502 1000 HRS. @ 212 F	brittle	******	brittle	******

	Dielectric strength
Unexposed	>14.10 kv

Exposure With:	recorded dielectric strength	
R-502 500 HRS. @ 212 F	>14.17	******
R-404A 168 HRS. @ 212 F	******	>14.34
R-404A 336 HRS. @ 212 F	******	>14.29
R-404A 500 HRS. @ 212 F	******	>14.48
R-502 1000 HRS. @ 212 F	>14.02	******

R-404A exposures are in addition to an initial 500 hour R-502 exposure

Results for R-502 / R-404A retrofit

Polyester film low oligomer

	Tensile strength	Elongation
Unexposed	19.1 ksi	142.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-502 500 HRS. @ 212 F	-10.5%	******	-26.7%	******
R-404A 168 HRS. @ 212 F	******	-14.9%	******	-56.2%
R-404A 336 HRS. @ 212 F	******	-13.5%	******	-94.6%
R-404A 500 HRS. @ 212 F	******	-12.1%	******	-95.1%
R-502 1000 HRS. @ 212 F	brittle	******	brittle	******

	Dielectric strength
Unexposed	>14.60 kv

Exposure With:	recorded dielectric strength	
R-502 500 HRS. @ 212 F	>14.68	******
R-404A 168 HRS. @ 212 F	******	>15.40
R-404A 336 HRS. @ 212 F	******	>14.48
R-404A 500 HRS. @ 212 F	******	>14.61
R-502 1000 HRS. @ 212 F	>13.98	******

Polyester film low oligomer (24 hour air bake)

	Tensile strength	Elongation
Unexposed	19.1 ksi	142.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-502 500 HRS. @ 212 F	-9.1%	******	-12.8%	******
R-404A 168 HRS. @ 212 F	******	-18.7%	******	-48.5%
R-404A 336 HRS. @ 212 F	******	-8.5%	******	-95.1%
R-404A 500 HRS. @ 212 F	******	-13.0%	******	-94.9%
R-502 1000 HRS. @ 212 F	brittle	******	brittle	******

	Dielectric strength
Unexposed	>14.60 kv

Exposure With:	recorded dielectric strength	
R-502 500 HRS. @ 212 F	>14.27	******
R-404A 168 HRS. @ 212 F	******	>14.76
R-404A 336 HRS. @ 212 F	******	>14.13
R-404A 500 HRS. @ 212 F	******	>15.28
R-502 1000 HRS. @ 212 F	>14.39	******

R-404A exposures are in addition to an initial 500 hour R-502 exposure

Sheet Insulation

Results for R-502 / R-404A retrofit

Dacron Mylar Dacron

	Tensile strength	Elongation
Unexposed	13.4 ksi	29.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-502 500 HRS. @ 212 F	-11.3%	******	-39.8%	******
R-404A 168 HRS. @ 212 F	******	-8.5%	******	-29.0%
R-404A 336 HRS. @ 212 F	******	-4.0%	******	-22.7%
R-404A 500 HRS. @ 212 F	******	-4.9%	******	-28.4%
R-502 1000 HRS. @ 212 F	-83.1%	******	-93.8%	******

	Dielectric strength
Unexposed	>18.56 kv

Exposure With:	recorded dielectric strength	
R-502 500 HRS. @ 212 F	>16.79	******
R-404A 168 HRS. @ 212 F	******	>17.20
R-404A 336 HRS. @ 212 F	******	>19.15
R-404A 500 HRS. @ 212 F	******	>17.90
R-502 1000 HRS. @ 212 F	>16.68	******

Dacron Mylar Dacron (24 hour air bake)

	Tensile strength	Elongation
Unexposed	13.4 ksi	29.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-502 500 HRS. @ 212 F	-0.2%	******	-29.3%	******
R-404A 168 HRS. @ 212 F	******	-3.5%	******	-32.4%
R-404A 336 HRS. @ 212 F	******	-3.0%	******	-34.1%
R-404A 500 HRS. @ 212 F	******	-2.7%	******	-24.4%
R-502 1000 HRS. @ 212 F	brittle	******	brittle	******

	Dielectric strength
Unexposed	>18.56 kv

Exposure With:	recorded dielectric strength	
R-502 500 HRS. @ 212 F	>19.37	******
R-404A 168 HRS. @ 212 F	******	>19.05
R-404A 336 HRS. @ 212 F	******	>19.66
R-404A 500 HRS. @ 212 F	******	>17.76
R-502 1000 HRS. @ 212 F	>17.17	******

R-404A exposures are in addition to an initial 500 hour R-502 exposure

Sheet Insulation

Results for R-502 / R-404A retrofit

Nomex

	Tensile strength	Elongation
Unexposed	18.1 ksi	16.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-502 500 HRS. @ 212 F	-10.4%	******	-15.9%	******
R-404A 168 HRS. @ 212 F	******	-5.6%	******	-37.4%
R-404A 336 HRS. @ 212 F	******	-3.4%	******	-35.9%
R-404A 500 HRS. @ 212 F	******	-0.4%	******	-27.2%
R-502 1000 HRS. @ 212 F	-7.4%	******	-47.2%	******

	Dielectric strength
Unexposed	10.24 kv

Exposure With:	recorded dielectric strength	
R-502 500 HRS. @ 212 F	12.19	******
R-404A 168 HRS. @ 212 F	******	13.53
R-404A 336 HRS. @ 212 F	******	12.59
R-404A 500 HRS. @ 212 F	******	13.34
R-502 1000 HRS. @ 212 F	13.54	******

Nomex (24 hour air bake)

	Tensile strength	Elongation
Unexposed	18.1 ksi	16.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-502 500 HRS. @ 212 F	11.8%	******	-43.1%	******
R-404A 168 HRS. @ 212 F	******	-4.7%	******	-12.8%
R-404A 336 HRS. @ 212 F	******	-1.9%	******	-40.0%
R-404A 500 HRS. @ 212 F	******	-9.5%	******	-42.1%
R-502 1000 HRS. @ 212 F	-6.5%	******	-50.3%	******

	Dielectric strength
Unexposed	10.24 kv

Exposure With:	recorded dielectric strength	
R-502 500 HRS. @ 212 F	11.02	******
R-404A 168 HRS. @ 212 F	******	12.71
R-404A 336 HRS. @ 212 F	******	10.96
R-404A 500 HRS. @ 212 F	******	11.36
R-502 1000 HRS. @ 212 F	10.67	******

R-404A exposures are in addition to an initial 500 hour R-502 exposure

Sheet Insulation

Results for R-502 / R-404A retrofit

Nomex Mica

	Tensile strength	Elongation
Unexposed	7.1 ksi	1.9%

Exposure With:	% change from unexposed		% change from unexposed	
R-502 500 HRS. @ 212 F	-22.5%	******	12.9%	******
R-404A 168 HRS. @ 212 F	******	-23.3%	******	8.5%
R-404A 336 HRS. @ 212 F	******	-12.4%	******	-13.2%
R-404A 500 HRS. @ 212 F	******	-14.4%	******	-8.9%
R-502 1000 HRS. @ 212 F	-12.5%	******	-17.5%	******

	Dielectric strength
Unexposed	11.39 kv

Exposure With:	recorded dielectric strength	
R-502 500 HRS. @ 212 F	13.56	******
R-404A 168 HRS. @ 212 F	******	13.58
R-404A 336 HRS. @ 212 F	******	11.46
R-404A 500 HRS. @ 212 F	******	12.72
R-502 1000 HRS. @ 212 F	13.30	******

Nomex Mica (24 hour air bake)

	Tensile strength	Elongation
Unexposed	7.1 ksi	1.9%

Exposure With:	% change from unexposed		% change from unexposed	
R-502 500 HRS. @ 212 F	-4.7%	******	-8.9%	******
R-404A 168 HRS. @ 212 F	******	-23.4%	******	21.5%
R-404A 336 HRS. @ 212 F	******	-15.9%	******	-17.5%
R-404A 500 HRS. @ 212 F	******	-16.7%	******	-8.9%
R-502 1000 HRS. @ 212 F	-17.8%	******	-13.2%	******

	Dielectric strength
Unexposed	11.39 kv

Exposure With:	recorded dielectric strength	
R-502 500 HRS. @ 212 F	10.78	******
R-404A 168 HRS. @ 212 F	******	12.17
R-404A 336 HRS. @ 212 F	******	12.20
R-404A 500 HRS. @ 212 F	******	12.84
R-502 1000 HRS. @ 212 F	11.34	******

R-404A exposures are in addition to an initial 500 hour R-502 exposure

Results for R-502 / R-404A retrofit

Nomex Mylar Nomex

	Tensile strength	Elongation
Unexposed	17.1 ksi	15.5%

Exposure With:	% change from unexposed		% change from unexposed	
R-502 500 HRS. @ 212 F	-16.1%	******	-39.2%	******
R-404A 168 HRS. @ 212 F	******	-8.9%	******	-39.2%
R-404A 336 HRS. @ 212 F	******	-4.8%	******	-42.5%
R-404A 500 HRS. @ 212 F	******	-17.2%	******	-57.8%
R-502 1000 HRS. @ 212 F	-66.1%	******	-76.5%	******

	Dielectric strength
Unexposed	>17.76 kv

Exposure With:	recorded dielectric strength	
R-502 500 HRS. @ 212 F	>18.62	******
R-404A 168 HRS. @ 212 F	******	>18.65
R-404A 336 HRS. @ 212 F	******	>17.81
R-404A 500 HRS. @ 212 F	******	>18.65
R-502 1000 HRS. @ 212 F	>19.25	******

Nomex Mylar Nomex (24 hour air bake)

	Tensile strength	Elongation
Unexposed	17.1 ksi	15.5%

Exposure With:	% change from unexposed		% change from unexposed	
R-502 500 HRS. @ 212 F	-0.2%	******	-65.7%	******
R-404A 168 HRS. @ 212 F	******	-40.2%	******	-69.0%
R-404A 336 HRS. @ 212 F	******	-8.0%	******	-62.4%
R-404A 500 HRS. @ 212 F	******	-16.7%	******	-68.6%
R-502 1000 HRS. @ 212 F	-55.2%	******	-64.1%	******

	Dielectric strength
Unexposed	>17.76 kv

Exposure With:	recorded dielectric strength	
R-502 500 HRS. @ 212 F	>17.67	******
R-404A 168 HRS. @ 212 F	******	>19.30
R-404A 336 HRS. @ 212 F	******	>18.25
R-404A 500 HRS. @ 212 F	******	>18.24
R-502 1000 HRS. @ 212 F	>18.72	******

R-404A exposures are in addition to an initial 500 hour R-502 exposure

Tapes and Tie Cords

Results for R-12 / R134a retrofit

Heat shrinkable braided polyester

	Tensile strength	Elongation
Unexposed	42.55 lbs.	21.2%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	-18.1%	******	-38.6%	******
R-134a 168 HRS. @ 212 F	******	-19.9%	******	-31.5%
R-134a 500 HRS. @ 212 F	******	-20.8%	******	-49.6%
R-134a 500 HRS. @ 212 F	******	-29.1%	******	-56.7%
R-12 1000 HRS. @ 212 F	-88.7%	******	-78.7%	******

Braided polyester acrylic binder

	Tensile strength	Elongation
Unexposed	452.17 lbs	5.7%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	0.9%	******	38.2%	******
R-134a 168 HRS. @ 212 F	******	-16.4%	******	-17.7%
R-134a 500 HRS. @ 212 F	******	-12.6%	******	-11.8%
R-134a 500 HRS. @ 212 F	******	-8.4%	******	-5.9%
R-12 1000 HRS. @ 212 F	-13.4%	******	-2.9%	******

Polyester tie cord

	Tensile strength	Elongation
Unexposed	34.47 lbs.	16.7%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	-36.5%	******	12.0%	******
R-134a 168 HRS. @ 212 F	******	-41.8%	******	1.0%
R-134a 500 HRS. @ 212 F	******	-49.5%	******	-21.0%
R-134a 500 HRS. @ 212 F	******	-55.8%	******	-17.5%
R-12 1000 HRS. @ 212 F	-72.7%	******	-69.0%	******

R-134a exposures are in addition to an initial 500 hr. R-12 exposure

Results for R-22 /R-407C retrofit

Heat shrinkable braided polyester

	Tensile strength	Elongation
Unexposed	42.55 lbs	29.1%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	24.2%	******	29.1%	******
R-407C HRS. @ 212 F	******	5.5%	******	3.2%
R-407C 336 HRS. @ 212 F	******	-4.9%	******	-12.6%
R-407C 500 HRS. @ 212 F	******	-1.6%	******	-29.1%
R-22 1000 HRS. @ 212 F	-18.6%	******	-39.4%	******

Braided polyester acrylic binder

	Tensile strength	Elongation
Unexposed	452.17 lbs	5.7%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	-28.1%	******	-35.3%	******
R-407C HRS. @ 212 F	******	-2.9%	******	-11.8%
R-407C 336 HRS. @ 212 F	******	-15.3%	******	-23.5%
R-407C 500 HRS. @ 212 F	******	-32.3%	******	-41.2%
R-22 1000 HRS. @ 212 F	-0.5%	******	-11.8%	******

Polyester tie cord

	Tensile strength	Elongation
Unexposed	34.47 lbs	16.7%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	-2.5%	******	18.0%	******
R-407C HRS. @ 212 F	******	-9.5%	******	57.0%
R-407C 336 HRS. @ 212 F	******	-3.4%	******	159.0%
R-407C 500 HRS. @ 212 F	******	-14.6%	******	52.0%
R-22 1000 HRS. @ 212 F	-31.3%	******	13.0%	******

R-407C exposures are in addition to an initial 500 hr. R-22 exposure

Tapes and Tie Cords

Results for R-502 / R-404A retrofit

Heat shrinkable braided polyester

	Tensile strength	Elongation
Unexposed	38.52 lbs	21.2%

Exposure With:	% change from unexposed		% change from unexposed	
R-502 500 HRS. @ 212 F	-9.5%	******	-21.4%	******
R-404A 168 HRS. @ 212 F	******	-6.4%	******	-31.5%
R-404A 336 HRS. @ 212 F	******	-19.0%	******	-29.1%
R-404A 500 HRS. @ 212 F	******	-8.0%	******	-30.7%
R-502 1000 HRS. @ 212 F	-40.4%	******	-82.7%	******

Braided polyester acrylic binder

	Tensile strength	Elongation
Unexposed	452.2 lbs	5.7%

Exposure With:	% change from unexposed		% change from unexposed	
R-502 500 HRS. @ 212 F	-16.6%	******	-17.7%	******
R-404A 168 HRS. @ 212 F	******	-1.5%	******	8.8%
R-404A 336 HRS. @ 212 F	******	-22.2%	******	-29.4%
R-404A 500 HRS. @ 212 F	******	-20.7%	******	-17.7%
R-502 1000 HRS. @ 212 F	-33.2%	******	17.7%	******

Polyester tie cord

	Tensile strength	Elongation
Unexposed	32.0 lbs	34.0%

Exposure With:	% change from unexposed		% change from unexposed	
R-502 500 HRS. @ 212 F	-12.3%	******	34.0%	******
R-404A 168 HRS. @ 212 F	******	-20.6%	******	-7.0%
R-404A 336 HRS. @ 212 F	******	-24.8%	******	22.0%
R-404A 500 HRS. @ 212 F	******	-7.2%	******	27.0%
R-502 1000 HRS. @ 212 F	-36.7%	******	-4.0%	******

R-404A exposures are in addition to an initial 500 hr. R-502 exposure

Motorette

Results after 500-hour exposure to old refrigerant.

