

A STUDY OF THE COMPARATIVE STRENGTH VALUES OF
COTTON-MODIFIED RAYON AND OF ALL-COTTON FABRICS
OF SIMILAR CONSTRUCTION

A THESIS

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We hereby recommend that the **thesis** prepared under
our supervision by Soae Lee

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Cotton-Modified Rayon and of All-Cotton Fabrics
of Similar Construction

be accepted as fulfilling this part of the requirements for the Degree of
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INTRODUCTION

In recent years, a modified form of rayon has appeared on the market which is higher in strength than was the case earlier, and which has posed a serious problem to the cotton industry. This is because of the fact that the modified rayon can be produced at a cheaper price than cotton at the present time and because of the further fact that staple fibers of the modified rayon can be blended with cotton producing a fabric having a good appearance. Horne and McCord (2) staff members of the National Cotton Council of America, have the following to say concerning the threat to cotton of modified rayon, which is coming onto the market in increasing quantities:

"The modified rayons are being put into direct competition with cotton through blends with cotton. Sheets and pillowcases illustrate the threat from modified rayons. They represent an annual outlet for 600,000 bales of cotton. The cost of cotton in a combed sheet is about \$1.04; fiber costs for cotton (82¢) and modified rayon (36¢) in a 60 per cent cotton -- 40 per cent modified rayon blended sheet total approximately 98 cents. If these 60-40 blended sheets should take half of the market over the next five years, cotton consumption would decline by at least 120,000 bales unless the blended sheets cause the total market to expand by at least 25 per cent. Blended sheets still have to be tested in consumer markets, and tests are just beginning. As of now, cotton satisfies all major quality requirements in sheets, and it has strong consumer acceptance; yet, because of price considerations, manufacturers are beginning to test modified rayons in sheets."

Two types of cotton-modified rayon blends are coming with increasing speed onto the consumer market. These are being promoted chiefly for women's and children's wear and for sheets and

pillowcases. The two major types of modified rayon are Zantrel, promoted by the American Enka Corporation, and Avril, manufactured by the American Viscose Corporation. Women's and children's ready-made dresses are on the market made of blends of each of these fibers with cotton. The advertising literature concerning these blends is lavish in praise of the appearance and strength of these blends.

OBJECTIVES OF THE STUDY

The purpose of the study upon which this thesis is based was to ascertain the validity of the modified rayon manufacturers' claim as having good dry strength, superior wet strength and superior wash-and-wear performance throughout repeated launderings of the fabrics.

The specific objectives of the study were as follows:

- a). To find the modified rayon and blends of cotton fabrics and match these fabrics with 100 per cent cotton fabrics comparable in construction.
- b). To compare the modified rayon and cotton blends with 100 per cent cotton with respect to tensile and tearing strengths, and wash-and-wear properties initially, and after one, five, 10, 20, 35, and 50 launderings.

- c). To determine the retention of whiteness initially,
after 20, and 50 launderings.

METHODS OF PROCEDURE

DESCRIPTION OF EXPERIMENTAL FABRICS

Eleven fabrics composed of cotton and modified rayon were purchased as the experimental fabrics of this study. In addition, each of the cotton-modified rayon fabrics were matched with a 100 per cent cotton fabric which was comparable in construction. All of the experimental fabrics were chosen as suitable for the making of women's and children's dresses.

Approximately 30 yards of each fabric were purchased at major retail and wholesale sources in the late winter and spring, 1962-1963. The cotton-modified rayon fabrics were intimate blends of the two types of fibers, with percentage composition and other characteristics given in Summary I on the following page. The 11 experimental fabrics were matched with 100 per cent cotton fabrics of similar construction.

There was a similarity in weight and construction of some of the experimental fabrics, although they were manufactured by different establishments. The chief source of these fabrics was through a retail outlet, sometimes by locating a manufacturing source and requesting a retail store to order the specific textile.

S U M M A R Y I

PRICE LIST AND PHYSICAL CHARACTERISTICS OF THE EXPERIMENTAL FABRICS

PART A: MODIFIED RAYON FABRICS

Fabric Number	Fiber Content	Yarn Count		Weight per Square Yard	Price
		Warp	Filling		
1	50% Zantrel - 50% Cotton	116.0	60.4	4.05 ounces	\$ 1.19
2	50% Zantrel - 50% Cotton	84.6	80.6	3.00 ounces	1.00
3	50% Zantrel - 50% Cotton	116.8	61.0	3.70 ounces	--
4	50% Avril - 50% Cotton	85.8	78.2	3.25 ounces	0.39
5	50% Avril - 50% Cotton	111.4	55.2	3.91 ounces	0.48
6	50% Avril - 50% Cotton	112.0	55.2	3.99 ounces	0.48
7	50% Zantrel - 50% Cotton	114.6	56.8	3.98 ounces	0.74
8	50% Zantrel - 50% Cotton	83.2	77.8	3.24 ounces	0.74
9	50% Zantrel - 50% Cotton	115.2	62.0	4.13 ounces	0.58
10	50% Zantrel - 50% Cotton	113.4	61.0	3.89 ounces	0.74
11	45% Zantrel - 55% Cotton	97.2	87.0	3.74 ounces	1.00

PART B: COTTON FABRICS

Fabric Number	Fiber Content	Yarn Count		Weight per Square Yard	Price
		Warp	Filling		
1a	100% Cotton	115.8	55.0	3.71 ounces	\$ 0.39
2a	100% Cotton	86.8	75.4	3.07 ounces	1.00
3a	100% Cotton	115.8	55.0	3.62 ounces	0.39
4a	100% Cotton	86.8	75.4	3.07 ounces	1.00
5a	100% Cotton	116.4	56.2	3.60 ounces	1.19
6a	100% Cotton	116.4	56.2	3.63 ounces	1.19
7a	100% Cotton	116.4	56.2	3.63 ounces	1.19
8a	100% Cotton	84.8	75.4	3.20 ounces	0.77
9a	100% Cotton	115.8	55.0	3.71 ounces	0.39
10a	100% Cotton	116.4	56.2	3.63 ounces	1.19
11a	100% Cotton	98.0	90.0	3.79 ounces	1.00

METHODS OF LAUNDERING EXPERIMENTAL FABRICS

Each of the 11 experimental fabrics used in the study were divided into three equal lengths after initial test pieces were removed and a small amount of reserve fabric was saved. These three pieces of experimental fabrics were laundered at three different temperatures in an automatic home washing machine.

The experimental fabrics were subjected to a series of 50 washings with the following as the highest temperatures in the washing cycle: (a) 120° to 125° F.; (b) 140° to 145° F.; (c) 160° to 165° F.

The laundering methods used in this part of the study were the following:

AUTOMATIC HOME WASHING MACHINE METHOD

<u>METHOD:</u>	<u>I</u> <u>REGULAR</u> <u>COTTON CYCLE</u>	<u>II</u> <u>REGULAR</u> <u>COTTON CYCLE</u>	<u>III</u> <u>REGULAR</u> <u>COTTON CYCLE</u>
<u>TEMPERATURE:</u>	120° - 125° F.	140° - 145° F.	160° - 165° F.
<u>TIME:</u>	10 minutes	10 minutes	10 minutes
<u>AGITATION:</u>	68 strokes per minute	68 strokes per minute	68 strokes per minute
<u>WASHING LOAD:</u>	8 pounds	8 pounds	8 pounds
<u>WATER:</u>	Softened	Softened	Softened
<u>DETERGENT:</u>	Tide	Tide	Tide

(Note: Tide for entire study will be secured in one lot, and concentration will be 0.2% of wash water volume)

After each laundering, all fabrics were hung by means of straight pins to a cloth-covered line inside the University Laundry, and the fabrics were allowed to dry on the lines.

Dummy pieces were used to make up a full capacity load for the machine during the laundering as pieces of the experimental fabrics and the matching cottons were removed for testing.

STRENGTH RETENTION OF EXPERIMENTAL FABRICS

BREAKING STRENGTH

The breaking strength determinations were made in the dry as well as the wet state, according to the Raveled Strip Method of the American Society For Testing Materials, D 39-59 (1).

