006428

1 OF 1

DOE/CE/23810--4B

DE93 006428

JAN 6 1993

COMPATIBILITY OF REFRIGERANTS AND LUBRICANTS WITH MOTOR MATERIALS

Quarterly Technical Progress Report

1 July 1992 - 30 September 1992

Robert Doerr
Stephen Kujak

The Trane Company
3600 Pammel Creek Road
La Crosse, Wisconsin 54601-7599

October 1992

Prepared for
The Air-Conditioning and Refrigeration Technology Institute
Under
ARTI MCLR Project Number 650-50400

This research project is supported, in whole or in part, by U.S. Department of Energy grant DE-FG02-91CE23810: Materials Compatibility and Lubricant Research (MCLR) on CFC-Refrigerant Substitutes. Federal funding supporting this project constitutes 93.67% of allowable costs. Funding from non-government sources supporting this project consists of direct cost sharing of 6.33% of allowable costs; and in-kind contributions from the air-conditioning and refrigeration industry.

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

for

DISCLAIMER

The U.S. Department of Energy's and the air-conditioning industry's support for the Materials Compatibility and Lubricant Research (MCLR) program does not constitute an endorsement by the U.S. Department of Energy, nor by the air-conditioning and refrigeration industry, of the views expressed herein.

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the Department of Energy, nor the Air-Conditioning and Refrigeration Technology Institute, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product or process disclosed or represents that its use would not infringe privately-owned rights.

COPYRIGHT NOTICE

(for journal publication submissions)

By acceptance of the article, the publisher and/or recipient acknowledges the right of the U.S. Government's and the Air-Conditioning and Refrigeration Technology Institutes, Inc. (ARTI) rights to retain a nonexclusive, royalty-free license in and to any copyright covering this paper.

COMPATIBILITY OF REFRIGERANTS AND LUBRICANTS WITH MOTOR MATERIALS

Quarterly Technical Progress Report
1 July 1992-30 September 1992

ABSTRACT

During the compatibility study of 10 pure refrigerants with 24 motor materials, it was observed that the greatest damage to the insulation system was caused by absorption of refrigerant followed by rapid desorption. The observed effects were blisters, cracking, internal bubbles and delamination. Measured results includes decreased bond strength, dielectric strength and overall integrity of the material. Refrigerants HCFC-22, HFC-32, HFC-134 and HFC-152a exhibited this phenomena. The effect of HCFC-22 was most severe of the tested refrigerants. Since HCFC-22 has an excellent reliability history with many of the materials tested, compatibility with the new refrigerants is expected.

SCOPE

The scope of this report covers the compatibility results of 24 commercially used motor materials with ten refrigerants. The effect of heat alone was determined by exposures in nitrogen gas at the same temperatures as the refrigerant exposures. The refrigerants and test temperature are shown below. All exposures were for 500 hours.

HCFC Refrigerants

HCFC-22 @ 90°C*
HCFC-123 @ 90°C
HCFC-124 @ 90°C
HCFC-142b @ 90°C

HFC- Refrigerants

HFC-152a @ 90°C
HFC-134a @ 90°C
HFC-134 @ 90°C
HFC-125 @ 60°C**
HFC-32 @ 60°C
HFC-143a @ 60°C

Baseline Exposures

Nitrogen @ 60°C
Nitrogen @ 90°C
*90°C=194°F
**60°C=140°F

Evaluations conducted on the various types of motor materials are listed below. Materials were evaluated immediately after the 500 hour exposures and after the 500 hour exposure followed by an additional 24 hour bake at 150°C(302°F) in air to remove absorbed refrigerant.

Varnish

-Weight Change

Lead Wire

-Weight Change
-Dielectric Strength

Tie Cord

-Weight Change
-Break Load Strength

Magnet Wire/Varnish

-Bond Strength
-Burnout Resistance
-Dielectric Strength

Spiral Wrapped Sleeveing

-Weight Change
-Break Load Strength

Sheet Insulation

-Weight Change
-Tensile Strength
-Elongation
-Dielectric Strength

Tapes

-Weight Change

TABLE OF CONTENTS

	<u>Pages</u>
ABSTRACT	1
SCOPE	1
SIGNIFICANT RESULTS	2
DISCUSSION OF RESULTS	2
Introduction	2
Varnishes	3
Magnet Wire	4
Sheet Insulation	6
Spiral Wrapped Sleeving Insulation	6
Lead Wire	6
Tapes and Tie Cord	6
Refrigerant Stability	7
Conclusion	7
COMPLIANCE WITH AGREEMENT	7
PRINCIPAL INVESTIGATOR EFFORT	7
DATA TABLES	7
Magnet Wire A-Varnish Bond Strength	8
Magnet Wire A-Burnout Strength	9
Magnet Wire A-Dielectric Strength	10
Magnet Wire B-Varnish Bond Strength	11
Magnet Wire B-Burnout Strength	12
Magnet Wire B-Dielectric Strength	13
Magnet Wire C-Varnish Bond Strength	14
Magnet Wire C-Burnout Strength	15
Magnet Wire C-Dielectric Strength	16
Varnish Disks-% Weight Change	17
Sheet Insulation-% Weight Change	18
Sheet Insulation-% Change in Tensile Strength	19
Sheet Insulation-% Change in Elongation	20
Sheet Insulation-% Change in Dielectric Strength	21
Spiral Wrapped Sheet Insulation-% Weight Change	22
Lead Wire-% Weight Change	23
Lead Wire-% Change in Dielectric Strength	24
Tapes-% Weight Change	25
Tapes-% Change in Break Load	26
Tie Cord-% Weight Change	27
Tie Cord-% Change in Break Load	28
Gas Chromatography Analysis of Refrigerants after 500 hour Exposure.	29

Compatibility studies of ten pure refrigerants with motor materials are nearly complete. Only dielectric strength, burnout resistance and bond strength of samples exposed to HFC-134 remain to be evaluated. A potential low pressure refrigerant, HFC-245ca, will be tested as soon as sufficient quantities are obtained. Compatibility tests with six refrigerant/lubricant combinations were also completed. However discussion of the results will be postponed until the next quarter when all refrigerant/lubricant combinations are finished. This report summarizes the compatibility results of the ten refrigerants with the motor materials.

SIGNIFICANT RESULTS

This third quarter report summarizes the effects of ten pure refrigerants on 24 motor materials. Absorption of HCFC-123 was higher than other refrigerants. However, absorption of HCFC-22, HFC-32, HFC-134 and HFC-152a followed by desorption of these refrigerants at higher temperatures, resulted in greater damage to the insulation material than was observed with HCFC-123. This suggests that rate of refrigerant desorption appears to be more important than the amount of refrigerant absorbed. Rapid desorption of refrigerant caused blisters, cracking, internal bubbles and delamination. The measured effect on properties of some materials was a decrease of bond strength(as high as 95%), a decrease of dielectric strength(as high as 70%), and a decrease of the physical integrity of the material. Compared to the bond and dielectric strengths, burnout was less influenced by desorption prior to the test. This is because the burnout test causes desorption of refrigerant during the test. Magnet wire with polyester-glass serving had the best burnout resistance and was influenced much less by the effect of absorbed refrigerant when compared with the other types of wires.

The sheet insulation, sleeving, lead wire and tape appeared to be less affected by the refrigerant than the varnished magnet wires. High extract of the Permacel assembly tape was a concern.

Of the ten refrigerants tested, HCFC-22 appeared to produce the most deleterious effects on motor materials. However, since HCFC-22 has an excellent reliability history with many of these materials, the alternative refrigerants are also expected to be compatible with most materials.

The results of the exposures of various motor materials to ten pure refrigerants are presented in tabular form on pages 8-29 and are discussed in the next section.

DISCUSSION OF RESULTS

INTRODUCTION

The compatibility of a polymeric insulation material with refrigerants depends primarily on three primary modes of interaction: absorption of the refrigerant, extraction by the refrigerant, and chemical dissolution.

Absorption of the refrigerant can affect the insulation material by changing its dielectric strength or physical integrity. Absorption of refrigerant can cause excessive swelling, softening, or decreased strength. In addition to the direct

effect of the absorbed refrigerant, a more deleterious effect may be experienced due to rapid desorption of the refrigerant. Desorption can result in high internal pressures causing blisters, crazing, craters or bubbles within the insulating material. A pronounced decrease in the dielectric and physical strength of the material is often observed.

Extraction of material by the refrigerant results in a range of effects varying from complete dissolution to only a slight change in properties as a result of dissolving only unpolymerized material. The usual effect of the extraction on insulation materials is embrittlement caused by extraction of low molecular weight polymers(oligomers) or plasticizers.

Besides the direct effects of extraction on the insulating materials, extraction can cause serious problems within hermetic systems by causing components to stick or by clogging passages such as capillary tubes.

The data presented in the tables on pages 8-28 show the effects of absorption, desorption and extraction on the physical properties of the insulating materials. Results immediately after exposures illustrate the effects of absorbed refrigerant on insulation properties such as bond strength, burnout time, dielectric strength, elongation and tensile strength. The results after 150°C(302°F) bake in air following the refrigerant exposure indicate the effects of desorption on the same properties. The amount of extract was not determined directly for each material, however the weight loss by a material after removal of absorbed refrigerant gives an excellent indication of the amount of material extracted. The exposure vessels were also examined for evidence of extracted material and its identity.

VARNISHES

Before discussing the effect of refrigerants on the bond, dielectric and burnout strength of the varnished magnet wires, it is best to examine the effects on pure varnish cast in the form of thin disks. Examination of Table IVA1. on page 17 reveals that HCFC-123 is absorbed to the greatest extent(13.9% to 44.0%) by all varnishes followed by HCFC-22(7.4% to 18.7%).

Other refrigerants such as HCFC 124 (0.9-13.2%), HCFC-142b (0-10.0%) were also absorbed in fairly large amounts by the varnishes. This trend suggests that HCFC's with some chlorine are generally absorbed to greater amounts than HFC's. However, HFC-32 (4.8-9.5%), HFC-134 (-1.1-9.1%) and HFC-152a (0.1-9.1%) are absorbed to an extent similar to HCFC-124 and HCFC-142b, suggesting that other factors are involved besides the presence or absence of chlorine.

Noting the high absorption values for HCFC-123 one would expect that HCFC-123 should cause the greatest compatibility concerns. However, only the 833 varnish at 44% absorption was found to be incompatible with HCFC-123 from previous Trane studies.¹ Those studies showed that 833 varnish absorbed even more refrigerant at lower temperatures and showed extensive degradation during exposure.

¹R. Doerr, "Absorption of HCFC-123 and CFC-11 by Epoxy Motor Varnishes", ASHRAE Annual Meeting, Baltimore, MD, June 30, 1992. Transactions Vol. 98(2). Varnish C is Y-833.

