Santoprene® Rubber Fluid Resistance Guide

- Acids and Alkalis
- Aqueous Solutions
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- Oils and Fuels
- Automotive Fluids
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INTRODUCTION

This bulletin summarizes the physical properties of general purpose Santoprene® thermoplastic rubber after exposure to a variety of fluids and solvents. Immersion times were approximately one week (166 hours, per ASTM method D-471) at temperatures ranging from 5°C to 150°C (41°F to 302°F), depending upon the fluid. The data for a given hardness level are applicable to the 100 series (black) as well as the 200 series (colorable) general purpose grades of Santoprene rubber and are representative of performances expected for many of the grades.

Results of these tests demonstrate that Santoprene rubber is inherently resistant to a wide variety of oils, solvents and chemicals. Santoprene rubber is not readily soluble in any common solvent, but will swell in aromatic solvents, halogenated organic solvents and hot petroleum oils.

Highly polar fluids, such as alcohols, ketones, glycols, esters and aqueous solutions of acids, salts and bases have little effect upon Santoprene rubber. Weight changes in these fluids are typically less than 10%, and physical property changes are minimal.

Test Methods

Injection molded test plaques (82.4 mm x 117 mm x 2.97 mm) were prepared. Test specimens were die cut from these plaques to measure the effect of fluid immersion upon tensile properties, hardness and weight change, using ASTM procedures.

Property	ASTM Test Procedure
Ultimate Elongation	D 412, die C*
Tensile Strength	D 412, die C*
Stress at 100% Elongation	D 412, die C*
Hardness	D 2240, 5 sec. delay
Weight Change	D 471

*Note: 50D is D638

Discussion

Santoprene thermoplastic rubber is designed to offer fluid and oil resistance equivalent to that of conventional thermoset rubbers such as neoprene.

The resistance of the Santoprene rubber grades to oil and heat can be classified by using the SAE J200/ASTM D2000 Standard Classification System for rubber.

Santoprene Rubber Grade	Type and Class
111-35	AA, BA, BC, CA
111-45, 211-45	AA, BA, BC, CA
101-55, 201-55	AA, BA, BC, CA
101-64, 201-64	AA, BA, BC, BE, CA
101-73, 201-73	AA, BA, BC, BE, CA, CE
101-80, 201-80	AA, BA, BC, BE, BF, CA, CE
101-87, 201-87	AA, BA, BC, CA
103-40, 203-40	AA, BA, BC, BG

In this classification system, the first of the two letters designates the heat resistance of the rubber. The second letter designates the oil resistance (volume swell in IRM 903 oil). As the letters progress through the alphabet, the heat and oil resistance become progressively higher.

Rubber compounds with a hardness of 50 Shore D are not included in the ASTM D2000 classification. Therefore, Santoprene rubber grades 103-50 and 203-50 are not included.

Table I provides a qualitative rating of the effect of immersion in each fluid on Santoprene rubber grades with hardnesses 55A, 64A, 73A, 80A, 87A, 40D and 50D. In this rating, percent weight change is the variable shown according to the scale:

Rating	Percent Weight Change
A	< 20
B	20-39
C	40-59
D	60-79
E	80-100
F	> 100

Tables II-VIII provide detailed information on the effect of immersion upon tensile properties, hardness and weight change of general purpose Santoprene rubber grades with hardness of 35 Shore A to 50 Shore D, following ASTM test procedure D-471.

TABLE I:

Fluid Resistance of Santoprene Thermoplastic Rubber, Qualitative Ratings[1,2]

	Fluids	Immersion Temperature °C	Santoprene Rubber Shore Hardness 55A	64A	73A	80A	87A	40D	50D
Acids and Alkalis	98% Sulfuric Acid	23	A	A	A	A	A	A	A
	10% Hydrochloric Acid	23	A	A	A	A	A	A	A
	50% Sodium Hydroxide	23	A	A	A	A	A	A	A
	10% Potassium Hydroxide	23	A	A	A	A	A	A	A
Aqueous Solutions	Water	100	A	A	A	A	A	A	A
	10% Zinc Chloride	23	A	A	A	A	A	A	A
	Sea Water	23	A	A	A	A	A	A	A
	15% Sodium Chloride	23	A	A	A	A	A	A	A
	18% Calcium Chloride/ 14% Calcium Bromide	150	A	A	A	A	A	A	A
	2.5% Detergent (Tide)	23	A	A	A	A	A	A	A
Organic Solvents	Acetic Acid	23	A	A	A	A	A	A	A
	Acrylonitrile	23	A	A	A	A	A	A	A
	Aniline	23	A	A	A	A	A	A	A
	Bromobenzene	23	F	E	D	C	B	B	B
	n-Butyl Acetate	23	A	A	A	A	A	A	A
	Cyclohexane	23	E	C	D	B	B	A	A
	Diethyl Ether	23	A	A	A	A	A	A	A
	Dimethylformamide	23	A	A	A	A	A	A	A
	Dioctyl Phthalate	23	A	A	A	A	A	A	A
	1,4-Dioxane	23	B	A	A	A	A	A	A
	95% Ethanol	23	A	A	A	A	A	A	A
	Glycerol	23	A	A	A	A	A	A	A
	n-Hexane	23	B	A	A	A	A	A	A
	Methylethylketone	23	B	B	A	A	A	A	A
	Nitrobenzene	23	A	A	A	A	A	A	A
	Piperidine	23	C	B	A	A	A	A	A
	1-Propanol	23	A	A	A	A	A	A	A
	Pyridine	23	A	A	A	A	A	A	A
	Trichloroethylene	23	F	F	F	F	E	D	C
	Turpentine	23	E	D	C	C	B	B	A
	Xylene	23	D	C	C	B	B	B	A
Petroleum Oils and Fuels	ASTM #1 Oil	100	B	B	B	A	A	A	A
		125	B	B	B	B	B	A	A
	IRM 902 Oil	100	D	C	C	B	B	A	A
		125	D	D	C	C	B	B	B
	IRM 903 Oil	100	E	E	D	C	B	B	B
		125	F	E	D	D	C	C	C
	Reference Fuel A (Isooctane)	23	B	B	B	B	A	A	A
	Reference Fuel B (Isooctane/Toluene, 70/30)	23	D	C	C	C	B	B	A
	Reference Fuel C (Isooctane/Toluene, 50/50)	23	D	C	C	C	B	B	A
Automotive Fluids	Automatic Transmission Fluid	125	D	C	C	C	C	B	B
	Hydraulic Brake Fluid	23	A	A	A	A	A	A	A
		100	B	A	A	A	A	A	A
	Lithium Grease	23	A	A	A	A	A	A	A
		100	C	C	B	B	A	A	A
	Power Steering Fluid	125	E	D	D	C	C	B	B
	Antifreeze, 50/50 Ethylene Glycol (Prestone®)/water	125	A	A	A	A	A	A	A
Industrial Fluids	Pydraul® 312 (Monsanto, phosphate ester)	125	A	A	B	A	A	A	A
	Skydrol® 500 B4 (Solutia, phosphate ester)	125	B	A	A	A	A	A	A
	Sunvis® 706 Fluid (Sun Oil, petroleum base)	125	C	C	C	C	B	B	B
	Ucon® CC732 (Union Carbide, polyalkylene glycol)	125	A	A	A	A	A	A	A
	Ucon® 50HB5100 (Union Carbide, polyalkylene glycol)	125	A	B	B	B	A	A	A
	Freon® 11 (DuPont, halocarbon)	5	F	C	C	C	B	B	B

