07:28 91 OCA PAD INITIATION - PROJECT HEADER INFORMATION 07/05/91

Active

Project #: E-27-631 Cost share #: Rev #: 0
Center # : 10/24-6-R7220-0A0 Center shr #: OCA file #:
Work type : RES
Contract#: AGREEMENT DTD 6/11/91 Mod #: INITIATION Document : AGR
Prime #: Contract entity: GTRC

Subprojects ? : N CFDA: N/A
Main project #: PE #:

Project unit: TEXT ENGR Unit code: 02.010.130
Project director(s):
THOMAS W TEXT ENGR (404)894-2490

Sponsor/division names: ICI AMERICAS INC / CHARLESTOWN, IN
Sponsor/division codes: 240 / 016

Award period: 910513 to 920513 (performance) 920513 (reports)

Sponsor amount	New this change	Total to date
Contract value	58,000.00	58,000.00
Funded	58,000.00	58,000.00
Cost sharing amount		0.00

Does subcontracting plan apply ?: N

Title: SPECIFICATION DEVELOPMENT FOR BALLISTIC PROPELLANT FABRIC

PROJECT ADMINISTRATION DATA

OCA contact: Mildred S. Heyser 894-4820

Sponsor technical contact

(812)284-7992

LARRY KOPPLE
ICI AMERICAS INC.
INDIANA ARMY AMMUNITION PLANT
CHARLESTOWN, INDIANA 47111

Sponsor issuing office

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(812)284-7992

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ICI AMERICAS INC.
INDIANA ARMY AMMUNITION PLANT
CHARLESTOWN, INDIANA 47111

Security class (U,C,S,TS) : U
Defense priority rating :
Equipment title vests with: Sponsor

ONR resident rep. is ACO (Y/N): N
supplemental sheet
GIT X

Administrative comments -
INITIATION

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

NOTICE OF PROJECT CLOSEOUT

Closeout Notice Date 01/29/93

Project No. E-27-631_____ Center No. 10/24-6-R7220-0A0_

Project Director THOMAS W_____ School/Lab TEXT ENGR_____

Sponsor ICI AMERICAS INC/CHARLESTOWN, IN_____

Contract/Grant No. AGREEMENT DTD 6/11/91_____ Contract Entity GTRC

Prime Contract No. _____

Title SPECIFICATION DEVELOPMENT FOR BALLISTIC PROPELLANT FABRIC_____

Effective Completion Date 920513 (Performance) 920513 (Reports)

Closeout Actions Required:	Y/N	Date Submitted
Final Invoice or Copy of Final Invoice	Y	_____
Final Report of Inventions and/or Subcontracts	Y	_____
Government Property Inventory & Related Certificate	Y	_____
Classified Material Certificate	N	_____
Release and Assignment	Y	_____
Other _____	N	_____

CommentsEFFECTIVE DATE 5-13-91. CONTRACT VALUE $58,000._____

Subproject Under Main Project No. _____

Continues Project No. _____

Distribution Required:

Project Director	Y
Administrative Network Representative	Y
GTRI Accounting/Grants and Contracts	Y
Procurement/Supply Services	Y
Research Property Managment	Y
Research Security Services	N
Reports Coordinator (OCA)	Y
GTRC	Y
Project File	Y
Other HARRY VANN-FMD_____	Y
FRED CAIN-OOD_____	Y

NOTE: Final Patent Questionnaire sent to PDPI.

GEORGIA TECH RESEARCH CORPORATION

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
PROGRAM INITIATION DIVISION
ATLANTA, GEORGIA 30332-0420

Telex: 542507 GTRC OCA ATL
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Phone: (404) 894-4817

Refer to: MG/E-27-631

9 July 1992

ICI Americas, Inc.
Indiana Army Ammunition Plant
Charlestown, Indiana 47111

Attention: Larry Kopple
Purchasing Department

Subject: Final Report for Phase 1 Research Project Entitled, "Specification Development for Ballistic Propellant Fabric"

Reference: P.O. 61016A

Dear Mr. Kopple:

The GEORGIA TECH RESEARCH CORPORATION desires to submit the subject final report prepared by Dr. Walter Thomas.