Of equal concern as the amount of refrigerant absorbed is the rate at which it is out-gassed or desorbed. The varnishes exposed to HCFC-22 and to a lesser extent HFC-32, HFC-134 and HFC-152a, exhibited internal bubbles and external blisters after the 150°C(302°F) air bake. HCFC-123 did not exhibit this effect because of slower rate of desorption. Other refrigerants were similarly unaffected perhaps because less refrigerant was absorbed or a slower rate of desorption. An indication of the rate of desorption is shown by weights of samples after bakeout (table IV.A.2). Positive numbers (i.e. HCFC-123 and HCFC-124) suggest that all the refrigerant has not been removed after 24 hours. Negative numbers indicate removal of absorbed refrigerant plus the loss of varnish material by extraction. Isopoxy 800 absorbs only about half as much refrigerant as the other varnishes but always exhibits a greater amount of extraction.

The effects of refrigerants on the relatively thick varnish disks are only indications of potential problems with varnished magnet wires in actual motors. As a further step to evaluate the effects, studies were conducted on actual varnished magnet wires.

MAGNET WIRE

Three separate types of magnet wires were evaluated with six different varnish overcoats. The three magnet wires were tested unvarnished and varnished with the six varnishes to determine the effect of the varnish on the magnet wire insulation.

Bond Strength

The greatest effect of the absorption/desorption phenomena is exhibited by changes in the helical coil bond strength. In this test a coil of magnet wire (resembling a four inch section of door spring) is dipped in varnish, cured, exposed to refrigerant and evaluated in a tensile test machine. Results of the bond strength for magnet wire A (ester with amide-imide overcoat) after exposure to refrigerant are presented in Table I.A.1 page 8. Data for the 833 varnish should not be compared to that of the other varnishes because the 833 is used primarily for its electrical insulation properties rather than its bonding strength. The refrigerant showing the greatest effect on the bond strength of magnet wire A immediately after the exposure was HCFC-22 (-20 to -49%). More spectacular is the effect of desorption as presented in Table I.A.2. After bakeout of HCFC-22 the bond strength was reduced -38 to -95%. HFC-32 (-19 to -86%) and HFC-152 (-19 to 91%) also show greatly decreased bond strengths after bakeout.

The decreased bond strength was also observed for magnet wire B (glass served) after exposures to HFC-22 (-20 to -59%), HFC-32 (-6 to -75%), HFC-152a (-7 to -59%) and also HCFC-123 (+1 to -80%) as shown in Table II.A.2, page 11. For magnet wire C (ester- imide/amide-imide) similar losses of bond strength were measured for HCFC-22 (-45 to -84%) and HFC-32 (+13 to -95%) but not for HFC-152a, HFC-123 or other refrigerants.

In general the helical coil bond strength of the varnished magnet wire is decreased by the effect of absorption and rapid desorption of refrigerants. The refrigerant having the greatest effect is HCFC-22 which also has a long reliability history. This suggests that the test is severe and should only be used for comparative purposes.

Burnout Resistance

The second major evaluation of the varnished and unvarnished magnet wires is the burnout strength. This test involves two magnet wires twisted together, varnished, cured, exposed to refrigerant and tested in a burnout instrument. The instrument increases a 120 volt AC current over time, causing resistance heating of the wire and records the time at which the insulation fails. A thermocouple was attached to the outside of the wire to measure the equilibrium temperature of the sample during the test. Results are shown below.

<u>Test Time(seconds)</u>	<u>Specimen Temperature(°F)</u>
0-180	380
181-360	420
361-540	520
541-720	650
721-900	>700

An examination of Tables I.B.1 and I.B.2 for magnet wire A on page 9 and Tables III.B.1 and III.B.2 on page 14 for magnet wire C show the effect of absorbed refrigerant on the burnout time. There appears to be a relationship between the amount of refrigerant absorbed and the decrease in burnout time. Desorption of refrigerant at 150°C(302°F) shows much less effect on burnout time than on other properties. This results because the burnout test heats the wire similar to the bake out, except to higher temperatures and faster. In many instances the effect on the wire is greater when the absorbed refrigerant was not completely expelled prior to the test.

The most important information derived from the burnout test is a comparison of magnet wire B (glass served) on Tables II.B.1 and II.B.2 on page 11 with the other types of magnet wires. The unexposed magnet wire B shows a burnout time of 736 to 755 seconds compared to 430 to 600 for magnet wire A(ester with amide-imide overcoat) and 469 to 632 seconds for magnet wire C(ester-imide with amide-imide overcoat). This translates into a vast difference in temperature resistance of the three types of wire insulation. Secondly, exposure to refrigerant has very little effect on the burnout time of magnet wire B compared to the other wire types.

Dielectric Strength

The test for dielectric strength of magnet wire uses the same type of twisted pairs that are used for the burnout test. Rather than increasing the current with time, the voltage between the two wires is increased until there is dielectric breakdown of the insulation and a spark jumps between the two wires. This dielectric breakdown voltage is automatically recorded.

Examination of Tables I.C.1 and I.C.2 on page 10 for magnet wire A(ester with amide-imide overcoat) shows the greatest decrease in dielectric breakdown voltage results after rapid desorption rather than from direct absorption of refrigerant. As observed directly from the varnish discs, the greatest effect was exhibited by HCFC-22 (+8.8 to -69.9%), HFC-32 (-2.2 to -59.0%) and R-152a (-1.0 to -50.1%)

Results for magnet wire C(ester-imide with amide-imide overcoat) are very similar to those of magnet wire A.

The dielectric strength of magnet wire B(Dacron-glass served) is less affected by refrigerant than the other magnet wire types. Surprisingly the dielectric strength of unexposed magnet wire B is less than the other magnet wires.

SHEET INSULATION

Absorption of refrigerant by the sheet insulation is not as high as absorption by the varnishes as shown in Table V.A.1 on page 18. The greatest absorption by sheet insulation is again exhibited by HCFC-123 (0.7 to 21.0%) followed by HCFC-22 (2.9 to 6.7%). HFC-134 and HFC-32 were absorbed to higher levels than the other refrigerants.

Removal of absorbed refrigerant from the sheet insulation by the 150°C (302°F) bake shows little effect except for bubbles between the laminates of the Nomex/Mylar/Nomex by HCFC-22, HCFC-123, HCFC-142b, HFC-134a, HFC-134, HCFC-124, and HFC-125. Weight loss from the Dacron/Mylar/Dacron by HCFC-22, HCFC-123, and HFC-125 (-1.2, -1.3, and -1.0%) and from the Nomex by HCFC-124 and HFC-125 (-1.4 and -2.9%) is higher than for other sheet materials. These weight losses do not correspond to disproportionate decreases in tensile strength or elongation as illustrated in Tables V.B.2 and V.C.2., but may contribute to extracted material in the refrigerant

Refrigerant has little effect on the measured dielectric strength of the sheet insulation. In most case, the dielectric discharge flashes through the air around the edges of the sheet insulation rather than passing through the insulation materials.

SPIRAL WRAPPED SLEEVING INSULATION

The spiral wrapped sleeving insulation absorbed a considerable amount of HCFC-123 (22.6 to 56.9%), HCFC-22 (7.2 to 15.3), HFC-152a (8.9 to 17.2%) and HCFC-124 (5.3 to 12.4%) as shown in Table VI.A.1 on page 22. In most cases absorption in the Nomex is higher than in the Mylar. Weight loss after the 150°C bake is highest for HCFC-123, HFC-125, HCFC-142b, HFC-32 and HCFC-22 especially in the Nomex and the Nomex/Mylar ranging from 1.25 to 3.80%.

LEAD WIRE

No significant losses in weight or dielectric strength were measured for the lead wires (Tables VII.A.1 and VII.B.2).

TAPES AND TIE CORD

Refrigerant appeared to have little effect on the tensile strength of the tapes and tie cord. Of concern was the high weight loss of the Permacel Assembly Tape after exposure to refrigerant followed by the 150°C (302°F) bake. Weight loss was as high as 14.5% in HCFC-123 indicating significant extraction.

REFRIGERANT STABILITY

No significant changes in refrigerant purity were measured following exposures. (Table X. page 28). Consequently no chemical decomposition of refrigerants occurred that could degrade the motor materials.

CONCLUSIONS

HCFC-123 exhibited higher absorption and extraction compared with the other refrigerants tested. The most severe effect of refrigerants on motor materials was caused by high absorption followed by rapid desorption at higher temperatures. In this case HCFC-22 caused more damage to the insulation system than any of the other refrigerants. Since HCFC-22 has an excellent reliability history with many of these materials, compatibility with the other refrigerant is highly probable. Final judgment about the compatibility of specific materials should be postponed until the studies with refrigerant/lubricants are completed.

COMPLIANCE WITH AGREEMENT

The Trane Company has complied with all terms of the grant agreement during the third quarter of calendar year 1992.

PRINCIPAL INVESTIGATOR EFFORT

Robert Doerr (Project Manager) has devoted 169 hours(33% of his available work hours) on this program this last quarter.

Stephen Kujak (Principal Investigator) has devoted 420 hours(82% of his available work hours) on this program this last quarter.

Technicians and other investigators worked approximately 540 hours on this project during the last quarter.

DATA TABLES

Data Tables are found on pages 8-29. Results are expressed as percent change after exposure compared to the corresponding results before exposure. Positive value indicate an increase in the test results. Negative numbers indicate a decrease in the test result. For weight changes, a positive value suggests absorption of refrigerant, negative value suggests a loss of material primarily through extraction.

I. Magnet Wire A- ester base with amide imide overcoat.

A. Bond Strength

1. After 500 hour exposure.

Table IA1.

	Varnish Type					
	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Unexposed	73.7 lbs.	43.8 lbs.	51.8 lbs.	9.9 lbs	41.3 lbs	45.0 lbs

Exposure with:	% Change from Unexposed					
	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Nitrogen @ 60°C(140°F)	-33.1%	38.3%	4.5%	-8.6%	3.4%	-27.9%
Nitrogen @ 90°C(194°F)	-11.0%	6.8%	10.5%	188.2%	0.2%	10.2%
HCFC-22 @ 90°C(194°F)	-49.2%	-20.2%	-35.4%	54.3%	-23.8%	-35.4%
HCFC-123 @ 90°C(194°F)	-4.7%	0.7%	-29.4%	39.7%	-18.0%	-15.0%
HCFC-124 @ 90°C(194°F)	-5.8%	7.6%	9.8%	58.8%	3.2%	-8.3%
HCFC-142b @ 90°C(194°F)	-23.1%	16.3%	-2.6%	16.7%	5.2%	-8.7%
HFC-152a @ 90°C(194°F)	-23.3%	-5.7%	9.3%	181.0%	-27.6%	-1.4%
HFC-134a @ 90°C(194°F)	-5.4%	-1.2%	11.2%	98.7%	-9.9%	-2.8%
HFC-134 @ 90°C(194°F)	n/a	n/a	n/a	n/a	n/a	n/a
HFC-125 @ 60°C(140°F)	-24.3%	-0.9%	2.8%	-27.6%	-10.0%	3.1%
HFC-32 @ 60°C(140°F)	-11.6%	9.1%	-0.5%	114.0%	-21.2%	-38.6%
HFC-143a @ 60°C(140°F)	-6.3%	43.3%	13.5%	8.3%	6.9%	13.2%

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table IA2.

