

SINGLE JERSEY PAD BATCH DYEING

A report of the processing carried out at Corah plc
during March 1988

AUTHOR: ROBERT D. LEAH
DATE: APRIL 1988
CLASSIFICATION: FABRICS/KNITTED/PROCESSING
KEY WORDS: SINGLE JERSEY, PAD BATCH, BLEACHING, DYEING, FINISHING

C O N T E N T S

1. INTRODUCTION
2. FABRICS
3. FABRIC PREPARATION AND ASSEMBLY
4. PRETREATMENT
5. PAD BATCH BLEACHING
6. DRYING AND SAMPLING
7. PAD BATCH DYEING
8. FINISHING
9. CONCLUSIONS

A P P E N D I C E S

- | | |
|---------|---------------------------|
| Table 1 | List of fabric qualities |
| Table 2 | Grey test data |
| Table 3 | Some process measurements |

INTRODUCTION

The pad batch dyeing technique has been used by the woven cotton dyeing industry for about 25 years. It is a technique which offers a number of distinct advantages but which also requires a big commitment by the company since special equipment is required for it to be carried out successfully. This equipment can be very costly not only in terms of the actual padding machine itself but also in the provision of storage beams and all the associated washing stations which require extensive services.

The pad batch procedure is very efficient in terms of dyestuff usage and energy. In effect, the liquor ratio is reduced from the typical levels of 20/1 for winch and 8/1 for jet down to 1.3/1. Also, because the fabric is dyed in the opened form rather than rope form the risk of patchy or uneven dyeing is reduced.

It is rather surprising therefore that it has taken so long for the knitgoods dyeing and finishing industry to show interest in this particular technique.

The availability of equipment for pad batch dyeing of knitted fabrics was highlighted at ITMA 84 in Milan but the then available equipment was largely for the dyeing of tubular fabric and the risk of problems of edge creasing was a major concern. For this reason, the pad batch dyeing operation did not really become commercial in the UK until equipment for open-width pad batch dyeing became available.

At the present time the following UK companies are known to be processing large quantities of knitted cotton fabrics by the open-width pad batch route:

Textured Jersey Limited
Loughborough Dyeworks Limited
Corah plc

During the past three or so years we have debated internally whether we should investigate the pad batch dyeing route to the extent that it could be included as an established option in the STARFISH model. The reason why the debate has gone on for so long is that there is not a single universal pad-batch dyeing route.

An essential requirement for pad-batch dyeing is a good fabric preparation and this is where the differences occur, Winches, jets or continuous rope preparation ranges are used for the preparation stage but the logical trend is to use the pad batch machine itself for the preparation stage so that the advantage of improved fabric surface appearance is not lost.

Here again, major variation is possible. Some companies give a cold pad-batch bleaching treatment over extended time periods whilst others are using

hot recirculated liquors for shorter periods of time. Obviously, between these two extremes the concentration of preparation chemicals used will be very different.

So, on numerous occasions, the question was asked:

"Should we investigate pad-batch dyeing and if so, which route should we use?".

The answer to this question was never really resolved although at one stage we almost started a case study on a standard fabric quality being processed by Loughborough Dyeworks. This never materialised because the particular contract on which the case study should have been carried out was not obtained.

Within the last six months however, Corah plc have expressed a serious interest in the purchase of STARFISH and have indicated that it would be of considerable interest to them if a pad-batch route option was available. Given this incentive it was agreed that with the co-operation of Corah, the pad-batch route, using the Corah procedure should be studied.

This report is a record of the planning and processing stages of this project.

FABRICS

Since the Norwegian Textile Institute (NTI) decided not to continue with the liquid ammonia project the fabrics which were contract knitted by TRD for that project have been held in stock and subsequently became the property of IIC. The knitting of these fabrics is described in Research Record No. 165.

This set of fabrics was knitted on a 24 gauge machine and it was subsequently augmented by the knitting of a further 13 qualities using both 18 and 28 gauge machines. This additional knitting is described in Research Record No. 209.