	Mottorette Wire Type		
	Wire Type A	Wire Type B	Wire Type C
Unexposed	Pass	Pass	Pass
Exposure With:	**Voltage Withstand**		
R-11 @ 212 F	******	******	Pass
R-12 @ 260 F	Pass	Pass	******
R-22 @ 260 F	Pass	Pass	******
R-502 @ 260F	Pass	Pass	******

Results after 500-hour exposure to old refrigerant plus 168-hour exposure to alternative refrigerant.

	Mottorette Wire Type		
	Wire Type A	Wire Type B	Wire Type C
Unexposed	Pass	Pass	Pass
Exposure With:	**Voltage Withstand**		
R-11 and R-123 @ 212 F	******	******	Pass
R-12 and R-134a @ 260 F	Pass	Pass	******
R-22 and R-(32/125/134a) @ 260 F	Pass	Pass	******
R-502 and R-(125/143a/134a) @ 260 F	Pass	Pass	******

R-11/R-123 exposures were not used for wire A and B.
R-12/R-134a, R-22/R-(32/125/134a), and R-502/R-(125/143a/134a) exposures were not used for wire C.
Wire Type A is Polyester base with amide imide overcoat
Wire Type B is Esterimide base with amide imide overcoat
Wire Type C is Polyester base with amide imide overcoat and epoxy saturated glass serving.

Motorette

Results after 500-hour exposure to old refrigerant plus 336-hour exposure to alternative refrigerant.

	Mottorette Wire Type		
	Wire Type A	Wire Type B	Wire Type C
Unexposed	Pass	Pass	Pass
Exposure With:	Voltage Withstand		
R-11 and R-123 @ 212 F	******	******	Pass
R-12 and R-134a @ 260 F	Pass	Pass	******
R-22 and R-(32/125/134a) @ 260 F	Pass	Pass	******
R-502 and R-(125/143a/134a) @ 260 F	Pass	Pass	******

Results after 500-hour exposure to old refrigerant plus 500-hour exposure to alternative refrigerant.

	Mottorette Wire Type		
	Wire Type A	Wire Type B	Wire Type C
Unexposed	Pass	Pass	Pass
Exposure With:	Voltage Withstand		
R-11 and R-123 @ 212 F	******	******	Pass
R-12 and R-134a @ 260 F	Pass	Pass	******
R-22 and R-(32/125/134a) @ 260 F	Pass	Pass	******
R-502 and R-(125/143a/134a) @ 260 F	Pass	Pass	******

R-11/R-123 exposures were not used for wire A and B.
R-12/R-134a, R-22/R-(32/125/134a), and R-502/R-(125/143a/134a) exposures were not used for wire C.
Wire Type A is Polyester base with amide imide overcoat
Wire Type B is Esterimide base with amide imide overcoat
Wire Type C is Polyester base with amide imide overcoat and epoxy saturated glass serving.

Motorette

Results after 500-hour exposure to old refrigerant.

	Mottorette Wire Type		
	Wire Type A	Wire Type B	Wire Type C
Unexposed	Pass	Pass	Pass
Exposure With:	**Voltage Withstand**		
R-11 @ 212 F	******	******	Pass
R-123 @ 212 F	******	******	Pass
R-12 @ 260 F	Pass	Pass	******
R-22 @ 260 F	Pass	Pass	******
R-502 @ 260F	Pass	Pass	******

Results after 500-hour exposure to old refrigerant plus 168-hour exposure to alternative refrigerant.

	Mottorette Wire Type		
	Wire Type A	Wire Type B	Wire Type C
Unexposed	Pass	Pass	Pass
Exposure With:	**Voltage Withstand**		
R-11 and R-123 @ 212 F	******	******	Pass
R-11 and R-245ca @ 212 F	******	******	Pass
R-123 and R-245ca @ 260 F	******	******	Pass
R-12 and R-134a @ 260 F	Pass	Pass	******
R-22 and R-407C @ 260 F	Pass	Pass	******
R-502 and R-404A @ 260 F	Pass	Pass	******

R-11/R-123, R-11/245ca, R-123/R245ca exposures were not used for wire A and B.
R-12/R-134a, R-22/R-407C, and R-502/R-404A exposures were not used for wire C.
Wire Type A is Polyester base with amide imide overcoat
Wire Type B is Esterimide base with amide imide overcoat
Wire Type C is Polyester base with amide imide overcoat and epoxy saturated glass serving.

Motorette

Results after 500-hour exposure to old refrigerant plus 336-hour exposure to alternative refrigerant.

	Mottorette Wire Type		
	Wire Type A	Wire Type B	Wire Type C
Unexposed	Pass	Pass	Pass
Exposure With:	Voltage Withstand		
R-11 and R-123 @ 212 F	******	******	Pass
R-11 and R-245ca @ 212 F	******	******	Pass
R-123 and R-245ca @ 260 F	******	******	Pass
R-12 and R-134a @ 260 F	Pass	Pass	******
R-22 and R-407C @ 260 F	Pass	Pass	******
R-502 and R-404A @ 260 F	Pass	Pass	******

Results after 500-hour exposure to old refrigerant plus 500-hour exposure to alternative refrigerant.

	Mottorette Wire Type		
	Wire Type A	Wire Type B	Wire Type C
Unexposed	Pass	Pass	Pass
Exposure With:	Voltage Withstand		
R-11 and R-123 @ 212 F	******	******	Pass
R-11 and R-245ca @ 212 F	******	******	Pass
R-123 and R-245ca @ 260 F	******	******	Pass
R-12 and R-134a @ 260 F	Pass	Pass	******
R-22 and R-407C @ 260 F	Pass	Pass	******
R-502 and R-404A @ 260 F	Pass	Pass	******

R-11/R-123, R-11/245ca, R-123/R245ca exposures were not used for wire A and B.
R-12/R-134a, R-22/R-407C, and R-502/R-404A exposures were not used for wire C.
Wire Type A is Polyester base with amide imide overcoat
Wire Type B is Esterimide base with amide imide overcoat
Wire Type C is Polyester base with amide imide overcoat and epoxy saturated glass serving.

Appendix E

Mylar MO Analysis

DUPONT

December 13, 1994

P.O. Box 89
Circleville, OH 43113

Robert Doerr, Ph.D.
Sr. Principal Chemist
The Trane Company
3600 Pammel Creek Rd.
LaCrosse, Wisconsin 54601

MYLAR® MO ANALYSIS

Dear Robert:

We have completed our analysis of Mylar® MO from the sealed tube test after your 1000 hours exposure to R12-mineral oil at 127°C. Intrinsic viscosity measurements on Mylar® allow the determination of the chain length(s) of the polymer and can provide information on the extent to which chain cleavage has occurred. We find that embrittlement of polyester insulation, under most accelerated test conditions, occurs as a result of chain cleavage due to hydrolysis. On occasion, in very dry systems, we find embrittled film due to deep seated structural changes (crystallization) with no evidence of significant chain cleavage, however, this requires excessive temperatures, >160°C.

The sample you provided was found to have an intrinsic viscosity of 0.24. Standard Mylar ® MO's viscosity typically is at 0.60 or higher as manufactured. Your sample, therefore, has undergone very substantial chain cleavage through hydrolysis and, not surprisingly, was extremely brittle. The density of the sample was 1.4076 g/cc. Hydrolysis is accompanied by density increases, so this result is expected. Had we seen a brittle sample with this density, and no evidence of substantial hydrolysis, we could attribute embrittlement to excessive test temperature(s) (>160°C) in a dry environment. This is not the case, and this failure is due to hydrolysis.

As discussed in our conversations, I do not think that your drying procedure is removing sufficient moisture from the film and apparatus. The reprint "CFC-Free Refrigeration", which I sent under a separate mailing should provide you with some guidelines in regard to drying and the critical nature of water management in these sealed tube tests.

As previously mentioned, I will be happy to assist you in your test program. Feel free to call on me if you have any questions or require additional film analysis.

Sincerely,

Charles C Walker

Charles C. Walker Ph.D.
Senior Research Associate

®Mylar is DuPont's registered trademark for its polyester film.
(CCW.325):bac

Appendix F

Summary Data Tables, Sheet Insulation, Extra Dry Conditions

EXPLANATION OF THE SUMMARY DATA TABLES

Physical and electrical property measurements were determined on replicate (3-5) samples of motor materials and entered into the original data tables. The original data tables are included in Volumes II and III of the final report. An average was taken of the replicate data and expressed as a percent change from the measurements taken on unexposed materials. This comparison of data for exposed and unexposed samples is presented as the summary data tables.

The summary data tables are divided according to the type of motor material tested, and further divided according to the six refrigerant retrofit exposures . The data, expressed as percent change from unexposed, is presented in a two-section box, as shown below.

Results for R-11 / R-123 retrofit

	Varnish Type
	Sterling U-475
Unexposed Bond Strength	27.4 lbs.

Exposure With:	**% Change from Unexposed**	
R-11 500 HRS. @ 212 F	-6.3%	******
R-123 168 HRS. @ 212 F	******	-11.9%
R-123 336 HRS. @ 212 F	******	15.0%
R-123 500 HRS. @ 212 F	******	-3.2%
R-11 1000 HRS. @ 212 F	-22.6%	******

The left section of the box contains data for the original refrigerant/mineral oil at 500 and 1000 hours and the right section of the box contains data for the retrofit refrigerant/lubricant at 168, 336, and 500 hours. The ****** signifies that data was not determined for the exposures indicated.

The refrigerant retrofit combinations R-22/R-407C, R-12/R-134a and R-502/R-404A exposures used two magnet wires (designated as **A.** & **B.**) in combination with two varnishes. Separate pages are necessary for each magnet wire type and two sets of data boxes are used for the two varnishes. In contrast, the R-11/R-123, R-11/R-245ca, and R-123/R-245ca exposures used only one magnet wire (designated as **C.**) and one varnish.

Sheet Insulation, Dry

Results for R-22 / R-407C retrofit

Polyester film

	Tensile strength	Elongation
Unexposed	22.5 ksi	134.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	-31.1%	******	-81.0%	******
R-407C 168 HRS. @ 212 F	******	-31.8%	******	-93.8%
R-407C 336 HRS. @ 212 F	******	-23.3%	******	-94.6%
R-407C 500 HRS. @ 212 F	******	-26.8%	******	-94.6%
R-22 1000 HRS. @ 212 F	-34.6%	******	-93.1%	******

	Dielectric strength
Unexposed	>14.10 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	>13.98	******
R-407C 168 HRS. @ 212 F	******	>14.38
R-407C 336 HRS. @ 212 F	******	>14.25
R-407C 500 HRS. @ 212 F	******	>14.55
R-22 1000 HRS. @ 212 F	>14.68	******

Polyester film (24 hour air bake)

	Tensile strength	Elongation
Unexposed	22.5 ksi	134.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	-21.6%	******	-90.6%	******
R-407C 168 HRS. @ 212 F	******	-23.7%	******	-94.6%
R-407C 336 HRS. @ 212 F	******	-26.4%	******	-94.9%
R-407C 500 HRS. @ 212 F	******	-23.3%	******	-94.7%
R-22 1000 HRS. @ 212 F	-30.3%	******	-94.9%	******

	Dielectric strength
Unexposed	>14.10 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	>13.54	******
R-407C 168 HRS. @ 212 F	******	>13.97
R-407C 336 HRS. @ 212 F	******	>14.13
R-407C 500 HRS. @ 212 F	******	>14.07
R-22 1000 HRS. @ 212 F	>14.35	******

R-407C exposures are in addition to an initial 500 hour R-22 exposure

Sheet Insulation, Dry

Results for R-22 / R-407C retrofit

Polyester film low oligomer

	Tensile strength	Elongation
Unexposed	19.1 ksi	142.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	-17.1%	******	-55.2%	******
R-407C 168 HRS. @ 212 F	******	-17.2%	******	-89.4%
R-407C 336 HRS. @ 212 F	******	-7.7%	******	-94.6%
R-407C 500 HRS. @ 212 F	******	-14.6%	******	-95.1%
R-22 1000 HRS. @ 212 F	-18.0%	******	-86.5%	******

	Dielectric strength
Unexposed	>14.60 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	>13.94	******
R-407C 168 HRS. @ 212 F	******	>14.53
R-407C 336 HRS. @ 212 F	******	>15.68
R-407C 500 HRS. @ 212 F	******	>15.09
R-22 1000 HRS. @ 212 F	>14.68	******

