A STUDY OF THE RELIABILITY OF LABORATORY TESTS IN MEASURING SERVICEABILITY OF RAYON SLIPS

Thesis for the Degree of M. A.
MICHIGAN STATE COLLEGE

Thelma Lucetta Thompson

1947

This is to certify that the

thesis entitled

"A Study of the Reliability of Laboratory Tests in Measuring Serviceability of Rayon Slips"

presented by

Thelma Lucetta Thompson

has been accepted towards fulfillment of the requirements for

M. A. degree in T. C. & R. A.

Hazel Strahan
Major professor

Date December 18, 1947

M-795

2419

JAN 1 1 1950

A STUDY OF THE RELIABILITY OF LABORATORY TESTS IN MEASURING SERVICEABILITY OF RAYON SLIPS

By

THELMA LUCETTA THOMPSON

A THESIS

Submitted to the School of Graduate Studies of Michigan State College of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

MASTER OF ARTS

Department of Textiles, Clothing and Related Arts

1947

ACKNOWLEDGMENTS

This serviceability study is a part of a more comprehensive research project on knitted and woven slips being conducted at Michigan State College. The writer wishes to express her sincere appreciation to Miss Hazel B. Strahan for her guidance and supervision of this thesis; to Dean Marie Dye for her assistance and to Mrs. Elaine Cowen for her help on statistical analysis of the data. The writer also desires to express her deepest gratitude to the eighteen co-operators who participated in this study by wearing and maintaining records on the slips.

TABLE OF CONTENTS

Page

I. INTRODUCTION

The consumer and manufacturer are both becoming increasingly interested in the merits of laboratory testing. The consumer is anxious to know what is the best buy for his money, while the reputable and progressive manufacturer wants to be able to present facts about his product to his clientele. As a result of such interest, many manufacturers now have set up their own laboratories for testing their products. In addition, mail-order houses and large department stores are maintaining testing laboratories for testing the products they sell. Government and commercial testing laboratories also play an important part in testing consumers' goods and in the development of specifications for them.

While great progress has been made in textiles as a result of laboratory testing, it is desirable that the laboratory findings predictive of serviceability be substantiated by performance under conditions of normal usage. A never-ceasing evaluation of laboratory equipment and standards for its use are imperative if results of laboratory testing are to be potential guides for the consumer.

Because slips are indispensable in most women's wardrobes, this study was conducted to compare the predictive value of laboratory testing on slips as a measure of serviceability with the performance findings following actual wear. The effect of laundering alone with

laundering combined with wear were compared. In addition, home and laboratory laundering procedures were compared in their effect on the serviceability of slips.

"A Comparative Study of Four Brands of Women's Rayon Woven Slips of Comparable Price" was completed by Rann[18] in 1946. This study on serviceability was planned as a continuation of the above study. By making a wear study of one of the brands studied, it is possible to analyze the findings of laboratory testing in relationship to actual wear.

II. REVIEW OF LITERATURE

Even though women's slips of today offer a sharp contrast with the silk ruffled petticoat of the early nineteen twenties, it was that particular garment which first introduced research in consumer textile goods, according to a report by O'Brien.[16] In spite of this early study's amusing complications with the changing fashion of the day, it did establish a precedence for serviceability testing. Specifically the purpose of this petticoat study was to establish the relationship between the amount of weighting and the wearing qualities of silk. As a result of this study came the first ruling on textiles from the Federal Trade Commission and the first informative label which stated that the term "silk" could not be used without being qualified by the word "weighted" if it contained more than ten per cent of materials other than silk. This carefully planned project introduced practices in setting up serviceability studies that are still considered to be of merit. The fabric was made to specification with varying amounts of metallic weighting, made into elaborate petticoats and worn by co-operators.

Similarly, a recent study, "Service Tests on Blends of New and Reclaimed Wool"[23] on wool skirts was carried out, again having the fabric woven to specification with variation in the type and amount of wool. Another comparable wear study, "Relative Serviceability of Three

Weights of Wool Serge"[11] has been conducted using three weights of wool serge for men's trousers. As in the early petticoat study, records were kept by the co-operators on the number of hours of wear, number of launderings or dry cleanings, signs of wear and other pertinent facts.

Serviceability studies have been evolved to compensate for the inadequacy of laboratory testing for measuring the kind and amount of wear which may be expected from the article of apparel. Although no standard techniques are established, certain recommendations can be made. According to Hayes and Rogers[8] a sufficient number of articles should be allowed for laboratory test samples, as well as for unavoidable accidents, the loss of articles and the failure of co-operators to complete the test. Further recommendations are to control as many variables as possible. Examples of controlled variables include uniformity in the style of garment, use of the same laundry or dry-cleaning establishment, specification of the number of hours of wear, selection of co-operators of the same occupational group in one geographical location. The garment used for wear studies must necessarily be of a styling and construction which is reasonably acceptable to the co-operator. Wear studies should be completed within a relatively short period of time and so planned as not to disrupt established routines if conducted in an institution. However, if the garment is to be worn to the point that it is ready to be discarded, the time required is a factor which highly complicates such a project. The human factor of individual differences in wear and care of clothing again supports the need for an ample number of co-operators.

In an article entitled "Textile Fibers and Fabrics"(7) Mary Anna Grimes presents some of the problems of sampling in that particular field. Sampling of garments is often complex because the size of the sample is often necessarily small. For this reason, it is imperative that good judgment be used in sampling. She further points out that successful sampling depends more upon sound textile knowledge and good judgment than upon the size of the sample, the number of tests or knowledge of statistical methods.

It has been pointed out by A. G. Ashcroft in his discussion "The Interpretation of Laboratory Tests as Quality Indices in Textiles"(1) that future emphasis in research in the field of textiles will be on the satisfactory performance of the product for the consumer rather than the utilization of existing stocks of raw materials. It would seem that with greater emphasis on the end use of consumer goods and the importance of satisfying human needs, that there will be pressure on industry for the development of new tests to measure length of service, as well as, other satisfactions. He further points out that it is impossible to standardize satisfactions because individuals place different values on any given commodity - for some it may be style satisfaction while for others it may be wear-life dependability. It is a challenge for industry to develop test methods which will add to the knowledge of the properties of materials and thus promote the development of new products which give wider satisfaction adequacy for specific use and dependability in performance.

A study reported by Ernest R. Kaswell on "Wear-Resistance of

Apparel Textiles"[9] showed a comparison of the performance results of fabrics in use on the Combat Course and the results obtained in the laboratory. The fabrics tested were cotton twill, herringbone twill and sateen. While uniforms were being subjected to the rigors of the Combat Course the identical fabrics were being analyzed in the laboratory for their physical properties and abrasion resistance as determined by the M. I. T. and Taber abrasers. The worn uniforms were carefully checked for direction and areas of wear. In comparing the results of the two abrasion machines, it was found that fabrics were placed in substantially the same order. Photomacrographs were made of the abraded specimens. An almost perfect qualitative agreement existed between the photomacrographic predictions and the Combat Course experimental results. Sateen back wore best while herringbone twill wore worst. The major problem encountered in this study in the use of laboratory abrasion testers was the interpretation of results. It was found that reduction in tensile strength was the best known criterion for measuring the extent of abrasion damage. The study showed the value of photomacrographs in measuring abrasion resistance qualitatively. However, precautions must be taken in using fabrics of the same weight, thickness, yarn size and fiber content if one is to obtain valid results.

A comprehensive study on 1,000 fabrics of various fiber content was conducted as a cooperative regional project during the years 1933 - 1942. A report from this project entitled "Colorfastness of Women's and Children's Wearing-Apparel Fabrics"[13] showed the colorfastness characteristics of these various fabrics. The objectives of the study were

(1) to determine the colorfastness properties of representative textile fabrics used for making women's and children's wearing apparel and (2) to ascertain how closely the present standard laboratory methods of testing textile fabrics for colorfastness performance predict the actual performance during wear. The study showed a definite need for colorfastness standards for all wearing-apparel fabrics and labeling to show the consumer the kind of colorfastness which can be expected of a particular fabric. The tests failed to predict actual wear performance in many cases. "The need for more rigorous tolerances in applying the tests and in the interpreting of the results was indicated."

Mentrup in "A Comparative Study of the Laboratory Performance with the Service Performance of Silk and Rayon Slips"(15) found that after one thousand two hundred hours of service and twenty-five launderings, the appearance of the slip was still good. Yarn slippage was found in rayon slips after the eleventh laundering. The greatest amount of wear appeared on the shoulder straps, the raised areas where the shoulder straps were inserted and at the darts in the upper part of the garment. This wear is explained by abrasion caused in wearing and ironing. At the end of the wear period, it was found that warp yarns had worn away at the point where straps were attached and at darts under the arm. Rayon slips showed shrinkage during the first seven launderings. Results of shrinkage in hand laundering were comparable to results obtained by using the Launder-Ometer. This study further showed that wear and laundering had comparatively little effect on tensile strength although laundering in Launder-Ometer tended to affect it more than hand

laundering. Among laboratory tests used, it was found that those for shrinkage, color-fastness, abrasion and yarn slippage seemed the most valuable in predicting the serviceability of a fabric in actual use. Also, it was found the yarns in bias-cut slips showed less distortion after wear and laundering than those in straight-cut slips. The breaking of stitching in the hem of the bias-cut slips however, was a disadvantage.

Dauner(6) made a serviceability study of six qualities of rayon woven slips of similar design which were worn by business and professional women. In analyzing the results of the worn slips, it was found that a slip of all viscose rayon gave better service than those of viscose and acetate. A high yarn count and a balance in the warp and filling count in the all-viscose fabrics contributed to a longer life expectancy of those slips. It was also concluded that serviceability is likewise dependent upon the type of seam, and stitching and fabric construction. In this particular study there seemed to be a direct relationship between the wear given a slip and the activity of the wearer, and to some extent, with the size of the wearer.

"Autopsy of Discarded Rayon Slips" by Sommaripa(20) was an extensive wear study of hundreds of rayon slips which varied in fiber content and weave construction. Approximately three hundred office employees of two large mail-order houses and one hundred twenty-five plant employees wore slips for the wear study. All garments were examined at least three times: after two washings, during the wearing period and when discarded. It was found that factory and store workers were accustomed to making numerous repairs and continued wearing their slips even in serious

conditions of deterioration. The discarded slips were classified into various types and then rated in terms of deterioration. It was found that raveling of raw edges is the major cuase for repairing and discarding viscose rayon slips. It was estimated that covered edge seams double the life of a fabric with a yarn count of 92 x 68, while locked stitch seams in fabric of 104 x 72 yarn count give excellent performance. Although satins and high-count taffetas show a high resistance to slippage when new, this characteristic decreases materially with wear. It was found that burned holes and holes near seams were the major causes for discarding slips of acetate rayon. Wearers also reported difficulty in ironing in spite of the fact that instructions on ironing had been given. Slip fabric which combined acetate and viscose showed a greater resistance to raveling of seams and a higher ironing temperature than can be used on an all acetate fabric.

In an effort to conserve essential material and to prevent depreciation through skimp cutting, the O. P. A. in 1942 requested the cooperation of the National Bureau of Standards to assist in the establishment of a commercial standard for women's slips made from woven fabrics. This conference resulted in the establishment of minimum measurements for slips of various styles. The standard became effective in April, 1945. Producers who were willing to meet the size and labeling specifications in the manufacture of women's slips accepted Commercial Standard CS121--45.(25)

III. MATERIALS AND METHODS

Only one style of one brand of slips was selected to be used in this serviceability study, because of the variables in laundering and individual differences in wear which are necessarily introduced in a study of this nature. A nationally advertised slip made of French crepe which retails at $1.85 was chosen for the study. This particular slip meets with the specifications of "Women's Slip Sizes," Commercial Standard CS121--45.[25] The slip was designed with double bodice in both front and back and a four-gore alternating bias-cut skirt. See Appendix, Plate 2, for design of the slip used. The front underarm bodice sections were darted for better fit over the bust line. Edge stitching around the top of the bodice and double rows of stitching for the one fourth inch hem was done with a machine stitch of eighteen stitches per inch. All slips were tearose in color.

In selecting individuals to wear the slips for this study, women of similar occupations were chosen. Of the eighteen selected, one was a dietition, two were secretaries, seven were graduate students and the remaining eight were faculty members. In order to get a variety of sizes represented, six co-operators were selected whose size corresponded to the manufacturer's size 12 slip; likewise six co-operators were selected to wear a size 14 and six to wear size 16 slips. Bust, waist and hip measurements were taken in accordance with the manufacturer's directions

in order that proper fit of the garment be assured and not constitute a complicating factor in wear.

Since it was impossible to purchase a large quantity of slips of one style within the same brand from a retail store, it was necessary to purchase them directly from the factory. The eighteen co-operators' measurements were submitted to the manufacturing company to insure proper fit of the slips. The fit of the slip was carefully checked upon being issued to the co-operators. Fifteen additional slips to be used as controls and for testing were purchased - making a total of thirty-three slips (eleven each in sizes 12, 14 and 16).

Six slips, (two in each size) were used to determine the initial specifications of yarn count, weight per square yard, wet and dry breaking strength, and yarn analysis consisting of denier, number of filaments per yarn and number of twists per inch. Three slips representing each size were retained as controls.

Six slips were used to determine the effect of laundering. Six of the eighteen slips worn by co-operators were also laundered in the laboratory. All worn slips were returned to the laboratory following the fifth, tenth, twentieth and thirtieth launderings in order that the investigator could determine yarn count, dimensional change and signs of wear. Slips which were laundered only, were similarly examined. Twelve of the eighteen co-operators laundered their own slips in the home according to specified directions. See Appendix for laundry instructions. Originally the study was to terminate at the end of one thousand hours of wear and forty launderings, but the period was shortened because some

of the slips were ready to be discarded at the end of seven hundred fifty hours of wear and after thirty launderings. Each co-operator was asked to wear the slip approximately twenty-five hours between launderings and to keep a record of the number of launderings and hours of wear. See Appendix for type of record kept.

At the end of the thirtieth laundering, the co-operators returned their slips to the laboratory for final physical testing and subjective analysis of wear. Weight per square yard, breaking strength, yarn count, dimensional change and evidences of wear were recorded. In addition to the co-operators' slips, the six which were laboratory laundered, but not worn, were similarly tested and examined.

Physical testing procedures used in fiber, yarn and fabric analysis, as well as inspection methods are described in the following paragraphs.

Fiber Content: Microscopic and chemical analysis for fiber identification was made. From the reaction of the warp yarns in acetone, it was concluded the type of rayon used for the warp yarns was acetate. Application of Texchrome, a dye product which reacts with a characteristic color to various fiber types, turned the filling yarns blue; therefore they were identified as cuprammonium according to the accompanying color-fiber identification chart. Identification for both warp and filling yarns was verified by microscopic analysis. See Plate 1 in Appendix for fabric used in slips.

Yarn Analysis: An Alfred Suter Twist Tester was used to determine the

number of twists per inch. The procedure followed was adapted from a study by Platt.[17] A ten inch gauge length was used for both warp and filling yarns. The yarn was raveled from the fabric in such a manner as not to alter twist. It was securely clamped in place and a three gram deflection load lowered upon the yarn before clamping the opposite end to insure against undue tension. The load was lifted after the yarn was securely clamped and untwisted and then retwisted until it broke. The number of turns was recorded in each case. This data was substituted in the following formula:

$$N_1 - N_2 = 2T$$

$$\text{and} \quad t = \frac{T}{l} = \frac{N_1 - N_2}{2 \times l}$$

in which:

N_2 = number of turns to twist to rupture

N_1 = number of turns to untwist and retwist to rupture

T = total number of turns in yarn

t = turns per inch

l = length of yarn used.

For each of the six original slips tested, an average of ten determinations was used in reporting the twist per inch for the warp and filling yarns.

The Universal Yarn Numbering Balance was used to determine denier in both warp and filling yarns. The required length for each determination was ninety centimeters by the metal ruler devised for use with this

balance. The weight in denier was read directly from the balance dial indicating the number of .05 grams in four hundred fifty meters of yarn. Three determinations were made on each warp and filling yarns respectively from each of the six slips used for original testing.

Due to the high twist in the filling yarns, a correction was necessary. Denier is determined when there is no twist present. A method recommended by the United States Testing Company[4] was used in making the correction in the highly twisted filling yarn. The Suter Twist Tester was used to determine the per cent of elongation due to twist take-up. The correction in denier was made as follows:

Denier size (In twisted state) X (100% - % elongation) = Corrected Denier

Very slight twist in the warp yarn made it unnecessary to correct the denier.

The number of filaments per yarn was determined by pinning a yarn on a piece of black velvet and using a pick to separate and place filaments in groups of five. Placing a pin behind each group facilitated counting. Three counts were made each on warp and filling yarns.

Fabric Analysis: The procedure for determining the number of yarns per inch was determined in accordance with A. S. T. M.[3] A Suter Micrometer was used in counting the number of warp yarns per inch in five places selected at random on the garment. Similarly, the number of filling yarns per inch was counted. The determinations recorded are an average of five counts for warp and filling of each slip. Because there were no selvages to help determine warp and filling yarns, it was assumed the

higher count indicated warp yarns and the lower count, the filling yarns. These assumptions are in agreement with the characteristics of French crepe construction.