We also request that funding of Phase II of this project be initiated. Please let me know if you need anything in regard to Phase II.

We appreciate the opportunity of working with you and look forward to working further on this project.

Sincerely,

Matt Gedney
Contracting Officer

MG/ch

Georgia Tech

School of Textile & Fiber Engineering

Georgia Institute of Technology
Atlanta, Georgia 30332-0295
404•894•2490
FAX 404•894•8780

MEMORANDUM

DATE: July 6, 1992

TO: Matt Gedney
Contracting Officer

FROM: Dr. Walter Thomas
School of Textile & Fiber Engineering

SUBJECT: FINAL REPORT OF PHASE I FOR PROPOSAL ENTITLED, "SPECIFICATION DEVELOPMENT FOR BALLISTIC PROPELLANT FABRIC"

Attached is the final report for Phase I of our proposal to ICI Americas Inc., entitled "Specification Development for Ballistic Propellant Fabric." Please submit this to ICI along with a request to fund Phase II of the project. It appears that ICI will continue coordination of the project and recommend that Phase II be funded. I do not believe any additional paperwork will be required at this time.

Please call if you have any questions.

ljw

FINAL REPORT

PROPOSED REVISIONS FOR MIL-CI-43157

PREPARED BY

School of Textile and Fiber Engineering
Georgia Institute of Technology
Atlanta, GA 30332

Principal Investigator: Dr. Walter Thomas

PROPOSED REVISIONS FOR MIL-C-43157

INTRODUCTION

Military Specification, MIL-C-43157(MU), Cloth Spun Viscose Rayon, Resin Impregnated, was developed to cover the specifications for three classes of rayon cloth for use with artillery cartridge bags. This specification was issued September 4, 1963. Rayon cloth was selected to replace silk cartridge cloth as a result of extensive research conducted by Nadel and Bernstein as reported in Technical Report 2683, Development of Substitutes for Silk Cartridge Cloth, June 1960. The selection of rayon was made based on its unique characteristics in terms of combustibility, resistance to deterioration under adverse conditions of storage and compatibility with standard artillery propellants.

As a result of the research conducted to date on this project, it is recommended that MIL-C-43157(U) be revised to include specifications for both yarn and greige fabric. At this stage, we do not believe it is necessary to specify the properties of the rayon fiber used to produce the fabric. The proposed recommendations for the yarn and greige fabric are as follows:

RECOMMENDED YARN SPECIFICATIONS

	For Use in Class I Fabric	For Use in Class II Fabric
Yarn Number, Cotton Count		
Nominal	28/1	8.75/1
Standard Deviation	1.0	0.5
Twist, Turns Per Inch		
Direction	Z	Z
Average	21	10
Standard Deviation	1.0	0.50
Single-End Break Strength, lbs		
Average	0.5	3.00
Standard Deviation	0.03	0.30
Single-End Elongation, %		
Average	16.0	22.0
Standard Deviation	1.5	2.0
Skein Breaking Strength, lbs		
Average	100	435
Standard Deviation	1.5	3.0

RECOMMEND GRIEGE FABRIC PROPERTIES

	CLASS I		CLASS 2 & 3	
	MIN.	MAX.	MIN.	MAX.
Fabric Weight, oz/yd^2	2.85	3.15	6.25	6.75
Thread Count				
Warp	64	67	38	41
Filling	52	55	35	38
Breaking Strength, lbs/in				
Warp	60.0	---	145.0	---
Filling	48.0	---	130.0	---
Breaking Elongation, %				
Warp	12.0	20.0	10.0	18.0
Filling	20.0	25.0	18.0	23.4
Stiffness (ASTMD1388)				
Bending Length, cm				
Warp	3.0	4.5	4.0	5.5
Filling	1.9	3.0	3.0	4.5

The results of this phase of the research project suggest that the variability of the fabric properties is attributed primarily to the finishing process. Therefore, it is recommended that Phase II of the original proposal be conducted as outlined in the initial proposal.

OBJECTIVE

The objectives of Phase One of this Two-Phase research project were to investigate, conduct research, and propose revisions to MIL-C-43157(MU) for the manufacture of the Greige Rayon Fabrics covered in this specification. Phase-Two will involve the revision of the specifications for the finished fabric.

