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Rock Island Arsenal Laboratory

TECHNICAL REPORT

EFFECT OF STORAGE ON LUBRICATING GREASE COMPATIBILITY

By

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R. L. Young

Dept. of the Army Project No. 1-A-0-24401-A-107

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Rock Island Arsenal
Rock Island, Illinois

ABSTRACT

The compatibility of binary mixtures of twelve types of lubricating greases, when mixed in the three component ratios, 10%-90%, 50%-50%, and 90%-10%, and after storage for eighteen months was determined. Approximately 15% of the grease mixtures were re-examined for compatibility after three years storage. The greases studied included soap thickened, non-soap thickened, and an organic thickened product. Both mineral oil and synthetic fluid types were represented.

Approximately 64% of the binary grease mixtures were compatible after an eighteen month storage period. As the storage period was increased to three years, the number of compatible mixtures was decreased.

More grease mixtures were incompatible after eighteen months and after three years storage than were incompatible immediately after preparation. In only a very few instances did grease mixtures, which were incompatible immediately after preparation, become compatible after storage.

A table was prepared giving the compatibility data obtained after eighteen months storage, and, in a limited number of cases, after three years storage. Data obtained on similar mixtures immediately after preparation is given for comparison.

RECOMMENDATIONS

It is recommended that military publications whose aim is to instruct in lubrication procedures call attention to the probable undesirable results which could be produced by mixing different types of lubricating greases.

It is further recommended that a study be made to determine the fundamental cause of lubricating grease incompatibility.

EFFECT OF STORAGE ON LUBRICATING GREASE COMPATIBILITY

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EFFECT OF STORAGE ON LUBRICATING GREASE COMPATIBILITY

OBJECT

To determine the effect of storage for an eighteen month and a three year period on the compatibility of binary mixtures of lubricating greases.

INTRODUCTION

The problem of lubricating grease incompatibility has been recognized for some time. In the past ten years, several comprehensive studies in this area were made. However, the literature is silent concerning the effect of storage on lubricating grease compatibility.

All of the following studies involved the examination of freshly prepared grease mixtures.

McClellan and Calish[1] investigated a number of service difficulties due to lack of lubricating grease compatibility. This extensive investigation showed that mixing greases made with different types of soaps often produced undesirable effects upon consistency, dropping points, and bearing performance. These investigators developed a device for the laboratory determination of the compatibility of lubricating grease mixtures.

Ehrlich and Sayles[2] completed a study of the compatibility of a number of different types of greases. These investigators used the ASTM wheel bearing grease tester as a "go, no-go" gauge. The results of this study showed the inadvisability of mixing different types of greases. This study also showed that reactions produced with one specific grease could not be accepted as representative for all greases of that type.

The Joint Committee on Lubricating Greases for Railroad Antifriction Journal Bearings[3] made a study of the compatibility of lithium soap and sodium soap grease mixtures. This study showed that mixtures of different types of greases were a probable source of trouble and seldom resulted in improved performance.

A staff report in Motor Age[4] warns against mixing different types of greases in wheel bearing service. The combination of moisture, heat, and working are particularly effective in producing incompatibility difficulties in mixtures of greases.

Proudfoot[5], in his study of wheel bearing grease failures, reported that as little as 5% calcium soap grease in a sodium soap wheel bearing grease was sufficient to cause failure in a wheel bearing test. These investigators further determined that the small amount of calcium soap grease remaining on improperly cleaned wheel bearings was sufficient to cause incompatibility difficulties when the bearings were subsequently lubricated with a conventional sodium soap wheel bearing grease.

Glassman's[6] studies of the compatibility of four types of greases meeting the requirements of Specification MIL-G-18709A[7] showed that it is quite possible for incompatibility to be produced by mixing two greases both of which meet the same specification. He concluded that different lubricating greases can interact, depending upon the manner in which they are worked together. This interaction can affect bearing performance life as well as other grease properties. This study showed that dropping point and bearing life tests are suitable procedures for screening potentially incompatible grease mixtures.

Meade[8], in a study of the static compatibility characteristics of a number of 50% binary grease mixtures found that, with one exception, the mixtures hardened during storage. However, it was judged that the hardening was due to aging and not to incompatibility.

Meade[9], in another study, found that incompatibility problems were most evident in 50%-50% binary grease mixtures. This study also showed that among the incompatible binary mixtures, more than seven times as many instances of softening were found than instances of hardening.

PROCEDURE

Twenty-one commercial grease samples consisting, with three exceptions, of two samples of each type of grease were studied. The three exceptions were nonconventional types of greases of which only one sample was available.

Each grease was analyzed and the results are reported in Table I.

Binary grease mixtures were prepared in the following component ratios: 10% of the first component and 90% of the second component, 50% of each component, and 90% of the first component and 10% of the second component. The mixtures were prepared by thoroughly blending the components with a spatula,

TABLE I

ANALYSIS OF COMPONENT GREASES

GREASE NO.	THICKENER TYPE	THICKENER %	FLUID TYPE	FLUID %	VISCOSITY, cs 100°F	VISCOSITY, cs 200°F	VISCOSITY INDEX	PENETRATION UNWORKED	PENETRATION WORKED
1	Lithium soap	10.0	Mineral oil	89.0	173.1	11.63	37	272	272
2	Lithium soap	11.5	Mineral oil	88.0	105.0	9.65	69	253	287
3	Sodium soap	23.0	Mineral oil	76.0	38.5	5.75	93	278	293
4	Sodium soap	14.0	Mineral oil	84.5	215.4	16.83	90	269	290
5	Anhydrous Calcium soap	11.0	Mineral oil	89.0	13.10	2.92	72	269	267
6	Anhydrous Calcium soap	12.0	Mineral oil	87.0	12.57	2.92	87	270	265
7	Barium soap	12.0	Mineral oil	77.2	102.8	9.65	73	245	252
8	Barium soap	12.0	Mineral oil	77.0	102.8	8.77	47	271	295
9	Lithium soap	9.0	Diester	91.0	15.20	3.55	132	307	300
10	Lithium soap	23.0	Diester	76.0	16.24	4.20	>160	271	300
11	Lithium soap	10.0	Polyglycol	90.0	35.2	6.37	137	269	260
12	Lithium soap*	8.0	Polyglycol	89.0	93.7	14.55	138	260	261
13	Bentonite	8.0	Mineral oil	91.5	116.7	11.63	94	279	291
14	Bentonite	7.6	Mineral oil	92.0	598.0	33.4	94	306	340
15	Hydrophobic silica	16.0	Mineral oil	84.0	189.8	15.32	87	321	316
16	Hydrophobic silica	9.0	Mineral oil	90.4	980.0	26.7	<0	333	395
17	Aluminum soap	4.4	Mineral oil	95.5	249.4	14.55	39	300	336
18	Aluminum soap	6.4	Mineral oil	93.0	361.0	15.07	<0	232	284
19	Sodium N-octadecyl Terephthalamate	10.0	Mineral oil	90.0	107.2	10.50	86	243	277
20	Isocyanate amine	6.4	Mineral oil	93.6	143.3	12.71	86	287	280
21	Calcium and lead soaps	22.0	Mineral oil	78.0	151.5	11.63	60	255	263

*This grease contained approximately 3% molybdenum disulfide.

care being taken to work as little air as possible into the mixture. Duplicate mixtures were placed in double compression, tin coated, one pint cans. One pint of each mixture was worked 60 strokes, cooled to 77±1°F. and the penetration determined and recorded. These grease mixtures were then returned to their containers and stored at room temperature for eighteen months. The twenty-one original samples were also stored in duplicate in one pint cans.

After storage, the grease mixtures were worked in accordance with ASTM Method D217-52T[10] with the exception that the worker was operated for 10,000 double strokes instead of the prescribed 60 strokes. The worked mixtures were cooled to 77±1°F. and the penetrations determined and recorded. The grease mixtures were then returned to their respective cans and stored for an additional eighteen months at room temperature. After the second storage period, approximately 15% of the grease mixtures were again worked 10,000 double strokes, cooled to 77±1°F. and their penetrations determined and recorded.

Compatibility was determined by the penetration change exhibited by the binary mixtures after storage and the 10,000 stroke worker test as compared to the penetration change exhibited by the components when subjected to the same storage period and worker test.

RESULTS AND DISCUSSION

Knowledge of the effect of storage on lubricating grease compatibility is of value to the military services. Vehicles of both military and civilian origin are lubricated at the time of manufacture and again after the prescribed lubrication interval. If these vehicles are not in constant service, they can be considered to be in storage though the storage period may vary from a day or two to several years. It is inevitable that some of these vehicles will be lubricated with various types of greases. Table II lists a few of the grease specifications currently used by the military services. It is readily seen from this table that ample opportunity exists to mix lubricating greases, either intentionally or unintentionally. A surveillance program conducted jointly by this Arsenal and Detroit Arsenal several years ago showed that the practice of mixing greases in military equipment was widespread.

The purchase by the military services of civilian type automotive vehicles designed for extended lubrication periods has served to accentuate the lubricating grease compatibility problem. If such vehicles are relubricated with military

TABLE II

GREASES AND COMPONENTS

SPECIFICATION	REQUIRED OR USUAL THICKENER	REQUIRED OR USUAL FLUID
MIL-G-2108[11]*	Sodium soap	Mineral oil
MIL-G-10924A[12]	Calcium soap	Mineral oil
MIL-G-18709[7]	Sodium-calcium, lithium-calcium, or lithium-zinc	Mineral oil
MIL-G-3278A[13]	Lithium soap	Diester fluid
MIL-G-7118A[14]	Lithium soap	Diester fluid
MIL-L-15719A[15]	Lithium soap	Silicone fluid
MIL-L-4343A[16]	Lithium soap	Diester or silicone fluid
None	Sodium N-Octadecyl Terephthalamate**	Mineral oil

*This specification has been cancelled but the product is still in the supply system.

**This grease is highly resistant to the effects of gamma radiation.

specification lubricating greases, as they certainly will be, the chances are excellent that compatibility difficulties will become evident. Such vehicles depend upon the use of sealed bearings to prolong the lubrication periods. All of the investigations conducted to date in the area of grease compatibility have shown that grease mixtures tend to soften after working. Soft mixtures are more difficult to confine to a bearing area and are more prone to leak and become contaminated than are the original products.

The grease mixtures studied in this investigation were prepared in duplicate early in 1959. Duplicate mixtures were prepared on the chance that the compatibility test results at the end of an eighteen month storage period might be of sufficient interest to warrant further study. At the conclusion of the eighteen month storage study, it was decided to examine several mixtures after three years storage. The mixtures chosen for further study consisted of a portion of the mixtures which showed little consistency change and a portion of the mixtures which showed considerable consistency change after the eighteen month storage period.

The decision as to the length of the storage period was difficult because military records show that grease lubricated equipment is stored for periods varying from six months to eight years. The eighteen month storage period was chosen as representing the period of time a portion of the grease lubricated vehicles remain in storage. The three year storage period was chosen simply because it was twice as long as the eighteen month period. Had a longer storage period been chosen for this investigation, it is quite probable that more extensive compatibility difficulties would be found.

Consideration was given to the use of the ASTM wheel bearing grease tester as a device for determining the compatibility of grease mixtures. This instrument closely simulates actual wheel bearing service. However, it actually works only five grams of grease, the remainder of the charge in the hub being merely heated to 220°F. for six hours. This test procedure is also time consuming, requiring more than six hours for a complete test. The Shell roll test and the 100,000 stroke worker test procedures were also considered, but were discarded because of the length of time required to make these tests. The 10,000 stroke grease worker test was selected as the most desirable procedure for working the grease mixtures. This procedure provides considerable working of the grease mixture, sufficient charge for an accurate penetration determination, and can be completed in one-half the time required for the ASTM wheel bearing test procedure. It is quite possible that had the Shell roll test

or the 100,000 stroke worker test procedure been selected for this investigation, more of the binary grease mixtures might have been found to be incompatible.

The types of lubricating greases studied, while fairly comprehensive, did not include all of the greases used or available for use by the military services. No silicone or fluorocarbon greases were studied. These two products are quite expensive and their military use is limited. Only binary mixtures were studied. Compatibility data on multi-component lubricating grease mixtures would be of value. An actual bearing performance test in conjunction with the 10,000 stroke worker test would also have been of value.