In effect, three complete sets became available to TRD since the original NTI contract called for three pieces of each quality to be knitted.

One of these sets was used in August 1986 for a winch bleaching/dyeing exercise at Martins (Leicester) Limited which was designated SJ86. The dyeing and finishing operations are described in Research Record No. 219. For this current pad-batch study it was decided that we should use a second set of SJ86 fabrics.

Discussions with Corah about the proposed project highlighted the fact that for some of their single jersey qualities they in fact use rotor spun yarns. The SJ86 fabrics however were made entirely from ring spun yarns both carded and combed.

Once agreement in principle to carry out the pad-batch study had been obtained, Corah undertook to knit a further six qualities using rotor spun yarns. These additional qualities consisted of:

1/30's rotor spun yarns knitted to stitch lengths of 0.270 cms, 0.284 cms, and 0.298 cms.

1/34's rotor spun yarns knitted to stitch lengths of 0.264 cms, 0.277 cms, and 0.290 cms.

All these qualities were knitted on a 28 gauge machine.

The total number of qualities available for the pad-batch study was therefore 39. The full list of fabric qualities is given in Table 1. The usual fabric marking code applies, viz:

Gauge/Yarn count/stitch length

Additional coding letters indicate the following:

CD = carded yarns

R = rotor spun yarns (Corah knitted)

For ease of identification and retrieval of the test data each fabric quality was given a simple key number in the range 1-39. Qualities 1-33 consisted of IIC knitted fabrics and qualities 34-39 consisted of the Corah knitted rotor spun fabrics.

Testing of the IIC greigestate knitted fabric and also of the yarn from which it was knitted has been documented already, and is also on computer file.

Greige test data is given for convenience in Table 2.

Representative samples of the Corah greigestate fabrics and yarns were collected and were submitted for full laboratory evaluation. These results, when available, will be appended onto the SJ86 greige test results.

FABRIC PREPARATION AND ASSEMBLY

The total batch weight of the IIC knitted fabrics (pieces 1-33) was approximately 550kg. The addition of the rotorspun fabric raised this to approximately 620kg which is excessive for a single pad-batch dyeing. A typical dyelot consists of 400-450kg of fabric which gives a batch with acceptable porosity and negligible risk of beam collapse.

To reduce the batch size therefore the length of the IIC fabrics was reduced from 75 metres to 50 metres which had the overall effect of reducing batch weight to 430kg.

The complete wet processing operation by the pad-batch route as operated by Corah is carried out entirely in the slit open-width form and as a consequence the first operation was that of slitting and batch assembly.

STARFISH was used to obtain tentative finishing targets of course density and finished width for each of the 39 qualities. For the purposes of assembly the jet dyeing route was used and target shrinkage values of 8% length and 8% width selected. From the width targets obtained qualities were grouped together in bands to give a total of 5 widths over the 39 qualities.

The fabric rolls were flapped and circular sewn using a flat seam stitch. They were slit on a Calator slitter equipped with a Calator low-tension batching unit in the order of narrow to wide. This was to ensure that when the fabrics were pad batched the widest fabrics were towards the inside of the perforated beam.

PRETREATMENT

Corah have successfully developed a pretreatment technique which substantially reduces the time of pretreatment and gives, they claim, a very good base for pad-batch dyeing.

The pad-batch process whether pre-bleaching or dyeing itself normally consists of the application of a solution of chemicals on the pad mangle, rolling onto a beam, slowly rotating at room temperature for several hours and finally continuous flow washing on the beam.

The usual cold pad-batch peroxide operation which gives a reasonable degree of preparation and which is operated by at least 2 UK companies involves a 24 hour reaction time.

The Corah technique consists of recirculating a hot bleaching liquor (95°C) through the batch for three hours followed by the continuous rinsing operation. The introduction of this technique has necessitated the construction of a separate preparation station with storage tanks and facilities for three beams to be treated simultaneously.