[1] See note A, Disclaimer of Warranty and Liability, on inside front cover.
[2] All solution concentrations by weight. These alphabetical ratings are based on a specific range in the percentage of weight change as described on page 2.

TABLE II: 35 Shore A

Effect of 166 Hour Immersion (ASTM D-471) on Properties of 35 Shore A General Purpose Santoprene Thermoplastic Rubber[1,2]

	Fluids	Temp., °C	Ultimate Elongation, % Change	Tensile Strength, % Change	Stress at 100% Elongation, % Change	Hardness Change, Shore A Units	Weight, % Change
Acids and Alkalis	98% Sulfuric Acid	23	-4	-1	8	2	0.2
	50% Sodium Hydroxide	23	-7	-10	7	0	2.2
Aqueous Solutions	Water	100	-2	1	7	-2	4.5
	15% Sodium Chloride	23	-1	-1	6	1	0.5
Petroleum Oils and Fuels	ASTM #1 Oil	100	-28	-17	8	-15	51.9
	IRM 902 Oil	100	-38	-24	13	-15	80.2
	IRM 903 Oil	100	-60	-52	10	-27	108.4
	Reference Fuel B (Isooctane/Toluene, 70/30)	23	-39	-33	6	-12	40.0
Automotive Fluids	Automatic Transmission Fluid	125	-60	-60	-7	-28	86.9
	Hydraulic Brake Fluid	100	86	90	41	22	-45.0
	Lithium Grease	100	-36	-33	-2	-18	60.6
	Antifreeze, 50/50 Ethylene Glycol (Prestone®)/water	125	-10	-8	6	-4	6.8
Industrial Fluids	Pydraul® 312	125	-43	-44	-7	-14	30.5
	Skydrol® 500 B4	100	63	45	15	17	-40.0
	Sunvis® 706 Fluid	125	-57	-53	-1	-23	89.9

[1] See note A, Disclaimer of Warranty and Liability, on inside front cover.
[2] All solution concentrations by weight.

TABLE III: 45 Shore A

Effect of 166 Hour Immersion (ASTM D-471) on Properties of 45 Shore A General Purpose Santoprene Thermoplastic Rubber[1,2]

	Fluids	Temp., °C	Ultimate Elongation, % Change	Tensile Strength, % Change	Stress at 100% Elongation, % Change	Hardness Change, Shore A Units	Weight, % Change
Acids and Alkalis	98% Sulfuric Acid	23	-4	8	10	4	5.0
	50% Sodium Hydroxide	23	-6	-6	0	0	0.1
Aqueous Solutions	15% Sodium Chloride	23	-10	-11	-4	0	0.3
Petroleum Oils and Fuels	ASTM #1 Oil	100	-32	-17	9	-11	40.8
	Reference Fuel B (Isooctane/Toluene, 70/30)	23	-51	-36	5	-15	59.9
Automotive Fluids	Hydraulic Brake Fluid	23	66	79	27	20	-36.8
Industrial Fluids	Pydraul® 312	125	-38	-36	-16	-11	28.8
	Skydrol® 500 B4	125	51	31	11	15	2.2
	Sunvis® 706 Fluid	125	-57	-46	-4	-20	77.2

[1] See note A, Disclaimer of Warranty and Liability, on inside front cover.
[2] All solution concentrations by weight.

TABLE IV: 55 Shore A

Effect of 166 Hour Immersion (ASTM D-471) on Properties of 55 Shore A General Purpose Santoprene Thermoplastic Rubber[1,2]