A definition of lubricating grease incompatibility has been proposed by Eubank[17] and accepted by the National Lubricating Grease Institute. This definition is as follows: "Two lubricating greases show incompatibility when a mixture of the products shows physical properties or service performance which are markedly inferior to those of either of the greases before mixing. Performance or properties inferior to one of the products and superior to the other may be due to simple mixing and would not be considered as evidence of incompatibility". It can be deduced from this accepted definition that two lubricating greases show compatibility when a mixture of the products shows physical properties or service performance which are nearly the same as those of either of the component greases before mixing.

The compatibility or incompatibility of the binary grease mixtures originally after the eighteen month and after the three year storage periods was determined in the following manner. Graphs were drawn for each of the grease mixtures with the abscissas representing the percentage composition of the mixtures and the ordinates representing the 10,000 stroke worked penetration of the mixtures. Lines were drawn parallel to the abscissas to indicate a penetration ten units harder than the 10,000 stroke worked penetration of the harder component originally after eighteen months storage and after three years storage. Similar lines were drawn to indicate a penetration ten units softer than the 10,000 stroke worked penetration of the softer component originally after eighteen months storage and after three years storage. The ten units below and above the component penetration is the equivalent of the ASTM reproducibility factor for the worked penetration test. In this manner an area was created, the dimensions of which encompassed the 10,000 stroke worked penetration plus the reproducibility factors for the component greases originally after the eighteen month and after the three year storage

period. The penetrations of the binary mixtures originally and after the storage periods were plotted on the graphs. A mixture whose penetration fell outside the above described area was judged to be incompatible. Judgement was based on the assumption that a reaction other than simple mixing was responsible for the change in penetration beyond that of the 10,000 stroke worked penetration of either component grease plus the ten unit reproducibility factor. Conversely, a mixture whose penetration fell within the area was judged to be compatible. Figures 1 and 2 are representative of compatible mixtures and Figures 3, 4, 5, and 6 are representative of incompatible mixtures.

Table III gives penetration data on the component greases originally, after eighteen months storage, and after three years storage. This data was used in the preparation of the graphs ("lower limits of compatibility" and "upper limits of compatibility") from which compatibility of the mixtures after storage was determined. Incidently, this table also serves to show that the mechanical stability of certain types of lubricating greases is affected by storage.

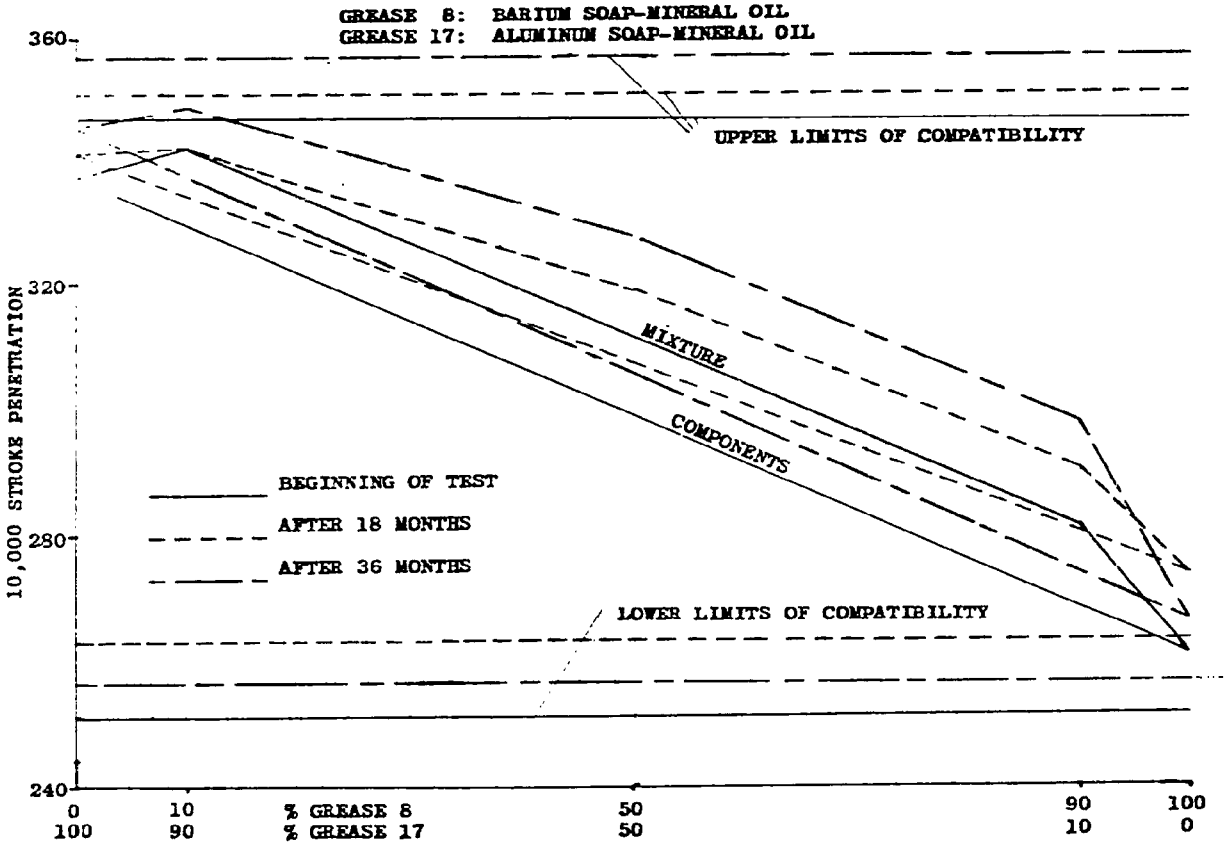
Table IV gives the compatibility data obtained on the grease mixtures studied in this investigation. The table is arranged in alphabetical order in terms of the first component of the mixture. The column entitled "Grease No." show the serial numbers of the grease samples and serves to show that two greases of each type were studied in this investigation. The columns entitled, "First Component" and "Second Component" show the types of greases which were worked together. The three major columns under the heading "Compatibility, % First Component" give the compatibility of the grease mixtures at the beginning of the storage period, after eighteen months storage, and after three years storage. In these columns, the letter "C" indicates the mixture is compatible. The letters "H" and "S" followed by a number indicate that the mixture hardened or softened respectively, the extent of hardening or softening being indicated by the number following the letter.

A study of Table IV produces the following conclusions:

1. More grease mixtures were incompatible after eighteen months and three years storage than were incompatible immediately after preparation.

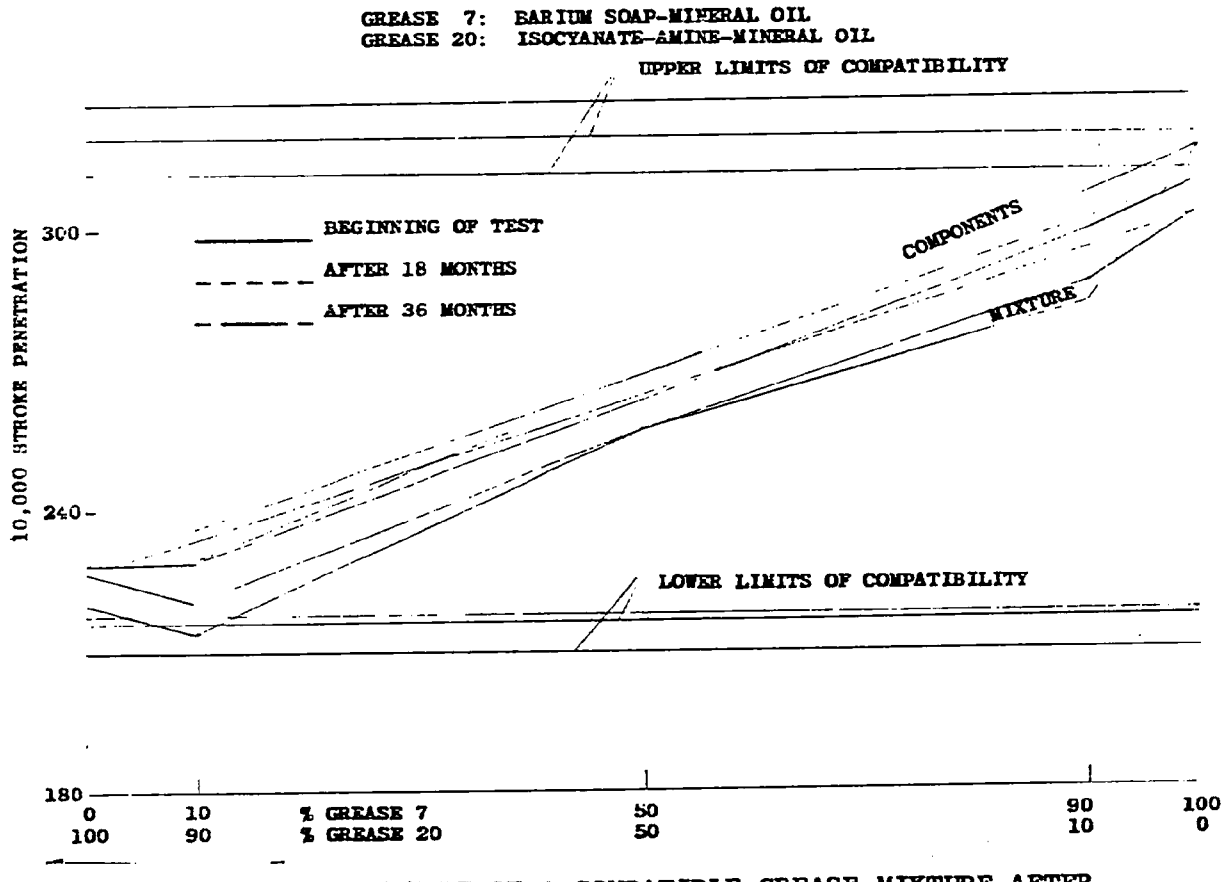
2. In only a few instances did grease mixtures, which were incompatible immediately after preparation, become compatible after storage.