Two sets of warp and filling specimens were cut from the initial fabrics after five, 10, 20, 35, and 50 respective laundrings. Specimens were cut 1 1/4 inches wide and six inches long; and they were raveled to one inch in width with approximately the same number of yarns removed from each side.

The warp specimens were cut with the longer dimension parallel to the warp yarns; and the filling specimens were cut with the longer dimension parallel to the filling yarns.

After being prepared, the dry specimens were placed under standard conditions in a constant humidity, constant temperature

65 \pm 2 per cent relative humidity, and 70⁰F. \pm 2⁰F. at least four hours before testing.

The wet specimens were immersed in distilled water two hours ahead of testing.

The Scott Tensile Tester Model DH-2 was used for the tests. Breaking strengths of the five specimens of each fabric were recorded and averaged. The yarn counts were taken after each respective set of launderings, and breaking strengths were calculated per 100 yarns.

TEARING STRENGTH

Dry and wet tearing strength of the experimental fabrics was determined according to the A.S.T.M. Designation: d 1424-56T.

Two sets of warp and filling specimens were cut approximately four inches long and 2.5 inches wide after initial, five, 10, 20, 35, and 50 launderings for the tests. No test specimens were taken nearer than one-tenth the width of the fabric from the selvage.

The conditions of both the dry and wet testing for tearing strength were the same as the breaking strength method cited before.

After the tearing tests were made by the falling pendulum (Elmendorf) technique, resistance to tear per 100 yarns was calculated according to the following formula:

$$\begin{array}{rcl} \text{Pounds Tearing Strength} & \text{Average tearing strength} & \\ \text{per 100 yarns} & \frac{\times 100}{\text{Yarn count} \times 1.69} & \times 0.0706 \\ & = & \end{array}$$

Then the value in pounds was converted into grams, with the latter units given in the tables.

MEASUREMENTS FOR RETENTION OF WHITENESS OF EXPERIMENTAL FABRICS DURING LAUNDERING

REFLECTOMETER MEASUREMENTS

The per cent reflectance of fabrics was determined by the Hunterlab Whiteness Reflectometer, Model D40 initially, after 20 and 50 launderings, respectively.

The six thicknesses of each fabric were measured to determine reflectance of the 11 white fabrics included in the study.

The reading was taken with the green and blue filters without fluorescent illumination, and with the blue filter with fluorescent light.

EVALUATION OF WASH-AND-WEAR PROPERTIES OF LAUNDERED FABRICS

A panel of three specialists evaluated the wash-and-wear properties of the 16 experimental fabrics after one, five, 10, 20, 35, and 50 launderings. Three panelists rated the fabrics independently, using the specified lighting and other equipment recommended by

Tentative Test Method 88-1960 which was developed by Committee R A 61 of the American Association of Textile Chemists and Colorists.

Monsanto Three-Dimensional "Wash 'N Wear" Standards developed by the Plastics Division of the Monsanto Chemical Company were used for evaluation. The set of standards is composed of five plastic replicas ranging from Class 1 to Class 5. Class 1 represents the least degree of wrinkle resistance of fabrics, while Class 5 represents the highest degree of wrinkle resistance.

The illumination for the evaluation was provided by a side lighting device, consisting of a 14-watt cool white fluorescent light, developed by the Cranston Print Works Company of Cranston, Rhode Island.

Text specimens were placed, individually, flat on the table 12 inches from the seated observer and 19 inches from the edge of the lighting to the center of the area to be evaluated. The warp direction of the fabric was placed parallel to the lighting device.

The three panelists made their evaluations one at a time, scoring the fabric according to the number of the standard to which the fabric corresponded most closely, without any communication among them.

The sum of the ratings assigned to each fabric by the panelists constituted the wash-and-wear score.

P R E S E N T A T I O N O F F I N D I N G S

The findings of the study are given in the text of this Section of the thesis. The data concerning the blends are found in the APPENDIX. The results are given in terms of breaking or tensile strength, tearing strength, whiteness of white fabrics, and wash-and-wear performance, initially and after repeated launderings.

D R Y B R E A K I N G S T R E N G T H C O M P A R I S O N S

F A B R I C S L A U N D E R E D A T 120° - 125° F.

Table I (Appendix) summarizes the values of the experimental blends for dry warp breaking, or tensile strength, and Table II gives the same type of values for the filling direction of the 11 fabrics in the study. The tabulation given below summarizes the average values for dry warp and filling breaking strengths for the blends and the all-cotton fabrics laundered at 120° - 125° F.

Initial and Periodic Dry Breaking Strength Average

Values of Fabrics Laundered at 120° - 125° F.

(Pounds per 100 Yarns)

	<u>Warp</u>		<u>Filling</u>	
	<u>Blends</u>	<u>Cottons</u>	<u>Blends</u>	<u>Cottons</u>
Initial	55.8	54.0	29.2	26.8
Number of Launderings				
5	52.0	51.6	28.5	23.8
10	49.9	56.6	27.4	28.4
20	50.2	54.2	27.8	27.8
35	51.3	52.6	28.2	28.7
50	50.0	54.6	28.7	29.0

This summary shows that there were only small differences between the mean dry warp and filling tensile strength values of the cotton-modified rayon blends when the fabrics were tested in the dry state. This was true for the initial fabrics and for the fabrics throughout the 120° F. laundering series.

FABRICS LAUNDERED AT 140° - 145° F.

Tables III and IV in the Appendix give the data on the dry tensile strength values of the blended fabrics laundered at 140° - 145° F. The following summarizes the mean dry strength values of the blends

and of the cottons laundered at the temperature under discussion.

Initial and Periodic Dry Breaking Strength Average

Values of Fabrics Laundered at 140° - 145° F.

(Pounds per 100 Yarns)

	<u>Warp</u>		<u>Filling</u>	
	<u>Blends</u>	<u>Cottons</u>	<u>Blends</u>	<u>Cottons</u>
Initial	55.8	54.0	29.2	26.8
Number of Launderings				
5	50.1	48.4	28.8	26.6
10	48.8	53.4	28.4	28.1
20	50.9	55.1	28.0	28.1
35	50.8	48.6	29.3	26.3
50	49.7	54.8	29.0	29.6

Except for the dry warp of the cotton fabrics after 50 launderings, there were no noteworthy differences again between the dry tensile strengths of the blends and the cottons.

FABRICS LAUNDERED AT 160° - 165° F.

Tables V and VI (Appendix) give the data on dry warp and filling tensile strengths of the cotton-modified rayon blends which were laundered at 160° F. The summary below shows the comparison of the average tensile strength values of the blends and the cottons

laundered at this temperature. Again, no differences were found in dry strength for this series.

Initial and Periodic Dry Breaking Strength Average

Values of Fabrics Laundered at 160^o - 165^o F.

(Pounds per 100 Yarns)

	<u>Warp</u>		<u>Filling</u>	
	<u>Blends</u>	<u>Cottons</u>	<u>Blends</u>	<u>Cottons</u>
Initial	55.8	54.0	29.2	26.8
Number of Launderings				
5	51.8	48.1	29.1	27.4
10	48.4	52.2	28.2	29.4
20	51.4	53.6	28.0	27.4
35	50.1	53.6	28.6	28.8
50	50.1	53.6	30.1	28.6

WET BREAKING STRENGTH COMPARISONS

FABRICS LAUNDERED AT 120^o - 125^o F.

The data on the wet breaking strength values of the blended fabrics laundered at 120^o - 125^o F. appear in Tables VII and VIII in the Appendix. The average wet warp and filling strength values for blends and cottons are compared in the following summary for this temperature:

Initial and Periodic Wet Breaking Strength Average

Values of Fabrics Laundered at 120° - 125° F.

(Pounds per 100 Yarns)

	<u>Warp</u>		<u>Filling</u>	
	<u>Blends</u>	<u>Cottons</u>	<u>Blends</u>	<u>Cottons</u>
Initial	46.2	54.9	23.6	30.6
Number of Launderings				
5	43.5	56.4	23.4	29.6
10	44.8	57.6	23.4	31.2
20	43.7	61.8	22.6	32.0
35	45.2	60.9	23.6	30.6
50	43.2	59.9	23.6	29.6

Contrary to the findings concerning dry breaking strength, the all-cotton fabrics markedly surpassed the cotton-modified rayon blends in wet breaking strength, both in the warp and filling direction, as seen in the above summary.