	Fluids	Temp., °C	Ultimate Elongation, % Change	Tensile Strength, % Change	Stress at 100% Elongation, % Change	Hardness Change, Shore A Units	Weight, % Change
Acids and Alkalis	98% Sulfuric Acid	23	-18	-16	-2	-3	3.2
	10% Hydrochloric Acid	23	-5	-8	-4	-3	-1.1
	50% Sodium Hydroxide	23	3	9	-16	-1	0.0
	10% Potassium Hydroxide	23	-13	-13	-4	-4	-1.6
Aqueous Solutions	Water	100	-20	-13	3	-4	6.4
	10% Zinc Chloride	23	9	2	-12	-2	0.4
	Sea Water	23	9	3	-12	-1	0.5
	15% Sodium Chloride	23	9	2	-12	-1	0.3
	18% Calcium Chloride/ 14% Calcium Bromide	150	-37	-28	1	-6	1.0
	2.5% Detergent (Tide)	23	2	-5	-12	-2	0.4
Organic Solvents	Acetic Acid	23	-3	-13	-24	-5	8.8
	Acrylonitrile	23	6	-5	-19	-3	-6.2
	Aniline	23	3	-6	-15	-5	0.8
	Bromobenzene	23	-35	-30	-16	-15	116.2
	n-Butyl Acetate	23	27	16	-20	-1	-11.6
	Cyclohexane	23	-17	-12	-20	-13	87.5
	Diethyl Ether	23	-3	3	-16	-12	12.6
	Dimethylformamide	23	3	-4	-16	-8	4.5
	Dioctyl Phthalate	23	21	11	-12	-1	-9.0
	1,4-Dioxane	23	38	27	-8	12	-22.7
	95% Ethanol	23	3	-8	-20	-8	2.4
	Glycerol	23	0	-5	-12	-4	1.3
	n-Hexane	23	27	14	-20	-9	36.3
	Methylethylketone	23	24	6	-24	2	-21.6
	Nitrobenzene	23	39	16	-19	2	16.7
	Piperidine	23	32	16	-27	2	50.5
	1-Propanol	23	24	8	-24	2	-15.8
	Pyridine	23	21	2	-24	2	-16.1
	Trichloroethylene	23	-52	-41	-7	-23	194.7
	Turpentine	23	-32	-27	-16	-16	84.1
	Xylene	23	-54	-44	-7	-20	78.2
Petroleum Oils and Fuels	ASTM #1 Oil	100	-18	-13	-8	-12	35.4
		125	-40	-32	-8	-19	39.8
	IRM 902 Oil	100	-39	-27	-4	-17	69.3
		125	-38	-36	-20	-21	76.9
	IRM 903 Oil	100	-54	-41	-6	-20	94.0
		125	-49	-52	-33	-27	107.0
	Reference Fuel A (Isooctane)	23	-15	-9	-20	-13	36.6
	Reference Fuel B (Isooctane/Toluene, 70/30)	23	-49	-40	-7	-19	66.4
	Reference Fuel C (Isooctane/Toluene, 50/50)	23	-32	-25	-20	-17	68.9
Automotive Fluids	Automatic Transmission Fluid	125	-53	-46	-16	-18	62.2
	Hydraulic Brake Fluid	23	3	-6	-20	-3	0.2
		100	18	12	-7	5	-28.7
	Lithium Grease	23	-9	-9	-16	-7	11.9
		100	-26	-25	-20	-14	42.8
	Power Steering Fluid	125	-41	-33	-16	-20	71.7
	Antifreeze, 50/50 Ethylene Glycol (Prestone®)/water	125	-6	-8	-20	-6	6.8
Industrial Fluids	Pydraul® 312	125	-15	-19	-24	-8	17.6
	Skydrol® 500 B4	125	18	6	-17	2	-29.9
	Sunvis® 706 Fluid	125	-35	-30	-24	-15	58.1
	Ucon® CC732	125	-9	-14	-24	-8	11.4
	Ucon® 50HB5100	125	9	-2	-16	2	-18.9
	Freon® 11	5	-21	-10	-12	-15	106.7

[1] See note A, Disclaimer of Warranty and Liability, on inside front cover.
[2] All solution concentrations by weight.

TABLE V: 64 Shore A

Effect of 166 Hour Immersion (ASTM D-471) on Properties of 64 Shore A General Purpose Santoprene Thermoplastic Rubber[1,2]

	Fluids	Temp., °C	Ultimate Elongation, % Change	Tensile Strength, % Change	Stress at 100% Elongation, % Change	Hardness Change, Shore A Units	Weight, % Change
Acids and Alkalis	98% Sulfuric Acid	23	-21	-8	9	1	4.8
	10% Hydrochloric Acid	23	2	3	3	1	0.4
	50% Sodium Hydroxide	23	2	2	7	1	-0.1
	10% Potassium Hydroxide	23	5	5	5	1	0.2
Aqueous Solutions	Water	100	-5	-3	3	-3	5.8
	10% Zinc Chloride	23	2	2	8	1	0.2
	Sea Water	23	-1	2	-1	0	0.5
	15% Sodium Chloride	23	-13	-11	9	3	0.2
	18% Calcium Chloride/ 14% Calcium Bromide	150	-12	-13	-6	-3	-0.5
	2.5% Detergent (Tide)	23	3	1	9	2	0.1
Organic Solvents	Acetic Acid	23	2	1	-2	-2	6.4
	Acrylonitrile	23	3	11	9	0	-0.4
	Aniline	23	-1	-3	1	0	1.3
	Bromobenzene	23	-28	-22	-9	-14	95.5
	n-Butyl Acetate	23	10	12	-7	2	-7.0
	Cyclohexane	23	-20	-17	-11	-16	84.7
	Diethyl Ether	23	4	5	-9	-9	2.1
	Dimethylformamide	23	-1	-3	-4	1	1.9
	Dioctyl Phthalate	23	10	4	-3	1	-5.9
	1,4-Dioxane	23	3	-3	-7	0	-0.3
	95% Ethanol	23	11	2	-10	0	-1.6
	Glycerol	23	2	0	5	0	0.2
	n-Hexane	23	-14	-8	-6	-12	17.7
	Methylethylketone	23	16	16	0	4	-22.7
	Nitrobenzene	23	13	10	-5	4	-9.3
	Piperidine	23	-11	-7	-7	-12	24.9
	1-Propanol	23	17	11	-1	5	-12.7
	Pyridine	23	6	4	-3	3	-12.3
	Trichloroethylene	23	-49	-48	-18	-27	174.0
	Turpentine	23	-37	-26	-13	-19	74.1
	Xylene	23	-35	-24	-9	-14	56.8
Petroleum Oils and Fuels	ASTM #1 Oil	100	-20	-11	-5	-12	31.5
		125	-42	-28	6	-15	35.6
	IRM 902 Oil	100	-30	-20	-6	-16	57.7
		125	-39	-27	-10	-20	66.8
	IRM 903 Oil	100	-44	-31	-8	-20	80.2
		125	-51	-44	-19	-26	97.3
	Reference Fuel A (Isooctane)	23	-27	-15	-2	-15	29.9
	Reference Fuel B (Isooctane/Toluene, 70/30)	23	-39	-36	-11	-18	59.2
	Reference Fuel C (Isooctane/Toluene, 50/50)	23	-46	-28	-6	-20	59.1
Automotive Fluids	Automatic Transmission Fluid	125	-46	-27	-4	-21	61.9
	Hydraulic Brake Fluid	23	-1	2	7	1	-0.1
		100	11	26	10	7	-24.2
	Lithium Grease	23	-6	-4	5	-7	12.4
		100	-32	-16	5	-15	44.4
	Power Steering Fluid	125	-49	-26	-3	-22	73.4
	Antifreeze, 50/50 Ethylene Glycol (Prestone®)/water	125	-14	-11	-6	-2	5.7
Industrial Fluids	Pydraul® 312	125	-1	-12	-5	-11	19.0
	Skydrol® 500 B4	125	12	8	-9	4	-16.1
	Sunvis® 706 Fluid	125	-44	-25	-2	-21	58.3
	Ucon® CC732	125	-3	-5	-9	-4	4.6
	Ucon® 50HB5100	125	11	22	9	7	-21.2
	Freon® 11	5	-21	-12	-5	-13	56.7

[1] See note A, Disclaimer of Warranty and Liability, on inside front cover.
[2] All solution concentrations by weight.