Yarn count determinations were likewise made on the slips which were worn and those being used as laundry controls after the fifth, tenth, twentieth and thirtieth launderings.

Weight per square yard was determined according to the method given in A. S. T. M.[3] Five two-inch squares were cut at random from six new, six laundered and unworn, and six laundered and worn slips. The bone dry weight of the five specimens was obtained by drying them in a conditioning oven for one and one half hours and cooling for at least one half hour in a desiccator containing CaCl. The specimens were weighed on an analytical balance until the weight was constant to within .003 grams. The following formula from Lomax[10] was used in calculating weight per square yard:

$$\frac{45.71 \times \text{grams}}{\text{area in square inches}} = \text{ounces per square yard}$$

The raveled-strip method according to A. S. T. M.[3] was used in determining breaking strength. Two sets of five specimens were cut, one set for warp breaking strength having the longer dimension parallel to the warp yarns and the other set for filling breaking strength, having the longer dimension parallel to the filling yarn. No two specimens for warp breaking strength contained the same warp yarns, or for filling breaking strength the same filling yarns. Each strip was cut one and one fourth inches wide and six inches long and by taking approximately the

same number of yarns from each side of the strip, it was raveled to one inch in width. The breaking strength was tested when the strips were both dry and wet.

Because a conditioning room was not available, dry strips were conditioned in the following manner. Specimens were conditioned in a desiccator where an approximate temperature of 77°F and humidity of 65 per cent was maintained through the use of a 36 per cent H_2SO_4 solution. The raveled dry strips were allowed to condition for a period of at least twelve hours before being broken in a Scott-tester.

Wet breaking strips were prepared by allowing them to stand in tap water at room temperature for a period of two hours. One strip at a time was removed from the water and broken in less than one minute from the time they were removed.

In order to compare wear in various areas of the slips which were worn, groups of five strips each were taken from the skirt front, skirt back, waist-line areas in both front and back and sides. See cutting charts, Plates 3 and 4, in Appendix for locations of areas tested.

Laundry Procedure: A laundry procedure used by Lyle and Black in their study "The Effect of Wringing upon Tensile Strength of Rayon Fabrics"(12) was modified for the laundering of the six slips held as controls and the six worn by co-operators. A machine was used in washing because uniform agitation was desired for all slips laboratory laundered. It was found that the three minute washing period as used by Lyle and Black in laundering rayons was not a long enough period to remove soil from

slips which had been worn. It was necessary to apply soap solution (one cup Lux Flakes and one half cup hot water) with a small brush on seam lines to loosen soil and to increase the washing period from three to six minutes.

Sixteen liters of 37.7 degrees ± 1 degree C were poured into a portable Baby Grande washer. One fourth cup of Calgon was used to soften the water and two cups of Lux Flakes used to make a standing suds of about two inches. The slips (after being brushed with soap solution on seam lines) were placed in the washer and allowed to wash for six minutes after which time they were gently squeezed and rinsed for two minutes in softened water of the same temperature. Again the slips were squeezed and rinsed in the same manner.

Following the washing, each slip was rolled in a Turkish towel and allowed to stand at least one half hour before ironing.

The slips were ironed on the wrong side in direction of the grain. The double yokes were ironed first and then the gored sections. The ironing temperature was kept within the range of 225-275°F. Because the double yoke and the seams remained damp, it was found most satisfactory to finish ironing these sections on the right side. Slips were allowed to dry thoroughly before taking yarn count or measurements.

The hand laundry procedure suggested for use of the co-operators was in accordance with directions by the manufacturing company which accompanied the slips and is fully described in the Appendix.

Measurements: To insure uniform measurements in testing for dimensional

change, all slips to be laundered were placed on padded commercial dress forms and points of measurement were established for taking both horizontal and vertical measurements. Markings for horizontal measurements were located at the bust, waist and hips. Eight points for vertical measurement were established at center front, center back, midway of side panels and at adjoining seam lines. Points of measurements were marked by dots of indelible ink. See sketches in Appendix, Plate 2, for locations of lines of measurement.

Measurements were taken when the slips were new and following the fifth, tenth, twentieth and thirtieth launderings. The procedure in taking measurements consisted of placing the slip over the end of the ironing board, pinning a tape line connecting the points established for measurements. Measurements were recorded to the nearest one tenth inch.

Methods of Sampling: In planning areas to be used for physical testing, the size 12 slip (front, back and sides) was drawn to the scale of one fourth inch to one inch. From this diagram, cutting charts of the areas to be tested were made. The cutting plans for laundered slips were identical to the plans for new slips with the exception that twice as many strips were cut. See Appendix for cutting charts.

The specimens for breaking strength which were one and one fourth inches wide and six inches long were charted for warp and filling directions respectively. It will be noted that a greater number of breaking strength determinations were planned for slips which were worn and those which were laundered only than for new slips. This was done in order to

compare loss in strength due to laundering and wear in the areas of front skirt, back skirt, front waist, back waist and the left and right sides. Because it was impossible to test both warp and filling directions at the same location of the slip, it was necessary to divide the worn slips into two groups and alternate warp and filling specimens in the area to be tested.

Two specimens, one inch by fifteen inches, were charted parallel to warp and filling yarns respectively for the purpose of determining denier and twist in the new slips. The five weight squares, two inches by two inches, were located at different areas in all slips tested. Breaking strength and weight per square yard were planned for slips which were new, laundered only and laundered and worn; while areas were charted only in new slips for denier and twist.

It was found necessary to draw yarns in order to cut accurately the specimens.

Visual Inspection: Periodic inspection included examination of all of the slips in the study. Yarn slippage was detected by placing the slip over a dissecting cabinet and carefully examining the entire slip. Signs of abrasion, holes, seam slippage and color change were also noted. Comments as to breaking of straps and rips were recorded. At the end of the thirty launderings, after the final inspection had been made, the slips were subjectively scored for performance as indicated by visual signs of wear. An arbitrary rating was devised for purposes of comparison. A positive score was assigned to each type and degree of

wear as follows:

Hole - - - - - - - - - - 0 to 5

Abrasion - - - - - - - - 0 to 4

Yarn Slippage - - - - 0 to 3

Wear in Straps - - - - 0 to 2

Color Change - - - - - 0 to 1

By such rating, a perfect score was fifteen, while the lowest possible score was zero.

IV. DISCUSSION OF RESULTS

A. Analysis of the Original Fabrics

An analysis of the results of physical testing of the new fabric with that of the fabric after laundering only and laundering combined with wear is discussed in this section. A comparison of initial properties with those same properties at the end of the wear study serves as a basis for judging the performance value of this fabric and the value of laboratory testing as predictive of wear expectancy. Physical tests are supplemented by a subjective analysis of the slips and a relationship established. A summary of the initial properties of the fabric, namely, yarn analysis (consisting of denier, filament count and twist) and fabric analysis including weight per square yard, yarn count and breaking strength is shown on Table 1. Data for dimensional change, yarn count, weight per square yard and breaking strength of unworn laundered and worn laundered slips are shown in Table 2. It will be noted that the original plan included twelve slips to be worn and laundered in the home; but during the wearing period one of the slips was lost, so complete results are recorded for only eleven slips.

Fiber Content: Upon chemical and microscopic analysis of the fiber, the warp was found to be acetate rayon and the filling to be cuprammonium rayon. Of the thirty-three slips purchased, all but four were made of

Table 1

Initial Properties of Slips*

Code	Weight in oz. sq. yd.	Yarn Count		Yarn Twist		Filaments per yarn		Denier per yarn		Breaking Strength in pounds			
										Warp		Filling	
		Warp	Filling	Warp	Filling	Warp**	Filling	Warp	Filling	Dry	Wet	Dry	Wet
a/PT	2.61	155.2	104.0	S 5.13	Z 29.19	26.0	60.0	75.0	73.13	28.4	14.0	27.8	14.6
a_1/PT	2.55	155.4	104.4	S 6.41	Z 28.01	26.0	60.0	76.7	74.09	28.2	11.4	27.8	14.4
b/PT	2.65	156.2	106.0	S 2.38	Z 23.11	50.0	59.7	76.0	73.88	30.4	12.6	28.6	14.0
b_1/PT	2.64	155.8	105.8	S 4.15	Z 22.66	50.0	59.7	76.7	73.12	31.0	14.4	27.4	13.0
c/PT	2.67	155.2	107.0	S 2.15	Z 22.37	50.0	60.0	74.3	75.44	29.4	12.4	26.2	14.0
c_1/PT	2.54	155.8	104.8	S 5.22	Z 26.34	50.0	60.0	74.0	74.47	30.4	14.2	27.6	12.6
Average	2.61	155.6	105.3	S 4.24	Z 25.28	**	59.7	75.5	74.02	29.6	13.2	27.6	13.8

* Based on six slips

** Because of the great difference in the number of warp filaments of a/PT and a_1/PT with the other four, an average was not computed.

Table 2

Summary Chart of Properties of Original, Laundered and Worn Slips

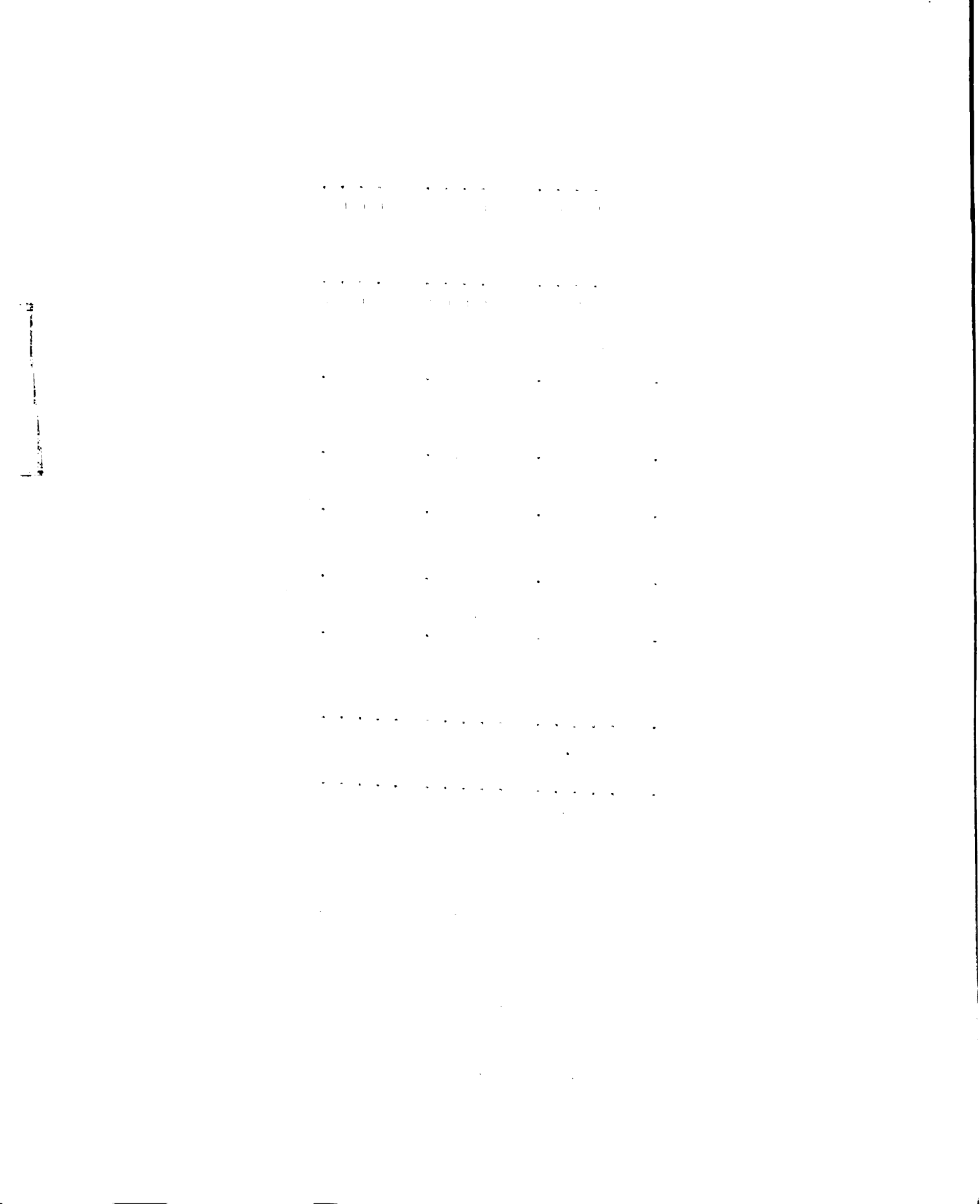
Code	Times Laundered	Yarn Count Warp	Yarn Count Filling	Breaking Strength in Pounds Warp Dry	Breaking Strength in Pounds Warp Wet	Breaking Strength in Pounds Filling Dry	Breaking Strength in Pounds Filling Wet	Weight in oz. per sq. yd.	Percentage of Dimensional Change Width	Percentage of Dimensional Change Length
Originals*	0	155.6	105.3	29.6	13.2	27.6	13.8	2.61		
Laboratory Controls*	0	154.9	104.5							
	5	157.1	109.2						-3.3	-3.9
	10	156.8	109.6						-2.4	-4.03
	20	157.6	110.3						-3.1	-4.73
	30	157.8	109.7	25.6	11.2	26.2	13.8	2.71	-1.52	-5.0
Worn, Laboratory* Laundered	0	155.2	105.0							
	5	157.5	110.2						-4.65	-2.07
	10	158.9	111.3						-4.44	-2.92
	20	158.5	112.3						-4.63	-3.25
	30	157.1	111.1	25.2	10.8	25.8	12.6	2.85***	-4.32	-3.05
Worn, Home** Laundered	0	154.6	104.5							
	5	157.4	110.2						-4.16	-2.66
	10	157.3	110.7						-3.76	-2.43
	20	157.1	109.8						-3.57	-2.7
	30	156.6	108.7	21.6	10.5	23.7	10.7	2.68****	-4.04	- .92

*Six determinations on six slips

**Six determinations on eleven slips

***Weight computed on two slips

****Weight computed on four slips



delustered rayon. Other than appearance, no differences were evident.

Weight in Ounces per Square Yard: Calculations of the bone-dry weight of the new fabric specimens showed a range of 2.54 to 2.67 ounces per square yard with an average of 2.61 ounces. Rann[18] in her study found an average of 2.82 ounces per square yard for the crepe in the same brand of slip.

Yarn Count: Yarn count in the warp of the six new slips averaged 156 yarns per inch and showed practically no variation. The filling yarn count ranged from 104 to 107 with an average of 105 yarns per inch. The study done by Rann[18] showed 158 and 109 yarn count respectively for warp and filling for the same brand of slip as used in this study. Similarly, Crawford[5] found a ratio of 1.5 warp yarns to 1.0 filling in the crepes of her study.

Yarn Analysis: Analysis of yarn included denier, filament count and number of twists per inch. The denier of the warp yarns was found to be 75.45 while the denier of the filling yarns averaged 74.02. Results show the size of the warp and filling yarns to be very balanced. In checking with the New Additions in American Rayon Denier and Filament Table as of September, 1946,[14] a corresponding denier of seventy-five and sixty filaments is found to be made in both acetate and cuprammonium yarns. Rann[18] found an average of 75.2 for warp denier and 78.0 for filling denier.

Filament count in the yarns was found to be highly consistent

within each slip. However, in checking filament count in the acetate rayon yarns in the warp, two slips had an average filament count of fifty. These, likewise, are listed under yarns produced by the acetate process. Filament count in the cuprammonium filling yarns was likewise highly consistent. The count was sixty in every case with exception of two, which were 59.7. Rann[18] found a filament count of twenty-six for the warp yarns and a filling count of fifty-three. A comparison of filament count shows that a higher quality yarn was available in the fall of 1946 than was available in the fall of 1945. This is substantiated in the comparative breaking strength results.

In examining the twist of the warp yarns, it was found that the number of twists per inch average 4.24 and the average for the filling yarns was 25.28. The warp had a S twist, while filling had a Z twist. In the study by Rann[18] the twist was found to be somewhat lower in both sets of yarns; the direction of twist being the same. According to studies reported by Roseberry,[19] the filling breaking strength increases with twist to a certain point and then decreases with additional twist.

Breaking Strength: Dry warp breaking strength averaged 29.6 pounds and showed a standard deviation of 1.06. When wet, the warp strength showed a decrease of 55.4 per cent. The strength of the warp when wet averaged 13.2 pounds and the standard deviation was 1.1. Rann[18] found warp breaking strength to be 20.5 pounds when dry and 9.7 when wet.

Breaking strength for the cuprammonium rayon filling yarns when

dry averaged 27.6 pounds and had a standard deviation of .72. The filling strength showed a decrease of 50 per cent when wet averaging 13.8 pounds and having a standard deviation of .73. Rann's study showed an average of 24.2 pounds for dry filling breaking strength and 8.3 pounds when wet.

