

**THE EFFECT OF FIVE SYNTHETIC LUBRICANTS
ON USAF FABRICS**

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FOREWORD

This report was prepared by the Textiles Branch and was initiated under Project No. 3044, "Aviation Lubricants", Task No. 73314, "Lubricants", formerly RDO 613-15, "Hydraulic Fluids and Lubricants", and was administered under the direction of the Materials Laboratory, Directorate of Research, Wright Air Development Center, with Lt. R. A. Sublette and Lt. R. A. Frey acting as project engineers.

The lubricants tested were not developed or intended by the manufacturer for the condition to which they have been subjected. Any poor performance of a lubricant under these test conditions is not indicative of the utility of the lubricant under less stringent conditions or for other applications.

The names Orlon and Dacron, are registered trade names belonging to the E. I. duPont deNemours and Co., Inc.

This report covers work from April 1955 to May 1955.

WADC TR 55-379

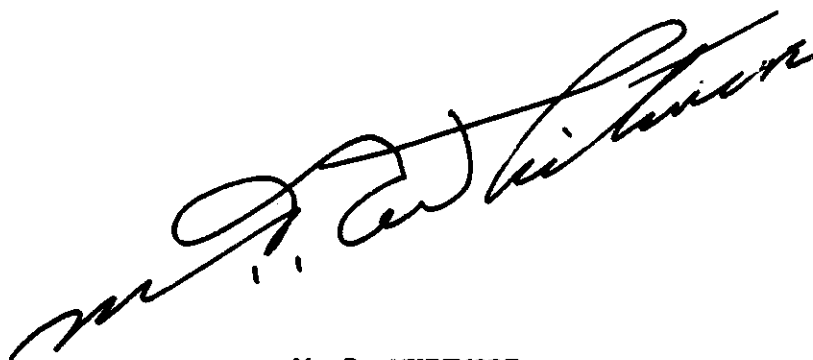
ABSTRACT

This investigation was conducted to determine if textile fibers and fabrics employed by the USAF are subject to deterioration or degradation when exposed to synthetic lubricants. In order to accomplish the desired program, two series of fabrics, composed of fibers that are commonly used in USAF fabrics, were prepared by immersing one series in synthetic lubricants at room temperature and the other series in a similar group of lubricants at 160°F. Both series were immersed in the lubricants for 72 hours. After exposure, laundering and dry cleaning tests were conducted on the fabrics. Diaphragm burst strength tests indicated the synthetic lubricants did not cause a loss in strength of the fabrics.

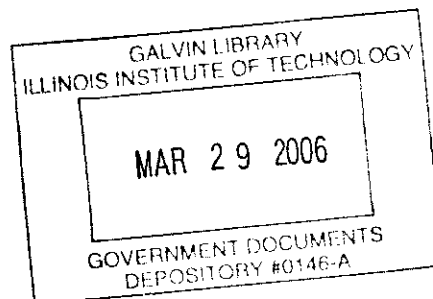
PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:



M. R. WHITMORE
Technical Director
Materials Laboratory
Directorate of Research



WADC TR 55-379

iii

Contrails

TABLE OF CONTENTS

	Page
I. INTRODUCTION	1
II. SELECTION OF FABRICS	1
III. IDENTIFICATION OF LUBRICANTS USED.	2
IV. PREPARATION OF FABRICS FOR TESTS	2
V. TEST METHOD.	4
VI. EVALUATION	5

LIST OF TABLES

Table	Page
1. Strengths of Cotton Fabric Exposed to Lubricants at Room Temperature and at 160°F.	6
2. Strengths of Wool Fabric Exposed to Lubricants at Room Temperature and at 160°F.	6
3. Strengths of Dacron Fabric Exposed to Lubricants at Room Temperature and at 160°F.	7
4. Strengths of Orlon Fabric Exposed to Lubricants at Room Temperature and at 160°F.	7
5. Strengths of Nylon Fabrics Exposed to Lubricants at Room Temperature and at 160°F.	8
6. Strengths of Rayon Fabrics Exposed to Lubricants at Room Temperature and at 160°F.	9
7. Summary of Data Presented in Tables 1, 2, 3, 4, 5 and 6. . .	10

THE EFFECT OF FIVE SYNTHETIC LUBRICANTS ON USAF FABRICS

I INTRODUCTION

In the development of synthetic lubricants for use by the Air Force it is necessary to consider the effect of these lubricants on the various aircraft components and items they may contact. It is for this reason that the investigation reported herein was initiated.