INVESTIGATION AND RESEARCH

Plant Visits

Visits were made to ICI/Indiana Army Ammunition Plant (IAAP), Charlestown, IN, Windsor Textile Processing, Inc., Newberg, NY (Fabric Finisher), and Marion Manufacturing, Inc., Marion, NC (Fabric Weaver). These visits were made in order to thoroughly understand all phases of the manufacturing process from the greige fabric to the finished products.

The major concerns expressed by ICI/IAAP were that inconsistencies in fabric properties were seen from shipment-to-shipment. These inconsistencies resulted in problems in cutting, handling, and sewing of the fabrics and in poor and unacceptable quality sewn products. Approximately fifty percent of the finished fabric received had to be rejected. The major inconsistencies were more prevalent prior to utilizing the present weaver and finisher. ICI/IAAP considered the specifications of MIL-C-43157(MU) to be insufficiently defined to restrict the type of inconsistencies encountered.

Process capabilities were observed at both the weaver (Marion Manufacturing) and the finisher (Windsor Textile Manufacturing) in order to assess potential manufacturing problems. Our assessment, based on the visits, is that more potential for error is with the finisher than the weaver due primarily to the technology of the process at the finisher. However, final judgement of the quality of the fabric is based on the evaluation of the fabric samples.

Samples

Fiber, yarn and fabric samples were obtained from the various sources for evaluation. However, very few fabric samples representing the problems of concern were available for evaluation. In addition, a complete statistical fabric sampling of the processes at both the weaver and the finisher were not provided as requested. Sufficient samples, however, were available to analyze and to make conclusive recommendations. A list of the materials that were evaluated is shown in Table 1.

TABLE 1

LIST OF MATERIALS EVALUATED

MATERIAL	DESCRIPTION	ASSIGNED IDENTIFICATION
FIBER:	1-1/2" x 1-1/2" Denier Semi-dull	-------
Rayon Staple		
YARN:	Received from Marion Mfg.	1
28/1		
8.75/1	Received from Marion Mfg.	2
FABRIC:		
Greige - Class I	Received from Marion Mfg.	1
Greige - Class I	Received from Widder Bros.	2
Scoured - Class I	Received from Widder Bros.	3
FINISHED:		
Class I	P.O.-58746, R.R.-36701, Roll #70954	A
Class I	P.O.-58746, R.R.-39361, Roll #116559	K
Class I	P.O.-58746, R.R.-39360, Roll #113916	L
Class I	P.O.-59828, R.R.-39359, Roll #113911	M
Class I	P.O.-59828, R.R.-39655, Roll #116538	N
Class I	Received from Widder Bros. (4100/207)	R
Class II	P.O.-55827, R.R.-33035, Roll #101194	B
Class II	P.O.-57537, R.R.-38087, Roll #107947	C
Class II	P.O.-57537, R.R.-38090, Roll #107953	D
Class II	P.O.-57537, R.R.-38090, Roll #107959	E
Class II	P.O.-61536, R.R.-38274, Roll #38274	F
Class II	P.O.-61536, R.R.-38268, Roll #38268	G
Class II	P.O.-58072, R.R.-38835, Roll #92169	H
Class II	P.O.-58072, R.R.-38834, Roll #113881	I
Class II	P.O.-61573, R.R.-39362, Roll #116361	J
Class II	P.O.-61014, R.R.-39656, Roll #11516	O
Class II	P.O.-58072, R.R.-39654, Roll #111177	P
Class II	P.O. 56738, R.R.-39657, Roll #111169	Q

RESEARCH

Yarn

Marion Manufacturing uses two different yarn counts for weaving fabric for conformance to the specifications of MIL-C-43157. A nominal 30/1 cotton count yarn is used for Class I fabric and a nominal 8.75/1 cotton count yarn is used for Classes II and Classes III. An evaluation of these two yarns is shown in Table 2.

