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THE USE OF ACCEPTANCE TESTING DATA TO SUBSTANTIATE SPECIFICATION REQUIREMENTS

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FOREWORD

During World War II the Quartermaster Corps encountered serious difficulties in the maintenance of high quality levels in its procurement of military clothing and equipage. Critical supply situations, unprecedented production schedules, and crippling labor shortages all contributed to the creation of a difficult problem with respect to the meeting of specification standards. As the war progressed, it became evident that the capacity of the Army's inspection laboratory at Philadelphia was too limited to handle the volume of testing necessary to ensure that military requirements were satisfied by the accepted items. The Inspection Service of the Quartermaster Corps therefore initiated a plant testing program which vastly multiplied the facilities available for control testing. Under this plan the acceptance laboratory at Philadelphia assumed the character of a standards laboratory.

At this time it was recognized that the control data available at Philadelphia formed a valuable basis for review of current specifications. The technique of analyzing these data and using them as a basis for revision of existing specification limits for physical and chemical properties of military textile materials is discussed in this report.

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1 May 1947

The Use of Acceptance Testing Data to Substantiate Specification Requirements

The function of the Philadelphia Quartermaster Depot textile laboratory in acceptance testing is well known to the textile industry in connection with heavy wartime procurements. For a long time this laboratory served as a traffic light in controlling the flow of materials to Quartermaster warehouses, approving shipments which met the exacting requirements of material specifications and rejecting lots which failed to possess the minimum levels in physical and chemical characteristics deemed essential for proper field performance.

In the latter part of 1944, the volume of procurements increased to the extent that these laboratory facilities, considered by many as the most complete in the country for acceptance testing of textiles, were proved inadequate to control the quality levels of wartime cloth purchases.

To utilize available laboratory data in the most efficient manner possible, statistical procedures were applied in analyzing the test reports. The quality-control techniques developed from Shewhart's original work and standardized by such organizations as the American Society for Testing Materials and the American Standards Association were substituted* for the formal accounting system of prewar days to reduce in so far as was possible the danger inherent in acceptance or rejection of manufacturers' lots on the basis of inadequate sampling. Inspectors charged with evaluation of lot quality were aided in this manner by possessing, in easily ascertainable, graphic form, a record of average quality level and variability of the production of each contractor. Trends in quality levels over an extended period of time became evident at once and led to immediate requests by contracting officers for changes in manufacturing methods where deemed necessary to improve production standards.

Presentation of comparative data of competing plants, suitably coded, spurred the feeling of pride in product quality and the patriotic conscience of certain plant officials and resulted in prompt adjustments of manufacturing techniques in the direction of an improved end product without the need for contractual penalties. In many cases mill executives were afforded the first concrete evidence of their quality level in form of the graphic compilations drawn up in the Philadelphia laboratory, and seized the opportunity to impress on production supervisors the importance of complying with the technical requirements listed in government specifications.

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*Recognition of the value of statistical techniques in the Philadelphia laboratory is due to the extensive training program for laboratory personnel initiated by Lt. Col. Frank M. Steadman, Director of Research and Development, Philadelphia Quartermaster Depot, and to the complete support which he afforded their use.

The general uses of the ASA quality-control chart procedures at Philadelphia are too numerous to be cited at present and may well be the subject of a separate paper. It is sufficient to say that they served as a valuable tool in making greatest use of acceptance testing data. In addition, their utilization in controlling test-method variability in research and development experimentation has become standard laboratory procedure at the Philadelphia Depot. Nevertheless, it must be remembered that their primary intent is to control the quality of manufacturing output. Through the use of standardized statistical procedures they are intended to give indications of engineering defects in operator techniques, materials, or machines, before the occurrence of considerable product, personnel or plant damage. This goal has not been realized by the acceptance testing laboratory at Philadelphia because (1) sampling has been inadequate to permit accumulation of the data necessary in establishing control limits, (2) identification of test samples was insufficient to permit corrective plant action even if sufficient data were available to justify such a move, (3) conditions of production (scarcity of raw materials and resulting substitutions) and the time lag between availability of laboratory information and actual manufacture often created a situation whereby the data, because of changed conditions, no longer bore any engineering relationship to current production techniques.

An example of the conditions existing can be cited in the use in acceptance testing of five breaking-strength tests taken from a single specimen which resulted in a narrower range and therefore closer control limits than would have been the case if the average of single breaks taken from five different specimens within a manufacturing lot had been used. Under such conditions, few manufacturers were shown to be in statistical control. On the other hand, grouping the averages of five individual breaking-strength values to form a single point on the graph representing, for example, the average of twenty or twenty-five individual breaks, extended the time necessary to accumulate basic data for setting initial control limits to such an extent that the information was meaningless in relation to manufacturing schedules. To correct deficiencies of this sort, would require expansion of government laboratory facilities and personnel, vastly increased sampling, and modified sampling procedures at the manufacturers' plant.

The corrective action taken by the Inspection Service of the Office of The Quartermaster General involved conversion of the acceptance-testing procedure to the plant-testing plan in which the laboratories of all mills were used to expand the available effective testing facilities beyond the stage possible in a single government laboratory. Simultaneously, the sampling was increased and an improved technique of gathering and utilizing inspection data was instituted under the Sequential Analysis Plan. Under this general procedure the Philadelphia Depot served as a standards laboratory or check on plant testing. Samples were submitted for analysis at planned intervals and the reports of government tests were compared by the Inspection Service with data submitted from the plant on each manufacturing lot. The larger sample tested in the mill now served as the basis for acceptance or rejection of production, while the Philadelphia data merely provided control on plant testing.

Acceptance Testing Data as an Aid to Improved Specifications

Even as the laboratory at the Philadelphia Depot assumed a second-line position in the control of the product quality of those mills possessing sufficient laboratory facilities to qualify under the plant testing program, the worth of its acceptance reports was recognized by research and development technologists. Here was a valuable source of information for determining the validity of specification limits from the standpoint of full-scale production. Under the pressure of wartime procurements, technologists were often forced to base material requirements on insufficient samples which, in many instances, were hardly representative of full-scale manufacturing conditions. The data obtained from initial procurements served as the testing ground for specifications and led to the raising or lowering of standards to conform to that which was available on full-scale production. It was obvious that "too few of the best" did not equip an army.

The data available for evaluation of quality levels and validity of specifications were too extensive to permit efficient study in their original form and, therefore, it was deemed advisable to summarize them as frequency distribution curves. The values for each fabric property were grouped in arbitrarily chosen class intervals and the frequency at each of these intervals was determined. Using this grouping the average value of the given property was computed as well as the standard deviation of all specimens about the average. The observed frequency distribution of test values was used as a basis for determining expected frequencies and thus provide a theoretical frequency curve which, without the irregularities of the original data, indicates what parameters might be expected if the properties of all the fabric deliveries made to the Army had been determined.

