

**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.

(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

- o Polyester base with amide imide overcoat
- o Esterimide base with amide imide overcoat
- o Polyester base with amide imide overcoat⁽³⁾ and epoxy saturated glass serving

VARNISHES

- o Waterbase-epoxy-phenolic; Isopoxy 800
- o Solvent-epoxy-phenolic; P.D. George 923
- o Solvent-Epoxy; Sterling U-475EH⁽³⁾

SHEET INSULATION

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

SPIRAL WRAPPED SLEEVING

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

LEAD WIRE INSULATION

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

TIE CORD

- o Polyester

ASSEMBLY TAPES

- o Braided polyester, acrylic binder
- o Polyester mats

(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.

| <u>Original</u> | <u>Alternative</u> |
|---|---|
| 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

| <u>Material</u> | <u>Sample Type</u> | <u>Unexposed Samples</u> | <u>Samples per Refrigerant</u> | <u>Total Samples for Unexposed + 6 refrigerants</u> |
|-----------------------------|--------------------|--------------------------|--------------------------------|---|
| 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 | Delaminate | 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 | Delaminate | 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 showing 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 sleeveings 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 exposed 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 increasing 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 polyol 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

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

* -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

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

*-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 Dacron /0.010 inches Mylar/0.005 inches Dacron
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 Overcoat
 - 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 1 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 | PO - amideirnide |
| 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 cracks |
| 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

| Varnish | Weight | Step Cure | | Final Cure | | Solids |
|---------|--------|-----------|--------------|------------|--------------|--------|
| | | Hours | Temp. | Hours | Temp. | |
| 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:

| <u>Sheet Insulation type</u> | <u>Initial Head Distance(in)</u> | <u>Rate(in/min)</u> |
|------------------------------|----------------------------------|---------------------|
| 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:

| <u>Tape type</u> | <u>Head Distance(in)</u> | <u>Rate(in/min)</u> |
|------------------|--------------------------|---------------------|
| 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:

| <u>Tie Cord type</u> | <u>Initial Head Distance(in)</u> | <u>Rate(in/min)</u> |
|----------------------|----------------------------------|---------------------|
| 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, charge 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.

| <u>2000 ml Pressure Vessel</u> | <u>Original Refrigerant/ Mineral Oil</u> | <u>Alternative refrigerant</u> |
|---------------------------------------|---|---------------------------------------|
| #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 were 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 motorettes tie cords and tapes

#2 Denotes helical coils and sheet insulation

#3 Denotes helical coils and sheet insulation

#4 Denotes twisted pairs

#5 Denotes 2 motorettes 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 motorettes tie cords and tapes
 #2 Denotes helical coils and sheet insulation
 #3 Denotes helical coils and sheet insulation
 #4 Denotes twisted pairs
 #5 Denotes 2 motorettes 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 motorettes tie cords and tapes
 #2 Denotes helical coils and sheet insulation
 #3 Denotes helical coils and sheet insulation
 #4 Denotes twisted pairs
 #5 Denotes 2 motorettes 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 motorettes

#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 motorettes

#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 motorettes
#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 |
|-------------------------|----------------|
| Unexposed Bond Strength | Sterling U-475 |
| | 27.4 lbs. |

| <u>Exposure With:</u> | <u>% Change from Unexposed</u> | |
|------------------------|--------------------------------|--------|
| 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

Varnished Helical Coils

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

| | Varnish Type | Varnish Type |
|-------------------------|--------------------------------|--------------------------------|
| Unexposed Bond Strength | Isopoxy 800 57.3 lbs. | P. D. George 923 66.6 lbs. |
| <u>Exposure With:</u> | <u>% Change from Unexposed</u> | <u>% Change from Unexposed</u> |
| 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 |
|-------------------------|--------------------------------|--------------------------------|
| Unexposed Bond Strength | Isopoxy 800 57.3 lbs. | P. D. George 923 66.6 lbs. |
| <u>Exposure With:</u> | <u>% Change from Unexposed</u> | <u>% Change from Unexposed</u> |
| 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

Varnished Helical Coils

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

Results for R-12 / R-134a retrofit

| | Varnish Type | Varnish Type |
|-------------------------|--------------------------------|--------------------------------|
| Unexposed Bond Strength | Isopoxy 800 57.3 lbs. | P. D. George 923 66.6 lbs. |
| <u>Exposure With:</u> | % 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 |
|-------------------------|--------------------------------|--------------------------------|
| Unexposed Bond Strength | Isopoxy 800 57.3 lbs. | P. D. George 923 66.6 lbs. |
| <u>Exposure With:</u> | % 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

Varnished Helical Coils

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

Results for R-22 / R-407C retrofit

| | Varnish Type | Varnish Type |
|-------------------------|--------------------------------|--------------------------------|
| Unexposed Bond Strength | Isopoxy 800 57.3 lbs. | P. D. George 923 66.6 lbs. |
| <u>Exposure With:</u> | <u>% Change from Unexposed</u> | <u>% Change from Unexposed</u> |
| 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 |
|-------------------------|--------------------------------|--------------------------------|
| Unexposed Bond Strength | Isopoxy 800 57.3 lbs. | P. D. George 923 66.6 lbs. |
| <u>Exposure With:</u> | <u>% Change from Unexposed</u> | <u>% Change from Unexposed</u> |
| 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

Varnished Helical Coils

Varnish Coated on Magnet Wire B

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

| | Varnish Type | Varnish Type |
|-------------------------|--------------------------------|--------------------------------|
| Unexposed Bond Strength | Isopoxy 800 57.3 lbs. | P. D. George 923 66.6 lbs. |
| <u>Exposure With:</u> | <u>% Change from Unexposed</u> | <u>% Change from Unexposed</u> |
| 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 |
|-------------------------|--------------------------------|--------------------------------|
| Unexposed Bond Strength | Isopoxy 800 57.3 lbs. | P. D. George 923 66.6 lbs. |
| <u>Exposure With:</u> | <u>% Change from Unexposed</u> | <u>% Change from Unexposed</u> |
| 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

Varnished Helical Coils

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

Results for R-502 / R-404A retrofit

| | Varnish Type | Varnish Type |
|-------------------------|--------------------------------|--------------------------------|
| Unexposed Bond Strength | Isopoxy 800 57.3 lbs. | P. D. George 923 66.6 lbs. |
| <u>Exposure With:</u> | <u>% Change from Unexposed</u> | <u>% Change from Unexposed</u> |
| 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 |
|-------------------------|--------------------------------|--------------------------------|
| Unexposed Bond Strength | Isopoxy 800 57.3 lbs. | P. D. George 923 66.6 lbs. |
| <u>Exposure With:</u> | <u>% Change from Unexposed</u> | <u>% Change from Unexposed</u> |
| 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

Varnished Helical Coils

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

Results for R-502 / R-404A retrofit

| | Varnish Type | Varnish Type |
|-------------------------|--------------------------------|--------------------------------|
| Unexposed Bond Strength | Isopoxy 800 57.3 lbs. | P. D. George 923 66.6 lbs. |
| <u>Exposure With:</u> | <u>% Change from Unexposed</u> | <u>% Change from Unexposed</u> |
| 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 |
|-------------------------|--------------------------------|--------------------------------|
| Unexposed Bond Strength | Isopoxy 800 57.3 lbs. | P. D. George 923 66.6 lbs. |
| <u>Exposure With:</u> | <u>% Change from Unexposed</u> | <u>% Change from Unexposed</u> |
| 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

Magnet Wire

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

Results for R-12 / R-134a retrofit

| | Varnish Type |
|-------------------|--------------|
| Unexposed Burnout | none |
| | 555 sec. |

| <u>Exposure With:</u> | % 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 |
|-------------------------------|--------------|
| Unexposed Dielectric Strength | none |
| | 15.25 kv. |

| <u>Exposure With:</u> | % 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

Magnet Wire

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

Results for R-12 / R-134a retrofit

| | Varnish Type |
|-------------------|--------------|
| Unexposed Burnout | none |
| | 584 sec. |

| <u>Exposure With:</u> | % 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 |
|-------------------------------|--------------|
| Unexposed Dielectric Strength | none |
| | 13.43 kv. |

| <u>Exposure With:</u> | % 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

Magnet Wire

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

Results for R-12 / R-134a retrofit

| | Varnish Type | Varnish Type |
|-------------------------|--------------------------------|--------------------------------|
| Unexposed Burnout | Isopoxy 800 536 sec. | P. D. George 923 612 sec. |
| <u>Exposure With:</u> | % 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 |
|-------------------------------|--------------------------------|--------------------------------|
| Unexposed Dielectric Strength | Isopoxy 800 15.98 kv. | P. D. George 923 17.01 kv. |
| <u>Exposure With:</u> | % 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

Magnet Wire

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

Results for R-12 / R-134a retrofit

| | Varnish Type | Varnish Type |
|-------------------------|--------------------------------|--------------------------------|
| Unexposed Burnout | Isopoxy 800 543 sec. | P. D. George 923 554 sec. |
| <u>Exposure With:</u> | % 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 |
|-------------------------------|--------------------------------|--------------------------------|
| Unexposed Dielectric Strength | Isopoxy 800 18.88 kv. | P. D. George 923 19.79 kv. |
| <u>Exposure With:</u> | % 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

Magnet Wire

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

Results for R-502 / R-404A retrofit

| | Varnish Type |
|-------------------|--------------|
| Unexposed Burnout | none |
| | 555 sec. |

| <u>Exposure With:</u> | % 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 |
|-------------------------------|--------------|
| Unexposed Dielectric Strength | none |
| | 15.25 kv. |

| <u>Exposure With:</u> | % 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

Magnet Wire

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

Results for R-502 / R-404A retrofit

| | Varnish Type | Varnish Type |
|-------------------------|--------------------------------|--------------------------------|
| Unexposed Burnout | Isopoxy 800 536 sec. | P. D. George 923 612 sec. |
| <u>Exposure With:</u> | % 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 |
|-------------------------------|--------------------------------|--------------------------------|
| Unexposed Dielectric Strength | Isopoxy 800 15.98 kv. | P. D. George 923 17.01 kv. |
| <u>Exposure With:</u> | % 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

Magnet Wire

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

Results for R-502 / R-404A retrofit

| | Varnish Type |
|-------------------|--------------|
| Unexposed Burnout | none |
| | 584 sec. |

Exposure With:

R-502 500 HRS. @ 260 F
 R-404A 168 HRS. @ 260 F
 R-404A 336 HRS. @ 260 F
 R-404A 500 HRS. @ 260 F
 R-502 1000 HRS. @ 260 F

| % Change from Unexposed | |
|-------------------------|--------|
| -8.7% | ***** |
| ***** | -39.8% |
| ***** | -26.9% |
| ***** | -26.9% |
| -40.5% | ***** |

| | Varnish Type |
|-------------------------------|--------------|
| Unexposed Dielectric Strength | none |
| | 13.43 kV |

Exposure With:

R-502 500 HRS. @ 260 F
 R-404A 168 HRS. @ 260 F
 R-404A 336 HRS. @ 260 F
 R-404A 500 HRS. @ 260 F
 R-502 1000 HRS. @ 260 F

| % Change from Unexposed | |
|-------------------------|-------|
| 17.6% | ***** |
| ***** | 16.0% |
| ***** | 13.1% |
| ***** | 16.3% |
| 10.7% | ***** |

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

Magnet Wire

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

Results for R-502 / R-404A retrofit

| | Varnish Type | Varnish Type |
|-------------------------|--------------------------------|--------------------------------|
| Unexposed Burnout | Isopoxy 800 543 sec. | P. D. George 923 554 sec. |
| <u>Exposure With:</u> | % 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 |
|-------------------------------|--------------------------------|--------------------------------|
| Unexposed Dielectric Strength | Isopoxy 800 18.88 kv. | P. D. George 923 19.78 kv. |
| <u>Exposure With:</u> | % 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

Magnet Wire

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

Results for R-22 / R-407C retrofit

| | Varnish Type |
|-------------------|--------------|
| Unexposed Burnout | none |
| | 555 sec. |

Exposure With:

R-22 500 HRS. @ 260 F
 R-407C 168 HRS. @ 260 F
 R-407C 336 HRS. @ 260 F
 R-407C 500 HRS. @ 260 F
 R-22 1000 HRS. @ 260 F

| % Change from Unexposed | |
|-------------------------|--------|
| -41.4% | ***** |
| ***** | -25.5% |
| ***** | -10.9% |
| ***** | -15.9% |
| -33.7% | ***** |

| | Varnish Type |
|-------------------------------|--------------|
| Unexposed Dielectric Strength | none |
| | 15.25 kv. |

Exposure With:

R-22 500 HRS. @ 260 F
 R-407C 168 HRS. @ 260 F
 R-407C 336 HRS. @ 260 F
 R-407C 500 HRS. @ 260 F
 R-22 1000 HRS. @ 260 F

| % Change from Unexposed | |
|-------------------------|-------|
| 1.0% | ***** |
| ***** | 38.4% |
| ***** | 7.4% |
| ***** | 0.6% |
| 15.5% | ***** |

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

Magnet Wire

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

Results for R-22 / R-407C retrofit

| | Varnish Type |
|-------------------|--------------|
| Unexposed Burnout | none |
| | 584 sec. |

Exposure With:

R-22 500 HRS. @ 260 F
 R-407C 168 HRS. @ 260 F
 R-407C 336 HRS. @ 260 F
 R-407C 500 HRS. @ 260 F
 R-22 1000 HRS. @ 260 F

| % Change from Unexposed | |
|-------------------------|--------|
| -45.7% | ***** |
| ***** | -40.7% |
| ***** | -53.5% |
| ***** | -20.1% |
| -59.1% | ***** |

| | Varnish Type |
|-------------------------------|--------------|
| Unexposed Dielectric Strength | none |
| | 13.4 lbs. |

Exposure With:

R-22 500 HRS. @ 260 F
 R-407C 168 HRS. @ 260 F
 R-407C 336 HRS. @ 260 F
 R-407C 500 HRS. @ 260 F
 R-22 1000 HRS. @ 260 F

| % Change from Unexposed | |
|-------------------------|-------|
| 27.2% | ***** |
| ***** | 19.5% |
| ***** | 6.5% |
| ***** | 25.3% |
| 26.9% | ***** |

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

Magnet Wire

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

Results for R-22 / R-407C retrofit

| | Varnish Type | Varnish Type |
|-------------------------|--------------------------------|--------------------------------|
| Unexposed Burnout | Isopoxy 800 543 sec. | P. D. George 923 554 sec. |
| <u>Exposure With:</u> | % 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 |
|-------------------------------|--------------------------------|--------------------------------|
| Unexposed Dielectric Strength | Isopoxy 800 15.98 kv. | P. D. George 923 17.01 kv. |
| <u>Exposure With:</u> | % 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

Magnet Wire

Varnish Coated on Magnet Wire B

(Esterimide base with amide imide overcoat)

Results for R-22 / R-407C retrofit

| | Varnish Type | Varnish Type |
|-------------------------|--------------------------------|--------------------------------|
| Unexposed Burnout | Isopoxy 800 543 sec. | P. D. George 923 554 sec. |
| <u>Exposure With:</u> | % 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 |
|-------------------------------|--------------------------------|--------------------------------|
| Unexposed Dielectric Strength | Isopoxy 800 18.88 kv. | P. D. George 923 19.78 kv. |
| <u>Exposure With:</u> | % 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

Lead Wire

Results for R-12 / R-134a retrofit

| | |
|-------------------------------|-------------|
| | type |
| | DMD |
| Unexposed Dielectric Strength | 9.77 KV. |

| | | |
|-------------------------|--------------------------------|--------|
| <u>Exposure With:</u> | % 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. |

| | | |
|-------------------------|--------------------------------|-------|
| <u>Exposure With:</u> | % 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

Lead Wire

Results for R-22 / R-407C retrofit

| | |
|-------------------------------|-------------|
| | type |
| | DMD |
| Unexposed Dielectric Strength | 9.77 KV. |

| | | |
|-------------------------|--------------------------------|--------|
| <u>Exposure With:</u> | % 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. |

| | | |
|-------------------------|--------------------------------|-------|
| <u>Exposure With:</u> | % 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

Lead Wire

Results for R-502 / R-404A retrofit

| | |
|-------------------------------|-------------|
| | type |
| | DMD |
| Unexposed Dielectric Strength | 9.77 KV. |

| | | |
|-------------------------|--------------------------------|--------|
| <u>Exposure With:</u> | % 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. |

| | | |
|-------------------------|--------------------------------|-------|
| <u>Exposure With:</u> | % 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

Spiral Wrapped Sleeving

Results for R-12 / R-134a retrofit

Sleeving type

| |
|--------|
| PET |
| >17.60 |

Unexposed Dielectric Strength

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

Dielectric Strength

| | |
|---------|---------|
| brittle | ***** |
| ***** | brittle |
| ***** | brittle |
| ***** | brittle |
| brittle | ***** |

Sleeving type

| |
|------------|
| Nomex- PET |
| >12.12 |

Unexposed Dielectric Strength

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

Dielectric Strength

| | |
|-------|-------|
| 5.64 | ***** |
| ***** | >9.68 |
| ***** | 7.96 |
| ***** | 6.35 |
| 4.26 | ***** |

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

Spiral Wrapped Sleeving

Results for R-22 / R-407C retrofit

Sleeving type

Unexposed Dielectric Strength

| |
|--------|
| PET |
| >17.60 |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

Dielectric Strength

| | |
|---------|---------|
| >16.33 | ***** |
| ***** | >19.99 |
| ***** | brittle |
| ***** | >14.62 |
| brittle | ***** |

Sleeving type

Unexposed Dielectric Strength

| |
|------------|
| Nomex- PET |
| >12.12 |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

Dielectric Strength

| | |
|--------|--------|
| >16.84 | ***** |
| ***** | >15.12 |
| ***** | >15.83 |
| ***** | >11.88 |
| 8.18 | ***** |

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

Spiral Wrapped Sleeving

Results for R-502 / R-404C retrofit

Sleeving type

Unexposed Dielectric Strength

| |
|--------|
| PET |
| >17.60 |

Exposure With:

R-502 500 HRS. @ 212 F
R-404C 168 HRS. @ 212 F
R-404C 336 HRS. @ 212 F
R-404C 500 HRS. @ 212 F
R-502 1000 HRS. @ 212 F

Dielectric Strength

| | |
|--------|--------|
| >17.19 | ***** |
| ***** | >17.19 |
| ***** | >17.32 |
| ***** | >16.10 |
| >13.02 | ***** |

Sleeving type

Unexposed Dielectric Strength

| |
|------------|
| Nomex- PET |
| >12.12 |

Exposure With:

R-502 500 HRS. @ 212 F
R-404C 168 HRS. @ 212 F
R-404C 336 HRS. @ 212 F
R-404C 500 HRS. @ 212 F
R-502 1000 HRS. @ 212 F

Dielectric Strength

| | |
|--------|--------|
| >12.21 | ***** |
| ***** | >12.21 |
| ***** | >10.81 |
| ***** | 10.80 |
| 6.04 | ***** |

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

Sheet Insulation

Results for R-12 / R-134a retrofit

Polyester film

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 22.5 ksi | 134.8% |

Exposure With:

- R-12 500 HRS. @ 212 F
- R-134a 168 HRS. @ 212 F
- R-134a 336 HRS. @ 212 F
- R-134a 500 HRS. @ 212 F
- R-12 1000 HRS. @ 212 F

% change from unexposed

| | |
|---------|--------|
| -21.5% | ***** |
| ***** | -25.4% |
| ***** | -30.4% |
| ***** | -35.2% |
| brittle | ***** |

% change from unexposed

| | |
|---------|--------|
| -10.6% | ***** |
| ***** | -25.5% |
| ***** | -75.7% |
| ***** | -81.8% |
| brittle | ***** |

Unexposed

| |
|---------------------|
| Dielectric strength |
| 14.10 kv |

Exposure With:

- R-12 500 HRS. @ 212 F
- R-134a 168 HRS. @ 212 F
- R-134a 336 HRS. @ 212 F
- R-134a 500 HRS. @ 212 F
- R-12 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >14.12 | ***** |
| ***** | >13.83 |
| ***** | >14.42 |
| ***** | >14.14 |
| >14.37 | ***** |

Polyester film (24 hour air bake)

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 22.5 ksi | 134.8% |

Exposure With:

- R-12 500 HRS. @ 212 F
- R-134a 168 HRS. @ 212 F
- R-134a 336 HRS. @ 212 F
- R-134a 500 HRS. @ 212 F
- R-12 1000 HRS. @ 212 F

% change from unexposed

| | |
|---------|---------|
| brittle | ***** |
| ***** | brittle |
| ***** | brittle |
| ***** | brittle |
| brittle | ***** |

% change from unexposed

| | |
|---------|---------|
| brittle | ***** |
| ***** | brittle |
| ***** | brittle |
| ***** | brittle |
| brittle | ***** |

Unexposed

| |
|---------------------|
| Dielectric strength |
| >14.10 kv |

Exposure With:

- R-12 500 HRS. @ 212 F
- R-134a 168 HRS. @ 212 F
- R-134a 336 HRS. @ 212 F
- R-134a 500 HRS. @ 212 F
- R-12 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >14.16 | ***** |
| ***** | >14.63 |
| ***** | >13.00 |
| ***** | >14.46 |
| >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:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

% change from unexposed

| | |
|---------|--------|
| -14.9% | ***** |
| ***** | -16.9% |
| ***** | -15.1% |
| ***** | -16.0% |
| brittle | ***** |

% change from unexposed

| | |
|--------|--------|
| -26.6% | ***** |
| ***** | -25.3% |
| ***** | -94.8% |
| ***** | -93.8% |
| britte | ***** |

Dielectric strength

| | |
|--|-----------|
| | >14.60 kv |
|--|-----------|

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >14.74 | ***** |
| ***** | >14.46 |
| ***** | >14.67 |
| ***** | >14.27 |
| >14.33 | ***** |

Polyester film low oligomer (24 hour air bake)