Polyester film low oligomer (24 hour air bake)

	Tensile strength	Elongation
Unexposed	19.1 ksi	142.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	-7.3%	******	-95.0%	******
R-407C 168 HRS. @ 212 F	******	-35.0%	******	-95.0%
R-407C 336 HRS. @ 212 F	******	-8.1%	******	-86.8%
R-407C 500 HRS. @ 212 F	******	-9.3%	******	-94.9%
R-22 1000 HRS. @ 212 F	-24.3%	******	-94.6%	******

	Dielectric strength
Unexposed	>14.60 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	>14.30	******
R-407C 168 HRS. @ 212 F	******	>14.37
R-407C 336 HRS. @ 212 F	******	>16.04
R-407C 500 HRS. @ 212 F	******	>14.73
R-22 1000 HRS. @ 212 F	>13.99	******

R-407C exposures are in addition to an initial 500 hour R-22 exposure

Sheet Insulation, Dry

Results for R-22 / R-407C retrofit

Dacron Mylar Dacron

	Tensile strength	Elongation
Unexposed	13.4 ksi	29.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	-1.6%	******	-15.9%	******
R-407C 168 HRS. @ 212 F	******	-6.2%	******	-25.0%
R-407C 336 HRS. @ 212 F	******	0.2%	******	-17.6%
R-407C 500 HRS. @ 212 F	******	-27.0%	******	-26.1%
R-22 1000 HRS. @ 212 F	-10.9%	******	-35.8%	******

	Dielectric strength
Unexposed	>18.56 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	>15.90	******
R-407C 168 HRS. @ 212 F	******	>17.09
R-407C 336 HRS. @ 212 F	******	>15.66
R-407C 500 HRS. @ 212 F	******	>17.72
R-22 1000 HRS. @ 212 F	>16.29	******

Dacron Mylar Dacron (24 hour air bake)

	Tensile strength	Elongation
Unexposed	13.4 ksi	29.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	4.1%	******	-14.8%	******
R-407C 168 HRS. @ 212 F	******	0.9%	******	-21.0%
R-407C 336 HRS. @ 212 F	******	-3.7%	******	-34.7%
R-407C 500 HRS. @ 212 F	******	0.9%	******	-25.0%
R-22 1000 HRS. @ 212 F	-16.9%	******	-66.5%	******

	Dielectric strength
Unexposed	>18.56 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	>18.73	******
R-407C 168 HRS. @ 212 F	******	>16.71
R-407C 336 HRS. @ 212 F	******	>16.60
R-407C 500 HRS. @ 212 F	******	>17.72
R-22 1000 HRS. @ 212 F	>17.29	******

R-407C exposures are in addition to an initial 500 hour R-22 exposure

Sheet Insulation, Dry

Results for R-22 / R-407C retrofit

Nomex

	Tensile strength	Elongation
Unexposed	18.1 ksi	16.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	-46.9%	******	-66.7%	******
R-407C 168 HRS. @ 212 F	******	-11.9%	******	-52.8%
R-407C 336 HRS. @ 212 F	******	-7.0%	******	-67.2%
R-407C 500 HRS. @ 212 F	******	-38.3%	******	-64.1%
R-22 1000 HRS. @ 212 F	-32.4%	******	-60.0%	******

	Dielectric strength
Unexposed	10.24 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	13.08	******
R-407C 168 HRS. @ 212 F	******	12.68
R-407C 336 HRS. @ 212 F	******	12.00
R-407C 500 HRS. @ 212 F	******	13.10
R-22 1000 HRS. @ 212 F	13.93	******

Nomex (24 hour air bake)

	Tensile strength	Elongation
Unexposed	18.1 ksi	16.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	-32.3%	******	-61.0%	******
R-407C 168 HRS. @ 212 F	******	-4.6%	******	-63.6%
R-407C 336 HRS. @ 212 F	******	-8.0%	******	-53.3%
R-407C 500 HRS. @ 212 F	******	2.3%	******	-56.9%
R-22 1000 HRS. @ 212 F	-43.1%	******	-66.7%	******

	Dielectric strength
Unexposed	10.24 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	10.02	******
R-407C 168 HRS. @ 212 F	******	9.95
R-407C 336 HRS. @ 212 F	******	13.22
R-407C 500 HRS. @ 212 F	******	11.27
R-22 1000 HRS. @ 212 F	9.73	******

R-407C exposures are in addition to an initial 500 hour R-22 exposure

Sheet Insulation, Dry

Results for R-22 / R-407C retrofit

Nomex Mica

	Tensile strength	Elongation
Unexposed	7.1 ksi	1.9%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	-29.8%	******	-34.9%	******
R-407C 168 HRS. @ 212 F	******	-19.1%	******	-47.9%
R-407C 336 HRS. @ 212 F	******	-10.9%	******	-39.2%
R-407C 500 HRS. @ 212 F	******	-27.1%	******	-34.9%
R-22 1000 HRS. @ 212 F	-15.2%	******	-39.2%	******

	Dielectric strength
Unexposed	11.39 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	>14.06	******
R-407C 168 HRS. @ 212 F	******	12.94
R-407C 336 HRS. @ 212 F	******	>13.18
R-407C 500 HRS. @ 212 F	******	12.77
R-22 1000 HRS. @ 212 F	>14.17	******

Nomex Mica (24 hour air bake)

	Tensile strength	Elongation
Unexposed	7.1 ksi	1.9%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	-24.5%	******	-39.2%	******
R-407C 168 HRS. @ 212 F	******	-22.7%	******	-43.6%
R-407C 336 HRS. @ 212 F	******	-28.4%	******	-30.6%
R-407C 500 HRS. @ 212 F	******	-18.2%	******	-34.9%
R-22 1000 HRS. @ 212 F	-14.6%	******	-43.6%	******

	Dielectric strength
Unexposed	11.39 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	10.42	******
R-407C 168 HRS. @ 212 F	******	11.96
R-407C 336 HRS. @ 212 F	******	>12.99
R-407C 500 HRS. @ 212 F	******	12.14
R-22 1000 HRS. @ 212 F	10.26	******

R-407C exposures are in addition to an initial 500 hour R-22 exposure

Sheet Insulation, Dry

Results for R-22 / R-407C retrofit

Nomex Mylar Nomex

	Tensile strength	Elongation
Unexposed	17.1 ksi	25.5%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	-14.0%	******	-58.2%	******
R-407C 168 HRS. @ 212 F	******	-5.7%	******	-35.3%
R-407C 336 HRS. @ 212 F	******	-4.0%	******	-72.6%
R-407C 500 HRS. @ 212 F	******	-15.7%	******	-83.0%
R-22 1000 HRS. @ 212 F	-7.5%	******	-36.9%	******

	Dielectric strength
Unexposed	>17.76 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	>19.13	******
R-407C 168 HRS. @ 212 F	******	>17.90
R-407C 336 HRS. @ 212 F	******	>18.72
R-407C 500 HRS. @ 212 F	******	>19.18
R-22 1000 HRS. @ 212 F	>19.85	******

Nomex Mylar Nomex (24 hour air bake)

	Tensile strength	Elongation
Unexposed	17.1 ksi	25.5%

Exposure With:	% change from unexposed		% change from unexposed	
R-22 500 HRS. @ 212 F	3.7%	******	-55.6%	******
R-407C 168 HRS. @ 212 F	******	2.0%	******	-50.0%
R-407C 336 HRS. @ 212 F	******	-9.4%	******	-65.4%
R-407C 500 HRS. @ 212 F	******	-10.4%	******	-79.7%
R-22 1000 HRS. @ 212 F	-7.5%	******	-79.4%	******

	Dielectric strength
Unexposed	>17.76 kv

Exposure With:	recorded dielectric strength	
R-22 500 HRS. @ 212 F	>17.73	******
R-407C 168 HRS. @ 212 F	******	>18.56
R-407C 336 HRS. @ 212 F	******	>18.05
R-407C 500 HRS. @ 212 F	******	>19.55
R-22 1000 HRS. @ 212 F	>17.86	******

R-407C exposures are in addition to an initial 500 hour R-22 exposure

Sheet Insulation, Dry

Results for R-12 / R-134a retrofit

Polyester film

	Tensile strength	Elongation
Unexposed	22.5 ksi	134.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	-24.5%	******	-95.3%	******
R-134a 168 HRS. @ 212 F	******	-26.0%	******	-94.7%
R-134a 336 HRS. @ 212 F	******	-26.6%	******	-93.7%
R-134a 500 HRS. @ 212 F	******	-27.9%	******	-91.0%
R-12 1000 HRS. @ 212 F	-26.5%	******	-95.2%	******

	Dielectric strength
Unexposed	14.10 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	>14.46	******
R-134a 168 HRS. @ 212 F	******	>14.35
R-134a 336 HRS. @ 212 F	******	>14.74
R-134a 500 HRS. @ 212 F	******	>13.87
R-12 1000 HRS. @ 212 F	>14.11	******

Polyester film (24 hour air bake)

	Tensile strength	Elongation
Unexposed	22.5 ksi	134.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	-25.0%	******	-94.2%	******
R-134a 168 HRS. @ 212 F	******	-23.5%	******	-94.3%
R-134a 336 HRS. @ 212 F	******	-24.1%	******	-94.3%
R-134a 500 HRS. @ 212 F	******	-26.1%	******	-94.3%
R-12 1000 HRS. @ 212 F	-24.9%	******	-95.1%	******

	Dielectric strength
Unexposed	>14.10 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	>14.66	******
R-134a 168 HRS. @ 212 F	******	>13.91
R-134a 336 HRS. @ 212 F	******	>14.94
R-134a 500 HRS. @ 212 F	******	>13.96
R-12 1000 HRS. @ 212 F	>13.74	******

R-134a exposures are in addition to an initial 500 hour R-12

Sheet Insulation, Dry

Results for R-12 / R-134a retrofit

Polyester film low oligomer

	Tensile strength	Elongation
Unexposed	19.1 ksi	142.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	-3.1%	******	-95.1%	******
R-134a 168 HRS. @ 212 F	******	-26.0%	******	-94.7%
R-134a 336 HRS. @ 212 F	******	-26.6%	******	-93.7%
R-134a 500 HRS. @ 212 F	******	-27.9%	******	-91.0%
R-12 1000 HRS. @ 212 F	-26.5%	******	-95.2%	******

	Dielectric strength
Unexposed	>14.60 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	>14.46	******
R-134a 168 HRS. @ 212 F	******	>14.35
R-134a 336 HRS. @ 212 F	******	>14.74
R-134a 500 HRS. @ 212 F	******	>13.87
R-12 1000 HRS. @ 212 F	>14.11	******

Polyester film low oligomer (24 hour air bake)

	Tensile strength	Elongation
Unexposed	19.1 ksi	147.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	-4.6%	******	-80.4%	******
R-134a 168 HRS. @ 212 F	******	-23.5%	******	-94.3%
R-134a 336 HRS. @ 212 F	******	-24.1%	******	-94.3%
R-134a 500 HRS. @ 212 F	******	-7.7%	******	-89.5%
R-12 1000 HRS. @ 212 F	-24.9%	******	-95.1%	******

	Dielectric strength
Unexposed	>14.60 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	>14.02	******
R-134a 168 HRS. @ 212 F	******	>13.91
R-134a 336 HRS. @ 212 F	******	>14.94
R-134a 500 HRS. @ 212 F	******	>14.64
R-12 1000 HRS. @ 212 F	>13.74	******

R-134a exposures are in addition to an initial 500 hour R-12

Sheet Insulation, Dry

Results for R-12 / R-134a retrofit

Dacron Mylar Dacron

	Tensile strength	Elongation
Unexposed	13.4 ksi	29.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	3.5%	******	-15.3%	******
R-134a 168 HRS. @ 212 F	******	4.9%	******	-11.9%
R-134a 336 HRS. @ 212 F	******	3.6%	******	-13.1%
R-134a 500 HRS. @ 212 F	******	2.3%	******	-18.2%
R-12 1000 HRS. @ 212 F	47.4%	******	-26.7%	******

	Dielectric strength
Unexposed	>18.56 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	>17.26	******
R-134a 168 HRS. @ 212 F	******	>15.90
R-134a 336 HRS. @ 212 F	******	>16.61
R-134a 500 HRS. @ 212 F	******	>16.61
R-12 1000 HRS. @ 212 F	>17.16	******

Dacron Mylar Dacron (24 hour air bake)

	Tensile strength	Elongation
Unexposed	13.4 ksi	29.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	3.1%	******	-17.0%	******
R-134a 168 HRS. @ 212 F	******	5.4%	******	-17.6%
R-134a 336 HRS. @ 212 F	******	3.5%	******	-5.7%
R-134a 500 HRS. @ 212 F	******	6.6%	******	-21.6%
R-12 1000 HRS. @ 212 F	-2.5%	******	-27.8%	******

	Dielectric strength
Unexposed	>18.56 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	>17.01	******
R-134a 168 HRS. @ 212 F	******	>15.87
R-134a 336 HRS. @ 212 F	******	>16.23
R-134a 500 HRS. @ 212 F	******	>17.83
R-12 1000 HRS. @ 212 F	>17.19	******

R-134a exposures are in addition to an initial 500 hour R-12

Sheet Insulation, Dry

Results for R-12 / R-134a retrofit

Nomex

	Tensile strength	Elongation
Unexposed	18.1 ksi	16.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	-6.3%	******	-61.5%	******
R-134a 168 HRS. @ 212 F	******	-10.7%	******	-55.4%
R-134a 336 HRS. @ 212 F	******	-10.5%	******	-59.5%
R-134a 500 HRS. @ 212 F	******	-6.4%	******	-54.9%
R-12 1000 HRS. @ 212 F	0.0%	******	-55.9%	******

	Dielectric strength
Unexposed	10.29 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	>13.78	******
R-134a 168 HRS. @ 212 F	******	>13.28
R-134a 336 HRS. @ 212 F	******	13.32
R-134a 500 HRS. @ 212 F	******	>13.76
R-12 1000 HRS. @ 212 F	>14.00	******