FABRICS LAUNDERED AT 140° - 145° F.

The values for the wet tensile strengths of the blends laundered at 140° F. are given in Tables IX and X (Appendix). The mean values for blends and for cottons appear in the following summarization:

Initial and Periodic Wet Breaking Strength Average

Values of Fabrics Laundered at 140° - 145° F.

(Pounds per 100 Yarns)

	<u>Warp</u>		<u>Filling</u>	
	<u>Blends</u>	<u>Cottons</u>	<u>Blends</u>	<u>Cottons</u>
Initial	46.2	54.9	23.6	30.6
Number of Launderings				
5	44.7	55.3	23.6	28.2
10	44.4	59.4	23.5	30.1
20	44.6	59.8	22.8	31.8
35	45.2	59.8	23.4	30.1
50	43.4	63.2	23.6	29.0

Again the wet breaking strength values of the fabrics laundered at 160° F. were far superior for the cotton fabrics, with the difference in the warp strength becoming wider with increasing numbers of launderings.

FABRICS LAUNDERED AT 160° - 165° F.

When the cotton-modified rayon and all-cotton fabrics were laundered at 160° F., the gap between the mean wet breaking strength values became wider with repeated launderings, as seen in the summary given below. Tables XI and XII give details on the wet tensile

strengths of the modified rayons at this temperature.

Initial and Periodic Wet Breaking Strength Average

Values of Fabrics Laundered at 160° - 165° F.

(Pounds per 100 Yarns)

	<u>Warp</u>		<u>Filling</u>	
	<u>Blends</u>	<u>Cottons</u>	<u>Blends</u>	<u>Cottons</u>
Initial	46.2	54.9	23.6	30.6
Number of Launderings				
5	46.3	54.5	23.0	28.6
10	44.3	57.7	22.9	29.2
20	45.1	60.4	22.6	30.8
35	42.3	55.5	22.3	30.0
50	43.9	60.1	24.1	31.5

DRY TEARING STRENGTH COMPARISONS

Tables XVI through XXI give summaries of the data on dry tearing strengths of the cotton-modified rayon blended fabrics. See Appendix.

FABRICS LAUNDERED AT 120° - 125° F.

The summary given below shows that, although the average dry tearing strength values of the experimental fabrics surpassed those of the blends following the thirty-fifth and fiftieth washings in

the warp direction. In the filling direction, the dry tearing strength values were 113 grams less for the cottons than for the blends initially, and only 27 grams less after the fiftieth washing.

Initial and Periodic Dry Tearing Strength Average

Values of Fabrics Laundered at 120° - 125° F.

(Grams per 100 Yarns)

	<u>Warp</u>		<u>Filling</u>	
	<u>Blends</u>	<u>Cottons</u>	<u>Blends</u>	<u>Cottons</u>
Initial	868	695	531	418
Number of Launderings				
5	788	635	529	376
10	707	678	486	439
20	673	600	475	415
35	654	650	442	419
50	615	617	453	426

FABRICS LAUNDERED AT 140° - 145° F.

When dry tearing strength values were determined for the blends and the matching cottons initially and after the steps in the 140° F. laundering series, the blends lost proportionately more of their strength through the 50 launderings than the cottons. Initially the blends had a 173-gram higher dry tearing strength, which was

reduced to an 18-gram difference when this washing series closed.

The tearing strength in the filling direction was 106 grams lower for the cotton initially, with the values for blends and cottons the same after 50 washings. This is shown in the following summary.

Initial and Periodic Dry Tearing Strength Average

Values of Fabrics Laundered at 140° - 145° F.

(Grams per 100 Yarns)

	<u>Warp</u>		<u>Filling</u>	
	<u>Blends</u>	<u>Cottons</u>	<u>Blends</u>	<u>Cottons</u>
Initial	868	695	531	418
Number of Launderings				
5	780	702	504	398
10	718	702	494	436
20	657	642	436	401
35	626	622	444	389
50	649	631	453	455

FABRICS LAUNDERED AT 160° - 165° F.

The summary given below shows the same trend of tearing strength values for the fabrics laundered at 160° F. as was found when they were washed at 140° F. The blends, although higher in

initial dry tearing strength, lost strength more rapidly than did the cottons.

Initial and Periodic Dry Tearing Strength Average

Values of Fabrics Laundered at 160° - 165° F.

(Grams per 100 Yarns)

	<u>Warp</u>		<u>Filling</u>	
	<u>Blends</u>	<u>Cottons</u>	<u>Blends</u>	<u>Cottons</u>
Initial	868	695	531	418
Number of Launderings				
5	792	662	506	407
10	739	692	466	410
20	641	601	418	389
35	617	576	437	414
50	576	562	382	389

WET TEARING STRENGTH COMPARISONS

Tables XVI through XXVII summarize the data concerning the wet tearing strength values of the blended fabrics laundered at 120°F., 140°F., and 160°F., respectively. In wet tearing strength the cotton fabrics greatly surpassed the blends.

FABRICS LAUNDERED AT 120°F. - 125°F.

The summary given below shows that the cotton fabrics initially had a mean wet tearing strength value which was 9.4 per cent higher than that of the blends in the warp direction. The loss in warp strength was more rapid in the blends than in the cottons with the result that the latter were 25.5 per cent higher in wet tearing strength than the former after 50 launderings. The difference between the two fabrics was similar in the filling direction. See the following summary:

Initial and Periodic Wet Tearing Strength Average

Values of Fabrics Laundered at 120° - 125° F.

(Grams per 100 Yarns)

	<u>Warp</u>		<u>Filling</u>	
	<u>Blends</u>	<u>Cottons</u>	<u>Blends</u>	<u>Cottons</u>
Initial	696	768	410	452
Number of Launderings				
5	606	693	353	405
10	564	717	322	453
20	526	727	346	458
35	538	667	335	400
50	531	713	340	425

FABRICS LAUNDERED AT 140° - 145° F.

When the blends and the cottons were laundered together at 140° F., the wet warp and filling tearing strength values showed the same trends as when they were laundered at 120° F., except for the fact that the difference between the fabrics at the higher of the two temperatures was wider as the number of launderings progressed. After 50 launderings, the mean wet tearing strength values of the cottons in the warp direction, for example, was 30.8 per cent higher than that of the blends. See the following summarization:

Initial and Periodic Wet Tearing Strength Average

Values of Fabrics Laundered at 140° - 145° F.

(Grams per 100 Yarns)

	<u>Warp</u>		<u>Filling</u>	
	<u>Blends</u>	<u>Cottons</u>	<u>Blends</u>	<u>Cottons</u>
Initial	696	768	410	452
Number of Launderings				
5	638	726	374	415
10	620	780	339	423
20	586	727	334	437
35	544	679	333	397
50	534	772	337	462

FABRICS LAUNDERED AT 160° - 165° F.

As in the case of the fabrics laundered at the two lower temperatures cottons greatly surpassed in wet tearing strength throughout the series when the highest laundering temperature was 160° F., as shown in the following summary:

Initial and Periodic Wet Tearing Strength Average

Values of Fabrics Laundered at 160° - 165° F.

(Grams per 100 Yarns)

	<u>Warp</u>		<u>Filling</u>	
	<u>Blends</u>	<u>Cottons</u>	<u>Blends</u>	<u>Cottons</u>
Initial	696	768	410	452
Number of Launderings				
5	638	723	355	426
10	559	709	337	434
20	576	697	341	453
35	544	649	329	414
50	534	652	306	406

In initial wet warp tearing strength, all-cotton fabrics surpassed the cotton-modified rayon blends by 9.4 per cent as mentioned above. After the 160° F. laundering series, the mean value for wet tearing strength of cottons in the warp direction was 18.1 per cent higher than that for the blends.

In the filling direction, the mean cotton wet strength values were 16.7 per cent higher than those for blends initially and 24.6 per cent higher at the close of the 160° F. laundering series.