Since the pretreatment stage and the pad dyeing stage are two completely separate operations with an intermediate drying, this gave the opportunity to effectively carry out two studies in one.

By sampling all the qualities after pretreatment and also after dyeing/finishing we should be able to determine whether the equations for a pad batch bleaching only operation are the same or substantially different than for a pad batch dyeing operation.

PAD BATCH BLEACHING

The pad batch equipment installed at Corah is manufactured by Beatech and is essentially a vertical 2-bowl padding mangle over a low volume padding trough. It is equipped with driven scrolls and edge uncurlers (Tandematic) and has a surface driven batching unit. It is also equipped with liquor level detectors and independent dye and alkali dosing pumps.

When the hot recirculation preparation sequence is being carried out, the unit is simply used to place the fabric on a perforated beam.

The trial fabrics were padded in the order wide to narrow through a solution of wetting agent (1.25g/l MATEXIL WNPB) and batched onto a perforated beam. Although it is virtually impossible to take meaningful measurements of width and course density during such an operation we attempted to determine whether anything useful could be determined by closely observing the operation.

The main conclusions drawn were that fabrics with longer stitch lengths tended to lose more width during the operation and this appeared to be independent of yarn count. This loss of width is probably also associated with greater fabric elongation during the padding operation.

The other major observation was that fabrics made from rotor yarns tended to be wider after wet padding than the corresponding fabrics made from ring spun yarns.

The next stage was the bleaching operation and the perforated beam assembly with integral catch tray was connected to the services at the preparation station. The hot bleaching liquor is pumped into the centre of the perforated beam where it then percolates through the fabric mass and is collected in the catch tray. It is then returned to the storage vessel, reheated and recirculated.

The beam is continuously rotated throughout this operation to prevent channelling of the bleach liquor.

The bleach formulation and procedure is as follows:-

- 6.0g/l BAYSTABIL (Bayer - Stabiliser)
- 0.5g/l TRILON A (BASF - Sequestering agent)
- 10g/l CAUSTIC SODA LIQ. (70° tw 32% w/w)
- 25g/l HYDROGEN PEROXIDE (35%)
- 2g/l DIADAVIN (Bayer - Detergent)
- 1.25g/l MATEXIL WNPB (ICI - wetting agent)

Recirculate 180 mins at 95°C.

Transfer to washing station and flow wash:

60 mins - hot
20 mins - cold

followed by airblow to reduce water content.

The above formulation and procedure is to be treated as HIGHLY CONFIDENTIAL.

Following the airblow the beam is disconnected from the services and the fabric further dewatered by passing through a KUSTER water mangle. A number of width measurements were obtained at this stage. These are given in Table 3.

Prior to the pad batch dyeing operation, it is usual to dry the fabric on the KIEFER "Rotoswing" drying machine

DRYING AND SAMPLING

This operation gave us a very good opportunity to observe how single jersey fabrics behave when open-width dried on a Kiefer rotoswing dryer. To prevent back tension the fabric batch was kept rotating by manual control. The fabric was overfed onto the lower carrier band in the ratio of 1.8:1. Fabric leaving the conveyor was still considerably pleated indicating that it was in a completely relaxed state throughout the whole of the drying operation.

Measurements of course density and width were made on a number of qualities both before and after the drying operation. The data is given in Table 3. This indicated that:-

- considerable length reduction was being obtained
- generally fabric width increased slightly.

It was also observed that fabric edge curling was not a major problem. Whether this is indicative of the flat setting effect of a pad batch wet processing treatment is open to speculation.

Following the drying operation the whole of the fabric was run over the plaiter of a raising machine to facilitate sampling.

Samples (7 metres) were removed from each of the 39 qualities by breaking alternate seams, sampling and resewing. The samples were returned to TRD for full testing.