Nomex (24 hour air bake)

	Tensile strength	Elongation
Unexposed	18.1 ksi	16.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	-4.0%	******	-58.0%	******
R-134a 168 HRS. @ 212 F	******	-1.1%	******	-58.5%
R-134a 336 HRS. @ 212 F	******	0.4%	******	56.9%
R-134a 500 HRS. @ 212 F	******	-12.3%	******	-54.4%
R-12 1000 HRS. @ 212 F	-8.9%	******	-45.1%	******

	Dielectric strength
Unexposed	10.29 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	10.46	******
R-134a 168 HRS. @ 212 F	******	11.43
R-134a 336 HRS. @ 212 F	******	11.57
R-134a 500 HRS. @ 212 F	******	10.91
R-12 1000 HRS. @ 212 F	11.09	******

R-134a exposures are in addition to an initial 500 hour R-12

Sheet Insulation, Dry

Results for R-12 / R-134a retrofit

Nomex Mica

	Tensile strength	Elongation
Unexposed	7.1 ksi	1.9%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	-2.6%	******	-34.9%	******
R-134a 168 HRS. @ 212 F	******	-7.1%	******	-39.2%
R-134a 336 HRS. @ 212 F	******	-19.6%	******	-39.2%
R-134a 500 HRS. @ 212 F	******	-11.6%	******	-43.6%
R-12 1000 HRS. @ 212 F	-25.1%	******	-43.6%	******

	Dielectric strength
Unexposed	11.39 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	>14.18	******
R-134a 168 HRS. @ 212 F	******	13.09
R-134a 336 HRS. @ 212 F	******	12.05
R-134a 500 HRS. @ 212 F	******	13.07
R-12 1000 HRS. @ 212 F	>12.90	******

Nomex Mica (24 hour air bake)

	Tensile strength	Elongation
Unexposed	7.1 ksi	1.9%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	-15.5%	******	-39.2%	******
R-134a 168 HRS. @ 212 F	******	-14.1%	******	-34.9%
R-134a 336 HRS. @ 212 F	******	-14.6%	******	-43.6%
R-134a 500 HRS. @ 212 F	******	-18.0%	******	-26.2%
R-12 1000 HRS. @ 212 F	-19.3%	******	-39.2%	******

	Dielectric strength
Unexposed	11.39 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	10.72	******
R-134a 168 HRS. @ 212 F	******	12.31
R-134a 336 HRS. @ 212 F	******	13.30
R-134a 500 HRS. @ 212 F	******	11.10
R-12 1000 HRS. @ 212 F	9.78	******

R-134a exposures are in addition to an initial 500 hour R-12

Sheet Insulation, Dry

Results for R-12 / R-134a retrofit

Nomex Mylar Nomex

	Tensile strength	Elongation
Unexposed	17.1 ksi	25.5%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	3.0%	******	-48.7%	******
R-134a 168 HRS. @ 212 F	******	-3.8%	******	-52.0%
R-134a 336 HRS. @ 212 F	******	-3.6%	******	-50.0%
R-134a 500 HRS. @ 212 F	******	-0.9%	******	-48.4%
R-12 1000 HRS. @ 212 F	-1.2%	******	-58.5%	******

	Dielectric strength
Unexposed	>17.76 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	>18.88	******
R-134a 168 HRS. @ 212 F	******	>18.04
R-134a 336 HRS. @ 212 F	******	>18.89
R-134a 500 HRS. @ 212 F	******	>18.48
R-12 1000 HRS. @ 212 F	>18.98	******

Nomex Mylar Nomex (24 hour air bake)

	Tensile strength	Elongation
Unexposed	17.1 ksi	25.5%

Exposure With:	% change from unexposed		% change from unexposed	
R-12 500 HRS. @ 212 F	2.7%	******	-52.0%	******
R-134a 168 HRS. @ 212 F	******	-0.3%	******	-65.7%
R-134a 336 HRS. @ 212 F	******	0.6%	******	-52.9%
R-134a 500 HRS. @ 212 F	******	-3.5%	******	-29.1%
R-12 1000 HRS. @ 212 F	-4.2%	******	-37.3%	******

	Dielectric strength
Unexposed	>17.76 kv

Exposure With:	recorded dielectric strength	
R-12 500 HRS. @ 212 F	>17.43	******
R-134a 168 HRS. @ 212 F	******	>17.60
R-134a 336 HRS. @ 212 F	******	>19.13
R-134a 500 HRS. @ 212 F	******	>18.97
R-12 1000 HRS. @ 212 F	>17.94	******

R-134a exposures are in addition to an initial 500 hour R-12

Appendix G

Summary Data Tables Low Pressure Refrigerants

EXPLANATION OF THE SUMMARY DATA TABLES

Physical and electrical property measurements were determined on replicate (3-5) samples of motor materials and entered into the original data tables. The original data tables are included in Volumes II and III of the final report. An average was taken of the replicate data and expressed as a percent change from the measurements taken on unexposed materials. This comparison of data for exposed and unexposed samples is presented as the summary data tables.

The summary data tables are divided according to the type of motor material tested, and further divided according to the six refrigerant retrofit exposures . The data, expressed as percent change from unexposed, is presented in a two-section box, as shown below.

Results for R-11 / R-123 retrofit

	Varnish Type
	Sterling U-475
Unexposed Bond Strength	27.4 lbs.

Exposure With:	**% Change from Unexposed**	
R-11 500 HRS. @ 212 F	-6.3%	******
R-123 168 HRS. @ 212 F	******	-11.9%
R-123 336 HRS. @ 212 F	******	15.0%
R-123 500 HRS. @ 212 F	******	-3.2%
R-11 1000 HRS. @ 212 F	-22.6%	******

The left section of the box contains data for the original refrigerant/mineral oil at 500 and 1000 hours and the right section of the box contains data for the retrofit refrigerant/lubricant at 168, 336, and 500 hours. The ****** signifies that data was not determined for the exposures indicated.

The refrigerant retrofit combinations R-22/R-407C, R-12/R-134a and R-502/R-404A exposures used two magnet wires (designated as **A.** & **B.**) in combination with two varnishes. Separate pages are necessary for each magnet wire type and two sets of data boxes are used for the two varnishes. In contrast, the R-11/R-123, R-11/R-245ca, and R-123/R-245ca exposures used only one magnet wire (designated as **C.**) and one varnish.

Varnish Weight and Volume Changes

Results for R-11 / R-245ca retrofit

Sterling U-475

Exposure With:	% Change from Unexposed Weight		Volume	
R-11 500 HRS. @ 212 F	7.2%	******	0.9%	******
R-245ca 168 HRS. @ 212 F	******	3.6%	******	-1.2%
R-245ca 336 HRS. @ 212 F	******	2.8%	******	-1.8%
R-245ca 500 HRS. @ 212 F	******	2.7%	******	-1.8%
R-11 1000 HRS. @ 212 F	3.4%	******	-1.6%	******

R-245ca exposures are in addition to an initial 500 hr. R-11 exposure

Results for R-123 / R-245ca retrofit

Sterling U-475

Exposure With:	% Change from Unexposed Weight		Volume	
R-123 500 HRS. @ 212 F	17.1%	******	8.9%	******
R-245ca 168 HRS. @ 212 F	******	5.2%	******	1.2%
R-245ca 336 HRS. @ 212 F	******	3.6%	******	-0.2%
R-245ca 500 HRS. @ 212 F	******	2.5%	******	-0.9%
R-123 1000 HRS. @ 212 F	15.9%	******	8.4%	******

R-245ca exposures are in addition to an initial 500 hr. R-123 exposure

Results for R-11 / R-123 retrofit

Sterling U-475

Exposure With:	% Change from Unexposed Weight		Volume	
R-11 500 HRS. @ 212 F	4.7%	******	1.3%	******
R-123 168 HRS. @ 212 F	******	13.9%	******	7.9%
R-123 336 HRS. @ 212 F	******	14.4%	******	8.2%
R-123 500 HRS. @ 212 F	******	14.3%	******	8.2%
R-11 1000 HRS. @ 212 F	6.6%	******	2.0%	******

R-123 exposures are in addition to an initial 500 hr. R-11 exposure

Varnish Coated on Magnet Wire C
(PET - Glass serving)

Results for R-11 / R-123 retrofit

	Varnish Type
	Sterling U-475
Unexposed Bond Strength	27.4 lbs.

Exposure With:	% Change from Unexposed	
R-11 500 HRS. @ 212 F	-6.3%	******
R-123 168 HRS. @ 212 F	******	-11.9%
R-123 336 HRS. @ 212 F	******	15.0%
R-123 500 HRS. @ 212 F	******	-3.2%
R-11 1000 HRS. @ 212 F	-22.6%	******

	Varnish Type
	Sterling U-475
Unexposed Bond Strength	27.4 lbs.

Exposure With:	% Change from Unexposed	
R-11 500 HRS. @ 212 F	-2.2%	******
R-123 168 HRS. @ 212 F	******	-16.7%
R-123 336 HRS. @ 212 F	******	-5.5%
R-123 500 HRS. @ 212 F	******	9.8%
R-11 1000 HRS. @ 212 F	-3.9%	******

R-123 exposures are in addition to an initial 500 hr. R-11 exposure

Varnish Coated on Magnet Wire C
(PET - Glass serving)

Results for R-11 / R-245ca retrofit

	Varnish Type
	Sterling U-475
Unexposed Bond Strength	27.4 lbs.

Exposure With:	% Change from Unexposed	
R-11 500 HRS. @ 212 F	13.3%	******
R-245ca 168 HRS. @ 212 F	******	25.4%
R-245ca 336 HRS. @ 212 F	******	26.0%
R-245ca 500 HRS. @ 212 F	******	9.8%
R-11 1000 HRS. @ 212 F	9.4%	******

	Varnish Type
	Sterling U-475
Unexposed Bond Strength	27.4 lbs.

Exposure With:	% Change from Unexposed	
R-11 500 HRS. @ 212 F	23.3%	******
R-245ca 168 HRS. @ 212 F	******	19.6%
R-245ca 336 HRS. @ 212 F	******	26.3%
R-245ca 500 HRS. @ 212 F	******	21.3%
R-11 1000 HRS. @ 212 F	10.3%	******

R-245ca exposures are in addition to an initial 500 hr. R-11 exposure

Varnish Coated on Magnet Wire C
(PET - Glass serving)

Results for R-123 / R-245ca retrofit

	Varnish Type	
	Sterling U-475	
Unexposed Bond Strength	27.4 lbs.	
Exposure With:	% Change from Unexposed	
R-123 500 HRS. @ 212 F	13.9%	******
R-245ca 168 HRS. @ 212 F	******	8.5%
R-245ca 336 HRS. @ 212 F	******	18.6%
R-245ca 500 HRS. @ 212 F	******	10.5%
R-123 1000 HRS. @ 212 F	-4.9%	******

	Varnish Type	
	Sterling U-475	
Unexposed Bond Strength	27.4 lbs.	
Exposure With:	% Change from Unexposed	
R-123 500 HRS. @ 212 F	12.5%	******
R-245ca 168 HRS. @ 212 F	******	18.6%
R-245ca 336 HRS. @ 212 F	******	13.9%
R-245ca 500 HRS. @ 212 F	******	6.3%
R-123 1000 HRS. @ 212 F	14.1%	******

R-245ca exposures are in addition to an initial 500 hr. R-123 exposure

Varnish Coated on Magnet Wire C
(PET - Glass serving)

Results for R-11 / R-123 retrofit

	Varnish Type
	none
Unexposed Burnout	734 sec.

Exposure With:	% Change from Unexposed	
R-11 500 HRS. @ 212 F	-1.8%	******
R-123 168 HRS. @ 212 F	******	-0.3%
R-123 336 HRS. @ 212 F	******	-0.4%
R-123 500 HRS. @ 212 F	******	-0.2%
R-11 1000 HRS. @ 212 F	-3.5%	******

	Varnish Type
	none
Unexposed Dielectric Strength	12.35 kv

Exposure With:	% Change from Unexposed	
R-11 500 HRS. @ 212 F	12.4%	******
R-123 168 HRS. @ 212 F	******	5.0%
R-123 336 HRS. @ 212 F	******	17.8%
R-123 500 HRS. @ 212 F	******	3.4%
R-11 1000 HRS. @ 212 F	13.4%	******

R-123 exposures are in addition to an initial 500 hr. R-11 exposure

Varnish Coated on Magnet Wire C
(PET - Glass serving)

Results for R-11 / R-123 retrofit

	Varnish Type
	Sterling U-475
Unexposed Burnout	751sec

Exposure With:	% Change from Unexposed	
R-11 500 HRS. @ 212 F	0.6%	******
R-123 168 HRS. @ 212 F	******	-1.2%
R-123 336 HRS. @ 212 F	******	-1.4%
R-123 500 HRS. @ 212 F	******	-1.4%
R-11 1000 HRS. @ 212 F	-2.8%	******

	Varnish Type
	Sterling U-475
Unexposed Dielectric Strength	13.25 kv

Exposure With:	% Change from Unexposed	
R-11 500 HRS. @ 212 F	20.9%	******
R-123 168 HRS. @ 212 F	******	23.4%
R-123 336 HRS. @ 212 F	******	23.8%
R-123 500 HRS. @ 212 F	******	14.9%
R-11 1000 HRS. @ 212 F	10.1%	******

R-123 exposures are in addition to an initial 500 hr. R-11 exposure

Varnish Coated on Magnet Wire C
(PET - Glass serving)

Results for R-11 / R-245ca retrofit

	Varnish Type
	none
Unexposed Burnout	734 sec.