WASH-AND-WEAR COMPARISONS

Table XIII, XIV, and XV summarize the data on the wash-and wear ratings on all of the blended fabrics.

The following were sold as wash-and-wear or as easy care fabrics: Fabrics 1, 3, 4, 5, 6, 7, 8, 9, and 10. Their scores made after one, five, 10, 20, 35, and 50 launderings were the following, with 15 the maximum score possible:

Number of Launderings (Blends)	<u>Laundering Temperatures</u>		
	120 ^o F.	140 ^o F.	160 ^o F.
1	8.7	8.3	7.6
5	9.0	9.0	8.1
10	10.0	9.7	9.7
20	8.5	9.8	9.1
35	9.6	10.0	9.6
50	8.6	9.4	9.0

Three of the cotton fabrics which matched the blends as to construction were sold as wash-and-wear fabrics, with the following as their average scores throughout the washing series:

Number of Launderings (Cottons)	<u>Laundering Temperatures</u>		
	120 ^o F.	140 ^o F.	160 ^o F.
1	8.1	9.3	9.4
5	8.3	7.9	7.7
10	7.7	11.1	9.3
20	9.0	9.6	9.8
35	8.8	8.7	9.6
50	10.0	10.3	11.0

WHITENESS RETENTION

Four white fabrics were included in the 11 fabrics in the cotton-modified rayon blend classification. The initial whiteness values and the values after the three series of launderings are shown in Tables XXVIII, XXIX, and XXX. As noted, the whiteness determinations were made only after 20 and 50 launderings, respectively.

The data in the tables show that the fabrics increased in whiteness with repeated launderings. Three white fabrics in the all-cotton group showed the same trend.

S U M M A R Y

This is a study of 11 fabrics made of an intimate blend of cotton and modified rayon. The purpose of the study was to find the breaking strength, tearing strength, wash-and-wear properties (of those sold as wash-and-wear), and whiteness retention (of white fabrics).

Cottons of similar construction were studied also in order to make comparisons.

The tests were applied initially and after five, 10, 20, 35, and 50 launderings at three temperatures: 120° F., 140° F., and 160° F.

The findings of the study showed the following:

Dry Breaking Strength. There was only small differences between the blends and the all-cotton fabrics in dry breaking strength initially or throughout the washing series.

Wet Breaking Strength. Cotton was distinctly better in wet breaking strength throughout the laundering series.

Dry Tearing Strength. The cotton-modified rayon blends were better than the all-cotton fabrics in most instances initially and throughout the washing series.

Wet Tearing Strength. The all-cotton fabrics were markedly superior to the blends in wet tearing strength.

Wash-and-Wear Characteristics. The fabrics of each type sold as having wash-and-wear properties behaved about the same in this respect throughout.

Whiteness Retention. The few white fabrics of each kind tended to become whiter with repeated launderings. No bleach was used in the washing formulas.

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TABLE I

VALUES FOR DRY WARP TENSILE STRENGTH OF EXPERIMENTAL FABRICS
INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 120⁰-125⁰ F.

Fiber Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50%, Zantrel 50%	59.8	58.7	47.0	53.2	56.0	51.6
2. Cotton 50%, Zantrel 50%	45.5	46.2	42.8	43.4	45.7	43.0
3. Cotton 50%, Zantrel 50%	63.6	57.2	47.6	48.2	51.7	50.4
4. Cotton 50%, Avril 50%	53.4	43.0	47.6	46.2	49.4	49.6
5. Cotton 50%, Avril 50%	64.9	49.6	51.6	53.6	53.0	52.8
6. Cotton 50%, Avril 50%	70.1	50.8	58.4	55.4	53.2	52.2
7. Cotton 50%, Zantrel 50%	48.0	45.0	52.4	50.4	51.6	50.4
8. Cotton 50%, Zantrel 50%	45.6	46.6	50.0	46.0	43.0	46.3
9. Cotton 50%, Zantrel 50%	51.6	57.6	53.2	50.0	55.0	44.4
10. Cotton 50%, Zantrel 50%	51.4	55.0	49.2	55.6	56.2	54.4
11. Cotton 55%, Zantrel 45%	60.6	52.4	49.8	50.4	49.8	54.6

TABLE II

VALUES FOR DRY FILLING TENSILE STRENGTH OF EXPERIMENTAL FABRICS
INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 120⁰-125⁰F.

Fiber Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50 %, Zantrel 50 %	27.1	31.3	26.8	28.8	28.1	30.2
2. Cotton 50 %, Zantrel 50 %	25.6	23.4	22.4	21.4	23.9	19.6
3. Cotton 50 %, Zantrel 50 %	31.6	24.2	21.8	21.8	26.8	29.0
4. Cotton 50 %, Avril 50 %	27.4	27.8	27.2	26.0	24.8	26.8
5. Cotton 50 %, Avril 50 %	28.1	27.7	27.4	28.0	30.6	28.6
6. Cotton 50 %, Avril 50 %	30.2	19.2	25.8	26.3	27.8	26.4
7. Cotton 50 %, Zantrel 50 %	24.0	25.6	21.2	25.0	26.4	23.2
8. Cotton 50 %, Zantrel 50 %	29.4	31.6	25.3	28.3	26.0	29.3
9. Cotton 50 %, Zantrel 50 %	24.8	25.6	25.6	25.6	25.7	23.6
10. Cotton 50 %, Zantrel 50 %	32.0	30.4	32.2	29.6	29.2	31.6
11. Cotton 55 %, Zantrel 45 %	40.6	47.0	45.8	44.6	41.6	45.4

TABLE III

VALUES FOR DRY WARP TENSILE STRENGTH OF EXPERIMENTAL FABRICS
INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 140-145°F.

Fiber Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50%, Zantrel 50%	59.8	53.0	43.4	52.8	51.1	51.6
2. Cotton 50%, Zantrel 50%	45.5	46.8	38.4	41.8	45.0	42.6
3. Cotton 50%, Zantrel 50%	63.6	48.8	45.2	50.6	46.2	47.0
4. Cotton 50%, Avril 50%	53.4	51.2	48.4	50.6	49.9	52.2
5. Cotton 50%, Avril 50%	64.9	51.4	54.0	55.0	56.6	49.8
6. Cotton 50%, Avril 50%	70.1	50.2	47.6	48.5	56.2	60.0
7. Cotton 50%, Zantrel 50%	48.0	44.4	47.8	52.4	48.0	48.4
8. Cotton 50%, Zantrel 50%	45.6	46.6	45.3	49.0	43.3	45.0
9. Cotton 50%, Zantrel 50%	51.6	52.2	53.6	54.4	51.8	47.8
10. Cotton 50%, Zantrel 50%	51.4	55.4	56.8	49.2	55.8	52.8
11. Cotton 55%, Zantrel 45%	60.6	51.0	56.2	55.8	54.8	49.6

TABLE IV

VALUES FOR DRY FILLING TENSILE STRENGTH OF EXPERIMENTAL FABRICS
INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 140-145° F.

Fiber Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50%, Zantrel 50%	27.1	36.0	33.0	28.2	28.9	29.4
2. Cotton 50%, Zantrel 50%	25.5	22.4	22.0	20.2	23.3	19.2
3. Cotton 50%, Zantrel 50%	31.6	28.4	26.4	27.8	25.5	35.0
4. Cotton 50%, Avril 50%	27.4	29.4	28.2	28.6	27.8	31.0
5. Cotton 50%, Avril 50%	28.1	24.2	27.2	26.0	28.2	24.8
6. Cotton 50%, Avril 50%	30.2	28.8	25.8	26.5	28.6	28.8
7. Cotton 50%, Zantrel 50%	24.0	22.8	24.6	26.6	29.0	27.4
8. Cotton 50%, Zantrel 50%	29.4	24.3	26.6	29.0	29.0	26.0
9. Cotton 50%, Zantrel 50%	24.8	25.6	27.4	22.2	28.4	25.6
10. Cotton 50%, Zantrel 50%	32.0	32.4	30.6	30.2	29.6	30.4
11. Cotton 55%, Zantrel 45%	40.6	43.4	41.0	42.8	44.4	41.6

TABLE V

VALUES FOR DRY WARP TENSILE STRENGTH OF EXPERIMENTAL FABRICS
INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 160°-165°F.