As an illustration, both the recorded distribution of fabric weight per square yard of 9-oz. sateen and the theoretical distribution are plotted in Figure 1 to show how the observed frequencies deviated from the distribution expected for the entire yardage delivered to the depot. In Figure 2, the theoretical frequencies are again plotted and a smooth symmetrical curve drawn through the plotted points.

The data for four fabrics which have been purchased in great quantities during the war are presented below to illustrate the distribution of their properties relative to specification limits. The fabrics selected for study, 9-oz. Sateen, 5-oz. Poplin, 8.5-oz. Herringbone Twill, and 20-oz. Wool Melton are listed in Table I together with the specification limits applicable during June and July 1944, when these data were selected for the first three types, and February to April 1945, for the Wool Melton. Of the four the herringbone twill and melton were not treated for water repellency and therefore were not tested for air permeability, hydrostatic resistance and spray ratings. Frequency distribution curves were not plotted for the herringbone twill.

TABLE I

SPECIFICATION REQUIREMENTS FOR FOUR ARMY UNIFORM FABRICS

Property	Unit	Specification Limits			
		Sateen	Poplin	HBT	Melton
		Spec. PQD 245D	Spec. USA No.6-321A	Spec. USA No.6-261	Spec. USA 8S-39A
Weight	oz/sq yd	9.0 min.	5.0 min.	8.5 min.	19 min.
Texture					
Warp	ends/in	112 min.	106 min.	72 min.	46 min.
Filling	picks/in	68 min.	52 min.	46 min.	44 min.
Breaking Strength					
Warp	lbs.	150 min.	116 min.	125 min.	70 min.
Filling	lbs.	125 min.	60 min.	85 min.	60 min.
Shrinkage					
Warp	%	1 max.	2 max.	1 max.	--
Filling	%	2 max.	2 max.	1 max.	--
Air Permeability	sec.	100 min.	70 min.	--	--
Hydrostatic Resistance					
Original	cm.	40 min.	30 min.	--	--
After 3 launderings	cm.	25 min.	20 min.	--	--
After 3 dry cleanings	cm.	30 min.	20 min.	--	--
Spray Ratings					
Original	--	90 min.	90 min.	--	--
After 3 launderings	--	70 min.	70 min.	--	--
After 3 dry cleanings	--	60 min.	70 min.	--	--

The properties listed in Table I were tested in accordance with the methods described in two textile test method manuals, Federal Specification CCC-T-191a and QMC Tentative Specification PQD 447 (later issued as USA Specification 100-48 and finally as a supplement to CCC-T-191a). The "grab" method was used in testing breaking strength. Shrinkage was determined after one cotton laundering at 210°F for 60 minutes. Air permeability was measured with the "Gurley Densometer." The Suter machine was used in determining hydrostatic resistance. The values recorded in the laboratory were the averages of three measurements made of each characteristic of individual fabric specimens.

Tests were conducted at room conditions with temperatures approximating the 70°F to 80°F limits of the Federal Specification, but with relative humidities well under the 65% level. The fact that a government laboratory would test at nonstandard conditions may be startling to the uninitiated reader but the reasons behind the omission are readily understood and the corrective action taken appears logical upon explanation. First, limitations in the conditioned space at the Philadelphia laboratory did not permit exposure of all the test specimens to standard temperature and humidity until moisture equilibrium was reached. Second, the test schedule which had been set up to furnish the contractor prompt notification of acceptance or rejection no later than 24 hours after receipt of the test specimen at Philadelphia did not leave time for a four to six hour conditioning period. The urgent need for materials, the lack of storage space at the contractor's plant, and the strained transportation facilities during the war all contributed pressure to early reporting of test data.

Of the properties listed in Table I, only weight and breaking strength were considered to be significantly affected by moisture content of the material and so when doubt existed as to the conformance of a given specimen with specification weight or strength requirements the fabric was conditioned and then retested. Because of this practice weight and strength data presented in Figures 2, 3 and 4 are generally lower than true specimen values when tested at standard conditions. The data showed that a high percentage of the fabrics were below all specification requirements. These failures were dealt with in many ways: the lots considered below standard were rejected outright; the defective lots were accepted with contractual penalties as agreed upon with the contracting officer; or the lots were accepted without penalty but with a warning of failure to pass laboratory tests. The course of action taken by the contracting officer depended upon the nature and extent of the deficiency and the immediate demand for the material.

The average property values for each contractor's fabric have been computed and are listed in Tables II to V inclusive. A circle identified by proper alphabetic code has been placed on the frequency curves of Figures 2, 3, and 4 to show the relative performance levels of each contractor.

In Figure 2 it is seen that contractor A has furnished 9-oz. sateen fabric whose average weight, warp texture, warp strength and warp shrinkage failed to meet specification requirements, while contractor D consistently failed in weight, warp shrinkage, and warp strength. The majority of the contractors produced sateen which tested, on the average, well above specification requirements in warp and filling texture and shrinkage, weight, filling strength, air permeability, and spray rating. Failure of a high percentage of the fabrics to meet the minimum level of 40 cm. original hydrostatic resistance indicated that this test limit was out of line with the other properties of the desired fabric structure. This requirement was later eliminated from the sateen specification. A similar failure to meet limits set for warp strength is minimized when strength taken at standard conditions of test is considered; nevertheless, it is noted that manufacturers of the other three fabrics were able to meet warp strength limits without conditioning of the sample prior to test. Data plotted for hydrostatic tests after laundering and dry cleaning indicated the possibility of raising these requirements without resulting in a large number of rejections. This has been substantiated by the most recent specification USA-6-337A, dated 1 February 1946. Based upon an average of 5 samples, the hydrostatic resistance after laundering has been raised from 25 to 30 cm. and after dry cleaning from 30 to 35 cm. Only contractor J would fail significantly in meeting the new specification for hydrostatic after laundering and all the contractors could easily meet the new value for dry cleaning. In addition, the limit for the warp shrinkage maximum has been raised to 2% which would be met by all. Similarly, the filling shrinkage maximum could be reduced without causing serious rejection.

Of all the contractors delivering 5-oz. poplin, only one, Company E, (Figure 3) failed on the average to meet specification requirements for separate characteristics. The frequency distribution curve in Figure 3 indicates an unusually large number of failures to meet the warp texture requirement for poplin. Reference to raw data, however, shows a large number of counts of 106 ends per inch with relatively few counts of 105 and 104 ends per inch. This phenomenon which was obscured in the statistical curve smoothing process indicated either absolute control in manufacture which caused a sharp break in the normal distribution of the raw data, or hesitancy of the inspector to reject a lot for lack of one end per inch. In any event the requirement was easily met.