TABLE VI: 73 Shore A

Effect of 166 Hour Immersion (ASTM D-471) on Properties of 73 Shore A General Purpose Santoprene Thermoplastic Rubber[1,2]

	Fluids	Temp., °C	Ultimate Elongation, % Change	Tensile Strength, % Change	Stress at 100% Elongation, % Change	Hardness Change, Shore A Units	Weight, % Change
Acids and Alkalis	98% Sulfuric Acid	23	-25	-12	20	2	4.0
	10% Hydrochloric Acid	23	0	4	8	1	0.6
	50% Sodium Hydroxide	23	1	5	15	1	-0.1
	10% Potassium Hydroxide	23	2	2	11	1	0.3
Aqueous Solutions	Water	100	-7	2	0	-3	4.5
	10% Zinc Chloride	23	0	2	2	3	0.1
	Sea Water	23	-4	-5	0	0	0.4
	15% Sodium Chloride	23	0	-4	-2	2	0.3
	18% Calcium Chloride/ 14% Calcium Bromide	150	-15	-10	8	-3	0.4
	2.5% Detergent (Tide)	23	1	1	9	1	0.1
Organic Solvents	Acetic Acid	23	1	1	2	-2	5.9
	Acrylonitrile	23	0	6	12	1	-0.8
	Aniline	23	-3	-3	12	1	1.3
	Bromobenzene	23	-17	-18	-13	-10	67.0
	n-Butyl Acetate	23	5	3	-11	1	-4.1
	Cyclohexane	23	-32	-25	-13	-16	64.7
	Diethyl Ether	23	0	-1	6	-5	0.3
	Dimethylformamide	23	5	6	0	2	0.9
	Dioctyl Phthalate	23	4	-1	2	1	-3.7
	1,4-Dioxane	23	3	-1	-2	0	0.7
	95% Ethanol	23	-1	-7	-2	1	-1.6
	Glycerol	23	-3	-6	2	1	0.3
	n-Hexane	23	-17	-12	-1	-12	12.8
	Methylethylketone	23	8	13	0	3	-10.2
	Nitrobenzene	23	6	6	4	3	-5.3
	Piperidine	23	-12	-12	-9	-10	18.0
	1-Propanol	23	13	21	0	6	-8.5
	Pyridine	23	5	7	-4	3	-11.6
	Trichloroethylene	23	-23	-14	-9	-14	139.0
	Turpentine	23	-30	-22	-5	-14	54.5
	Xylene	23	-25	-21	-11	-13	45.2
Petroleum Oils and Fuels	ASTM #1 Oil	100	-20	-12	-6	-9	28.7
		125	-27	-16	-9	-15	33.5
	IRM 902 Oil	100	-30	-21	-6	-13	42.1
		125	-41	-29	-10	-17	50.2
	IRM 903 Oil	100	-44	-33	-13	-20	60.6
		125	-51	-40	-21	-26	74.5
	Reference Fuel A (Isooctane)	23	-25	-15	-9	-11	22.5
	Reference Fuel B (Isooctane/Toluene, 70/30)	23	-20	-14	-15	-20	41.6
	Reference Fuel C (Isooctane/Toluene, 50/50)	23	-27	-20	-13	-12	46.9
Automotive Fluids	Automatic Transmission Fluid	125	-42	-27	-21	-22	59.1
	Hydraulic Brake Fluid	23	5	8	-4	2	-2.4
		100	15	21	6	6	-18.7
	Lithium Grease	23	-12	-6	-4	-2	8.8
		100	-20	-17	-6	-10	32.6
	Power Steering Fluid	125	-50	-38	-19	-28	68.2
	Antifreeze, 50/50 Ethylene Glycol (Prestone®)/water	125	-15	-4	-6	-1	4.4
Industrial Fluids	Pydraul® 312	125	-25	-19	-13	-11	21.7
	Skydrol® 500 B4	125	8	9	-11	3	-11.6
	Sunvis® 706 Fluid	125	-42	-29	-17	-19	54.5
	Ucon® CC732	125	-12	-4	-6	-4	7.3
	Ucon® 50HB5100	125	5	21	9	10	-21.7
	Freon® 11	5	-12	-7	-8	-11	43.0

[1] See note A, Disclaimer of Warranty and Liability, on inside front cover.
[2] All solution concentrations by weight.

TABLE VII: 80 Shore A

Effect of 166 Hour Immersion (ASTM D-471) on Properties of 80 Shore A General Purpose Santoprene Thermoplastic Rubber[1,2]

