



SURFACE VEHICLE INFORMATION REPORT



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Defining Hydraulic Oil Compatibility with Hydraulic Hose Elastomers

RATIONALE

This document has been determined to contain basic and stable technology which is not dynamic in nature.

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FOREWORD

Engine oils have had well defined and standardized tests for many years, using both laboratory and engine test cells. These tests describe and control the engine wear that is acceptable to automobile manufactures, as well as oil service periods. These engine oil test methods do not describe the compatibility of oils with elastomers used for hydraulic hose liners and due to a lack of test methods a project, by SAE/FCCTC/S2, to develop a process to determine a relational index for hydraulic fluid compatibility using a standard ISO formulation of two common polymers used in hydraulic hose, Nitrile and chloroprene rubber.

1. SCOPE

This SAE Information Report is intended to provide the hydraulic oil manufacturer and hydraulic equipment manufacturer with information that can be used predicting the relative impact that non petroleum based hydraulic oils may have on the hose elastomers in the existing system. This document contains the information necessary to perform the tests using standard elastomer formulations, representative of material used in hydraulic hose. The test methods used are defined within ASTM D471, standard test method for Rubber Property—Effect of Liquids. The physical properties measured, are volume swell, tensile strength, percent elongation, shore A hardness and load at 100% elongation. The properties were measured, after immersion, at 72 hours, 168 hours, 336 hours, 504 hours, 672 hours, 840 hours, and 1008 hours and the percent calculated as change from the unaged properties. The detail of the testing process is described in the following report.

2. REFERENCES

2.1 Applicable Publications

The following standards contain provisions which, through reference in this text, constitute provisions of this document. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this document are encouraged to investigate the possibility of applying the most recent edition of the standards indicated as follows. Members of IEC and ISO maintain registers of currently valid International Standards.

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2.1.1 SAE Publications

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J343 Tests and Procedures for SAE 100R Series Hydraulic Hose and Hose Assemblies

SAE J517 Hydraulic Hose

2.1.2 ASTM Publications

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D 380 Standard Methods of Testing Rubber Hose

ASTM D 471 Standard Test Method for Rubber Property—Effect of Liquids

2.1.3 ISO Publications

Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 13226 Standard reference elastomers

ISO 2393 Rubber test mixes—Preparation, mixing and vulcanization equipment and procedures

3. BACKGROUND

Current SAE J517 for hydraulic hose has defined for each 100R type of hose, an Oil Resistance Test. This test is performed using a industry standard reference fluid IRM 903 and is useful as a quality check relative to product consistency. The use of petroleum based hydraulic fluids in J517 products, is based on both long term use, as well as field testing performed with newly developed hydraulic applications. New biodegradable hydraulic fluids, based on non-petroleum fluids have come into the hydraulic industry within the last 5 years. These fluids are based on materials that have not been widely used with J517 hydraulic hoses, therefore little is know about the long term impact these fluids will have on the synthetic rubber formulations used in hydraulic hose.

3.1 Test Description

The original physical properties are measured and testing is performed after each time period to obtain the percent change. These results are used to determine the value as found in the Table 1.

TABLE 1 - RANGES AND VALUES FOR EACH PROPERTY

Property	% Change	Value	Property	Range	Value
Tensile	0 to 15%	1	Volume Swell	-5% to +10%	1
	>15% to 25%	2		>+ 10% to +20%	2
	>25% to 40%	3		>+20% to +30%	3
	>40% to 60%	4		>+30% to +40%	4
	>60%	5		>+40%	5
Property	% Change	Value	Property	Points changed	Value
Elongation	0 to 15%	1	Hardness	0 to 5	1
	>15% to 25%	2		>5 to 10	2
	>25% to 40%	3		>10 to 15	3
	>40% to 60%	4		>15 to 20	4
	>60%	5		>20	5

The tests results are weighted, giving higher multipliers to properties that have greater impact on hose life. Elongation at break, weight = 2, volume swell, weight = 2 all others are weighted at 1. A higher number ECI in comparison to a standard fluid ECI is a warning to evaluate the fluid in the application with the selected hydraulic hose.

The ECI is then the result of multiplying the property values.