TABLE 2

TEST RESULTS OF RAYON YARN FROM MARION MANUFACTURING

	YARN	
	1	2
Yarn Number, Cotton Count	28/1	8.75/1
Twist, Turns per inch		
Average	21.12	10.48
Standard Dev.	2.05	0.66
Twist Direction	Z	Z
Single-end Break Strength, lbs		
Average	0.46	3.03
Standard Dev.	0.13	0.35
Elongation, Percent (Single-End)		
Average	15.8	21.7
Standard Dev.	1.02	2.41
Tenacity, Grams/Denier		
Average	1.1	2.26
Standard Dev.	0.32	0.27
Skein Breaking Strength, lbs		
Average	101.5	433.6
	1.41	2.88

The data shows that the yarn properties are generally within industry specifications for those properties which were evaluated. However, the following yarn specifications are recommended for inclusion in MIL-C-43157(MU):

RECOMMENDED YARN SPECIFICATIONS

	For Use in Class I Fabric	For Use in Class II Fabric
Yarn Number, Cotton Count		
Nominal	28/1	8.75/1
Standard Deviation	1.0	0.5
Twist, Turns Per Inch		
Direction	Z	Z
Average	21	10
Standard Deviation	1.0	0.50
Single-End Break Strength, lbs		
Average	0.5	3.00
Standard Deviation	0.03	0.30
Single-End Elongation, %		
Average	16.0	22.0
Standard Deviation	1.5	2.0
Skein Breaking Strength, lbs		
Average	100	435
Standard Deviation	1.5	3.0

Unfinished Fabric

Three greige fabric samples, one from Marion Mfg. and two (one scoured) from Widder Bros., were tested for physical properties in accordance with the requirements specified in MIL-C-43157 (MU) and other selected ASTM Test Methods. A summary of the test results is shown in Table 3. All three fabrics are Class I. Greige Class II and Class III fabrics were unavailable for evaluation in this phase.

TABLE 3

TEST RESULTS OF GREIGE AND SCOURED FABRIC

PROPERTY	FABRIC 1	FABRIC 2	FABRIC 3 (SCOURED)
Weight, oz/yd^2			
Average	3.01	3.08	3.32
Construction			
Ends/inch			
Average	65.8	65.3	72
Picks/inch			
Average	52.5	53.0	55
Breaking Strength, lbs			
Warp			
Average	63.4	62.8	77.38
Standard Dev.	4.93	6.52	2.56
Filling			
Average	50.3	59.1	53.9
Standard Dev.	0.93	3.06	7.46
Elongation, %			
@ Break			
Warp-Average	15.13	19.0	21.25
Standard Dev.	0.79		
Filling-Average	22.41	28.5	41.5
Standard Dev.	0.61	1.37	3.22
@ 20 lbs			
Warp-Average	n/a	7.0	5.25
Standard Dev.		1.83	0.42
Filling-Average	n/a	11.88	25.03
Standard Dev.		0.42	7.37
Bursting Strength, lbs/in^2			
Average	131.5	141.2	139.2
Standard Dev.	5.8	16.36	5.36
Tear Strength, lbs (Tongue-tear)	n/a	9.56	6.39
Warp		8.54	9.34
Filling			
Seam Slippage, lbs			
Warp	n/a	39.0	41.5
Filling		32.35	31.25

TABLE 3 - CONTINUED

PROPERTY	FABRIC 1	FABRIC 2	FABRIC 3 (SCOURED)
Abrasion Test			
Strength, lbs after 10 min. @ 125 cycle/min.	39.25	36.42	42.8
Warp-Average	4.83	10.48	5.43
Standard Dev.	34.9	37.96	28.64
Filling-Average	3.23	6.77	6.75
Standard Dev.			
Percent strength loss After 10 min. @ 125 cycles/min.			
Warp-Average	21.97	40.40	44.69
Standard Dev.	n/a	n/a	n/a
Filling-Average	44.95	35.77	46.86
Standard Dev.	n/a	n/a	n/a
Stiffness (Cantilever)			
Weight/Unit Area (g/sq.cm)			
Warp	0.01172	.01095	.01188
Filling	0.0118	.01095	.0115
Bending Length, CM			
Warp	4.14	3.61	2.45
Filling	2.647	2.41	1.90
Flexural Rigidity			
Warp, g-cm	0.8342	.44902	.15309
Warp, lbs-in	0.00075	.00251	.00086
Filling, g-cm	0.22014	.13328	.070953
Filling, lbs-in	0.0002	.00074	.0004