	Fluids	Temp., °C	Ultimate Elongation, % Change	Tensile Strength, % Change	Stress at 100% Elongation, % Change	Hardness Change, Shore A Units	Weight, % Change
Acids and Alkalis	98% Sulfuric Acid	23	-25	-19	8	0	3.0
	10% Hydrochloric Acid	23	7	11	1	1	0.6
	50% Sodium Hydroxide	23	-4	1	6	0	-0.1
	10% Potassium Hydroxide	23	0	-2	7	0	0.9
Aqueous Solutions	Water	100	-26	-13	2	-2	3.1
	10% Zinc Chloride	23	0	2	2	1	0.4
	Sea Water	23	-7	-8	2	0	0.5
	15% Sodium Chloride	23	-10	-14	2	0	0.4
	18% Calcium Chloride/ 14% Calcium Bromide	150	-27	-19	8	-4	0.7
	2.5% Detergent (Tide)	23	-1	-3	7	1	-0.1
Organic Solvents	Acetic Acid	23	-2	-3	3	-2	4.6
	Acrylonitrile	23	1	2	9	0	0.7
	Aniline	23	-2	-5	0	-1	1.3
	Bromobenzene	23	-19	-19	-10	-10	50.0
	n-Butyl Acetate	23	2	6	-3	0	-6.6
	Cyclohexane	23	-19	-21	-18	-14	54.8
	Diethyl Ether	23	-5	-6	-11	-5	0.3
	Dimethylformamide	23	2	4	-1	1	1.0
	Dioctyl Phthalate	23	0	-3	3	0	-1.0
	1,4-Dioxane	23	0	-4	-2	-1	1.6
	95% Ethanol	23	6	0	-2	0	-1.9
	Glycerol	23	-4	-6	4	0	0.4
	n-Hexane	23	-10	-11	-14	-12	11.3
	Methylethylketone	23	7	10	-3	2	-11.1
	Nitrobenzene	23	2	1	2	1	-4.6
	Piperidine	23	-6	-7	-7	-14	16.8
	1-Propanol	23	10	12	-6	1	-7.2
	Pyridine	23	2	8	3	2	-7.1
	Trichloroethylene	23	-29	-24	-13	-16	120.0
	Turpentine	23	-26	-27	-17	-15	48.9
	Xylene	23	-24	-24	-15	-14	37.8
Petroleum Oils and Fuels	ASTM #1 Oil	100	-17	-4	-2	-7	17.1
		125	-38	-23	-7	-10	25.2
	IRM 902 Oil	100	-27	-18	-3	-12	36.7
		125	-44	-26	-4	-16	45.9
	IRM 903 Oil	100	-40	-28	-10	-17	55.4
		125	-54	-38	-16	-24	71.3
	Reference Fuel A (Isooctane)	23	-10	-7	-4	-7	20.2
	Reference Fuel B (Isooctane/Toluene, 70/30)	23	-14	-16	-10	-9	40.7
	Reference Fuel C (Isooctane/Toluene, 50/50)	23	-17	-16	-10	-11	42.5
Automotive Fluids	Automatic Transmission Fluid	125	-43	-27	-18	-10	46.7
	Hydraulic Brake Fluid	23	7	16	-3	1	-1.7
		100	10	22	-1	3	-14.5
	Lithium Grease	23	-10	-5	-3	-1	5.5
		100	-24	-7	-4	-9	23.2
	Power Steering Fluid	125	-40	-30	-19	-21	56.0
	Antifreeze, 50/50 Ethylene Glycol (Prestone®)/water	125	-17	-21	-3	-2	4.2
Industrial Fluids	Pydraul® 312	125	-21	-11	-7	-8	18.3
	Skydrol® 500 B4	125	-12	-4	-6	0	-7.1
	Sunvis® 706 Fluid	125	-43	-24	-16	-17	44.2
	Ucon® CC732	125	-31	-4	-1	-3	4.6
	Ucon® 50HB5100	125	0	21	12	6	-21.8
	Freon® 11	5	-13	-12	-12	-12	41.8

[1] See note A, Disclaimer of Warranty and Liability, on inside front cover.
[2] All solution concentrations by weight.

TABLE VIII: 87 Shore A

Effect of 166 Hour Immersion (ASTM D-471) on Properties of 87 Shore A General Purpose Santoprene Thermoplastic Rubber[1,2]

	Fluids	Temp., °C	Ultimate Elongation, % Change	Tensile Strength, % Change	Stress at 100% Elongation, % Change	Hardness Change, Shore A Units	Weight, % Change
Acids and Alkalis	98% Sulfuric Acid	23	-23	-18	8	-1	2.1
	10% Hydrochloric Acid	23	-12	-13	-15	6	0.3
	50% Sodium Hydroxide	23	1	7	4	-4	-0.1
	10% Potassium Hydroxide	23	1	1	6	-1	0.1
Aqueous Solutions	Water	100	-16	-6	6	4	2.9
	10% Zinc Chloride	23	-11	-13	-17	5	0.0
	Sea Water	23	-2	7	-1	4	0.3
	15% Sodium Chloride	23	-7	-10	-6	5	0.7
	18% Calcium Chloride/ 14% Calcium Bromide	150	-29	-14	10	-2	-0.1
	2.5% Detergent (Tide)	23	3	3	3	0	-0.1
Organic Solvents	Acetic Acid	23	3	2	2	-2	3.2
	Acrylonitrile	23	2	4	10	-4	0.9
	Aniline	23	-1	-6	-1	-2	1.5
	Bromobenzene	23	-6	-9	-12	-3	41.9
	n-Butyl Acetate	23	-5	-8	-20	5	0.3
	Cyclohexane	23	-37	-42	-38	-6	45.3
	Diethyl Ether	23	-2	-3	-5	-7	-1.8
	Dimethylformamide	23	-4	5	0	6	0.0
	Dioctyl Phthalate	23	1	-3	3	-1	-0.2
	1,4-Dioxane	23	-2	-6	-5	-3	1.1
	95% Ethanol	23	6	-2	-1	0	-1.7
	Glycerol	23	2	1	3	-2	0.2
	n-Hexane	23	-10	-8	-6	-10	5.7
	Methylethylketone	23	-5	-6	-21	6	-4.8
	Nitrobenzene	23	0	-2	2	-2	-1.5
	Piperidine	23	-13	-15	-7	-9	12.8
	1-Propanol	23	-7	-2	0	6	-4.3
	Pyridine	23	-2	5	-6	6	-1.9
	Trichloroethylene	23	7	5	-15	-13	97.2
	Turpentine	23	-20	-25	-15	-10	34.8
	Xylene	23	-16	-15	-10	-11	24.9
Petroleum Oils and Fuels	ASTM #1 Oil	100	-12	-9	-1	1	13.5
		125	-30	-22	-9	-1	21.6
	IRM 902 Oil	100	-15	-14	0	-5	20.8
		125	-29	-21	-3	-7	29.3
	IRM 903 Oil	100	-24	-22	-9	-9	35.4
		125	-40	-31	-16	-15	50.6
	Reference Fuel A (Isooctane)	23	-14	-15	-18	-1	13.2
	Reference Fuel B (Isooctane/Toluene, 70/30)	23	-18	-16	-19	-7	24.5
	Reference Fuel C (Isooctane/Toluene, 50/50)	23	-33	-32	-25	-4	29.4
Automotive Fluids	Automatic Transmission Fluid	125	-37	-23	-18	-11	43.4
	Hydraulic Brake Fluid	23	-5	2	-5	5	-1.8
		100	-11	-6	-3	6	-12.8
	Lithium Grease	23	-7	-2	-8	5	3.5
		100	-12	-12	-8	-7	18.8
	Power Steering Fluid	125	-46	-41	-32	-12	52.2
	Antifreeze, 50/50 Ethylene Glycol (Prestone®)/water	125	-16	-1	-4	2	3.1
Industrial Fluids	Pydraul® 312	125	-21	-15	-10	0	17.6
	Skydrol® 500 B4	125	-7	4	1	4	-4.2
	Sunvis® 706 Fluid	125	-33	-23	-16	-8	39.9
	Ucon® CC732	125	-9	-1	-4	2	5.3
	Ucon® 50HB5100	125	-5	14	16	8	-17.6
	Freon® 11	5	-8	-12	-12	-9	32.3

[1] See note A, Disclaimer of Warranty and Liability, on inside front cover.
[2] All solution concentrations by weight.