For example Tensile value = 3 weighting is 1, Elongation value = 5 weighting is 2, Hardness value = 2 weighting is 1 and the Volume Swell value = 2 weighting is 2, this multiplication results in the ECI. Example $3 \times 1 = 3$, $5 \times 2 = 10$, $2 \times 1 = 2$, $2 \times 2 = 4$, and $3 \times 10 \times 2 \times 4 = 240$, as the elastomer compatibility index (ECI).

4. STANDARD TEST MATERIALS

This report provides formulation, mixing and vulcanization procedures for the following polymeric Formulas for use as test standards are in the following ISO standard.

- a. acrylonitrile-butadiene rubber ISO 13226 SRE-NBR 28/SX
- b. chloroprene rubber ISO 13226 SRE-CR/1

The reference formulations found in ISO 13226—Standard reference elastomers (SRE) for characterizing the effect of liquids on vulcanized rubber, are also in Appendix A of this document. The mixing of compounds and the vulcanization of test sheets shall be carried out in accordance with ISO 2393.

These formulations are sensitive to fluid variations and have comparatively high swelling characteristics. The changes in volume, hardness, tensile strength and elongation at break can be used to establish an elastomer compatibility index ECI, for the test fluid. The ECI, which can be established and documented by the hydraulic fluid suppliers, allows selection of standard hydraulic hoses if the specific hydraulic fluid ECI is in the range of existing OEM fill fluids. The ECI will also assist producers of additives and hydraulic fluids in the development of products compatible with common hydraulic hoses.

The following data sheets show ECI results of testing standard NBR and CR with ASTM test oils.

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TABLE 2 - ELASTOMER COMPATIBILITY INDEX DEVELOPMENT

Time = 168 HOURS**212 °F – NBR – ASTM #1 Oil**

Property	Property Multiplier	Rating Factor	Property Index
Tensile	1	1	1
% Elongation	2	2	4
Hardness	1	1	1
% Swell	2	1	2
ECI =			8

212 °F – NBR – ASTM 903 Oil

Property	Property Multiplier	Rating Factor	Property Index
Tensile	1	2	2
% Elongation	2	3	6
Hardness	1	2	2
% Swell	2	4	8
ECI =			192

212 °F – CR – ASTM #1 Oil

Property	Property Multiplier	Rating Factor	Property Index
Tensile	1	2	2
% Elongation	2	1	2
Hardness	1	1	1
% Swell	2	1	2
ECI =			8

212 °F – CR – ASTM 903 Oil

Property	Property Multiplier	Rating Factor	Property Index
Tensile	1	5	5
% Elongation	2	3	6
Hardness	1	4	4
% Swell	2	5	10
ECI =			1200

Summary

ECI Ratings	#1	#3
NBR – 212 °F	8	192
NBR – 250 °F	8	432
CR – 212 °F	8	1200
CR – 250 °F	144	1600

250 °F – NBR – ASTM #1 Oil

Property	Property Multiplier	Rating Factor	Property Index
Tensile	1	1	1
% Elongation	2	2	4
Hardness	1	1	1
% Swell	2	1	2
ECI =			8

250 °F – NBR – ASTM 903 Oil

Property	Property Multiplier	Rating Factor	Property Index
Tensile	1	3	3
% Elongation	2	3	6
Hardness	1	3	3
% Swell	2	4	8
ECI =			432

250 °F – CR – ASTM #1 Oil

Property	Property Multiplier	Rating Factor	Property Index
Tensile	1	3	3
% Elongation	2	3	6
Hardness	1	2	2
% Swell	2	2	4
ECI =			144

250 °F – CR – ASTM 903 Oil

Property	Property Multiplier	Rating Factor	Property Index
Tensile	1	5	5
% Elongation	2	4	8
Hardness	1	4	4
% Swell	2	5	10
ECI =			1600