PAD-BATCH DYEING

In order to make the counting of courses less demanding for the lab staff and also to keep costs to a minimum it was decided to dye the fabric to a pale bright pink colour. In pad-batch dyeing it is essential that the

Dyestuffs and alkali are mixed just prior to padding and this is achieved by using two separate dosing tanks each controlled independently by sensors and metering pumps. The ratio of the dosing is controlled by regulating the speed of the dosing pumps. The ratio of the two additions was approximately 2½:1. (Dyestuff pump 2000 rpm, Alkali pump 800 rpm).

The formulations for the dyestuff and alkali were as follows:-

CIBACRON RED FB	1.3g/l	
LEVAFIX YELLOW E2RA	0.0255g/l	
MATEXIL PAL	2.0g/l	
CAUSTIC SODA	20g/l	70*tw
SODIUM SILICATE	200g/l	(Q79 grade)

Temperature of mixture 25°C

Mangle pressure 250kPa
Wet pick-up 120-130%
Machine speed 40m/minute

This information is to be treated as HIGHLY CONFIDENTIAL.

When all the fabric had been padded with dyestuff and batched on a perforated beam, the beam was transferred to a turning station, covered with polythene film and rotated for 6 hours.

After the reaction time the beam was connected to the services and washing commenced as follows:

Cold water	20 gallons/minute for 120 minutes
Hot wash (95°C)	20 gallons/minute for 120 minutes
Cold wash	20 gallons/minute for 120 minutes

After washing the beam was air blown to remove excess liquor and extracted on the Kuster water mangle.

FINISHING

The final finishing operation was carried out on a gas fired 5-bay Artos stenter equipped with a Hall and Boydon pad mangle.

Corah's usual softening formulation for pad-batch dyed fabric was used. This consists of:-

RUCOFIN GNA (silicone softener)	800g
BRADSYN G (polyethylene emulsion)	20,000g
DYTET BN20 (wetting agent)	320g

	2,000 litres

The fabric was padded and dried with approximately 15% overfeed and width was altered in steps. In the majority of cases, target width was achieved and all qualities were processed remarkably easily bearing in mind the wide range of qualities being handled.

At the exit end of the stenter fabrics were rolled onto cardboard tubes and a fabric accumulator enabled the individual qualities to be separated at this stage without having to stop the stenter at each sewing.

The fabrics were returned to TRD for systematic sampling and testing.

CONCLUSIONS

The operations of pad batch bleaching and dyeing described in this report which were carried out on the 39 single jersey qualities were completely representative of the Corah pad-batch procedure. The final finishing stage could not be optimised for each individual quality however, and therefore fabric performance for any quality shall not be taken as being indicative of what might be achieved in production. However, because nothing was done which was outside the scope of normal production procedures, the reference state dimensions of all the qualities should be representative of what would be obtained in bulk production.

FABRIC QUALITIES

TABLE 1

LAB. REF. N°	QUALITIES	LAB REF. N°	QUALITIES
1	18/18/327	20	24/28 G / 321
2	24/32/276	21	24/32 / 337
3	28/50/230	22	28/38 / 273
4	18/18/344	23	24/24 / 321
5	24/32/291	24	24/28 / 337
6	28/50/243	25	24/28 G / 337
7	18/18/362	26	28/38 / 287
8	24/28/291	27	24/24 / 337
9	28/38/246	28	24/28 / 354
10	24/32/306	29	24/28 G / 354
11	18/18/380	30	28/38 / 301
12	24/28/306	31	24/24 / 354
13	24/28 G / 306	32	24/28 G / 372
14	28/50/267	33	24/24 / 372
15	24/32/321	34	28/30E / 270
16	28/38/259	35	28/30E / 284
17	24/24/306	36	28/30E / 298
18	18/18/399	37	28/34E / 264
19	24/28/321	38	28/34E / 277
		39	28/34E / 290