	Varnish Type					
	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Unexposed	73.7 lbs.	43.8 lbs.	51.8 lbs.	9.9 lbs	41.3 lbs	45.0 lbs

Exposure with:	% Change from Unexposed					
	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Nitrogen @ 60°C(140°F)	-5.8%	23.8%	6.9%	56.2%	12.9%	-23.5%
Nitrogen @ 90°C(194°F)	-15.9%	28.0%	37.8%	353.0%	7.9%	-1.4%
HCFC-22 @ 90°C(194°F)	-94.6%	-79.6%	-90.4%	14.7%	-83.9%	-37.6%
HCFC-123 @ 90°C(194°F)	-1.0%	12.8%	-59.9%	49.7%	6.0%	18.1%
HCFC-124 @ 90°C(194°F)	0.3%	22.7%	27.3%	134.6%	6.2%	6.5%
HCFC-142b @ 90°C(194°F)	-9.7%	30.5%	22.3%	36.1%	25.5%	13.4%
HFC-152a @ 90°C(194°F)	-91.2%	-83.1%	-84.8%	152.0%	-19.4%	-36.7%
HFC-134a @ 90°C(194°F)	19.0%	-11.1%	7.6%	4.6%	7.5%	5.7%
HFC-134 @ 90°C(194°F)	n/a	n/a	n/a	n/a	n/a	n/a
HFC-125 @ 60°C(140°F)	-10.7%	42.0%	13.5%	-29.1%	-11.5%	2.1%
HFC-32 @ 60°C(140°F)	-86.2%	-80.1%	-92.9%	-26.9%	-56.0%	-19.0%
HFC-143a @ 60°C(140°F)	4.7%	22.3%	12.5%	13.4%	20.1%	-3.3%

I. Magnet Wire A-ester base with amide imide overcoat.

B. Burnout Strength

1. After 500 hour exposure

Table IB1.

	Varnish Type						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
	576 sec	430 sec	510 sec	442 sec	578 sec	606 sec	580 sec
Unexposed							
Exposure with:	% Change from Unexposed						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Nitrogen @ 60°C(140°F)	-4.3%	-6.5%	-22.5%	2.1%	-2.2%	4.8%	-17.3%
Nitrogen @ 90°C(194°F)	-2.3%	-24.4%	-0.5%	-5.6%	-5.4%	-17.6%	-10.4%
HCFC-22 @ 90°C(194°F)	-27.7%	-16.7%	-22.9%	-22.7%	-14.0%	-12.6%	-33.6%
HCFC-123 @ 90°C(194°F)	-28.9%	-41.4%	-37.0%	-10.1%	-24.9%	-54.3%	-56.6%
HCFC-124 @ 90°C(194°F)	-21.0%	-27.1%	3.8%	-7.2%	-21.2%	-32.5%	-1.9%
HCFC-142b @ 90°C(194°F)	-54.9%	-54.7%	-24.3%	-30.2%	-34.8%	-41.1%	-47.9%
HFC-152a @ 90°C(194°F)	-28.4%	-12.2%	-41.2%	2.0%	-26.4%	-12.1%	-14.2%
HFC-134a @ 90°C(194°F)	-23.0%	4.9%	-14.0%	-14.8%	-4.3%	-12.5%	-9.7%
HFC-134 @ 90°C(194°F)	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HFC-125 @ 60°C(140°F)	-11.1%	-21.1%	-18.8%	-9.4%	-3.1%	-30.6%	-8.2%
HFC-32 @ 60°C(140°F)	-9.3%	-8.1%	-7.9%	-24.3%	-22.4%	-9.9%	-19.4%
HFC-143a @ 60°C(140°F)	-6.5%	-22.3%	-7.8%	-14.5%	-4.3%	-25.9%	-10.7%

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table IB2.

	Varnish Type						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
	576 sec	430 sec	510 sec	442 sec	578 sec	606 sec	580 sec
Unexposed							
Exposure with:	% Change from Unexposed						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Nitrogen @ 60°C(140°F)	-0.043	-21.0%	-6.8%	-5.2%	-4.7%	-26.6%	-1.2%
Nitrogen @ 90°C(194°F)	-3.0%	-12.6%	9.2%	-12.2%	-9.7%	-24.2%	-0.1%
HCFC-22 @ 90°C(194°F)	-8.9%	-24.0%	-16.2%	-29.7%	-15.1%	-35.3%	-43.6%
HCFC-123 @ 90°C(194°F)	-28.2%	-35.1%	-35.6%	-9.7%	-24.1%	-55.0%	-47.7%
HCFC-124 @ 90°C(194°F)	-19.7%	-36.7%	-10.6%	-2.9%	-7.7%	-37.0%	-1.1%
HCFC-142b @ 90°C(194°F)	-12.7%	-47.6%	-23.5%	-16.5%	-12.0%	-45.8%	-22.9%
HFC-152a @ 90°C(194°F)	-11.2%	-22.3%	-30.9%	-1.1%	-12.1%	-12.2%	-16.6%
HFC-134a @ 90°C(194°F)	-1.5%	-32.5%	-18.4%	-6.9%	-6.5%	-8.7%	-8.1%
HFC-134 @ 90°C(194°F)	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HFC-125 @ 60°C(140°F)	-2.4%	-16.0%	-4.4%	-6.3%	-10.6%	-29.6%	-8.5%
HFC-32 @ 60°C(140°F)	-7.5%	-36.3%	-9.2%	-22.4%	-10.3%	-16.5%	-12.2%
HFC-143a @ 60°C(140°F)	-0.6%	-19.5%	-4.4%	-13.0%	-14.1%	-19.8%	-10.6%

I. Magnet Wire A-ester base with amide imide overcoat.

C. Dielectric Strength

1. After 500 hour exposure

Table IC1.

	Varnish Type						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Unexposed	15.8 Kv	16.2 Kv	18.8 Kv	15.6 Kv	12.0 Kv	16.8 Kv	19.1 Kv
	% Change from Unexposed						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Exposure with:							
Nitrogen @ 60°C(140°F)	2.3%	-6.5%	-22.5%	2.1%	-2.2%	4.8%	-17.3%
Nitrogen @ 90°C(194°F)	-7.9%	11.1%	-1.2%	2.8%	-7.2%	-22.6%	-26.7%
HCFC-22 @ 90°C(194°F)	-8.0%	5.9%	6.6%	-5.0%	3.7%	11.0%	-4.0%
HCFC-123 @ 90°C(194°F)	-17.7%	-1.2%	-15.0%	-9.0%	13.2%	-44.3%	-18.4%
HCFC-124 @ 90°C(194°F)	3.1%	-5.3%	4.2%	-15.2%	-6.2%	-5.6%	-25.4%
HCFC-142b @ 90°C(194°F)	7.5%	2.8%	1.6%	-13.1%	-4.4%	3.9%	-2.0%
HFC-152a @ 90°C(194°F)	7.5%	-18.2%	-15.2%	-9.1%	-5.2%	-23.3%	-21.4%
HFC-134a @ 90°C(194°F)	6.9%	6.4%	-4.6%	3.8%	1.0%	16.5%	-18.5%
HFC-134 @ 90°C(194°F)	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HFC-125 @ 60°C(140°F)	0.0%	-24.9%	-21.7%	10.8%	-4.4%	-29.2%	-2.7%
HFC-32 @ 60°C(140°F)	-13.6%	-18.5%	-24.7%	-17.7%	-15.9%	2.5%	-0.2%
HFC-143a @ 60°C(140°F)	18.4%	12.6%	-23.9%	-9.5%	-7.3%	19.3%	4.6%

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table IC2.

	Varnish Type						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Unexposed	15.8 Kv	16.2 Kv	18.8 Kv	15.6 Kv	12.0 Kv	16.8 Kv	19.1 Kv
	% Change from Unexposed						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Exposure with:							
Nitrogen @ 60°C(140°F)	9.4%	-11.0%	-12.4%	-19.4%	-9.3%	-30.2%	-11.8%
Nitrogen @ 90°C(194°F)	-14.2%	8.5%	-11.2%	10.2%	-5.7%	-15.4%	-7.6%
HCFC-22 @ 90°C(194°F)	8.8%	-18.4%	-44.8%	-42.0%	-2.9%	-16.1%	-69.9%
HCFC-123 @ 90°C(194°F)	-15.0%	-3.0%	-19.9%	-2.1%	9.1%	-3.0%	-26.9%
HCFC-124 @ 90°C(194°F)	-2.8%	-5.5%	-7.6%	-21.5%	-12.2%	19.3%	-13.8%
HCFC-142b @ 90°C(194°F)	-9.8%	0.0%	-8.0%	-9.2%	-11.7%	-9.5%	-2.9%
HFC-152a @ 90°C(194°F)	-1.0%	-8.4%	-40.5%	-26.1%	-6.4%	-50.1%	-24.6%
HFC-134a @ 90°C(194°F)	-20.4%	-18.1%	-17.1%	-14.2%	-18.3%	8.4%	-20.5%
HFC-134 @ 90°C(194°F)	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HFC-125 @ 60°C(140°F)	13.2%	-7.3%	-21.4%	-18.3%	-3.4%	7.5%	-2.3%
HFC-32 @ 60°C(140°F)	-2.2%	-21.0%	-54.0%	-54.7%	-7.0%	-59.0%	-28.9%
HFC-143a @ 60°C(140°F)	-0.1%	23.2%	6.6%	-4.7%	-0.1%	19.3%	-19.2%

II. Magnet Wire B-dacron/glass served wire

A. Bond Strength

1. After 500 hour exposure.

Table IIA1.

	Varnish Type					
	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Unexposed	40.1 lbs.	36.1 lbs.	36.0 lbs.	33.1 lbs.	40.5 lbs.	20.2 lbs.

Exposure with:	% Change from Unexposed					
	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Nitrogen @ 60°C(140°F)	-15.0%	-10.6%	-9.4%	-20.6%	-7.3%	-3.5%
Nitrogen @ 90°C(194°F)	-13.7%	-0.8%	-17.6%	-39.1%	-20.1%	16.6%
HCFC-22 @ 90°C(194°F)	59.5%	60.5%	28.7%	-51.1%	31.2%	29.3%
HCFC-123 @ 90°C(194°F)	34.9%	25.5%	-4.6%	-75.5%	5.5%	5.2%
HCFC-124 @ 90°C(194°F)	-16.8%	0.7%	-5.9%	-8.4%	22.9%	-7.2%
HCFC-142b @ 90°C(194°F)	6.7%	9.5%	-1.0%	-38.1%	-8.3%	-11.8%
HFC-152a @ 90°C(194°F)	23.6%	43.3%	24.7%	-59.3%	10.4%	40.4%
HFC-134a @ 90°C(194°F)	-9.5%	0.6%	-14.7%	2.7%	11.8%	-6.9%
HFC-134 @ 90°C(194°F)	n/a	n/a	n/a	n/a	n/a	n/a
HFC-125 @ 60°C(140°F)	-7.6%	-2.1%	-5.2%	-3.7%	-2.4%	-2.6%
HFC-32 @ 60°C(140°F)	38.1%	75.2%	34.6%	83.8%	21.8%	28.6%
HFC-143a @ 60°C(140°F)	8.1%	-17.8%	-15.3%	51.2%	-23.8%	33.6%

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table IIA2.

	Varnish Type					
	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Unexposed	40.1 lbs.	36.1 lbs.	36.0 lbs.	33.1 lbs.	40.5 lbs.	20.2 lbs.