Weighting Factors

Tensile	1
% Elongation	2
Hardness	1
% Volume Swell	2

TABLE 3 - ELASTOMER COMPATIBILITY INDEX DEVELOPMENT

Time = 1008 HOURS							
212 °F – NBR – ASTM #1 Oil				250 °F – NBR – ASTM #1 Oil			
Property	Property Multiplier	Rating Factor	Property Index	Property	Property Multiplier	Rating Factor	Property Index
Tensile	1	3	3	Tensile	1	5	5
% Elongation	2	4	8	% Elongation	2	5	10
Hardness	1	1	1	Hardness	1	1	1
% Swell	2	1	2	% Swell	2	1	2
		ECI =	48			ECI =	100
212 °F – NBR – ASTM 903 Oil				250 °F – NBR – ASTM 903 Oil			
Property	Property Multiplier	Rating Factor	Property Index	Property	Property Multiplier	Rating Factor	Property Index
Tensile	1	5	5	Tensile	1	5	5
% Elongation	2	5	10	% Elongation	2	5	10
Hardness	1	1	1	Hardness	1	2	2
% Swell	2	4	8	% Swell	2	4	8
		ECI =	400			ECI =	800
212 °F – CR – ASTM #1 Oil				250 °F – CR – ASTM #1 Oil			
Property	Property Multiplier	Rating Factor	Property Index	Property	Property Multiplier	Rating Factor	Property Index
Tensile	1	3	3	Tensile	1	4	4
% Elongation	2	2	4	% Elongation	2	4	8
Hardness	1	1	1	Hardness	1	1	1
% Swell	2	1	2	% Swell	2	3	6
		ECI =	24			ECI =	192
212 °F – CR – ASTM 903 Oil				250 °F – CR – ASTM 903 Oil			
Property	Property Multiplier	Rating Factor	Property Index	Property	Property Multiplier	Rating Factor	Property Index
Tensile	1	5	5	Tensile	1	5	5
% Elongation	2	3	6	% Elongation	2	4	8
Hardness	1	5	5	Hardness	1	5	5
% Swell	2	5	10	% Swell	2	5	10
		ECI =	1500			ECI =	2000
Summary				Weighting Factors			
ECI Ratings	#1	#3		Tensile		1	
NBR – 212 °F	48	400		% Elongation		2	
NBR – 250 °F	100	800		Hardness		1	
CR – 212 °F	24	1500		% Volume Swell		2	
CR – 250 °F	192	2000					

PREPARED BY THE SAE HYDRAULIC HOSE AND HOSE FITTINGS SUBCOMMITTEE
OF THE SAE FLUID CONDUCTORS AND CONNECTORS TECHNICAL COMMITTEE

STABILIZED BY THE SAE HYDRAULIC HOSE AND HOSE FITTINGS COMMITTEE

APPENDIX A

A.1 Formulations for ISO 13226 SRE-CR/1 and ISO 13226 SRE-NBR/SX test samples:

TABLE A1 - SRE-CR/1

Ingredients	Parts by Mass
Chloroprene rubber ⁽¹⁾	100
Stearic acid	0.5
Light calcined magnesia	4.0
Zinc oxide	5.0
Carbon black N 550 ⁽²⁾	20 (nominal)
Organic accelerator ⁽³⁾	0.75 to 1.0
Antioxidant ⁽⁴⁾	2.0
Total	132.5

1. A slow crystalline form of a non-sulphur modified polymer is required. Neoprene WRT has been found to be suitable.
2. Corax N 550[®] from Degussa AG or equivalent.
3. Vulkacit CRV has been found to be suitable.
4. Octamine has been found to be suitable.

TABLE A2 - SRE-NBR/SX

Ingredients	Parts by Mass
NBR with (28 ± 0.5%) by mass of Acrylonitrile ⁽¹⁾	100
2,2,4-trimethyl-1,2-dihydroquinoline polymerized (TMQ) ⁽²⁾	2.0
Zinc oxide, precipitated ⁽³⁾	5.0
Stearic acid	10
Carbon black N 550 ⁽⁴⁾	65.0
Tetra methyl thiuram disulfide (TMTD) ⁽⁵⁾	2.5
Benzothiazyl-2-cyclohexyl-sulphenamide (CBS) ⁽⁶⁾	1.5
Sulphur	0.2
Total	177.2

1. Perbunan NT 2845[®] from Bayer AG or equivalent.
2. Vulkanox HS/LG from Bayer AG or equivalent.
3. Zinkoxyd aktiv[®] from Bayer AG or equivalent.
4. Corax N 550[®] from Degussa AG or equivalent.
5. Vulkacit Thiuram/C[®] from Bayer AG or equivalent.
6. Vulkacit CZ/C[®] from Bayer AG or equivalent.