Key

Gauge / Yarn Count / STITCH LENGTH

G = (GATED) YARNS
 R = Rotor spun YARNS

GREY FABRIC TEST RESULTS TABLE 2

Lab Ref No. 1178

Project Name - Single Jersey 86 - Grey Fabrics

GREY	<u>LAB</u>	<u>REF</u>	1	2	3	4	5	6	7	8	9	10
			38/246	38/259	38/273	38/287	38/301	18/327	18/344	18/362	18/380	18/399
Length shrinkage, 5x			6.98	7.59	13.39	14.17	18.32	1.35	4.60	7.08	8.99	13.42
Width shrinkage, 5x			27.35	24.30	19.11	17.39	14.04	29.40	25.00	21.17	14.92	15.06
Weight (gsm)BW			107.64	105.78	102.50	97.40	89.34	176.89	175.44	168.39	166.55	154.70
Weight (gsm)AW			152.42	147.29	140.51	137.18	129.97	237.75	225.35	217.18	210.96	204.83
Courses per 3cm BW			67.30	61.40	55.90	51.60	48.09	55.00	50.60	47.10	42.70	39.00
Courses per 3cm AW			70.40	66.50	61.90	58.40	55.60	55.50	52.50	49.50	47.00	45.10
Wales per 3cm BW			37.80	38.10	39.30	39.20	38.90	27.20	27.60	27.60	29.30	28.50
Wales per 3cm AW			52.90	51.40	50.50	49.10	47.86	38.50	37.20	35.70	34.80	33.80
Stitch length (mm) BW			2.48	2.62	2.75	2.87	3.02	3.28	3.46	3.61	3.81	4.00
Stitch length (mm) AW			2.46	2.57	2.72	2.84	2.99	3.24	3.39	3.56	3.74	3.92
Burst strength, BW			510.20	481.20	417.30	431.10	390.90	809.00	764.00	738.40	776.60	756.00
Burst strength, AW			465.30	470.00	446.40	448.00	420.20	840.20	787.40	766.40	708.00	676.70
Distension at burst, BW			18.84	17.53	16.58	18.67	18.61	17.48	17.11	19.48	19.14	19.51
Distension at burst, AW			21.69	20.96	21.61	21.73	21.31	22.24	22.08	22.31	21.66	21.91
Angle of spirality, BW			8.25	7.86	11.26	14.07	14.00	2.56	3.85	7.33	10.31	11.06
Angle of spirality, AW			19.37	20.71	23.83	25.28	26.73	9.57	9.74	10.90	16.31	18.58
Width, BW			89.20	88.83	88.63	88.93	89.07	82.50	82.27	79.73	79.27	81.27
Yarn strength, BW			185.84	174.85	179.15	198.41	184.96	449.21	460.29	453.16	458.23	480.00
Yarn strength, AW			185.97	191.43	185.95	185.79	188.41	483.92	456.48	450.31	458.03	449.36
Yarn extension at break, BW			6.01	5.79	6.40	6.51	6.17	7.16	8.04	8.27	8.53	8.55
Yarn extension at break, AW			7.66	7.92	8.05	7.84	8.32	9.20	9.23	9.85	10.36	9.95
Yarn count (tex), BW			15.38	15.25	15.60	15.38	15.50	31.68	31.86	32.41	32.27	32.55
Yarn count (tex), AW			15.14	15.35	15.22	15.35	15.27	31.94	31.67	32.10	31.77	32.30
Thickness, BW			589.20	579.30	586.20	582.90	579.00	738.00	759.90	773.10	798.10	771.20
Thickness, AW			780.30	785.10	818.00	814.60	823.60	969.10	985.00	993.10	1065.70	1071.30
Turns per metre			962.00	1022.50	972.00	1006.50	997.50	717.50	693.00	664.00	686.00	679.50