FIGURE 1



EXAMPLE OF A COMPATIBLE GREASE MIXTURE AFTER EIGHTEEN MONTHS AND THREE YEARS STORAGE

FIGURE 2



EXAMPLE OF A COMPATIBLE GREASE MIXTURE AFTER EIGHTEEN MONTHS AND THREE YEARS STORAGE

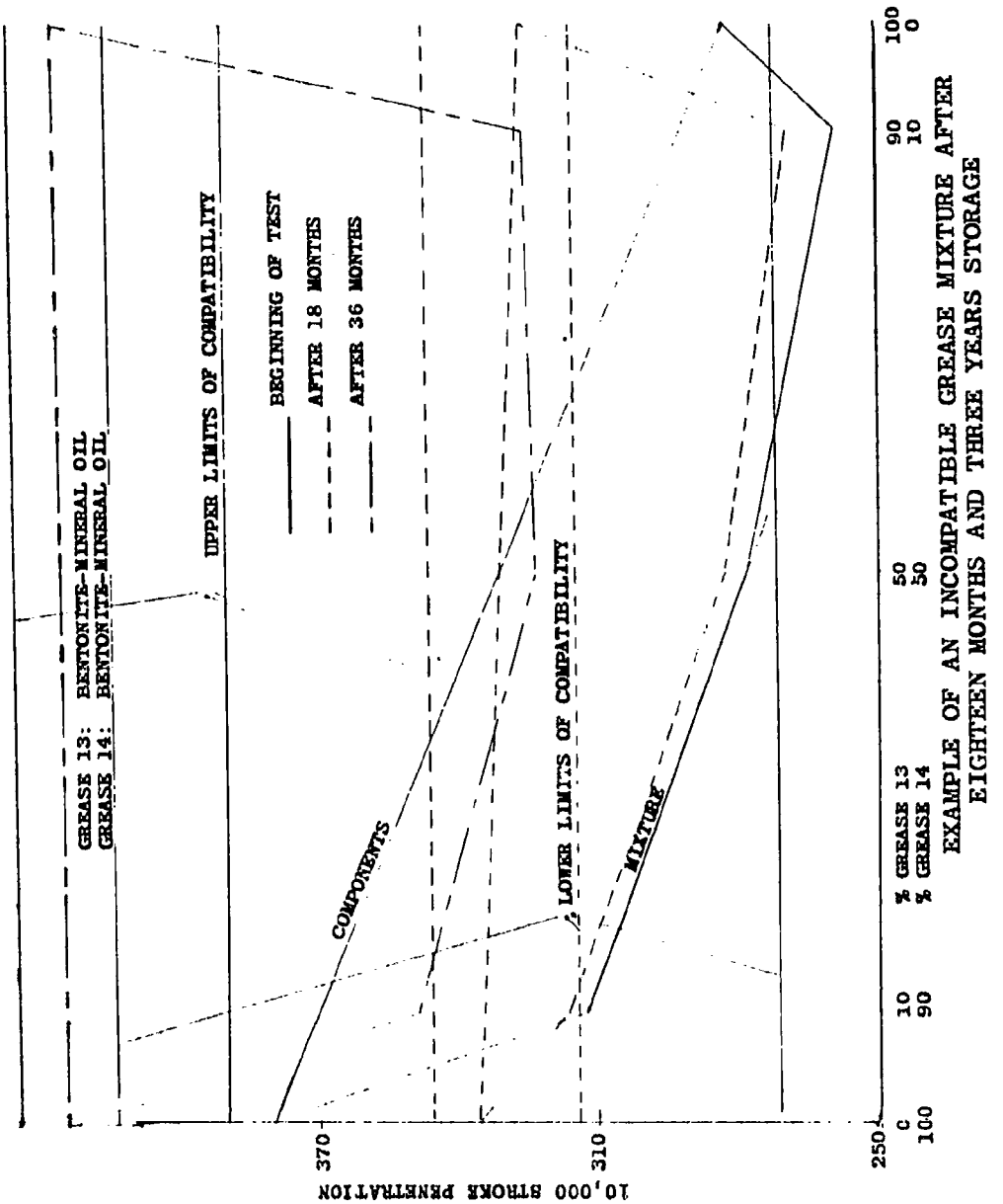


FIGURE 3

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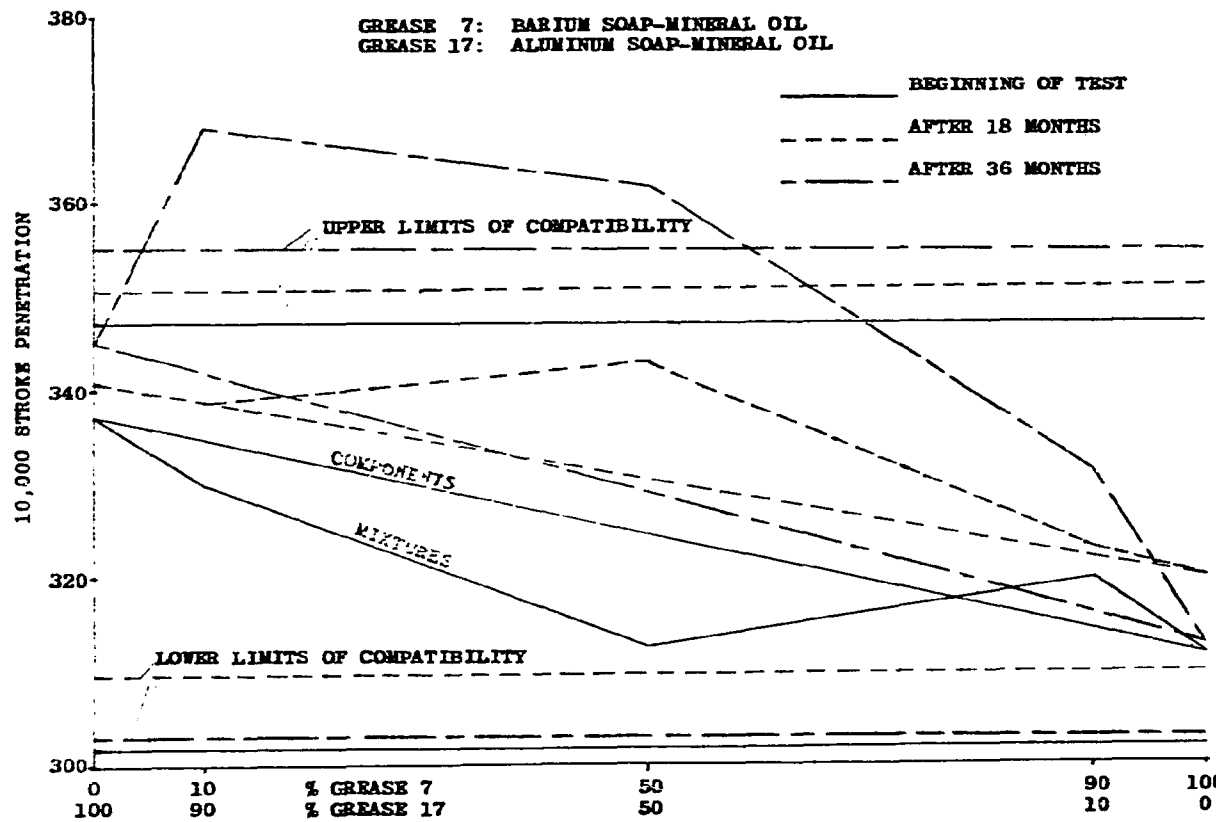
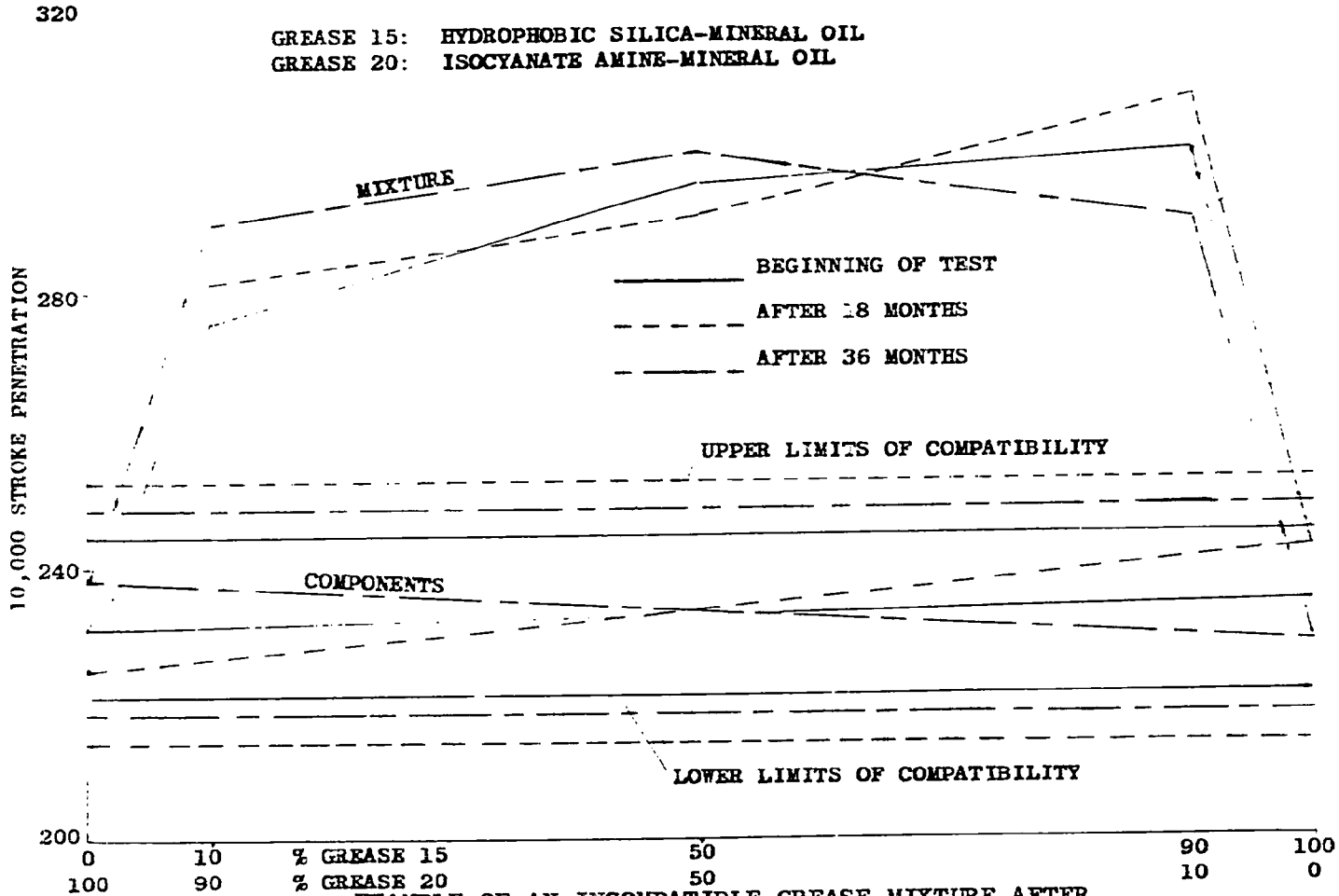
FIGURE 4