This report covers an investigation and evaluation of the degradation or deterioration that five recently developed synthetic lubricants might have on six fabrics under various conditions of exposure. Each fabric was subjected to the following variables:

1. Lubricant
2. Temperature
3. Cleaning method.

The exposure periods and methods of evaluation are similar to those outlined in WADC Technical Report 54-12, "The Effect of Synthetic Lubricant and Dibasic Acid Esters on Certain USAF Fabrics".

II SELECTION OF FABRICS

It was impractical to conduct tests on all fabrics used by the Air Force, therefore a set of fabrics containing various natural and synthetic fibers was selected to represent those fibers used by the Air Force today and those that may be used in the near future. The following fabrics were selected for testing:

1. Cotton - 2 X 2 basket weave. 4.75 oz/yd² maximum.
2. Wool - Specification MIL-C-823, Shade 84. 18.00 oz/yd² maximum.
3. Nylon - Specification MIL-C-7020, Type II. 1.6 oz/yd² maximum.
4. Rayon - Experimental cargo parachute fabric. 3 to 5 oz/yd² approximate.
5. Dacron - Experimental fabric similar to Specification MIL-C-7020, Type II.
6. Orlon - Experimental fabric. 4 to 6 oz/yd² approximate.

III IDENTIFICATION OF LUBRICANTS USED

The following lubricants were used during this investigation:

Manufacturer's Designation	Chemical Description	Manufacturer
* GE81406, lot X3023-1	Chlorinated silicone	General Electric Co.
OS-45, lot W2556	Silicate base fluid	Monsanto Chemical Co.
OS-45-1 lot V787	Silicate base fluid	Monsanto Chemical Co.
MLO 8200 (Materials Laboratory Designation)	Disiloxane base fluid	Oronite Chemical Co.
TL2456	Ester Base Oil	The Texas Co.

IV PREPARATION OF FABRICS FOR TESTS

Each of the six fabrics was prepared for tests in accordance with the following schedule:

1. Preparation of fabrics with lubricants at room temperature.
 - A. Original fabric - not soaked in any lubricant
 - B. Fabric soaked in GE81406* at room temperature for 72 hours.
 - C. Fabric soaked in OS-45 at room temperature for 72 hours.
 - D. Fabric soaked in OS-45-1 at room temperature for 72 hours.
 - E. Fabric soaked in MLO 8200 at room temperature for 72 hours.
 - F. Fabric soaked in TL2456 at room temperature for 72 hours.
2. Preparation of fabrics with lubricants at elevated temperature.
 - A. Fabric subjected to 160°F for 72 hours - not soaked in any lubricant.
 - B. Fabric soaked in GE81406 at 160°F for 72 hours.
 - C. Fabric soaked in OS-45 at 160°F for 72 hours.
 - D. Fabric soaked in OS-45-1 at 160°F for 72 hours.
 - E. Fabric soaked in MLO 8200 at 160°F for 72 hours.
 - F. Fabric soaked in TL2456 at 160°F for 72 hours.

* General Electric Company has changed the designation of 81406 to Versilube F 50.