It was noted that minimum limits for filling texture, warp and filling strength, filling shrinkage, weight, hydrostatic resistance after washing and dry cleaning, and air permeability were readily exceeded. Original spray requirements were easily met although not clearly shown in the curve. This is due to the fact that the original data were cut short at the rating of 100, thus distorting the smooth prediction curve. The basic data, however, showed few specimens testing original spray at 90, 80 and 70. Accordingly, it was found possible to increase this requirement in subsequent specifications. This is shown by the latest Specification USA-6-321B, dated 28 May 1946. Here more rigid requirements, based upon an average of 5 samples, have raised the minimum for the spray rating after laundering from 70 to 80. Hydrostatic resistance after dry cleaning has been increased from 20 to 35 cm. which can be met by all but contractors A, I, and K. The minimum for each sample for hydrostatic resistance after laundering was raised to 25 cm. Only contractors A, E, and F would fail to meet this level, but most would not meet the high one of 30 cm. based, however, on an average of 5. In the case of weight and filling shrinkage, significant increases in requirements were possible without affecting acceptance percentages. On the other hand, manufacturers had difficulty staying within the 2% warp shrinkage limit.

Figure 4 shows that the various contractors adhered to the specifications established for weight, texture and breaking strength for melton cloth. There has not been any change to date on the specifications and no necessity was indicated.

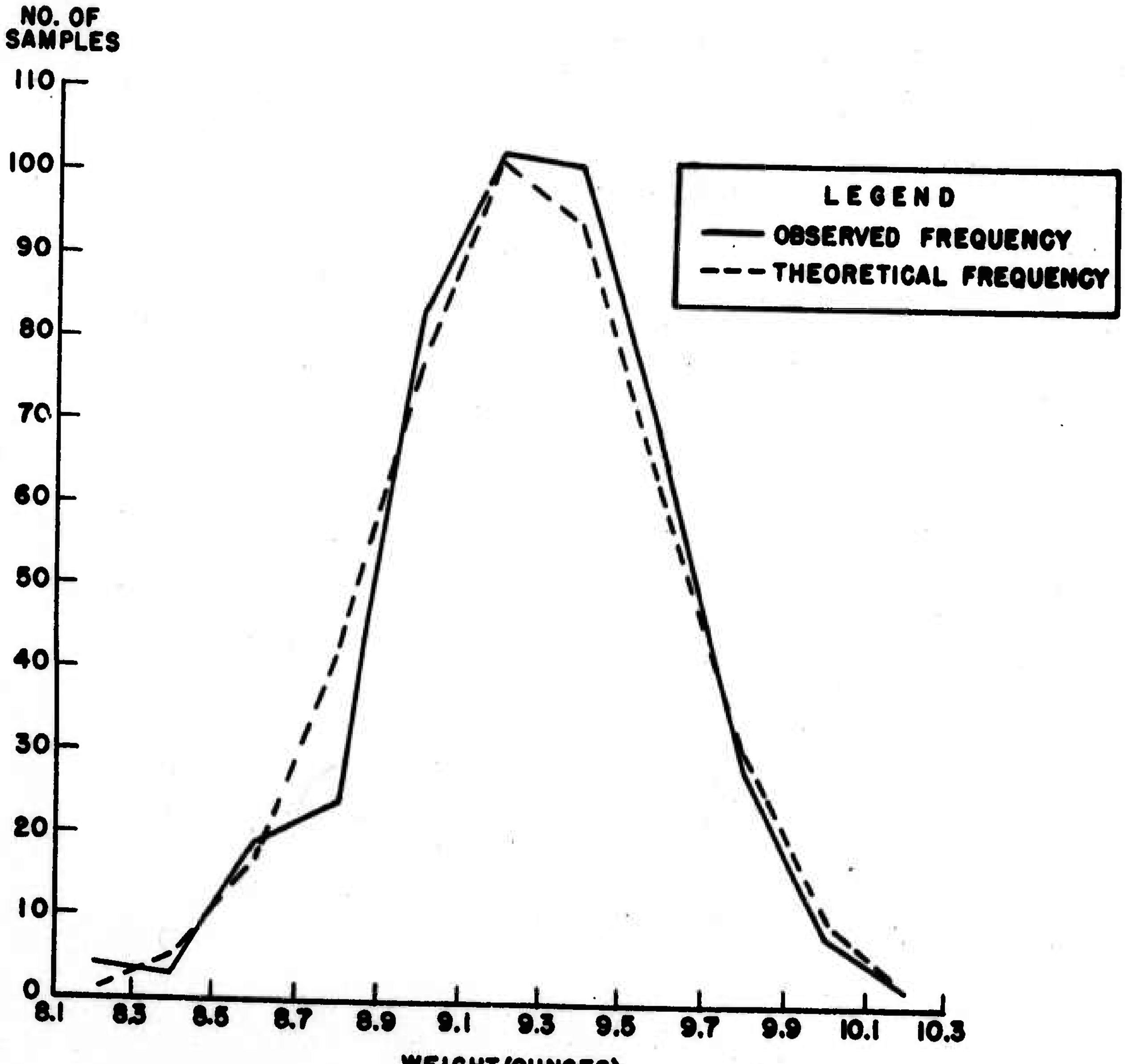
In Table 5, it is seen that contractors I and O had trouble in meeting weight requirements for herringbone twill, while contractors C and J were low on warp strength. As a whole, little difficulty was experienced in meeting the herringbone twill limits for weight, texture, strength, and shrinkage, and no necessity was indicated for any revision of specification requirements with respect to this failure.

The procedures discussed were also followed in the analysis of properties of a series of additional wool fabrics procured by the Quartermaster Corps. The results of such studies are to be reported at a later date. The fact to be emphasized is that analysis of acceptance test data over a period of time has been useful to a government procurement depot in critical evaluation of relative quality standards of wartime contractors and in establishing the validity of specification limits in accordance with full-scale manufacturing capacities. Studies of this nature have demonstrated the existence of poor quality levels on the part of certain manufactures and have resulted in (1) immediate efforts on the part of the mills affected to correct the situation and (2) the establishment of optimum compromise requirements in material specifications.

The program outlined reflects but a part of the efforts of technicians of the Office of The Quartermaster General to satisfy military requirements for textile materials by setting the highest specification limits which the industry could meet and still satisfy the extreme demands of wartime procurements.