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 19.1 ksi | 147.3% |

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

% change from unexposed

| | |
|---------|---------|
| brittle | ***** |
| ***** | brittle |
| ***** | brittle |
| ***** | brittle |
| brittle | ***** |

% change from unexposed

| | |
|---------|---------|
| brittle | ***** |
| ***** | brittle |
| ***** | brittle |
| ***** | brittle |
| britte | ***** |

Dielectric strength

| | |
|--|-----------|
| | >14.60 kv |
|--|-----------|

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >14.03 | ***** |
| ***** | >15.22 |
| ***** | >14.59 |
| ***** | >14.86 |
| >14.64 | ***** |

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

Sheet Insulation

Results for R-12 / R-134a retrofit

Dacron Mylar Dacron

Unexposed

| |
|------------------|
| Tensile strength |
| 13.4 ksi |

| |
|------------|
| Elongation |
| 29.3% |

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

% change from unexposed

| | |
|---------|--------|
| -1.9% | ***** |
| ***** | -10.4% |
| ***** | -12.7% |
| ***** | -15.1% |
| brittle | ***** |

% change from unexposed

| | |
|---------|--------|
| -15.2% | ***** |
| ***** | 13.1% |
| ***** | -20.5% |
| ***** | 14.8% |
| brittle | ***** |

Unexposed

| |
|---------------------|
| Dielectric strength |
| >18.56 kv |

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >17.13 | ***** |
| ***** | >17.64 |
| ***** | >17.47 |
| ***** | >19.60 |
| >19.46 | ***** |

Dacron Mylar Dacron (24 hour air bake)

Unexposed

| |
|------------------|
| Tensile strength |
| 13.4 ksi |

| |
|------------|
| Elongation |
| 29.3% |

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

% change from unexposed

| | |
|---------|---------|
| -86.9% | ***** |
| ***** | brittle |
| ***** | brittle |
| ***** | brittle |
| brittle | ***** |

% change from unexposed

| | |
|---------|---------|
| -95.5% | ***** |
| ***** | brittle |
| ***** | brittle |
| ***** | brittle |
| brittle | ***** |

Unexposed

| |
|---------------------|
| Dielectric strength |
| >18.56 kv |

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >17.60 | ***** |
| ***** | >13.87 |
| ***** | >15.33 |
| ***** | >16.14 |
| >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

Unexposed

| |
|------------------|
| Tensile strength |
| 18.1 ksi |

| |
|------------|
| Elongation |
| 16.3% |

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

% change from unexposed

| | |
|-------|-------|
| -7.0% | ***** |
| ***** | 2.8% |
| ***** | 0.0% |
| ***** | -6.0% |
| -7.9% | ***** |

% change from unexposed

| | |
|--------|--------|
| -20.5% | ***** |
| ***** | -7.2% |
| ***** | -52.8% |
| ***** | -25.6% |
| -29.2% | ***** |

Unexposed

| |
|---------------------|
| Dielectric strength |
| 10.29 kv |

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|-------|-------|
| 13.82 | ***** |
| ***** | 13.79 |
| ***** | 13.96 |
| ***** | 13.28 |
| 13.33 | ***** |

Nomex (24 hour air bake)

Unexposed

| |
|------------------|
| Tensile strength |
| 18.1 ksi |

| |
|------------|
| Elongation |
| 16.3% |

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

% change from unexposed

| | |
|-------|-------|
| 7.7% | ***** |
| ***** | 5.9% |
| ***** | 3.9% |
| ***** | -3.2% |
| 6.4% | ***** |

% change from unexposed

| | |
|--------|--------|
| -41.0% | ***** |
| ***** | -39.0% |
| ***** | -20.5% |
| ***** | -43.6% |
| -23.1% | ***** |

Unexposed

| |
|---------------------|
| Dielectric strength |
| 10.29 kv |

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|-------|-------|
| 11.49 | ***** |
| ***** | 11.25 |
| ***** | 10.84 |
| ***** | 10.34 |
| 9.80 | ***** |

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

Sheet Insulation

Results for R-12 / R-134a retrofit

Nomex Mica

| | | |
|-------------------------|--------------------------------|--------------------------------|
| | Tensile strength | Elongation |
| Unexposed | 7.1 ksi | 1.9% |
| <u>Exposure With:</u> | % 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 |

| | |
|-------------------------|-------------------------------------|
| <u>Exposure With:</u> | 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% |
| <u>Exposure With:</u> | % 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 |

| | |
|-------------------------|-------------------------------------|
| <u>Exposure With:</u> | 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

Unexposed

| |
|------------------|
| Tensile strength |
| 17.1 ksi |

| |
|------------|
| Elongation |
| 25.5% |

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

% change from unexposed

| | |
|--------|-------|
| -5.2% | ***** |
| ***** | 3.2% |
| ***** | 2.5% |
| ***** | -6.7% |
| -51.5% | ***** |

% change from unexposed

| | |
|--------|--------|
| -22.2% | ***** |
| ***** | -54.6% |
| ***** | -61.1% |
| ***** | -68.6% |
| -72.2% | ***** |

Unexposed

| |
|---------------------|
| Dielectric strength |
| >17.76 kv |

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >18.55 | ***** |
| ***** | >18.61 |
| ***** | >19.06 |
| ***** | >19.73 |
| >17.58 | ***** |

Nomex Mylar Nomex (24 hour air bake)

Unexposed

| |
|------------------|
| Tensile strength |
| 17.1 ksi |

| |
|------------|
| Elongation |
| 25.5% |

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

% change from unexposed

| | |
|---------|---------|
| -54.2% | ***** |
| ***** | -62.6% |
| ***** | brittle |
| ***** | brittle |
| brittle | ***** |

% change from unexposed

| | |
|---------|---------|
| -76.5% | ***** |
| ***** | -85.0% |
| ***** | brittle |
| ***** | brittle |
| brittle | ***** |

Unexposed

| |
|---------------------|
| Dielectric strength |
| >17.76 kv |

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >16.54 | ***** |
| ***** | >19.48 |
| ***** | >17.35 |
| ***** | >19.03 |
| >15.81 | ***** |

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

Sheet Insulation

Results for R-22 / R-407C retrofit

Polyester film

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 22.5 ksi | 134.8% |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

% change from unexposed

| | |
|---------|--------|
| -25.2% | ***** |
| ***** | -28.2% |
| ***** | -31.3% |
| ***** | -32.5% |
| brittle | ***** |

% change from unexposed

| | |
|---------|--------|
| 1.0% | ***** |
| ***** | -38.2% |
| ***** | -71.9% |
| ***** | -84.3% |
| brittle | ***** |

| | |
|-----------|---------------------|
| | Dielectric strength |
| Unexposed | >14.10 kv |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >14.41 | ***** |
| ***** | >14.36 |
| ***** | >14.22 |
| ***** | >14.42 |
| >14.04 | ***** |

Polyester film (24 hour air bake)

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 22.5 ksi | 134.8% |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

% change from unexposed

| | |
|---------|---------|
| brittle | ***** |
| ***** | brittle |
| ***** | brittle |
| ***** | brittle |
| brittle | ***** |

% change from unexposed

| | |
|---------|---------|
| brittle | ***** |
| ***** | brittle |
| ***** | brittle |
| ***** | brittle |
| britte | ***** |

| | |
|-----------|---------------------|
| | Dielectric strength |
| Unexposed | >14.10 kv |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|---------|--------|
| >13.18 | ***** |
| ***** | >14.59 |
| ***** | >13.24 |
| ***** | >12.53 |
| brittle | ***** |

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

Sheet Insulation

Results for R-22 / R-407C retrofit

Polyester film low oligomer

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 19.1 ksi | 142.8% |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

% change from unexposed

| | |
|---------|--------|
| -13.2% | ***** |
| ***** | -13.8% |
| ***** | -18.3% |
| ***** | -18.1% |
| brittle | ***** |

% change from unexposed

| | |
|---------|--------|
| -25.2% | ***** |
| ***** | -1.2% |
| ***** | -56.9% |
| ***** | -95.1% |
| brittle | ***** |

Unexposed

| |
|---------------------|
| Dielectric strength |
| >14.60 kv |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >14.84 | ***** |
| ***** | >14.51 |
| ***** | >14.59 |
| ***** | >15.15 |
| >14.82 | ***** |

Polyester film low oligomer (24 hour air bake)

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 19.1 ksi | 142.8% |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

% change from unexposed

| | |
|---------|---------|
| brittle | ***** |
| ***** | brittle |
| ***** | brittle |
| ***** | brittle |
| brittle | ***** |

% change from unexposed

| | |
|---------|---------|
| brittle | ***** |
| ***** | brittle |
| ***** | brittle |
| ***** | brittle |
| brittle | ***** |

Unexposed

| |
|---------------------|
| Dielectric strength |
| >14.60 kv |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|---------|--------|
| >14.45 | ***** |
| ***** | >15.24 |
| ***** | >14.35 |
| ***** | >13.61 |
| 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:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

% change from unexposed

| | |
|--------|--------|
| -8.7% | ***** |
| ***** | -11.2% |
| ***** | -14.2% |
| ***** | -30.9% |
| -80.4% | ***** |

% change from unexposed

| | |
|--------|-------|
| -14.8% | ***** |
| ***** | 50.6% |
| ***** | 15.4% |
| ***** | 30.7% |
| -93.8% | ***** |

Unexposed

| |
|---------------------|
| Dielectric strength |
| >18.56 kv |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >16.46 | ***** |
| ***** | >17.73 |
| ***** | >19.99 |
| ***** | >19.48 |
| >18.76 | ***** |

Dacron Mylar Dacron (24 hour air bake)

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 13.4 ksi | 29.3% |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

% change from unexposed

| | |
|---------|---------|
| brittle | ***** |
| ***** | brittle |
| ***** | brittle |
| ***** | brittle |
| brittle | ***** |

% change from unexposed

| | |
|---------|---------|
| brittle | ***** |
| ***** | brittle |
| ***** | brittle |
| ***** | brittle |
| brittle | ***** |

Unexposed

| |
|---------------------|
| Dielectric strength |
| >18.56 kv |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >14.75 | ***** |
| ***** | >16.38 |
| ***** | >16.77 |
| ***** | >12.53 |
| 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:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

% change from unexposed

| | |
|--------|-------|
| -8.2% | ***** |
| ***** | -3.0% |
| ***** | -9.8% |
| ***** | -8.1% |
| -13.6% | ***** |

% change from unexposed

| | |
|--------|--------|
| -19.0% | ***** |
| ***** | -54.4% |
| ***** | -21.5% |
| ***** | -59.0% |
| -47.7% | ***** |

| | |
|-----------|---------------------|
| | Dielectric strength |
| Unexposed | 10.24 kv |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|-------|-------|
| 13.70 | ***** |
| ***** | 14.84 |
| ***** | 13.10 |
| ***** | 12.62 |
| 13.80 | ***** |

Nomex (24 hour air bake)

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 18.1 ksi | 16.3% |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

% change from unexposed

| | |
|--------|-------|
| 6.3% | ***** |
| ***** | -1.4% |
| ***** | -2.3% |
| ***** | -9.2% |
| -13.7% | ***** |