Exposure With:	% Change from Unexposed	
R-11 500 HRS. @ 212 F	-9.7%	******
R-245ca 168 HRS. @ 212 F	******	-11.5%
R-245ca 336 HRS. @ 212 F	******	-6.8%
R-245ca 500 HRS. @ 212 F	******	-13.6%
R-11 1000 HRS. @ 212 F	-10.3%	******

	Varnish Type
	none
Unexposed Dielectric Strength	12.35 kv

Exposure With:	% Change from Unexposed	
R-11 500 HRS. @ 212 F	7.8%	******
R-245ca 168 HRS. @ 212 F	******	9.4%
R-245ca 336 HRS. @ 212 F	******	6.5%
R-245ca 500 HRS. @ 212 F	******	14.6%
R-11 1000 HRS. @ 212 F	11.0%	******

R-245ca exposures are in addition to an initial 500 hr. R-11 exposure

Varnish Coated on Magnet Wire C
(PET - Glass serving)

Results for R-11 / R-245ca retrofit

	Varnish Type
	Sterling U-475
Unexposed Burnout	751sec

Exposure With:	% Change from Unexposed	
R-11 500 HRS. @ 212 F	-1.8%	******
R-245ca 168 HRS. @ 212 F	******	-0.9%
R-245ca 336 HRS. @ 212 F	******	0.2%
R-245ca 500 HRS. @ 212 F	******	-1.0%
R-11 1000 HRS. @ 212 F	-2.2%	******

	Varnish Type
	Sterling U-475
Unexposed Dielectric Strength	13.25 kv

Exposure With:	% Change from Unexposed	
R-11 500 HRS. @ 212 F	12.9%	******
R-245ca 168 HRS. @ 212 F	******	14.0%
R-245ca 336 HRS. @ 212 F	******	10.5%
R-245ca 500 HRS. @ 212 F	******	12.6%
R-11 1000 HRS. @ 212 F	7.4%	******

R-123 exposures are in addition to an initial 500 hr. R-11 exposure

Varnish Coated on Magnet Wire C
(PET - Glass serving)

Results for R-123 / R-245ca retrofit

	Varnish Type
	none
Unexposed Burnout	734 sec.

Exposure With:	% Change from Unexposed	
R-123 500 HRS. @ 212 F	-6.1%	******
R-245ca 168 HRS. @ 212 F	******	-3.5%
R-245ca 336 HRS. @ 212 F	******	-3.0%
R-245ca 500 HRS. @ 212 F	******	-8.3%
R-123 1000 HRS. @ 212 F	-12.5%	******

	Varnish Type
	none
Unexposed Dielectric Strength	12.35 kv

Exposure With:	% Change from Unexposed	
R-123 500 HRS. @ 212 F	3.5%	******
R-245ca 168 HRS. @ 212 F	******	13.0%
R-245ca 336 HRS. @ 212 F	******	14.1%
R-245ca 500 HRS. @ 212 F	******	13.5%
R-123 1000 HRS. @ 212 F	6.3%	******

R-245ca exposures are in addition to an initial 500 hr. R-123 exposure

Varnish Coated on Magnet Wire C
(PET - Glass serving)

Results for R-123 / R-245ca retrofit

	Varnish Type
	Sterling U-475
Unexposed Burnout	751sec

Exposure With:	% Change from Unexposed	
R-123 500 HRS. @ 212 F	-2.7%	******
R-245ca 168 HRS. @ 212 F	******	0.1%
R-245ca 336 HRS. @ 212 F	******	-1.1%
R-245ca 500 HRS. @ 212 F	******	0.0%
R-123 1000 HRS. @ 212 F	0.1%	******

	Varnish Type
	Sterling U-475
Unexposed Dielectric Strength	13.25 kv

Exposure With:	% Change from Unexposed	
R-123 500 HRS. @ 212 F	15.1%	******
R-245ca 168 HRS. @ 212 F	******	13.8%
R-245ca 336 HRS. @ 212 F	******	15.6%
R-245ca 500 HRS. @ 212 F	******	5.8%
R-123 1000 HRS. @ 212 F	13.5%	******

R-245ca exposures are in addition to an initial 500 hr. R-123 exposure

Results for R-11 / R-123 retrofit

	type
	DMD
Unexposed Dielectric Strength	9.77 KV.

Exposure With:	% Change from Unexposed	
R-11 500 HRS. @ 212 F	14.5%	******
R-123 168 HRS. @ 212 F	******	4.8%
R-123 336 HRS. @ 212 F	******	-8.7%
R-123 500 HRS. @ 212 F	******	-17.7%
R-11 500 HRS. @ 212 F	2.6%	******

	type
	DMTD
Unexposed Dielectric Strength	10.16 kv.

Exposure With:	% Change from Unexposed	
R-11 500 HRS. @ 212 F	49.1%	******
R-123 168 HRS. @ 212 F	******	46.3%
R-123 336 HRS. @ 212 F	******	52.2%
R-123 500 HRS. @ 212 F	******	30.3%
R-11 500 HRS. @ 212 F	47.4%	******

R-123 exposures are in addition to an initial 500 hr. R-11 exposure
DMD denotes Dacron Mylar Dacron lead wire material
DMTD denoted Dacron Mylar Teflon Dacron lead wire material

Results for R-11 / R-245ca retrofit

	type
	DMD
Unexposed Dielectric Strength	9.77 KV.

Exposure With:	% Change from Unexposed	
R-11 500 HRS. @ 212 F	-8.4%	******
R-245ca 168 HRS. @ 212 F	******	-39.2%
R-245ca 336 HRS. @ 212 F	******	-31.1%
R-245ca 500 HRS. @ 212 F	******	-31.3%
R-11 500 HRS. @ 212 F	-23.5%	******

	type
	DMTD
Unexposed Dielectric Strength	10.16 kv.

Exposure With:	% Change from Unexposed	
R-11 500 HRS. @ 212 F	39.1%	******
R-245ca 168 HRS. @ 212 F	******	74.4%
R-245ca 336 HRS. @ 212 F	******	87.5%
R-245ca 500 HRS. @ 212 F	******	51.8%
R-11 500 HRS. @ 212 F	56.5%	******

R-245ca exposures are in addition to an initial 500 hr. R-11 exposure
DMD denotes Dacron Mylar Dacron lead wire material
DMTD denoted Dacron Mylar Teflon Dacron lead wire material

Results for R-123 / R-245ca retrofit

	type
	DMD
Unexposed Dielectric Strength	9.77 KV.

Exposure With:	% Change from Unexposed	
R-11 500 HRS. @ 212 F	-32.1%	******
R-123 168 HRS. @ 212 F	******	-39.3%
R-123 336 HRS. @ 212 F	******	-17.5%
R-123 500 HRS. @ 212 F	******	-19.6%
R-11 500 HRS. @ 212 F	-23.5%	******

	type
	DMTD
Unexposed Dielectric Strength	10.16 kv.

Exposure With:	% Change from Unexposed	
R-11 500 HRS. @ 212 F	38.4%	******
R-123 168 HRS. @ 212 F	******	29.2%
R-123 336 HRS. @ 212 F	******	34.9%
R-123 500 HRS. @ 212 F	******	77.3%
R-11 500 HRS. @ 212 F	50.8%	******

R-123 exposures are in addition to an initial 500 hr. R-11 exposure
DMD denotes Dacron Mylar Dacron lead wire material
DMTD denoted Dacron Mylar Teflon Dacron lead wire material

Spiral Wrapped Sleeving

Results for R-11 / R-123 retrofit

	Sleeving type
	PET
Unexposed Dielectric Strength	>17.60

Exposure With:	Dielectric Strength	
R-11 500 HRS. @ 212 F	>17.79	******
R-123 168 HRS. @ 212 F	******	>16.61
R-123 336 HRS. @ 212 F	******	>15.95
R-123 500 HRS. @ 212 F	******	>11.84
R-11 1000 HRS. @ 212 F	>17.41	******

	Sleeving type
	Nomex- PET
Unexposed Dielectric Strength	>12.12

Exposure With:	Dielectric Strength	
R-11 500 HRS. @ 212 F	>11.84	******
R-123 168 HRS. @ 212 F	******	>12.38
R-123 336 HRS. @ 212 F	******	>9.96
R-123 500 HRS. @ 212 F	******	>11.75
R-11 1000 HRS. @ 212 F	>13.99	******

R-123 exposures are in addition to an initial 500 hr. R-11 exposure

Spiral Wrapped Sleeving

Results for R-11 / R-245ca retrofit

	Sleeving type
	PET
Unexposed Dielectric Strength	>17.60

Exposure With:	Dielectric Strength	
R-11 500 HRS. @ 212 F	>9.37	******
R-245ca 168 HRS. @ 212 F	******	>11.44
R-245ca 336 HRS. @ 212 F	******	>11.98
R-245ca 500 HRS. @ 212 F	******	>12.01
R-11 1000 HRS. @ 212 F	>11.13	******

	Sleeving type
	Nomex- PET
Unexposed Dielectric Strength	>12.12

Exposure With:	Dielectric Strength	
R-11 500 HRS. @ 212 F	>9.64	******
R-245ca 168 HRS. @ 212 F	******	>10.66
R-245ca 336 HRS. @ 212 F	******	>11.42
R-245ca 500 HRS. @ 212 F	******	>11.62
R-11 1000 HRS. @ 212 F	>12.27	******

R-245ca exposures are in addition to an initial 500 hr. R-11 exposure

Results for R-123 / R-245ca retrofit

	Sleeving type
	PET
Unexposed Dielectric Strength	>17.60

Exposure With:	Dielectric Strength	
R-123 500 HRS. @ 212 F	>10.21	******
R-245ca 168 HRS. @ 212 F	******	>11.00
R-245ca 336 HRS. @ 212 F	******	>12.02
R-245ca 500 HRS. @ 212 F	******	>9.77
R-123 1000 HRS. @ 212 F	>10.96	******

	Sleeving type
	Nomex- PET
Unexposed Dielectric Strength	>12.12

Exposure With:	Dielectric Strength	
R-123 500 HRS. @ 212 F	>11.70	******
R-245ca 168 HRS. @ 212 F	******	>11.10
R-245ca 336 HRS. @ 212 F	******	>11.22
R-245ca 500 HRS. @ 212 F	******	>9.77
R-123 1000 HRS. @ 212 F	>11.32	******

R-245ca exposures are in addition to an initial 500 hr. R-123 exposure

Results for R-11 / R-123 retrofit

Polyester film

	Tensile strength	Elongation
Unexposed	22.5 ksi	134.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-7.9%	******	-10.8%	******
R-123 168 HRS. @ 212 F	******	-22.3%	******	-30.9%
R-123 336 HRS. @ 212 F	******	-26.0%	******	-35.6%
R-123 500 HRS. @ 212 F	******	-26.1%	******	-26.0%
R-11 1000 HRS. @ 212 F	-25.6%	******	-38.7%	******

	Dielectric strength
Unexposed	>14.10 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	>14.61	******
R-123 168 HRS. @ 212 F	******	>14.34
R-123 336 HRS. @ 212 F	******	>14.12
R-123 500 HRS. @ 212 F	******	>14.32
R-11 1000 HRS. @ 212 F	>14.28	******

Polyester film (24 hour air bake)

	Tensile strength	Elongation
Unexposed	22.5 ksi	134.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-19.3%	******	-24.0%	******
R-123 168 HRS. @ 212 F	******	-21.5%	******	-25.3%
R-123 336 HRS. @ 212 F	******	-22.0%	******	-28.8%
R-123 500 HRS. @ 212 F	******	-26.9%	******	-94.1%
R-11 1000 HRS. @ 212 F	-28.2%	******	-94.9%	******

	Dielectric strength
Unexposed	>14.10 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	>13.78	******
R-123 168 HRS. @ 212 F	******	>13.68
R-123 336 HRS. @ 212 F	******	>14.21
R-123 500 HRS. @ 212 F	******	>14.23
R-11 1000 HRS. @ 212 F	>14.19	******

R-123 exposures are in addition to an initial 500 hour R-11 exposure

Results for R-11 / R-123 retrofit

Polyester film low oligomer

	Tensile strength	Elongation
Unexposed	19.1 ksi	142.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-6.9%	******	-18.2%	******
R-123 168 HRS. @ 212 F	******	-2.7%	******	6.9%
R-123 336 HRS. @ 212 F	******	-5.7%	******	4.0%
R-123 500 HRS. @ 212 F	******	-12.7%	******	-9.3%
R-11 1000 HRS. @ 212 F	-15.2%	******	-66.0%	******

	Dielectric strength
Unexposed	>14.60 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	>14.22	******
R-123 168 HRS. @ 212 F	******	>14.47
R-123 336 HRS. @ 212 F	******	>14.19
R-123 500 HRS. @ 212 F	******	>14.37
R-11 1000 HRS. @ 212 F	>14.18	******

Polyester film low oligomer (24 hour air bake)

	Tensile strength	Elongation
Unexposed	19.1 ksi	142.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-2.2%	******	-0.6%	******
R-123 168 HRS. @ 212 F	******	-8.9%	******	-6.9%
R-123 336 HRS. @ 212 F	******	-6.3%	******	-28.8%
R-123 500 HRS. @ 212 F	******	-10.2%	******	-96.1%
R-11 1000 HRS. @ 212 F	-27.8%	******	-93.8%	******

	Dielectric strength
Unexposed	>14.60 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	>14.79	******
R-123 168 HRS. @ 212 F	******	>14.24
R-123 336 HRS. @ 212 F	******	>14.17
R-123 500 HRS. @ 212 F	******	>14.33
R-11 1000 HRS. @ 212 F	>14.08	******

R-123 exposures are in addition to an initial 500 hour R-11 exposure

Results for R-11 / R-123 retrofit

Dacron Mylar Dacron

	Tensile strength	Elongation
Unexposed	13.4 ksi	29.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-5.3%	******	-6.2%	******
R-123 168 HRS. @ 212 F	******	-14.7%	******	-23.3%
R-123 336 HRS. @ 212 F	******	-12.0%	******	-14.8%
R-123 500 HRS. @ 212 F	******	-6.9%	******	-9.1%
R-11 1000 HRS. @ 212 F	-27.0%	******	-54.0%	******