FIGURE I

COMPARISON OF OBSERVED FREQUENCY OF FABRIC* WEIGHTS WITH THEORETICAL FREQUENCY



*CLOTH, COTTON, WIND-RESISTANT, SATEEN, 9 OZ., TYPE I

TABLE II

AVERAGE QUALITY LEVEL OF CLOTH, COTTON, SATEEN, WIND RESISTANT DELIVERED AT PQMD DURING JUNE AND JULY 1944

CONTRACTOR	*APPROX. NUMBER OF SAMPLES OBSERVED	WEIGHT	TEXTURE		STRENGTH		**SHRINKAGE		AIR PERMEABILITY	SPRAY			HYRO		
		OZS.	WARP ENDS PER IN.	FILLING PICKS PER IN.	WARP LBS.	FILLING LBS.	WARP %	FILLING %	GURLEY SEC.	ORIG.	3RD WASH	3RD D.C.	ORIG. CM	3RD WASH CM	3RD D.C. CM
		(SPEC. 9.0 MIN.)	(SPEC. 112 MIN.)	(SPEC. 68 MIN.)	(SPEC. 150 MIN.)	(SPEC. 125 MIN.)	(SPEC. 1 MAX.)	(SPEC. 2 MAX.)	(SPEC. 100 MIN. 300 CC PER .1 SQ. IN.)	(SPEC. 90 MIN.)	(SPEC. 70 MIN.)	(SPEC. 70 MIN.)	(SPEC. 40 MIN.)	(SPEC. 25 MIN.)	(SPEC. 30 MIN)
A	20	8.80***	111.8***	68.6	146.3***	127.6	1.24***	.36	123.3	100.	74.1	75.8	40.6	33.8	41.4
B	12	9.12	114.0	68.3	147.1***	136.1	.24	.63	116.5	99.	80.4	74.2	42.1	31.9	42.4
C	74	9.08	115.	69.0	162.1	146.5	.14	1.23	152.9	97.8	78.4	72.7	38.6***	33.6	43.2
D	18	8.97***	113.2	68.2	149. ***	134.3	1.49***	.99	125.2	100.	73.5	80.7	39.9***	31.1	44.9
E	23	9.46	115.7	69.6	139.7***	128.9	-.55	.30	124.6	100.	78.7	80.	41.3	35.7	48.4
F	23	9.40	115.6	69.3	145.4***	138.8	-.82	.49	111.5	100.	76.8	80.4	38.8***	36.8	46.8
G	35	9.02	112.5	68.6	146.5***	132.0	.82	.13	134.4	98.2	77.8	79.6	42.6	33.5	45.7
H	150	9.19	114.5	70.4	157.7	143.4	.23	.78	124.3	96.8	76.7	74.6	38.8***	31.1	39.2
I	145	9.22	112.4	69.5	145.6***	130.6	.32	.19	119.5	93.3	78.3	73.6	41.0	34.2	42.5
J	48	9.45	115.4	68.8	160.3	139.8	.10	.73	151.1	99.3	77.6	72.6	33.8***	28.9	37.6
K	11	9.15	112.	69.5	156.	134.	.68	.09	129.5	100.	80.0	80.0	43.4	42.3	47.2

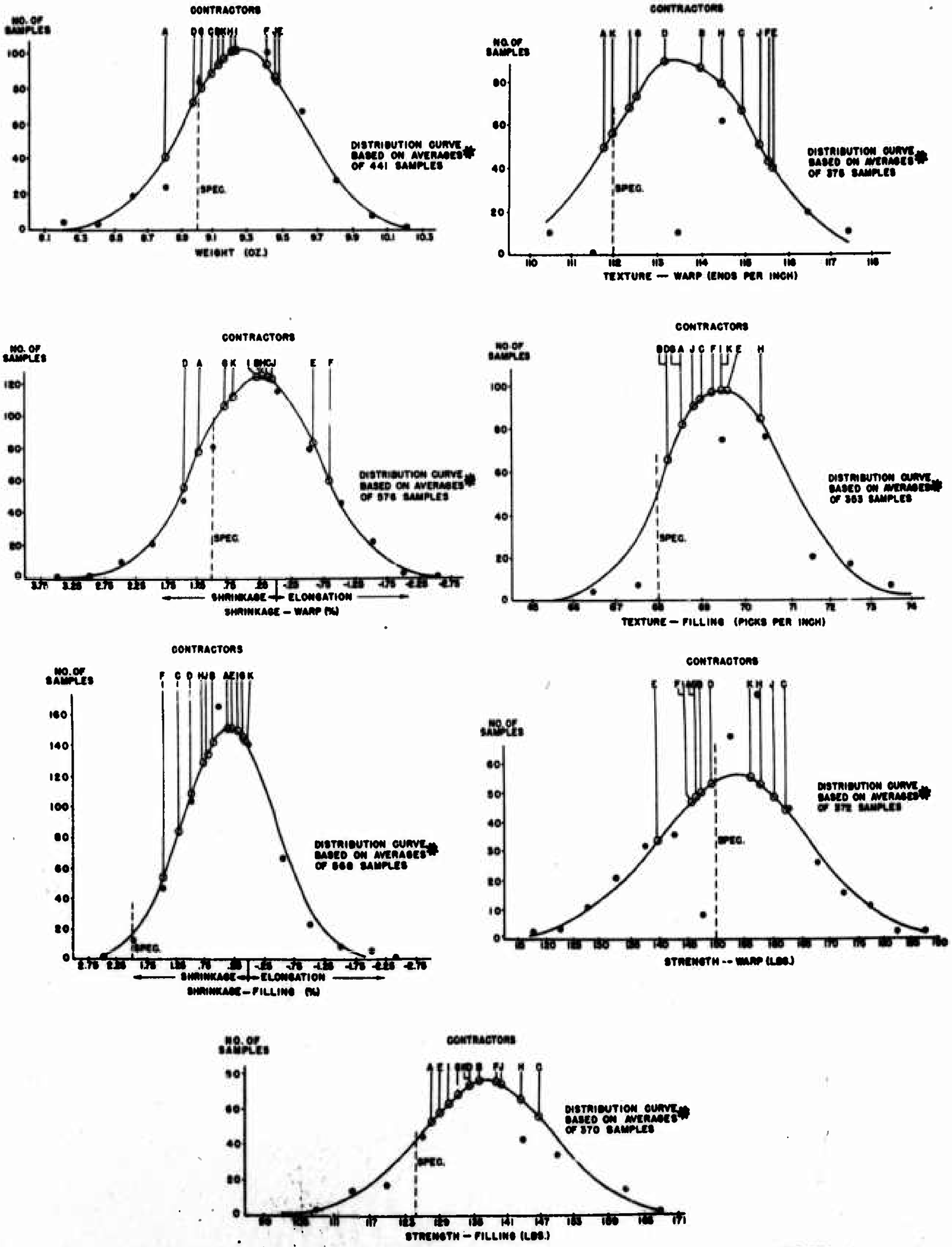
*The number of samples observed. Each sample consists of three tests which are averaged. Only unconditioned test values for Weight and Strength were considered.