Exposure with:	% Change from Unexposed					
	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Nitrogen @ 60°C(140°F)	-7.1%	-9.5%	2.2%	-10.0%	-9.4%	-4.2%
Nitrogen @ 90°C(194°F)	-22.4%	-1.8%	-7.6%	-40.1%	-27.7%	-10.5%
HCFC-22 @ 90°C(194°F)	-51.7%	-58.7%	-19.9%	-77.0%	-51.7%	-58.8%
HCFC-123 @ 90°C(194°F)	-53.0%	-78.8%	-16.8%	-69.8%	-80.4%	1.2%
HCFC-124 @ 90°C(194°F)	-9.5%	0.2%	6.7%	8.9%	1.8%	-5.6%
HCFC-142b @ 90°C(194°F)	-8.1%	-1.8%	-0.5%	-16.1%	-19.4%	-2.4%
HFC-152a @ 90°C(194°F)	-38.6%	-47.6%	-22.8%	-48.5%	-52.1%	-6.9%
HFC-134a @ 90°C(194°F)	0.0%	-2.2%	-5.5%	-11.5%	0.4%	-6.8%
HFC-134 @ 90°C(194°F)	n/a	n/a	n/a	n/a	n/a	n/a
HFC-125 @ 60°C(140°F)	-10.8%	-10.0%	-8.9%	-6.3%	-12.5%	-41.7%
HFC-32 @ 60°C(140°F)	-34.9%	-36.8%	-31.6%	-17.9%	-74.6%	-5.7%
HFC-143a @ 60°C(140°F)	23.5%	-10.4%	-5.1%	37.0%	-16.0%	15.2%

II. Magnet Wire B-dacron/glass served wire.

B. Burnout Strength

1. After 500 hour exposure

Table IIB1.

	Varnish Type						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
	736 sec	746 sec	755 sec	734 sec	734 sec	742 sec	747 sec
Unexposed							
Exposure with:	% Change from Unexposed						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Nitrogen @ 60°C(140°F)	-0.9%	-3.4%	-3.5%	-1.2%	-3.9%	-0.9%	-0.9%
Nitrogen @ 90°C(194°F)	-1.3%	-2.0%	-1.8%	-0.3%	-1.7%	-0.7%	-0.7%
HCFC-22 @ 90°C(194°F)	-0.3%	-2.1%	-1.9%	-2.5%	-0.6%	-1.0%	-2.6%
HCFC-123 @ 90°C(194°F)	-1.6%	-11.9%	-2.1%	-5.0%	-8.2%	-9.4%	-2.5%
HCFC-124 @ 90°C(194°F)	-0.7%	-3.6%	-2.4%	-0.8%	-1.4%	-1.5%	-4.4%
HCFC-142b @ 90°C(194°F)	-0.5%	-10.1%	-9.4%	-12.7%	-11.4%	-8.5%	-2.8%
HFC-152a @ 90°C(194°F)	-3.5%	-9.3%	-3.9%	-3.9%	-8.4%	-3.7%	-2.6%
HFC-134a @ 90°C(194°F)	-2.1%	-3.4%	-4.4%	-1.7%	-1.7%	-2.6%	-3.4%
HFC-134 @ 90°C(194°F)	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HFC-125 @ 60°C(140°F)	-5.4%	-5.4%	-2.0%	-4.6%	-0.7%	-1.4%	-3.1%
HFC-32 @ 60°C(140°F)	-2.6%	-6.3%	-3.8%	-2.4%	-0.9%	-2.1%	1.2%
HFC-143a @ 60°C(140°F)	-0.3%	-4.8%	-2.6%	-4.8%	-7.1%	-2.3%	-2.3%

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table IIB2.

	Varnish Type						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
	736 sec	746 sec	755 sec	734 sec	734 sec	742 sec	747 sec
Unexposed							
Exposure with:	% Change from Unexposed						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Nitrogen @ 60°C(140°F)	-1.0%	-2.5%	-3.1%	-0.6%	-5.0%	-2.2%	-1.0%
Nitrogen @ 90°C(194°F)	-0.4%	-2.3%	-2.9%	-5.9%	-2.7%	-0.8%	-1.0%
HCFC-22 @ 90°C(194°F)	-2.8%	-2.1%	-1.7%	-4.6%	-1.2%	0.9%	-2.7%
HCFC-123 @ 90°C(194°F)	-0.9%	-2.5%	-3.7%	-0.6%	-1.5%	-1.2%	-2.7%
HCFC-124 @ 90°C(194°F)	0.3%	-2.1%	-3.1%	-5.1%	-1.0%	-2.0%	-2.1%
HCFC-142b @ 90°C(194°F)	-8.0%	-8.0%	-8.6%	-10.6%	-12.7%	-7.4%	-2.9%
HFC-152a @ 90°C(194°F)	-5.8%	-6.0%	-3.6%	-6.9%	-8.1%	-10.0%	-2.1%
HFC-134a @ 90°C(194°F)	-6.3%	-3.3%	-4.4%	-4.4%	-1.8%	-3.0%	-3.6%
HFC-134 @ 90°C(194°F)	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HFC-125 @ 60°C(140°F)	-4.4%	-3.7%	-1.3%	-9.9%	-2.0%	-1.1%	-1.9%
HFC-32 @ 60°C(140°F)	-5.6%	-5.4%	-3.4%	-6.8%	-3.6%	-4.2%	-1.4%
HFC-143a @ 60°C(140°F)	-0.8%	-5.5%	-2.5%	-0.6%	-5.6%	-2.3%	-11.2%

II. Magnet wire B-dacron/glass served wire.

C. Dielectric Strength

1. After 500 hour exposure

Table IIC1.

	Varnish Type						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Unexposed	11.6 Kv	13.3 Kv	12.3 Kv	12.8 Kv	12.5 Kv	14.4 Kv	12.3 Kv
	% Change from Unexposed						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Exposure with:							
Nitrogen @ 60°C(140°F)	6.7%	9.4%	4.3%	-9.5%	-8.8%	-6.9%	3.9%
Nitrogen @ 90°C(194°F)	5.1%	-0.9%	-6.5%	-7.0%	-6.0%	-19.5%	-3.9%
HCFC-22 @ 90°C(194°F)	-0.1%	-4.2%	35.2%	1.1%	1.6%	39.1%	30.6%
HCFC-123 @ 90°C(194°F)	7.4%	6.5%	59.4%	-0.1%	3.6%	22.4%	5.7%
HCFC-124 @ 90°C(194°F)	1.5%	-3.6%	-2.4%	-0.8%	-1.4%	-1.5%	-4.4%
HCFC-142b @ 90°C(194°F)	5.1%	18.5%	-5.7%	9.7%	0.7%	-17.5%	1.3%
HFC-152a @ 90°C(194°F)	7.8%	-6.9%	2.4%	1.3%	-6.1%	-21.0%	3.6%
HFC-134a @ 90°C(194°F)	3.0%	-13.1%	9.7%	9.7%	3.6%	8.0%	10.6%
HFC-134 @ 90°C(194°F)	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HFC-125 @ 60°C(140°F)	0.1%	1.2%	2.2%	7.0%	-1.0%	-7.9%	0.8%
HFC-32 @ 60°C(140°F)	-5.1%	-1.8%	11.8%	-0.9%	-10.8%	-3.2%	-0.2%
HFC-143a @ 60°C(140°F)	1.5%	-13.1%	-5.4%	-5.0%	-7.2%	-19.8%	2.0%

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table IIC2.

	Varnish Type						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Unexposed	11.6 Kv	13.3 Kv	12.3 Kv	12.8 Kv	12.5 Kv	14.4 Kv	12.3 Kv
	% Change from Unexposed						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Exposure with:							
Nitrogen @ 60°C(140°F)	0.0%	-3.1%	-1.1%	-13.8%	-5.6%	-6.7%	-1.1%
Nitrogen @ 90°C(194°F)	5.5%	-7.4%	-0.7%	1.9%	-6.6%	34.3%	-1.9%
HCFC-22 @ 90°C(194°F)	4.0%	-8.4%	-11.9%	-5.6%	5.6%	-19.4%	6.9%
HCFC-123 @ 90°C(194°F)	4.6%	-2.0%	6.6%	-7.4%	-0.6%	-10.7%	-2.3%
HCFC-124 @ 90°C(194°F)	0.3%	-6.4%	6.3%	-0.8%	-1.3%	-5.1%	-10.3%
HCFC-142b @ 90°C(194°F)	6.0%	-1.9%	-3.6%	-6.4%	0.3%	-17.6%	1.8%
HFC-152a @ 90°C(194°F)	-5.1%	-6.0%	-3.6%	-6.9%	-8.1%	-10.0%	-2.1%
HFC-134a @ 90°C(194°F)	-8.5%	-8.3%	11.1%	-10.5%	-6.7%	-8.4%	-4.4%
HFC-134 @ 90°C(194°F)	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HFC-125 @ 60°C(140°F)	2.0%	-8.7%	2.5%	2.8%	0.5%	-8.4%	-0.8%
HFC-32 @ 60°C(140°F)	0.1%	-10.7%	-11.1%	-14.5%	-7.8%	-33.6%	-1.2%
HFC-143a @ 60°C(140°F)	-8.0%	-0.4%	1.2%	-14.6%	-10.7%	-16.1%	-1.4%

III. Magnet Wire C- ester imide overcoated with amide imide.

A. Bond Strength

1. After 500 hour exposure.

Table IIIA1.

	Varnish Type					
	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Unexposed	51.2 lbs.	50.7 lbs.	58.3 lbs.	5.8 lbs.	49.3 lbs.	36.1 lbs.

Exposure with:	% Change from Unexposed					
	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Nitrogen @ 60°C(140°F)	30.7%	2.1%	-0.7%	54.1%	-19.3%	12.9%
Nitrogen @ 90°C(194°F)	18.8%	-4.1%	-10.4%	223.0%	-14.1%	38.2%
HCFC-22 @ 90°C(194°F)	-1.7%	-23.8%	-35.3%	304.0%	-30.0%	0.4%
HCFC-123 @ 90°C(194°F)	5.2%	-11.2%	-51.3%	193.0%	14.8%	-24.9%
HCFC-124 @ 90°C(194°F)	5.5%	20.9%	-5.9%	170.0%	-20.0%	25.5%
HCFC-142b @ 90°C(194°F)	26.2%	-12.6%	-11.5%	306.0%	-17.1%	41.9%
HFC-152a @ 90°C(194°F)	17.0%	-3.2%	-16.3%	44.7%	-35.3%	38.4%
HFC-134a @ 90°C(194°F)	18.4%	-4.4%	5.1%	327.0%	-14.7%	20.0%
HFC-134 @ 90°C(194°F)	n/a	n/a	n/a	n/a	n/a	n/a
HFC-125 @ 60°C(140°F)	-8.3%	8.1%	-10.5%	20.7%	-20.2%	42.4%
HFC-32 @ 60°C(140°F)	4.4%	-8.4%	-15.3%	215.0%	-27.6%	-19.8%
HFC-143a @ 60°C(140°F)	8.1%	-17.8%	-15.3%	51.2%	-23.8%	33.6%

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table IIIA2.