Lab Ref No. 1178

Project Name - Single Jersey '86 - Grey Fabrics

	11	12	13	14	15	16	17	18	19	20
	24/306	24/321	24/337	24/354	24/372	28/291	28/306	28/321	28/337	28/354
Length shrinkage, 5x	17.19	19.36	23.18	27.01	27.64	17.48	19.27	22.69	23.73	26.96
Width shrinkage, 5x	17.23	13.55	9.74	5.82	2.16	20.46	17.78	14.97	12.91	7.82
Weight (gsm)BW	140.80	135.48	125.11	118.93	117.05	127.13	122.30	113.40	111.36	105.56
Weight (gsm)AW	195.17	187.23	180.10	169.80	168.08	182.04	176.05	170.64	164.37	156.62
Courses per 3cm BW	48.80	44.50	40.60	36.60	33.90	50.40	46.70	42.50	39.20	35.40
Courses per 3cm AW	58.30	55.10	51.80	49.40	47.60	60.80	57.90	53.90	51.20	48.60
Wales per 3cm BW	33.50	34.00	34.20	33.90	34.10	34.50	33.80	33.90	33.80	33.67
Wales per 3cm AW	41.20	40.30	39.30	37.97	36.80	43.50	42.40	41.70	39.90	38.50
Stitch length (mm) BW	3.09	3.24	3.39	3.56	3.74	2.94	3.09	3.23	3.40	3.57
Stitch length (mm) AW	3.05	3.19	3.38	3.51	3.68	2.92	3.04	3.19	3.36	3.52
Burst strength, BW	711.90	686.00	649.30	612.50	625.70	674.40	632.00	606.40	573.60	578.10
Burst strength, AW	697.30	667.60	621.90	605.40	585.60	668.20	622.40	594.10	580.90	515.00
Distension at burst, BW	16.82	17.35	16.95	16.12	16.46	16.19	16.52	16.78	16.07	17.30
Distension at burst, AW	23.20	21.80	23.65	21.61	21.80	21.37	21.40	21.76	21.64	21.59
Angle of spirality, BW	6.07	6.98	6.99	7.92	9.39	6.16	7.38	8.98	9.64	10.37
Angle of spirality, AW	11.29	12.30	14.21	17.17	20.11	18.24	19.48	21.89	23.73	25.34
Width, BW	82.97	83.40	82.43	82.47	83.73	81.60	81.67	82.25	82.70	81.83
Yarn strength, BW	335.31	302.60	321.29	322.55	321.96	307.95	311.41	302.77	309.84	307.32
Yarn strength, AW	341.51	340.40	322.89	326.57	331.92	304.93	292.17	279.88	296.24	285.29
Yarn extension at break, BW	7.47	6.86	7.21	7.39	7.42	6.78	7.43	6.94	7.43	7.22
Yarn extension at break, AW	8.86	8.72	8.72	8.88	9.15	7.44	7.67	7.69	8.10	7.89
Yarn count (tex), BW	24.66	25.23	24.92	25.37	24.68	21.96	21.89	22.07	22.22	21.87
Yarn count (tex), AW	24.02	24.43	24.39	24.47	24.45	21.45	21.57	21.74	21.85	21.46
Thickness, BW	580.30	585.20	580.70	581.10	586.70	560.90	561.30	559.30	564.30	553.20
Thickness, AW	845.00	876.70	881.00	895.40	918.20	813.40	825.70	849.50	864.40	868.10
Turns per metre	740.50	721.67	750.50	737.50	690.00	793.00	807.50	785.00	770.50	760.00