% change from unexposed

| | |
|--------|--------|
| -76.9% | ***** |
| ***** | -66.2% |
| ***** | -41.5% |
| ***** | -56.4% |
| -69.7% | ***** |

| | |
|-----------|---------------------|
| | Dielectric strength |
| Unexposed | 10.24 kv |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|-------|-------|
| 9.97 | ***** |
| ***** | 12.09 |
| ***** | 10.41 |
| ***** | 11.44 |
| 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:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

% change from unexposed

| | |
|--------|--------|
| -18.0% | ***** |
| ***** | -9.3% |
| ***** | -20.6% |
| ***** | -18.6% |
| -15.3% | ***** |

% change from unexposed

| | |
|--------|--------|
| 4.2% | ***** |
| ***** | -17.5% |
| ***** | 8.5% |
| ***** | -26.2% |
| -17.5% | ***** |

Unexposed

| |
|---------------------|
| Dielectric strength |
| 11.39 kv |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|-------|
| >13.80 | ***** |
| ***** | 12.47 |
| ***** | 12.69 |
| ***** | 11.89 |
| 13.24 | ***** |

Nomex Mica (24 hour air bake)

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 7.1 ksi | 1.9% |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

% change from unexposed

| | |
|--------|-------|
| -1.1% | ***** |
| ***** | -1.0% |
| ***** | -0.1% |
| ***** | -6.9% |
| -15.2% | ***** |

% change from unexposed

| | |
|--------|--------|
| -65.3% | ***** |
| ***** | -56.6% |
| ***** | -47.9% |
| ***** | -47.9% |
| -56.6% | ***** |

Unexposed

| |
|---------------------|
| Dielectric strength |
| 11.39 kv |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|-------|-------|
| 10.39 | ***** |
| ***** | 13.19 |
| ***** | 12.45 |
| ***** | 12.20 |
| 8.29 | ***** |

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

Sheet Insulation

Results for R-22 / R-407C retrofit

Nomex Mylar Nomex

Unexposed

| Tensile strength |
|------------------|
| 17.1 ksi |

| Elongation |
|------------|
| 25.5% |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

% change from unexposed

| | |
|--------|--------|
| -15.0% | ***** |
| ***** | -25.8% |
| ***** | -54.1% |
| ***** | -60.1% |
| -53.3% | ***** |

% change from unexposed

| | |
|--------|--------|
| -40.2% | ***** |
| ***** | -74.8% |
| ***** | -94.1% |
| ***** | -79.4% |
| -92.2% | ***** |

Unexposed

| Dielectric strength |
|---------------------|
| >17.76 kv |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >19.65 | ***** |
| ***** | >19.53 |
| ***** | >19.95 |
| ***** | >19.50 |
| >17.17 | ***** |

Nomex Mylar Nomex (24 hour air bake)

Unexposed

| Tensile strength |
|------------------|
| 17.1 ksi |

| Elongation |
|------------|
| 25.5% |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

% change from unexposed

| | |
|--------------|--------------|
| -49.3% | ***** |
| ***** | -53.1% |
| ***** | -49.6% |
| ***** | delamination |
| delamination | ***** |

% change from unexposed

| | |
|--------------|--------------|
| -86.9% | ***** |
| ***** | -69.6% |
| ***** | -68.0% |
| ***** | delamination |
| delamination | ***** |

Unexposed

| Dielectric strength |
|---------------------|
| >17.76 kv |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >14.04 | ***** |
| ***** | >19.85 |
| ***** | >16.38 |
| ***** | >16.34 |
| >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:

R-502 500 HRS. @ 212 F
 R-404A 168 HRS. @ 212 F
 R-404A 336 HRS. @ 212 F
 R-404A 500 HRS. @ 212 F
 R-502 1000 HRS. @ 212 F

% change from unexposed

| | |
|---------|--------|
| -26.3% | ***** |
| ***** | -20.8% |
| ***** | -13.5% |
| ***** | -12.1% |
| brittle | ***** |

% change from unexposed

| | |
|---------|--------|
| -45.9% | ***** |
| ***** | -50.8% |
| ***** | -94.6% |
| ***** | -95.1% |
| brittle | ***** |

| | |
|-----------|---------------------|
| | Dielectric strength |
| Unexposed | >14.10 kv |

Exposure With:

R-502 500 HRS. @ 212 F
 R-404A 168 HRS. @ 212 F
 R-404A 336 HRS. @ 212 F
 R-404A 500 HRS. @ 212 F
 R-502 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >14.50 | ***** |
| ***** | >14.50 |
| ***** | >14.48 |
| ***** | >14.43 |
| >14.42 | ***** |

Polyester film (24 hour air bake)

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 22.5 ksi | 134.8% |

Exposure With:

R-502 500 HRS. @ 212 F
 R-404A 168 HRS. @ 212 F
 R-404A 336 HRS. @ 212 F
 R-404A 500 HRS. @ 212 F
 R-502 1000 HRS. @ 212 F

% change from unexposed

| | |
|---------|--------|
| -21.2% | ***** |
| ***** | -17.8% |
| ***** | -20.4% |
| ***** | -19.7% |
| brittle | ***** |

% change from unexposed

| | |
|---------|--------|
| -26.6% | ***** |
| ***** | -36.1% |
| ***** | -59.5% |
| ***** | -94.4% |
| brittle | ***** |

| | |
|-----------|---------------------|
| | Dielectric strength |
| Unexposed | >14.10 kv |

Exposure With:

R-502 500 HRS. @ 212 F
 R-404A 168 HRS. @ 212 F
 R-404A 336 HRS. @ 212 F
 R-404A 500 HRS. @ 212 F
 R-502 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >14.17 | ***** |
| ***** | >14.34 |
| ***** | >14.29 |
| ***** | >14.48 |
| >14.02 | ***** |

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

Sheet Insulation

Results for R-502 / R-404A retrofit

Polyester film low oligomer

| | Tensile strength | Elongation |
|-----------|------------------|------------|
| Unexposed | 19.1 ksi | 142.8% |

Exposure With:

R-502 500 HRS. @ 212 F
 R-404A 168 HRS. @ 212 F
 R-404A 336 HRS. @ 212 F
 R-404A 500 HRS. @ 212 F
 R-502 1000 HRS. @ 212 F

% change from unexposed

| | |
|---------|--------|
| -10.5% | ***** |
| ***** | -14.9% |
| ***** | -13.5% |
| ***** | -12.1% |
| brittle | ***** |

% change from unexposed

| | |
|---------|--------|
| -26.7% | ***** |
| ***** | -56.2% |
| ***** | -94.6% |
| ***** | -95.1% |
| brittle | ***** |

| | Dielectric strength |
|-----------|---------------------|
| Unexposed | >14.60 kv |

Exposure With:

R-502 500 HRS. @ 212 F
 R-404A 168 HRS. @ 212 F
 R-404A 336 HRS. @ 212 F
 R-404A 500 HRS. @ 212 F
 R-502 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >14.68 | ***** |
| ***** | >15.40 |
| ***** | >14.48 |
| ***** | >14.61 |
| >13.98 | ***** |

Polyester film low oligomer (24 hour air bake)

| | Tensile strength | Elongation |
|-----------|------------------|------------|
| Unexposed | 19.1 ksi | 142.8% |

Exposure With:

R-502 500 HRS. @ 212 F
 R-404A 168 HRS. @ 212 F
 R-404A 336 HRS. @ 212 F
 R-404A 500 HRS. @ 212 F
 R-502 1000 HRS. @ 212 F

% change from unexposed

| | |
|---------|--------|
| -9.1% | ***** |
| ***** | -18.7% |
| ***** | -8.5% |
| ***** | -13.0% |
| brittle | ***** |

% change from unexposed

| | |
|---------|--------|
| -12.8% | ***** |
| ***** | -48.5% |
| ***** | -95.1% |
| ***** | -94.9% |
| brittle | ***** |

| | Dielectric strength |
|-----------|---------------------|
| Unexposed | >14.60 kv |

Exposure With:

R-502 500 HRS. @ 212 F
 R-404A 168 HRS. @ 212 F
 R-404A 336 HRS. @ 212 F
 R-404A 500 HRS. @ 212 F
 R-502 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >14.27 | ***** |
| ***** | >14.76 |
| ***** | >14.13 |
| ***** | >15.28 |
| >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

Unexposed

| |
|------------------|
| Tensile strength |
| 13.4 ksi |

| |
|------------|
| Elongation |
| 29.3% |

Exposure With:

R-502 500 HRS. @ 212 F
 R-404A 168 HRS. @ 212 F
 R-404A 336 HRS. @ 212 F
 R-404A 500 HRS. @ 212 F
 R-502 1000 HRS. @ 212 F

% change from unexposed

| | |
|--------|-------|
| -11.3% | ***** |
| ***** | -8.5% |
| ***** | -4.0% |
| ***** | -4.9% |
| -83.1% | ***** |

% change from unexposed

| | |
|--------|--------|
| -39.8% | ***** |
| ***** | -29.0% |
| ***** | -22.7% |
| ***** | -28.4% |
| -93.8% | ***** |

Unexposed

| |
|---------------------|
| Dielectric strength |
| >18.56 kv |

Exposure With:

R-502 500 HRS. @ 212 F
 R-404A 168 HRS. @ 212 F
 R-404A 336 HRS. @ 212 F
 R-404A 500 HRS. @ 212 F
 R-502 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >16.79 | ***** |
| ***** | >17.20 |
| ***** | >19.15 |
| ***** | >17.90 |
| >16.68 | ***** |

Dacron Mylar Dacron (24 hour air bake)

Unexposed

| |
|------------------|
| Tensile strength |
| 13.4 ksi |

| |
|------------|
| Elongation |
| 29.3% |

Exposure With:

R-502 500 HRS. @ 212 F
 R-404A 168 HRS. @ 212 F
 R-404A 336 HRS. @ 212 F
 R-404A 500 HRS. @ 212 F
 R-502 1000 HRS. @ 212 F

% change from unexposed

| | |
|---------|-------|
| -0.2% | ***** |
| ***** | -3.5% |
| ***** | -3.0% |
| ***** | -2.7% |
| brittle | ***** |

% change from unexposed

| | |
|---------|--------|
| -29.3% | ***** |
| ***** | -32.4% |
| ***** | -34.1% |
| ***** | -24.4% |
| brittle | ***** |

Unexposed

| |
|---------------------|
| Dielectric strength |
| >18.56 kv |

Exposure With:

R-502 500 HRS. @ 212 F
 R-404A 168 HRS. @ 212 F
 R-404A 336 HRS. @ 212 F
 R-404A 500 HRS. @ 212 F
 R-502 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >19.37 | ***** |
| ***** | >19.05 |
| ***** | >19.66 |
| ***** | >17.76 |
| >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

Sheet Insulation

Results for R-502 / R-404A retrofit

Nomex Mylar Nomex

Unexposed

| |
|------------------|
| Tensile strength |
| 17.1 ksi |

| |
|------------|
| Elongation |
| 15.5% |

Exposure With:

R-502 500 HRS. @ 212 F
 R-404A 168 HRS. @ 212 F
 R-404A 336 HRS. @ 212 F
 R-404A 500 HRS. @ 212 F
 R-502 1000 HRS. @ 212 F

% change from unexposed

| | |
|--------|--------|
| -16.1% | ***** |
| ***** | -8.9% |
| ***** | -4.8% |
| ***** | -17.2% |
| -66.1% | ***** |

% change from unexposed

| | |
|--------|--------|
| -39.2% | ***** |
| ***** | -39.2% |
| ***** | -42.5% |
| ***** | -57.8% |
| -76.5% | ***** |

Unexposed

| |
|---------------------|
| Dielectric strength |
| >17.76 kv |

Exposure With:

R-502 500 HRS. @ 212 F
 R-404A 168 HRS. @ 212 F
 R-404A 336 HRS. @ 212 F
 R-404A 500 HRS. @ 212 F
 R-502 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >18.62 | ***** |
| ***** | >18.65 |
| ***** | >17.81 |
| ***** | >18.65 |
| >19.25 | ***** |

Nomex Mylar Nomex (24 hour air bake)

Unexposed

| |
|------------------|
| Tensile strength |
| 17.1 ksi |

| |
|------------|
| Elongation |
| 15.5% |

Exposure With:

R-502 500 HRS. @ 212 F
 R-404A 168 HRS. @ 212 F
 R-404A 336 HRS. @ 212 F
 R-404A 500 HRS. @ 212 F
 R-502 1000 HRS. @ 212 F

% change from unexposed

| | |
|--------|--------|
| -0.2% | ***** |
| ***** | -40.2% |
| ***** | -8.0% |
| ***** | -16.7% |
| -55.2% | ***** |

% change from unexposed

| | |
|--------|--------|
| -65.7% | ***** |
| ***** | -69.0% |
| ***** | -62.4% |
| ***** | -68.6% |
| -64.1% | ***** |

Unexposed

| |
|---------------------|
| Dielectric strength |
| >17.76 kv |

Exposure With:

R-502 500 HRS. @ 212 F
 R-404A 168 HRS. @ 212 F
 R-404A 336 HRS. @ 212 F
 R-404A 500 HRS. @ 212 F
 R-502 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >17.67 | ***** |
| ***** | >19.30 |
| ***** | >18.25 |
| ***** | >18.24 |
| >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% |

| <u>Exposure With:</u> | % 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% |

| <u>Exposure With:</u> | % 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% |

| <u>Exposure With:</u> | % 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

Tapes and Tie Cords

Results for R-22 /R-407C retrofit

Heat shrinkable braided polyester

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 42.55 lbs | 29.1% |

| <u>Exposure With:</u> | % 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% |

| <u>Exposure With:</u> | % 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% |

| <u>Exposure With:</u> | % 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% |

| <u>Exposure With:</u> | % 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% |

| <u>Exposure With:</u> | % 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% |

| <u>Exposure With:</u> | % 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.

Unexposed

Motorette Wire Type

| Wire Type A | Wire Type B | Wire Type C |
|-------------|-------------|-------------|
| Pass | Pass | Pass |

Exposure With:

R-11 @ 212 F

R-12 @ 260 F

R-22 @ 260 F

R-502 @ 260F

Voltage Withstand

| | | |
|-------|-------|-------|
| ***** | ***** | Pass |
| Pass | Pass | ***** |
| Pass | Pass | ***** |
| Pass | Pass | ***** |

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

Unexposed

Motorette Wire Type

| Wire Type A | Wire Type B | Wire Type C |
|-------------|-------------|-------------|
| Pass | Pass | Pass |

Exposure With:

R-11 and R-123 @ 212 F

R-12 and R-134a @ 260 F

R-22 and R-(32/125/134a) @ 260 F

R-502 and R-(125/143a/134a) @ 260 F

Voltage Withstand

| | | |
|-------|-------|-------|
| ***** | ***** | Pass |
| Pass | Pass | ***** |
| Pass | Pass | ***** |
| 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.

Motorette Wire Type

Unexposed

| Wire Type A | Wire Type B | Wire Type C |
|-------------|-------------|-------------|
| Pass | Pass | Pass |

Exposure With:

R-11 and R-123 @ 212 F

R-12 and R-134a @ 260 F

R-22 and R-(32/125/134a) @ 260 F

R-502 and R-(125/143a/134a) @ 260 F

Voltage Withstand

| | | |
|-------|-------|-------|
| ***** | ***** | Pass |
| Pass | Pass | ***** |
| Pass | Pass | ***** |
| Pass | Pass | ***** |

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

Motorette Wire Type

Unexposed

| Wire Type A | Wire Type B | Wire Type C |
|-------------|-------------|-------------|
| Pass | Pass | Pass |

Exposure With:

R-11 and R-123 @ 212 F

R-12 and R-134a @ 260 F

R-22 and R-(32/125/134a) @ 260 F

R-502 and R-(125/143a/134a) @ 260 F

Voltage Withstand

| | | |
|-------|-------|-------|
| ***** | ***** | Pass |
| Pass | Pass | ***** |
| Pass | Pass | ***** |
| 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:

R-11 @ 212 F
 R-123 @ 212 F
 R-12 @ 260 F
 R-22 @ 260 F
 R-502 @ 260F

Voltage Withstand

| | | |
|-------|-------|-------|
| ***** | ***** | Pass |
| ***** | ***** | Pass |
| Pass | Pass | ***** |
| Pass | Pass | ***** |
| 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:

R-11 and R-123 @ 212 F
 R-11 and R-245ca @ 212 F
 R-123 and R-245ca @ 260 F
 R-12 and R-134a @ 260 F
 R-22 and R-407C @ 260 F
 R-502 and R-404A @ 260 F

Voltage Withstand

| | | |
|-------|-------|-------|
| ***** | ***** | Pass |
| ***** | ***** | Pass |
| ***** | ***** | Pass |
| Pass | Pass | ***** |
| Pass | Pass | ***** |
| 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 |
|-------------|-------------|-------------|
| Pass | Pass | Pass |

Unexposed

Exposure With:

R-11 and R-123 @ 212 F
 R-11 and R-245ca @ 212 F
 R-123 and R-245ca @ 260 F
 R-12 and R-134a @ 260 F
 R-22 and R-407C @ 260 F
 R-502 and R-404A @ 260 F

Voltage Withstand

| | | |
|-------|-------|-------|
| ***** | ***** | Pass |
| ***** | ***** | Pass |
| ***** | ***** | Pass |
| Pass | Pass | ***** |
| Pass | Pass | ***** |
| 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 |
|-------------|-------------|-------------|
| Pass | Pass | Pass |

Unexposed

Exposure With:

R-11 and R-123 @ 212 F
 R-11 and R-245ca @ 212 F
 R-123 and R-245ca @ 260 F
 R-12 and R-134a @ 260 F
 R-22 and R-407C @ 260 F
 R-502 and R-404A @ 260 F

Voltage Withstand

| | | |
|-------|-------|-------|
| ***** | ***** | Pass |
| ***** | ***** | Pass |
| ***** | ***** | Pass |
| Pass | Pass | ***** |
| Pass | Pass | ***** |
| 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



P.O. Box 89
Circleville, OH 43113

December 13, 1994

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 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 |
|-------------------------|----------------|
| Unexposed Bond Strength | Sterling U-475 |
| | 27.4 lbs. |

| <u>Exposure With:</u> | <u>% Change from Unexposed</u> | |
|------------------------|--------------------------------|--------|
| 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:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

| % change from unexposed | | % change from unexposed | |
|-------------------------|--------|-------------------------|--------|
| -31.1% | ***** | -81.0% | ***** |
| ***** | -31.8% | ***** | -93.8% |
| ***** | -23.3% | ***** | -94.6% |
| ***** | -26.8% | ***** | -94.6% |
| -34.6% | ***** | -93.1% | ***** |

| | |
|-----------|---------------------|
| | Dielectric strength |
| Unexposed | >14.10 kv |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

| recorded dielectric strength | |
|------------------------------|--------|
| >13.98 | ***** |
| ***** | >14.38 |
| ***** | >14.25 |
| ***** | >14.55 |
| >14.68 | ***** |

Polyester film (24 hour air bake)

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 22.5 ksi | 134.8% |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

| % change from unexposed | | % change from unexposed | |
|-------------------------|--------|-------------------------|--------|
| -21.6% | ***** | -90.6% | ***** |
| ***** | -23.7% | ***** | -94.6% |
| ***** | -26.4% | ***** | -94.9% |
| ***** | -23.3% | ***** | -94.7% |
| -30.3% | ***** | -94.9% | ***** |

| | |
|-----------|---------------------|
| | Dielectric strength |
| Unexposed | >14.10 kv |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

| recorded dielectric strength | |
|------------------------------|--------|
| >13.54 | ***** |
| ***** | >13.97 |
| ***** | >14.13 |
| ***** | >14.07 |
| >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:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

% change from unexposed

| | |
|--------|--------|
| -17.1% | ***** |
| ***** | -17.2% |
| ***** | -7.7% |
| ***** | -14.6% |
| -18.0% | ***** |

% change from unexposed

| | |
|--------|--------|
| -55.2% | ***** |
| ***** | -89.4% |
| ***** | -94.6% |
| ***** | -95.1% |
| -86.5% | ***** |

| | | |
|-----------|---------------------|--|
| | Dielectric strength | |
| Unexposed | >14.60 kv | |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >13.94 | ***** |
| ***** | >14.53 |
| ***** | >15.68 |
| ***** | >15.09 |
| >14.68 | ***** |

Polyester film low oligomer (24 hour air bake)

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 19.1 ksi | 142.8% |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

% change from unexposed

| | |
|--------|--------|
| -7.3% | ***** |
| ***** | -35.0% |
| ***** | -8.1% |
| ***** | -9.3% |
| -24.3% | ***** |

% change from unexposed

| | |
|--------|--------|
| -95.0% | ***** |
| ***** | -95.0% |
| ***** | -86.8% |
| ***** | -94.9% |
| -94.6% | ***** |

| | | |
|-----------|---------------------|--|
| | Dielectric strength | |
| Unexposed | >14.60 kv | |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >14.30 | ***** |
| ***** | >14.37 |
| ***** | >16.04 |
| ***** | >14.73 |
| >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:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

% change from unexposed

| | |
|--------|--------|
| -1.6% | ***** |
| ***** | -6.2% |
| ***** | 0.2% |
| ***** | -27.0% |
| -10.9% | ***** |

% change from unexposed

| | |
|--------|--------|
| -15.9% | ***** |
| ***** | -25.0% |
| ***** | -17.6% |
| ***** | -26.1% |
| -35.8% | ***** |

| | |
|-----------|---------------------|
| | Dielectric strength |
| Unexposed | >18.56 kv |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >15.90 | ***** |
| ***** | >17.09 |
| ***** | >15.66 |
| ***** | >17.72 |
| >16.29 | ***** |

Dacron Mylar Dacron (24 hour air bake)

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 13.4 ksi | 29.3% |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

% change from unexposed

| | |
|--------|-------|
| 4.1% | ***** |
| ***** | 0.9% |
| ***** | -3.7% |
| ***** | 0.9% |
| -16.9% | ***** |