APPENDIX B

TABLE B1 - AGED TEST DATA FROM FACTORY FILL FLUID
TYPE CAT 8T-9580 STANDARD NITRILE

212 °F						250 °F				
hrs	ΔTB%	ΔEB%	ΔIRC%	% Vol. inc	ECl	ΔTB%	ΔEB%	ΔIRC%	% Vol. inc	ECl
72	-35.6	-58.1	-3	+7.6	48	-50.4	-63.8	-3	+8.5	80
168	-48.7	-68.1	-1	+7.5	80	-56.4	-69.5	-2	+7.8	80
336	-55.2	-74.6	-1	+7.1	80	-67.2	-75.7	+2	+7.4	100
504	-51.2	-75.4	+2	+7.0	80	-80.9	-83.0	+1	+7.2	100
672	-49.8	-74.5	+5	+7.0	80	-84.5	-85.2	+5	+7.0	100
840	-53.5	-77.3	+6	+7.1	160	-88.4	-89.9	+8	+6.8	200
1008	-59.1	-79.1	+4	+6.9	80	-87.9	-94.2	+11	+6.6	300

TABLE B2 - AGED TEST DATA FROM FACTORY FILL FLUID
TYPE CAT 8T-9580 STANDARD CHLOROPRENE

212 °F						250 °F				
hrs	ΔTB%	ΔEB%	ΔIRC%	% Vol. inc	ECl	ΔTB%	ΔEB%	ΔIRC%	% Vol. inc	ECl
72	-24.0	-8.6	-11	+33.7	96	-47.3	-29.0	-11	+37.9	576
168	-37.8	-19.7	-10	+34.2	192	-54.5	-38.9	-11	+37.8	576
336	-35.2	-22.7	-10	+32.6	192	-65.9	-53.7	-11	+37.3	960
504	-42.0	-22.6	-9	+32.4	256	-75.3	-65.2	-6	+34.6	800
672	-44.3	-31.5	-11	+31.8	576	-78.0	-72.0	-5	+32.3	400
840	-52.6	-38.4	-10	+31.4	384	-80.8	-81.7	-4	+30.3	400
1008	-45.3	-36.4	-9	+31.2	384	-80.1	-85.5	-6	+29.1	600

TABLE B3 - AGED TEST DATA FROM FACTORY FILL FLUID
TYPE JDM J21A STANDARD NITRILE

212 °F						250 °F				
hrs	ΔTB%	ΔEB%	ΔIRC%	% Vol. inc	ECl	ΔTB%	ΔEB%	ΔIRC%	% Vol. inc	ECl
72	+19	-7	-7	+12	32	+16	-21	-10	+14	64
168	+15	-21	-9	+14	32	+14	-25	-7	+13	32
336	+13	-21	-7	+13	64	+4	-39	-4	+14	24
504	+14	-34	-7	+13	86	-34	-66	-5	+13	120
672	+4	-38	-7	+13	48	-58	-78	-2	+13	160
840	+10	-43	-5	+13	32	-67	-83	-1	+12	200
1008	+13	-40	-2	+12	40	-75	-89	-2	+12	200

TABLE B4 - AGED TEST DATA FROM FACTORY FILL FLUID
TYPE JDM J21A STANDARD CHLOROPRENE

hrs	212 °F					250 °F				
	Δ TB%	Δ EB%	Δ IRC%	% Vol. inc	ECl	Δ TB%	Δ EB%	Δ IRC%	% Vol. inc	ECl
72	-45	-24	-11	+51	480	-42	-18	-11	+51	480
168	-44	-22	-13	+50	480	-59	-34	-11	+51	720
336	-43	-17	-11	+50	480	-49	-20	-18	+53	640
504	-47	-18	-15	+49	480	-53	-30	-12	+51	720
672	-51	-15	-18	+50	320	-48	-23	-11	+52	480
840	-47	-23	-14	+48	480	-50	-42	-10	+50	640
1008	-48	-17	-15	+43	480	-53	-55	-11	+47	960

TABLE B5 - AGED TEST DATA FROM FACTORY FILL FLUID
TYPE CASE MS-1209 STANDARD NITRILE

hrs	212 °F					250 °F				
	Δ TB%	Δ EB%	Δ IRC%	% Vol. inc	ECl	Δ TB%	Δ EB%	Δ IRC%	% Vol. inc	ECl
72										
168	-2	-20	-6	+10.1	32	-9	-26	-5	+11.3	24
336	-7	-33	-4	+10.3	24	-20	-51	-7	+11.5	128
504	-1	-35	-5	+9.8	12	-38	-68	-2	+9.3	60
672	-3	-33	-4	+9.7	12	-48	-73	-1	+9.9	80
840	-3	-33	-1	+9.4	12	-51	-83	+4	+9.2	80
1008	-1	-30	-2	+9.8	12	-68	-88	+6	+7.5	200