Mechanical Properties of Unfinished Class I Fabrics

Lower-Stress: The low-stress mechanical properties of a group of four Class I fabrics were measured using Kawabata equipment. Kawabata Tensile Tester was used to measure tensile elongation and tensile resilience properties of the fabrics in both warp and filling directions under a load of 500 grams/cm. The shear rigidity was measured by shearing the fabrics to $\pm$ 8 degrees in both warp and filling directions. Bending rigidity and bending hysteresis were measured by bending the fabric to a limit radius of curvature in both warp and filling directions. Table 6 identifies the test fabrics while Tables 5, 6 and 7 present the average values of the mechanical properties for the four fabrics.

TABLE 4 TEST FABRICS

S. NO.	FABRIC IDENTITY
1	Finished Class I Fabric (1D - #R)
2	Unfinished Class I Fabric supplied by Marion Manufacturing (1D - #1)
3	Unfinished Class I Fabric supplied by Widder Brothers (1D - #2)
4	Scoured Class I Fabric supplied by Widder Brothers (1D -#3)

TABLE 5. BENDING BEHAVIOR

FABRIC	BENDING PROPERTIES					
	B			2HB		
	WARP	FILL	AVG	WARP	FILL	AVG
Class I Finished	0.36	0.19	0.28	0.78	0.45	0.61
Class I Unfinished (Marion)	0.31	0.23	0.27	0.56	0.41	0.49
Class I Unfinished (Widden)	0.31	0.04	0.18	0.40	0.09	0.24
Class I Scoured	0.11	0.05	0.08	0.10	0.05	0.08

B: Bending Rigidity ($g.cm^2/cm$)
2HB: Bending Hysteresis (g.cm/cm)

TABLE 6. SHEAR BEHAVIOR

	SHEAR PROPERTIES					
	G			2HG		
FABRIC	WARP	FILL	AVG.	WARP	FILL	AVG.
CLASS I FINISHED	1.21	0.7	0.95	0.95	0.70	0.83
CLASS I FINISHED (MARION)	1.8	0.87	1.33	1.9	0.57	1.23
CLASS I UNFINISHED (WIDDEN)	1.42	1.26	1.34	4.7	3.8	4.3
CLASS I SCOURED	0.48	0.43	0.45	0.41	0.41	0.41

G: Shear Rigidity (g/cm. degree)
2HG: Shear Hysteresis (g/cm)

TABLE 7. TENSILE BEHAVIOR

	TENSILE BEHAVIOR					
	RT%			EMT%		
FABRIC	WARP	FILL	AVG.	WARP	FILL	AVG.
CLASS I FINISHED (#R)	47.0	29.4	38.2	1.5	4.0	2.75
CLASS I UNFINISHED (MARION) (#1)	44.0	31.0	37.8	1.7	3.1	2.4
CLASS I UNFINISHED (WIDDEN) (#2)	49.7	37.7	43.7	1.5	6.6	4.1
CLASS I SCOURED (#3)	49.1	33.6	41.3	1.9	15.3	8.6

RT: Percentage Tensile Resilience
EMT: Percentage Tensile Elongation at a load of 500 grams/cm width of fabric.

Discussion of Results: The bending rigidity and bending hysteresis values listed in Table 7 are not high enough to cause problems in sewing. In general, fabrics whose bending rigidity values lie outside the measuring range of the bending tester can be expected to cause problems such as needle chews, excessive heating of needles, needle breaks, rough edges of cut parts and a need for frequent sharpening of cutter blades. The Bending rigidity values of the four fabrics are well within the measuring range of the bending tester. All the four fabrics, therefore, qualify as good sewing materials on the basis of their bending properties.

The dimensional stability of sewn bags as they are packed with ammunition may be influenced by the values obtained for warp and fillingwise tensile elongation. Warp and fillingwise shear rigidities may also relate to the shape formation and shape retention properties. Fabrics showing high values of warpwise tensile elongation or low values of warpwise shear rigidity can be expected to result in longitudinally elongated ammunition bags after packing. Fabrics showing high values of fillingwise elongation or low values of fillingwise shear rigidity can be expected to cause "Swollen Bellies" in the packed bags. From table 9, it can be seen that the scoured and unfinished fabrics show higher values of tensile elongation in the filling direction. To obtain uniform diameter of packed artillery bags, it may be necessary to reduce fillingwise stretch by making appropriate changes in the construction of griege fabric.