Fiber Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50 %, Zantrel 50 %	59.8	53.6	42.8	59.4	50.5	48.8
2. Cotton 50 %, Zantrel 50 %	45.5	46.6	41.6	41.4	47.3	43.8
3. Cotton 50 %, Zantrel 50 %	63.6	54.3	45.2	55.0	49.0	58.6
4. Cotton 50 %, Avril 50 %	53.4	49.6	47.4	49.8	51.9	51.0
5. Cotton 50 %, Avril 50 %	64.9	48.4	48.3	55.0	51.4	52.6
6. Cotton 50 %, Avril 50 %	70.1	63.0	54.0	57.2	60.8	60.0
7. Cotton 50 %, Zantrel 50 %	48.0	44.8	52.2	51.0	50.8	42.8
8. Cotton 50 %, Zantrel 50 %	45.6	44.0	40.0	46.6	42.3	42.3
9. Cotton 50 %, Zantrel 50 %	51.6	56.0	51.6	48.4	52.0	42.2
10. Cotton 50 %, Zantrel 50 %	51.4	53.8	54.0	51.4	45.2	54.4
11. Cotton 55 %, Zantrel 45 %	60.6	55.5	54.8	50.4	49.6	54.4

TABLE VI

VALUES FOR DRY FILLING TENSILE STRENGTH OF EXPERIMENTAL FABRICS

INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 160-165° F.

Fiber Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50%, Zantrel 50%	27.1	31.4	31.8	29.4	26.6	28.4
2. Cotton 50%, Zantrel 50%	25.6	22.0	17.2	20.0	22.4	21.6
3. Cotton 50%, Zantrel 50%	31.6	28.6	27.2	21.0	26.3	36.6
4. Cotton 50%, Avril 50%	27.4	25.2	26.2	25.0	29.2	28.8
5. Cotton 50%, Avril 50%	28.1	26.8	26.8	25.0	28.4	27.2
6. Cotton 50%, Avril 50%	30.2	32.4	30.8	30.4	30.0	31.4
7. Cotton 50%, Zantrel 50%	24.0	25.2	26.6	25.6	24.8	28.6
8. Cotton 50%, Zantrel 50%	29.4	29.0	28.0	30.0	30.6	31.0
9. Cotton 50%, Zantrel 50%	24.8	25.0	27.4	28.6	27.0	28.4
10. Cotton 50%, Zantrel 50%	32.0	29.8	30.2	33.6	29.8	30.2
11. Cotton 55%, Zantrel 45%	40.6	44.7	38.4	39.3	40.5	38.7

TABLE VII

VALUES FOR WET WARP TENSILE STRENGTH OF EXPERIMENTAL FABRICS
INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 120-125° F.

Fiber Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50%, Zantrel 50%	53.7	48.0	49.2	46.8	47.1	46.8
2. Cotton 50%, Zantrel 50%	39.4	36.6	37.0	35.6	40.8	35.4
3. Cotton 50%, Zantrel 50%	48.5	36.0	34.6	39.6	43.2	43.4
4. Cotton 50%, Avril 50%	42.6	41.5	44.4	41.2	42.1	41.6
5. Cotton 50%, Avril 50%	44.6	39.8	38.4	41.0	39.6	39.6
6. Cotton 50%, Avril 50%	49.0	41.4	46.8	49.2	47.0	47.0
7. Cotton 50%, Zantrel 50%	44.2	41.2	45.0	45.4	46.8	38.8
8. Cotton 50%, Zantrel 50%	42.0	42.0	35.0	28.3	37.3	39.3
9. Cotton 50%, Zantrel 50%	46.4	45.8	48.8	47.2	44.8	36.2
10. Cotton 50%, Zantrel 50%	44.4	48.6	47.4	46.8	50.2	44.4
11. Cotton 55%, Zantrel 45%	54.0	57.6	66.2	60.0	58.8	63.4

TABLE VIII

VALUES FOR WET FILLING TENSILE STRENGTH OF EXPERIMENTAL FABRICS
INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 120⁰-125⁰ F.

Fiber Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50%, Zantrel 50%	27.7	29.4	26.0	22.4	25.6	27.6
2. Cotton 50%, Zantrel 50%	18.8	18.5	19.2	16.0	19.8	17.0
3. Cotton 50%, Zantrel 50%	25.4	16.6	15.2	16.4	21.9	24.4
4. Cotton 50%, Avril 50%	26.0	23.4	23.4	26.2	22.4	23.4
5. Cotton 50%, Avril 50%	20.3	22.7	21.2	23.0	24.0	24.2
6. Cotton 50%, Avril 50%	23.0	22.4	25.4	17.0	27.0	22.2
7. Cotton 50%, Zantrel 50%	23.0	24.6	24.0	24.2	23.4	20.0
8. Cotton 50%, Zantrel 50%	25.6	25.0	25.3	26.3	22.6	24.8
9. Cotton 50%, Zantrel 50%	21.8	23.8	23.7	25.6	20.2	20.2
10. Cotton 50%, Zantrel 50%	27.2	27.2	27.4	26.6	28.0	29.8
11. Cotton 55%, Zantrel 45%	21.6	23.6	26.4	24.6	25.4	26.0

TABLE IX

VALUES FOR WET WARP TENSILE STRENGTH OF EXPERIMENTAL FABRICS
INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 140⁰-145⁰F.

Fiber Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50%, Zantrel 50%	53.7	39.2	40.8	40.6	46.3	45.2
2. Cotton 50%, Zantrel 50%	39.4	34.6	37.4	35.8	39.4	35.0
3. Cotton 50%, Zantrel 50%	48.5	39.6	41.6	40.2	39.6	42.2
4. Cotton 50%, Avril 50%	42.6	51.9	43.0	45.2	44.2	44.4
5. Cotton 50%, Avril 50%	44.6	39.0	40.0	41.0	43.8	38.0
6. Cotton 50%, Avril 50%	49.0	45.6	47.2	40.0	48.2	46.8
7. Cotton 50%, Zantrel 50%	44.2	36.4	41.8	45.8	45.6	43.2
8. Cotton 50%, Zantrel 50%	42.0	39.6	38.0	42.6	33.6	31.3
9. Cotton 50%, Zantrel 50%	46.4	48.8	45.8	48.0	44.0	36.8
10. Cotton 50%, Zantrel 50%	44.4	53.0	50.8	49.4	47.4	47.2
11. Cotton 55%, Zantrel 45%	54.0	64.2	62.2	62.6	66.0	67.4

TABLE X

VALUES FOR WET FILLING TENSILE STRENGTH OF EXPERIMENTAL FABRICS
INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 140-145° F.

Fiber Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50%, Zantrel 50%	27.7	31.2	31.6	24.8	25.7	25.2
2. Cotton 50%, Zantrel 50%	18.8	19.1	20.4	16.2	20.0	18.0
3. Cotton 50%, Zantrel 50%	25.4	20.8	21.0	19.8	20.2	26.8
4. Cotton 50%, Avril 50%	26.0	25.6	23.4	25.4	26.1	26.4
5. Cotton 50%, Avril 50%	20.3	18.9	18.0	21.8	21.8	19.2
6. Cotton 50%, Avril 50%	23.0	22.6	22.8	21.4	24.0	25.2
7. Cotton 50%, Zantrel 50%	23.0	22.6	21.2	26.0	23.8	23.8
8. Cotton 50%, Zantrel 50%	25.6	25.6	23.0	24.3	22.6	22.0
9. Cotton 50%, Zantrel 50%	21.8	21.8	24.6	19.0	22.6	21.4
10. Cotton 50%, Zantrel 50%	27.2	27.0	25.8	29.0	25.4	27.2
11. Cotton 55%, Zantrel 45%	21.6	24.6	26.6	24.0	25.2	24.2

TABLE XI

VALUES FOR WET WARP TENSILE STRENGTH OF EXPERIMENTAL FABRICS
INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 160-165°F.