	Dielectric strength
Unexposed	>18.56 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	>17.64	******
R-123 168 HRS. @ 212 F	******	>17.34
R-123 336 HRS. @ 212 F	******	>17.05
R-123 500 HRS. @ 212 F	******	>16.40
R-11 1000 HRS. @ 212 F	>18.69	******

Dacron Mylar Dacron (24 hour air bake)

	Tensile strength	Elongation
Unexposed	13.4 ksi	29.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-3.2%	******	-0.6%	******
R-123 168 HRS. @ 212 F	******	2.1%	******	-10.8%
R-123 336 HRS. @ 212 F	******	-1.5%	******	-11.9%
R-123 500 HRS. @ 212 F	******	-0.1%	******	-18.2%
R-11 1000 HRS. @ 212 F	-24.9%	******	-80.7%	******

	Dielectric strength
Unexposed	>18.56 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	>16.63	******
R-123 168 HRS. @ 212 F	******	>16.39
R-123 336 HRS. @ 212 F	******	>17.98
R-123 500 HRS. @ 212 F	******	>17.92
R-11 1000 HRS. @ 212 F	>19.73	******

R-123 exposures are in addition to an initial 500 hour R-11 exposure

Results for R-11 / R-123 retrofit

Nomex

	Tensile strength	Elongation
Unexposed	18.1 ksi	16.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-3.4%	******	-7.2%	******
R-123 168 HRS. @ 212 F	******	-6.8%	******	-34.4%
R-123 336 HRS. @ 212 F	******	-15.5%	******	-60.5%
R-123 500 HRS. @ 212 F	******	-15.4%	******	-68.2%
R-11 1000 HRS. @ 212 F	-25.7%	******	-77.4%	******

	Dielectric strength
Unexposed	10.24 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	13.29	******
R-123 168 HRS. @ 212 F	******	>13.59
R-123 336 HRS. @ 212 F	******	13.51
R-123 500 HRS. @ 212 F	******	>13.21
R-11 1000 HRS. @ 212 F	>13.94	******

Nomex (24 hour air bake)

	Tensile strength	Elongation
Unexposed	18.1 ksi	16.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-0.9%	******	-20.0%	******
R-123 168 HRS. @ 212 F	******	1.6%	******	-36.9%
R-123 336 HRS. @ 212 F	******	-15.8%	******	-65.6%
R-123 500 HRS. @ 212 F	******	-20.3%	******	-79.0%
R-11 1000 HRS. @ 212 F	-25.5%	******	-77.4%	******

	Dielectric strength
Unexposed	10.24 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	11.09	******
R-123 168 HRS. @ 212 F	******	11.97
R-123 336 HRS. @ 212 F	******	11.64
R-123 500 HRS. @ 212 F	******	10.75
R-11 1000 HRS. @ 212 F	10.65	******

R-123 exposures are in addition to an initial 500 hour R-11 exposure

Sheet Insulation

Results for R-11 / R-123 retrofit

Nomex Mica

	Tensile strength	Elongation
Unexposed	7.1 ksi	1.9%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-19.7%	******	21.5%	******
R-123 168 HRS. @ 212 F	******	-17.9%	******	-0.2%
R-123 336 HRS. @ 212 F	******	-24.3%	******	-26.2%
R-123 500 HRS. @ 212 F	******	-33.7%	******	-56.6%
R-11 1000 HRS. @ 212 F	-46.3%	******	-56.6%	******

	Dielectric strength
Unexposed	11.39 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	11.68	******
R-123 168 HRS. @ 212 F	******	11.18
R-123 336 HRS. @ 212 F	******	12.15
R-123 500 HRS. @ 212 F	******	>12.63
R-11 1000 HRS. @ 212 F	13.40	******

Nomex Mica (24 hour air bake)

	Tensile strength	Elongation
Unexposed	7.1 ksi	1.9%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-20.0%	******	4.2%	******
R-123 168 HRS. @ 212 F	******	-10.1%	******	-26.2%
R-123 336 HRS. @ 212 F	******	-10.3%	******	-34.9%
R-123 500 HRS. @ 212 F	******	-28.8%	******	-30.6%
R-11 1000 HRS. @ 212 F	-15.7%	******	-39.2%	******

	Dielectric strength
Unexposed	11.39 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	11.42	******
R-123 168 HRS. @ 212 F	******	10.89
R-123 336 HRS. @ 212 F	******	11.33
R-123 500 HRS. @ 212 F	******	11.17
R-11 1000 HRS. @ 212 F	11.45	******

R-123 exposures are in addition to an initial 500 hour R-11 exposure

Results for R-11 / R-123 retrofit

Nomex Mylar Nomex

	Tensile strength	Elongation
Unexposed	17.1 ksi	25.5%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-9.2%	******	-31.4%	******
R-123 168 HRS. @ 212 F	******	-14.1%	******	-56.5%
R-123 336 HRS. @ 212 F	******	-17.7%	******	-60.8%
R-123 500 HRS. @ 212 F	******	-13.1%	******	-52.3%
R-11 1000 HRS. @ 212 F	-16.9%	******	-73.2%	******

	Dielectric strength
Unexposed	>17.76 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	>16.78	******
R-123 168 HRS. @ 212 F	******	>16.60
R-123 336 HRS. @ 212 F	******	>17.16
R-123 500 HRS. @ 212 F	******	>17.58
R-11 1000 HRS. @ 212 F	>17.36	******

Nomex Mylar Nomex (24 hour air bake)

	Tensile strength	Elongation
Unexposed	17.1 ksi	25.5%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-5.1%	******	-26.1%	******
R-123 168 HRS. @ 212 F	******	-6.4%	******	-56.5%
R-123 336 HRS. @ 212 F	******	-22.3%	******	-77.8%
R-123 500 HRS. @ 212 F	******	-8.7%	******	-68.6%
R-11 1000 HRS. @ 212 F	-8.3%	******	-68.0%	******

	Dielectric strength
Unexposed	>17.76 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	>17.99	******
R-123 168 HRS. @ 212 F	******	>17.71
R-123 336 HRS. @ 212 F	******	>17.20
R-123 500 HRS. @ 212 F	******	>17.78
R-11 1000 HRS. @ 212 F	>19.08	******

R-123 exposures are in addition to an initial 500 hour R-11 exposure

Results for R-11 / R-245ca retrofit

Polyester film

	Tensile strength	Elongation
Unexposed	22.5 ksi	134.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-11.9%	******	0.7%	******
R-245ca 168 HRS. @ 212 F	******	-12.7%	******	2.9%
R-245ca 336 HRS. @ 212 F	******	-9.4%	******	18.5%
R-245ca 500 HRS. @ 212 F	******	-10.3%	******	5.8%
R-11 1000 HRS. @ 212 F	-12.3%	******	6.9%	******

	Dielectric strength
Unexposed	14.10 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	>13.94	******
R-245ca 168 HRS. @ 212 F	******	>14.03
R-245ca 336 HRS. @ 212 F	******	>13.78
R-245ca 500 HRS. @ 212 F	******	>14.10
R-11 1000 HRS. @ 212 F	>14.18	******

Polyester film (24 hour air bake)

	Tensile strength	Elongation
Unexposed	22.5 ksi	134.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-18.7%	******	-30.0%	******
R-245ca 168 HRS. @ 212 F	******	-12.5%	******	1.9%
R-245ca 336 HRS. @ 212 F	******	-12.7%	******	-8.9%
R-245ca 500 HRS. @ 212 F	******	-8.8%	******	9.9%
R-11 1000 HRS. @ 212 F	-14.5%	******	-27.0%	******

	Dielectric strength
Unexposed	>14.10 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	>15.50	******
R-245ca 168 HRS. @ 212 F	******	>13.99
R-245ca 336 HRS. @ 212 F	******	>13.76
R-245ca 500 HRS. @ 212 F	******	>14.62
R-11 1000 HRS. @ 212 F	>13.90	******

R-245ca exposures are in addition to an initial 500 hour R-11

Results for R-11 / R-245ca retrofit

Polyester film low oligomer

	Tensile strength	Elongation
Unexposed	19.1 ksi	142.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-9.6%	******	-36.2%	******
R-245ca 168 HRS. @ 212 F	******	1.1%	******	-13.8%
R-245ca 336 HRS. @ 212 F	******	-7.0%	******	-1.5%
R-245ca 500 HRS. @ 212 F	******	-13.5%	******	-40.8%
R-11 1000 HRS. @ 212 F	-10.7%	******	-11.6%	******

	Dielectric strength
Unexposed	>14.60 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	>14.48	******
R-245ca 168 HRS. @ 212 F	******	>14.35
R-245ca 336 HRS. @ 212 F	******	>14.35
R-245ca 500 HRS. @ 212 F	******	>14.90
R-11 1000 HRS. @ 212 F	>14.30	******

Polyester film low oligomer (24 hour air bake)

	Tensile strength	Elongation
Unexposed	19.1 ksi	147.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-4.7%	******	-58.1%	******
R-245ca 168 HRS. @ 212 F	******	-6.8%	******	-3.9%
R-245ca 336 HRS. @ 212 F	******	-0.9%	******	-10.3%
R-245ca 500 HRS. @ 212 F	******	-6.1%	******	-26.7%
R-11 1000 HRS. @ 212 F	-6.8%	******	-46.1%	******

	Dielectric strength
Unexposed	>14.60 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	>15.55	******
R-245ca 168 HRS. @ 212 F	******	>14.07
R-245ca 336 HRS. @ 212 F	******	>14.26
R-245ca 500 HRS. @ 212 F	******	>14.18
R-11 1000 HRS. @ 212 F	>14.15	******

R-245ca exposures are in addition to an initial 500 hour R-11

Results for R-11 / R-245ca retrofit

Dacron Mylar Dacron

	Tensile strength	Elongation
Unexposed	13.4 ksi	29.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	0.5%	******	-13.6%	******
R-245ca 168 HRS. @ 212 F	******	-1.1%	******	-5.7%
R-245ca 336 HRS. @ 212 F	******	-0.8%	******	-6.2%
R-245ca 500 HRS. @ 212 F	******	-1.4%	******	-2.3%
R-11 1000 HRS. @ 212 F	-1.3%	******	-10.8%	******

	Dielectric strength
Unexposed	>18.56 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	>19.26	******
R-245ca 168 HRS. @ 212 F	******	>18.85
R-245ca 336 HRS. @ 212 F	******	>18.75
R-245ca 500 HRS. @ 212 F	******	>18.26
R-11 1000 HRS. @ 212 F	>18.34	******

Dacron Mylar Dacron (24 hour air bake)

	Tensile strength	Elongation
Unexposed	13.4 ksi	29.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	2.8%	******	-13.1%	******
R-245ca 168 HRS. @ 212 F	******	1.6%	******	-10.8%
R-245ca 336 HRS. @ 212 F	******	1.8%	******	-4.0%
R-245ca 500 HRS. @ 212 F	******	4.7%	******	1.2%
R-11 1000 HRS. @ 212 F	2.8%	******	-7.9%	******

	Dielectric strength
Unexposed	>18.56 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	>18.71	******
R-245ca 168 HRS. @ 212 F	******	>17.66
R-245ca 336 HRS. @ 212 F	******	>18.00
R-245ca 500 HRS. @ 212 F	******	>16.07
R-11 1000 HRS. @ 212 F	>18.32	******

R-245ca exposures are in addition to an initial 500 hour R-11

Sheet Insulation

Results for R-11 / R-245ca retrofit

Nomex

	Tensile strength	Elongation
Unexposed	18.1 ksi	16.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-1.7%	******	-39.5%	******
R-245ca 168 HRS. @ 212 F	******	-4.7%	******	-58.0%
R-245ca 336 HRS. @ 212 F	******	-1.4%	******	-43.1%
R-245ca 500 HRS. @ 212 F	******	-8.6%	******	-55.9%
R-11 1000 HRS. @ 212 F	-8.2%	******	-56.9%	******

	Dielectric strength
Unexposed	10.29 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	13.02	******
R-245ca 168 HRS. @ 212 F	******	>12.90
R-245ca 336 HRS. @ 212 F	******	12.57
R-245ca 500 HRS. @ 212 F	******	>13.12
R-11 1000 HRS. @ 212 F	>12.59	******

Nomex (24 hour air bake)

	Tensile strength	Elongation
Unexposed	18.1 ksi	16.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	0.1%	******	-48.2%	******
R-245ca 168 HRS. @ 212 F	******	0.5%	******	-58.0%
R-245ca 336 HRS. @ 212 F	******	0.3%	******	-49.7%
R-245ca 500 HRS. @ 212 F	******	1.6%	******	-51.3%
R-11 1000 HRS. @ 212 F	-1.7%	******	-62.6%	******

	Dielectric strength
Unexposed	10.29 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	10.87	******
R-245ca 168 HRS. @ 212 F	******	12.63
R-245ca 336 HRS. @ 212 F	******	11.49
R-245ca 500 HRS. @ 212 F	******	12.41
R-11 1000 HRS. @ 212 F	10.60	******

R-245ca exposures are in addition to an initial 500 hour R-11

Sheet Insulation

Results for R-11 / R-245ca retrofit

Nomex Mica

	Tensile strength	Elongation
Unexposed	7.1 ksi	1.9%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-42.7%	******	-30.6%	******
R-245ca 168 HRS. @ 212 F	******	-28.6%	******	-43.6%
R-245ca 336 HRS. @ 212 F	******	-34.3%	******	-21.9%
R-245ca 500 HRS. @ 212 F	******	-36.1%	******	-21.9%
R-11 1000 HRS. @ 212 F	-24.9%	******	-39.2%	******

	Dielectric strength
Unexposed	11.39 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	10.80	******
R-245ca 168 HRS. @ 212 F	******	>13.49
R-245ca 336 HRS. @ 212 F	******	10.54
R-245ca 500 HRS. @ 212 F	******	>14.16
R-11 1000 HRS. @ 212 F	11.32	******

Nomex Mica (24 hour air bake)