Recommendations for Greige Fabric Properties

Based on the test results from the physical properties and the Kawabata tests, the following recommendations are proposed for revision to MIL-C-43157(MU) for the greige fabric properties.

RECOMMEND GRIEGE FABRIC PROPERTIES

	CLASS I		CLASS 2 & 3	
	MIN.	MAX.	MIN.	MAX.
Fabric Weight, oz/yd^2	2.85	3.15	6.25	6.75
Thread Count				
Warp	64	67	38	41
Filling	52	55	35	38
Breaking Strength, lbs/in				
Warp	60.0	---	145.0	---
Filling	48.0	---	130.0	---
Breaking Elongation, %				
Warp	12.0	20.0	10.0	18.0
Filling	20.0	25.0	18.0	23.4
Stiffness (ASTMD1388)				
Bending Length, cm				
Warp	3.0	4.5	4.0	5.5
Filling	1.9	3.0	3.0	4.5

FINISHED FABRIC

Six Class I and twelve Class II fabrics were evaluated for conformance to MIL-C-43157(MU). Other selected ASTM Test Methods were used to evaluate the fabrics. These fabrics were primarily received from ICI as representing typical supplier shipments. Most of the fabrics were considered acceptable for cutting, handling and sewing. The test results are shown in Tables 4 and 5.

These results show considerable variability among the fabric samples tested. The variability of the samples is attributed primarily to the finishing process. In order to reduce the

variability attributed to the finishing process, a much more indepth investigation is required.

CONCLUSIONS

The results of this investigation indicate that variabilities in yarn, griege fabric and finished fabric properties exceed the limits necessary to control the properties of the final product made from this fabric as specified in MIL-C-43157(MU). Further research is required and recommended in order to specify the properties of the finished fabric in order to control the critical properties encountered when manufacturing the propellant bags.

It is recommended that MIL-C-43157 be revised at this stage on an interim basis to include the yarn and greige fabric specifications as outlined in the report. Further, it is recommended that Phase II of this overall proposal be funded to determine the required modifications necessary for the finished fabric. The results from this study show that the primary variation in the fabric properties is due to the finishing process.

TABLE 8
SUMMARY OF CLASS I FINISHED FABRICS

PROPERTY	A	K	L	M	N	R
Weight, oz/yd^2						
Average	2.93	3.12	3.19	3.61	3.2	3.25
% CV	1.29	1.38	1.85	1.58	1.98	
Construction						
Ends Per Inch-Avg.	65	62	64	64	64	63
% CV	0.84	1.14	.7	.7	.7	
Picks per inch-Avg	51	50	52	52	52	54
% CV	1.65	1.09	.86	1.1	.86	
Breaking Strength, lbs						
Warp-Average	96.3	57	56.4	59.8	72	64.0
% CV	6.75	8.04	3.68	8.88	4.8	
Filling-Average	73	45.6	43.2	48.2	58.4	54.8
% CV	4.22	5.5	7.02	8.09	4.5	
Elongation, %						
Warp-Average	6.18	14.36	13.5	15.4	12.6	5.00
% CV	16.9	3.36	5.5	12.2	1.8	
Filling-Average	16.78	20.2	22.9	24.1	20.1	25.67
% CV	10.3	2.71	5.53	5.26	2.1	
Tear Strength, lbs						
Warp	19.1	n/a	n/a	n/a	n/a	8.53
Filling	7.88					9.46
Bursting Strength, PSI	106	n/a	n/a	n/a	n/a	132
Stiffness (Cantilever)						
Warp						
Weight per unit area, g/sqcm	0.0114	.01	.011	.012	.012	.0017
Bending Length, cm	7.00	11.3	11.0	10.2	12.1	2.59
Flexural Rigidity, G-Cm	3.92	14.3	14.2	12.7	21.5	.180014
Flexural Rigidity, lbs-in	0.0035	.013	.013	.012	.019	.00101
Filling						
Weight per unit area, g/sqcm	0.0107	.01	.011	.012	.012	.0114
Bending Length, cm	5.08	8.32	7.96	7.92	9.84	2.15
Flexural Rigidity, G-CM	1.4	5.76	5.4	5.95	11.6	.0972
Flexural Rigidity, lbs-in	0.0013	.005	.005	.005	.011	.00054
Abrasion Strength Loss, % (After 10 min @ 125 cycles/min)						
Warp	49.3	14.2	n/a	n/a	n/a	25.06
Filling	21.4	76.3				38.58