EXAMPLE OF AN INCOMPATIBLE GREASE MIXTURE AFTER EIGHTEEN MONTHS AND THREE YEARS STORAGE

FIGURE 5



EXAMPLE OF AN INCOMPATIBLE GREASE MIXTURE AFTER EIGHTEEN MONTHS AND THREE YEARS STORAGE

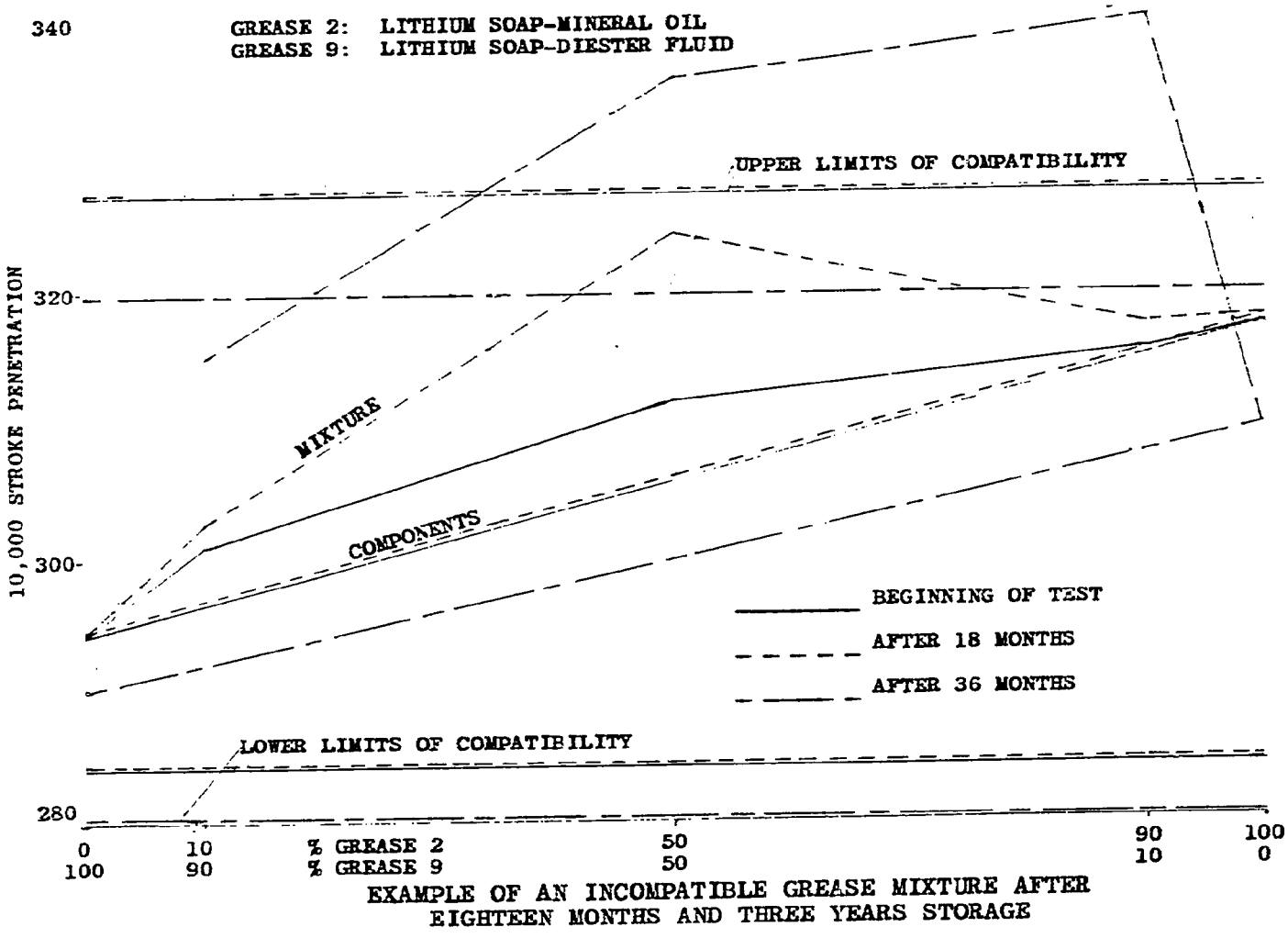


FIGURE 6

EXAMPLE OF AN INCOMPATIBLE GREASE MIXTURE AFTER EIGHTEEN MONTHS AND THREE YEARS STORAGE

TAPLE III

EFFECT OF STORAGE ON COMPONENT GREASES

GREASE NO.	THICKENER TYPE	THICKENER %	FLUID TYPE	FLUID %	PENETRATIONS: BEGINNING OF TEST 60 STROKE	BEGINNING OF TEST 10,000 STROKE	18 MONTHS STORAGE 60 STROKE	18 MONTHS STORAGE 10,000 STROKE	36 MONTHS STORAGE 60 STROKE	36 MONTHS STORAGE 10,000 STROKE
1	Lithium soap	10.0	Mineral oil	89.0	272	275	283	269	267	259
2	Lithium soap	11.5	Mineral oil	88.0	287	317	325	317	310	309
3	Sodium soap	23.0	Mineral oil	76.0	293	315	302	304	264	295
4	Sodium soap	14.0	Mineral oil	84.5	290	335	298	330	305	350
5	Anhydrous Calcium soap	11.0	Mineral oil	89.0	267	278	266	275	255	266
6	Anhydrous Calcium soap	12.0	Mineral oil	87.0	265	260	265	254	267	258
7	Barium soap	12.0	Mineral oil	77.2	252	312	269	319	263	313
8	Barium soap	12.0	Mineral oil	77.0	295	262	288	274	290	267
9	Lithium soap	9.0	Diester fluid	91.0	300	294	293	294	296	290
10	Lithium soap	23.0	Diester fluid	76.0	300	277	291	292	294	290
11	Lithium soap	10.0	Polyglycol	90.0	260	255	258	259	254	255
12	Lithium soap*	8.0	Polyglycol	89.0	261	263	256	275	248	273
13	Bentonite	8.0	Mineral oil	91.5	291	282	337	326	426+	426+
14	Bentonite	7.6	Mineral oil	92.0	340	380	331	337	400	426+
15	Hydrophobic silica	16.0	Mineral oil	84.0	316	234	272	242	255	228
16	Hydrophobic silica	9.0	Mineral oil	90.4	395	249	385	262	390	289
17	Aluminum soap	4.4	Mineral oil	95.5	336	337	338	341	339	345
18	Aluminum soap	5.4	Mineral oil	93.0	284	309	290	311	294	315
19	Sodium N-Octadecyl Terephthalamate	10.0	Mineral oil	90.0	277	276	262	282	274	297
20	Isocyanate amine	6.4	Mineral oil	93.6	280	231	277	224	283	237
21	Calcium and lead soaps	22.0	Mineral oil	78.0	263	284	286	295	272	305

*Contains approximately 3% molybdenum disulfide.

TABLE IV

EFFECT OF STORAGE ON BINARY GREASE MIXTURES

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING OF TEST			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
17	Al soap-Min.oil	18	Al soap-Min.oil	C	C	C	C	C	C	C	C	S8
17	Al soap-Min.oil	7	Ba soap-Min.oil	C	C	C	C	C	C	S12	S7	C
17	Al soap-Min.oil	8	Ba soap-Min.oil	C	C	C	C	C	C	C	C	C
18	Al soap-Min.oil	7	Ba soap-Min.oil	H8	H1	C	C	C	S2			
18	Al soap-Min.oil	8	Ba soap-Min.oil	C	C	C	C	C	C	C	C	S8
17	Al soap-Min.oil	13	Bent.-Min.oil	C	S32	S8	C	S76	S29	C	C	C
17	Al soap-Min.oil	14	Bent.-Min.oil	C	C	C	C	S37	S2			
18	Al soap-Min.oil	13	Bent.-Min.oil	C	S32	S5	H1	S30	C			
18	Al soap-Min.oil	14	Bent.-Min.oil	C	C	C	C	S21	C			
17	Al soap-Min.oil	5	Ca soap-Min.oil	C	C	C	C	C	C			
17	Al soap-Min.oil	6	Ca soap-Min.oil	C	C	C	C	C	C			
18	Al soap-Min.oil	5	Ca soap-Min.oil	C	C	C	C	C	C	C	C	S5
18	Al soap-Min.oil	6	Ca soap-Min.oil	C	C	C	C	C	C			
17	Al soap-Min.oil	21	Ca-Pb soap-Min.oil	C	S19	S10	C	S29	C			
18	Al soap-Min.oil	21	Ca-Pb soap-Min.oil	S5	S19	C	S25	S29	C			
17	Al soap-Min.oil	20	*Isocy.ami.-Min.oil	C	C	C	C	C	C			
18	Al soap-Min.oil	20	Isocy.ami.-Min.oil	C	C	C	C	C	S1			

*Isocyanate amine

C = Compatible H = Hardened S = Softened

TABLE IV (Cont.)

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING OF TEST			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
17	Al soap-Min.oil	9	Li soap-Diester	C	C	S2	C	C	S3			
17	Al soap-Min.oil	10	Li soap-Diester	C	C	C	C	C	C			
18	Al soap-Min.oil	9	Li soap-Diester	C	S9	S8	C	C	S5			
18	Al soap-Min.oil	10	Li soap-Diester	C	S12	S7	C	S18	S2			
17	Al soap-Min.oil	1	Li soap-Min.oil	C	C	C	C	C	C			
17	Al soap-Min.oil	2	Li soap-Min.oil	C	C	C	C	C	C			
18	Al soap-Min.oil	1	Li soap-Min.oil	C	C	C	C	C	C			
18	Al soap-Min.oil	2	Li soap-Min.oil	C	C	C	C	S1	C			
17	Al soap-Min.oil	11	Li soap-Polyglycol	C	C	C	C	C	C			
17	Al soap-Min.oil	12	Li soap-Polyglycol	C	C	C	C	C	C			
18	Al soap-Min.oil	11	Li soap-Polyglycol	C	C	C	C	C	C			
18	Al soap-Min.oil	12	Li soap-Polyglycol	C	C	C	C	C	S4			
17	Al soap-Min.oil	15	*Sil.Hyd.-Min.oil	C	S3	C	C	S7	C			
17	Al soap-Min.oil	16	Sil.Hyd.-Min.oil	C	S12	C	S9	S16	S1			
18	Al soap-Min.oil	15	Sil.Hyd.-Min.oil	C	S11	C	C	S27	S3			
18	Al soap-Min.oil	16	Sil.Hyd.-Min.oil	S28	S14	C	S35	S34	C			
17	Al soap-Min.oil	3	Na soap-Min.oil	H3	C	C	C	C	C			
17	Al soap-Min.oil	4	Na soap-Min.oil	C	C	C	C	C	S1			
18	Al soap-Min.oil	3	Na soap-Min.oil	C	C	C	C	S10	C			
18	Al soap-Min.oil	4	Na soap-Min.oil	C	C	C	S2	S4	C			
17	Al soap-Min.oil	19	** -Mineral oil	C	C	C	C	C	C			
18	Al soap-Min.oil	19	** -Mineral oil	C	C	C	C	C	S6			

*Silica, Hydrophobic
**Sodium N-Octadecyl Terephthalamate

TABLE IV (Cont.)

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING OF TEST			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
7	Ba soap-Min.oil	8	Ba soap-Min.oil	C	C	C	C	C	C	C	C	S2
7	Ba soap-Min.oil	17	Al soap-Min.oil	C	C	C	C	C	C	S8	C	C
7	Ba soap-Min.oil	18	Al soap-Min.oil	C	H1	H8	S2	C	C			
8	Ba soap-Min.oil	17	Al soap-Min.oil	C	C	C	C	C	C	C	C	C
8	Ba soap-Min.oil	18	Al soap-Min.oil	C	C	C	C	C	C	C	S7	S12
7	Ba soap-Min.oil	13	Bent.-Min.oil	C	C	C	S2	C	C			
7	Ba soap-Min.oil	14	Bent.-Min.oil	C	C	C	C	C	C			
8	Ba soap-Min.oil	13	Bent.-Min.oil	S31	S45	C	S5	C	C			
8	Ba soap-Min.oil	14	Bent.-Min.oil	C	C	C	S6	C	C			
7	Ba soap-Min.oil	5	Ca soap-Min.oil	C	C	C	C	C	C	C	C	S6
7	Ba soap-Min.oil	6	Ca soap-Min.oil	C	C	C	C	C	C			
8	Ba soap-Min.oil	5	Ca soap-Min.oil	C	C	C	C	C	C			
8	Ba soap-Min.oil	6	Ca soap-Min.oil	C	C	C	C	C	C	C	C	S8
7	Ba soap-Min.oil	21	Ca-Pb soap-Min.oil	C	C	C	S2	C	C			
8	Ba soap-Min.oil	21	Ca-Pb soap-Min.oil	S42	S6	C	S47	S12	C			
7	Ba soap-Min.oil	20	*Isocy.ami.-Min.oil	C	C	C	C	C	C	C	C	C
8	Ba soap-Min.oil	20	Isocy.ami.-Min.oil	C	S4	S4	C	C	S7			
7	Ba soap-Min.oil	9	Li soap-Diester	C	C	C	C	C	C			
7	Ba soap-Min.oil	10	Li soap-Diester	C	C	C	C	C	C			
8	Ba soap-Min.oil	9	Li soap-Diester	C	S11	C	C	S2	C			
8	Ba soap-Min.oil	10	Li soap-Diester	S9	S17	C	S10	S17	C			

*Isocyanate amine

TABLE IV (Cont.)

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING OF TEST			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
7	Ba soap-Min.oil	1	Li soap-Min.oil	C	C	C	H11	H11	C			
7	Ba soap-Min.oil	2	Li soap-Min.oil	H38	H74	H7	H32	H50	C			
8	Ba soap-Min.oil	1	Li soap-Min.oil	C	C	C	C	C	C	C	S11	S20
8	Ba soap-Min.oil	2	Li soap-Min.oil	C	C	C	C	C	C	S16	C	C
7	Ba soap-Min.oil	11	Li soap-Polyglycol	C	C	C	C	C	C			
7	Ba soap-Min.oil	12	Li soap-Polyglycol	C	C	C	C	C	C	C	C	S10
8	Ba soap-Min.oil	11	Li soap-Polyglycol	C	C	S9	C	C	C			
8	Ba soap-Min.oil	12	Li soap-Polyglycol	S10	S12	S12	C	C	S4			
7	Ba soap-Min.oil	15	*Sil.Hyd.-Min.oil	C	C	C	C	C	C			
7	Ba soap-Min.oil	16	Sil.Hyd.-Min.oil	C	C	C	C	S9	S9			
8	Ba soap-Min.oil	15	Sil.Hyd.-Min.oil	S16	S15	S7	S9	S5	S9			
8	Ba soap-Min.oil	16	Sil.Hyd.-Min.oil	S40	S44	S18	S46	S44	S19			
7	Ba soap-Min.oil	3	Sod.soap-Min.oil	C	C	C	C	C	C	C	C	S2
7	Ba soap-Min.oil	4	Sod.soap-Min.oil	C	C	C	C	C	C			
8	Ba soap-Min.oil	3	Sod.soap-Min.oil	C	C	C	C	C	C			
8	Ba soap-Min.oil	4	Sod.soap-Min.oil	C	C	C	S-6	C	C			
7	Ba soap-Min.oil	19	** -Mineral oil	C	H12	C	C	H12	C			
8	Ba soap-Min.oil	19	** -Mineral oil	S15	S14	S10	S32	S10	S4			
13	Bent.-Min.oil	14	Bent.-Min.oil	C	C	H13	C	H36	H51	H76	H102	H99

*Silica, Hydrophobic
**Sodium N-Octadecyl Terephthalamate

TABLE IV (Cont.)