Fiber Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50%, Zantrel 50%	53.7	47.6	45.0	48.4	42.9	45.4
2. Cotton 50%, Zantrel 50%	39.4	38.0	36.2	35.8	37.6	36.6
3. Cotton 50%, Zantrel 50%	48.5	43.0	40.8	40.4	38.3	44.6
4. Cotton 50%, Avril 50%	42.6	45.0	41.8	45.8	41.6	47.4
5. Cotton 50%, Avril 50%	44.6	42.1	32.4	40.8	38.8	40.4
6. Cotton 50%, Avril 50%	49.0	46.4	46.2	46.0	49.8	47.2
7. Cotton 50%, Zantrel 50%	44.2	40.2	44.6	45.4	42.6	43.2
8. Cotton 50%, Zantrel 50%	42.0	43.3	38.3	40.6	34.3	33.3
9. Cotton 50%, Zantrel 50%	46.4	47.8	49.2	45.0	43.2	37.4
10. Cotton 50%, Zantrel 50%	44.4	50.8	50.8	48.4	41.0	46.2
11. Cotton 55%, Zantrel 45%	54.0	65.6	62.4	60.0	55.8	61.6

TABLE XII

VALUES FOR WET FILLING TENSILE STRENGTH OF EXPERIMENTAL FABRICS
INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 160⁰-165⁰ F.

Fiber Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50%, Zantrel 50%	27.7	26.8	27.6	26.4	23.7	27.8
2. Cotton 50%, Zantrel 50%	18.8	14.7	17.2	15.2	16.8	16.8
3. Cotton 50%, Zantrel 50%	25.4	18.8	18.6	16.4	15.9	28.0
4. Cotton 50%, Avril 50%	26.0	25.6	22.4	24.0	26.6	24.8
5. Cotton 50%, Avril 50%	20.3	21.0	20.7	19.4	22.6	19.0
6. Cotton 50%, Avril 50%	23.0	25.4	24.8	25.6	26.2	27.4
7. Cotton 50%, Zantrel 50%	23.0	18.4	21.8	23.6	17.0	22.6
8. Cotton 50%, Zantrel 50%	25.6	26.3	23.0	25.6	21.3	21.3
9. Cotton 50%, Zantrel 50%	21.8	24.0	25.8	18.2	25.0	21.4
10. Cotton 50%, Zantrel 50%	27.2	27.0	25.2	30.2	25.8	28.2
11. Cotton 55%, Zantrel 45%	21.6	24.7	25.4	24.3	24.0	27.4

TABLE XIII

VALUES FOR WASH-AND-WEAR RATINGS OF EXPERIMENTAL FABRICS

IMMEDIATELY AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 120-125° F.

Fiber Composition	Number of Launderings					
	1	5	10	20	35	50
1. Cotton 50%, Zantrel 50%	6.25	6.50	9.75	7.50	5.25	8.00
2. Cotton 50%, Zantrel 50%	4.50	6.50	10.75	6.50	10.25	6.25
3. Cotton 50%, Zantrel 50%	8.25	9.00	10.00	9.00	9.25	6.75
4. Cotton 50%, Avril 50%	8.75	10.75	9.25	5.50	6.25	6.75
5. Cotton 50%, Avril 50%	9.25	11.00	11.75	9.00	11.00	9.50
6. Cotton 50%, Avril 50%	9.25	9.25	10.00	9.75	10.50	10.75
7. Cotton 50%, Zantrel 50%	9.00	9.50	10.50	9.75	9.25	11.75
8. Cotton 50%, Zantrel 50%	8.25	8.75	9.25	9.25	6.75	7.25
9. Cotton 50%, Zantrel 50%	7.50	9.75	9.50	8.50	10.75	9.00
10. Cotton 50%, Zantrel 50%	11.50	7.50	10.25	9.75	12.50	9.75
11. Cotton 55%, Zantrel 45%	4.00	4.75	4.75	4.00	5.00	4.25

TABLE XIV

VALUES FOR WASH-AND-WEAR RATINGS OF EXPERIMENTAL FABRICS
IMMEDIATELY AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 140-145° F.

Fiber Composition	Number of Launderings					
	1	5	10	20	35	50
1. Cotton 50%, Zantrel 50%	6.75	7.50	7.25	9.50	7.00	7.00
2. Cotton 50%, Zantrel 50%	6.50	9.25	10.25	8.75	9.50	9.75
3. Cotton 50%, Zantrel 50%	6.50	8.75	8.50	10.00	10.00	9.50
4. Cotton 50%, Avril 50%	6.75	10.25	8.75	8.75	9.50	7.50
5. Cotton 50%, Avril 50%	9.25	9.75	10.50	8.25	9.25	10.00
6. Cotton 50%, Avril 50%	8.25	10.50	10.50	10.75	10.25	10.50
7. Cotton 50%, Zantrel 50%	9.75	9.30	11.00	11.75	11.50	9.75
8. Cotton 50%, Zantrel 50%	5.50	9.50	9.25	9.25	8.25	9.50
9. Cotton 50%, Zantrel 50%	11.00	6.50	8.75	10.00	10.25	7.25
10. Cotton 50%, Zantrel 50%	11.00	8.00	10.00	11.00	12.75	11.25
11. Cotton 55%, Zantrel 45%	2.50	2.25	2.25	6.00	3.50	7.50

TABLE XV

VALUES FOR WASH-AND-WEAR RATINGS OF EXPERIMENTAL FABRICS

IMMEDIATELY AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 160°-165° F.

Fiber Composition	Number of Launderings					
	1	5	10	20	35	50
1. Cotton 50%, Zantrel 50%	7.00	10.75	8.75	5.00	5.00	7.75
2. Cotton 50%, Zantrel 50%	4.75	8.25	8.25	5.75	7.00	7.00
3. Cotton 50%, Zantrel 50%	4.25	9.25	11.75	7.50	9.75	8.50
4. Cotton 50%, Avril 50%	6.50	5.00	11.50	10.25	9.50	7.75
5. Cotton 50%, Avril 50%	7.75	8.50	7.50	8.75	9.00	11.75
6. Cotton 50%, Avril 50%	10.00	9.50	6.75	11.25	11.25	10.50
7. Cotton 50%, Zantrel 50%	9.00	7.50	11.50	12.00	11.75	10.75
8. Cotton 50%, Zantrel 50%	4.25	11.00	11.50	9.00	7.50	8.50
9. Cotton 50%, Zantrel 50%	10.50	6.50	7.50	7.00	10.00	6.75
10. Cotton 50%, Zantrel 50%	11.25	7.75	11.50	10.50	12.25	9.75
11. Cotton 55%, Zantrel 45%	1.75	4.25	2.50	7.00	4.00	5.00

TABLE XVI

VALUES FOR DRY WARP TEARING STRENGTH OF EXPERIMENTAL FABRICS
INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 120°-125° F.

Fiber Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50%, Zantrel 50%	928.0	876.8	857.6	716.8	678.4	684.8
2. Cotton 50%, Zantrel 50%	915.2	908.8	761.6	761.6	832.0	838.4
3. Cotton 50%, Zantrel 50%	787.2	825.6	691.2	556.8	672.0	723.2
4. Cotton 50%, Avril 50%	992.0	966.4	774.4	851.2	915.2	928.0
5. Cotton 50%, Avril 50%	1024.0	768.0	819.2	768.0	684.8	768.0
6. Cotton 50%, Avril 50%	1216.0	998.4	1043.2	1024.0	876.8	960
7. Cotton 50%, Zantrel 50%	588.8	512.0	531.2	492.8	492.8	473.6
8. Cotton 50%, Zantrel 50%	691.2	691.2	595.2	595.2	544.0	627.2
9. Cotton 50%, Zantrel 50%	819.2	704.0	556.8	422.4	435.2	435.2
10. Cotton 50%, Zantrel 50%	704.0	608.0	556.8	595.2	544.0	678.4
11. Cotton 55%, Zantrel 45%	883.2	806.4	595.2	627.2	518.4	512.0

TABLE XVII

VALUES FOR DRY FILLING TEARING STRENGTH OF EXPERIMENTAL FABRICS
INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 120-125°F.