TABLE B6 - AGED TEST DATA FROM FACTORY FILL FLUID
TYPE CASE MS-1209 STANDARD CHLOROPRENE

hrs	212 °F					250 °F				
	Δ TB%	Δ EB%	Δ IRC%	% Vol. inc	ECl	Δ TB%	Δ EB%	Δ IRC%	% Vol. inc	ECl
72										
168	-49	-29	-13	+19.2	288	-44	-22	-16	36	512
336	-46	-32	-12	+31.2	576	-43	-33	-16	+36	768
504	-46	-33	-14	+30.4	576	-49	-37	-14	+33	576
672	-38	-21	-13	+30.8	480	-55	-49	-13	+31.4	768
840	-44	-23	-14	+31.5	384	-59	-49	-13	+31.4	768
1008	-38	-17	-14	+31.3	288	-58	-62	-6	+31.1	640

APPENDIX C

TABLE C1 - AGED TEST DATA FROM ASTM REFERENCE
OIL #1 STANDARD NITRILE

hrs	212 °F					250 °F				
	Δ TB%	Δ EB%	Δ IRC%	% Vol. inc	ECl	Δ TB%	Δ EB%	Δ IRC%	% Vol. inc	ECl
72	-3.5	-20.3	-3	+0.6	8	+3.3	-17.4	-3	+1.2	8
168	+1.0	-25.5	-2	+1.1	12	+1.3	-26.5	-3	+1.4	12
336	+4.4	-30.2	-2	+1.1	12	-14.4	-47.3	-2	+1.3	16
504	-0.7	-37.2	0	+1.0	12	-30.5	-58.0	0	+0.9	48
672	+0.9	-31.5	+3	+0.6	12	-43.6	-69.5	+1	+1.1	80
840	-1.3	-42.4	+3	+0.6	16	-66.4	-82.5	-3	+1.0	100
1008	+0.5	-38.2	+4	+0.6	12	-59.1	-82.2	+3	+0.5	80

TABLE C2 - AGED TEST DATA FROM FACTORY ASTM REFERENCE
OIL #1 STANDARD CHLOROPRENE

hrs	212 °F					250 °F				
	Δ TB%	Δ EB%	Δ IRC%	% Vol. inc	ECl	Δ TB%	Δ EB%	Δ IRC%	% Vol. inc	ECl
72	-15.1	-9.7	-8	+12.0	32	-9.1	-8.2	-9	+15.6	16
168	-20.8	-18.1	-8	+13.2	64	-24.1	-27.0	-8	+16.1	96
336	-20.8	-22.3	-9	+12.9	64	-31.0	-37.1	-8	+15.8	144
504	-12.8	-15.6	-7	+12.8	32	-44.8	-51.2	-5	+15.5	256
672	-17.9	-15.1	-8	+13.0	64	-64.9	-68.1	-7	+15.6	400
840	-26.8	-32.4	-6	+12.8	144	-53.7	-64.3	-7	+16.7	320
1008	-25.1	-26.1	-6	+12.4	144	-61.2	-77.4	+2	+16.8	200

TABLE C3 - AGED TEST DATA FROM ASTM REFERENCE
OIL IRM 903 STANDARD NITRILE

hrs	212 °F					250 °F				
	Δ TB%	Δ EB%	Δ IRC%	% Vol. inc	ECl	Δ TB%	Δ EB%	Δ IRC%	% Vol. inc	ECl
72	-14.5	-27.2	-13	+21.7	108	-18.9	-39.8	-15	+24.1	216
168	-13.4	-32.0	-13	+21.5	108	-24.5	-34.8	-17	+25.7	288
336	-17.6	-39.5	-13	+20.7	216	-63.8	-55.7	-23	+28.2	120
504	-12.9	-37.2	-13	+21.7	108	-84.7	-78.9	-18	+29.1	150
672	-24.2	-43.2	-12	+22.3	288	-89.0	-86.1	-18	+29.8	150
840	-31.2	-51.3	-11	+23.1	432	-89.8	-88.2	-18	+29.5	150
1008	-42.9	-55.7	-13	+23.7	576	-91.0	-83.8	-14	+30.3	160