The very close relationship of breaking strength between the warp and filling yarns shows the fabric in this study to be very well balanced in strength. Table 3 shows a summary of all breaking strength averages. The fact that there was lower breaking strength for both warp and filling yarns when wet or dry in Rann's study may be accounted for by the fact that her study was conducted during a post-war period at which time standard qualities of yarn were not yet available. Rann[18] found a lower filament count in the warp yarns which according to Tait[21] would also result in lower breaking strength. He states that the number of filaments per yarn directly affects breaking strength; that is, as the number of filaments increases, the breaking strength increases. The two of the six slips studied which had a lower filament count showed a lower breaking strength in relationship to the other four.

B. Analysis of Fabrics Which Were Laundered Only

Six of the slips which were used as laboratory controls were analyzed after thirty launderings for the purpose of determining the effect of laundering upon breaking strength, weight per square yard, yarn count and dimensional change. These slips were also examined after the fifth, tenth and twentieth launderings to determine progressive

Table 3

Breaking Strength in Pounds*

Summary of Averages

	Warp				Filling			
	Dry		Wet		Dry		Wet	
Original*	29.6		13.2		27.6		13.8	
		% Loss*****		% Loss		% Loss		% Loss
Unworn, laboratory laundered**	25.6	13.5	11.2	15.2	26.2	5.1	13.8	0.0
Worn, laboratory laundered***	25.2	14.9	10.8	18.2	25.8	6.5	12.6	8.7
Worn, home laundered****	21.6	27.0	10.5	20.5	23.7	14.1	10.7	22.5

*30 determinations

**60 determinations

***60 determinations.

****110 determinations

*****Per cent loss in strength based on original breaking strength

change in yarn count, dimensional change and observable signs of wear.

It was found that the warp breaking strength after the thirtieth laundering when dry was 25.6 pounds as compared with 29.6 pounds when the fabric was new; thus resulting in a 13.5 per cent loss. When wet, the warp breaking strength averaged 11.2 pounds as compared with 13.2 pounds when new; a loss of 15.2 per cent. Filling breaking strength (dry) showed a smaller per cent of loss due to laundering. Similarly the strength of filling yarns showed a loss of 5.1 per cent which is less than half than that occurring in the warp. The average was 26.2 pounds as compared with 27.6 pounds when new. The filling yarns when wet showed no loss of strength in laundering; the filling breaking strength being 13.8 pounds when new as well as after thirty launderings. In this study, a decrease in strength is found while the results from Rann's study show an increase in strength following thirty launderings. This difference may be accounted for, in part, by the different laundering procedure; a harsher and longer washing period being used in this study as compared to hand laundering in the preceding one. According to Textile World's Synthetic Table, cuprammonium rayon has a breaking strength of 1.7 to 2.3 per denier, while acetate has a tenacity of 1.25 to 1.5 per denier. In examining Table 2, it will be seen that the filling yarns which were of cuprammonium maintained a higher breaking strength than the warp yarns of acetate. Because the denier of the two sets of yarns is nearly the same, the difference can no doubt be explained by inherent differences in the two fibers when wet and dry.

After the thirtieth laundering, the weight of the fabric was found

to have increased by .10 ounces per square yard. This is due to shrinkage which increases the number of warp and filling yarns per inch.

The greatest increase in warp yarn count occurred within the first five launderings; total increase in count after thirty launderings being only three yarns per inch. Although the increase in filling yarn count was somewhat greater than in warp yarns, the greatest increase again occurred within the first five launderings. After thirty launderings, filling yarns increased from 105 to 110 yarns per inch.

The laundered slips showed progressive shrinkage in length throughout the laundering period. Within the first five launderings, the slips shrank an average of 3.9 per cent or approximately 1.3 inches. After the thirtieth laundering, the shrinkage per cent averaged five or 1.6 inches. In other words, about 80 per cent of the shrinkage occurred in the first five launderings. While shrinkage in width was greatest during the first five launderings, there was at first a decline, then rise and then a downward trend or shrinkage in width. This was undoubtedly due to the fact that the garment was stretched more in width in ironing than in length. Following the fifth laundering the shrinkage in width was 3.3 per cent while after the thirtieth laundering, it decreased to 1.5 per cent.

Upon examining the slips subjectively for signs of wear, it was found that the slips were still in excellent condition after thirty launderings. In each slip, however, the double bodice showed signs of wear where the straps were inserted. In one case, there was a tiny hole in that area. In two slips, a small amount of yarn slippage was noted

and in one slip there were two tiny holes in the center back panel. Perhaps the most obvious change due to laundering was the loss of color. However, it is thought that this is of less importance than other qualities desirable in slip serviceability. See Plate 1 in Appendix for change in color due to laundering.

C. Analysis of Fabrics After Wear and Thirty Launderings

In order to compare and contrast the differences which occur from controlled laboratory and home laundering, all slips which were worn will be discussed in the following paragraphs.

Slips which were unworn and laboratory laundered showed less average loss in strength than those which had been worn and laundered. By examining Charts 1 and 2 it is possible to compare the per cent loss in strength in relationship to the area from which the breaking strength strips were cut. The slips which were worn and laboratory laundered showed that the greatest loss in warp strength occurred in the side sections, while the strips taken from the waist showed the least loss of strength. The filling yarns showed the greatest loss of strength in the side and back waist sections; the least loss in areas taken from the skirt front.

In comparing the worn laboratory laundered slips with home laundered slips it is found that breaking strength averaged higher for worn laboratory laundered slips. Refer to Chart 3.

Examination of Chart 4 shows the relative defferences in filling breaking strength of the worn slips laundered under the two different

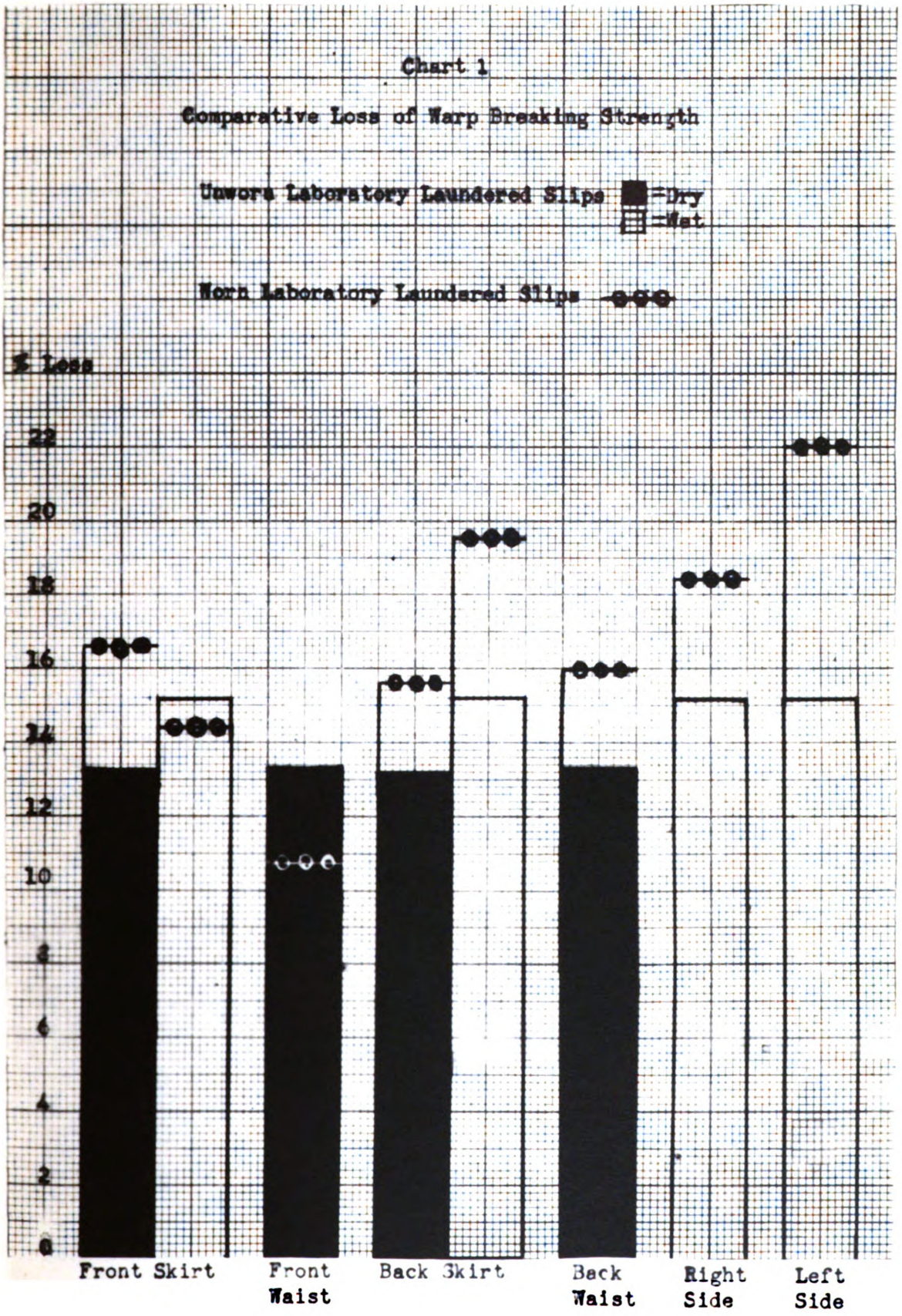


Chart 1
Comparative Loss of Warp Breaking Strength
Unworn Laboratory Laundered Slips =Dry =Wet
Worn Laboratory Laundered Slips
% Loss
22
20
18
16
14
12
10
8
6
4
2
0
Front Skirt
Front Waist
Back Skirt
Back Waist
Right Side
Left Side

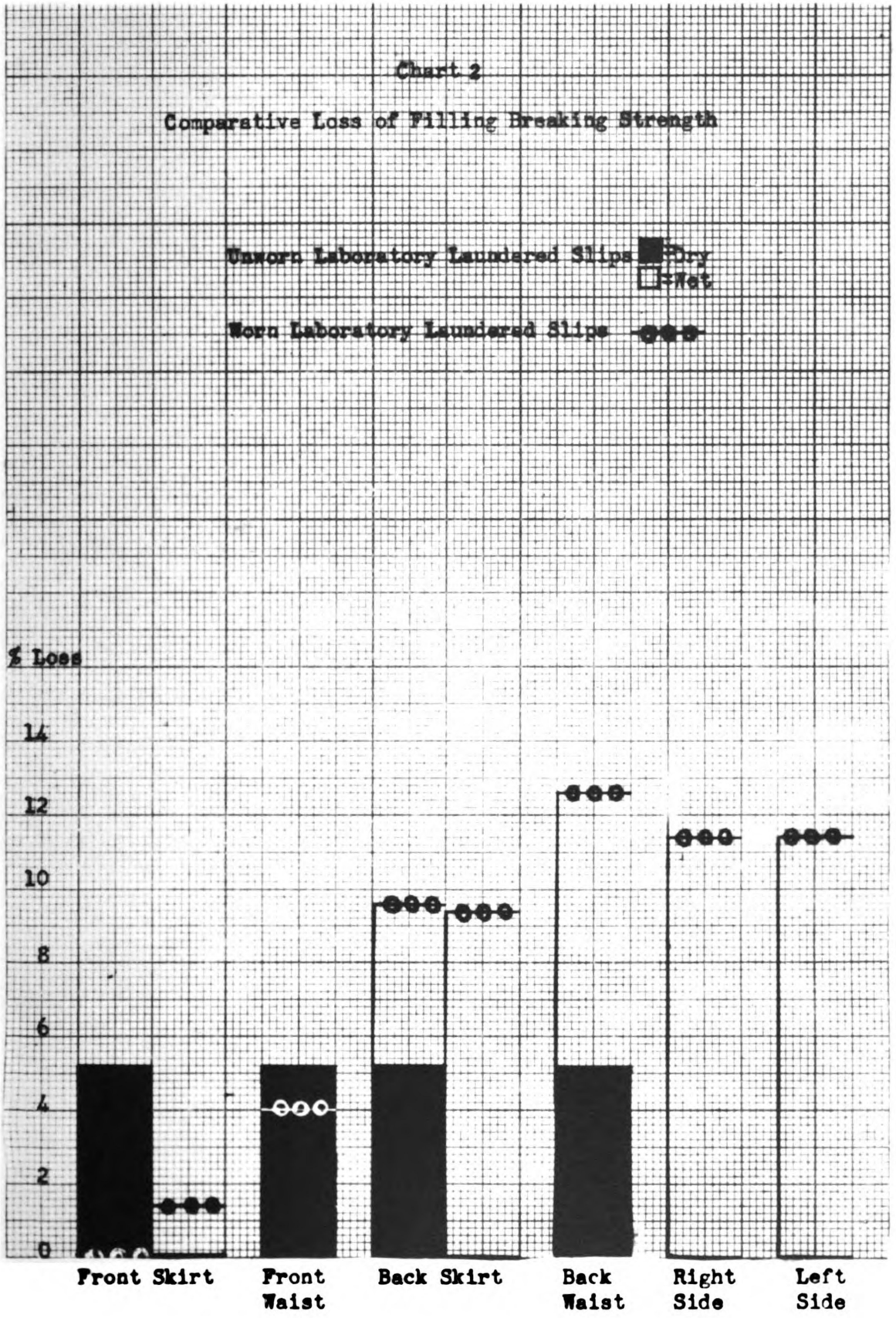


Chart 2
Comparative Loss of Filling Breaking Strength
Unworn Laboratory Laundered Slips
Dry
Wet
Worn Laboratory Laundered Slips
% Loss
14
12
10
8
6
4
2
0
Front Skirt
Front Waist
Back Skirt
Back Waist
Right Side
Left Side

conditions. In every case with the exception of the back waist area, a greater loss is shown in the slips which were laundered by the co-operators. The greatest loss of filling strength occurred in the side sections in both methods of laundering.

Of all of the slips worn, laundered in both home and laboratory, loss of strength in the warp yarns was greatest in the back waist section, while strips cut from the side waist were second in their loss of strength. The front and back sections showed very similar strength, while the front waist section showed the least loss of strength in warp yarns. See Chart 5 for relative loss of warp strength of all slips which were worn.

Chart 6 shows the relative difference of breaking strength in filling yarns of all worn slips. The side areas show the greatest loss in strength, the front waist second, front and back skirt showing the least loss of strength. The fact that in both warp and filling directions, there is greater loss in strength in areas tested from the side waist is probably due to the effect of perspiration by direct contact with the body and greater strain of fabric in this particular area.

Chart 7 shows there is a close relationship in strength between slips which were laundered only and those which were worn and laboratory laundered. Worn slips, laundered in the laboratory and home, showed a greater variance. The relative loss of breaking strength would indicate that laundering in the laboratory is much less strenuous than home laundering. Table 4, which shows the significant differences of the means in breaking strength, verifies the statement made above.