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING OF TEST			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
13	Bent.-Min.oil	17	Al soap-Min.oil	S8	S32	C	S29	S76	C	C	C	C
13	Bent.-Min.oil	18	Al soap-Min.oil	S5	S32	C	C	S30	H1			
14	Bent.-Min.oil	17	Al soap-Min.oil	C	C	C	S2	S37	C			
14	Bent.-Min.oil	18	Al soap-Min.oil	C	C	C	C	S21	C			
13	Bent.-Min.oil	7	Ba soap-Min.oil	C	C	C	C	C	S2			
13	Bent.-Min.oil	8	Ba soap-Min.oil	C	S45	S31	C	C	S5			
14	Bent.-Min.oil	7	Ba soap-Min.oil	C	C	C	C	C	C			
14	Bent.-Min.oil	8	Ba soap-Min.oil	C	C	C	C	C	S6			
13	Bent.-Min.oil	5	Ca soap-Min.oil	S1	S24	S35	C	C	S9			
13	Bent.-Min.oil	6	Ca soap-Min.oil	C	S5	S75	C	C	S35			
14	Bent.-Min.oil	5	Ca soap-Min.oil	C	C	C	C	C	S2			
14	Bent.-Min.oil	6	Ca soap-Min.oil	C	C	C	C	C	S23			
13	Bent.-Min.oil	21	Ca-Pb soap-Min.oil	S31	S60	S46	S23	S35	S34			
14	Bent.-Min.oil	21	Ca-Pb soap-Min.oil	C	C	C	S8	S39	S28			
13	Bent.-Min.oil	20	*Isocy.ami.-Min.oil	C	S46	C	C	S5	C			
14	Bent.-Min.oil	20	Isocy.ami.-Min.oil	C	C	C	C	C	C			
13	Bent.-Min.oil	9	Li soap-Diester	S12	S63	S42	C	S23	S22			
13	Bent.-Min.oil	10	Li soap-Diester	S42	S77	S58	S10	S45	S15			
14	Bent.-Min.oil	9	Li soap-Diester	C	C	C	C	S9	S16			
14	Bent.-Min.oil	10	Li soap-Diester	C	C	C	C	S2	S16			

*Isocyanate amine

TABLE IV (Cont.)

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING STORAGE			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
13	Bent.-Min.oil	1	Li soap-Min.oil	C	C	C	C	C	C			
13	Bent.-Min.oil	2	Li soap-Min.oil	S13	S25	C	C	S24	C			
14	Bent.-Min.oil	1	Li soap-Min.oil	C	C	C	C	C	C			
14	Bent.-Min.oil	2	Li soap-Min.oil	C	C	C	C	S14	S9			
13	Bent.-Min.oil	11	Li soap-Polyglycol	C	S29	S87	C	S11	S75			
13	Bent.-Min.oil	12	Li soap-Polyglycol	C	S62	S98	C	S37	S52	C	C	C
14	Bent.-Min.oil	11	Li soap-Polyglycol	C	C	C	C	C	S36			
14	Bent.-Min.oil	12	Li soap-Polyglycol	C	C	C	C	C	S23			
13	Bent.-Min.oil	15	*Sil.Hyd.-Min.oil	S20	S47	C	C	S22	C			
13	Bent.-Min.oil	16	Sil.Hyd.-Min.oil	C	S30	C	C	C	C			
14	Bent.-Min.oil	15	Sil.Hyd.-Min.oil	C	C	C	C	S25	C			
14	Bent.-Min.oil	16	Sil.Hyd.-Min.oil	C	C	C	C	C	C			
13	Bent.-Min.oil	3	Sod.soap-Min.oil	C	C	H3	C	C	C			
13	Bent.-Min.oil	4	Sod.soap-Min.oil	C	C	C	S2	S18	S20			
14	Bent.-Min.oil	3	Sod.soap-Min.oil	C	H20	C	C	C	C			
14	Bent.-Min.oil	4	Sod.soap-Min.oil	C	C	C	C	S6	S11			
13	Bent.-Min.oil	19	** -Mineral oil	S23	S42	C	C	S5	C			
14	Bent.-Min.oil	19	** -Mineral oil	C	C	C	C	C	C			
5	Ca soap-Min.oil	6	Ca soap-Min.oil	C	C	C	C	C	C	C	S4	S10

*Silica, Hydrophobic
**Sodium N-Octadecyl Terephthalamate

TABLE IV (Cont.)

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING STORAGE			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
5	Ca soap-Min.oil	17	Al soap-Min.oil	C	C	C	C	C	C			
5	Ca soap-Min.oil	18	Al soap-Min.oil	C	C	C	C	C	C	S5	C	C
6	Ca soap-Min.oil	17	Al soap-Min.oil	C	C	C	C	C	C			
6	Ca soap-Min.oil	18	Al soap-Min.oil	C	C	C	C	C	C			
5	Ca soap-Min.oil	7	Ba soap-Min.oil	C	C	C	C	C	C	S6	C	C
5	Ca soap-Min.oil	8	Ba soap-Min.oil	C	C	C	C	C	C			
6	Ca soap-Min.oil	7	Ba soap-Min.oil	C	C	C	C	C	C			
6	Ca soap-Min.oil	8	Ba soap-Min.oil	C	C	C	C	C	C	S8	C	C
5	Ca soap-Min.oil	13	Bent.-Min.oil	S35	S24	S1	S9	C	C			
5	Ca soap-Min.oil	14	Bent.-Min.oil	C	C	C	S2	C	C			
6	Ca soap-Min.oil	13	Bent.-Min.oil	S75	S5	C	S35	C	C			
6	Ca soap-Min.oil	14	Bent.-Min.oil	C	C	C	S23	C	C			
5	Ca soap-Min.oil	21	Ca-Pb soap-Min.oil	S38	H14	C	S18	H11	C			
6	Ca soap-Min.oil	21	Ca-Pb soap-Min.oil	S20	H10	H3	C	H31	H10			
5	Ca soap-Min.oil	20	*Isocy.ami.-Min.oil	C	S1	C	C	S8	C			
6	Ca soap-Min.oil	20	Isocy.ami.-Min.oil	C	S8	C	C	S13	C			
5	Ca soap-Min.oil	9	Li soap-Diester	C	C	C	C	C	C			
5	Ca soap-Min.oil	10	Li soap-Diester	S20	S16	S1	S42	S35	C			
6	Ca soap-Min.oil	9	Li soap-Diester	C	C	C	C	C	C	S8	C	C
6	Ca soap-Min.oil	10	Li soap-Diester	S15	S6	C	S39	C	C			

*Isocyanate amine

TABLE IV (Cont.)

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING STORAGE			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
5	Ca soap-Min.oil	1	Li soap-Min.oil	C	S2	C	C	S10	C			
5	Ca soap-Min.oil	2	Li soap-Min.oil	C	C	C	C	C	C			
6	Ca soap-Min.oil	1	Li soap-Min.oil	C	C	C	S3	C	C			
6	Ca soap-Min.oil	2	Li soap-Min.oil	C	C	C	C	C	C			
5	Ca soap-Min.oil	11	Li soap-Polyglycol	C	C	C	C	C	C			
5	Ca soap-Min.oil	12	Li soap-Polyglycol	C	C	C	S4	C	C			
6	Ca soap-Min.oil	11	Li soap-Polyglycol	C	C	C	C	C	C			
6	Ca soap-Min.oil	12	Li soap-Polyglycol	C	C	C	S6	C	C			
5	Ca soap-Min.oil	15	*Sil.Hyd.-Min.oil	C	C	C	C	C	C			
5	Ca soap-Min.oil	16	Sil.Hyd.-Min.oil	S22	C	C	S16	S12	C			
6	Ca soap-Min.oil	15	Sil.Hyd.-Min.oil	C	C	C	C	C	C			
6	Ca soap-Min.oil	16	Sil.Hyd.-Min.oil	S26	S30	C	S30	S30	C			
5	Ca soap-Min.oil	3	Sod.soap-Min.oil	C	C	C	C	C	C			
5	Ca soap-Min.oil	4	Sod.soap-Min.oil	C	C	C	S6	C	C			
6	Ca soap-Min.oil	3	Sod.soap-Min.oil	C	C	C	C	C	C			
6	Ca soap-Min.oil	4	Sod.soap-Min.oil	C	C	C	C	C	C			
5	Ca soap-Min.oil	19	** -Mineral oil	C	C	C	S1	C	C	S2	C	C
6	Ca soap-Min.oil	19	** -Mineral oil	C	C	C	S2	C	C			
21	Ca-Pb soap-Min.oil	17	Al soap-Min.oil	S10	S19	C	C	S29	C			
21	Ca-Pb soap-Min.oil	18	Al soap-Min.oil	C	S19	S5	C	S29	S25			

*Silica Hydrophobic
**Sodium N-Octadecyl Terephthalamate

TABLE IV (Cont.)

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING STORAGE			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
21	Ca-Pb soap-Min.oil	7	Ba soap-Min.oil	C	C	C	C	C	S2			
21	Ca-Pb soap-Min.oil	8	Ba soap-Min.oil	C	S6	S42	C	S12	S47			
21	Ca-Pb soap-Min.oil	13	Bent.-Min.oil	S46	S60	S31	S34	S35	S23			
21	Ca-Pb soap-Min.oil	14	Bent.-Min.oil	C	C	C	S28	S39	S8			
21	Ca-Pb soap-Min.oil	5	Ca soap-Min.oil	C	H14	S38	C	H11	S18			
21	Ca-Pb soap-Min.oil	6	Ca soap-Min.oil	H3	H10	S20	H10	H31	C			
21	Ca-Pb soap-Min.oil	20	*Isocy.ami.-Min.oil	C	S9	S44	C	C	S49			
21	Ca-Pb soap-Min.oil	9	Li soap-Diester	C	S18	S58	H4	C	S47			
21	Ca-Pb soap-Min.oil	10	Li soap-Diester	C	S27	S70	S9	C	H8			
21	Ca-Pb soap-Min.oil	1	Li soap-Min.oil	C	C	C	C	C	S15			
21	Ca-Pb soap-Min.oil	2	Li soap-Min.oil	C	C	C	C	C	C			
21	Ca-Pb soap-Min.oil	11	Li soap-Polyglycol	H8	H18	H2	C	H23	H5			
21	Ca-Pb soap-Min.oil	12	Li soap-Polyglycol	H19	H40	H43	C	H38	H13			
21	Ca-Pb soap-Min.oil	15	**Sil.Hyd.-Min.oil	C	S25	C	C	S34	S48			
21	Ca-Pb soap-Min.oil	16	Sil.Hyd.-Min.oil	S40	S29	S20	S32	S91	S75			
21	Ca-Pb soap-Min.oil	3	Sod.soap-Min.oil	C	C	C	C	H34	S13			
21	Ca-Pb soap-Min.oil	4	Sod.soap-Min.oil	C	C	C	S5	S14	C			

*Isocyanate amine
**Silica Hydrophobic

TABLE IV (Cont.)