TABLE C4 - AGED TEST DATA FROM ASTM REFERENCE
OIL IRM 903 STANDARD CHLOROPRENE

hrs	212 °F					250 °F				
	Δ TB%	Δ EB%	Δ IRC%	% Vol. inc	ECI	Δ TB%	Δ EB%	Δ IRC%	% Vol. inc	ECI
72	-51.7	-48.9	-19	81.6	1280	-48.4	-51.2	-20	86.4	1280
168	-63.4	-55.6	-19	80.3	1600	-55.7	-44.9	-22	88.2	1600
336	-72.5	-62.6	-20	81.1	2000	-57.8	-44.0	-23	113.5	1600
504	-66.9	-58.8	-20	86.5	2000	-71.0	-48.7	-39	138.0	2000
672	-77.2	-60.1	-20	93.9	2000	-77.9	-50.8	-39	148.0	2000
840	-72.1	-55.2	-26	99.4	2500	-90.1	-67.5	-30	140.7	2500
1008	-78.4	-54.6	-26	99.8	2500	-88.1	-65.4	-31	152.5	2500

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APPENDIX D

D.1 Aged test data from OEM fill oils and Dayco, Gates and Parker's hose liners:

TABLE D1 - AGED TEST DATA FROM CASE FILL OIL
CASE MS-1209 AND DAYCO NITRILE

hrs	212 °F					250 °F				
	Δ TB%	Δ EB%	Δ IRC%	% Vol. inc	ECI	Δ TB%	Δ EB%	Δ IRC%	% Vol. inc	ECI
72	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
168	N.A.	N.A.	N.A.	N.A.	N.A.	-2	-45	+2	+3	16
336	N.A.	N.A.	N.A.	N.A.	N.A.	+1.2	-69	+5	+3	20
504	N.A.	N.A.	N.A.	N.A.	N.A.	+11	-80	+7	+2	40
672	N.A.	N.A.	N.A.	N.A.	N.A.	-6	-88	+10	+2	40
840	N.A.	N.A.	N.A.	N.A.	N.A.	-8	-81	+10	+2	40
1008	N.A.	N.A.	N.A.	N.A.	N.A.	-1	-95	+13	+2	60

TABLE D2 - AGED TEST DATA FROM CASE FILL OIL
CASE MS-1209 AND DAYCO CHLOROPRENE

hrs	212 °F					250 °F				
	Δ TB%	Δ EB%	Δ IRC%	% Vol. inc	ECI	Δ TB%	Δ EB%	Δ IRC%	% Vol. inc	ECI
72	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
168	N.A.	N.A.	N.A.	N.A.	N.A.	-20	-27	-13	+14	144
336	N.A.	N.A.	N.A.	N.A.	N.A.	-29	-46	-9	+13	192
504	N.A.	N.A.	N.A.	N.A.	N.A.	-44	-73	-3	+11	160
672	N.A.	N.A.	N.A.	N.A.	N.A.	-46	-80	+0	+12	160
840	N.A.	N.A.	N.A.	N.A.	N.A.	-55	-91	+2	+11	160
1008	N.A.	N.A.	N.A.	N.A.	N.A.	-53	-95	+3	+11	160

TABLE D3 - AGED TEST DATA FROM CATERPILLAR FILL OIL
CAT 8T-9580 AND GATES NITRILE

hrs	212 °F					250 °F				
	Δ TB%	Δ EB%	Δ IRC%	% Vol. inc	ECI	Δ TB%	Δ EB%	Δ IRC%	% Vol. inc	ECI
72	-22	-61	+3	+0	40	-55	-71	+3	+0	80
168	-31	-69	+4	+0	60	-71	-79	+4	+0	100
336	-45	-80	+6	+0	160	-76	-85	+7	+0	200
504	-53	-84	+7	+0	160	-79	-90	+9	-1	200
672	-61	-87	+8	+0	200	-83	-91	+10	-1	200
840	-59	-88	+9	+0	160	-83	-94	+10	-1	200
1008	-64	-90	+11	-1	300	-82	-96	+11	-1	300