Contrails

3. Preparation of fabrics with lubricants at room temperature and dry cleaned.
 - A. Fabric dry cleaned - not soaked in any lubricant.
 - B. Fabric soaked in GE81406 at room temperature for 72 hrs then dry cleaned.
 - C. Fabric soaked in OS-45 at room temperature for 72 hrs then dry cleaned.
 - D. Fabric soaked in OS-45-1 at room temperature for 72 hours then dry cleaned.
 - E. Fabric soaked in MLO 8200 at room temperature for 72 hrs then dry cleaned.
 - F. Fabric soaked in TL 2456 at room temperature for 72 hrs then dry cleaned.
4. Preparation of fabrics with lubricants at elevated temperature and dry cleaned.
 - A. Fabric subjected to 160°F for 72 hours then dry cleaned - not soaked in any lubricant.
 - B. Fabric soaked in GE81406 at 160°F for 72 hours then dry cleaned.
 - C. Fabric soaked in OS-45 at 160°F for 72 hours then dry cleaned.
 - D. Fabric soaked in MLO 8200 at 160°F for 72 hrs then dry cleaned.
 - E. Fabric soaked in TL2456 at 160°F for 72 hours then dry cleaned.
 - F. Fabric soaked in OS-45-1 at 160°F for 72 hours then dry cleaned.
5. Preparation of fabrics with lubricants at room temperature and laundering.
 - A. Fabric laundered - not soaked in any lubricant.
 - B. Fabric soaked in GE81406 at room temperature for 72 hrs then laundered.
 - C. Fabric soaked in OS-45 at room temperature for 72 hrs then laundered.
 - D. Fabric soaked in MLO 8200 at room temperature for 72 hrs then laundered.
 - E. Fabric soaked in TL2456 at room temperature for 72 hrs then laundered.
 - F. Fabric soaked in OS-45-1 at room temperature for 72 hrs then laundered.

Contrails

6. Preparation of fabrics with lubricants at elevated temperature and laundering.

- A. Fabric subjected to 160°F for 72 hrs then laundered - not soaked in any lubricant.
- B. Fabric soaked in GE81406 at 160°F for 72 hrs then laundered.
- C. Fabric soaked in OS-45 at 160°F for 72 hrs then laundered.
- D. Fabric soaked in MLC-8200 at 160°F for 72 hrs then laundered.
- E. Fabric soaked in TL2456 at 160°F for 72 hrs then laundered.
- F. Fabric soaked in OS-45-1 at 160°F for 72 hrs then laundered.

The fabrics were brought to standard conditions, 70°F and 65% relative humidity, by conditioning for 24 hours, after each preparation, and then evaluation tests were conducted.

Dry cleaning of the fabric was conducted as described in Method 5610, Federal Specification CCC-T-191b. Dry cleaning solvent conformed to the requirements of Federal Specification P-S-661. Each dry cleaning was conducted using five samples of fabric, 4 inches by 4 inches and 350 milliliters of solvent per jar. The Launder-Ometer was run for 25 minutes at a temperature of 85°F, after which the samples were extracted in a centrifugal extractor, air dried and conditioned.

The laundering was also conducted in the Launder-Ometer and was conducted with five samples, 4 inches by 4 inches, contained in each jar. Laundering was accomplished by using 350 milliliters of 0.5 percent soap solution per jar. The treatment was run for 30 minutes at 100°F, after which the samples were rinsed thoroughly, extracted in a centrifugal extractor, air dried and conditioned.

V TEST METHOD

The test chosen for evaluation of the effect of the various treatments was, "Strength of Cloth; Diaphragm Bursting Method", Number 5122, Federal Specification CCC-T-191b. This test is a good means for rapid evaluation, although it does not provide accuracy to the degree that a ravel strip test does. Five specimens of each fabric prepared, as previously outlined, were tested. Results of tests on these specimens have been tabulated in Tables 1, 2, 3, 4, 5 and 6. The values reported are Mullen Burst Points that were read to the nearest 5.0 points.

Contrails

VI EVALUATION

Table 7 is a summary of the results reported in Tables 1, 2, 3, 4, 5, and 6. This table was computed by averaging the individual averages of the 6 conditions under which a specific fabric was exposed to a specific lubricant. For example, the burst strength of cotton exposed under all conditions in lubricant MLO 8200

is $\frac{147+152+137+146+148+136}{6} = 144.3$ Mullens burst points. The lubricants in Table 7 are arranged for each fabric according to the magnitude of the burst strength.

Upon examination of the data presented in Table 7, it is noted that the control for all fabrics, except cotton, had the lowest burst strength. The control for cotton was only 0.2 of a Mullens burst point above the lowest value. A possible explanation for the increase in strength of the various fabrics after exposure to the lubricants is that the addition of lubricants reduces the friction between the yarns and fibers, thereby increasing the efficiency of the fabric.