% change from unexposed

| | |
|--------|--------|
| -14.8% | ***** |
| ***** | -21.0% |
| ***** | -34.7% |
| ***** | -25.0% |
| -66.5% | ***** |

| | |
|-----------|---------------------|
| | Dielectric strength |
| Unexposed | >18.56 kv |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >18.73 | ***** |
| ***** | >16.71 |
| ***** | >16.60 |
| ***** | >17.72 |
| >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% |
| <u>Exposure With:</u> | % 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 |

| | |
|-------------------------|-------------------------------------|
| <u>Exposure With:</u> | 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% |
| <u>Exposure With:</u> | % 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 |

| | |
|-------------------------|-------------------------------------|
| <u>Exposure With:</u> | 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% |
| <u>Exposure With:</u> | % 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 |

| | |
|-------------------------|-------------------------------------|
| <u>Exposure With:</u> | 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% |
| <u>Exposure With:</u> | % 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 |

| | |
|-------------------------|-------------------------------------|
| <u>Exposure With:</u> | 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:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

% change from unexposed

| | |
|--------|--------|
| -14.0% | ***** |
| ***** | -5.7% |
| ***** | -4.0% |
| ***** | -15.7% |
| -7.5% | ***** |

% change from unexposed

| | |
|--------|--------|
| -58.2% | ***** |
| ***** | -35.3% |
| ***** | -72.6% |
| ***** | -83.0% |
| -36.9% | ***** |

| | |
|-----------|---------------------|
| | Dielectric strength |
| Unexposed | >17.76 kv |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >19.13 | ***** |
| ***** | >17.90 |
| ***** | >18.72 |
| ***** | >19.18 |
| >19.85 | ***** |

Nomex Mylar Nomex (24 hour air bake)

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 17.1 ksi | 25.5% |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

% change from unexposed

| | |
|-------|--------|
| 3.7% | ***** |
| ***** | 2.0% |
| ***** | -9.4% |
| ***** | -10.4% |
| -7.5% | ***** |

% change from unexposed

| | |
|--------|--------|
| -55.6% | ***** |
| ***** | -50.0% |
| ***** | -65.4% |
| ***** | -79.7% |
| -79.4% | ***** |

| | |
|-----------|---------------------|
| | Dielectric strength |
| Unexposed | >17.76 kv |

Exposure With:

R-22 500 HRS. @ 212 F
 R-407C 168 HRS. @ 212 F
 R-407C 336 HRS. @ 212 F
 R-407C 500 HRS. @ 212 F
 R-22 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >17.73 | ***** |
| ***** | >18.56 |
| ***** | >18.05 |
| ***** | >19.55 |
| >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% |
| <u>Exposure With:</u> | % 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 |

| | |
|-------------------------|-------------------------------------|
| <u>Exposure With:</u> | 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% |
| <u>Exposure With:</u> | % 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 |

| | |
|-------------------------|-------------------------------------|
| <u>Exposure With:</u> | 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:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

% change from unexposed

| | |
|--------|--------|
| -3.1% | ***** |
| ***** | -26.0% |
| ***** | -26.6% |
| ***** | -27.9% |
| -26.5% | ***** |

% change from unexposed

| | |
|--------|--------|
| -95.1% | ***** |
| ***** | -94.7% |
| ***** | -93.7% |
| ***** | -91.0% |
| -95.2% | ***** |

Dielectric strength

Unexposed

>14.60 kv

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >14.46 | ***** |
| ***** | >14.35 |
| ***** | >14.74 |
| ***** | >13.87 |
| >14.11 | ***** |

Polyester film low oligomer (24 hour air bake)

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 19.1 ksi | 147.3% |

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

% change from unexposed

| | |
|--------|--------|
| -4.6% | ***** |
| ***** | -23.5% |
| ***** | -24.1% |
| ***** | -7.7% |
| -24.9% | ***** |

% change from unexposed

| | |
|--------|--------|
| -80.4% | ***** |
| ***** | -94.3% |
| ***** | -94.3% |
| ***** | -89.5% |
| -95.1% | ***** |

Dielectric strength

Unexposed

>14.60 kv

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

recorded dielectric strength

| | |
|--------|--------|
| >14.02 | ***** |
| ***** | >13.91 |
| ***** | >14.94 |
| ***** | >14.64 |
| >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% |
| <u>Exposure With:</u> | % 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 |

| | |
|-------------------------|-------------------------------------|
| <u>Exposure With:</u> | 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% |
| <u>Exposure With:</u> | % 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 |

| | |
|-------------------------|-------------------------------------|
| <u>Exposure With:</u> | 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% |
| <u>Exposure With:</u> | % 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 |

| | |
|-------------------------|-------------------------------------|
| <u>Exposure With:</u> | 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% |
| <u>Exposure With:</u> | % 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 |

| | |
|-------------------------|-------------------------------------|
| <u>Exposure With:</u> | 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% |
| <u>Exposure With:</u> | % 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 |

| | |
|-------------------------|-------------------------------------|
| <u>Exposure With:</u> | 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% |
| <u>Exposure With:</u> | % 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 |

| | |
|-------------------------|-------------------------------------|
| <u>Exposure With:</u> | 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:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

| % change from unexposed | | % change from unexposed | |
|-------------------------|-------|-------------------------|--------|
| 3.0% | ***** | -48.7% | ***** |
| ***** | -3.8% | ***** | -52.0% |
| ***** | -3.6% | ***** | -50.0% |
| ***** | -0.9% | ***** | -48.4% |
| -1.2% | ***** | -58.5% | ***** |

| | |
|-----------|---------------------|
| | Dielectric strength |
| Unexposed | >17.76 kv |

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

| recorded dielectric strength | |
|------------------------------|--------|
| >18.88 | ***** |
| ***** | >18.04 |
| ***** | >18.89 |
| ***** | >18.48 |
| >18.98 | ***** |

Nomex Mylar Nomex (24 hour air bake)

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 17.1 ksi | 25.5% |

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

| % change from unexposed | | % change from unexposed | |
|-------------------------|-------|-------------------------|--------|
| 2.7% | ***** | -52.0% | ***** |
| ***** | -0.3% | ***** | -65.7% |
| ***** | 0.6% | ***** | -52.9% |
| ***** | -3.5% | ***** | -29.1% |
| -4.2% | ***** | -37.3% | ***** |

| | |
|-----------|---------------------|
| | Dielectric strength |
| Unexposed | >17.76 kv |

Exposure With:

R-12 500 HRS. @ 212 F
 R-134a 168 HRS. @ 212 F
 R-134a 336 HRS. @ 212 F
 R-134a 500 HRS. @ 212 F
 R-12 1000 HRS. @ 212 F

| recorded dielectric strength | |
|------------------------------|--------|
| >17.43 | ***** |
| ***** | >17.60 |
| ***** | >19.13 |
| ***** | >18.97 |
| >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 |
|-------------------------|----------------|
| Unexposed Bond Strength | Sterling U-475 |
| | 27.4 lbs. |

| <u>Exposure With:</u> | <u>% Change from Unexposed</u> | |
|------------------------|--------------------------------|--------|
| 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

Varnished Helical Coils

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

Results for R-11 / R-123 retrofit

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

| <u>Exposure With:</u> | <u>% Change from Unexposed</u> | |
|------------------------|--------------------------------|--------|
| 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 |
|-------------------------|----------------|
| Unexposed Bond Strength | Sterling U-475 |
| | 27.4 lbs. |

| <u>Exposure With:</u> | <u>% Change from Unexposed</u> | |
|------------------------|--------------------------------|--------|
| 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

Varnished Helical Coils

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

Results for R-11 / R-245ca retrofit

| | Varnish Type |
|-------------------------|-----------------------------|
| Unexposed Bond Strength | Sterling U-475 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 |
|-------------------------|-----------------------------|
| Unexposed Bond Strength | Sterling U-475 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

Varnished Helical Coils

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

Results for R-123 / R-245ca retrofit

| | Varnish Type |
|-------------------------|-----------------------------|
| Unexposed Bond Strength | Sterling U-475 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 |
|-------------------------|-----------------------------|
| Unexposed Bond Strength | Sterling U-475 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

Magnet Wire

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

Results for R-11 / R-123 retrofit

| | Varnish Type |
|-------------------|--------------|
| Unexposed Burnout | none |
| | 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 |
|-------------------------------|--------------|
| Unexposed Dielectric Strength | none |
| | 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

Magnet Wire

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

Results for R-11 / R-123 retrofit

| | Varnish Type |
|-------------------|----------------|
| Unexposed Burnout | Sterling U-475 |
| | 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 |
|-------------------------------|----------------|
| Unexposed Dielectric Strength | Sterling U-475 |
| | 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

Magnet Wire

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

Results for R-11 / R-245ca retrofit

| | Varnish Type |
|-------------------|--------------|
| Unexposed Burnout | none |
| | 734 sec. |

Exposure With:

R-11 500 HRS. @ 212 F
 R-245ca 168 HRS. @ 212 F
 R-245ca 336 HRS. @ 212 F
 R-245ca 500 HRS. @ 212 F
 R-11 1000 HRS. @ 212 F

| % Change from Unexposed | |
|-------------------------|--------|
| -9.7% | ***** |
| ***** | -11.5% |
| ***** | -6.8% |
| ***** | -13.6% |
| -10.3% | ***** |

| | Varnish Type |
|-------------------------------|--------------|
| Unexposed Dielectric Strength | none |
| | 12.35 kv |

Exposure With:

R-11 500 HRS. @ 212 F
 R-245ca 168 HRS. @ 212 F
 R-245ca 336 HRS. @ 212 F
 R-245ca 500 HRS. @ 212 F
 R-11 1000 HRS. @ 212 F

| % Change from Unexposed | |
|-------------------------|-------|
| 7.8% | ***** |
| ***** | 9.4% |
| ***** | 6.5% |
| ***** | 14.6% |
| 11.0% | ***** |

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

Magnet Wire

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

Results for R-11 / R-245ca retrofit

| | Varnish Type |
|-------------------|----------------|
| Unexposed Burnout | Sterling U-475 |
| | 751sec |

Exposure With:

R-11 500 HRS. @ 212 F
R-245ca 168 HRS. @ 212 F
R-245ca 336 HRS. @ 212 F
R-245ca 500 HRS. @ 212 F
R-11 1000 HRS. @ 212 F

| % Change from Unexposed | |
|-------------------------|-------|
| -1.8% | ***** |
| ***** | -0.9% |
| ***** | 0.2% |
| ***** | -1.0% |
| -2.2% | ***** |

| | Varnish Type |
|-------------------------------|----------------|
| Unexposed Dielectric Strength | Sterling U-475 |
| | 13.25 kv |

Exposure With:

R-11 500 HRS. @ 212 F
R-245ca 168 HRS. @ 212 F
R-245ca 336 HRS. @ 212 F
R-245ca 500 HRS. @ 212 F
R-11 1000 HRS. @ 212 F

| % Change from Unexposed | |
|-------------------------|-------|
| 12.9% | ***** |
| ***** | 14.0% |
| ***** | 10.5% |
| ***** | 12.6% |
| 7.4% | ***** |