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING STORAGE			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
21	Ca-Pb soap-Min.oil	19	* -Mineral oil	H9	C	S17	C	H22	H45			
20	**Isocy.ami.-Min.oil	17	Al soap-Min.oil	C	C	C	C	C	C			
20	Isocy.ami.-Min.oil	18	Al soap-Min.oil	C	C	C	S1	C	C			
20	Isocy.ami.-Min.oil	7	Ba soap-Min.oil	C	C	C	C	C	C	C	C	C
20	Isocy.ami.-Min.oil	8	Ba soap-Min.oil	S4	S4	C	S7	C	C			
20	Isocy.ami.-Min.oil	13	Bent.-Min.oil	C	S46	C	C	S5	C			
20	Isocy.ami.-Min.oil	14	Bent.-Min.oil	C	C	C	C	C	C			
20	Isocy.ami.-Min.oil	5	Ca soap-Min.oil	C	S1	C	C	S8	C			
20	Isocy.ami.-Min.oil	6	Ca soap-Min.oil	C	S8	C	C	S13	C			
20	Isocy.ami.-Min.oil	21	Ca-Pb soap-Min.oil	S44	S9	C	S49	C	C			
20	Isocy.ami.-Min.oil	9	Li soap-Diester	C	C	C	C	C	C			
20	Isocy.ami.-Min.oil	10	Li soap-Diester	S15	S24	C	S3	S14	C			
20	Isocy.ami.-Min.oil	1	Li soap-Min.oil	C	C	C	S3	S5	C			
20	Isocy.ami.-Min.oil	2	Li soap-Min.oil	C	C	C	C	C	C			
20	Isocy.ami.-Min.oil	11	Li soap-Polyglycol	S13	S36	S37	S1	S27	S15	S16	S53	S34
20	Isocy.ami.-Min.oil	12	Li soap-Polyglycol	S29	S65	S20	S4	S140	S5			
20	Isocy.ami.-Min.oil	15	***Sil.Hyd.-Min.oil	S56	S54	S33	S54	S39	S29	S38	S52	S42
20	Isocy.ami.-Min.oil	16	Sil.Hyd.-Min.oil	S72	S53	S12	S90	S53	S4	S67	S35	C

*Sodium N-Octadecyl Terephthalamate

**Isocyanate amine

***Silica Hydrophobic

TABLE IV (Cont.)

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING STORAGE			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
20	*Isocy.ami.-Min.oil	3	Sod.soap-Min.oil	C	C	C	C	C	C			
20	Isocy.ami.-Min.oil	4	Sod.soap-Min.oil	C	C	C	C	C	C			
20	Isocy.ami.-Min.oil	19	** -Mineral oil	S9	C	C	S11	C	C			
9	Li soap-Diester	10	Li soap-Diester	C	C	C	C	S18	S1			
9	Li soap-Diester	17	Al soap-Min.oil	S2	C	C	S3	C	C			
9	Li soap-Diester	18	Al soap-Min.oil	S8	S9	C	S5	C	C			
10	Li soap-Diester	17	Al soap-Min.oil	C	C	C	C	C	C			
10	Li soap-Diester	18	Al soap-Min.oil	S7	S12	C	S2	S18	C			
9	Li soap-Diester	7	Ba soap-Min.oil	C	C	C	C	C	C			
9	Li soap-Diester	8	Ba soap-Min.oil	C	S11	C	C	S2	C			
10	Li soap-Diester	7	Ba soap-Min.oil	C	C	C	C	C	C			
10	Li soap-Diester	8	Ba soap-Min.oil	C	S17	S9	C	S17	S10			
9	Li soap-Diester	13	Bent.-Min.oil	S42	S63	S12	S22	S23	C			
9	Li soap-Diester	14	Bent.-Min.oil	C	C	C	S16	S9	C			
10	Li soap-Diester	13	Bent.-Min.oil	S58	S77	S42	S15	S45	S10			
10	Li soap-Diester	14	Bent.-Min.oil	C	C	C	S16	S2	C			
9	Li soap-Diester	5	Ca soap-Min.oil	C	C	C	C	C	C			
9	Li soap-Diester	6	Ca soap-Min.oil	C	C	C	C	C	C	C	C	S8
10	Li soap-Diester	5	Ca soap-Min.oil	S1	S16	S20	C	S35	S42			
10	Li soap-Diester	6	Ca soap-Min.oil	C	S6	S15	C	C	S39			

*Isocyanate amine

**Sodium N-Octadecyl Terephthalamate

TABLE IV (Cont.)

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING STORAGE			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
9	Li soap-Diester	21	Ca-Pb soap-Min.oil	S58	S18	C	S47	C	H4			
10	Li soap-Diester	21	Ca-Pb soap-Min.oil	S70	S27	C	H8	C	S9			
9	Li soap-Diester	20	*Isocy.ami.-Min.oil	C	C	C	C	C	C			
10	Li soap-Diester	20	Isocy.ami.-Min.oil	C	S24	S15	C	S14	S3			
9	Li soap-Diester	1	Li soap-Min.oil	C	C	C	C	C	S3			
9	Li soap-Diester	2	Li soap-Min.oil	C	C	C	C	C	C	S21	S16	C
10	Li soap-Diester	1	Li soap-Min.oil	C	S11	C	C	S7	C			
10	Li soap-Diester	2	Li soap-Min.oil	C	C	C	C	S23	S2			
9	Li soap-Diester	11	Li soap-Polyglycol	C	C	C	C	C	S1			
9	Li soap-Diester	12	Li soap-Polyglycol	C	C	C	C	S7	C			
10	Li soap-Diester	11	Li soap-Polyglycol	C	S18	S15	C	S16	C			
10	Li soap-Diester	12	Li soap-Polyglycol	C	S18	S14	C	S3	C			
9	Li soap-Diester	15	**Sil.Hyd.-Min.oil	S2	C	C	S11	S2	C			
9	Li soap-Diester	16	Sil.Hyd.-Min.oil	C	S19	S2	S12	S24	S5			
10	Li soap-Diester	15	Sil.Hyd.-Min.oil	S12	S34	S3	S13	S21	S2	S11	S25	S15
10	Li soap-Diester	16	Sil.Hyd.-Min.oil	C	S36	S5	C	S22	S8			
9	Li soap-Diester	3	Sod.soap-Min.oil	C	C	C	S7	S5	C			
9	Li soap-Diester	4	Sod.soap-Min.oil	C	C	C	S3	C	C			
10	Li soap-Diester	3	Sod.soap-Min.oil	C	C	H2	S6	S6	C			
10	Li soap-Diester	4	Sod.soap-Min.oil	C	C	C	S3	S13	C			

*Isocyanate amine
**Silica Hydrophobic

TABLE IV (Cont.)

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING STORAGE			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
9	Li soap-Diester	19	* -Mineral oil	C	S3	C	C	C	C			
10	Li soap-Diester	19	* -Mineral oil	S17	S17	S17	S8	S13	S5			
1	Li soap-Min.oil	2	Li soap-Min.oil	C	C	C	C	C	C	S11	S1	C
1	Li soap-Min.oil	17	Al soap-Min.oil	C	C	C	C	C	C			
1	Li soap-Min.oil	18	Al soap-Min.oil	C	C	C	C	C	C			
2	Li soap-Min.oil	17	Al soap-Min.oil	C	C	C	C	C	C			
2	Li soap-Min.oil	18	Al soap-Min.oil	C	C	C	C	S1	C			
1	Li soap-Min.oil	7	Ba soap-Min.oil	C	C	C	C	H11	H11			
1	Li soap-Min.oil	8	Ba soap-Min.oil	C	C	C	C	C	C	S20	S11	C
2	Li soap-Min.oil	7	Ba soap-Min.oil	H7	H74	H38	C	H50	H32			
2	Li soap-Min.oil	8	Ba soap-Min.oil	C	C	C	C	C	C	C	C	S16
1	Li soap-Min.oil	13	Bent.-Min.oil	C	C	C	C	C	C			
1	Li soap-Min.oil	14	Bent.-Min.oil	C	C	C	C	C	C			
2	Li soap-Min.oil	13	Bent.-Min.oil	C	S25	S13	C	S24	C			
2	Li soap-Min.oil	14	Bent.-Min.oil	C	C	C	S9	S14	C			
1	Li soap-Min.oil	5	Ca soap-Min.oil	C	S2	C	C	S10	C			
1	Li soap-Min.oil	6	Ca soap-Min.oil	C	C	C	C	C	S3			
2	Li soap-Min.oil	5	Ca soap-Min.oil	C	C	C	C	C	C			
2	Li soap-Min.oil	6	Ca soap-Min.oil	C	C	C	C	C	C			
1	Li soap-Min.oil	21	Ca-Pb soap-Min.oil	C	C	C	S15	C	C			
2	Li soap-Min.oil	21	Ca-Pb soap-Min.oil	C	C	C	C	C	C			

*Sodium N-Octadecyl Terephthalamate

TABLE IV (Cont.)

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING STORAGE			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
1	Li soap-Min.oil	20	*Isocy.ami.-Min.oil	C	C	C	C	S5	S3			
2	Li soap-Min.oil	20	Isocy.ami.-Min.oil	C	C	C	C	C	C			
1	Li soap-Min.oil	9	Li soap-Diester	C	C	C	S3	C	C			
1	Li soap-Min.oil	10	Li soap-Diester	C	S11	C	C	S7	C			
2	Li soap-Min.oil	9	Li soap-Diester	C	C	C	C	C	C	C	S16	S21
2	Li soap-Min.oil	10	Li soap-Diester	C	C	C	S2	S23	C			
1	Li soap-Min.oil	11	Li soap-Polyglycol	C	C	C	C	C	S2			
1	Li soap-Min.oil	12	Li soap-Polyglycol	C	C	C	C	C	C			
2	Li soap-Min.oil	11	Li soap-Polyglycol	C	C	C	C	C	C	C	C	S17
2	Li soap-Min.oil	12	Li soap-Polyglycol	C	C	C	C	S47	C			
1	Li soap-Min.oil	15	**Sil.Hyd.-Min.oil	C	C	C	C	S3	S5			
1	Li soap-Min.oil	16	Sil.Hyd.-Min.oil	C	C	C	C	C	C	C	C	C
2	Li soap-Min.oil	15	Sil.Hyd.-Min.oil	C	C	C	C	C	C			
2	Li soap-Min.oil	16	Sil.Hyd.-Min.oil	C	S15	C	S66	S29	S1			
1	Li soap-Min.oil	3	Sod. soap-Min.oil	C	C	H9	C	C	H4	S8	C	C
1	Li soap-Min.oil	4	Sod. soap-Min.oil	C	C	C	S8	C	C			
2	Li soap-Min.oil	3	Sod. soap-Min.oil	C	C	C	C	C	C			
2	Li soap-Min.oil	4	Sod. soap-Min.oil	C	H4	C	S11	C	C			
1	Li soap-Min.oil	19	*** -Mineral oil	S7	C	C	S13	C	C			
2	Li soap-Min.oil	19	*** -Mineral oil	C	C	C	C	C	C			

*Isocyanate amine
**Silica Hydrophobic
***Sodium N-Octadecyl Terephthalamate

TABLE IV (Cont.)

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING STORAGE			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
11	Li soap-Polyglycol	12	Li soap-Polyglycol	S9	C	C	C	C	C			
11	Li soap-Polyglycol	17	Al soap-Min.oil	C	C	C	C	C	C			
11	Li soap-Polyglycol	18	Al soap-Min.oil	C	C	C	C	C	C			
12	Li soap-Polyglycol	17	Al soap-Min.oil	C	C	C	C	C	C			
12	Li soap-Polyglycol	18	Al soap-Min.oil	C	C	C	S4	C	C			
11	Li soap-Polyglycol	7	Ba soap-Min.oil	C	C	C	C	C	C			
11	Li soap-Polyglycol	8	Ba soap-Min.oil	S9	C	C	C	C	C			
12	Li soap-Polyglycol	7	Ba soap-Min.oil	C	C	C	C	C	C			
12	Li soap-Polyglycol	8	Ba soap-Min.oil	S12	S12	S10	S4	C	C			
11	Li soap-Polyglycol	13	Bent.-Min.oil	S87	S29	C	S75	S11	C			
11	Li soap-Polyglycol	14	Bent.-Min.oil	C	C	C	S36	C	C			
12	Li soap-Polyglycol	13	Bent.-Min.oil	S98	S62	C	S52	S37	C	C	C	C
12	Li soap-Polyglycol	14	Bent.-Min.oil	C	C	C	S23	C	C			
11	Li soap-Polyglycol	5	Ca soap-Min.oil	C	C	C	C	C	C			
11	Li soap-Polyglycol	6	Ca soap-Min.oil	C	C	C	C	C	C			
12	Li soap-Polyglycol	5	Ca soap-Min.oil	C	C	C	C	C	S4			
12	Li soap-Polyglycol	6	Ca soap-Min.oil	C	C	C	C	C	S6			
11	Li soap-Polyglycol	21	Ca-Pb soap-Min.oil	H2	H18	H8	H5	H23	C			
12	Li soap-Polyglycol	21	Ca-Pb soap-Min.oil	H43	H40	H19	H13	H38	C			
11	Li soap-Polyglycol	20	*Isocy.ami.-Min.oil	S37	S36	S13	S15	S27	S1			
12	Li soap-Polyglycol	20	Isocy.ami.-Min.oil	S20	S65	S29	S5	S140	S4			

*Isocyanate amine

TABLE IV (Cont.)