TABLE IX: 40 Shore D

Effect of 166 Hour Immersion (ASTM D-471) on Properties of 40 Shore D General Purpose Santoprene Thermoplastic Rubber[1,2]

	Fluids	Temp., °C	Ultimate Elongation, % Change	Tensile Strength, % Change	Stress at 100% Elongation, % Change	Hardness Change, Shore A Units	Weight, % Change
Acids and Alkalis	98% Sulfuric Acid	23	-21	-18	3	4	1.7
	10% Hydrochloric Acid	23	2	4	1	1	0.2
	50% Sodium Hydroxide	23	-1	4	1	2	-0.2
	10% Potassium Hydroxide	23	0	1	1	1	0.3
Aqueous Solutions	Water	100	-7	0	4	-1	1.7
	10% Zinc Chloride	23	0	2	0	0	0.2
	Sea Water	23	4	3	0	1	0.2
	15% Sodium Chloride	23	2	4	1	0	0.2
	18% Calcium Chloride/ 14% Calcium Bromide	150	-26	-12	6	2	-0.2
	2.5% Detergent (Tide)	23	-2	-3	0	1	0.1
Organic Solvents	Acetic Acid	23	-5	-6	-2	1	2.6
	Acrylonitrile	23	-1	1	3	4	1.3
	Aniline	23	-2	-6	-6	-2	1.3
	Bromobenzene	23	-10	-14	-14	-10	45.7
	n-Butyl Acetate	23	-4	-7	-6	0	-1.4
	Cyclohexane	23	-5	-14	-23	-15	35.6
	Diethyl Ether	23	-7	-6	-11	-5	-3.1
	Dimethylformamide	23	-2	-8	-2	0	0.5
	Dioctyl Phthalate	23	-5	-8	-2	0	-0.6
	1,4-Dioxane	23	-6	-9	-8	0	2.0
	95% Ethanol	23	11	1	-4	0	-1.5
	Glycerol	23	-2	-2	-1	-1	0.4
	n-Hexane	23	-11	-11	-12	-9	3.0
	Methylethylketone	23	2	0	-6	1	-4.4
	Nitrobenzene	23	-5	-8	-2	0	0.8
	Piperidine	23	-10	-10	-11	-7	11.1
	1-Propanol	23	2	-1	-1	0	-1.7
	Pyridine	23	0	-2	-6	1	-0.5
	Trichloroethylene	23	-23	-24	-21	-13	76.9
	Turpentine	23	-17	-21	-16	-12	27.7
	Xylene	23	-19	-22	-22	-11	21.2
Petroleum Oils and Fuels	ASTM #1 Oil	100	-9	-2	1	-4	6.5
		125	-20	-11	-4	-9	14.4
	IRM 902 Oil	100	-12	-12	2	-4	16.0
		125	-25	-17	0	-8	24.0
	IRM 903 Oil	100	-21	-20	-9	-11	29.0
		125	-39	-26	-14	-17	44.0
	Reference Fuel A (Isooctane)	23	0	-6	-11	-6	12.4
	Reference Fuel B (Isooctane/Toluene, 70/30)	23	-2	-6	-16	-10	21.3
	Reference Fuel C (Isooctane/Toluene, 50/50)	23	-2	-6	-18	-11	25.7
Automotive Fluids	Automatic Transmission Fluid	125	-37	-24	-16	-18	32.6
	Hydraulic Brake Fluid	23	-2	1	-2	0	-0.7
		100	0	7	9	1	-8.8
	Lithium Grease	23	-4	0	-4	-1	1.7
		100	-12	-9	-3	-8	11.5
	Power Steering Fluid	125	-30	-21	-19	-18	39.3
	Antifreeze, 50/50 Ethylene Glycol (Prestone®)/water	125	-9	-5	0	0	2.4
Industrial Fluids	Pydraul® 312	125	-11	-6	-3	-4	14.6
	Skydrol® 500 B4	125	-7	2	3	-1	-0.5
	Sunvis® 706 Fluid	125	37	-25	-15	-16	29.6
	Ucon® CC732	125	-12	-2	3	2	2.0
	Ucon® 50HB5100	125	-2	7	15	6	-15.3
	Freon® 11	5	-7	-12	-7	-9	27.0

[1] See note A, Disclaimer of Warranty and Liability, on inside front cover.
[2] All solution concentrations by weight.

TABLE X: 50 Shore D

Effect of 166 Hour Immersion (ASTM D-471) on Properties of 50 Shore D General Purpose Santoprene Thermoplastic Rubber[1,2]