Fiber Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50 %, Zantrel 50 %	582.4	595.2	531.2	473.6	505.6	544.0
2. Cotton 50 %, Zantrel 50 %	422.4	512.0	428.4	364.8	409.6	435.2
3. Cotton 50 %, Zantrel 50 %	492.8	569.6	505.6	492.8	518.4	512.0
4. Cotton 50 %, Avril 50 %	448.0	454.4	416.0	377.6	416.0	403.2
5. Cotton 50 %, Avril 50 %	601.6	544.0	470.0	470.0	416.0	473.6
6. Cotton 50 %, Avril 50 %	665.6	524.8	569.6	620.8	614.4	556.8
7. Cotton 50 %, Zantrel 50 %	294.4	345.6	339.2	326.4	339.2	345.6
8. Cotton 50 %, Zantrel 50 %	428.8	390.6	403.2	489.6	371.2	499.2
9. Cotton 50 %, Zantrel 50 %	470.0	505.6	339.2	352.0	307.2	364.8
10. Cotton 50 %, Zantrel 50 %	454.4	428.8	505.6	416.0	409.6	492.8
11. Cotton 55 %, Zantrel 45 %	985.6	953.6	844.8	838.4	556.8	352.0

TABLE XVIII

VALUES FOR DRY WARP TEARING STRENGTH OF EXPERIMENTAL FABRICS
INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 140-145° F.

Fiber Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50 %, Zantrel 50 %	928.0	876.8	691.2	595.2	652.8	550.4
2. Cotton 50 %, Zantrel 50 %	915.2	864.0	793.6	774.4	864.0	819.2
3. Cotton 50 %, Zantrel 50 %	787.2	825.6	761.0	665.6	716.4	716.4
4. Cotton 50 %, Avril 50 %	992.0	876.8	876.8	857.6	464.4	691.2
5. Cotton 50 %, Avril 50 %	1024.0	915.2	844.8	774.4	691.2	732.4
6. Cotton 50 %, Avril 50 %	1216.0	985.6	1011.2	985.6	857.6	870.4
7. Cotton 50 %, Zantrel 50 %	588.8	576.0	524.8	460.8	473.6	601.6
8. Cotton 50 %, Zantrel 50 %	691.2	691.2	713.6	489.6	608.0	608.0
9. Cotton 50 %, Zantrel 50 %	819.2	652.8	505.6	499.2	505.6	441.6
10. Cotton 50 %, Zantrel 50 %	704.0	678.4	608.0	576.0	550.4	697.6
11. Cotton 55 %, Zantrel 45 %	883.2	640.0	563.2	550.4	505.6	416.0

TABLE XVIX

VALUES FOR DRY FILLING TEARING STRENGTH OF EXPERIMENTAL FABRICS
INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 140⁰-145⁰ F.

Fabric Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50%, Zantrel 50%	582.4	614.4	620.8	480.8	524.8	435.2
2. Cotton 50%, Zantrel 50%	422.4	505.6	448.0	416.0	460.8	352.0
3. Cotton 50%, Zantrel 50%	492.8	576.0	524.8	454.4	512.0	608.0
4. Cotton 50%, Avril 50%	448.0	422.4	384.0	358.4	473.6	384.0
5. Cotton 50%, Avril 50%	601.6	454.4	518.4	422.4	428.8	441.6
6. Cotton 50%, Avril 50%	665.6	633.6	627.2	512.0	531.2	544.0
7. Cotton 50%, Zantrel 50%	294.4	416.0	339.2	320.0	339.2	422.4
8. Cotton 50%, Zantrel 50%	428.8	339.2	489.6	329.6	384.0	531.2
9. Cotton 50%, Zantrel 50%	470.0	492.8	364.8	326.4	326.4	345.6
10. Cotton 50%, Zantrel 50%	454.4	435.2	409.6	416.0	377.6	492.8
11. Cotton 55%, Zantrel 45%	985.6	652.8	704.0	754.8	524.8	428.8

TABLE XX

VALUES FOR DRY WARP TEARING STRENGTH OF EXPERIMENTAL FABRICS
INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 160-165°F.

Fabric Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50%, Zantrel 50%	928.0	896.0	736.0	595.2	601.6	448.0
2. Cotton 50%, Zantrel 50%	915.2	857.6	851.2	748.8	832.0	768.0
3. Cotton 50%, Zantrel 50%	787.2	787.2	806.4	499.2	492.8	563.2
4. Cotton 50%, Avril 50%	992.0	902.4	883.2	812.8	851.2	627.2
5. Cotton 50%, Avril 50%	1024.0	857.6	876.8	716.8	691.2	716.8
6. Cotton 50%, Avril 50%	1216.0	1132.8	1056.0	1004.8	992.4	921.6
7. Cotton 50%, Zantrel 50%	588.8	537.6	473.6	473.6	390.4	512.0
8. Cotton 50%, Zantrel 50%	691.2	640.0	694.4	617.6	576.0	489.6
9. Cotton 50%, Zantrel 50%	819.2	662.8	512.0	441.6	396.4	467.2
10. Cotton 50%, Zantrel 50%	704.0	678.4	582.4	569.6	524.8	646.4
11. Cotton 55%, Zantrel 45%	883.2	774.4	652.8	576.0	524.8	467.2

TABLE XXI

VALUES FOR DRY FILLING TEARING STRENGTH OF EXPERIMENTAL FABRICS
INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 160-165°.

Fabric Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50 %, Zantrel 50 %	582.4	652.8	505.6	460.8	499.2	332.8
2. Cotton 50 %, Zantrel 50 %	422.4	467.2	358.4	320.0	422.4	441.6
3. Cotton 50 %, Zantrel 50 %	492.8	576.0	518.4	364.8	409.6	281.6
4. Cotton 50 %, Avril 50 %	448.0	396.8	371.2	345.6	441.6	326.4
5. Cotton 50 %, Avril 50 %	601.6	428.8	537.6	441.6	435.2	460.8
6. Cotton 50 %, Avril 50 %	665.6	684.8	633.6	659.2	633.6	614.4
7. Cotton 50 %, Zantrel 50 %	294.4	320.0	320.0	320.0	307.2	307.2
8. Cotton 50 %, Zantrel 50 %	428.8	384.0	489.6	393.6	361.6	320.0
9. Cotton 50 %, Zantrel 50 %	470.0	512.0	384.0	332.8	326.4	320.0
10. Cotton 50 %, Zantrel 50 %	454.4	505.6	396.8	435.2	428.8	428.8
11. Cotton 55 %, Zantrel 45 %	985.6	633.6	608.0	524.8	544.0	364.8

TABLE XXII

VALUES FOR WET FILLING TEARING STRENGTH OF EXPERIMENTAL FABRICS
INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 120-125° F.

Fiber Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50 %, Zantrel 50 %	537.6	467.2	345.6	512.0	435.2	332.8
2. Cotton 50 %, Zantrel 50 %	416.0	416.0	320.0	281.6	358.4	281.6
3. Cotton 50 %, Zantrel 50 %	428.8	268.8	268.8	268.8	403.2	416.0
4. Cotton 50 %, Avril 50 %	390.4	326.4	262.4	268.8	371.2	320.0
5. Cotton 50 %, Avril 50 %	460.8	358.4	326.4	364.8	230.4	352.0
6. Cotton 50 %, Avril 50 %	499.2	377.6	384.0	403.2	352.0	409.6
7. Cotton 50 %, Zantrel 50 %	313.6	300.8	300.8	288.0	288.0	307.2
8. Cotton 50 %, Zantrel 50 %	352.0	329.6	297.6	361.6	339.2	371.2
9. Cotton 50 %, Zantrel 50 %	352.0	326.4	288.0	384.0	281.6	307.2
10. Cotton 50 %, Zantrel 50 %	371.2	384.0	416.0	275.2	345.6	352.0
11. Cotton 55 %, Zantrel 45 %	390.4	326.4	332.8	339.2	275.2	294.4

TABLE XXIII

VALUES FOR WET WARP TEARING STRENGTH OF EXPERIMENTAL FABRICS

INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 120°-125° F.