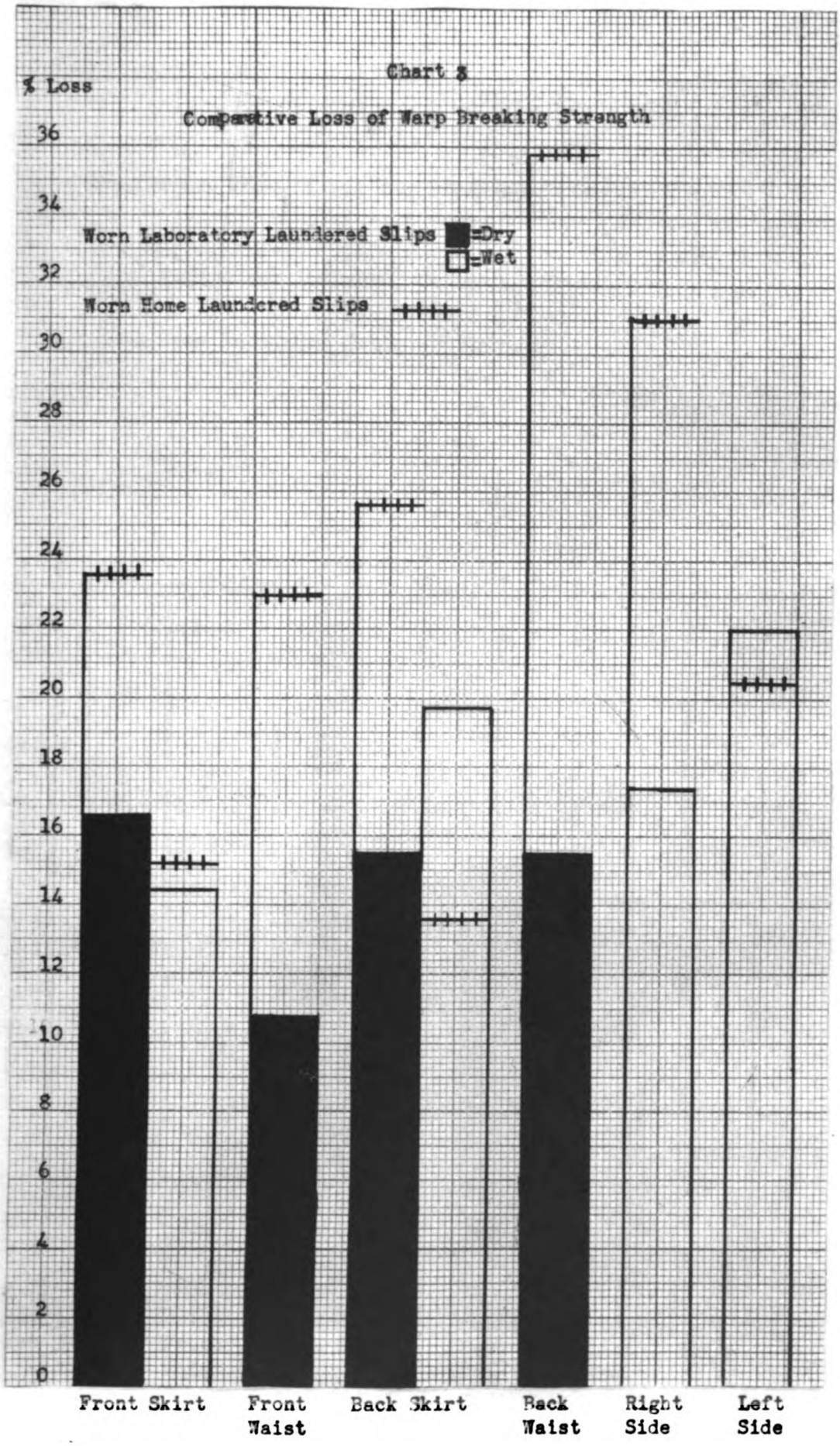
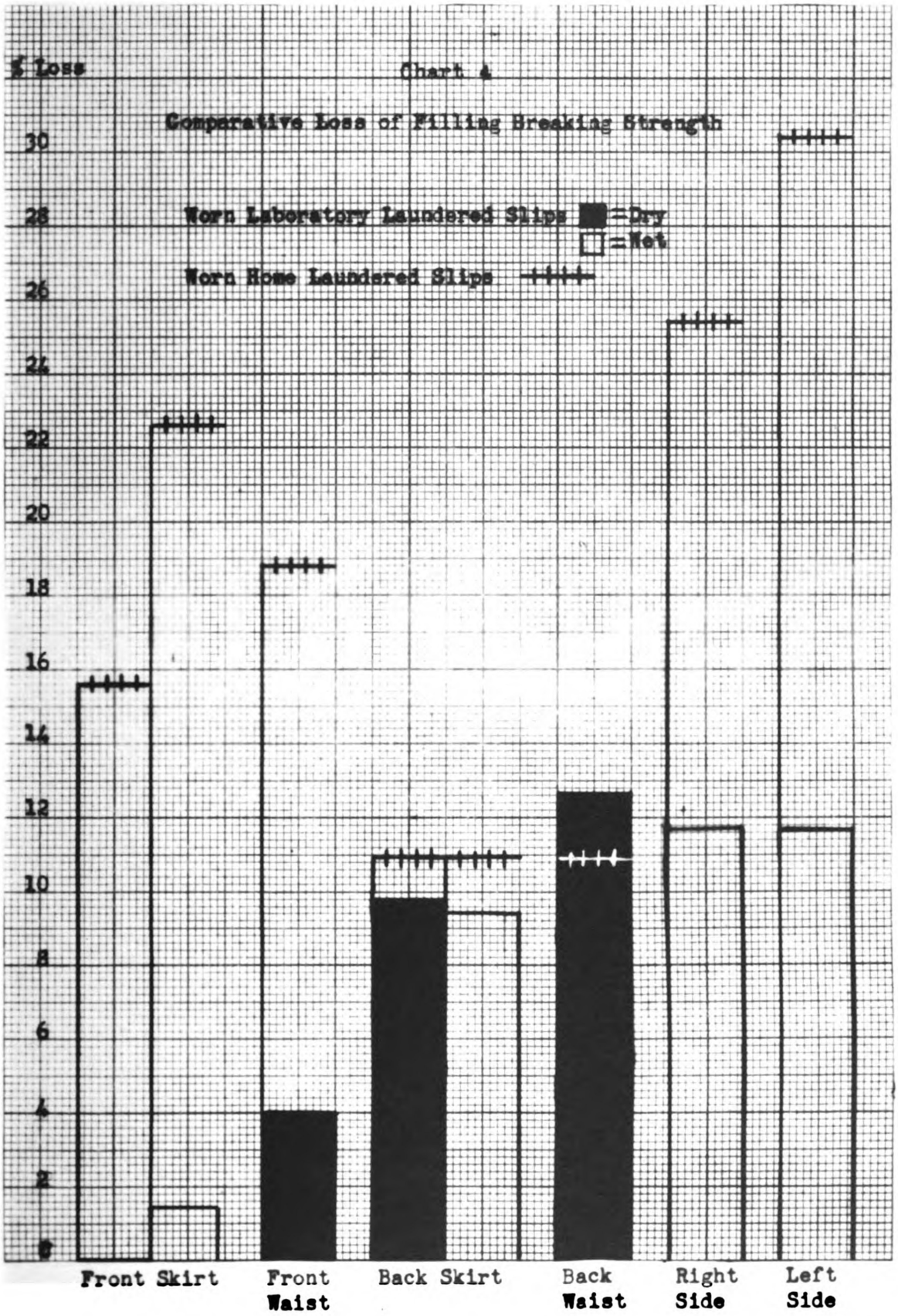


Chart 3
% Loss
Comparative Loss of Warp Breaking Strength
36
34
Worn Laboratory Laundered Slips
=Dry
=Wet
32
Worn Home Laundered Slips
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
Front Skirt
Front Waist
Back Skirt
Back Waist
Right Side
Left Side


% Loss
Chart 4
Comparative Loss of Filling Breaking Strength
Worn Laboratory Laundered Slips ■ = Dry
□ = Wet
Worn Home Laundered Slips
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
Front Skirt
Front Waist
Back Skirt
Back Waist
Right Side
Left Side

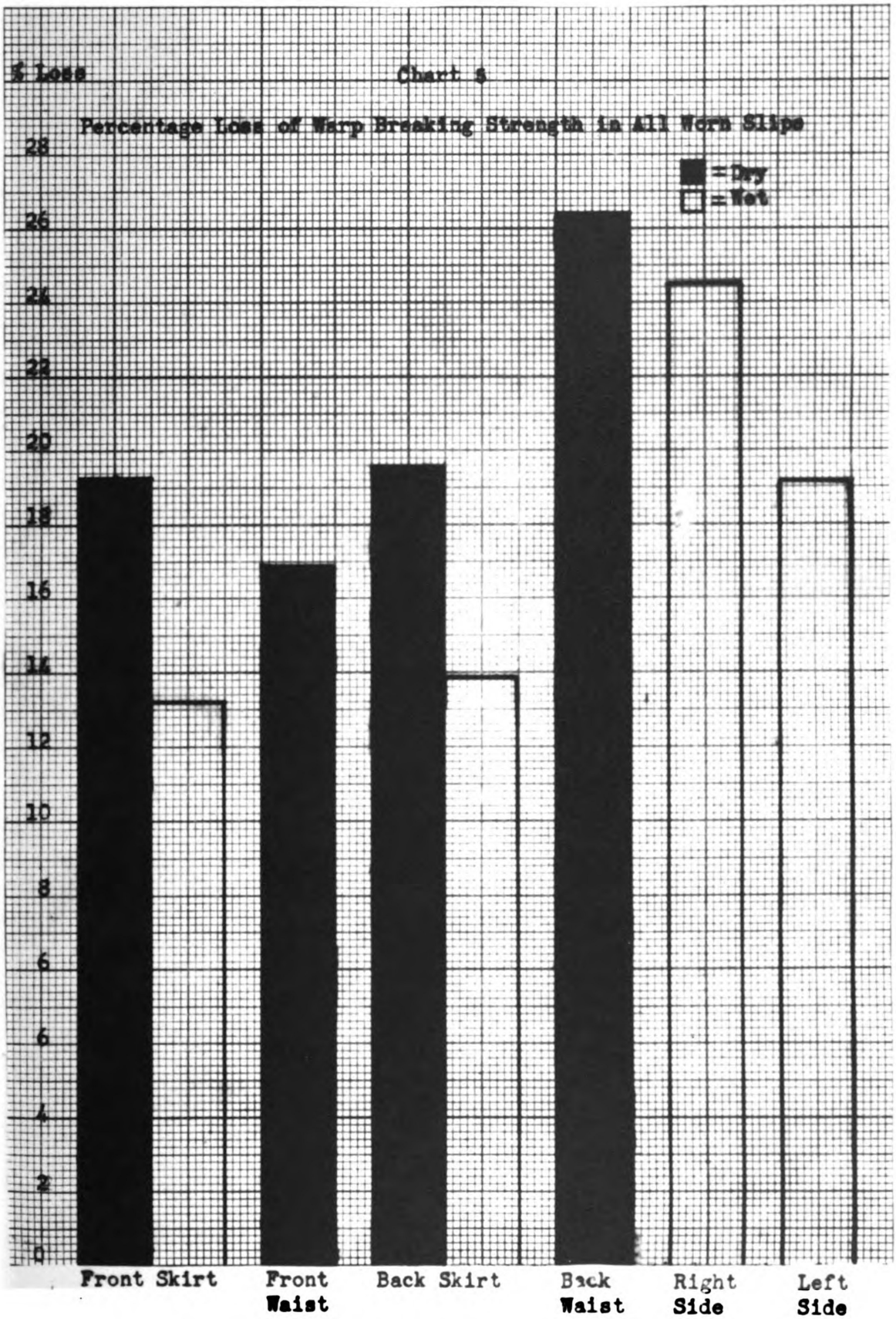

% Loss
Chart 4
Percentage Loss of Warp Breaking Strength in All Worn Slips
= Dry
= Wet
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
Front Skirt
Front Waist
Back Skirt
Back Waist
Right Side
Left Side