TABLE 9
SUMMARY OF CLASS II FINISHED FABRICS

PROPERTY	B	C	D	E	F	G	H	I	J	O	P	Q
Weight, oz/yd^2												
Average	6.5	6.39	6.61	7.11	7.85	7.68	6.66	6.95	6.91	6.5	6.41	6.4
% CV	1.74	1.47	1.05	1.42	7.27	4.15	.25	1.56	1.21	1.03	1.28	1.32
Construction												
Ends Per Inch-Avg.	40	40	40	40	40	40	39	39	39	39	39	38
% CV	1.11	1.77	1.11	1.38	1.77	1.77	1.14	1.14	2.13	1.15	0	0
Picks per inch-Avg	35	36	35	36	36	38	35	35	35	35	36	36
% CV	2.38	1.25	0	1.25	1.96	1.86	2.38	1.55	1.27	1.55	1.54	1.25
Breaking Strength, lbs												
Warp-Average	174	215	176	183	178	182	192	181	114	142.6	173.2	168.8
% CV	6.45	3.24	4.47	3.64	6.09	4.12	4.57	3.56	6.23	5.9	6.81	5.1
Filling-Average	142	183	172	170	154	152	158	143	92.2	118	90.8	126
% CV	5	3.08	3.13	2.73	5.01	12.96	12.5	5.32	9.63	10.1	33.8	10.5
Elongation, %												
Warp-Average	15.4	14.3	18.8	16.4	14.0	14.5	13.3	17.7	19.9	15	13.7	14.6
% CV	8.53	7.01	3.4	4.65	9.99	5.12	8.62	7.37	14.1	3.6	6.44	5.1
Filling-Average	26.1	18.5	28.8	27.5	35.4	35.8	23.7	30	31.1	27.1	20.8	20.4
% CV	4.67	2.42	3.36	5.94	9.29	4.91	7.9	6.63	4.44	5.4	3.4	2.4
Tear Strength, lbs												
Warp	25.6	18.9	19.1	15.1	.836	1.9	2.36	2.04	20.8	N/A	21.4	25.6
Filling	25.8	21.9	21.1	18	1.85	1.84	2.35	2.12	21.3		19.1	25.0
Bursting Strength, PSI	258	282	244	260	230	214	300	252	271	N/A	273	294
Stiffness (Cantilever)												
Warp												
Weight per unit area, g/sqcm	.022	.022	.023	.025	.028	.029	.024	.023	.023	.023	.022	.023
Bending Length, cm	7.47	7.46	8.29	8.17	16.9	15.6	16.2	12.7	13.2	15.7	15.5	16.1
Flexural Rigidity, G-Cm	9.06	8.97	12.8	13.5	135	109	99.8	47.2	52.8	89.6	80.3	94.4
Flexural Rigidity, lbs-in	.008	.008	.012	.012	.121	.098	.09	.043	.048	.081	.072	.085
Filling												
Weight per unit area, g/sqcm	.021	.021	.022	.024	.027	.027	.023	.022	.023	.024	.022	.023
Bending Length, cm	7.56	6.92	7.52	7.62	11.7	11.5	12.8	11.1	11.3	13.6	14.1	14.1
Flexural Rigidity, G-Cm	9.11	6.99	9.39	10.6	42.4	40	48.5	30.2	33	59.6	62.1	63.9
Flexural Rigidity, lbs-in	.008	.006	.009	.01	.038	.036	.044	.027	.03	.054	.056	.058
Abrasion Strength Loss, % (After 10 min @ 125 cycles/min)												
Warp	18.1	40.5	20.1	21.2	11.24	14.07	7.08	23.09	0	N/A	9.81	4.74
Filling	23	27.7	22.7	22	51.69	43.82	0	29.79	30.59		0	2.89