It is pointed out that the data presented in Table 7 are useful only as a rough yardstick for considering the effect of the various lubricants on the various fabrics, since the data presented do not consider the interactions between the variables.

It is also pointed out that the 72 hour exposure period used is relatively short in duration. An additional program with exposure periods extending from 6 to 12 months may indicate a gradual deterioration of the fabrics, resulting from prolonged exposure to the lubricants.

TABLE 1
STRENGTHS OF COTTON FABRIC EXPOSED TO LUBRICANTS AT ROOM TEMPERATURE AND AT 160°F

Cleaning Method	Exposed for 72 Hours at Room Temperature						Exposed for 72 Hours at 160°F					
	Control no Lubricant	Lubricant GE81406	Lubricant OS-45	Lubricant MLO-8200	Lubricant TL2456	Lubricant OS-45-1	Control no Lubricant	Lubricant GE81406	Lubricant OS-45	Lubricant MLO-8200	Lubricant TL2456	Lubricant OS-45-1
Fabric tested after exposure to lubricant. No cleaning accomplished.	145	155	155	150	160	160	140	150	165	140	140	155
	160	160	150	155	140	140	135	150	160	155	145	150
	170	150	145	140	155	140	130	160	150	145	145	140
	165	155	130	145	155	150	140	150	145	150	150	145
	165	160	135	145	140	140	135	140	145	140	140	150
Average	161	156	143	147	150	146	136	150	153	146	144	148
Fabric tested after exposure to lubricant and dry cleaned.	140	145	155	160	145	155	150	155	155	140	130	140
	150	150	155	150	165	145	145	145	145	145	145	140
	130	155	160	145	165	145	150	140	165	160	135	150
	155	160	150	160	170	145	140	150	145	140	135	140
	150	160	150	145	150	155	145	150	145	155	130	150
Average	145	154	154	152	159	149	146	148	151	148	135	144
Fabric tested after exposure to lubricant and laundered.	135	145	135	145	140	140	135	140	135	135	140	140
	145	140	135	135	140	140	140	130	135	135	145	145
	155	145	140	130	140	150	140	130	120	135	140	140
	145	150	155	135	160	140	125	140	135	130	135	145
	140	150	145	140	150	140	135	140	140	145	135	145
Average	144	146	142	137	146	142	135	136	133	136	139	143

TABLE 2
STRENGTHS OF WOOL FABRIC EXPOSED TO LUBRICANTS AT ROOM TEMPERATURE AND AT 160°F

Fabric tested after exposure to lubricant. No cleaning accomplished.	210	215	190	205	215	210	195	215	210	205	210	220
	205	215	195	205	210	205	195	210	210	210	210	215
	210	215	210	210	210	210	190	215	215	210	215	210
	210	215	210	210	215	205	195	215	215	215	215	215
	210	210	215	205	215	210	195	215	220	205	215	215
Average	209	214	204	207	213	208	194	214	214	209	213	215
Fabric tested after exposure to lubricant and dry cleaned	200	200	210	210	210	205	195	215	210	205	200	205
	200	205	205	210	205	205	190	220	205	205	205	200
	200	205	205	200	200	210	195	210	205	210	200	210
	200	205	210	200	205	205	190	210	205	210	205	210
	200	205	205	200	200	205	195	215	200	200	200	210
Average	200	204	207	204	204	206	193	214	205	206	202	207

Table 2 (Cont'd)
STRENGTHS OF WOOL FABRIC EXPOSED TO LUBRICANTS AT ROOM TEMPERATURE AND AT 160°F

Cleaning Method	Exposed for 72 Hours at Room Temperature						Exposed for 72 Hours at 160°F					
	Control no Lubricant	Lubricant GE81406	Lubricant OS-45	Lubricant MLO-8200	Lubricant TL2456	Lubricant OS-45-1	Control no Lubricant	Lubricant GE81406	Lubricant OS-45	Lubricant MLO-8200	Lubricant TL2456	Lubricant OS-45-1
Fabric tested after exposure to lubricant and laundered.	190	185	185	180	195	190	170	165	185	185	180	190
	185	190	185	175	195	190	170	170	180	185	180	190
	190	190	185	180	185	190	175	170	185	185	180	195
	190	185	190	175	190	190	175	170	185	185	185	190
	185	195	185	185	190	190	170	170	185	190	180	190
Average	188	189	186	179	191	190	172	169	184	186	181	191