Chart 6

Percentage Loss of Filling Breaking Strength in All Worn Slips

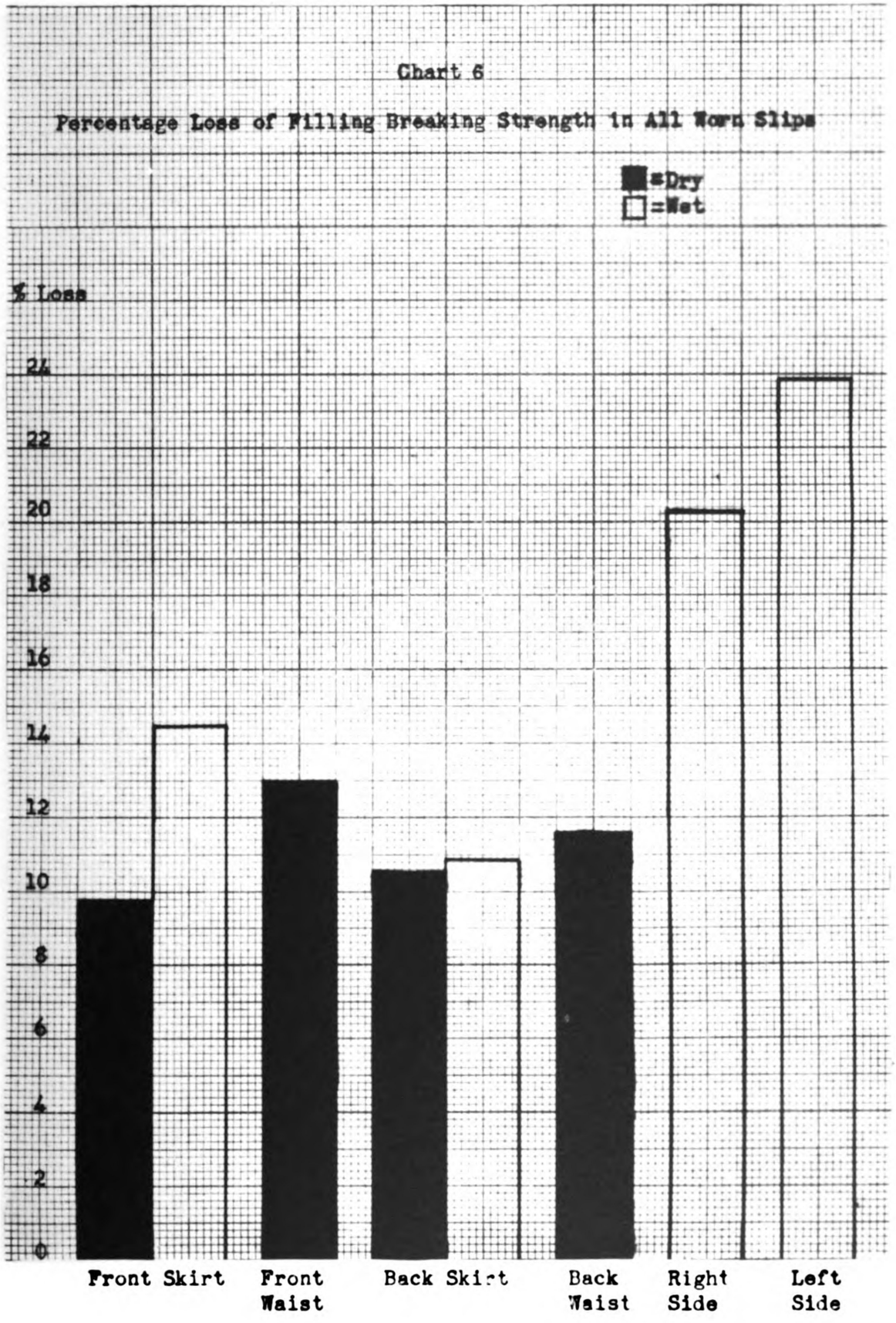


Chart 7

Average Breaking Strength of All Slips

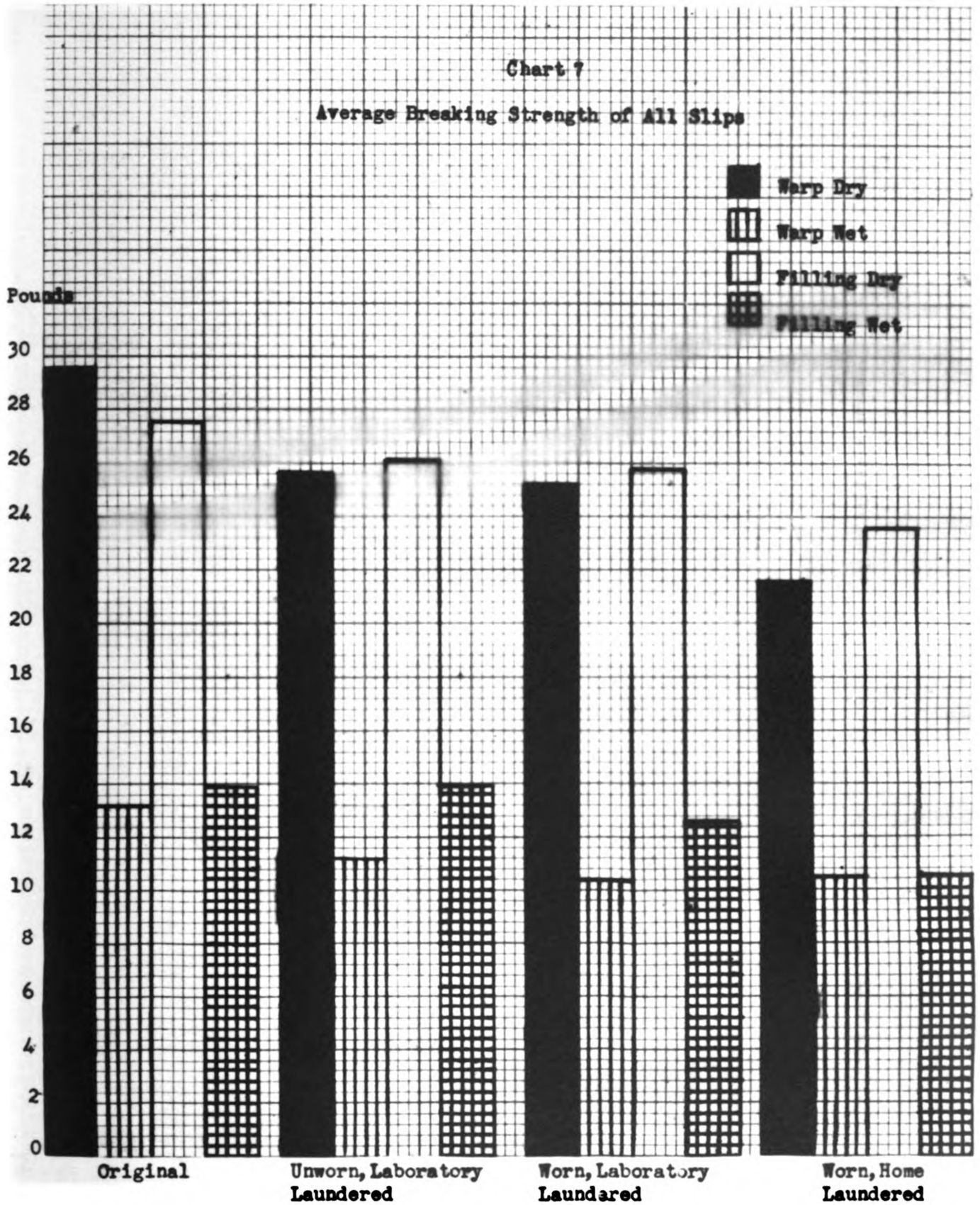
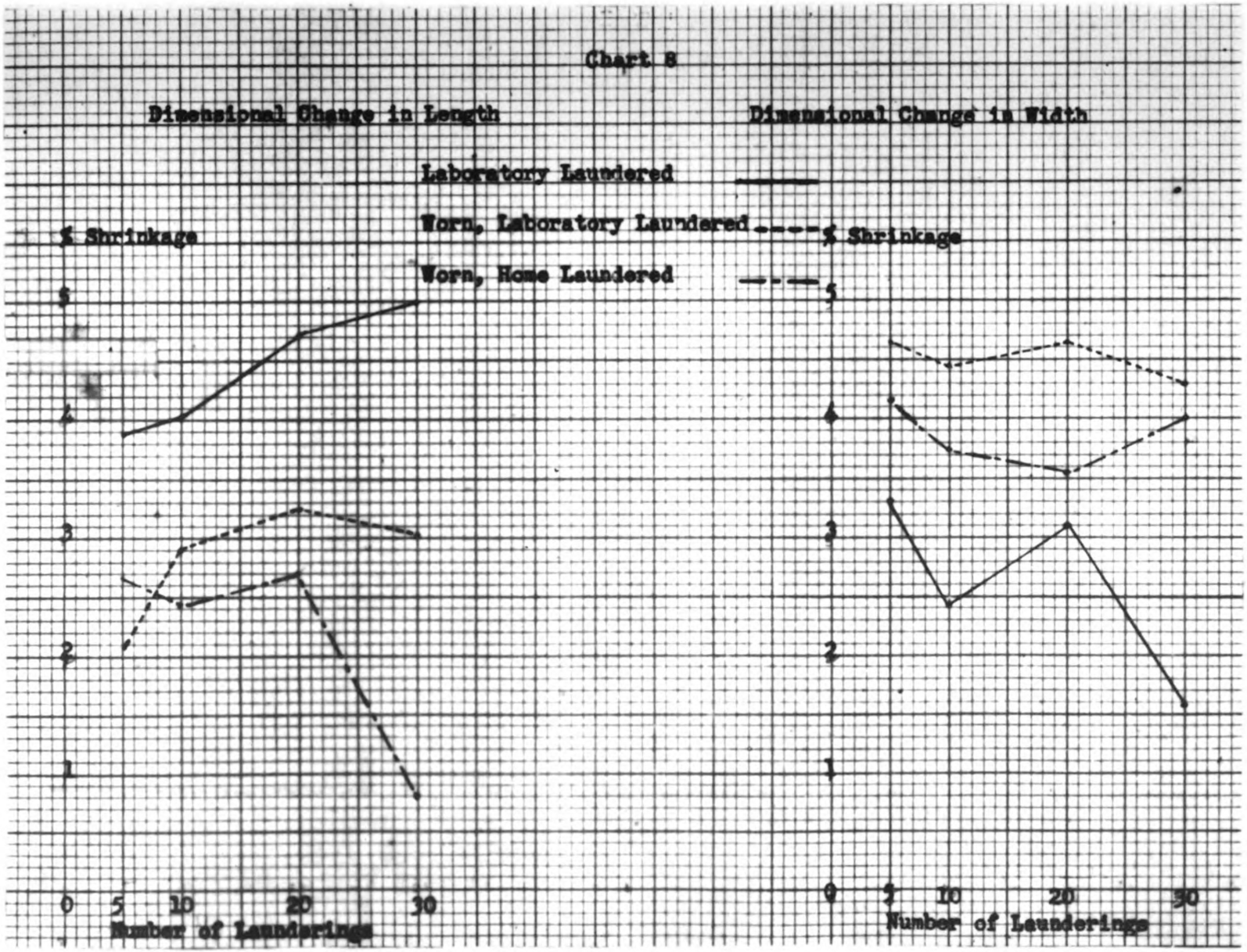


Chart 8


Dimensional Change in Length
Dimensional Change in Width
Laboratory Laundered
Worn, Laboratory Laundered
Worn, Home Laundered
% Shrinkage
% Shrinkage
5
4
3
2
1
0
5
10
20
30
Number of Launderings
Number of Launderings

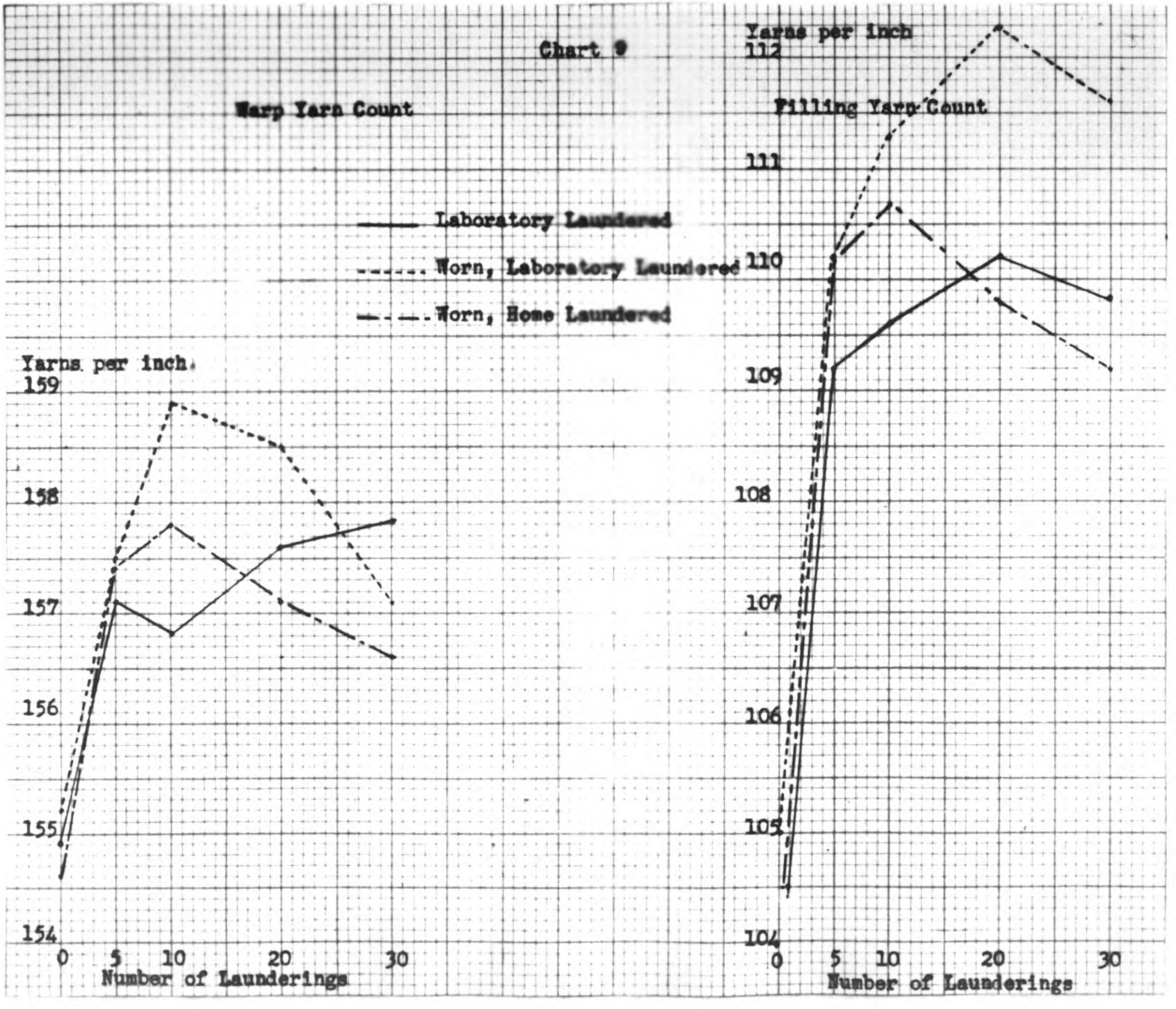


Chart 9
Warp Yarn Count
Laboratory Laundered
Worn, Laboratory Laundered
Worn, Home Laundered
Yarns per inch
159
158
157
156
155
154
0
5
10
20
30
Number of Launderings
Yarns per inch
112
111
110
109
108
107
106
105
104
Filling Yarn Count
0
5
10
20
30
Number of Launderings

Table 4

Significant Differences of Means of Breaking Strength

	Unworn, laboratory laundered with Worn, laboratory laundered	Worn, laboratory laundered with Worn, home laundered
Warp-dry	2.35, significant	7.29, highly significant
Warp-wet	5.66, highly significant	.859, not significant
Filling-dry	1.53, not significant	6.58, highly significant
Filling-wet	7.29, highly significant	7.48, highly significant

The means of breaking strength of laboratory laundered slips and worn laboratory laundered slips were shown to be significantly different. The means of worn laboratory laundered and home laundered slips are found to be even more different by comparison. There is greater consistency in the breaking strength averages in the worn laboratory laundered slips than in those which were laundered by the co-operators at home. This may indicate that laundering procedure is responsible for this difference. These differences are shown in the standard deviations which appear in the Appendix, Tables 11 - 14. The results of breaking strength of two slips worn by co-operators who were quite active in the nursery school work were extremely low. Visual examination showed the slips to be extremely worn indicating that the activity of the person, as well as the laundering procedure used, constitute factors of wear.

The slips which were worn and laboratory laundered showed an increase of .18 ounces per square yard over those which were home laundered. Greater shrinkage in these slips no doubt explains the increased

weight.

Charts 8 and 9 (Dimensional change and change in yarn count) show the slips which were worn and laundered in the laboratory to have shrunk the most and to have the greatest increase in yarn count at the end of the study. The bias cut of the slip made accurate measurements very difficult and the results inconsistent. It is thought, however, that the laboratory ironing procedure followed is largely responsible for the greater dimensional change in those slips. Very slight pressure was used and the ironing strokes were consistently made in direction of the grain to prevent stretching. In examining slips which had been laundered by the co-operators it was noted that, in some cases, too hot an iron had been used and the slips were ironed crosswise rather than in the direction of the grain of the cloth. Inasmuch as there was less change in width, length and yarn count, it is thought that perhaps greater pressure with a hotter iron and ironing on the bias grain could account for the fabric showing a less marked degree of dimensional change. Results of dimensional change showed the fabric to be very unstable and shrinkage is not due alone to laundering procedure. According to Clayton,[2] in some rayons, no matter how carefully the washing method is standardized, a wide variation of results will be obtained by the same and different persons. He states that this condition may be explained by the way the yarns are woven into the cloth and the use of stabilizing agents have a tendency to retard shrinkage or stretchage until progressively removed by succeeding washings. The high twist in the filling yarns, no doubt, explains shrinkage in that set of yarns. This too, is evidenced by the

change in yarn count.

D. Subjective Analysis of Worn Slips

Inspection records were kept by the investigator for each slip. See Appendix for type of record used. Before slips were issued, each co-operator was asked to try the slip on in order that the investigator might check the fit. In six cases, it was found that the slips were excessively large through the bust line. However, after laundering, the fabric shrank enough to overcome this fitting problem. It was necessary to put one inch hems in three of the slips because they were too long. In six slips, straps were shortened to take care of the excess length, but after the first few launderings, the slips had shrunk sufficiently in length so that the straps were released to their original position. In two cases, the slips were too short, attributable to the fact that one of the co-operators was quite tall and the other was the largest in her group, as well as being tall. Most of the hemlines were found to hang unevenly due to the bias cut. Practically all of the slips fitted very smoothly and the majority of the co-operators expressed satisfaction in the comfort of the slip. The most unsatisfactory feature was the retention of soil on seams and hemlines which was found to be a problem in laundering in both the laboratory and the home. Most of worn slips showed considerable yarn slippage in the warp directions.

Comments most frequently recorded by co-operators during the period of wear concerned the great amount of shrinkage, signs of wear at top edge of the bodice and underarms, and the wear of straps. Broken

straps were also noted. Others commented to the effect that ironing was responsible for the deterioration in their slips. Some commented on the excellent fit of the garment.

Among the first evidences of wear found by the investigator was abrasion on the inside section of the bodice where the straps joined the slip. Twelve of the seventeen slips showed abrasion after only five launderings. Of the five which did not show abrasion in this area, four were laboratory laundered. The areas at which the straps were inserted in the bodice showed progressive wear. By the end of this study, with one exception, all slips showed either holes or deterioration of warp yarns. Similarly, Dauner[6] found in her study that warp yarns wore away after a few hundred hours of wear. All of the slips which were laundered by the co-operators showed a more marked degree of wear in the warp yarns at points where straps were inserted than did those which were laundered in the laboratory by the investigator. In addition to extreme wear at points where straps were inserted in the bodice, severe wear was noted under the arms and across the back. Frequently, it was found that the under section of the double bodice had been stretched by ironing from only one side. As a result, the edge which was stretched beyond the seam line frequently wore into slash-like holes. This was not characteristic of those laundered in the laboratory because of the fact that the investigator ironed the double bodice on both sides in order to remove the excess dampness. This tended to equalize stretchage. Holes sometimes appeared along seam lines but this was undoubtedly due to increased pressure and heat when required to dry out the several

thicknesses of fabric at the seams. Worn areas of slips are charted on Plate 5 in Appendix. According to Mentrup[15] a study completed by Adella E. Genter on cotton night gowns showed extreme wear in the same areas as reported in this study. Breaks in the double stitched hem was characteristic of slips which were worn. More breaks occurred in the center front panel than any other section; walking and sitting probably causing more strain in this area. Dauner,[6] similarly, found breaks in the bias slips in her wear study.

Slips which were laundered in the laboratory were lighter in color by comparison than those which were laundered by the co-operators. The washing period of six minutes which was used in the laboratory probably was longer than that used in home laundering, thus accounting for a greater loss in color. Soil on the zigzag stitched seam lines and inside hemline seemed more or less characteristic of most of the slips worn. In "Women's Dresses and Slips, A Buying Guide,"[24] U. S. D. A. Bulletin, No. 1851, zigzag stitching is described as being strong, but also characterized as retaining soil which can hardly be removed without rubbing, which eventually wears and breaks the stitching. The strength of this seam was borne out by this study as in only one case did the seam break.

In order to determine the relationship of wear and breaking strength in the present study, a final subjective rating of each slip for type and degree of wear was made. This score was correlated with the breaking strength total for that particular slip. The subjective scores and breaking strength totals showed a rank correlation coefficient

of .493 which is not particularly high, yet it does show a relationship between the two variables. In other words, the slips which appear badly worn tend to have lower breaking strength totals than those which do not show a marked degree of wear. In the examination of individual scores, it was found that a greater relationship existed between the two variables when the slip was extremely worn. In reporting a wear study on rayon slips, Sommaripa[20] found that tensile strength had no forecast value because the study showed that garments with holes near the seams still retained a high breaking strength.

Co-operators' wearing records showed that individuals varied in the total hours of wear from 672 to 929 hours. A rank correlation coefficient analysis was made between the variables of total hours of wear and the breaking strength total for each slip worn. It was found that there was a rank correlation coefficient of only .086 for slips which were laundered in the laboratory; in other words, there was practically no relationship of hours worn and breaking strength results. However, in similarly analyzing slips which were worn and laundered at home, a rank correlation coefficient of .409 was found which does evidence a relationship between the two variables. A much greater variation in total hours of wear and also in breaking strength totals was found within the group of home laundered slips as compared with slips laundered in the laboratory. This may partially explain the greater correlation. See Table 5 for data on co-operators' slips.

Table 5

Subjective Analysis Chart

Code No.	Size Slip	Occupation	Hours of Wear	Percentage Loss in Breaking Strength: Warp Dry	Warp Wet	Filling Dry	Filling Wet	Rank in Subjective: Br. St.	Rank in Subjective: Score*
				Laboratory Laundered					
1/aL	12	Teacher	730	14.9	18.9	14.1	11.6	9.0	12
2/aL	12	Teacher	706	18.6	17.4	3.6	5.1	4.5	8
3/bL	14	Graduate	775	14.2	21.2	4.7	1.4	1.0	9
4/bL	14	Graduate	759	14.5	3.8	10.1	5.8	3.0	11
5/cL	16	Graduate	791	11.5	25.0	9.8	14.5	7.0	9
6/cL	16	Graduate	771	14.2	24.2	6.9	10.9	6.0	9
				Home Laundered					
7/aH	12	Graduate	743	34.1	17.4	17.4	19.6	14.0	10
8/aH	12	Teacher	806	18.6	12.1	16.7	37.7	13.0	4
9/aH	12	Teacher	929	20.3	22.0	10.1	5.8	8.0	7
10/aH	12	Teacher**	822	48.0	32.6	1.8	23.2	15.0	3
11/bH	14	Teacher	774	33.4	17.4	17.4	26.8	17.0	4
12/bH	14	Secretary	868	14.5	3.8	10.1	5.8	2.0	6
13/bH	14	Research Worker	761	22.6	3.8	17.0	7.2	10.0	5
14/bH	14	Secretary	850	15.9	8.3	6.9	13.0	4.5	5
16/cH	16	Graduate**	824	44.6	30.3	14.1	20.3	16.0	0
17/cH	16	Research Worker	690	18.9	19.7	17.4	19.6	12.0	9
18/cH	16	Dietitian	672	16.6	29.5	9.1	17.4	11.0	4

* 0 = Lowest score, 15 = Highest score

** Worked in Nursery

V. CONCLUSIONS

An analysis of the data of the initial properties of the yarn and fabric in this study when compared with the fabric used in the same brand of slips of the previous year reflects an improved quality. This is substantiated by the performance test results following laundering and wear.