**Negative shrinkage denotes elongation.

***Values failing to meet specification requirements.

FIGURE 2

AVERAGE QUALITY LEVEL OF CLOTH, COTTON, SATEEN, WIND-RESISTANT, 9 OZ., TYPE I DELIVERED AT P.Q.M.D. DURING JUNE AND JULY 1944



* THREE MEASUREMENTS OR TEST MADE ON EACH SAMPLE AND THE AVERAGE OF THESE THREE RECORDED AS A REPRESENTATIVE VALUE FOR THE SAMPLE

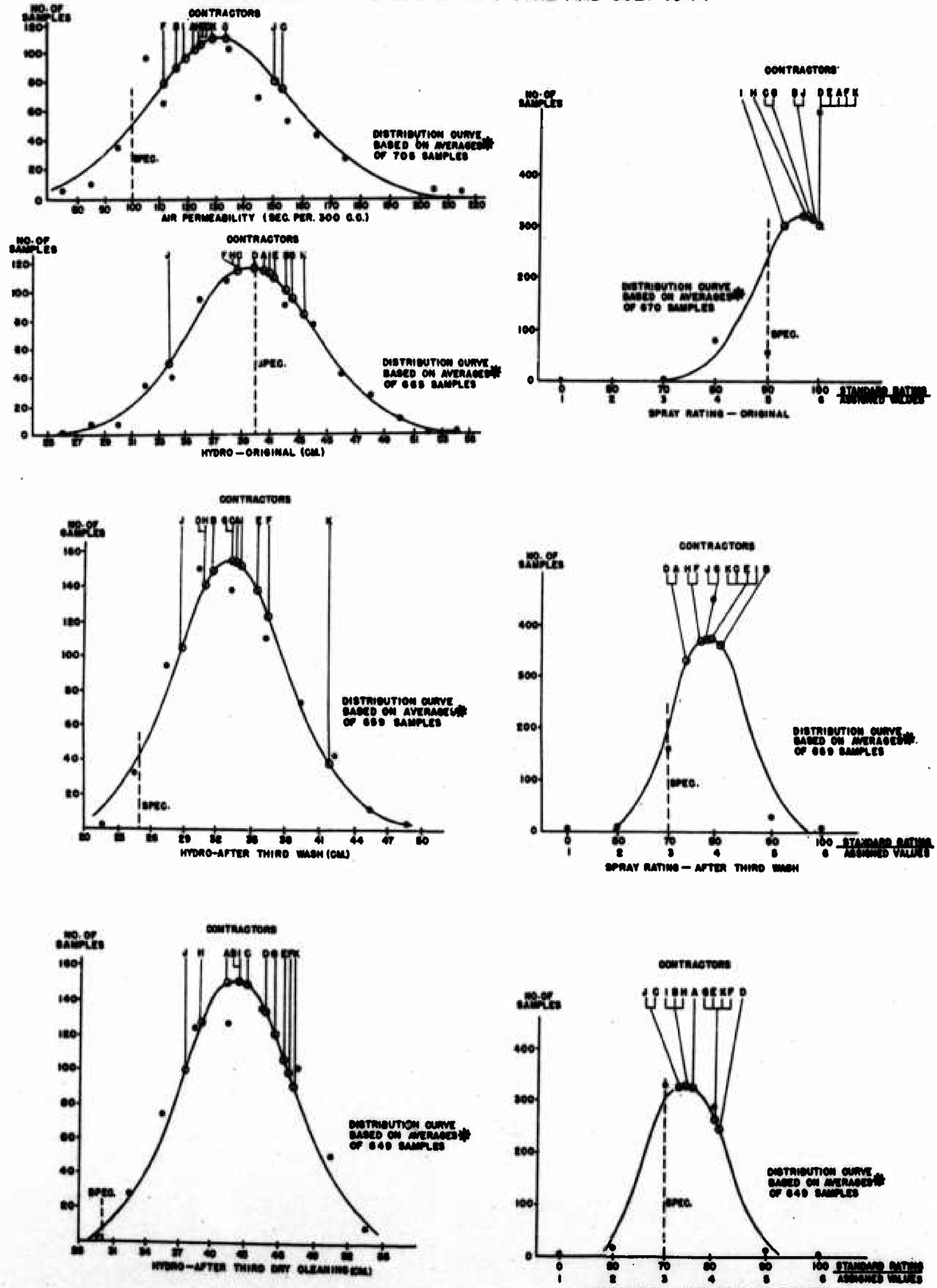
LEGEND

o — CONTRACTOR'S WEIGHED AVERAGE

• — OBSERVED FREQUENCY

FIGURE 2

AVERAGE QUALITY LEVEL OF CLOTH, COTTON, SATEEN, WIND-RESISTANT, 9 OZ., TYPE I DELIVERED AT P.Q.M.D. DURING JUNE AND JULY 1944



* THREE MEASUREMENTS OR TEST MADE ON EACH SAMPLE AND THE AVERAGE OF THESE THREE RECORDED AS A REPRESENTATIVE VALUE FOR THE SAMPLE