	Tensile strength	Elongation
Unexposed	7.1 ksi	1.9%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-29.6%	******	-26.2%	******
R-245ca 168 HRS. @ 212 F	******	-28.9%	******	-52.3%
R-245ca 336 HRS. @ 212 F	******	-14.3%	******	-30.6%
R-245ca 500 HRS. @ 212 F	******	-22.3%	******	-34.9%
R-11 1000 HRS. @ 212 F	-32.5%	******	-34.9%	******

	Dielectric strength
Unexposed	11.39 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	11.42	******
R-245ca 168 HRS. @ 212 F	******	11.70
R-245ca 336 HRS. @ 212 F	******	11.78
R-245ca 500 HRS. @ 212 F	******	12.88
R-11 1000 HRS. @ 212 F	10.29	******

R-245ca exposures are in addition to an initial 500 hour R-11

Results for R-11 / R-245ca retrofit

Nomex Mylar Nomex

	Tensile strength	Elongation
Unexposed	17.1 ksi	25.5%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-4.6%	******	-39.5%	******
R-245ca 168 HRS. @ 212 F	******	-5.2%	******	-49.4%
R-245ca 336 HRS. @ 212 F	******	2.0%	******	-65.7%
R-245ca 500 HRS. @ 212 F	******	-6.0%	******	-52.0%
R-11 1000 HRS. @ 212 F	-9.0%	******	-64.1%	******

	Dielectric strength
Unexposed	>17.76 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	>17.55	******
R-245ca 168 HRS. @ 212 F	******	>17.73
R-245ca 336 HRS. @ 212 F	******	>17.08
R-245ca 500 HRS. @ 212 F	******	>18.97
R-11 1000 HRS. @ 212 F	>18.05	******

Nomex Mylar Nomex (24 hour air bake)

	Tensile strength	Elongation
Unexposed	17.1 ksi	25.5%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	3.7%	******	-54.6%	******
R-245ca 168 HRS. @ 212 F	******	0.6%	******	-61.4%
R-245ca 336 HRS. @ 212 F	******	-1.0%	******	-45.8%
R-245ca 500 HRS. @ 212 F	******	3.0%	******	-53.3%
R-11 1000 HRS. @ 212 F	1.3%	******	-64.4%	******

	Dielectric strength
Unexposed	>17.76 kv

Exposure With:	recorded dielectric strength	
R-11 500 HRS. @ 212 F	>18.95	******
R-245ca 168 HRS. @ 212 F	******	>17.93
R-245ca 336 HRS. @ 212 F	******	>17.69
R-245ca 500 HRS. @ 212 F	******	>18.36
R-11 1000 HRS. @ 212 F	>18.17	******

R-245ca exposures are in addition to an initial 500 hour R-11

Sheet Insulation

Results for R-123 / R-245ca retrofit

Polyester film

	Tensile strength	Elongation
Unexposed	22.5 ksi	134.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-123 500 HRS. @ 212 F	-16.5%	******	3.6%	******
R-245ca 168 HRS. @ 212 F	******	-13.3%	******	3.0%
R-245ca 336 HRS. @ 212 F	******	-18.4%	******	-5.4%
R-245ca 500 HRS. @ 212 F	******	-21.4%	******	-34.0%
R-123 1000 HRS. @ 212 F	-17.4%	******	-4.8%	******

	Dielectric strength
Unexposed	14.10 kv

Exposure With:	recorded dielectric strength	
R-123 500 HRS. @ 212 F	>14.04	******
R-245ca 168 HRS. @ 212 F	******	>14.31
R-245ca 336 HRS. @ 212 F	******	>14.29
R-245ca 500 HRS. @ 212 F	******	>14.19
R-123 1000 HRS. @ 212 F	>14.51	******

Polyester film (24 hour air bake)

	Tensile strength	Elongation
Unexposed	22.5 ksi	134.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-123 500 HRS. @ 212 F	-16.2%	******	-12.6%	******
R-245ca 168 HRS. @ 212 F	******	-14.7%	******	-9.8%
R-245ca 336 HRS. @ 212 F	******	-17.3%	******	-0.5%
R-245ca 500 HRS. @ 212 F	******	-16.3%	******	-0.6%
R-123 1000 HRS. @ 212 F	-19.1%	******	-12.4%	******

	Dielectric strength
Unexposed	>14.10 kv

Exposure With:	recorded dielectric strength	
R-123 500 HRS. @ 212 F	>13.73	******
R-245ca 168 HRS. @ 212 F	******	>14.03
R-245ca 336 HRS. @ 212 F	******	>13.98
R-245ca 500 HRS. @ 212 F	******	>14.45
R-123 1000 HRS. @ 212 F	>14.54	******

R-245ca exposures are in addition to an initial 500 hour R-123

Sheet Insulation

Results for R-123 / R-245ca retrofit

Polyester film low oligomer

	Tensile strength	Elongation
Unexposed	19.1 ksi	142.8%

Exposure With:	% change from unexposed		% change from unexposed	
R-123 500 HRS. @ 212 F	1.8%	******	14.1%	******
R-245ca 168 HRS. @ 212 F	******	-7.4%	******	-17.0%
R-245ca 336 HRS. @ 212 F	******	0.2%	******	-19.1%
R-245ca 500 HRS. @ 212 F	******	-8.8%	******	-17.2%
R-123 1000 HRS. @ 212 F	-0.5%	******	12.5%	******

	Dielectric strength
Unexposed	>14.60 kv

Exposure With:	recorded dielectric strength	
R-123 500 HRS. @ 212 F	>14.65	******
R-245ca 168 HRS. @ 212 F	******	>14.55
R-245ca 336 HRS. @ 212 F	******	>14.41
R-245ca 500 HRS. @ 212 F	******	>14.75
R-123 1000 HRS. @ 212 F	>15.00	******

Polyester film low oligomer (24 hour air bake)

	Tensile strength	Elongation
Unexposed	19.1 ksi	147.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-123 500 HRS. @ 212 F	-3.3%	******	2.5%	******
R-245ca 168 HRS. @ 212 F	******	-5.4%	******	-7.7%
R-245ca 336 HRS. @ 212 F	******	-8.1%	******	-2.7%
R-245ca 500 HRS. @ 212 F	******	-5.2%	******	2.6%
R-123 1000 HRS. @ 212 F	-3.7%	******	-4.9%	******

	Dielectric strength
Unexposed	>14.60 kv

Exposure With:	recorded dielectric strength	
R-123 500 HRS. @ 212 F	>14.30	******
R-245ca 168 HRS. @ 212 F	******	>14.81
R-245ca 336 HRS. @ 212 F	******	>14.63
R-245ca 500 HRS. @ 212 F	******	>14.61
R-123 1000 HRS. @ 212 F	>14.66	******

R-245ca exposures are in addition to an initial 500 hour R-123

Sheet Insulation

Results for R-123 / R-245ca retrofit

Dacron Mylar Dacron

	Tensile strength	Elongation
Unexposed	13.4 ksi	29.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-123 500 HRS. @ 212 F	-0.8%	******	0.0%	******
R-245ca 168 HRS. @ 212 F	******	-0.1%	******	-1.7%
R-245ca 336 HRS. @ 212 F	******	1.1%	******	-3.4%
R-245ca 500 HRS. @ 212 F	******	-0.3%	******	-7.9%
R-123 1000 HRS. @ 212 F	-2.1%	******	-3.4%	******

	Dielectric strength
Unexposed	>18.56 kv

Exposure With:	recorded dielectric strength	
R-123 500 HRS. @ 212 F	>18.41	******
R-245ca 168 HRS. @ 212 F	******	>18.50
R-245ca 336 HRS. @ 212 F	******	>18.25
R-245ca 500 HRS. @ 212 F	******	>18.46
R-123 1000 HRS. @ 212 F	>18.32	******

Dacron Mylar Dacron (24 hour air bake)

	Tensile strength	Elongation
Unexposed	13.4 ksi	29.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-123 500 HRS. @ 212 F	2.3%	******	-7.4%	******
R-245ca 168 HRS. @ 212 F	******	4.5%	******	-3.4%
R-245ca 336 HRS. @ 212 F	******	2.2%	******	-5.1%
R-245ca 500 HRS. @ 212 F	******	1.7%	******	-10.2%
R-123 1000 HRS. @ 212 F	3.4%	******	-5.7%	******

	Dielectric strength
Unexposed	>18.56 kv

Exposure With:	recorded dielectric strength	
R-123 500 HRS. @ 212 F	>16.94	******
R-245ca 168 HRS. @ 212 F	******	>17.04
R-245ca 336 HRS. @ 212 F	******	>16.99
R-245ca 500 HRS. @ 212 F	******	>16.84
R-123 1000 HRS. @ 212 F	>16.05	******

R-245ca exposures are in addition to an initial 500 hour R-123

Sheet Insulation

Results for R-123 / R-245ca retrofit

Nomex

	Tensile strength	Elongation
Unexposed	18.1 ksi	16.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-123 500 HRS. @ 212 F	0.3%	******	-35.4%	******
R-245ca 168 HRS. @ 212 F	******	-0.6%	******	-41.0%
R-245ca 336 HRS. @ 212 F	******	-3.7%	******	-32.8%
R-245ca 500 HRS. @ 212 F	******	-6.0%	******	-36.4%
R-123 1000 HRS. @ 212 F	-7.8%	******	-47.2%	******

	Dielectric strength
Unexposed	10.29 kv

Exposure With:	recorded dielectric strength	
R-123 500 HRS. @ 212 F	12.95	******
R-245ca 168 HRS. @ 212 F	******	>13.29
R-245ca 336 HRS. @ 212 F	******	12.07
R-245ca 500 HRS. @ 212 F	******	>12.65
R-123 1000 HRS. @ 212 F	>13.13	******

Nomex (24 hour air bake)

	Tensile strength	Elongation
Unexposed	18.1 ksi	16.3%

Exposure With:	% change from unexposed		% change from unexposed	
R-123 500 HRS. @ 212 F	1.0%	******	-47.7%	******
R-245ca 168 HRS. @ 212 F	******	-3.9%	******	-56.9%
R-245ca 336 HRS. @ 212 F	******	-3.0%	******	-49.2%
R-245ca 500 HRS. @ 212 F	******	-2.1%	******	-169200.0%
R-123 1000 HRS. @ 212 F	-3.3%	******	-33.3%	******

	Dielectric strength
Unexposed	10.29 kv

Exposure With:	recorded dielectric strength	
R-123 500 HRS. @ 212 F	11.35	******
R-245ca 168 HRS. @ 212 F	******	11.97
R-245ca 336 HRS. @ 212 F	******	11.10
R-245ca 500 HRS. @ 212 F	******	12.02
R-123 1000 HRS. @ 212 F	11.22	******

R-245ca exposures are in addition to an initial 500 hour R-123

Sheet Insulation

Results for R-123 / R-245ca retrofit

Nomex Mica

	Tensile strength	Elongation
Unexposed	7.1 ksi	1.9%

Exposure With:	% change from unexposed		% change from unexposed	
R-123 500 HRS. @ 212 F	-35.3%	******	-26.2%	******
R-245ca 168 HRS. @ 212 F	******	-23.3%	******	-21.9%
R-245ca 336 HRS. @ 212 F	******	-14.8%	******	-30.6%
R-245ca 500 HRS. @ 212 F	******	-15.1%	******	-21.9%
R-123 1000 HRS. @ 212 F	-30.4%	******	-34.9%	******

	Dielectric strength
Unexposed	11.39 kv

Exposure With:	recorded dielectric strength	
R-123 500 HRS. @ 212 F	12.29	******
R-245ca 168 HRS. @ 212 F	******	>14.14
R-245ca 336 HRS. @ 212 F	******	10.59
R-245ca 500 HRS. @ 212 F	******	10.53
R-123 1000 HRS. @ 212 F	14.38	******

Nomex Mica (24 hour air bake)

	Tensile strength	Elongation
Unexposed	7.1 ksi	1.9%

Exposure With:	% change from unexposed		% change from unexposed	
R-123 500 HRS. @ 212 F	-23.3%	******	-34.9%	******
R-245ca 168 HRS. @ 212 F	******	-14.6%	******	-9.8%
R-245ca 336 HRS. @ 212 F	******	-14.8%	******	-30.6%
R-245ca 500 HRS. @ 212 F	******	-15.1%	******	-21.9%
R-123 1000 HRS. @ 212 F	-29.7%	******	-39.2%	******

	Dielectric strength
Unexposed	11.39 kv

Exposure With:	recorded dielectric strength	
R-123 500 HRS. @ 212 F	10.56	******
R-245ca 168 HRS. @ 212 F	******	>14.03
R-245ca 336 HRS. @ 212 F	******	10.59
R-245ca 500 HRS. @ 212 F	******	10.53
R-123 1000 HRS. @ 212 F	11.09	******

R-245ca exposures are in addition to an initial 500 hour R-123

Results for R-123 / R-245ca retrofit

Nomex Mylar Nomex

	Tensile strength	Elongation
Unexposed	17.1 ksi	25.5%

Exposure With:	% change from unexposed		% change from unexposed	
R-123 500 HRS. @ 212 F	-4.2%	******	-24.5%	******
R-245ca 168 HRS. @ 212 F	******	-5.9%	******	-44.1%
R-245ca 336 HRS. @ 212 F	******	-1.9%	******	-29.7%
R-245ca 500 HRS. @ 212 F	******	-3.9%	******	-24.8%
R-123 1000 HRS. @ 212 F	-7.9%	******	-53.3%	******

	Dielectric strength
Unexposed	>17.76 kv

Exposure With:	recorded dielectric strength	
R-123 500 HRS. @ 212 F	>17.64	******
R-245ca 168 HRS. @ 212 F	******	>17.88
R-245ca 336 HRS. @ 212 F	******	>18.21
R-245ca 500 HRS. @ 212 F	******	>18.80
R-123 1000 HRS. @ 212 F	>17.47	******

Nomex Mylar Nomex (24 hour air bake)