In this particular study, it was found that slips which were worn and laundered in the laboratory did not show loss in breaking strength or apparent signs of wear to the same extent as slips which were worn and laundered in the home by the co-operators. Thus, it may be concluded that deterioration in the slips studied was, in part, due to a difference in the laundering procedure practiced by the various co-operators. Too high an ironing temperature was evidenced by a shiny surface, abrasion and holes in the fabric in many of the slips laundered by them.

There was an appreciable loss in warp breaking strength for the unworn laundered slips, and a slightly greater percentage loss for the worn, laboratory laundered slips. However, the slips laundered by the co-operators showed approximately twice as great a loss. Although there was not an extremely high relationship between visual signs of wear and loss in breaking strength, a correlation did exist. Because of the fact that greatest deterioration occurred in the bodice or near the seams, it was not possible to secure samples for testing from those areas. If that

had been possible, there would undoubtedly have been a higher correlation between apparent signs of wear and loss in breaking strength. It may further be concluded that fabric deterioration in the most severely worn areas may be largely attributed to the method of ironing. From observations made in this study, it would seem advisable that double fabric sections should be ironed on both sides to equalize stretching and to prevent undue wear on one side.

The warp yarns of acetate rayon not only showed greater deterioration on visual examination, but warp breaking strength also showed a corresponding greater loss in strength than did the filling yarns of cuprammonium rayon.

Perspiration and strain in wear are likewise contributing factors to a garment's deterioration. Areas of the slips which were exposed directly to the body, namely, the waist back and side waist areas, showed a greater loss in breaking strength than did other sections. It was found that the slips which were worn by co-operators who were extremely active showed not only much lower results in breaking strength, but also more appreciable signs of wear in comparison with the other slips tested and examined. Because the slips showed such a wide range of deterioration at the end of the wear period, it is not possible to make any prediction as to total wear expectancy. Some slips were ready to be discarded, while a few were in sufficiently good condition that they might be worn for a limited period.

There was wide variation in dimensional change in slips laundered both at home and in the laboratory. The bias cut in the slip was perhaps

largely responsible for this variation. Greater dimensional change in the slips which were laundered in the laboratory is probably due to the fact that the co-operators used a higher ironing temperature in the direction of the bias grain thus partially restoring the garment to its original measurements. The high twist in the filling yarns probably accounts for greater shrinkage in the filling direction of all slips. However, there is a great need for stabilization in certain rayon crepes to prevent undue shrinkage or stretchage if garments of such fabrics are to meed consumer satisfaction.

Satisfaction was expressed by all of the co-operators as to the styling and fit of this garment. It is accurately cut to meet commercial standards and the excellence of seam construction is evidenced by the fact that of seventeen slips examined, there was only one broken seam. However, this construction feature is somewhat minimized by the fact that the zigzag stitching soiled readily and retained soil persistently.

In conducting a wear study, it is imperative to have a large number of samples because of the many variables of wear and care which are introduced. It would have been desirable to have had a greater number of co-operators, for the wear expectancy of the slips at the termination of the study varied widely between the individuals who wore them. However, the factors of time and cost are necessarily limiting factors in planning any study. A continuation of this study might be so devised as to have the same individual alternately wear two or more slips so as to provide withdrawl of slips at such intervals as to measure the rate of deterioration and total wear expectancy.

The investigator considers, after an analysis of the data from the laboratory tests for the initial properties of the fabric, that they are indicative of serviceability to a limited degree but cannot be used independently as a valid standard for predicting performance in use. However, when supplemented by data from worn garments similarly tested, the laboratory data constitutes a reliable basis for judgment of a given fabric, for comparison of two or more quality grades or different types of fabrics for a specified end use.

While a wear study involves a great deal of effort on the part of both the investigator and co-operators, it is believed it has significant merit in measuring actual wear due to perspiration strain, abrasion, soil and laundering which cannot be duplicated in laboratory testing alone.

VI. SUMMARY

A wear study of one brand of women's rayon slips was carried out as a continuation of a laboratory study of slips completed by Rann in 1946. Thirty-three slips of one style and brand were purchased directly from the factory. Co-operators of similar occupations, representing sizes 12, 14 and 16 were asked to wear the slips. Eighteen of the slips were worn, twelve of which were laundered in the home, and the other six laundered in the laboratory under controlled conditions. Six additional unworn slips were laundered in the laboratory and six others were used to establish initial properties; three were retained as controls. Slips which were issued to co-operators were laundered thirty times and worn approximately seven hundred fifty hours. The period of wear between launderings was approximately twenty-five hours. Co-operators were asked to follow a specified laundering procedure and at the end of the fifth, tenth, twentieth and thirtieth launderings they were asked to return their slips to the laboratory for examination for signs of wear, change in yarn count and dimensions.

Fiber, yarn and fabric analysis were made on the new slips. Following the seven hundred fifty hour wear period, those slips as well as those which were unworn and laundered were examined and scored for degree of wear and measured for dimensional change. Tests consisting of breaking strength and weight per square yard were made to determine

changes in strength and weight following laundering only, and wear combined with laundering.

The four-gore alternating bias-cut slip was very satisfactory in comfort and fit; however, the cut of the slips did produce an uneven hemline. Other disadvantages were the breaking of stitches in the hemline and the affinity for soil on the zigzagged stitched seams.

Consistent results were found in yarn count, breaking strength, and denier within this group of slips studied. There was some variation in the number of twists per inch in the warp yarns. In checking denier and filament, it was found that there was consistency within each slip, but the number of filaments in warp yarns varied in two of the slips tested. Twenty-nine of the slips were of delustered French crepe, while four were of lustrous crepe.

An increase in yarn count was progressive through the tenth laundering, and in some cases through the twentieth, and then it tended to stabilize or decrease. There was also a corresponding increase in the weight per square yard when tested after the thirtieth laundering. The warp breaking strength loss for unworn laboratory laundered, worn laboratory laundered and worn home laundered was respectively 13.5, 14.9 and 27 per cent. Correspondingly, the per cent loss in the filling was 5.1, 6.5 and 14.1.

Visual examination of the unworn laundered slips showed little evidence of wear. The worn slips, however, showed much greater signs of deterioration; in fact, a few slips which had been laundered by the co-operators were ready to be discarded. The greatest deterioration was

observed on the inside double edge bodice top along the seam line in the back and underarm sections particularly. Distortion of the fabric also resulted from the slippage of warp yarns in the areas of strain and wear. A few straps were broken in the process of wear.

Results from breaking strength tests showed greatest loss in strength in fabric taken from side and back waist sections of the worn slips which were areas directly in contact with the body.

LITERATURE CITED

LITERATURE CITED

(1) Ashcroft, A. G. The interpretation of laboratory tests as quality indices in textiles. American Dyestuff Reporter 33 (Nov. 20, 1944), pp. 490-491.

(2) Clayton, Howard D. The elimination of chaos from shrinkage testing. (Proceedings of the Am. Assoc. of Textile Chemists and Colorists) American Dyestuff Reporter 35 (July 29, 1946), p. 311.

(3) Committee D-13. Standards on Textile Materials. Philadelphia: American Society for Testing Materials (1946), p. 85, p. 87.

(4) Course Text. Refresher Course in Textiles and Testing. Hoboken, New Jersey: United States Testing Company, Inc. (Summer, 1945).

(5) Crawford, Madelyn. Serviceability of certain rayon fabrics as determined by laboratory tests. (Unpublished thesis, Kansas State College of Agriculture and Applied Science, 1938).

(6) Dauner, Lucile Florence. The serviceability of certain ready-made rayon garments. (Unpublished thesis, Kansas State College of Agriculture and Applied Science, 1940).

(7) Grimes, Mary Anna. Some problems of sampling - textile fibers and fabrics. Journal of Home Economics 39 (Feb. 1947), pp. 93-94.

(8) Hayes, Margaret B. and Rogers, Ruth Elmquist. Evaluating the serviceability of fabrics. Journal of Home Economics 34 (1942), p. 435.

(9) Kaswell, Ernest R. Wear-resistance of apparel textiles. Textile Research Journal 16 (Oct. 1946), pp. 502-521.

(10) Lomax, James. Textile Testing, New York: Longmans, Green and Company (1937), p. 162.

(11) Lund, Lillian O., Phelps, Ethel L., Norton, Helen Ward and Miller, Barbara Bailey. Relative serviceability of three weights of wool serge. Journal of Home Economics 39 (Feb., 1947), pp. 81-84.

(12) Lyle, Dorothy S. and Black, Dorothy C. The effect of wringing upon the tensile strength of rayon fabrics. American Dyestuff Reporter 33 (1044), pp. 441-444; 455-457.

(13) Mack, Pauline Berry, Chairman, et.al. Colorfastness of women's and children's wearing-apparel fabrics. Journal of Home Economics 34 (Oct. 1942), pp. 539-550.

(14) Mauersberger, H. R. New additions in American rayon denier and filament table. Rayon Textile Monthly 27 (Sept. 1946), p. 76.

(15) Mentrup, Sister Joan Marie, O.S.F. A comparative study of the laboratory performance with the service performance of silk and rayon slips. (Unpublished thesis, Purdue University, 1942).

(16) O'Brien, Ruth. The contribution of home economics to textile research. Journal of Home Economics 34 (Sept. 1942), pp. 433-435.

(17) Platt, Helen King. Comparison of the service qualities of certain all-silk, all rayon, and silk and rayon mixed fabrics before and after laundering. (Unpublished thesis, Kansas State College of Agriculture and Applied Science, 1940).

(18) Rann, Florence. A comparative study of four brands of women's rayon woven slips of comparable price. (Unpublished thesis, Michigan State College, 1946).

(19) Roseberry, Elizabeth D. The study of the relationship between the construction and durability of viscose rayon fabrics. (Unpublished thesis, Pennsylvania State College, 1940).

(20) Sommaripa, Alexis. Efficiency in consumption. Autopsy of Discarded Rayon Slips (1940), pp. 1-12.

(21) Tait, J. H. Abrasion resistance on rayon linings. Rayon Textile Monthly 26 (1945), pp. 61-62.

(22) Textile World's Synthetic Fiber Table. Textile World (Sept. 1945), pp. 117-132.

(23) Ward, Helen M. and Bailey, Barbara. Service tests on blends of new and reclaimed wool. Journal of Home Economics 36 (May, 1944), pp. 200-204.

(24) Women's dresses and slips, a buying guide. United States Department of Agriculture Bulletin No. 1851.

(25) Women's slip sizes (woven fabrics). Commercial Standard CS121-45. National Bureau of Standards (1945).