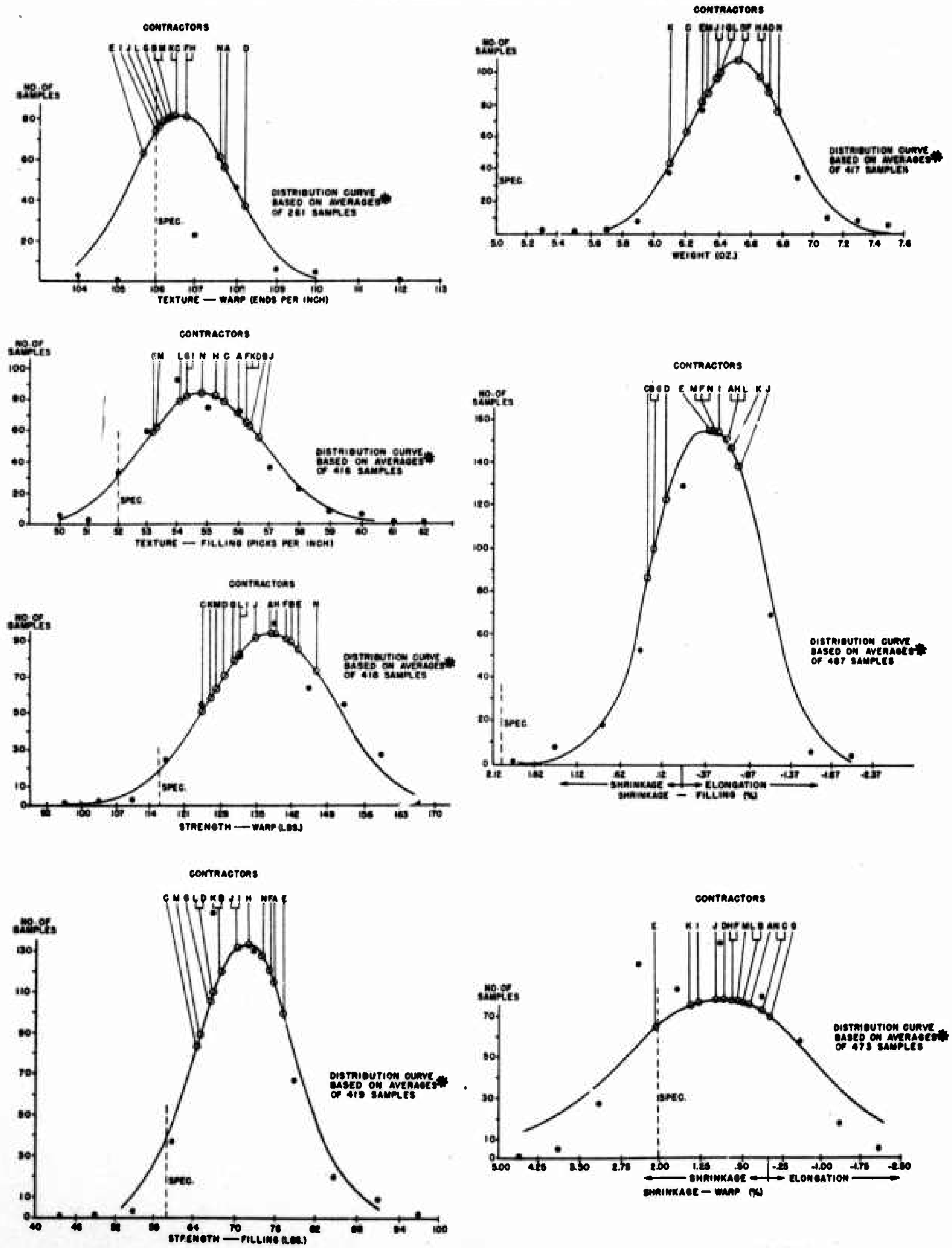
LEGEND

o — CONTRACTOR'S WEIGHED AVERAGE

• — OBSERVED FREQUENCY

FIGURE 3

AVERAGE QUALITY LEVEL OF CLOTH, COTTON, POPLIN, WIND-RESISTANT, 5 OZ., TYPE II DELIVERED AT P.Q.M.D. DURING MAY, JUNE, AND JULY, 1944



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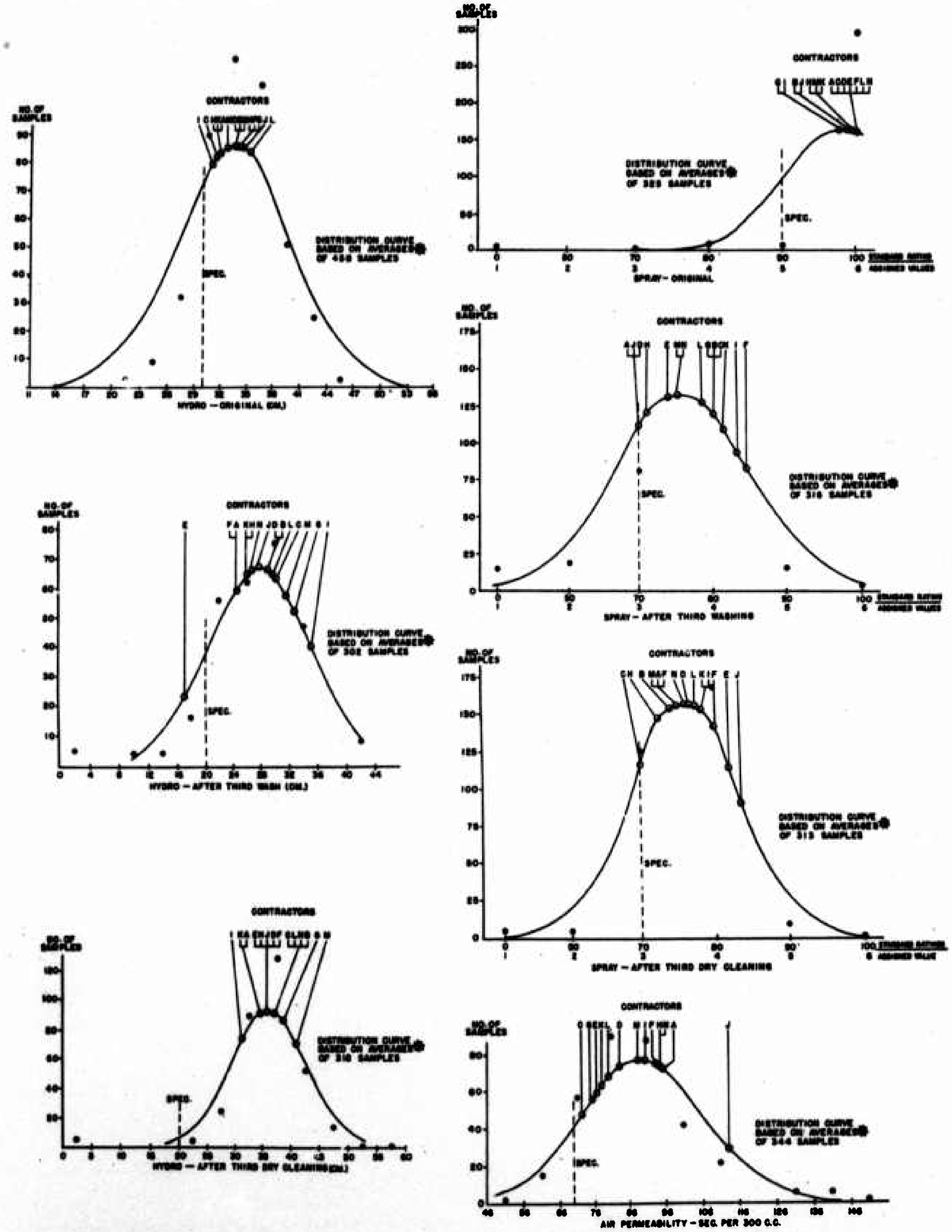
LEGEND