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

Magnet Wire

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

Results for R-123 / R-245ca retrofit

| | Varnish Type |
|-------------------|--------------|
| | none |
| Unexposed Burnout | 734 sec. |

| <u>Exposure With:</u> | % 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 |

| <u>Exposure With:</u> | % 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

Magnet Wire

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

Results for R-123 / R-245ca retrofit

| | Varnish Type |
|-------------------|----------------|
| | Sterling U-475 |
| Unexposed Burnout | 751sec |

| <u>Exposure With:</u> | % 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 |

| <u>Exposure With:</u> | % 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

Lead Wire

Results for R-11 / R-123 retrofit

| | |
|-------------------------------|-------------|
| | type |
| | DMD |
| Unexposed Dielectric Strength | 9.77 KV. |

Exposure With:

R-11 500 HRS. @ 212 F
R-123 168 HRS. @ 212 F
R-123 336 HRS. @ 212 F
R-123 500 HRS. @ 212 F
R-11 500 HRS. @ 212 F

% Change from Unexposed

| | |
|-------|--------|
| 14.5% | ***** |
| ***** | 4.8% |
| ***** | -8.7% |
| ***** | -17.7% |
| 2.6% | ***** |

| | |
|-------------------------------|-------------|
| | type |
| | DMTD |
| Unexposed Dielectric Strength | 10.16 kv. |

Exposure With:

R-11 500 HRS. @ 212 F
R-123 168 HRS. @ 212 F
R-123 336 HRS. @ 212 F
R-123 500 HRS. @ 212 F
R-11 500 HRS. @ 212 F

% Change from Unexposed

| | |
|-------|-------|
| 49.1% | ***** |
| ***** | 46.3% |
| ***** | 52.2% |
| ***** | 30.3% |
| 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

Lead Wire

Results for R-11 / R-245ca retrofit

| | |
|--------------------------------|-------------|
| | type |
| | DMD |
| Unexposed, Dielectric Strength | 9.77 KV. |

Exposure With:

R-11 500 HRS. @ 212 F
 R-245ca 168 HRS. @ 212 F
 R-245ca 336 HRS. @ 212 F
 R-245ca 500 HRS. @ 212 F
 R-11 500 HRS. @ 212 F

% Change from Unexposed

| | |
|--------|--------|
| -8.4% | ***** |
| ***** | -39.2% |
| ***** | -31.1% |
| ***** | -31.3% |
| -23.5% | ***** |

| | |
|-------------------------------|-------------|
| | type |
| | DMTD |
| Unexposed Dielectric Strength | 10.16 kv. |

Exposure With:

R-11 500 HRS. @ 212 F
 R-245ca 168 HRS. @ 212 F
 R-245ca 336 HRS. @ 212 F
 R-245ca 500 HRS. @ 212 F
 R-11 500 HRS. @ 212 F

% Change from Unexposed

| | |
|-------|-------|
| 39.1% | ***** |
| ***** | 74.4% |
| ***** | 87.5% |
| ***** | 51.8% |
| 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

Lead Wire

Results for R-123 / R-245ca retrofit

| | |
|-------------------------------|----------|
| | type |
| | DMD |
| Unexposed Dielectric Strength | 9.77 KV. |

Exposure With:

R-11 500 HRS. @ 212 F
 R-123 168 HRS. @ 212 F
 R-123 336 HRS. @ 212 F
 R-123 500 HRS. @ 212 F
 R-11 500 HRS. @ 212 F

% Change from Unexposed

| | |
|---------|--------|
| -32.1 % | ***** |
| ***** | -39.3% |
| ***** | -17.5% |
| ***** | -19.6% |
| -23.5% | ***** |

| | |
|-------------------------------|-----------|
| | type |
| | DMTD |
| Unexposed Dielectric Strength | 10.16 kv. |

Exposure With:

R-11 500 HRS. @ 212 F
 R-123 168 HRS. @ 212 F
 R-123 336 HRS. @ 212 F
 R-123 500 HRS. @ 212 F
 R-11 500 HRS. @ 212 F

% Change from Unexposed

| | |
|-------|-------|
| 38.4% | ***** |
| ***** | 29.2% |
| ***** | 34.9% |
| ***** | 77.3% |
| 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

Unexposed Dielectric Strength

| |
|--------|
| PET |
| >17.60 |

Exposure With:

R-11 500 HRS. @ 212 F
R-123 168 HRS. @ 212 F
R-123 336 HRS. @ 212 F
R-123 500 HRS. @ 212 F
R-11 1000 HRS. @ 212 F

Dielectric Strength

| | |
|--------|--------|
| >17.79 | ***** |
| ***** | >16.61 |
| ***** | >15.95 |
| ***** | >11.84 |
| >17.41 | ***** |

Sleeving type

Unexposed Dielectric Strength

| |
|------------|
| Nomex- PET |
| >12.12 |

Exposure With:

R-11 500 HRS. @ 212 F
R-123 168 HRS. @ 212 F
R-123 336 HRS. @ 212 F
R-123 500 HRS. @ 212 F
R-11 1000 HRS. @ 212 F

Dielectric Strength

| | |
|--------|--------|
| >11.84 | ***** |
| ***** | >12.38 |
| ***** | >9.96 |
| ***** | >11.75 |
| >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

Unexposed Dielectric Strength

| |
|--------|
| PET |
| >17.60 |

Exposure With:

R-11 500 HRS. @ 212 F
R-245ca 168 HRS. @ 212 F
R-245ca 336 HRS. @ 212 F
R-245ca 500 HRS. @ 212 F
R-11 1000 HRS. @ 212 F

Dielectric Strength

| | |
|--------|--------|
| >9.37 | ***** |
| ***** | >11.44 |
| ***** | >11.98 |
| ***** | >12.01 |
| >11.13 | ***** |

Sleeving type

Unexposed Dielectric Strength

| |
|------------|
| Nomex- PET |
| >12.12 |

Exposure With:

R-11 500 HRS. @ 212 F
R-245ca 168 HRS. @ 212 F
R-245ca 336 HRS. @ 212 F
R-245ca 500 HRS. @ 212 F
R-11 1000 HRS. @ 212 F

Dielectric Strength

| | |
|--------|--------|
| >9.64 | ***** |
| ***** | >10.66 |
| ***** | >11.42 |
| ***** | >11.62 |
| >12.27 | ***** |

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

Spiral Wrapped Sleeving

Results for R-123 / R-245ca retrofit

Sleeving type

Unexposed Dielectric Strength

| |
|--------|
| PET |
| >17.60 |

Exposure With:

R-123 500 HRS. @ 212 F
R-245ca 168 HRS. @ 212 F
R-245ca 336 HRS. @ 212 F
R-245ca 500 HRS. @ 212 F
R-123 1000 HRS. @ 212 F

Dielectric Strength

| | |
|--------|--------|
| >10.21 | ***** |
| ***** | >11.00 |
| ***** | >12.02 |
| ***** | >9.77 |
| >10.96 | ***** |

Sleeving type

Unexposed Dielectric Strength

| |
|------------|
| Nomex- PET |
| >12.12 |

Exposure With:

R-123 500 HRS. @ 212 F
R-245ca 168 HRS. @ 212 F
R-245ca 336 HRS. @ 212 F
R-245ca 500 HRS. @ 212 F
R-123 1000 HRS. @ 212 F

Dielectric Strength

| | |
|--------|--------|
| >11.70 | ***** |
| ***** | >11.10 |
| ***** | >11.22 |
| ***** | >9.77 |
| >11.32 | ***** |

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

Sheet Insulation

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

Sheet Insulation

Results for R-11 / R-123 retrofit

Polyester film low oligomer

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 19.1 ksi | 142.8% |

| <u>Exposure With:</u> | % 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 |

| <u>Exposure With:</u> | 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% |

| <u>Exposure With:</u> | % 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 |

| <u>Exposure With:</u> | 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

Sheet Insulation

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

Sheet Insulation

Results for R-11 / R-123 retrofit

Nomex

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 18.1 ksi | 16.3% |

| | | |
|------------------------|--------------------------------|--------------------------------|
| <u>Exposure With:</u> | % 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 |

| | |
|------------------------|-------------------------------------|
| <u>Exposure With:</u> | 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% |

| | | |
|------------------------|--------------------------------|--------------------------------|
| <u>Exposure With:</u> | % 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 |

| | |
|------------------------|-------------------------------------|
| <u>Exposure With:</u> | 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% |

| | | |
|------------------------|--------------------------------|--------------------------------|
| <u>Exposure With:</u> | % 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 |

| | |
|------------------------|-------------------------------------|
| <u>Exposure With:</u> | 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% |

| | | |
|------------------------|--------------------------------|--------------------------------|
| <u>Exposure With:</u> | % 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 |

| | |
|------------------------|-------------------------------------|
| <u>Exposure With:</u> | 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

Sheet Insulation

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

Sheet Insulation

Results for R-11 / R-245ca retrofit

Polyester film

| | | |
|-----------|------------------|------------|
| | Tensile strength | Elongation |
| Unexposed | 22.5 ksi | 134.8% |

| <u>Exposure With:</u> | % 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 |

| <u>Exposure With:</u> | 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% |

| <u>Exposure With:</u> | % 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 |

| <u>Exposure With:</u> | 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

Sheet Insulation

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

Sheet Insulation

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% |

| <u>Exposure With:</u> | % 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 |

| <u>Exposure With:</u> | 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% |

| <u>Exposure With:</u> | % 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 |

| <u>Exposure With:</u> | 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

Sheet Insulation

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% |

| <u>Exposure With:</u> | % 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 |

| <u>Exposure With:</u> | 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% |

| <u>Exposure With:</u> | % 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 |

| <u>Exposure With:</u> | 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 | -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

Sheet Insulation

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

| | | |
|-----------|------------------|------------|
| Unexposed | Tensile strength | Elongation |
| | 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

| | | |
|-----------|------------------|------------|
| Unexposed | Tensile strength | Elongation |
| | 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:

R-123 500 HRS. @ 212 F
 R-245ca 168 HRS. @ 212 F
 R-245ca 336 HRS. @ 212 F
 R-245ca 500 HRS. @ 212 F
 R-123 1000 HRS. @ 212 F

% change from unexposed

| | |
|-------|-------|
| 1.2% | ***** |
| ***** | 7.0% |
| ***** | -7.1% |
| ***** | -3.8% |
| -2.2% | ***** |

% change from unexposed

| | |
|--------|--------|
| -22.9% | ***** |
| ***** | -17.4% |
| ***** | 7.1% |
| ***** | -9.1% |
| 0.0% | ***** |

Polyester tie cord

| | Tensile strength | Elongation |
|-----------|------------------|------------|
| Unexposed | 34.5 lbs | 16.7% |

Exposure With:

R-123 500 HRS. @ 212 F
 R-245ca 168 HRS. @ 212 F
 R-245ca 336 HRS. @ 212 F
 R-245ca 500 HRS. @ 212 F
 R-123 1000 HRS. @ 212 F