APPENDIX

Plate 1

Slip Fabric

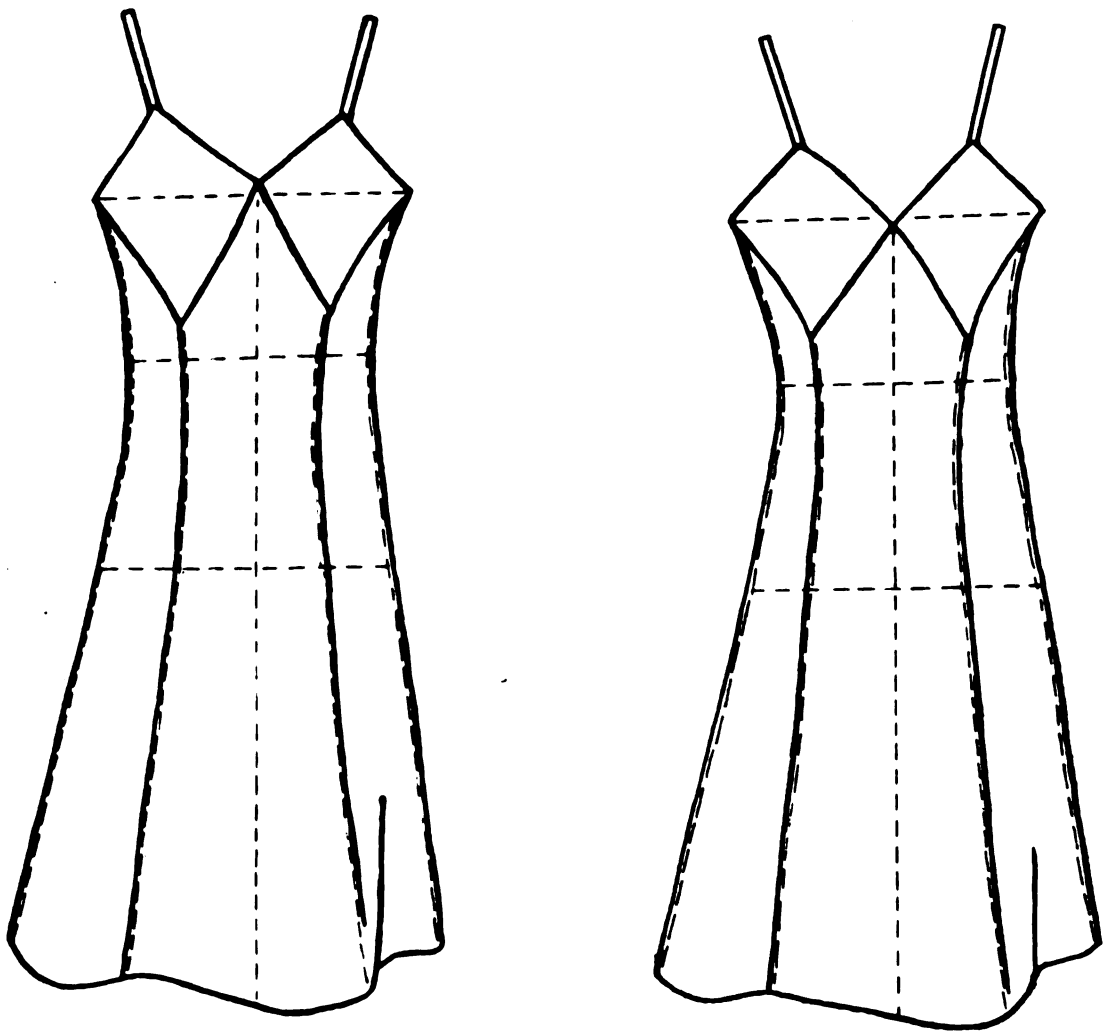
New

Laundered

Worn, Laboratory Laundered

Worn, Home Laundered

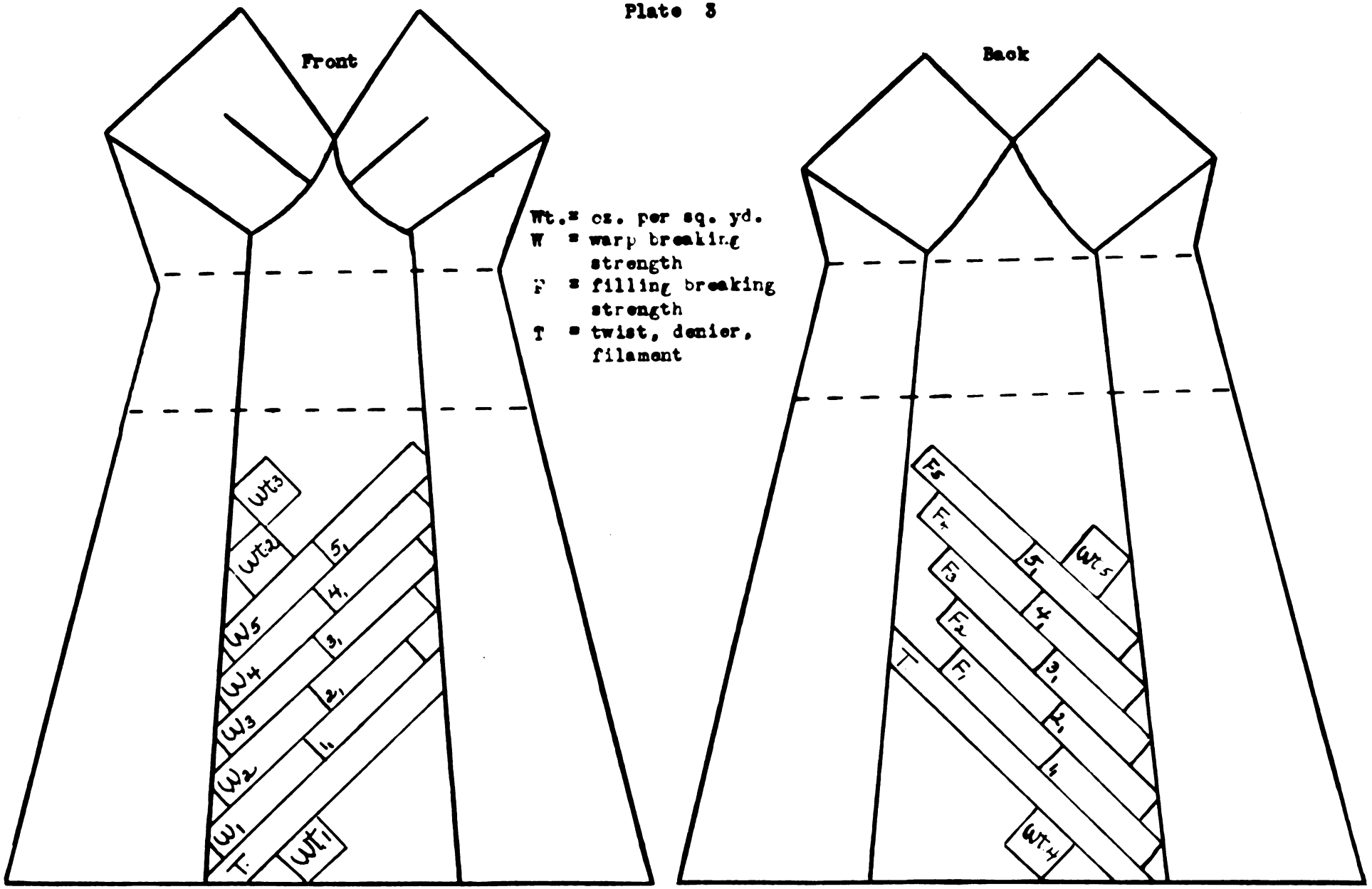
Plate 2



Design of Slip

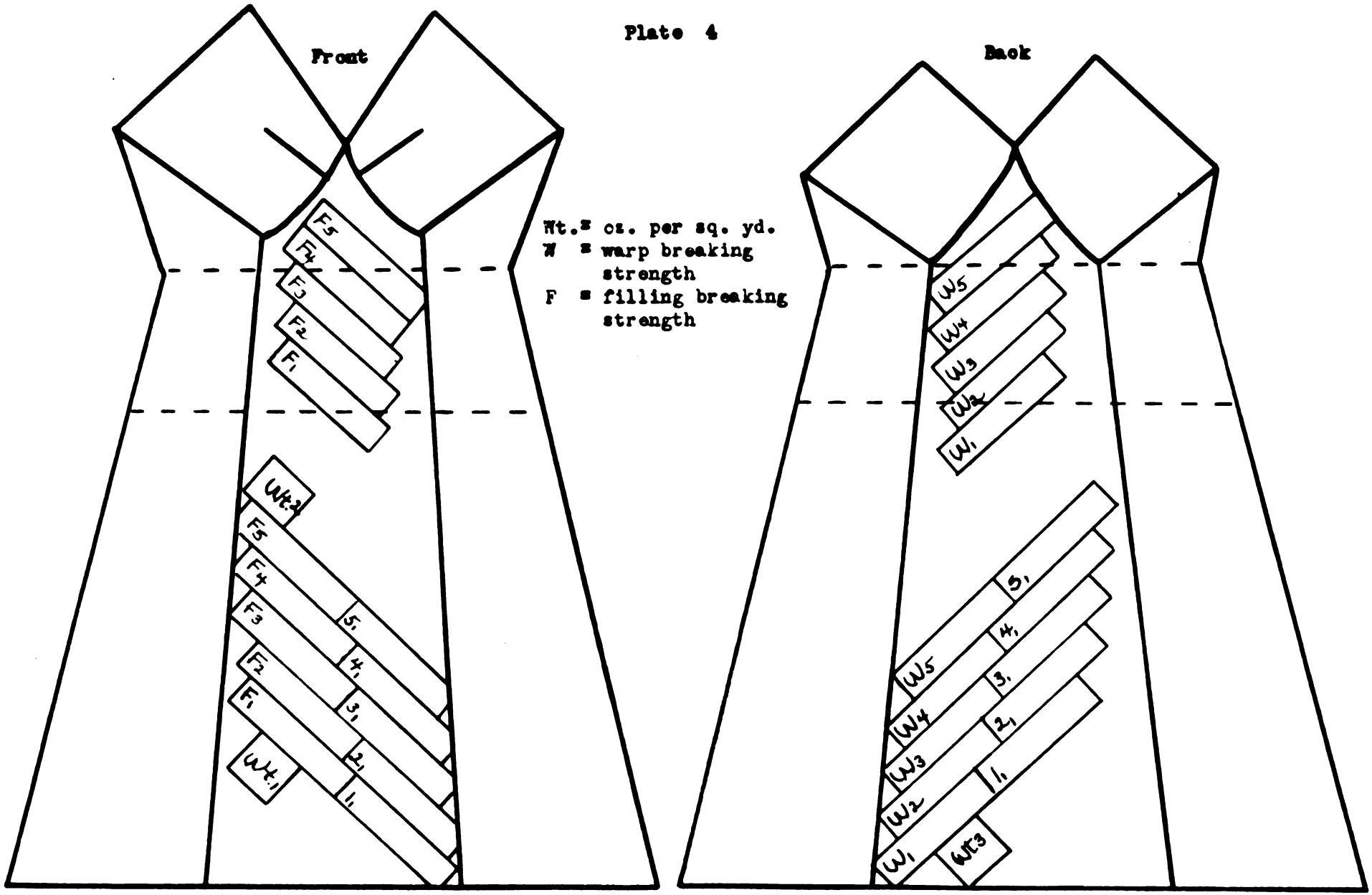
_____Lines of Measurement

Plate 8



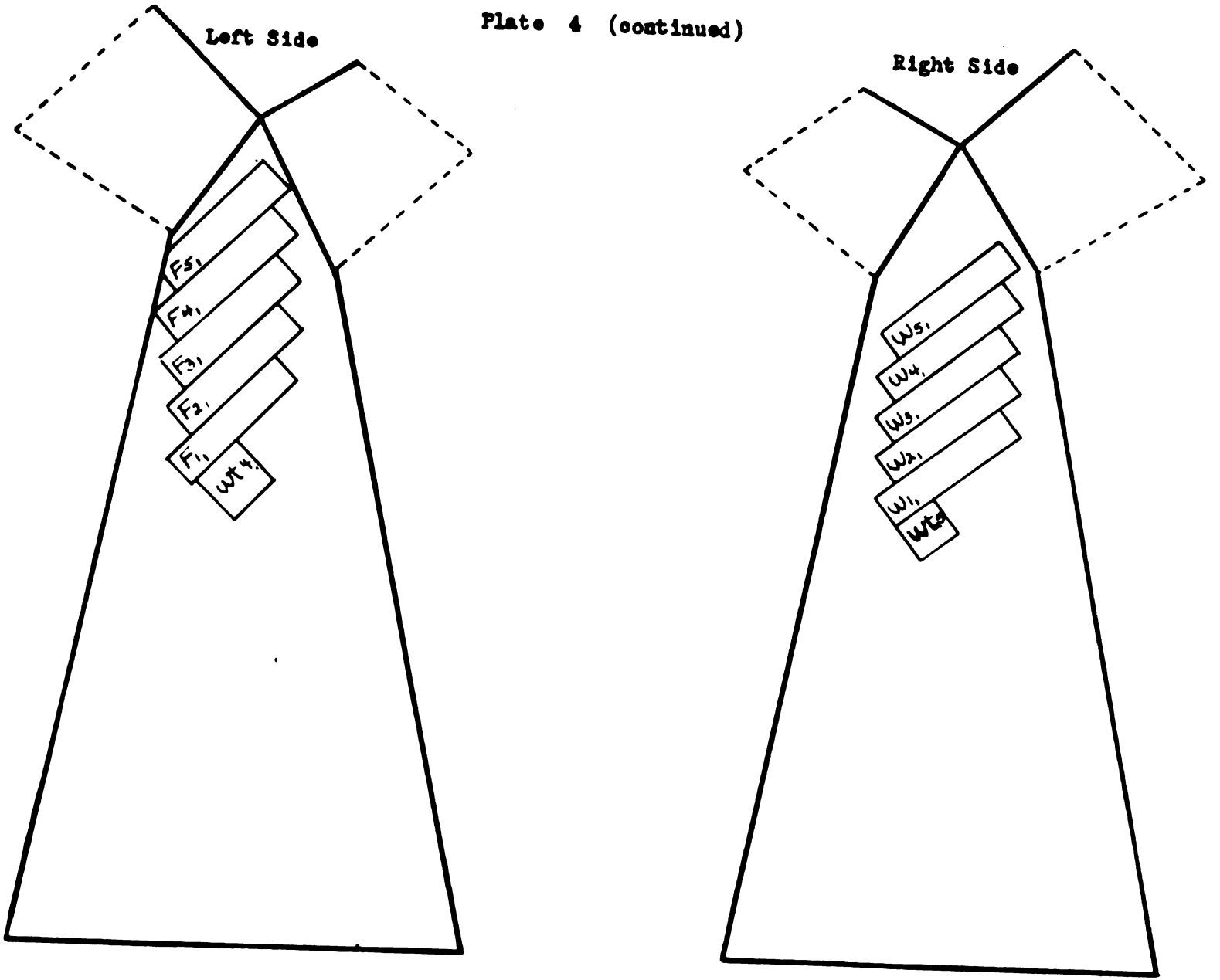
Cutting Charts for New and Laundered Slips

Plate 4



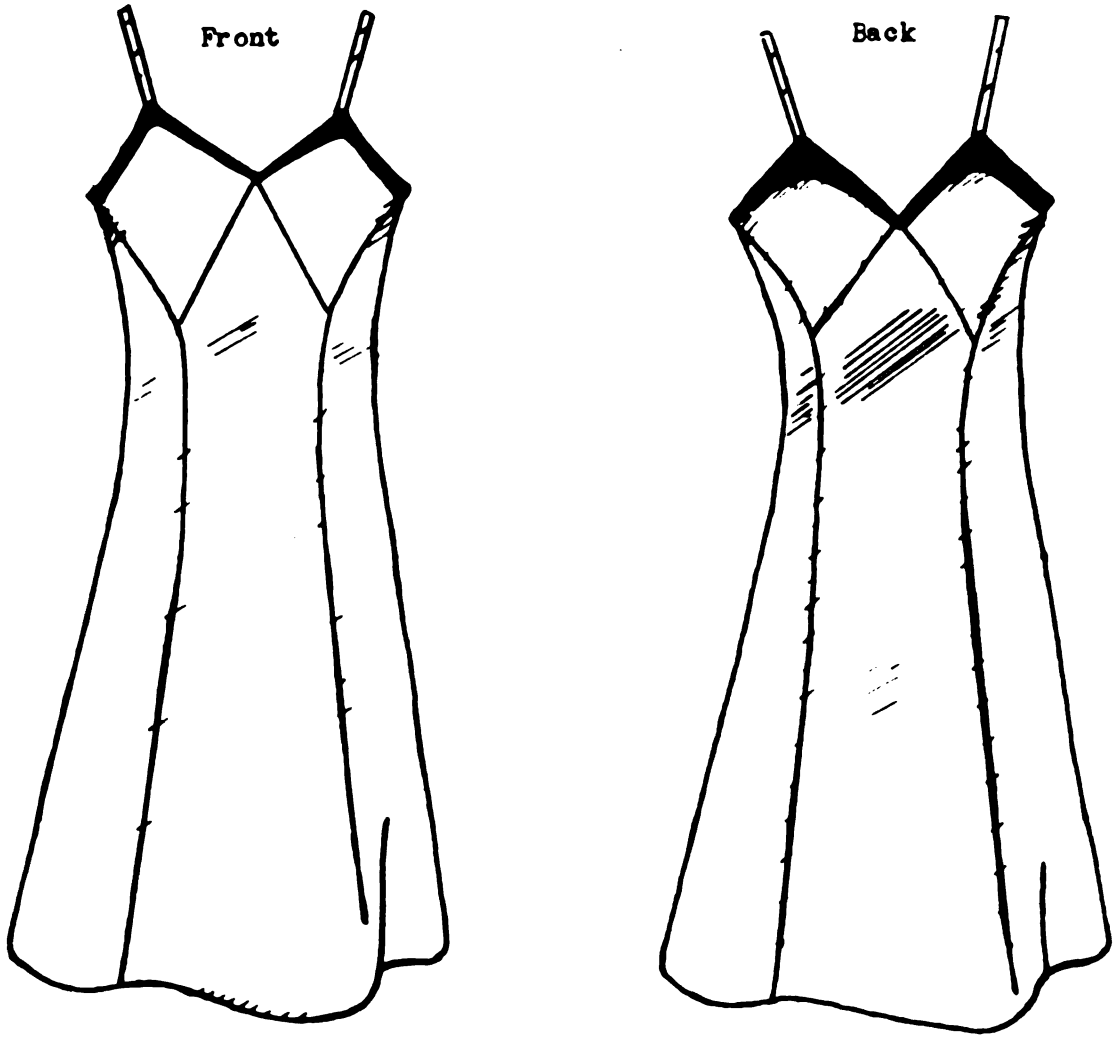
Cutting Charts for Worn Slips

Plate 4 (continued)



Cutting Charts for Worn Slips

Plate 5



Areas of Wear

■ Severely Worn

▨ Worn

Instructions to Co-operator

WEARING AND LAUNDERING SLIP

Would you be willing to wear this slip approximately fifty hours a week for a total period twenty weeks? During the fifty hours of wear per week, I hope you will launder the slip twice (or once for approximately twenty-five hours of wear) according to laundering suggestions given below. I should like to have the slip, with the record sheet, returned to the laboratory for visual inspection and shrinkage measurements five times during the entire wearing period. The five periods are scheduled as follows:

PERIOD	WEEKS OF WEAR	HOURS OF WEAR	LAUNDERINGS
1	$2\frac{1}{2}$	125	5
2	5	250	10
3	10	500	20
4	15	750	30
5	20	1,000	40

After the first 125 hours of wear, during which time the slip has been laundered five times, will you return it, with your wearing record to the laboratory for the first checking? At any time during the twenty weeks of wear, a break or hole should appear, will you please return your slip with the record sheet to the laboratory? This does not apply to broken seam stitching or broken straps.

I recommend the following laundry method:

Completely dissolve enough Lux Flakes in lukewarm water to make a

standing suds of about two or three inches. Gently squeeze the suds through the fabric. The slip is then rinsed twice in lukewarm water. After the second rinse the slip should be rolled in a towel to absorb excess moisture. It is preferred that the slip be ironed within two hours, but if it is inconvenient to do so, the slip may be allowed to dry (away from direct heat or sun) and at a convenient time be rinsed and rolled in a towel and allowed to stand for at least thirty minutes before ironing.

Iron on the wrong side with a warm (not hot) iron. Set control on "Rayon" if heat controlled iron is used. Iron with grain of fabric to prevent stretching.

I am attempting to make a comparison among the various slips worn for the same length of time and laundered the same number of times, so I shall appreciate your cooperation in helping me control these factors. If you have any questions concerning the directions, please do not hesitate to contact me. Thank you for your cooperation.