	Fluids	Temp., °C	Ultimate Elongation, % Change	Tensile Strength, % Change	Stress at 100% Elongation, % Change	Hardness Change, Shore A Units	Weight, % Change
Acids and Alkalis	98% Sulfuric Acid	23	-10	-12	1	3	0.4
	10% Hydrochloric Acid	23	0	0	1	3	0.1
	50% Sodium Hydroxide	23	-4	0	0	3	-0.3
	10% Potassium Hydroxide	23	-2	-1	6	2	0.1
Aqueous Solutions	Water	100	-9	-1	6	0	1.6
	10% Zinc Chloride	23	-7	0	6	2	0.1
	Sea Water	23	-2	-1	3	2	0.0
	15% Sodium Chloride	23	-4	-2	-1	3	-0.1
	18% Calcium Chloride/ 14% Calcium Bromide	150	-18	-7	12	1	0.2
	2.5% Detergent (Tide)	23	-3	-3	0	2	0.1
Organic Solvents	Acetic Acid	23	-2	-5	0	0	1.4
	Acrylonitrile	23	-3	0	3	2	1.5
	Aniline	23	-1	-7	-7	1	0.7
	Bromobenzene	23	-10	-17	-9	-10	32.2
	n-Butyl Acetate	23	-2	-8	-3	-3	2.1
	Cyclohexane	23	-3	-22	-25	-17	28.6
	Diethyl Ether	23	0	-9	-9	-7	0.2
	Dimethylformamide	23	-4	-1	4	2	0.2
	Dioctyl Phthalate	23	-2	-9	-6	0	0.5
	1,4-Dioxane	23	-2	-7	-8	-3	4.1
	95% Ethanol	23	10	1	-4	0	-0.7
	Glycerol	23	0	-2	-2	2	0.5
	n-Hexane	23	-1	-13	-16	-10	3.0
	Methylethylketone	23	-2	-5	-3	0	1.3
	Nitrobenzene	23	2	-8	-5	0	2.8
	Piperidine	23	-5	-14	-11	-11	11.1
	1-Propanol	23	1	-4	-3	4	-0.7
	Pyridine	23	0	-9	-9	-1	1.9
	Trichloroethylene	23	-8	-19	-17	-13	56.0
	Turpentine	23	-4	-17	-14	-12	19.6
	Xylene	23	-6	-17	-16	-12	14.4
Petroleum Oils and Fuels	ASTM #1 Oil	100	-9	-9	1	-2	5.4
		125	-21	-17	-3	-8	14.0
	IRM 902 Oil	100	-8	-7	5	-2	11.5
		125	-23	-17	4	-7	20.9
	IRM 903 Oil	100	-11	-18	-5	-9	23.6
		125	-32	-29	-10	-17	41.0
	Reference Fuel A (Isooctane)	23	-2	-17	-14	-11	7.5
	Reference Fuel B (Isooctane/Toluene, 70/30)	23	-11	-20	-18	-14	14.0
	Reference Fuel C (Isooctane/Toluene, 50/50)	23	-11	-24	-15	-15	16.8
Automotive Fluids	Automatic Transmission Fluid	125	-26	-26	-11	-15	31.4
	Hydraulic Brake Fluid	23	-5	-3	5	2	-0.3
		100	-7	-2	7	3	-2.4
	Lithium Grease	23	-3	-3	-1	0	1.6
		100	-11	-13	0	-7	12.0
	Power Steering Fluid	125	-34	-32	-13	-18	39.3
	Antifreeze, 50/50 Ethylene Glycol (Prestone®)/water	125	-16	-5	7	1	1.8
Industrial Fluids	Pydraul® 312	125	-15	-10	-1	-6	14.0
	Skydrol® 500 B4	125	-13	-9	8	0	1.2
	Sunvis® 706 Fluid	125	-25	-24	-8	-17	27.3
	Ucon® CC732	125	-15	-5	8	-1	3.0
	Ucon® 50HB5100	125	-8	-1	18	7	-11.3
	Freon® 11	5	-10	-17	-16	-10	23.9

[1] See note A, Disclaimer of Warranty and Liability, on inside front cover.
[2] All solution concentrations by weight.

Estimating Solvent Resistance of Santoprene Thermoplastic Rubber

The resistance of Santoprene thermoplastic rubber to a specific solvent can be estimated from that solvent's solubility parameter and hydrogen bonding group. For a given solvent the solubility parameter is a quantitative value, whereas the hydrogen bonding group is qualitative (low, medium, or high). A detailed discussion of these parameters may be found in (1) J. Brandup and E.H. Immergut, "Polymer Handbook", 2d Ed., Wiley-Interscience, New York, 1975, IV 340; (2) E.P. Lieberman, Official Digest, Federation Society of Paint Technologists, 34, 30-50 (1967).

Table XI gives these two parameters for those solvents in which the resistance of Santoprene rubber has actually been tested (Tables II-X), and for a second group of solvents not tested. The tested solvents may be grouped as shown in the chart below.

The various solvents are classed into three hydrogen bonding groups, with the solubility parameter progressively decreasing in each group. This arrangement thus provides a "map" of the solvents tested, which may be used to estimate the fluid resistance of an untested solvent if its hydrogen bonding group and solubility parameter are known.

The fluid resistance of an untested solvent should be comparable to that of a tested solvent with approximately the same solubility parameter and from the same hydrogen bonding group. As an example, the effect of furan (solubility parameter 9.4, medium hydrogen bonding group) on Santoprene rubber may be estimated from that of the tested solvent with the most similar solubility parameter in the same hydrogen bonding group. This solvent is methylethylketone (solubility parameter 9.3, medium hydrogen bonding group). Thus the solvent resistance of Santoprene rubber to furan should be similar to that of methylethylketone reported in Tables II-X.

These estimates are intended only as a guide to indicate the relative resistance of Santoprene rubber to different fluids. The estimates are not specific recommendations for the use of Santoprene rubber in a given fluid or solvent environment. Actual testing in the given fluid should be conducted before Santoprene rubber is used commercially in contact with it.

For additional technical information, call the AES AnswerPerson at 1-800-305-8070 or 330-849-5272 from 8:00 A.M. to 6:00 P.M. U.S. Eastern Time; or call your nearest AES representative listed on the back cover; or visit our web site at www.aestpe.com.

	Low Hydrogen Bonding Group	Medium Hydrogen Bonding Group	High Hydrogen Bonding Group	
increasing solubility parameter ↑	Bromobenzene	Dimethylformamide	Glycerol	↓ decreasing solubility parameter
	Trichloroethylene	1,4-Dioxane	1-Propanol	
	Xylene	Methylethylketone	Aniline	
	Cyclohexane	n-Butyl Acetate	Acetic Acid	
	n-Hexane	Diethyl Ether	Piperidine	

TABLE XI:

Solubility parameters and hydrogen bonding groups[1]

Solvents Tested With Santoprene® Rubber	Solubility Parameter	Hydrogen Bonding Group
n-Hexane	7.3	Low
Diethyl Ether	7.4	Medium
Freon 11	7.6	Low
Dioctyl Phthalate	7.9	Medium
Turpentine	8.1	Low
Cyclohexane	8.2	Low
n-Butyl Acetate	8.5	Medium
Piperidine	8.7	High
Xylene	8.8	Low
Trichloroethylene	9.3	Low
Methylethylketone	9.3	Medium
Bromobenzene	9.9	Low
1,4-Dioxane	10.0	Medium
Nitrobenzene	10.0	Low
Acetic Acid	10.1	High
Aniline	10.3	High
Acrylonitrile	10.5	Low
Pyridine	10.7	High
1-Propanol	11.9	High
Dimethylformamide	12.1	Medium
Glycerol	16.5	High
Water	23.4	High
Additional Common Solvents Not Tested		
Acetone	9.9	Medium
Acetonitrile	11.9	Low
Acetyl Chloride	9.5	Medium
Allyl Alcohol	11.8	High
n-Amyl Alcohol	10.9	High
Benzaldehyde	9.4	Medium
Benzene	9.2	Low
Benzyl Alcohol	12.1	High
1,4-Butanediol	12.1	High
n-Butanol	11.4	High
n-Butyl Cellosolve	9.5	Medium
Butyraldehyde	9.0	Medium
Butyric Acid	10.5	High
Caprolactone	10.1	Medium
Carbon Disulfide	10.0	Low
Carbon Tetrachloride	8.6	Low
Cellosolve Acetate	8.7	Medium
Chlorobenzene	9.5	Low
Chloroform	9.3	Low
m-Cresol	10.2	High
Cyclohexanol	11.4	High
n-Decane	6.6	Low
1,2-Dibromoethylene	10.1	Low
Dibromomethane	10.4	Low