O - CONTRACTOR'S WEIGHED AVERAGE

● - OBSERVED FREQUENCY

FIGURE 3

AVERAGE QUALITY LEVEL OF CLOTH, COTTON, POPLIN, WIND-RESISTANT, 5 OZ., TYPE II DELIVERED AT P.Q.M.D. DURING MAY, JUNE, AND JULY, 1944



* THREE MEASUREMENTS OR TEST MADE ON EACH SAMPLE AND THE AVERAGE OF THESE THREE RECORDED AS A REPRESENTATIVE VALUE FOR THE SAMPLE

LEGEND

O - CONTRACTOR'S WEIGHED AVERAGE
● - OBSERVED FREQUENCY

TABLE III

AVERAGE QUALITY LEVEL OF CLOTH, COTTON, POPLIN, WIND-RESISTANT DELIVERED AT PQMD DURING MAY, JUNE AND JULY, 1944

CONTRACTOR	*APPROX. NUMBER OF SAMPLES OBSERVED	WEIGHT OZS. (SPEC. 5.0 MIN.)	TEXTURE WARP ENDS PER IN. (SPEC. 106 MIN.)	TEXTURE FILLING PICKS PER IN. (SPEC. 52 MIN.)	STRENGTH WARP LBS. (SPEC. 116 MIN.)	STRENGTH FILLING LBS. (SPEC. 60 MIN.)	**SHRINKAGE WARP % (SPEC. 2 MAX.)	**SHRINKAGE FILLING % (SPEC. 2 MAX.)	AIR PERMEABILITY GURLEY SEC. (SPEC. 70 MIN. 300cc PER .1 SQ. IN.)	SPRAY ORIG. (SPEC. 90 MIN)	SPRAY 3RD WASH (SPEC. 70 MIN.)	SPRAY 3RD D. C. (SPEC. 70 MIN.)	HYDRO ORIG. cm (SPEC. 30 MIN.)	HYDRO 3RD WASH cm (SPEC. 20 MIN.)	HYDRO 3RD D. C. cm (SPEC. 20 MIN.)
A	31	6.66	107.7	55.9	138.0	75.9	.39	-.61	95.5	100	70.0	75.2	32.0	24.5	34.6
B	120	6.53	106.4	56.3	141.8	68.7	.49	.21	—	98.4	80.0	74.1	33.7	29.1	37.1
C	6	6.20	106.5	55.5	124.7	64.8	.12	.29	72.6	100	80.0	70.0	31.4	30.2	36.6
D	11	6.71	108.2	56.2	128.6	67.2	.84	.08	83.2	100	70.0	76.6	33.5	28.9	35.6
E	29	6.30	105.7***	53.2	143.3	77.4	2.07***	-.42	76.5	100	74.0	82.0	33.7	16.9***	35.5
F	23	6.51	106.8	56.2	141.0	75.0	.66	-.45	93.1	100	84.1	75.0	34.0	24.4	35.8
G	10	6.41	106.3	54.3	130.7	66.6	-.01	.20	75.3	97.5	80.0	80.0	34.0	32.4	38.4
H	40	6.65	106.8	55.2	138.7	72.0	.69	-.61	94.8	99.2	71.1	72.4	31.8	26.0	35.5
I	28	6.39	106.0	54.3	132.1	70.6	1.26	-.51	90.5	97.8	83.3	78.4	30.9	35.0	31.3
J	38	6.38	106.1	56.6	134.7	70.5	.94	-.74	113.0	98.5	70.0	83.5	34.4	27.8	35.5
K	50	6.10	106.5	56.2	126.3	68.4	1.37	-.65	78.1	99.6	81.3	78.2	31.9	26.0	34.6
L	17	6.42	106.2	54.1	131.5	67.1	.50	-.62	80.3	100	78.4	77.5	35.3	29.4	36.9
M	25	6.33	106.4	53.3	126.9	65.3	.59	-.44	88.4	99.5	75.2	74.8	32.8	31.4	40.7
N	22	6.77	107.6	54.8	146.7	74.3	.14	-.45	94.8	100	75.3	76.0	33.9	26.5	37.0
No. of Samples Observed in Determining Dist. Curve		417	261	417	418	419	473	487	374	458	302	318	458	302	318

*The number of samples observed. Each sample consists of three tests which are averaged. Only unconditioned test values for Weight and Strength were considered.