TABLE 3
STRENGTHS OF DACRON FABRIC EXPOSED TO LUBRICANTS AT ROOM TEMPERATURE AND 160°F

Fabric tested after exposure to lubricant. No cleaning accomplished.	150	150	150	145	155	150	145	150	150	150	145	150
	150	150	145	140	155	150	145	145	145	145	145	155
	150	145	150	140	155	150	145	155	145	155	150	150
	150	150	160	155	155	155	145	155	150	150	145	150
	155	145	145	150	150	150	140	145	150	150	145	145
Average	151	148	150	146	154	151	144	150	148	150	146	150
Fabric tested after exposure to lubricant and dry cleaned.	145	150	155	160	160	160	135	160	150	150	145	150
	140	155	150	155	150	160	135	160	145	155	150	150
	145	155	145	150	145	155	140	155	145	150	155	155
	140	150	145	150	145	160	145	155	150	150	150	145
	140	155	150	155	150	155	135	160	145	155	150	145
Average	142	153	149	154	150	158	138	158	147	152	150	149
Fabric tested after exposure to lubricant and laundered.	150	150	145	150	160	155	155	155	150	150	145	150
	145	145	155	150	155	150	150	150	150	145	150	145
	150	150	145	145	160	155	155	145	145	140	150	150
	150	145	150	145	145	155	150	145	145	140	145	145
	155	150	145	150	150	155	145	150	150	140	145	135
Average	150	148	148	148	154	154	151	149	148	143	147	145

TABLE 4
STRENGTHS OF ORLON FABRIC EXPOSED TO LUBRICANTS AT ROOM TEMPERATURE AND 160°F

Fabric tested after exposure to lubricant. No cleaning accomplished.	310	335	335	330	330	325	315	325	320	325	330	320
	330	330	340	320	335	330	320	320	320	320	335	325
	315	330	345	330	335	330	310	320	320	330	335	325
	315	330	335	300	320	315	310	325	315	330	335	325
	325	300	330	320	335	315	315	320	325	335	320	325
Average	319	325	337	320	331	323	314	322	320	328	331	325

TABLE 4 (Cont'd)
STRENGTHS OF ORLON FABRIC EXPOSED TO LUBRICANTS AT ROOM TEMPERATURE AND 160°F

Cleaning Method	Exposed for 72 Hours at Room Temperature						Exposed for 72 Hours at 160°F					
	Control no Lubricant	Lubricant GE81406	Lubricant OS-45	Lubricant MLO-8200	Lubricant TL2456	Lubricant OS-45-1	Control no Lubricant	Lubricant GE81406	Lubricant OS-45	Lubricant MLO-8200	Lubricant TL2456	Lubricant OS-45-1
Fabric tested after exposure to lubricant and dry cleaned.	320	335	340	335	325	320	320	340	300	330	335	310
	315	320	330	330	320	325	320	345	300	335	330	310
	310	335	320	320	330	320	315	335	300	335	325	310
	315	330	335	310	330	340	300	335	315	320	325	310
	330	335	335	325	200	360	315	335	300	325	315	320
Average	318	331	332	324	319	333	314	338	303	329	326	312
Fabric tested after exposure to lubricant. No cleaning accomplished.	310	315	335	315	360	315	320	335	305	320	305	310
	310	320	320	320	335	320	310	315	305	320	315	320
	320	315	320	320	340	320	315	320	300	325	315	315
	325	305	335	335	335	310	315	315	320	315	320	320
	315	320	320	310	335	315	320	330	305	320	310	305
Average	316	315	326	320	341	316	316	323	307	320	313	314