[1] See note A, Disclaimer of Warranty and Liability, on inside front cover.

Additional Common Solvents Not Tested	Solubility Parameter	Hydrogen Bonding Group
Dibutyl Ether	7.7	Medium
Dibutyl Phthalate	9.3	Medium
o-Dichlorobenzene	10.0	Low
Diethylene Glycol	12.1	High
Diethylformamide	10.6	Medium
Diisobutylene	7.7	Low
Diisopropyl Ether	6.9	Medium
Dimethyl Phosphite	12.5	Medium
Dimethyl Phthalate	10.7	Medium
Dimethyl Sulfoxide	12.0	Medium
Dioctyl Adipate	8.7	Medium
Dipropylene Glycol	10.0	High
Ethanol	12.7	High
Ethyl Acetate	9.1	Medium
Ethylbenzene	8.8	Low
Ethyl Chloride	9.2	Medium
Ethylene Glycol	14.6	High
Formamide	19.2	High
Formic Acid	12.1	High
Freon 12	5.5	Low
Freon 22	7.6	Low
Furan	9.4	Medium
n-Heptane	7.4	Low
Methanol	14.5	High
Methyl Cellosolve	10.8	Medium
Methyl Iodide	10.2	Medium
Methyl Methacrylate	8.8	Medium
Methylene Chloride	9.7	Low
Mineral Spirits	6.9	Low
Naphthalene	9.9	Low
Nitroethane	11.1	Low
1-Nitropropane	10.3	Low
n-Octane	7.6	Low
Pentachloroethane	9.4	Low
n-Pentane	7.0	Low
2,4-Pentanediol	10.8	High
Perchloroethylene	9.3	Low
Phenol	14.5	High
Propionic Acid	9.9	High
Propionitrile	10.8	Low
Propylene Oxide	9.2	Medium
2-Pyrrolidone	14.7	High
1,1,2,2-Tetrachloroethane	9.7	Low
Tetrahydrofuran	9.1	Medium
Toluene	8.9	Low
1,1,2-Trichloroethane	9.6	Low
"Varsol 2"	7.6	Low

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Fluid Resistance

The resistance of Santoprene rubber to heat and oil can be classified using the ASTM D2000/SAE J200 Standard Classification System for rubbers, as shown in Table IV.

Santoprene rubber offers fluid resistance equivalent to that of many specialty thermoset rubbers, such as polychloroprene compounds. A brief summary of the data for several fluids is given in Table V. These data show the excellent resistance of Santoprene rubber to aqueous fluids, including acids and bases.

Rubbers with hardnesses greater than 40 Shore Dare not included in the ASTM D2000/SAE J200 classification system.

Additional fluid resistance data for all grades of Santoprene rubber are included in TPE-03-07 "Santoprene Thermoplastic Rubber Fluid Resistance." Actual performance of parts made from Santoprene rubber in any specific application requiring fluid resistance is best determjned by specific testing in that application.

TABLE IV:

Standard Classification Systems

Grade	Type and Class
35A	AA, BA, BC, CA
45A	AA, BA, BC, CA
55A	AA, BA, BC, CA
64A	AA, BA, BC, BE, CA
73A	AA,BA,BC,BE,CA,CE
80A	AA, BA, BC, BE, BF, CA, CE
87A	AA, BA, BC, BE, BF, CA, CE
40D	AA, BA, BC, BE, BF, CA, CE

TABLE V: Typical Fluid Resistance, %Weight Change of Santoprene® Thermoplastic Rubber ASTM 0471[1]

Fluid	Test Time (hours)	Test Temp °C(OF)	Grades of Santoprene Rubber								
			35A	45A	55A	64A	73A	80A	87A	400	500
Water	166	100 (212)	5	6	6	6	5	3	3	2	2
Antifreeze[2]	166	125 (257)	7	5	7	6	4	4	3	2	2
15% Salt (NaCI)	166	23 (73)	0	0	0	0	0	0	0	0	0
50% Sodium Hydroxide	166	23 (73)	0	0	0	0	0	0	0	0	0
98% Sulfuric Acid	166	23 (73)	2	5	3	5	4	3	2	2	0
IRM 902 Oil	166	100 (212)	NIT	77	69	58	42	37	21	16	12
TRM 903 Oil	166	100 (212)	108	102	94	80	61	55	35	29	24
ASTM #1 Oil	166	100 (212)	52	45	35	30	30	20	15	6	5
Sunvis 706[3]	166	125 (257)	90	77	58	58	55	44	40	30	27
Skydrol®500 (B- 4)[4]	166	100 (212)	-40	-32	-30	-26	-13	-8	-5	-1	-I
Pydraul®312C'	166	125 (257)	30	29	18	19	22	18	18	15	14
DOT 3 Brake Fluid	166	100 (212)	-45	-37	-29	-30	-1 8	-14	-13	-9	-10
Automatic Transmission Fluid	166	125 (257)	87	88	62	62	59	47	43	33	31
Reference Fuel B	166	23 (73)	NIT	NIT	66	50	42	40	25	21	17
Lithium Grease[6]	166	100(212)	61	50	43	39	33	23	19	II	10

1. See Disclaimer on inside front cover.
2. 50% by volume Prestone antifreeze in type IV reagent water. Prestone is a trademark of Union Carbide Corp.
3. Sunvis is a trademark of Sun Oil Company and is a lubricating oil.
4. Skydrol' is the registered trademark of Solutia for hydraulic fluid.
5. NfT = Not Tested
6. DOT 3 SAE J 1703