	Varnish Type					
	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Unexposed	51.2 lbs.	50.7 lbs.	58.3 lbs.	5.8 lbs.	49.3 lbs.	36.1 lbs.

Exposure with:	% Change from Unexposed					
	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Nitrogen @ 60°C(140°F)	42.7%	9.8%	-8.4%	190.0%	-8.1%	45.4%
Nitrogen @ 90°C(194°F)	29.8%	-6.0%	4.5%	194.0%	-10.8%	46.6%
HCFC-22 @ 90°C(194°F)	-45.4%	-82.5%	-58.6%	445.0%	-83.8%	-71.2%
HCFC-123 @ 90°C(194°F)	5.4%	11.3%	-64.2%	214.0%	0.7%	14.9%
HCFC-124 @ 90°C(194°F)	11.2%	23.0%	6.3%	160.0%	-4.6%	2.4%
HCFC-142b @ 90°C(194°F)	10.2%	-11.6%	10.2%	528.0%	1.7%	38.7%
HFC-152a @ 90°C(194°F)	16.0%	13.4%	0.0%	155.0%	-39.1%	83.6%
HFC-134a @ 90°C(194°F)	22.9%	-15.0%	11.0%	395.0%	9.8%	-12.3%
HFC-134 @ 90°C(194°F)	n/a	n/a	n/a	n/a	n/a	n/a
HFC-125 @ 60°C(140°F)	40.6%	13.2%	-7.2%	-65.8%	-10.8%	47.1%
HFC-32 @ 60°C(140°F)	-21.0%	-41.8%	-94.5%	-9.3%	-82.9%	13.4%
HFC-143a @ 60°C(140°F)	23.5%	-10.4%	-5.1%	37.0%	-16.0%	15.2%

III. Magnet Wire C-ester imide overcoated with amide imide.

B. Burnout Strength

1. After 500 hour exposure

Table IIIB1.

	Varnish Type						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
	579 sec	469 sec	473 sec	494 sec	557 sec	503 sec	632 sec
Unexposed							
Exposure with:	% Change from Unexposed						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Nitrogen @ 60°C(140°F)	-6.3%	-39.7%	-5.1%	-30.4%	-41.3%	-4.4%	-10.5%
Nitrogen @ 90°C(194°F)	0.5%	18.7%	-2.3%	-11.4%	-42.0%	-13.7%	-9.1%
HCFC-22 @ 90°C(194°F)	-55.3%	-12.7%	-2.3%	-47.6%	-48.1%	3.4%	-36.3%
HCFC-123 @ 90°C(194°F)	-29.5%	-36.8%	-34.5%	-19.4%	-19.2%	-38.6%	-61.2%
HCFC-124 @ 90°C(194°F)	-13.6%	-35.8%	-6.3%	-34.6%	-2.9%	-20.8%	-9.2%
HCFC-142b @ 90°C(194°F)	-54.9%	-31.9%	-24.0%	-49.0%	-59.6%	-30.7%	-45.7%
HFC-152a @ 90°C(194°F)	-18.9%	-6.1%	-8.3%	-36.8%	-4.3%	11.5%	-11.1%
HFC-134a @ 90°C(194°F)	-23.0%	-11.0%	-11.4%	-16.9%	-2.2%	-12.1%	-12.6%
HFC-134 @ 90°C(194°F)	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HFC-125 @ 60°C(140°F)	0.4%	-36.1%	-3.5%	-22.1%	-0.9%	-5.7%	-14.7%
HFC-32 @ 60°C(140°F)	-24.0%	0.9%	13.1%	-37.7%	-7.7%	-3.6%	-24.5%
HFC-143a @ 60°C(140°F)	-10.1%	-23.7%	2.7%	-21.9%	-6.3%	-10.4%	-13.8%

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table IIIB2.

	Varnish Type						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
	579 sec	469 sec	473 sec	494 sec	557 sec	503 sec	632 sec
Unexposed							
Exposure with:	% Change from Unexposed						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Nitrogen @ 60°C(140°F)	-3.4%	-27.9%	1.2%	-28.1%	-39.7%	-12.3%	-11.5%
Nitrogen @ 90°C(194°F)	-29.8%	10.2%	9.3%	-20.6%	-35.9%	-4.8%	-8.2%
HCFC-22 @ 90°C(194°F)	-5.9%	-38.0%	-12.7%	-25.0%	-21.5%	-23.2%	-53.7%
HCFC-123 @ 90°C(194°F)	-22.7%	-41.9%	-37.9%	-13.5%	-16.5%	-40.4%	-50.4%
HCFC-124 @ 90°C(194°F)	-9.9%	-48.1%	-14.2%	-26.5%	-6.2%	-18.8%	-15.8%
HCFC-142b @ 90°C(194°F)	-28.4%	-9.8%	-17.4%	-41.8%	-59.6%	-36.1%	-33.8%
HFC-152a @ 90°C(194°F)	-15.8%	3.6%	-2.9%	-29.8%	-37.5%	2.7%	-16.2%
HFC-134a @ 90°C(194°F)	-2.9%	-30.3%	2.8%	-2.5%	-12.0%	-16.4%	-10.0%
HFC-134 @ 90°C(194°F)	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HFC-125 @ 60°C(140°F)	-5.0%	-43.0%	-17.2%	-10.5%	5.8%	-5.7%	-9.3%
HFC-32 @ 60°C(140°F)	-6.0%	4.9%	2.4%	-30.9%	-1.7%	-1.1%	-9.6%
HFC-143a @ 60°C(140°F)	-16.5%	-41.4%	1.1%	-24.9%	-16.4%	12.1%	-8.8%

III. Magnet Wire C-ester imide overcoated with amide imide.

C. Dielectric Strength

1. After 500 hour exposure

Table IIIC1.

	Varnish Type						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Unexposed	16.6 Kv	15.10 Kv	18.2 Kv	14.5 Kv	11.4 Kv	15.9 Kv	14.8 Kv
Exposure with:	% Change from Unexposed						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Nitrogen @ 60°C(140°F)	-3.8%	-37.5%	-7.0%	-37.2%	27.4%	-0.8%	18.7%
Nitrogen @ 90°C(194°F)	0.5%	-19.8%	-23.3%	3.1%	44.0%	20.7%	-11.0%
HCFC-22 @ 90°C(194°F)	4.2%	11.2%	6.6%	-7.8%	20.9%	23.2%	25.5%
HCFC-123 @ 90°C(194°F)	-17.0%	-17.0%	-7.9%	-7.8%	7.5%	23.6%	19.3%
HCFC-124 @ 90°C(194°F)	-17.0%	5.5%	-11.8%	7.9%	-4.1%	12.7%	25.8%
HCFC-142b @ 90°C(194°F)	-54.9%	-25.7%	-29.8%	14.8%	19.2%	20.2%	20.8%
HFC-152a @ 90°C(194°F)	-18.9%	-34.6%	9.7%	-8.3%	42.8%	-12.1%	-8.8%
HFC-134a @ 90°C(194°F)	-1.2%	10.3%	0.3%	-7.3%	1.5%	-0.6%	9.4%
HFC-134 @ 90°C(194°F)	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HFC-125 @ 60°C(140°F)	4.3%	-43.2%	-2.4%	8.6%	2.6%	16.3%	5.9%
HFC-32 @ 60°C(140°F)	-13.6%	-33.7%	-2.9%	-8.8%	35.9%	-21.5%	19.4%
HFC-143a @ 60°C(140°F)	-12.8%	-6.3%	-10.4%	-6.0%	-1.6%	-29.8%	21.5%

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table IIIC2.

	Varnish Type						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Unexposed	16.6 Kv	15.10 Kv	18.2 Kv	14.5 Kv	11.4 Kv	15.9 Kv	14.8 Kv
Exposure with:	% Change from Unexposed						
	Uncoated	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
Nitrogen @ 60°C(140°F)	-2.7%	-19.6%	-36.9%	-11.8%	52.0%	-11.2%	6.5%
Nitrogen @ 90°C(194°F)	-5.1%	-28.6%	-5.4%	5.1%	36.6%	-10.7%	-4.4%
HCFC-22 @ 90°C(194°F)	-5.9%	-15.3%	-44.9%	-42.3%	7.0%	-61.4%	-14.5%
HCFC-123 @ 90°C(194°F)	-28.3%	-15.3%	-26.8%	-5.2%	0.4%	16.1%	-2.4%
HCFC-124 @ 90°C(194°F)	-9.9%	3.2%	-5.6%	-10.1%	-6.4%	-7.6%	18.2%
HCFC-142b @ 90°C(194°F)	10.4%	-26.1%	-22.9%	5.2%	47.0%	1.4%	1.5%
HFC-152a @ 90°C(194°F)	-15.8%	-31.4%	-36.3%	-9.6%	12.4%	-3.0%	-32.6%
HFC-134a @ 90°C(194°F)	-12.6%	-9.5%	-17.5%	-24.3%	-20.5%	-6.7%	-8.5%
HFC-134 @ 90°C(194°F)	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HFC-125 @ 60°C(140°F)	-5.0%	10.8%	-15.0%	14.8%	3.3%	26.2%	-9.9%
HFC-32 @ 60°C(140°F)	-3.2%	-34.8%	-43.4%	-15.1%	-8.2%	-56.4%	-14.1%
HFC-143a @ 60°C(140°F)	-12.4%	-10.3%	-31.0%	-14.6%	-2.8%	26.2%	8.4%

IV. Varnish Disks

A. % Change in weight.

1. After 500 hour exposure.

Table IVA1.

	Varnish Type.					
	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
	% Change in Weight.					
Exposure with:						
Nitrogen @ 60°C(140°F)	0.3%	0.3%	0.4%	0.2%	0.3%	0.2%
Nitrogen @ 90°C(194°F)	0.0%	0.3%	0.3%	0.0%	-0.1%	-0.3%
HCFC-22 @ 90°C(194°F)	16.9%	12.5%	18.7%	15.4%	14.4%	7.4%
HCFC-123 @ 90°C(194°F)	27.6%	24.6%	25.5%	44.0%	26.2%	13.9%
HCFC-124 @ 90°C(194°F)	4.8%	2.4%	7.4%	13.2%	1.8%	0.9%
HCFC-142b @ 90°C(194°F)	6.1%	6.5%	10.0%	6.3%	6.2%	0.0%
HFC-152a @ 90°C(194°F)	6.4%	4.9%	9.1%	8.1%	5.2%	0.1%
HFC-134a @ 90°C(194°F)	1.7%	1.2%	2.8%	4.7%	1.5%	0.9%
HFC-134 @ 90°C(194°F)	7.5%	4.5%	9.1%	7.6%	7.3%	-1.1%
HFC-125 @ 60°C(140°F)	1.6%	2.4%	2.4%	2.0%	2.6%	1.0%
HFC-32 @ 60°C(140°F)	8.1%	6.8%	9.2%	9.5%	6.1%	4.8%
HFC-143a @ 60°C(140°F)	1.2%	8.5%	4.2%	5.1%	1.7%	0.1%

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table IVA2.