	Tensile strength	Elongation
Unexposed	17.1 ksi	25.5%

Exposure With:	% change from unexposed		% change from unexposed	
R-123 500 HRS. @ 212 F	2.9%	******	-46.1%	******
R-245ca 168 HRS. @ 212 F	******	3.7%	******	-47.1%
R-245ca 336 HRS. @ 212 F	******	2.2%	******	-41.2%
R-245ca 500 HRS. @ 212 F	******	0.7%	******	-21.9%
R-123 1000 HRS. @ 212 F	-4.3%	******	-50.0%	******

	Dielectric strength
Unexposed	>17.76 kv

Exposure With:	recorded dielectric strength	
R-123 500 HRS. @ 212 F	>18.28	******
R-245ca 168 HRS. @ 212 F	******	>19.41
R-245ca 336 HRS. @ 212 F	******	>18.42
R-245ca 500 HRS. @ 212 F	******	>18.52
R-123 1000 HRS. @ 212 F	>18.45	******

R-245ca exposures are in addition to an initial 500 hour R-123

Tapes and Tie Cords

Results for R-11 / R-123 retrofit

Braided polyester acrylic binder

	Tensile strength	Elongation
Unexposed	452.17 lbs	5.7%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-12.5%	******	-20.6%	******
R-123 168 HRS. @ 212 F	******	-2.0%	******	-14.7%
R-123 336 HRS. @ 212 F	******	-18.9%	******	-11.8%
R-123 500 HRS. @ 212 F	******	-3.6%	******	-11.8%
R-11 1000 HRS. @ 212 F	-9.8%	******	-2.9%	******

Polyester tie cord

	Tensile strength	Elongation
Unexposed	34.5 ksi	16.7%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-16.0%	******	5.0%	******
R-123 168 HRS. @ 212 F	******	-12.2%	******	14.0%
R-123 336 HRS. @ 212 F	******	-12.7%	******	13.0%
R-123 500 HRS. @ 212 F	******	-15.3%	******	19.0%
R-11 1000 HRS. @ 212 F	11.8%	******	33.0%	******

R-123 exposures are in addition to an initial 500 hr. R-11 exposure

Tapes and Tie Cords

Results for R-11 / R-245ca retrofit

Braided polyester acrylic binder

	Tensile strength	Elongation
Unexposed	452.17 lbs	5.7%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	0.7%	******	-12.9%	******
R-245ca 168 HRS. @ 212 F	******	-0.2%	******	-3.3%
R-245ca 336 HRS. @ 212 F	******	-1.2%	******	-9.1%
R-245ca 500 HRS. @ 212 F	******	3.9%	******	-6.3%
R-11 1000 HRS. @ 212 F	4.6%	******	3.1%	******

Polyester tie cord

	Tensile strength	Elongation
Unexposed	34.47 lbs	16.7%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-8.2%	******	-14.6%	******
R-245ca 168 HRS. @ 212 F	******	0.3%	******	-24.5%
R-245ca 336 HRS. @ 212 F	******	-5.0%	******	-10.3%
R-245ca 500 HRS. @ 212 F	******	-4.4%	******	-12.5%
R-11 1000 HRS. @ 212 F	-7.3%	******	2.3%	******

R-245ca exposures are in addition to an initial 500 hr. R-11 exposure

Tapes and Tie Cords

Results for R-123 / R-245ca retrofit

Braided polyester acrylic binder

	Tensile strength	Elongation
Unexposed	452.17 lbs	5.7%

Exposure With:	% change from unexposed		% change from unexposed	
R-123 500 HRS. @ 212 F	1.2%	******	-22.9%	******
R-245ca 168 HRS. @ 212 F	******	7.0%	******	-17.4%
R-245ca 336 HRS. @ 212 F	******	-7.1%	******	7.1%
R-245ca 500 HRS. @ 212 F	******	-3.8%	******	-9.1%
R-123 1000 HRS. @ 212 F	-2.2%	******	0.0%	******

***Polyester* tie cord**

	Tensile strength	Elongation
Unexposed	34.5 lbs	16.7%

Exposure With:	% change from unexposed		% change from unexposed	
R-123 500 HRS. @ 212 F	-17.4%	******	-13.9%	******
R-245ca 168 HRS. @ 212 F	******	-22.6%	******	-2.6%
R-245ca 336 HRS. @ 212 F	******	-13.8%	******	1.8%
R-245ca 500 HRS. @ 212 F	******	-11.5%	******	-26.5%
R-123 1000 HRS. @ 212 F	-11.4%	******	10.8%	******

R-245ca exposures are in addition to an initial 500 hr. R-123 exposure

Motorette

Results after 500-hour exposure to old refrigerant.

	Mottorette Wire Type		
	Wire Type A	Wire Type B	Wire Type C
Unexposed	Pass	Pass	Pass
Exposure With:	Voltage Withstand		
R-11 @ 212 F	******	******	Pass
R-123 @ 212 F	******	******	Pass
R-12 @ 260 F	Pass	Pass	******
R-22 @ 260 F	Pass	Pass	******
R-502 @ 260F	Pass	Pass	******

Results after 500-hour exposure to old refrigerant plus 168-hour exposure to alternative refrigerant.

	Mottorette Wire Type		
	Wire Type A	Wire Type B	Wire Type C
Unexposed	Pass	Pass	Pass
Exposure With:	Voltage Withstand		
R-11 and R-123 @ 212 F	******	******	Pass
R-11 and R-245ca @ 212 F	******	******	Pass
R-123 and R-245ca @ 260 F	******	******	Pass
R-12 and R-134a @ 260 F	Pass	Pass	******
R-22 and R-407C @ 260 F	Pass	Pass	******
R-502 and R-404A @ 260 F	Pass	Pass	******

R-11/R-123, R-11/245ca, R-123/R245ca exposures were not used for wire A and B.
R-12/R-134a, R-22/R-407C, and R-502/R-404A exposures were not used for wire C.
Wire Type A is Polyester base with amide imide overcoat
Wire Type B is Esterimide base with amide imide overcoat
Wire Type C is Polyester base with amide imide overcoat and epoxy saturated glass serving.

Results after 500-hour exposure to old refrigerant plus 336-hour exposure to alternative refrigerant.

	Mottorette Wire Type		
	Wire Type A	Wire Type B	Wire Type C
Unexposed	Pass	Pass	Pass
Exposure With:	Voltage Withstand		
R-11 and R-123 @ 212 F	******	******	Pass
R-11 and R-245ca @ 212 F	******	******	Pass
R-123 and R-245ca @ 260 F	******	******	Pass
R-12 and R-134a @ 260 F	Pass	Pass	******
R-22 and R-407C @ 260 F	Pass	Pass	******
R-502 and R-404A @ 260 F	Pass	Pass	******

Results after 500-hour exposure to old refrigerant plus 500-hour exposure to alternative refrigerant.

	Mottorette Wire Type		
	Wire Type A	Wire Type B	Wire Type C
Unexposed	Pass	Pass	Pass
Exposure With:	Voltage Withstand		
R-11 and R-123 @ 212 F	******	******	Pass
R-11 and R-245ca @ 212 F	******	******	Pass
R-123 and R-245ca @ 260 F	******	******	Pass
R-12 and R-134a @ 260 F	Pass	Pass	******
R-22 and R-407C @ 260 F	Pass	Pass	******
R-502 and R-404A @ 260 F	Pass	Pass	******

R-11/R-123, R-11/245ca, R-123/R245ca exposures were not used for wire A and B.
R-12/R-134a, R-22/R-407C, and R-502/R-404A exposures were not used for wire C.
Wire Type A is Polyester base with amide imide overcoat
Wire Type B is Esterimide base with amide imide overcoat
Wire Type C is Polyester base with amide imide overcoat and epoxy saturated glass serving.

Appendix H

Summary Data Tables
Elastomers

Results for R-11 / R-245ca retrofit

Nitrile

Exposure With:	Volume swell: % change from unexposed		Weight change: % change from unexposed	
R-11 500 HRS. @ 212 F	14.2%	******	18.6%	******
R-245ca 168 HRS. @ 212 F	******	17.4%	******	19.9%
R-245ca 336 HRS. @ 212 F	******	17.0%	******	19.5%
R-245ca 500 HRS. @ 212 F	******	16.5%	******	19.3%
R-11 1000 HRS. @ 212 F	13.4%	******	18.4%	******

	Tensile	Elongation
Unexposed	245.32 ksi	157.0%

Exposure With:	Tensile: % change from unexposed		Elongation: % change from unexposed	
R-11 500 HRS. @ 212 F	-30.70%	******	-44.3%	******
R-245ca 168 HRS. @ 212 F	******	-36.46%	******	-42.8%
R-245ca 336 HRS. @ 212 F	******	-41.97%	******	-53.3%
R-245ca 500 HRS. @ 212 F	******	-42.65%	******	-54.9%
R-11 1000 HRS. @ 212 F	-66.31%	******	-66.3%	******

	Durometer
Unexposed	73.0 Shore A

Exposure With:	Durometer: % change from unexposed	
R-11 500 HRS. @ 212 F	1.45%	******
R-245ca 168 HRS. @ 212 F	******	5.31%
R-245ca 336 HRS. @ 212 F	******	2.42%
R-245ca 500 HRS. @ 212 F	******	3.38%
R-11 1000 HRS. @ 212 F	-13.04%	******

R-245ca exposures are in addition to an initial 500 hour R-11 exposure

Results for R-11 / R-245ca retrofit

Neoprene

	Volume swell		Weight change	
Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	28.7%	******	31.0%	******
R-245ca 168 HRS. @ 212 F	******	-1.5%	******	-3.2%
R-245ca 336 HRS. @ 212 F	******	-2.6%	******	-5.1%
R-245ca 500 HRS. @ 212 F	******	-1.8%	******	-3.5%
R-11 1000 HRS. @ 212 F	29.0%	******	33.7%	******

	Tensile	Elongation
Unexposed	245.32 ksi	157.0%

Exposure With:	% change from unexposed		% change from unexposed	
R-11 500 HRS. @ 212 F	-49.98%	******	-35.1%	******
R-245ca 168 HRS. @ 212 F	******	-36.36%	******	-54.5%
R-245ca 336 HRS. @ 212 F	******	-32.65%	******	-38.7%
R-245ca 500 HRS. @ 212 F	******	-37.67%	******	-47.0%
R-11 1000 HRS. @ 212 F	-61.00%	******	-32.2%	******

	Durometer
Unexposed	73.0 Shore A

Exposure With:	% change from unexposed	
R-11 500 HRS. @ 212 F	-29.68%	******
R-245ca 168 HRS. @ 212 F	******	-8.68%
R-245ca 336 HRS. @ 212 F	******	-8.68%
R-245ca 500 HRS. @ 212 F	******	-5.02%
R-11 1000 HRS. @ 212 F	-31.05%	******

R-245ca exposures are in addition to an initial 500 hour R-11 exposure

Results for R-123 / R-245ca retrofit

Nitrile

Exposure With:	Volume swell % change from unexposed		Weight change % change from unexposed	
R-123 500 HRS. @ 212 F	76.7%	******	87.6%	******
R-245ca 168 HRS. @ 212 F	******	22.4%	******	25.3%
R-245ca 336 HRS. @ 212 F	******	20.4%	******	23.6%
R-245ca 500 HRS. @ 212 F	******	20.8%	******	23.6%
R-123 1000 HRS. @ 212 F	78.6%	******	90.1%	******

	Tensile	Elongation
Unexposed	245.32 ksi	157.0%

Exposure With:	Tensile % change from unexposed		Elongation % change from unexposed	
R-123 500 HRS. @ 212 F	-41.15%	******	-49.0%	******
R-245ca 168 HRS. @ 212 F	******	-41.85%	******	-48.5%
R-245ca 336 HRS. @ 212 F	******	-37.75%	******	-33.5%
R-245ca 500 HRS. @ 212 F	******	-37.70%	******	-34.4%
R-123 1000 HRS. @ 212 F	-34.64%	******	-59.7%	******

	Durometer
Unexposed	73.0 Shore A

Exposure With:	Durometer % change from unexposed	
R-123 500 HRS. @ 212 F	-13.53%	******
R-245ca 168 HRS. @ 212 F	******	-14.98%
R-245ca 336 HRS. @ 212 F	******	-8.70%
R-245ca 500 HRS. @ 212 F	******	-12.08%
R-123 1000 HRS. @ 212 F	-13.04%	******

R-245ca exposures are in addition to an initial 500 hour R-123 exposure

Results for R-123 / R-245ca retrofit

Neoprene

	Volume swell		Weight change	
Exposure With:	% change from unexposed		% change from unexposed	
R-123 500 HRS. @ 212 F	34.1%	******	29.1%	******
R-245ca 168 HRS. @ 212 F	******	-5.2%	******	-2.8%
R-245ca 336 HRS. @ 212 F	******	-5.3%	******	-2.4%
R-245ca 500 HRS. @ 212 F	******	-4.5%	******	-2.0%
R-123 1000 HRS. @ 212 F	32.9%	******	18.4%	******

	Tensile	Elongation
Unexposed	245.32 ksi	157.0%

Exposure With:	% change from unexposed		% change from unexposed	
R-123 500 HRS. @ 212 F	-3.51%	******	-25.9%	******
R-245ca 168 HRS. @ 212 F	******	18.10%	******	-41.9%
R-245ca 336 HRS. @ 212 F	******	55.72%	******	-26.1%
R-245ca 500 HRS. @ 212 F	******	38.10%	******	-40.3%
R-123 1000 HRS. @ 212 F	-17.38%	******	-40.6%	******

	Durometer
Unexposed	73.0 Shore A

Exposure With:	% change from unexposed	
R-123 500 HRS. @ 212 F	-11.11%	******
R-245ca 168 HRS. @ 212 F	******	4.23%
R-245ca 336 HRS. @ 212 F	******	9.52%
R-245ca 500 HRS. @ 212 F	******	9.52%
R-123 1000 HRS. @ 212 F	-7.94%	******

R-245ca exposures are in addition to an initial 500 hour R-123 exposure