% change from unexposed

| | |
|--------|--------|
| -17.4% | ***** |
| ***** | -22.6% |
| ***** | -13.8% |
| ***** | -11.5% |
| -11.4% | ***** |

% change from unexposed

| | |
|--------|--------|
| -13.9% | ***** |
| ***** | -2.6% |
| ***** | 1.8% |
| ***** | -26.5% |
| 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:

R-11 @ 212 F
 R-123 @ 212 F
 R-12 @ 260 F
 R-22 @ 260 F
 R-502 @ 260F

Voltage Withstand

| | | |
|-------|-------|-------|
| ***** | ***** | Pass |
| ***** | ***** | Pass |
| Pass | Pass | ***** |
| Pass | Pass | ***** |
| 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:

R-11 and R-123 @ 212 F
 R-11 and R-245ca @ 212 F
 R-123 and R-245ca @ 260 F
 R-12 and R-134a @ 260 F
 R-22 and R-407C @ 260 F
 R-502 and R-404A @ 260 F

Voltage Withstand

| | | |
|-------|-------|-------|
| ***** | ***** | Pass |
| ***** | ***** | Pass |
| ***** | ***** | Pass |
| Pass | Pass | ***** |
| Pass | Pass | ***** |
| 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 |
|-------------|-------------|-------------|
| Pass | Pass | Pass |

Unexposed

Exposure With:

R-11 and R-123 @ 212 F
 R-11 and R-245ca @ 212 F
 R-123 and R-245ca @ 260 F
 R-12 and R-134a @ 260 F
 R-22 and R-407C @ 260 F
 R-502 and R-404A @ 260 F

Voltage Withstand

| | | |
|-------|-------|-------|
| ***** | ***** | Pass |
| ***** | ***** | Pass |
| ***** | ***** | Pass |
| Pass | Pass | ***** |
| Pass | Pass | ***** |
| 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 |
|-------------|-------------|-------------|
| Pass | Pass | Pass |

Unexposed

Exposure With:

R-11 and R-123 @ 212 F
 R-11 and R-245ca @ 212 F
 R-123 and R-245ca @ 260 F
 R-12 and R-134a @ 260 F
 R-22 and R-407C @ 260 F
 R-502 and R-404A @ 260 F

Voltage Withstand

| | | |
|-------|-------|-------|
| ***** | ***** | Pass |
| ***** | ***** | Pass |
| ***** | ***** | Pass |
| Pass | Pass | ***** |
| Pass | Pass | ***** |
| 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

Elastomers

Results for R-11 / R-245ca retrofit

Nitrile

| | |
|--------------|--|
| Volume swell | |
| | |

| | |
|---------------|--|
| Weight change | |
| | |

Exposure With:

R-11 500 HRS. @ 212 F
 R-245ca 168 HRS. @ 212 F
 R-245ca 336 HRS. @ 212 F
 R-245ca 500 HRS. @ 212 F
 R-11 1000 HRS. @ 212 F

| % change from unexposed | |
|-------------------------|-------|
| 14.2% | ***** |
| ***** | 17.4% |
| ***** | 17.0% |
| ***** | 16.5% |
| 13.4% | ***** |

| % change from unexposed | |
|-------------------------|-------|
| 18.6% | ***** |
| ***** | 19.9% |
| ***** | 19.5% |
| ***** | 19.3% |
| 18.4% | ***** |

Unexposed

| | |
|------------|--|
| Tensile | |
| 245.32 ksi | |

| | |
|------------|--|
| Elongation | |
| 157.0% | |

Exposure With:

R-11 500 HRS. @ 212 F
 R-245ca 168 HRS. @ 212 F
 R-245ca 336 HRS. @ 212 F
 R-245ca 500 HRS. @ 212 F
 R-11 1000 HRS. @ 212 F

| % change from unexposed | |
|-------------------------|---------|
| -30.70% | ***** |
| ***** | -36.46% |
| ***** | -41.97% |
| ***** | -42.65% |
| -66.31% | ***** |

| % change from unexposed | |
|-------------------------|--------|
| -44.3% | ***** |
| ***** | -42.8% |
| ***** | -53.3% |
| ***** | -54.9% |
| -66.3% | ***** |

Unexposed

| | |
|--------------|--|
| Durometer | |
| 73.0 Shore A | |

Exposure With:

R-11 500 HRS. @ 212 F
 R-245ca 168 HRS. @ 212 F
 R-245ca 336 HRS. @ 212 F
 R-245ca 500 HRS. @ 212 F
 R-11 1000 HRS. @ 212 F

| % change from unexposed | |
|-------------------------|-------|
| 1.45% | ***** |
| ***** | 5.31% |
| ***** | 2.42% |
| ***** | 3.38% |
| -13.04% | ***** |

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

Elastomers

Results for R-11 / R-245ca retrofit

Neoprene

| | |
|--------------|--|
| Volume swell | |
| | |

| | |
|---------------|--|
| Weight change | |
| | |

Exposure With:

R-11 500 HRS. @ 212 F
 R-245ca 168 HRS. @ 212 F
 R-245ca 336 HRS. @ 212 F
 R-245ca 500 HRS. @ 212 F
 R-11 1000 HRS. @ 212 F

| % change from unexposed | |
|-------------------------|-------|
| 28.7% | ***** |
| ***** | -1.5% |
| ***** | -2.6% |
| ***** | -1.8% |
| 29.0% | ***** |

| % change from unexposed | |
|-------------------------|-------|
| 31.0% | ***** |
| ***** | -3.2% |
| ***** | -5.1% |
| ***** | -3.5% |
| 33.7% | ***** |

Unexposed

| | |
|------------|--|
| Tensile | |
| 245.32 ksi | |

| | |
|------------|--|
| Elongation | |
| 157.0% | |

Exposure With:

R-11 500 HRS. @ 212 F
 R-245ca 168 HRS. @ 212 F
 R-245ca 336 HRS. @ 212 F
 R-245ca 500 HRS. @ 212 F
 R-11 1000 HRS. @ 212 F

| % change from unexposed | |
|-------------------------|---------|
| -49.98% | ***** |
| ***** | -36.36% |
| ***** | -32.65% |
| ***** | -37.67% |
| -61.00% | ***** |

| % change from unexposed | |
|-------------------------|--------|
| -35.1% | ***** |
| ***** | -54.5% |
| ***** | -38.7% |
| ***** | -47.0% |
| -32.2% | ***** |

Unexposed

| | |
|--------------|--|
| Durometer | |
| 73.0 Shore A | |

Exposure With:

R-11 500 HRS. @ 212 F
 R-245ca 168 HRS. @ 212 F
 R-245ca 336 HRS. @ 212 F
 R-245ca 500 HRS. @ 212 F
 R-11 1000 HRS. @ 212 F

| % change from unexposed | |
|-------------------------|--------|
| -29.68% | ***** |
| ***** | -8.68% |
| ***** | -8.68% |
| ***** | -5.02% |
| -31.05% | ***** |

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

Elastomers

Results for R-123 / R-245ca retrofit

Nitrile

| | |
|--------------|---------------|
| Volume swell | Weight change |
| | |

Exposure With:

R-123 500 HRS. @ 212 F
 R-245ca 168 HRS. @ 212 F
 R-245ca 336 HRS. @ 212 F
 R-245ca 500 HRS. @ 212 F
 R-123 1000 HRS. @ 212 F

| % change from unexposed | | % change from unexposed | |
|-------------------------|-------|-------------------------|-------|
| 76.7% | ***** | 87.6% | ***** |
| ***** | 22.4% | ***** | 25.3% |
| ***** | 20.4% | ***** | 23.6% |
| ***** | 20.8% | ***** | 23.6% |
| 78.6% | ***** | 90.1 % | ***** |

Unexposed

| | |
|------------|------------|
| Tensile | Elongation |
| 245.32 ksi | 157.0% |

Exposure With:

R-123 500 HRS. @ 212 F
 R-245ca 168 HRS. @ 212 F
 R-245ca 336 HRS. @ 212 F
 R-245ca 500 HRS. @ 212 F
 R-123 1000 HRS. @ 212 F

| % change from unexposed | | % change from unexposed | |
|-------------------------|---------|-------------------------|--------|
| -41.15% | ***** | -49.0% | ***** |
| ***** | -41.85% | ***** | -48.5% |
| ***** | -37.75% | ***** | -33.5% |
| ***** | -37.70% | ***** | -34.4% |
| -34.64% | ***** | -59.7% | ***** |

Unexposed

| |
|--------------|
| Durometer |
| 73.0 Shore A |

Exposure With:

R-123 500 HRS. @ 212 F
 R-245ca 168 HRS. @ 212 F
 R-245ca 336 HRS. @ 212 F
 R-245ca 500 HRS. @ 212 F
 R-123 1000 HRS. @ 212 F

| % change from unexposed | |
|-------------------------|---------|
| -13.53% | ***** |
| ***** | -14.98% |
| ***** | -8.70% |
| ***** | -12.08% |
| -13.04% | ***** |

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

Elastomers

Results for R-123 / R-245ca retrofit

Neoprene

| | |
|--------------|--|
| Volume swell | |
| | |

| | |
|---------------|--|
| Weight change | |
| | |

Exposure With:

R-123 500 HRS. @ 212 F
 R-245ca 168 HRS. @ 212 F
 R-245ca 336 HRS. @ 212 F
 R-245ca 500 HRS. @ 212 F
 R-123 1000 HRS. @ 212 F

| % change from unexposed | |
|-------------------------|-------|
| 34.1% | ***** |
| ***** | -5.2% |
| ***** | -5.3% |
| ***** | -4.5% |
| 32.9% | ***** |

| % change from unexposed | |
|-------------------------|-------|
| 29.1% | ***** |
| ***** | -2.8% |
| ***** | -2.4% |
| ***** | -2.0% |
| 18.4% | ***** |

Unexposed

| | |
|------------|--|
| Tensile | |
| 245.32 ksi | |

| | |
|------------|--|
| Elongation | |
| 157.0% | |

Exposure With:

R-123 500 HRS. @ 212 F
 R-245ca 168 HRS. @ 212 F
 R-245ca 336 HRS. @ 212 F
 R-245ca 500 HRS. @ 212 F
 R-123 1000 HRS. @ 212 F

| % change from unexposed | |
|-------------------------|--------|
| -3.51 % | ***** |
| ***** | 18.10% |
| ***** | 55.72% |
| ***** | 38.10% |
| -17.38% | ***** |

| % change from unexposed | |
|-------------------------|--------|
| -25.9% | ***** |
| ***** | -41.9% |
| ***** | -26.1% |
| ***** | -40.3% |
| -40.6% | ***** |

Unexposed

| | |
|--------------|--|
| Durometer | |
| 73.0 Shore A | |

Exposure With:

R-123 500 HRS. @ 212 F
 R-245ca 168 HRS. @ 212 F
 R-245ca 336 HRS. @ 212 F
 R-245ca 500 HRS. @ 212 F
 R-123 1000 HRS. @ 212 F

| % change from unexposed | |
|-------------------------|-------|
| -11.11 % | ***** |
| ***** | 4.23% |
| ***** | 9.52% |
| ***** | 9.52% |
| -7.94% | ***** |

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