	Varnish Type.					
	U-475EH	Y-390PG	ER-610	Y-833	No.923	Iso-800
	% Change in Weight.					
Exposure with:						
Nitrogen @ 60°C(140°F)	-0.8%	-1.4%	-0.3%	0.1%	0.0%	-1.6%
Nitrogen @ 90°C(194°F)	-0.7%	-1.3%	-0.3%	0.0%	-0.3%	-3.7%
HCFC-22 @ 90°C(194°F)	-1.6%	-2.2%	-0.1%	-4.2%	-2.8%	-4.5%
HCFC-123 @ 90°C(194°F)	0.5%	1.7%	-1.1%	0.7%	3.5%	-2.2%
HCFC-124 @ 90°C(194°F)	0.4%	-0.4%	2.0%	1.3%	0.4%	-1.9%
HCFC-142b @ 90°C(194°F)	-1.5%	-2.9%	-0.2%	-6.1%	-0.3%	-5.3%
HFC-152a @ 90°C(194°F)	-1.3%	-3.2%	0.5%	-7.5%	-1.6%	-5.7%
HFC-134a @ 90°C(194°F)	-1.7%	-1.9%	-0.7%	0.1%	-0.2%	-2.8%
HFC-134 @ 90°C(194°F)	0.9%	-1.1%	1.5%	-2.7%	1.1%	-7.8%
HFC-125 @ 60°C(140°F)	-1.7%	-2.2%	-0.9%	-0.8%	-0.7%	-2.6%
HFC-32 @ 60°C(140°F)	-2.0%	-2.4%	3.0%	-2.5%	-5.4%	-3.5%
HFC-143a @ 60°C(140°F)	-0.4%	-0.8%	-0.2%	0.2%	0.0%	-1.9%

V. Sheet Insulation

A. % change in weight.

1. After 500 hour exposure.

Table VA1.
Sheet Insulation Type

Exposure with:

Nitrogen @ 60°C(140°F)
Nitrogen @ 90°C(194°F)
HCFC-22 @ 90°C(194°F)
HCFC-123 @ 90°C(194°F)
HCFC-124 @ 90°C(194°F)
HCFC-142b @ 90°C(194°F)
HFC-152a @ 90°C(194°F)
HFC-134a @ 90°C(194°F)
HFC-134 @ 90°C(194°F)
HFC-125 @ 60°C(140°F)
HFC-32 @ 60°C(140°F)
HFC-143a @ 60°C(140°F)

Nomex/Mylar Nomex	Dacron/Mylar Dacron	Mylar Mo	Nomex	Nomex Mica	Melinex
% Change in Weight.					
0.0%	0.1%	0.0%	0.3%	0.2%	0.0%
0.1%	0.1%	0.2%	0.2%	0.2%	0.2%
6.7%	6.2%	6.1%	6.1%	2.9%	6.4%
21.0%	7.7%	8.2%	15.1%	0.7%	8.1%
6.0%	4.4%	3.9%	3.0%	0.2%	2.3%
3.4%	3.9%	3.3%	0.5%	3.9%	4.2%
4.1%	2.9%	2.9%	5.1%	2.0%	3.0%
3.0%	4.0%	2.4%	4.0%	1.3%	2.5%
6.6%	5.6%	5.0%	2.8%	2.5%	5.1%
0.0%	1.2%	0.1%	-0.6%	-0.5%	0.1%
5.7%	3.7%	4.0%	6.3%	2.2%	4.8%
1.4%	2.2%	0.4%	2.2%	1.4%	0.5%

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table VA2.
Sheet Insulation Type

Exposure with:

Nitrogen @ 60°C(140°F)
Nitrogen @ 90°C(194°F)
HCFC-22 @ 90°C(194°F)
HCFC-123 @ 90°C(194°F)
HCFC-124 @ 90°C(194°F)
HCFC-142b @ 90°C(194°F)
HFC-152a @ 90°C(194°F)
HFC-134a @ 90°C(194°F)
HFC-134 @ 90°C(194°F)
HFC-125 @ 60°C(140°F)
HFC-32 @ 60°C(140°F)
HFC-143a @ 60°C(140°F)

Nomex/Mylar Nomex	Dacron/Mylar Dacron	Mylar Mo	Nomex	Nomex Mica	Melinex
% Change in Weight.					
-0.1%	0.0%	0.0%	-0.2%	-0.3%	0.1%
-0.4%	-0.2%	0.0%	0.2%	-0.6%	0.0%
-0.1%	-1.2%	-0.6%	0.7%	0.3%	-0.2%
-0.4%	-1.3%	-0.5%	0.1%	0.0%	-0.2%
0.1%	0.6%	0.0%	-1.4%	0.8%	0.2%
0.3%	-0.4%	-0.2%	-0.6%	-0.9%	-0.2%
-0.1%	-0.4%	0.8%	-0.2%	-0.4%	0.0%
-0.3%	0.2%	0.0%	0.5%	0.2%	0.0%
0.2%	-0.4%	0.0%	0.5%	0.1%	0.1%
-0.1%	-1.0%	-0.1%	-2.9%	-1.6%	-0.2%
-0.1%	-0.1%	0.3%	-0.2%	0.0%	0.2%
0.0%	-0.1%	0.1%	0.0%	0.2%	-0.1%

V. Sheet Insulation

B. % change in tensile strength.

1. After 500 hour exposure.

Table VB1.
Sheet Insulation Type

	Nomex/Mylar Nomex	Dacron/Mylar Dacron	Mylar Mo	Nomex	Nomex Mica	Melinex
Unexposed	17.4 Ksi.	13.7 Ksi	21.7 Ksi	18.7 Ksi	7.5 Ksi	21.7 Ksi.

Exposure with:

Nitrogen @ 60°C(140°F)
 Nitrogen @ 90°C(194°F)
 HCFC-22 @ 90°C(194°F)
 HCFC-123 @ 90°C(194°F)
 HCFC-124 @ 90°C(194°F)
 HCFC-142b @ 90°C(194°F)
 HFC-152a @ 90°C(194°F)
 HFC-134a @ 90°C(194°F)
 HFC-134 @ 90°C(194°F)
 HFC-125 @ 60°C(140°F)
 HFC-32 @ 60°C(140°F)
 HFC-143a @ 60°C(140°F)

	% Change from Unexposed.					
Nitrogen @ 60°C(140°F)	-10.2%	-0.9%	-7.6%	0.5%	-17.5%	-10.7%
Nitrogen @ 90°C(194°F)	-8.5%	-6.5%	-6.8%	1.1%	-18.7%	-10.2%
HCFC-22 @ 90°C(194°F)	-18.0%	-23.1%	-15.1%	-9.6%	-21.3%	-28.9%
HCFC-123 @ 90°C(194°F)	-19.0%	-25.1%	-7.7%	-12.5%	-23.9%	-20.2%
HCFC-124 @ 90°C(194°F)	-7.2%	-9.7%	-13.9%	6.5%	-17.0%	-18.4%
HCFC-142b @ 90°C(194°F)	-5.2%	-7.7%	-8.7%	2.8%	-20.0%	-12.4%
HFC-152a @ 90°C(194°F)	-4.2%	-6.4%	-9.2%	6.7%	-28.4%	-15.2%
HFC-134a @ 90°C(194°F)	-30.7%	29.3%	-12.0%	-6.6%	-18.9%	-20.0%
HFC-134 @ 90°C(194°F)	-7.7%	-11.2%	-13.8%	3.9%	-31.3%	-18.0%
HFC-125 @ 60°C(140°F)	-5.1%	-3.8%	-12.1%	-6.5%	-16.6%	-13.3%
HFC-32 @ 60°C(140°F)	-12.1%	-12.2%	-6.7%	-7.7%	-24.9%	-11.4%
HFC-143a @ 60°C(140°F)	-5.9%	-2.7%	-15.4%	-6.3%	-22.6%	-20.9%

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table VB2.
Sheet Insulation Type

	Nomex/Mylar Nomex	Dacron/Mylar Dacron	Mylar Mo	Nomex	Nomex Mica	Melinex
Unexposed	17.4 Ksi.	13.7 Ksi	21.7 Ksi	18.7 Ksi	7.5 Ksi	21.7 Ksi.

Exposure with:

Nitrogen @ 60°C(140°F)
 Nitrogen @ 90°C(194°F)
 HCFC-22 @ 90°C(194°F)
 HCFC-123 @ 90°C(194°F)
 HCFC-124 @ 90°C(194°F)
 HCFC-142b @ 90°C(194°F)
 HFC-152a @ 90°C(194°F)
 HFC-134a @ 90°C(194°F)
 HFC-134 @ 90°C(194°F)
 HFC-125 @ 60°C(140°F)
 HFC-32 @ 60°C(140°F)
 HFC-143a @ 60°C(140°F)

	% Change from Unexposed.					
Nitrogen @ 60°C(140°F)	-7.2%	1.2%	-5.1%	-4.7%	-21.6%	-11.1%
Nitrogen @ 90°C(194°F)	-2.3%	-1.3%	-9.4%	9.2%	-19.2%	-9.9%
HCFC-22 @ 90°C(194°F)	-4.7%	-6.9%	-1.7%	-1.9%	-27.3%	-20.7%
HCFC-123 @ 90°C(194°F)	-7.1%	-7.2%	-11.5%	4.2%	-22.7%	-15.4%
HCFC-124 @ 90°C(194°F)	-4.0%	-4.6%	-13.9%	7.7%	-23.0%	-14.7%
HCFC-142b @ 90°C(194°F)	-4.8%	-3.9%	-13.4%	5.3%	-21.5%	-12.8%
HFC-152a @ 90°C(194°F)	-1.8%	0.1%	-10.3%	3.2%	-26.2%	-9.4%
HFC-134a @ 90°C(194°F)	-26.4%	32.9%	-13.6%	-4.7%	-11.9%	-30.6%
HFC-134 @ 90°C(194°F)	-6.5%	-1.4%	-8.7%	11.2%	-24.1%	-10.2%
HFC-125 @ 60°C(140°F)	-17.0%	-2.4%	-12.2%	-3.6%	-14.3%	-11.8%
HFC-32 @ 60°C(140°F)	1.5%	-0.5%	-7.6%	11.0%	-19.4%	-15.8%
HFC-143a @ 60°C(140°F)	-0.4%	-3.1%	-6.8%	-5.6%	-22.0%	-18.4%

V. Sheet Insulation.

C. % change in elongation.

1. After 500 hour exposure.

Table VC1.