TABLE 5
STRENGTHS OF NYLON FABRIC EXPOSED TO LUBRICANTS AT ROOM TEMPERATURE AND 160°F

Fabric tested after exposure to lubricant. No cleaning accomplished.	145	140	140	145	140	145	135	145	140	140	145	140
	140	145	140	140	145	140	125	145	140	150	140	135
	140	140	140	145	140	140	130	145	140	145	145	135
	140	140	145	145	140	135	130	145	135	145	145	135
	140	145	145	140	135	140	130	145	150	140	145	140
Average	141	142	142	143	140	140	130	145	141	144	144	137
Fabric tested after exposure to lubricant and dry cleaned.	145	150	145	145	145	140	135	145	135	145	145	140
	140	145	145	140	145	140	135	150	140	145	140	140
	145	150	140	140	145	145	135	155	135	140	140	140
	140	145	145	140	135	145	135	140	140	145	140	145
	140	140	145	145	140	145	135	150	140	145	140	140
Average	142	146	144	142	142	143	135	148	138	144	141	141
Fabric tested after exposure to lubricant and laundered.	150	150	140	140	145	145	140	140	145	140	140	140
	150	140	140	135	150	145	140	145	140	150	145	135
	150	140	145	145	145	145	140	140	145	140	145	150
	150	140	135	140	145	150	140	135	145	145	135	140
	145	145	140	145	150	145	135	140	140	145	135	135
Average	149	143	140	141	147	146	139	140	143	144	140	140

TABLE 6
STRENGTH OF RAYON FABRIC EXPOSED TO LUBRICANTS AT ROOM TEMPERATURE AND 160°F

Exposed for 72 Hours at Room Temperature

Cleaning Method	Control no Lubricant	Lubricant GE81406	Lubricant OS-45	Lubricant MLO-8200	Lubricant TL2456	Lubricant OS-45-1	Control no Lubricant	Lubricant GI81406	Lubricant OS-45	Lubricant MLO-8200	Lubricant TL2456	Lubricant OS-45-1
Fabric tested after exposure to lubricant. No cleaning accomplished.	170	165	170	170	165	160	135	170	160	165	160	170
	165	160	165	170	165	155	140	165	160	170	165	165
	170	160	165	165	150	160	140	170	160	165	165	165
	170	165	160	170	165	160	140	170	170	170	160	180
	170	165	160	145	160	160	140	175	165	170	180	165
Average	169	163	164	164	161	159	139	170	163	168	166	169
Fabric tested after exposure to lubricant and dry cleaned.	145	160	150	160	155	160	150	165	155	165	150	160
	150	170	160	155	155	160	150	155	155	160	165	160
	145	165	150	155	155	155	160	170	160	165	170	165
	155	160	160	165	160	165	150	165	155	165	165	160
	145	155	155	160	155	155	155	165	170	170	165	160
Average	148	162	155	159	156	159	153	164	159	165	163	161
Fabric tested after exposure to lubricant and laundered.	160	165	160	160	170	165	155	160	160	150	155	155
	145	160	150	160	160	160	150	155	155	150	155	150
	155	170	170	160	160	160	150	155	155	150	155	155
	165	165	160	165	160	155	155	165	155	145	155	145
	165	160	165	160	165	165	150	155	155	140	160	150
Average	158	164	161	161	163	161	152	158	156	148	156	151

Contrails

Table 7

Summary of Data Presented in Tables 1, 2, 3, 4, 5, and 6

Cotton		Wool		Dacron	
Control*	144.5	Control	192.6	Control	146.0
MLO 8200	144.3	MLO 8200	198.5	OS-45	148.3
OS-45-1	145.3	OS-45	200.0	MLO 8200	148.8
TL2456	145.5	TL2456	200.6	TL2456	150.1
OS-45	146.0	GE81406	200.6	GE81406	151.0
GE81406	148.3	OS-45-1	202.8	OS-45-1	151.1

Orlon		Nylon		Rayon	
Control	316.1	Control	139.3	Control	153.1
OS-45-1	320.5	OS-45-1	141.1	OS-45	159.6
OS-45	320.8	OS-45	141.3	OS-45-1	160.0
MLO 8200	323.5	TL2456	142.3	TL2456	160.8
GE81406	325.6	MLO 8200	143.0	MLO 8200	160.8
TL2456	326.8	GE81406	144.0	GE81406	163.5

* The Control is 0.2 of a Mullens burst point stronger than MLO 8200 but for the sake of heading each column with the Control strength the values were reversed.