WEARING RECORD

Co-operator's Name _____ Address _____

At the end of approximately _____ hours wear and _____ launderings please return slip and wearing record to:

Thelma Thompson
Room 202
Home Economics Building

Phone: 83083

Date	Number hours worn each day	Check when laundered	Comments--fit, comfort, etc.
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
1			
2			
3			
4			
5			
6			
7			

INVESTIGATOR'S RECORD SHEET

PERIOD I

CODE ____ Hours Wear ____ Home Laundered

Yarn Slippage

Seam Slippage

Abrasion

Color Change

Comments

Table 1

Yarn Count for Original Slips*

Code	Warp	Filling
a/PT	155.2	104.0
a_1/PT	155.4	104.4
b/PT	156.2	106.0
b_1/PT	155.8	105.8
c/PT	155.2	107.0
c_1/PT	155.8	104.8
Average	155.6	105.3

*Average of five determinations for each slip

Table 2

Yarn Count for Laundry Controls*

Slip Code	Number of Launderings 0		5		10		20		30	
	W	F	W	F	W	F	W	F	W	F
a/LC	155.6	102.8	158.0	107.2	158.6	108.4	158.8	108.2	157.4	107.6
a_1/LC	156.0	104.0	158.0	109.6	157.2	108.0	158.6	110.4	158.4	108.8
b/LC	154.4	104.2	156.4	108.8	156.2	108.8	156.4	110.4	158.2	109.6
b_1/LC	154.6	106.2	156.4	111.6	156.4	111.0	156.2	112.2	158.0	110.4
c/LC	154.8	106.0	157.2	110.0	156.0	112.0	158.2	110.4	157.4	111.4
c_1/LC	154.2	104.0	156.6	108.0	156.2	109.2	157.2	110.4	157.6	110.2
Average	154.9	104.5	157.1	109.2	156.8	109.6	157.6	110.3	157.8	109.7

*Average of five determinations for each slip

Table 3

Yarn Count for Co-operators' Slips*

Laboratory Laundered

Slip Code	Number of Launderings									
	0		5		10		20		30	
	W	F	W	F	W	F	W	F	W	F
1/a/L	156.0	104.0	158.0	109.2	159.2	108.8	159.2	111.0	159.0	110.6
2/a/L	156.0	104.0	159.0	108.6	158.4	110.2	160.0	111.8	157.4	111.2
3/b/L	156.0	103.2	158.6	108.2	159.6	111.2	158.0	109.6	157.2	111.8
4/b/L	154.8	106.0	156.0	107.6	159.0	110.8	157.6	109.2	156.0	107.2
5/c/L	154.2	105.6	156.8	113.2	157.2	113.6	158.8	116.4	156.6	111.8
6/c/L	154.0	107.0	156.4	114.4	159.8	113.4	157.6	116.0	156.6	113.8
Average	155.2	105.0	157.5	110.2	158.9	111.3	158.5	112.3	157.1	111.1

*Average of five counts

Table 4

Yarn Count for Co-operators' Slips*

Home Laundered

Slip Code	Number of Launderings									
	0		5		10		20		30	
	W	F	W	F	W	F	W	F	W	F
7/a/H	156.0	104.0	157.2	108.4	158.0	108.6	157.8	108.8	157.2	108.6
8/a/H	155.6	103.6	160.0	111.2	157.2	107.8	158.0	108.8	158.8	110.2
9/a/H	156.0	104.0	159.2	111.4	157.6	111.6	157.6	113.6	157.6	109.6
10/a/H	156.0	104.0	159.8	109.2	159.2	111.2	156.0	110.6	155.6	107.2
11/b/H	154.0	105.2	155.4	111.2	156.4	109.2	158.0	108.0	156.0	107.6
12/b/H	154.8	102.0	158.2	108.8	157.8	116.0	157.0	115.6	156.2	110.8
13/b/H	152.8	101.2	156.0	104.0	157.2	106.4	156.8	103.4	156.8	103.6
14/b/H	154.0	102.8	156.4	105.6	155.6	105.6	156.4	106.8	156.2	104.4
15/c/H	154.0	106.4	158.8	113.2	156.0	112.8	-----	-----	-----	-----
16/c/H	154.0	108.0	156.2	114.2	157.6	114.0	156.4	107.8	155.8	112.6
17/c/H	154.2	106.4	154.0	116.0	158.4	114.2	157.2	112.4	156.2	110.8
18/c/H	154.0	106.8	157.6	109.6	156.8	109.2	157.4	112.0	155.8	110.8
Average	154.6	104.5	157.4	110.2	157.3	110.7	157.1	109.8	156.6	108.7

*Average of five counts

Table 5

Weight in Ounces per Square Yard

Original		Unworn, laundered		Worn, laundered	
Code	Ounces	Code	Ounces	Code	Ounces
a/PT	2.61	a/LC	2.70	2/aL	2.83
a_1/PT	2.55	a_1/LC	2.62	5/cL	2.87
b/PT	2.65	b/LC	2.74	8/aH	2.66
b_1/PT	2.64	b_1/LC	2.71	10/aH	2.60
c/PT	2.67	c/LC	2.76	11/bH	2.67
c_1/PT	2.54	c_1/LC	2.73	17/cH	2.78
Average	2.61		2.71		2.73

Table 6

Denier*

Warp and Filling

Code	Warp	Filling
a/PT	75.0	73.13
a_1/PT	76.7	74.09
b/PT	76.0	73.88
b_1/PT	76.7	73.12
c/PT	74.3	75.44
c_1/PT	74.0	74.47
Average	75.45	74.02

*Average of three determinations

Table 7

Yarn Twist per Inch*

Warp and Filling

Code	Warp	Direction of Twist	Filling	Direction of Twist
a/PT	5.13	S	29.19	Z
a_1/PT	6.41	S	28.01	Z
b/PT	2.38	S	23.11	Z
b_1/PT	4.15	S	22.66	Z
c/PT	2.15	S	22.37	Z
c_1/PT	5.22	S	26.34	Z
Average	4.24	S	25.28	Z

*Average of ten determinations

Table 8

Filament Count

Code		Warp	Filling
a/PT		26	60
		26	60
		26	60
	Average	26.0	60.0
a_1/PT		26	60
		26	60
		26	60
	Average	26.0	60.0
b/PT		50	60
		50	60
		50	59
	Average	50.0	59.7
b_1/PT		50	60
		50	59
		50	60
	Average	50.0	59.7
c/PT		50	60
		50	60
		50	60
	Average	50.0	60.0
c_1/PT		50	60
		50	60
		50	60
	Average	50.0	60.0

Table 9

Breaking Strength in Pounds

(Original slips*)

Code	Warp		Filling	
	Dry	Wet	Dry	Wet
a/PT	28.4	14.0	27.8	14.6
a_1/PT	28.2	11.4	27.8	14.4
b/PT	30.4	12.6	28.6	14.0
b_1/PT	31.0	14.4	27.4	13.0
c/PT	29.4	12.4	26.2	14.0
c_1/PT	30.4	14.2	27.6	12.6
Average	29.6	13.2	27.6	13.8
S. D.	1.06	1.1	.72	.73

*Average of five determinations for each slip

Table 10

Breaking Strength in Pounds

(Unworn slips laboratory laundered*)

Code	Warp		Filling	
	Dry	Wet	Dry	Wet
a/LC	24.1	12.1	26.3	14.5
a_1/LC	26.2	12.4	25.9	14.4
b/LC	25.3	10.3	25.8	12.6
b_1/LC	26.3	10.8	25.3	12.6
c/LC	25.6	11.0	25.8	13.4
c_1/LC	26.3	10.6	28.0	15.0
Average	25.6	11.2	26.2	13.8
S. D.	.78	.75	.86	.94

*Average of ten determinations for each slip

Table 11

Warp Breaking Strength in Pounds

(Worn slips, laboratory laundered*)

Slip Code	Front Skirt		Front Waist	Back Skirt		Back Waist	Right Side	Left Side
	Dry	Wet	Dry	Dry	Wet	Dry	Wet	Wet
1/aL	25.0	11.2	25.4				10.2	
2/aL				23.2	11.4	25.0		10.4
3/bL				26.4	10.2	24.4		10.6
4/bL	24.2	12.8	26.4				12.6	
5/cL	25.0	9.8	27.4				10.0	
6/cL				25.4	10.2	25.4		9.8
Average	24.7	11.3	26.4	25.0	10.6	24.9	10.9	10.3
S. D.	.38	1.23	.82	1.34	.57	.41	1.18	.34

*Average of five determinations for each slip

Table 12

Filling Breaking Strength in Pounds

(Worn slips, laboratory laundered*)

Slip Code	Front Skirt		Front Waist	Back Skirt		Back Waist	Right Side	Left Side
	Dry	Wet	Dry	Dry	Wet	Dry	Wet	Wet
1/aL				24.0	12.4	23.4		12.0
2/aL	27.0	13.6	26.2				12.6	
3/bL	30.4	14.0	27.4				13.2	
4/bL				25.8	12.8	23.8		13.2
5/cL				24.8	12.2	25.0		11.4
6/cL	25.4	13.2	26.0				10.8	
Average	27.6	13.6	26.5	24.9	12.5	24.1	12.2	12.2
S. D.	2.09	.64	.62	.74	.25	.68	1.02	.75

*Average of five determinations for each slip

Table 13

Warp Breaking Strength in Pounds

(Worn slips, home laundered*)

Slip Code	Front Skirt		Front Waist	Back Skirt		Back Waist	Right Side	Left Side
	Dry	Wet	Dry	Dry	Wet	Dry	Wet	Wet
7/aH				21.8	11.4	17.2		10.4
8/aH				23.8	12.8	24.4		10.4
9/aH	24.4	11.6	22.8				9.0	
10/aH	16.6	10.6	14.2				7.2	
11/bH				21.0	10.6	18.4		10.2
12/bH	23.6	11.0	23.8				8.4	
13/bH				22.6	13.0	23.2		12.4
14/bH	24.6	13.4	25.2				10.8	
15/cH	----	----	----	----	----	----	----	----
16/cH				21.0	9.4	11.8		9.0
17/cH	23.2	11.2	24.8				10.0	
18/cH	23.4	9.2	26.0				9.4	
Average	22.6	11.2	22.8	22.0	11.4	19.0	9.1	10.5
S. D.	2.75	1.25	3.98	1.06	1.3	4.52	1.14	1.09

*Average of five determinations for each slip

Table 14

Filling Breaking Strength in Pounds

(Worn slips, home laundered*)

Slip Code	Front Skirt		Front Waist	Back Skirt		Back Waist	Right Side	Left Side
	Dry	Wet	Dry	Dry	Wet	Dry	Wet	Wet
7/aH	22.0	9.6	21.8				10.4	
8/aH	23.2	7.2	22.8				10.0	
9/aH				25.6	12.4	25.4		7.2
10/aH				27.4	12.8	26.8		8.4
11/bH	23.6	11.0	22.0				9.2	
12/bH				21.4	12.2	14.2		11.6
13/bH	22.6	13.2	23.2				12.4	
14/bH				23.8	11.2	24.8		10.4
15/cH	----	----	----	----	----	----	----	----
16/cH	25.2	12.4	22.2				9.6	
17/cH				24.0	12.6	21.6		9.6
18/cH				25.4	12.4	24.8		10.4
Average	23.3	10.7	22.4	24.6	12.3	24.6	10.3	9.6
S. D.	1.08	2.13	.52	1.86	.51	1.57	1.11	1.44

*Average of five determinations for each slip

Table 15

Dimensional Change in Length*

Unworn, laboratory laundered					Worn, laboratory laundered					Worn, home laundered				
	Times laundered					Times laundered					Times laundered			
	5	10	20	30		5	10	20	30		5	10	20	30
Code	-%**	-%	-%	-%	Code	-%	-%	-%	-%	Code	-%	-%	-%	-%
a/LC	4.4	4.3	4.9	4.3	1/aL	3.4	3.5	3.6	3.8	7/aH	2.0	2.6	3.6	2.0
a_1/LC	4.4	4.0	4.8	4.9	2/aL	3.7	4.7	5.0	5.2	8/aH	3.1	3.6	1.1	0.9
b/LC	4.3	4.2	5.1	4.8	3/bL	0.5	1.7	2.0	1.5	9/aH	3.4	2.2	2.1	0.6
b_1/LC	4.0	4.6	5.0	5.3	4/bL	2.0	2.7	2.5	2.8	10/aH	1.8	1.9	3.5	0.2
c/LC	2.6	2.7	3.4	4.1	5/cL	0.2	2.0	2.4	1.1	11/bH	2.7	3.7	2.1	0.1
c_1/LC	3.7	4.4	5.1	6.6	6/cL	2.6	---	4.0	3.9	12/bH	3.3	3.0	3.2	0.8
										13/bH	2.2	2.5	4.0	1.4
										14/bH	1.8	1.0	0.7	0.5
										15/cH	3.5	5.2	---	---
										16/cH	3.8	2.7	4.2	2.4
										17/cH	3.1	2.4	2.5	0.8
										18/cH	1.2	+1.6	---	0.4
Average	3.9	4.03	4.73	5.0		2.07	2.92	3.25	3.05		2.66	2.43	2.7	0.92
S. D.	.63	.62	.60	.82		1.33	1.08	1.05	1.42		.80	1.04	1.14	.70

* Average of center front, center back, midway of side panels and adjoining seam line measurements for each slip.

**Per cent shrinkage based on measurement of slip when new.

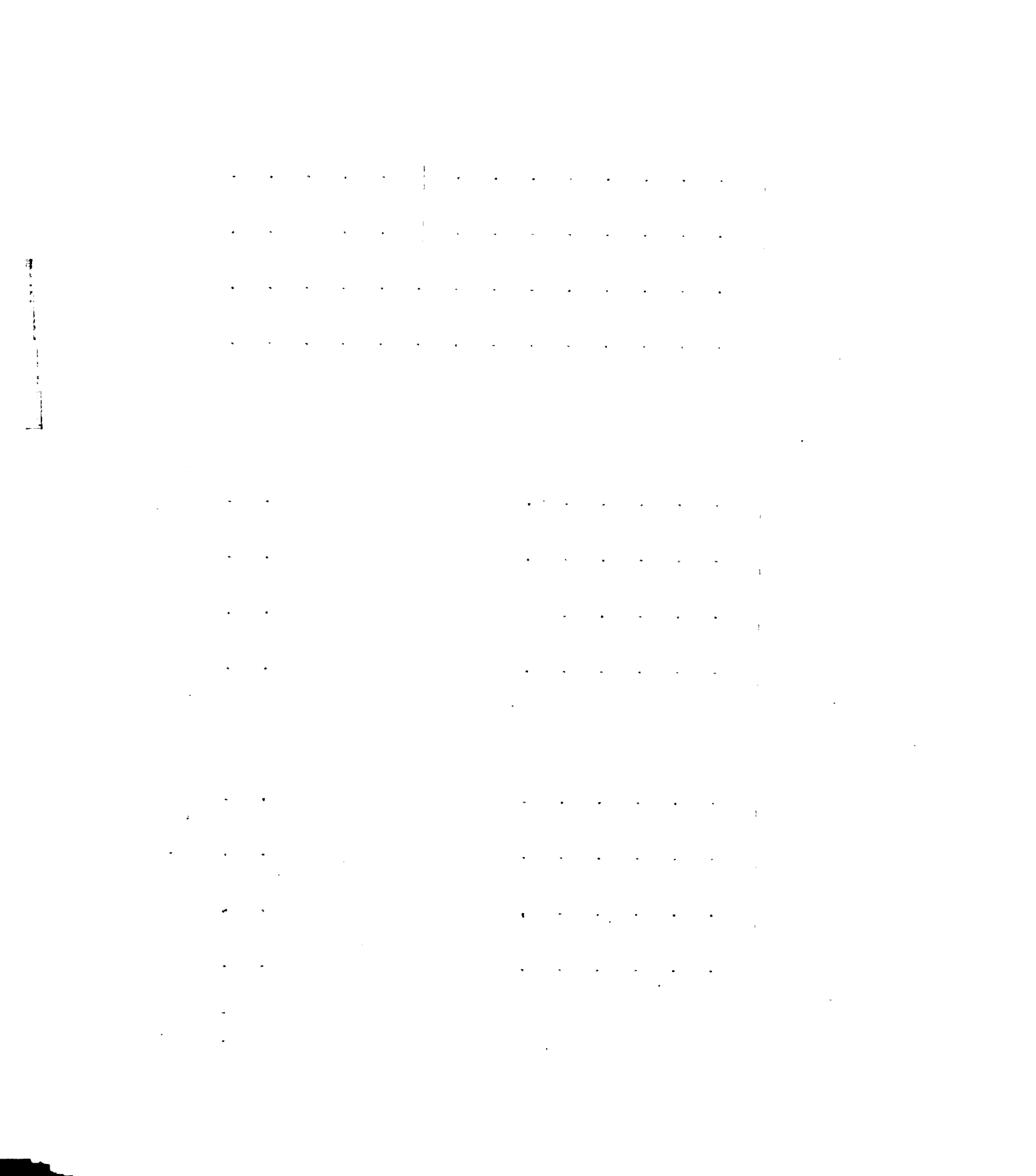


Table 16

Dimensional Change in Width*

Unworn, laboratory laundered					Worn, laboratory laundered					Worn, home laundered				
	Times laundered					Times laundered					Times laundered			
	5	10	20	30		5	10	20	30		5	10	20	30
Code	-%**	-%	-%	-%	Code	-%	-%	-%	-%	Code	-%	-%	-%	-%
a/LC	4.4	2.5	3.0	0.6	1/aL	3.3	3.1	4.1	3.2	7/aH	4.1	5.1	5.6	5.9
a_1/LC	3.5	2.3	3.2	2.3	2/aL	2.4	3.6	3.5	2.4	8/aH	5.7	4.5	6.3	6.8
b/LC	1.9	2.7	3.0	1.0	3/bL	6.2	7.4	5.6	8.3	9/aH	5.7	4.7	4.6	5.0
b_1/LC	2.2	1.4	1.4	1.5	4/bL	7.7	3.4	5.1	3.5	10/aH	3.7	3.0	3.1	2.4
c/LC	5.3	3.2	5.2	2.4	5/cL	4.0	4.7	5.3	5.4	11/bH	3.3	1.4	2.3	1.6
c_1/LC	2.5	2.3	2.8	1.3	6/cL	4.3	---	4.2	3.1	12/bH	6.1	5.6	4.8	6.0
										13/bH	3.7	2.0	1.6	2.2
										14/bH	2.5	3.3	2.9	3.6
										15/cH	0.0	0.9	---	---
										16/cH	1.9	2.7	1.7	2.0
										17/cH	7.1	5.8	2.8	4.4
										18/cH	6.1	6.1	---	4.5
Average	3.3	2.4	3.1	1.52		4.65	4.44	4.63	4.32		4.16	3.76	3.57	4.04
S. D.	1.23	.55	1.11	.66		1.79	1.57	.75	2.0		1.61	1.54	1.12	1.72

* Average of bust, waist and hips for each slip.

** Per cent shrinkage based on measurement of slip when new.