Sheet Insulation Type

	Nomex/Mylar Nomex	Dacron/Mylar Dacron	Mylar Mo	Nomex	Nomex Mica	Melinex
Unexposed	20.0%	46.0%	131.0%	17.0%	4.0%	160.0%

Exposure with:

	% Change from Unexposed.					
Nitrogen @ 60°C(140°F)	-40.0%	-36.2%	5.5%	-11.8%	-43.8%	2.9%
Nitrogen @ 90°C(194°F)	-1.9%	-43.1%	15.8%	-24.0%	-60.4%	9.8%
HCFC-22 @ 90°C(194°F)	20.8%	-28.6%	0.8%	-19.1%	-50.0%	-16.4%
HCFC-123 @ 90°C(194°F)	-12.9%	-40.6%	-8.5%	-30.9%	-60.4%	3.9%
HCFC-124 @ 90°C(194°F)	15.0%	-36.2%	-0.3%	-17.6%	-45.8%	6.9%
HCFC-142b @ 90°C(194°F)	21.7%	-30.8%	17.2%	-26.0%	-54.2%	5.3%
HFC-152a @ 90°C(194°F)	55.8%	-31.2%	17.0%	11.3%	-27.1%	-5.2%
HFC-134a @ 90°C(194°F)	38.3%	-46.7%	-7.4%	-19.6%	-43.8%	-5.1%
HFC-134 @ 90°C(194°F)	37.9%	-35.9%	-1.9%	-13.7%	-29.2%	7.9%
HFC-125 @ 60°C(140°F)	2.5%	-33.2%	-10.2%	-11.3%	-45.8%	-5.3%
HFC-32 @ 60°C(140°F)	38.8%	-33.3%	21.9%	13.2%	-56.3%	9.7%
HFC-143a @ 60°C(140°F)	40.0%	-45.3%	-6.6%	-15.2%	-47.9%	-2.6%

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table VC2.

Sheet Insulation Type

	Nomex/Mylar Nomex	Dacron/Mylar Dacron	Mylar Mo	Nomex	Nomex Mica	Melinex
Unexposed	20.0%	46.0%	131.0%	17.0%	4.0%	160.0%

Exposure with:

	% Change from Unexposed.					
Nitrogen @ 60°C(140°F)	-42.5%	-40.2%	12.7%	-23.5%	-47.9%	0.3%
Nitrogen @ 90°C(194°F)	-6.7%	-38.8%	17.8%	-21.1%	-56.3%	9.4%
HCFC-22 @ 90°C(194°F)	9.6%	-17.4%	-0.6%	-4.4%	-43.8%	-5.6%
HCFC-123 @ 90°C(194°F)	-20.4%	-43.1%	13.5%	-32.4%	-66.7%	-7.8%
HCFC-124 @ 90°C(194°F)	14.2%	-36.4%	-12.0%	-13.7%	-50.0%	-7.4%
HCFC-142b @ 90°C(194°F)	-16.7%	-46.0%	6.7%	-23.0%	-47.9%	5.6%
HFC-152a @ 90°C(194°F)	-9.6%	-38.0%	8.9%	-30.4%	-56.3%	4.9%
HFC-134a @ 90°C(194°F)	31.3%	-48.2%	-11.2%	-28.4%	-56.3%	-42.5%
HFC-134 @ 90°C(194°F)	-37.1%	-40.2%	6.0%	-16.2%	-58.3%	3.2%
HFC-125 @ 60°C(140°F)	-16.9%	-47.5%	-1.4%	-20.6%	-56.3%	-2.5%
HFC-32 @ 60°C(140°F)	20.4%	-43.8%	10.1%	-3.4%	-58.3%	-0.8%
HFC-143a @ 60°C(140°F)	6.7%	-42.0%	16.4%	-25.0%	-43.8%	2.6%

V. Sheet Insulation.

D. % change in dielectric strength.

1. After 500 hour exposure.

Table VD1.
Sheet Insulation Type

Nomex/Mylar Nomex	Dacron/Mylar Dacron	Mylar Mo	Nomex	Nomex Mica	Melinex
Unexposed	flash	flash	10.7 Kv	10.2 Kv	flash

Exposure with:

Nitrogen @ 60°C(140°F)
Nitrogen @ 90°C(194°F)
HCFC-22 @ 90°C(194°F)
HCFC-123 @ 90°C(194°F)
HCFC-124 @ 90°C(194°F)
HCFC-142b @ 90°C(194°F)
HFC-152a @ 90°C(194°F)
HFC-134a @ 90°C(194°F)
HFC-134 @ 90°C(194°F)
HFC-125 @ 60°C(140°F)
HFC-32 @ 60°C(140°F)
HFC-143a @ 60°C(140°F)

% Change from Unexposed.					
flash	flash	flash	0.9%	-14.5%	flash
flash	flash	flash	-9.2%	-7.3%	flash
flash	flash	flash	-1.6%	-4.0%	flash
flash	flash	flash	7.8%	2.9%	flash
flash	flash	flash	-6.4%	-3.6%	flash
flash	flash	flash	-0.8%	-2.7%	flash
flash	flash	flash	-0.1%	-9.0%	flash
flash	flash	flash	6.0%	-2.7%	flash
flash	flash	flash	2.0%	-7.8%	flash
flash	flash	flash	16.4%	-5.9%	flash
flash	flash	flash	3.3%	-6.1%	flash
flash	flash	flash	-1.3%	-9.7%	flash

*Flash indicates dielectric went around sheet insulation not through.

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table VD2.

Sheet Insulation Type

Nomex/Mylar Nomex	Dacron/Mylar Dacron	Mylar Mo	Nomex	Nomex Mica	Melinex
Unexposed	flash	flash	10.7 Kv	10.2 Kv	flash

Exposure with:

Nitrogen @ 60°C(140°F)
Nitrogen @ 90°C(194°F)
HCFC-22 @ 90°C(194°F)
HCFC-123 @ 90°C(194°F)
HCFC-124 @ 90°C(194°F)
HCFC-142b @ 90°C(194°F)
HFC-152a @ 90°C(194°F)
HFC-134a @ 90°C(194°F)
HFC-134 @ 90°C(194°F)
HFC-125 @ 60°C(140°F)
HFC-32 @ 60°C(140°F)
HFC-143a @ 60°C(140°F)

% Change from Unexposed.					
flash	flash	flash	-4.0%	-12.6%	flash
flash	flash	flash	3.7%	-12.1%	flash
flash	flash	flash	-0.1%	-16.8%	flash
flash	flash	flash	1.0%	-4.9%	flash
flash	flash	flash	-3.0%	-5.7%	flash
flash	flash	flash	-8.4%	-8.0%	flash
flash	flash	flash	-2.9%	-12.1%	flash
flash	flash	flash	3.9%	2.4%	flash
flash	flash	flash	-1.3%	-17.3%	flash
flash	flash	flash	-7.9%	-4.3%	flash
flash	flash	flash	6.0%	-4.1%	flash
flash	flash	flash	5.0%	-10.3%	flash

*Flash indicates dielectric went around sheet insulation not through.

VI. Spiral Wrapped Sleeving Insulation

A. % change in weight.

1. After 500 hour exposure.

Table VIA1.
Sleeving Insulation Type

Exposure with:

	Nomex	Mylar	Nomex/Mylar
	% Change in Weight.		
Nitrogen @ 60°C(140°F)	-0.37%	0.11%	0.60%
Nitrogen @ 90°C(194°F)	-0.18%	0.86%	0.22%
HCFC-22 @ 90°C(194°F)	15.31%	8.48%	7.20%
HCFC-123 @ 90°C(194°F)	56.87%	23.84%	22.57%
HCFC-124 @ 90°C(194°F)	13.36%	6.20%	5.27%
HCFC-142b @ 90°C(194°F)	11.77%	8.63%	3.45%
HFC-152a @ 90°C(194°F)	5.51%	8.91%	17.22%
HFC-134a @ 90°C(194°F)	9.30%	3.16%	3.00%
HFC-134 @ 90°C(194°F)	0.90%	6.54%	5.35%
HFC-125 @ 60°C(140°F)	1.37%	1.00%	0.15%
HFC-32 @ 60°C(140°F)	3.47%	8.29%	4.15%
HFC-143a @ 60°C(140°F)		1.59%	1.90%

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table VIA2.

Sleeving Insulation Type

Exposure with:

	Nomex	Mylar	Nomex/Mylar
	% Change in Weight.		
Nitrogen @ 60°C(140°F)	-0.24%	0.09%	0.00%
Nitrogen @ 90°C(194°F)	0.30%	-0.10%	-0.03%
HCFC-22 @ 90°C(194°F)	0.90%	-0.88%	-1.25%
HCFC-123 @ 90°C(194°F)	-3.47%	-1.63%	-2.62%
HCFC-124 @ 90°C(194°F)	-0.92%	-0.47%	-0.35%
HCFC-142b @ 90°C(194°F)	-2.26%	-0.26%	-0.79%
HFC-152a @ 90°C(194°F)	0.04%	-0.21%	-0.78%
HFC-134a @ 90°C(194°F)	0.43%	0.05%	-0.18%
HFC-134 @ 90°C(194°F)	0.34%	0.06%	0.38%
HFC-125 @ 60°C(140°F)	-3.80%	-0.71%	-3.09%
HFC-32 @ 60°C(140°F)	-1.76%	-0.77%	-0.45%
HFC-143a @ 60°C(140°F)	0.65%	0.63%	0.51%

VII. Lead Wire

A. % change in weight.

1. After 500 hour exposure.

Table VIIA1.
Lead Wire Type

Exposure with:

Nitrogen @ 60°C(140°F)
Nitrogen @ 90°C(194°F)
HCFC-22 @ 90°C(194°F)
HCFC-123 @ 90°C(194°F)
HCFC-124 @ 90°C(194°F)
HCFC-142b @ 90°C(194°F)
HFC-152a @ 90°C(194°F)
HFC-134a @ 90°C(194°F)
HFC-134 @ 90°C(194°F)
HFC-125 @ 60°C(140°F)
HFC-32 @ 60°C(140°F)
HFC-143a @ 60°C(140°F)

Dacron/Mylar Dacron	Dacron/Mylar/Teflon/Dacron
% Change in Weight.	
-0.06%	-0.01%
0.04%	0.04%
0.84%	0.86%
4.86%	3.94%
0.52%	-0.25%
0.46%	0.55%
0.51%	0.46%
0.37%	0.31%
0.73%	0.76%
0.14%	0.38%
0.39%	1.21%
0.28%	0.34%

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table VIIA2.
Lead Wire Type

Exposure with:

Nitrogen @ 60°C(140°F)
Nitrogen @ 90°C(194°F)
HCFC-22 @ 90°C(194°F)
HCFC-123 @ 90°C(194°F)
HCFC-124 @ 90°C(194°F)
HCFC-142b @ 90°C(194°F)
HFC-152a @ 90°C(194°F)
HFC-134a @ 90°C(194°F)
HFC-134 @ 90°C(194°F)
HFC-125 @ 60°C(140°F)
HFC-32 @ 60°C(140°F)
HFC-143a @ 60°C(140°F)

Dacron/Mylar Dacron	Dacron/Mylar/Teflon/Dacron
% Change in Weight.	
-0.08%	-0.04%
0.05%	-0.06%
-0.21%	-0.23%
-0.15%	-0.14%
-0.10%	-0.11%
-0.01%	-0.01%
-0.08%	-0.05%
-0.04%	-0.12%
-0.11%	-0.07%
-0.21%	-0.20%
-0.03%	-0.04%
0.01%	0.01%

VII. Lead Wire.

B. % change in dielectric strength.

1. After 500 hour exposure.

Table VIIB1.
Lead Wire Type

Unexposed	Dacron/Mylar Dacron	Dacron/Mylar/Teflon/Dacron
	9.61 Kilovolts	9.95 Kilovolts