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING STORAGE			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
11	Li soap-Polyglycol	9	Li soap-Diester	C	C	C	S1	C	C			
11	Li soap-Polyglycol	10	Li soap-Diester	S15	S18	C	C	S16	C			
12	Li soap-Polyglycol	9	Li soap-Diester	C	C	C	C	S7	C			
12	Li soap-Polyglycol	10	Li soap-Diester	S14	S18	C	C	S3	C			
11	Li soap-Polyglycol	1	Li soap-Min.oil	C	C	C	S2	C	C			
11	Li soap-Polyglycol	2	Li soap-Min.oil	C	C	C	C	C	C	S17	C	C
12	Li soap-Polyglycol	1	Li soap-Min.oil	C	C	C	C	C	C			
12	Li soap-Polyglycol	2	Li soap-Min.oil	C	C	C	C	S47	C			
11	Li soap-Polyglycol	15	*Sil.Hyd.-Min.oil	S30	S33	S12	S27	S27	S6			
11	Li soap-Polyglycol	16	Sil.Hyd.-Min.oil	S53	S53	S22	S34	S63	S11			
12	Li soap-Polyglycol	15	Sil.Hyd.-Min.oil	S32	S44	S11	S17	S65	S6	S13	S63	S22
12	Li soap-Polyglycol	16	Sil.Hyd.-Min.oil	S22	S37	S17	S24	S40	S8			
11	Li soap-Polyglycol	3	Sod.soap-Min.oil	C	C	C	C	C	C	S7	C	C
11	Li soap-Polyglycol	4	Sod.soap-Min.oil	C	C	C	C	C	C			
12	Li soap-Polyglycol	3	Sod.soap-Min.oil	C	C	C	C	C	C			
12	Li soap-Polyglycol	4	Sod.soap-Min.oil	C	C	C	C	S1	C			
11	Li soap-Polyglycol	19	** -Mineral oil	S11	S68	C	S7	C	C			
12	Li soap-Polyglycol	19	** -Mineral oil	S18	S35	C	S10	S133	C			
15	Sil.Hyd.-Min.oil	16	Sil.Hyd.-Min.oil	S32	S93	S48	S40	S88	S44			

*Silica Hydrophobic
**Sodium N-Octadecyl Terephthalamate

TABLE IV (Cont.)

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING STORAGE			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
15	*Sil.Hyd.-Min.oil	17	Al soap-Min.oil	C	S3	C	C	S7	C			
15	Sil.Hyd.-Min.oil	18	Al soap-Min.oil	C	S11	C	S3	S27	C			
16	Sil.Hyd.-Min.oil	17	Al soap-Min.oil	C	S12	C	S1	S16	S9			
16	Sil.Hyd.-Min.oil	18	Al soap-Min.oil	C	S14	S28	C	S34	S35			
15	Sil.Hyd.-Min.oil	7	Ba soap-Min.oil	C	C	C	C	C	C			
15	Sil.Hyd.-Min.oil	8	Ba soap-Min.oil	S7	S15	S16	S9	S5	S9			
16	Sil.Hyd.-Min.oil	7	Ba soap-Min.oil	C	C	C	S9	S9	C			
16	Sil.Hyd.-Min.oil	8	Ba soap-Min.oil	S18	S44	S40	S19	S44	S46			
15	Sil.Hyd.-Min.oil	13	Bent.-Min.oil	C	S47	S20	C	S22	C			
15	Sil.Hyd.-Min.oil	14	Bent.-Min.oil	C	C	C	C	S25	C			
16	Sil.Hyd.-Min.oil	13	Bent.-Min.oil	C	S30	C	C	C	C			
16	Sil.Hyd.-Min.oil	14	Bent.-Min.oil	C	C	C	C	C	C			
15	Sil.Hyd.-Min.oil	5	Ca soap-Min.oil	C	C	C	C	C	C			
15	Sil.Hyd.-Min.oil	6	Ca soap-Min.oil	C	C	C	C	C	C			
16	Sil.Hyd.-Min.oil	5	Ca soap-Min.oil	C	C	S22	C	S12	S16			
16	Sil.Hyd.-Min.oil	6	Ca soap-Min.oil	C	S30	S26	C	S30	S30			
15	Sil.Hyd.-Min.oil	21	Ca-Pb soap-Min.oil	C	S25	C	S48	S34	C			
16	Sil.Hyd.-Min.oil	21	Ca-Pb soap-Min.oil	S20	S29	S40	S75	S91	S32			
15	Sil.Hyd.-Min.oil	20	**Isocy.ami.-Min.oil	S33	S54	S56	S29	S39	S54	S42	S52	S38
16	Sil.Hyd.-Min.oil	20	Isocy.ami.-Min.oil	S12	S53	S72	S4	S53	S90	C	S35	S67

*Silica Hydrophobic
**Isocyanate amine

TABLE IV (Cont.)

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING STORAGE			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
15	*Sil.Hyd.-Min.oil	9	Li soap-Diester	C	C	S2	C	S2	S11			
15	Sil.Hyd.-Min.oil	10	Li soap-Diester	S3	S34	S12	S2	S21	S13	S15	S25	S11
16	Sil.Hyd.-Min.oil	9	Li soap-Diester	S2	S19	C	S5	S24	S12			
16	Sil.Hyd.-Min.oil	10	Li soap-Diester	S5	S36	C	S8	S22	C			
15	Sil.Hyd.-Min.oil	1	Li soap-Min.oil	C	C	C	S5	S3	C			
15	Sil.Hyd.-Min.oil	2	Li soap-Min.oil	C	C	C	C	C	C			
16	Sil.Hyd.-Min.oil	1	Li soap-Min.oil	C	C	C	C	C	C			
16	Sil.Hyd.-Min.oil	2	Li soap-Min.oil	C	S15	C	S1	S29	S66			
15	Sil.Hyd.-Min.oil	11	Li soap-Min.oil	S12	S33	S30	S6	S27	S27			
15	Sil.Hyd.-Min.oil	12	Li soap-Min.oil	S11	S44	S32	S6	S65	S17	S22	S63	S13
16	Sil.Hyd.-Min.oil	11	Li soap-Min.oil	S22	S53	S53	S11	S63	S34			
16	Sil.Hyd.-Min.oil	12	Li soap-Min.oil	S17	S37	S22	S8	S40	S24			
15	Sil.Hyd.-Min.oil	3	Sod.soap-Min.oil	C	C	C	C	C	C			
15	Sil.Hyd.-Min.oil	4	Sod.soap-Min.oil	C	C	C	S1	C	C			
16	Sil.Hyd.-Min.oil	3	Sod.soap-Min.oil	C	S2	C	C	S22	C			
16	Sil.Hyd.-Min.oil	4	Sod.soap-Min.oil	C	C	C	S3	S5	C			
15	Sil.Hyd.-Min.oil	19	** -Mineral oil	S12	S15	S2	S1	S10	S7			
16	Sil.Hyd.-Min.oil	19	** -Mineral oil	S18	S37	S40	S14	S28	S31			
3	Sod.soap-Min.oil	4	Sod.soap-Min.oil	C	C	C	S13	C	C			

*Silica Hydrophobic
**Sodium N-Octadecyl Terephthalamate

TABLE IV (Cont.)

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING STORAGE			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
3	Sod.soap-Min.oil	17	Al soap-Min.oil	C	C	H3	C	C	C			
3	Sod.soap-Min.oil	18	Al soap-Min.oil	C	C	C	C	S10	C			
4	Sod.soap-Min.oil	17	Al soap-Min.oil	C	C	C	S1	C	C			
4	Sod.soap-Min.oil	18	Al soap-Min.oil	C	C	C	C	S4	S2			
3	Sod.soap-Min.oil	7	Ba soap-Min.oil	C	C	C	C	C	C	S2	C	C
3	Sod.soap-Min.oil	8	Ba soap-Min.oil	C	C	C	C	C	C			
4	Sod.soap-Min.oil	7	Ba soap-Min.oil	C	C	C	C	C	C			
4	Sod.soap-Min.oil	8	Ba soap-Min.oil	C	C	C	C	C	S6			
3	Sod.soap-Min.oil	13	Bent.-Min.oil	H3	C	C	C	C	C			
3	Sod.soap-Min.oil	14	Bent.-Min.oil	C	H20	C	C	C	C			
4	Sod.soap-Min.oil	13	Bent.-Min.oil	C	C	C	S20	S18	S2			
4	Sod.soap-Min.oil	14	Bent.-Min.oil	C	C	C	S11	S6	C			
3	Sod.soap-Min.oil	5	Ca soap-Min.oil	C	C	C	C	C	C			
3	Sod.soap-Min.oil	6	Ca soap-Min.oil	C	C	C	C	C	C			
4	Sod.soap-Min.oil	5	Ca soap-Min.oil	C	C	C	C	C	S6			
4	Sod.soap-Min.oil	6	Ca soap-Min.oil	C	C	C	C	C	C			
3	Sod.soap-Min.oil	21	Ca-Pb soap-Min.oil	C	C	C	S13	H34	C			
4	Sod.soap-Min.oil	21	Ca-Pb soap-Min.oil	C	C	C	C	S14	S5			
3	Sod.soap-Min.oil	20	*Isocy.ami.-Min.oil	C	C	C	C	C	C			
4	Sod.soap-Min.oil	20	Isocy.ami.-Min.oil	C	C	C	C	C	C			

*Isocyanate amine

TABLE IV (Cont.)

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING STORAGE			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
3	Sod.soap-Min.oil	9	Li soap-Diester	C	C	C	C	S5	S7			
3	Sod.soap-Min.oil	10	Li soap-Diester	H2	C	C	C	S6	S6			
4	Sod.soap-Min.oil	9	Li soap-Diester	C	C	C	C	C	S3			
4	Sod.soap-Min.oil	10	Li soap-Diester	C	C	C	C	S13	S3			
3	Sod.soap-Min.oil	1	Li soap-Min.oil	H9	C	C	H4	C	C	C	C	S8
3	Sod.soap-Min.oil	2	Li soap-Min.oil	C	C	C	C	C	C			
4	Sod.soap-Min.oil	1	Li soap-Min.oil	C	C	C	C	C	S8			
4	Sod.soap-Min.oil	2	Li soap-Min.oil	C	H4	C	C	C	S11			
3	Sod.soap-Min.oil	11	Li soap-Polyglycol	C	C	C	C	C	C	C	C	S7
3	Sod.soap-Min.oil	12	Li soap-Polyglycol	C	C	C	C	C	C			
4	Sod.soap-Min.oil	11	Li soap-Polyglycol	C	C	C	C	C	C			
4	Sod.soap-Min.oil	12	Li soap-Polyglycol	C	C	C	C	S1	C			
3	Sod.soap-Min.oil	15	*Sil.Hyd.-Min.oil	C	C	C	C	C	C			
3	Sod.soap-Min.oil	16	Sil.Hyd.-Min.oil	C	S2	C	C	S22	C			
4	Sod.soap-Min.oil	15	Sil.Hyd.-Min.oil	C	C	C	C	C	S1			
4	Sod.soap-Min.oil	16	Sil.Hyd.-Min.oil	C	C	C	C	S5	S3			
3	Sod.soap-Min.oil	19	** -Mineral oil	C	C	C	C	C	C			
4	Sod.soap-Min.oil	19	** -Mineral oil	C	C	C	C	C	C			
19	** -Mineral oil	17	Al soap-Min.oil	C	C	C	C	C	C			
19	** -Mineral oil	18	Al soap-Min.oil	C	C	C	S6	C	C			

*Silica Hydrophobic
**Sodium N-Octadecyl Terephthalamate

TABLE IV (Cont.)