Fiber Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50%, Zantrel 50%	870.4	691.2	582.4	627.2	620.8	518.4
2. Cotton 50%, Zantrel 50%	633.6	652.8	582.4	595.2	665.6	614.4
3. Cotton 50%, Zantrel 50%	678.4	467.2	403.2	403.6	480.0	473.6
4. Cotton 50%, Avril 50%	652.8	588.8	550.4	544.0	627.2	563.2
5. Cotton 50%, Avril 50%	748.8	544.0	576.0	544.0	486.4	518.4
6. Cotton 50%, Avril 50%	921.6	736.0	704.0	646.4	582.4	672.0
7. Cotton 50%, Zantrel 50%	596.2	486.4	435.2	409.6	428.8	422.4
8. Cotton 50%, Zantrel 50%	537.6	544.0	544.0	521.6	544.0	489.6
9. Cotton 50%, Zantrel 50%	640.0	499.2	480.0	416.0	428.8	364.8
10. Cotton 50%, Zantrel 50%	569.6	556.8	512.0	416.0	473.6	480.0
11. Cotton 55%, Zantrel 45%	809.6	902.4	838.4	660.0	576.0	729.6

TABLE XXIV

VALUES FOR WET WARP TEARING STRENGTH OF EXPERIMENTAL FABRICS
INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 140⁰-145⁰F.

Fiber Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50%, Zantrel 50%	870.4	691.2	556.8	601.6	620.8	467.2
2. Cotton 50%, Zantrel 50%	633.6	723.2	608.0	576.0	646.4	582.4
3. Cotton 50%, Zantrel 50%	678.4	646.4	531.2	460.8	512.0	556.8
4. Cotton 50%, Avril 50%	652.8	595.2	582.4	556.8	627.2	550.4
5. Cotton 50%, Avril 50%	748.8	576.0	576.0	563.2	512.0	294.4
6. Cotton 50%, Avril 50%	921.6	780.8	812.8	729.6	633.6	774.4
7. Cotton 50%, Zantrel 50%	595.2	473.6	473.6	409.6	454.2	396.8
8. Cotton 50%, Zantrel 50%	537.6	480.0	627.2	512.0	480.0	467.2
9. Cotton 50%, Zantrel 50%	640.0	505.6	486.4	454.4	416.0	428.8
10. Cotton 50%, Zantrel 50%	569.6	550.4	537.6	473.6	454.4	569.6
11. Cotton 55%, Zantrel 45%	809.6	992.0	1030.4	1107.2	627.2	787.2

TABLE XXV

VALUES FOR WET FILLING TEARING STRENGTH OF EXPERIMENTAL FABRICS

INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 140-145° F.

Fiber Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50 %, Zantrel 50 %	537.6	464.0	435.2	358.4	428.8	352.0
2. Cotton 50 %, Zantrel 50 %	416.0	371.2	307.2	275.2	422.4	256.0
3. Cotton 50 %, Zantrel 50 %	428.8	460.8	377.6	377.6	358.4	384.0
4. Cotton 50 %, Avril 50 %	390.4	307.2	281.6	281.6	358.4	300.8
5. Cotton 50 %, Avril 50 %	460.8	307.2	320.0	294.4	230.4	326.4
6. Cotton 50 %, Avril 50 %	499.2	537.6	364.8	364.8	256.0	416.0
7. Cotton 50 %, Zantrel 50 %	313.6	307.2	275.2	275.2	307.2	320.0
8. Cotton 50 %, Zantrel 50 %	352.0	339.2	361.6	329.6	297.6	288.0
9. Cotton 50 %, Zantrel 50 %	352.0	326.4	320.0	320.0	300.8	313.6
10. Cotton 50 %, Zantrel 50 %	371.2	364.8	364.8	473.6	339.2	396.8
11. Cotton 55 %, Zantrel 45 %	390.4	332.8	320.0	326.4	364.8	358.4

TABLE XXVI

VALUES FOR WET WARP TEARING STRENGTH OF EXPERIMENTAL FABRICS

INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 160-165⁰ F.

Fiber Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50 %, Zantrel 50 %	870.4	732.4	569.6	560.0	550.4	473.6
2. Cotton 50 %, Zantrel 50 %	633.6	672.0	620.8	633.6	665.6	576.0
3. Cotton 50 %, Zantrel 50 %	678.4	550.4	403.2	332.8	441.6	467.2
4. Cotton 50 %, Avril 50 %	652.8	588.8	569.6	652.8	646.4	550.4
5. Cotton 50 %, Avril 50 %	748.8	544.0	614.4	563.2	492.8	556.8
6. Cotton 50 %, Avril 50 %	921.6	857.6	806.4	755.2	640.0	691.2
7. Cotton 50 %, Zantrel 50 %	595.2	480.8	467.2	396.8	377.6	416.0
8. Cotton 50 %, Zantrel 50 %	537.6	544.0	499.2	489.6	480.8	448.0
9. Cotton 50 %, Zantrel 50 %	640.0	454.4	454.4	467.2	384.0	377.6
10. Cotton 50 %, Zantrel 50 %	569.6	518.4	550.4	499.2	473.6	480.0
11. Cotton 55 %, Zantrel 45 %	809.6	915.2	960.0	985.6	857.6	838.4

TABLE XXVII

VALUES FOR WET FILLING TEARING STRENGTH OF EXPERIMENTAL FABRICS
INITIALLY AND AFTER THE DESIGNATED NUMBERS OF LAUNDERINGS AT 160-165° F.

Fabric Composition	Number of Launderings					
	0	5	10	20	35	50
1. Cotton 50%, Zantrel 50%	537.6	441.6	320.0	403.2	448.0	313.6
2. Cotton 50%, Zantrel 50%	416.0	371.2	288.0	326.4	384.0	371.2
3. Cotton 50%, Zantrel 50%	428.8	396.8	384.0	345.6	345.6	179.2
4. Cotton 50%, Avril 50%	390.4	326.4	262.4	349.0	377.6	281.6
5. Cotton 50%, Avril 50%	460.8	326.4	339.2	281.6	236.8	294.4
6. Cotton 50%, Avril 50%	499.2	428.8	460.8	396.8	262.4	390.4
7. Cotton 50%, Zantrel 50%	313.6	294.4	307.2	320.0	243.2	294.4
8. Cotton 50%, Zantrel 50%	352.0	288.0	297.6	371.2	371.2	297.6
9. Cotton 50%, Zantrel 50%	352.0	332.8	345.6	313.6	307.2	320.0
10. Cotton 50%, Zantrel 50%	371.2	377.6	377.6	294.4	339.2	320.0
11. Cotton 55%, Zantrel 45%	390.4	326.4	320.0	345.6	307.2	307.2

TABLE XXVIIIREFLECTANCE OF WHITE FABRICS AMONG THE BLENDSLAUNDERED AT 120° - 125° F.

Fiber Composition	Number of Launderings		
	0	20	50
1. Cotton 50 %, Zantrel 50 %	80.5	89.0	89.4
3. Cotton 50 %, Zantrel 50 %	81.2	87.2	87.4
4. Cotton 50 %, Avril 50 %	76.4	85.7	87.0
11. Cotton 55 %, Avril 45 %	85.2	91.7	91.4

TABLE XXIXREFLECTANCE OF WHITE FABRICS AMONG THE BLENDSLAUNDERED AT 120° - 125° F.

Fiber Composition	Number of Launderings		
	0	20	50
1. Cotton 50 %, Zantrel 50 %	80.5	89.5	90.7
3. Cotton 50 %, Zantrel 50 %	81.2	86.9	87.2
4. Cotton 50 %, Avril 50 %	76.4	84.7	86.8
11. Cotton 55 %, Zantrel 45 %	85.2	91.2	91.4

TABLE XXX
REFLECTANCE OF WHITE FABRICS AMONG THE BLENDS
LAUNDERED AT 160° - 165° F.

Fiber Composition	Number of Launderings		
	0	20	50
1. Cotton 50 %, Zantrel 50 %	80.5	89.5	90.3
3. Cotton 50 %, Zantrel 50 %	81.2	86.1	86.7
4. Cotton 50 %, Avril 50 %	76.4	86.9	87.1
11. Cotton 55 %, Zantrel 45 %	85.2	91.2	91.3