Exposure with:	% Change from Unexposed.	
Nitrogen @ 60°C(140°F)	-0.28%	-1.21%
Nitrogen @ 90°C(194°F)	-5.45%	8.34%
HCFC-22 @ 90°C(194°F)	-4.51%	-16.18%
HCFC-123 @ 90°C(194°F)	-5.06%	42.78%
HCFC-124 @ 90°C(194°F)	-10.06%	3.58%
HCFC-142b @ 90°C(194°F)	-3.75%	11.26%
HFC-152a @ 90°C(194°F)	-11.48%	-9.11%
HFC-134a @ 90°C(194°F)	1.63%	-10.02%
HFC-134 @ 90°C(194°F)	-6.73%	1.98%
HFC-125 @ 60°C(140°F)	-0.07%	-2.55%
HFC-32 @ 60°C(140°F)	-4.13%	-9.41%
HFC-143a @ 60°C(140°F)	-11.93%	-5.59%

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table VIIB2.
Lead Wire Type

Unexposed	Dacron/Mylar Dacron	Dacron/Mylar/Teflon/Dacron
	9.61 Kilovolts	9.95 Kilovolts

Exposure with:	% Change from Unexposed.	
Nitrogen @ 60°C(140°F)	-0.73%	-7.47%
Nitrogen @ 90°C(194°F)	-5.85%	-0.07%
HCFC-22 @ 90°C(194°F)	1.77%	-15.28%
HCFC-123 @ 90°C(194°F)	-4.82%	6.10%
HCFC-124 @ 90°C(194°F)	-1.77%	-9.51%
HCFC-142b @ 90°C(194°F)	-5.90%	0.37%
HFC-152a @ 90°C(194°F)	1.98%	-0.40%
HFC-134a @ 90°C(194°F)	-9.43%	6.10%
HFC-134 @ 90°C(194°F)	-3.43%	2.21%
HFC-125 @ 60°C(140°F)	-10.37%	-10.62%
HFC-32 @ 60°C(140°F)	-4.13%	-4.25%
HFC-143a @ 60°C(140°F)	-4.02%	-5.46%

VIII. Tapes

A. % change in weight.

1. After 500 hour exposure.

Table VIII A1.

Tape Type

Exposure with:

Nitrogen @ 60°C(140°F)
 Nitrogen @ 90°C(194°F)
 HCFC-22 @ 90°C(194°F)
 HCFC-123 @ 90°C(194°F)
 HCFC-124 @ 90°C(194°F)
 HCFC-142b @ 90°C(194°F)
 HFC-152a @ 90°C(194°F)
 HFC-134a @ 90°C(194°F)
 HFC-134 @ 90°C(194°F)
 HFC-125 @ 60°C(140°F)
 HFC-32 @ 60°C(140°F)
 HFC-143a @ 60°C(140°F)

Woven Glass	Polyester	Permace!
% Change in Weight.		
-0.07%	0.48%	0.35%
0.20%	0.46%	-0.47%
-0.55%	6.63%	1.67%
2.16%	6.49%	-5.62%
0.23%	3.82%	2.69%
-0.08%	3.73%	7.07%
N/A	3.15%	3.63%
-0.06%	2.44%	3.40%
0.40%	5.54%	11.76%
-0.45%	1.38%	6.66%
0.14%	3.38%	0.40%
0.01%	1.55%	0.29%

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table VIII A2.

Tape Type

Exposure with:

Nitrogen @ 60°C(140°F)
 Nitrogen @ 90°C(194°F)
 HCFC-22 @ 90°C(194°F)
 HCFC-123 @ 90°C(194°F)
 HCFC-124 @ 90°C(194°F)
 HCFC-142b @ 90°C(194°F)
 HFC-152a @ 90°C(194°F)
 HFC-134a @ 90°C(194°F)
 HFC-134 @ 90°C(194°F)
 HFC-125 @ 60°C(140°F)
 HFC-32 @ 60°C(140°F)
 HFC-143a @ 60°C(140°F)

Woven Glass	Polyester	Permace!
% Change in Weight.		
-0.08%	0.16%	-1.16%
0.26%	0.29%	-2.07%
0.88%	-0.36%	-4.39%
-0.11%	-1.53%	-14.53%
-0.26%	-0.18%	-7.19%
-0.01%	0.40%	-5.95%
0.22%	-0.02%	-3.35%
-0.57%	0.20%	-6.36%
0.18%	0.28%	-2.68%
-0.32%	-0.38%	-5.21%
0.24%	0.05%	-3.76%
-0.26%	0.56%	-1.89%

VIII. Tapes

B. % change in break load.

1. After 500 hour exposure.

Table VIII B1.

Tape Type

Unexposed

Woven Glass	Polyester	Permacel
39.0 lbs.	56.1 lbs.	88.5 lbs.

Exposure with:

Nitrogen @ 60°C(140°F)
 Nitrogen @ 90°C(194°F)
 HCFC-22 @ 90°C(194°F)
 HCFC-123 @ 90°C(194°F)
 HCFC-124 @ 90°C(194°F)
 HCFC-142b @ 90°C(194°F)
 HFC-152a @ 90°C(194°F)
 HFC-134a @ 90°C(194°F)
 HFC-134 @ 90°C(194°F)
 HFC-125 @ 60°C(140°F)
 HFC-32 @ 60°C(140°F)
 HFC-143a @ 60°C(140°F)

% Change from Unexposed.		
9.56%	5.40%	-31.44%
-5.52%	-1.61%	-6.89%
35.32%	6.20%	15.12%
0.69%	5.81%	-12.34%
12.16%	5.55%	10.64%
19.77%	5.07%	1.66%
43.58%	-7.94%	-15.16%
-0.06%	12.56%	27.34%
0.40%	5.54%	11.76%
-3.13%	5.73%	27.65%
15.75%	2.52%	-7.68%
1.96%	4.75%	-6.80%

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table VIII B2.

Tape Type

Unexposed

Woven Glass	Polyester	Permacel
39.0 lbs.	56.1 lbs.	88.5 lbs.

Exposure with:

Nitrogen @ 60°C(140°F)
 Nitrogen @ 90°C(194°F)
 HCFC-22 @ 90°C(194°F)
 HCFC-123 @ 90°C(194°F)
 HCFC-124 @ 90°C(194°F)
 HCFC-142b @ 90°C(194°F)
 HFC-152a @ 90°C(194°F)
 HFC-134a @ 90°C(194°F)
 HFC-134 @ 90°C(194°F)
 HFC-125 @ 60°C(140°F)
 HFC-32 @ 60°C(140°F)
 HFC-143a @ 60°C(140°F)

% Change from Unexposed.		
-3.94%	1.48%	20.41%
4.12%	8.46%	-0.01%
42.15%	1.48%	25.29%
18.83%	2.90%	20.49%
11.61%	4.39%	43.47%
17.97%	-2.95%	6.78%
0.53%	0.02%	-0.26%
16.44%	-8.17%	39.74%
-2.68%	0.28%	0.18%
30.70%	-0.60%	37.85%
23.56%	-17.13%	-11.28%
-2.40%	-1.40%	-13.33%

IX. Tie Cord

A. % change in weight.

1. After 500 hour exposure.

Table IXA1.
Tie Cord Type

Exposure with:

Nitrogen @ 60°C(140°F)
Nitrogen @ 90°C(194°F)
HCFC-22 @ 90°C(194°F)
HCFC-123 @ 90°C(194°F)
HCFC-124 @ 90°C(194°F)
HCFC-142b @ 90°C(194°F)
HFC-152a @ 90°C(194°F)
HFC-134a @ 90°C(194°F)
HFC-134 @ 90°C(194°F)
HFC-125 @ 60°C(140°F)
HFC-32 @ 60°C(140°F)
HFC-143a @ 60°C(140°F)

Polyester	
% Change in Weight.	
	0.52%
	-0.04%
	6.75%
	5.98%
	2.89%
	2.60%
	3.96%
	1.86%
	4.75%
	0.43%
	1.91%
	3.46%

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table IXA2.
Tie Cord Type

Exposure with:

Nitrogen @ 60°C(140°F)
Nitrogen @ 90°C(194°F)
HCFC-22 @ 90°C(194°F)
HCFC-123 @ 90°C(194°F)
HCFC-124 @ 90°C(194°F)
HCFC-142b @ 90°C(194°F)
HFC-152a @ 90°C(194°F)
HFC-134a @ 90°C(194°F)
HFC-134 @ 90°C(194°F)
HFC-125 @ 60°C(140°F)
HFC-32 @ 60°C(140°F)
HFC-143a @ 60°C(140°F)

Polyester	
% Change in Weight.	
	0.25%
	-0.15%
	-0.31%
	1.56%
	0.36%
	-0.08%
	0.64%
	-0.49%
	0.38%
	-0.96%
	-2.09%
	0.17%

IX. Tie Cord.

B. % change break load.

1. After 500 hour exposure.

Table IXB1.
Tie Cord Type

Unexposed

Polyester
28.4 lbs.

Exposure with:

Nitrogen @ 60°C(140°F)
 Nitrogen @ 90°C(194°F)
 HCFC-22 @ 90°C(194°F)
 HCFC-123 @ 90°C(194°F)
 HCFC-124 @ 90°C(194°F)
 HCFC-142b @ 90°C(194°F)
 HFC-152a @ 90°C(194°F)
 HFC-134a @ 90°C(194°F)
 HFC-134 @ 90°C(194°F)
 HFC-125 @ 60°C(140°F)
 HFC-32 @ 60°C(140°F)
 HFC-143a @ 60°C(140°F)

% Change from Unexposed
20.00%
23.47%
14.77%
10.13%
35.75%
14.36%
13.42%
13.95%
8.25%
38.52%
25.94%
12.13%

2. After 500 hour exposure plus a 24 hour air bake @ 150°C(302°F).

Table IXB2.
Tie Cord Type

Unexposed

Polyester
28.4 lbs.

Exposure with:

Nitrogen @ 60°C(140°F)
 Nitrogen @ 90°C(194°F)
 HCFC-22 @ 90°C(194°F)
 HCFC-123 @ 90°C(194°F)
 HCFC-124 @ 90°C(194°F)
 HCFC-142b @ 90°C(194°F)
 HFC-152a @ 90°C(194°F)
 HFC-134a @ 90°C(194°F)
 HFC-134 @ 90°C(194°F)
 HFC-125 @ 60°C(140°F)
 HFC-32 @ 60°C(140°F)
 HFC-143a @ 60°C(140°F)

% Change from Unexposed
29.29%
16.01%
-1.80%
4.96%
12.72%
-2.15%
14.36%
0.93%
4.84%
9.02%
8.12%
14.19%

X. Gas Chromatography Analysis of Refrigerants after 500 hour Exposure.

Refrigerant	Initial Analysis*	Analysis After 500 hr. Exposure*
HCFC-22	99.9%	99.9%
HCFC-123	99.7%	99.8%
HCFC-124	99.0%	99.1%
HCFC-142b	99.9%	99.9%
HFC-152a	99.9%	99.8%
HFC-134a	99.9%	99.8%
HFC-134	99.6%	99.6%
HFC-125	99.3%	99.3%
HFC-32	99.9%	99.7%
HFC-143a	99.4%	99.4%

*Analysis results are in area%.

END

DATE
FILMED

2/17/93