FIRST		SECOND		COMPATIBILITY, % FIRST COMPONENT								
				BEGINNING STORAGE			18 MONTHS STORAGE			36 MONTHS STORAGE		
GREASE NO.	COMPONENT	GREASE NO.	COMPONENT	10	50	90	10	50	90	10	50	90
19	* -Mineral oil	7	Ba soap-Min.oil	C	H12	C	C	H12	C			
19	* -Mineral oil	8	Ba soap-Min.oil	S10	S14	S15	S4	S10	S32			
19	* -Mineral oil	13	Bent.-Min.oil	C	S42	S23	C	S5	C			
19	* -Mineral oil	14	Bent.-Min.oil	C	C	C	C	C	C			
19	* -Mineral oil	5	Ca soap-Min.oil	C	C	C	C	C	S1	C	C	S2
19	* -Mineral oil	6	Ca soap-Min.oil	C	C	C	C	C	S2			
19	* -Mineral oil	21	Ca-Pb soap-Min.oil	S17	C	H9	H45	H22	C			
19	* -Mineral oil	20	**Isocy.ami.-Min.oil	C	C	S9	C	C	S11			
19	* -Mineral oil	9	Li soap-Diester	C	S3	C	C	C	C			
19	* -Mineral oil	10	Li soap-Diester	S17	S17	S17	S5	S13	S8			
19	* -Mineral oil	1	Li soap-Min.oil	C	C	S7	C	C	S13			
19	* -Mineral oil	2	Li soap-Min.oil	C	C	C	C	C	C			
19	* -Mineral oil	11	Li soap-Polyglycol	C	S68	S11	C	C	S7			
19	* -Mineral oil	12	Li soap-Polyglycol	C	S35	S18	C	S133	S10			
19	* -Mineral oil	15	***Sil.Hyd.-Min.oil	S2	S15	S12	S7	S10	S1			
19	* -Mineral oil	16	Sil.Hyd.-Min.oil	S40	S37	S18	S31	S28	S14			
19	* -Mineral oil	3	Sod.soap-Min.oil	C	C	C	C	C	C			
19	* -Mineral oil	4	Sod.soap-Min.oil	C	C	C	C	C	C			

*Sodium N-Octadecyl Terephthalamine

**Isocyanate amine

***Silica Hydrophobic

3. Two grease mixtures composed of the same type of components, but made by different manufacturers, do not necessarily behave the same after storage.

It is possible that the grease types studied in this investigation, which produced relatively few incompatible mixtures after the two storage periods, can be depended upon to produce few incompatible mixtures in service involving storage. However, it should be born in mind that every type of grease studied in this investigation produced some incompatible mixtures after the storage periods.

Table V summarizes numerically the compatibility data contained in Table IV in terms of grease type, mixture ratio, and number of instances of compatibility and incompatibility.

A study of Table V produces the following conclusions:

1. Considerably more mixtures were incompatible after eighteen months storage and a 10,000 stroke worker test than were incompatible immediately after preparation followed by the same test.

2. The ratio of components in grease mixtures was of little significance from the point of view of compatibility after eighteen months storage followed by a worker test.

3. Considerably more grease mixtures soften after eighteen months storage followed by a worker test than harden under the same treatment.

Earlier studies referenced in this report have shown that the probability exists for incompatible mixtures to be produced when two different types of grease (or even the same type made by a different company) are worked together. These findings led to the recommendation that different types of lubricating greases should not be mixed. The present study shows that the storage of lubricating grease mixtures followed by working, whether or not the mixtures are compatible immediately after preparation, may produce incompatible mixtures. This finding serves to reinforce the above recommendation, namely, do not mix different types of lubricating greases.

The significance of lubricating grease incompatibility is dependent almost entirely upon the individual application of the grease mixture. All compatibility studies have shown that grease incompatibility is primarily evidenced by a softening of the grease mixture. If the mixture is stored, there is a greater chance that it will soften. If an

TABLE V

SUMMARY OF COMPATIBILITY DATA

NUMBER OF COMPATIBLE AND INCOMPATIBLE MIXTURES IMMEDIATELY AFTER PREPARATION AND AFTER EIGHTEEN MONTHS STORAGE

GREASE TYPE	COMPATIBLE MIXTURES		INCOMPATIBLE MIXTURES					
			DUE TO HARDENING		DUE TO SOFTENING		TOTAL	
	IMMED. AFTER PREP.	AFTER STORAGE	IMMED. AFTER PREP.	AFTER STORAGE	IMMED. AFTER PREP.	AFTER STORAGE	IMMED. AFTER PREP.	AFTER STORAGE
Aluminum Soap-Mineral Oil:								
No. 17								
10%	19	19	1	0	0	1	1	1
50%	16	15	0	0	4	5	4	5
90%	17	15	0	0	3	5	3	5
No. 18								
10%	18	17	1	1	1	2	2	3
50%	13	11	1	0	6	9	7	9
90%	16	12	0	0	4	8	4	8
TOTAL	99	89	3	1	18	30	21	31
Barium Soap-Mineral Oil:								
No. 7								
10%	19	15	1	2	0	3	1	5
50%	17	16	3	3	0	1	3	4
90%	18	19	2	0	0	1	2	1
No. 8								
10%	13	12	0	0	7	8	7	8
50%	11	14	0	0	9	6	9	6
90%	14	15	0	0	6	5	6	5
TOTAL	92	91	6	5	22	24	28	29

TABLE V (Cont.)

GREASE TYPE	COMPATIBLE MIXTURES		INCOMPATIBLE MIXTURES					
			DUE TO HARDENING		DUE TO SOFTENING		TOTAL	
	IMMED. AFTER PREP.	AFTER STORAGE	IMMED. AFTER PREP.	AFTER STORAGE	IMMED. AFTER PREP.	AFTER STORAGE	IMMED. AFTER PREP.	AFTER STORAGE
Bentonite-Mineral Oil:								
No. 13								
10%	11	16	0	0	9	4	9	4
50%	5	7	0	1	15	12	15	13
90%	10	8	2	2	8	10	10	12
No. 14								
10%	19	17	1	1	0	2	1	3
50%	19	11	1	1	0	8	1	9
90%	20	10	0	0	0	10	0	10
TOTAL	84	69	4	5	32	46	36	51
Anhydrous Calcium Soap-Mineral Oil:								
No. 5								
10%	16	12	0	0	4	8	4	8
50%	15	15	1	1	4	4	5	5
90%	18	20	0	0	2	0	2	0
No. 6								
10%	16	13	0	0	4	7	4	7
50%	15	17	1	1	4	2	5	3
90%	19	19	1	1	0	0	1	1
TOTAL	99	96	3	3	18	21	21	24

TABLE V (Cont.)

GREASE TYPE	COMPATIBLE MIXTURES		INCOMPATIBLE MIXTURES					
			DUE TO HARDENING		DUE TO SOFTENING		TOTAL	
	IMMED. AFTER PREP.	AFTER STORAGE	IMMED. AFTER PREP.	AFTER STORAGE	IMMED. AFTER PREP.	AFTER STORAGE	IMMED. AFTER PREP.	AFTER STORAGE
Calcium Soap, Lead Soap-Mineral Oil:								
No. 21								
10%	13	14	4	1	3	5	7	6
50%	7	6	4	6	9	8	13	14
90%	8	3	2	5	10	12	12	17
TOTAL	28	23	10	12	22	25	32	37
Isocyanate Amine-Mineral Oil:								
No. 20								
10%	12	10	0	0	8	10	8	10
50%	10	11	0	0	10	9	10	9
90%	16	16	0	0	4	4	4	4
TOTAL	38	37	0	0	22	23	22	23

TABLE V (Cont.)

GREASE TYPE	COMPATIBLE MIXTURES		INCOMPATIBLE MIXTURES					
			DUE TO HARDENING		DUE TO SOFTENING		TOTAL	
	IMMED. AFTER PREP.	AFTER STORAGE	IMMED. AFTER PREP.	AFTER STORAGE	IMMED. AFTER PREP.	AFTER STORAGE	IMMED. AFTER PREP.	AFTER STORAGE
Lithium Soap-Diester Fluid:								
No. 9								
10%	15	11	0	0	5	9	5	9
50%	14	12	0	0	6	8	6	8
90%	18	15	0	1	2	4	2	5
No. 10								
10%	14	11	0	1	6	8	6	9
50%	7	4	0	0	13	16	13	16
90%	9	10	1	0	10	10	11	10
TOTAL	77	63	1	2	42	55	43	57
Lithium Soap-Mineral Oil:								
No. 1								
10%	19	15	0	0	1	5	1	5
50%	18	15	0	1	2	4	2	5
90%	19	15	1	2	0	3	1	5
No. 2								
10%	19	17	1	0	0	3	1	3
50%	16	13	2	1	2	6	4	7
90%	18	17	1	1	1	2	2	3
TOTAL	109	92	5	5	6	23	11	28

TABLE V (Cont.)

GREASE TYPE	COMPATIBLE MIXTURES		INCOMPATIBLE MIXTURES					
			DUE TO HARDENING		DUE TO SOFTENING		TOTAL	
	IMMED. AFTER PREP.	AFTER STORAGE	IMMED. AFTER PREP.	AFTER STORAGE	IMMED. AFTER PREP.	AFTER STORAGE	IMMED. AFTER PREP.	AFTER STORAGE
Lithium Soap-Polyglycol Fluid:								
No. 11								
10%	11	11	1	1	8	8	9	9
50%	13	14	1	1	6	5	7	6
90%	16	17	1	0	3	3	4	3
No. 12								
10%	11	9	1	0	8	11	9	11
50%	12	10	1	0	7	10	8	10
90%	15	17	1	0	4	3	5	3
TOTAL	78	78	6	2	36	40	42	42
Silica, Hydrophobic-Mineral Oil:								
No. 15								
10%	13	9	0	0	7	11	7	11
50%	9	6	0	0	11	14	11	14
90%	11	12	0	0	9	8	9	8
No. 16								
10%	11	7	0	0	9	13	9	13
50%	5	3	0	0	15	17	15	17
90%	9	7	0	0	11	13	11	13
TOTAL	58	44	0	0	62	76	62	76

TABLE V (Cont.)

GREASE TYPE	COMPATIBLE MIXTURES		INCOMPATIBLE MIXTURES					
			DUE TO HARDENING		DUE TO SOFTENING		TOTAL	
	IMMED. AFTER PREP.	AFTER STORAGE	IMMED. AFTER PREP.	AFTER STORAGE	IMMED. AFTER PREP.	AFTER STORAGE	IMMED. AFTER PREP.	AFTER STORAGE
Sodium Soap-Mineral Oil:								
No. 3								
10%	17	17	3	1	0	2	3	3
50%	18	16	1	1	1	3	2	4
90%	19	19	1	0	0	1	1	1
No. 4								
10%	20	17	0	0	0	3	0	3
50%	19	13	1	0	0	7	1	7
90%	20	8	0	0	0	12	0	12
TOTAL	113	90	6	2	1	28	7	30
Sodium N-Octadecyl-terephthalamate-Mineral Oil:								
No. 19								
10%	15	14	0	1	5	5	5	6
50%	11	12	1	2	8	6	9	8
90%	10	10	1	0	9	10	10	10
TOTAL	36	36	2	3	22	21	24	24
GRAND TOTAL	911	808	46	40	303	412	349	452

individual application is characterized by leakproof lubricant seals, then softening or even liquification could be of minor importance. Experience has shown that automotive rear wheel bearings designed for grease lubrication have operated satisfactorily for thousands of miles with no known failures when so badly contaminated that the resultant lubricating mixture had about the same consistency as the gear lubricant.

The softening of a binary grease mixture usually appears to be the result of loss of thickener ability to maintain the approximate average consistency of the components. It is doubtful if the lubricating characteristics of the fluid components of a softened grease mixture are affected. It is postulated that the softened or liquified mixture produced by grease incompatibility will provide satisfactory bearing lubrication if this fluid is maintained in contact with the bearing area.

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The compatibility of binary mixtures of twelve types of lubricating greases, when mixed in the three component ratios, 10%-90%, 50%-50%, and 90%-10%, and after storage for eighteen months was determined. Approximately 15% of the grease mixtures were re-examined for compatibility after three years storage. The greases studied included soap thickened, non-soap thickened, and an organic thickened product. Both mineral oil and synthetic fluid types were representec.

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More grease mixtures were incompatible after eighteen months and after three years storage than were incompatible immediately after preparation. In only a very few instances did grease mixtures, which were incompatible immediately after preparation, become compatible after storage.

A table was prepared giving the compatibility data obtained after eighteen months storage, and, in a limited number of cases, after three years storage. Data obtained on similar mixtures immediately after preparation is given for comparison.

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