**Negative shrinkage denotes elongation.

***Values failing to meet specification requirements.

TABLE IV

AVERAGE QUALITY LEVEL OF CLOTH, WOOL, MELTON, 20 OZ., O.D. DELIVERED AT PQMD DURING FEBRUARY, MARCH AND APRIL 1945

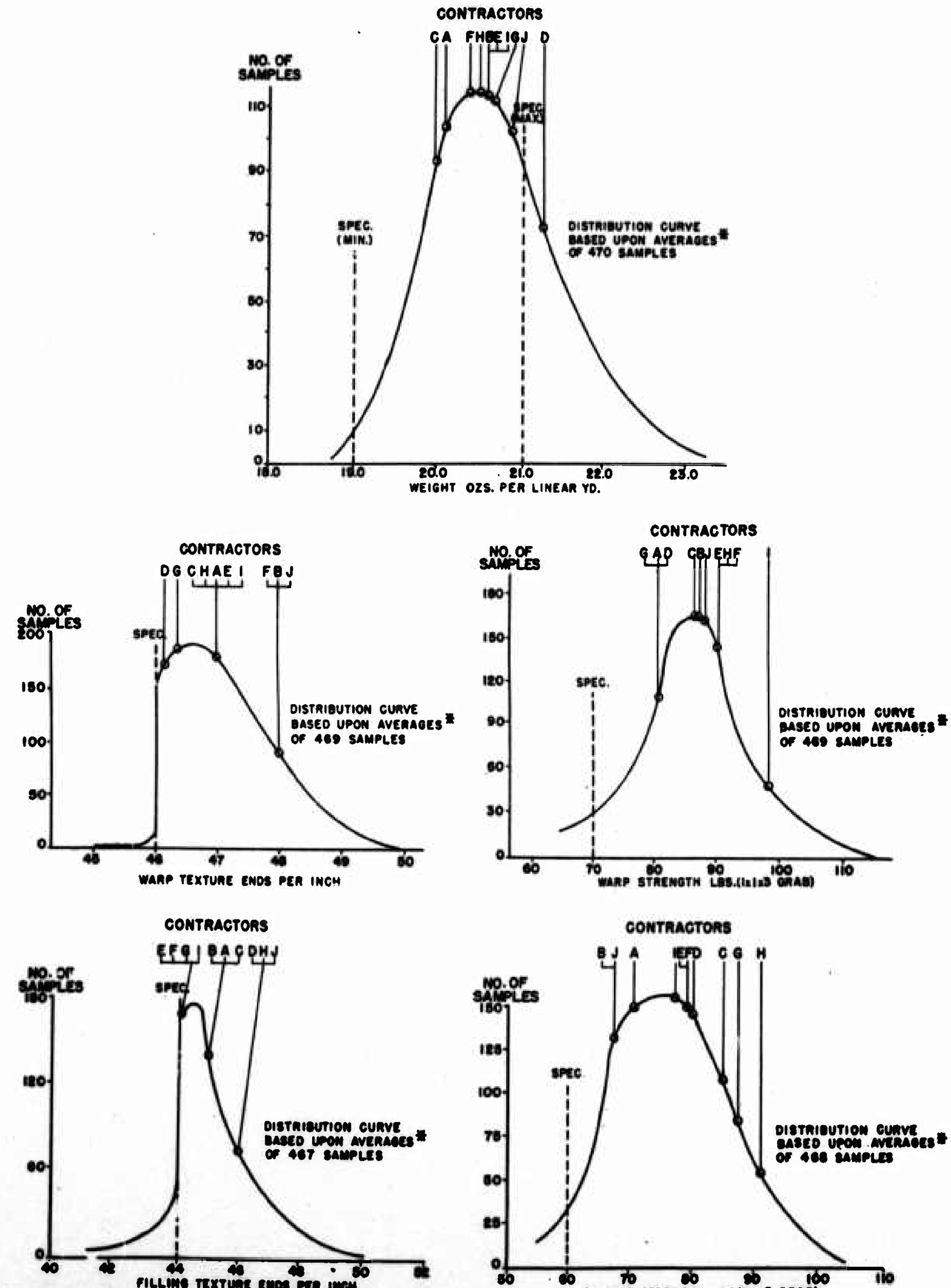
CONTRACTOR	*APPROX. NUMBER OF SAMPLES OBSERVED	WEIGHT	TEXTURE		STRENGTH	
		OZS.	WARP ENDS PER IN.	FILLING PICKS PER IN.	WARP LBS.	FILLING LBS.
		(SPEC. 19 - 21)	(SPEC. 46 MIN.)	(SPEC. 44 MIN.)	(SPEC. 70 MIN.)	(SPEC. 60 MIN.)
A	137	20.1	47	45	79	70
B	19	20.6	48	45	87	67
C	98	20.0	47	45	86	85
D	21	21.3**	46	46	80	80
E	7	20.6	47	44	90	79
F	10	20.4	48	44	90	79
G	18	20.7	46	44	79	87
H	19	20.5	47	46	90	91
I	64	20.6	47	44	98	77
J	76	20.9	48	46	88	67

*The number of samples observed. Each sample consists of three tests which are averaged. Only unconditioned test values for Weight and Strength were considered.

**Values failing to meet specification requirements.

FIGURE 4

AVERAGE QUALITY LEVEL OF CLOTH, WOOL, MELTON, 20 OZ., O.D. PIECE DYED
DELIVERED AT P.Q.M.D. DURING FEBRUARY, MARCH, & APRIL, 1945



* THREE MEASUREMENTS OR TEST MADE ON EACH SAMPLE AND THE AVERAGE OF THESE THREE RECORDED AS A REPRESENTATIVE VALUE FOR THE SAMPLE

LEGEND

O — CONTRACTOR'S WEIGHED AVERAGE

TABLE V

AVERAGE QUALITY LEVEL OF CLOTH, COTTON, HERRINGBONE TWILL DELIVERED AT PQMD DURING APRIL, MAY, AND JUNE, 1944

CONTRACTOR	*APPROX. NUMBER OF SAMPLES OBSERVED	WEIGHT	TEXTURE		STRENGTH		**SHRINKAGE	
		OZS.	WARP ENDS PER IN.	FILLING PICKS PER IN.	WARP LBS.	FILLING LBS.	WARP %	FILLING %
		(SPEC. 8.5 MIN.)	(SPEC. 72 MIN.)	(SPEC. 46 MIN.)	(SPEC. 125 MIN.)	(SPEC. 85 MIN.)	(SPEC. 1% MAX.)	(SPEC. 1% MAX.)
A	14	8.80	79.1	48.1	136.8	93.1	-.58	-1.00
B	16	8.55	75.2	47.6	137.1	100.6	-.38	-.69
C	160	8.80	79.0	51.1	***123.5	101.1	-.36	-.27
D	24	8.92	74.9	48.8	131.7	89.5	.27	-.30
E	32	9.00	75.1	47.6	138.8	93.4	.26	-.79
F	18	9.21	77.8	49.1	141.2	93.3	.85	-1.14
G	88	8.86	75.4	48.1	138.5	107.0	-.68	-.64
H	33	8.86	75.6	47.4	144.3	93.5	-.45	.22
I	17	***8.47	73.0	47.6	132.5	90.9	.68	.63
J	12	8.60	77.4	47.0	***118.2	109.0	-.09	-.61
K	18	8.55	74.0	47.0	129.3	101.0	-.03	-.21
L	25	9.08	74.7	48.1	142.8	91.4	.06	-.20
M	14	8.83	75.7	46.9	129.3	119.0	-.78	-.33
N	39	8.87	77.8	47.8	130.7	97.4	-.22	-.60
O	564	***8.37	73.8	49.0	135.3	88.6	-.97	.43
P	50	8.50	92.5	49.8	138.1	100.9	.09	-1.03
Q	28	8.77	78.2	47.9	134.8	93.7	-1.48	-.36
R	72	8.63	79.6	48.5	131.3	98.2	.12	-.97
S	26	8.72	88.0	47.8	128.3	137.9	-.65	-1.08
T	15	8.70	78.0	49.1	134.8	120.0	.46	.03

*THREE TESTS ARE MADE FOR EACH FABRIC CHARACTERISTIC ON EACH SAMPLE, THE AVERAGE OF THESE THREE IS TAKEN AS REPRESENTATIVE OF THAT SAMPLE.

**NEGATIVE SHRINKAGE DENOTES ELONGATION OF THE FABRIC.

***VALUES FAILING TO MEET SPECIFICATION REQUIREMENTS.