Lab Ref No. 1178

Project Name - Single Jersey '86 - Grey Fabrics

GREY	21	22	23	24	25	26	27	28	29	30
	32/276	32/291	32/306	32/321	32/337	28C306	28C321	28C337	28C354	28C372
Length shrinkage, 5x	17.65	22.26	21.62	24.11	27.48	18.81	23.69	24.85	27.71	29.51
Width shrinkage, 5x	24.56	15.69	17.42	14.91	18.54	15.58	12.08	10.84	5.94	2.12
Weight (gsm) BW	102.72	104.03	93.25	91.81	89.72	117.06	104.34	103.47	98.62	95.28
Weight (gsm) AW	157.97	152.69	146.07	141.97	135.13	160.70	154.26	148.39	140.15	134.60
Courses per 3cm BW	52.30	46.00	44.40	41.00	36.60	47.10	41.40	39.20	35.30	32.60
Courses per 3cm AW	62.60	58.60	56.00	52.70	50.60	56.90	53.90	50.90	48.50	45.67
Wales per 3cm BW	33.70	36.33	33.90	34.10	34.08	34.30	34.40	33.70	34.00	33.40
Wales per 3cm AW	46.10	44.70	43.30	42.23	41.38	40.90	39.80	38.50	36.30	35.95
Stitch length (mm) BW	2.80	2.94	3.07	3.22	3.40	3.00	3.23	3.39	3.57	3.74
Stitch length (mm) AW	2.77	2.90	3.04	3.18	3.35	3.04	3.20	3.36	3.54	3.70
Burst strength, BW	514.20	549.60	463.60	468.90	437.60	526.40	435.60	471.70	470.80	451.40
Burst strength, AW	581.10	550.70	507.90	488.10	457.30	522.00	455.00	481.30	431.10	437.30
Distension at burst, BW	16.58	15.95	17.11	16.44	16.53	15.58	15.94	18.20	16.41	15.62
Distension at burst, AW	22.21	22.04	21.54	22.04	21.83	21.10	21.64	21.28	21.74	21.47
Angle of spirality, BW	5.91	6.51	6.30	9.58	8.99	6.80	6.75	6.98	8.05	8.56
Angle of spirality, AW	17.70	17.71	19.37	24.52	26.84	18.88	20.79	22.66	25.06	27.44
Width, BW	80.63	73.40	80.40	81.43	81.93	81.30	81.33	84.67	83.47	84.50
Yarn strength, BW	237.65	232.37	223.61	233.67	227.72	228.83	252.87	252.32	225.07	247.55
Yarn strength, AW	227.59	227.28	230.60	235.00	231.45	224.53	245.47	245.21	233.34	235.14
Yarn extension at break, BW	7.63	7.36	7.40	7.45	7.91	5.91	6.48	6.43	6.22	6.63
Yarn extension at break, AW	6.92	7.46	8.00	8.63	9.44	7.33	7.99	7.97	7.86	7.85
Yarn count (tex), BW	18.02	18.22	18.64	18.54	18.36	21.16	21.09	21.23	21.41	21.02
Yarn count (tex), AW	18.11	18.08	18.12	18.10	17.93	20.56	20.75	20.61	20.49	20.82
Thickness, BW	512.30	515.20	519.00	530.90	512.00	584.10	564.40	566.00	564.10	555.40
Thickness, AW	806.40	816.00	823.90	843.00	855.20	857.20	867.30	883.40	898.00	914.20
Turns per metre	890.00	878.00	907.50	940.00	897.50	739.00	793.50	751.50	746.50	794.50

TABLE 2 CONT.

Lab Ref No. 1178

Project Name - Single Jersey '86 - Grey Fabrics

GREY

	31	32	33
	50/230	50/243	50/264
Length shrinkage, 5x	3.10	7.67	12.33
Width shrinkage, 5x	30.42	27.74	20.01
Weight (gsm) BW	89.70	87.50	82.04
Weight (gsm) AW	130.46	125.20	118.71
Courses per 3cm BW	75.00	67.90	58.90
Courses per 3cm AW	77.20	72.70	65.50
Wales per 3cm BW	39.60	39.00	42.30
Wales per 3cm AW	50.10	56.50	54.50
Stitch length (mm) BW	2.34	2.45	2.65
Stitch length (mm) AW	2.30	2.41	2.62
Burst strength, BW	376.20	373.60	356.00
Burst strength, AW	403.00	422.40	304.10
Distension at burst, BW	17.00	21.06	19.40
Distension at burst, AW	22.25	21.90	22.67
Angle of spirality, BW	13.50	16.11	20.03
Angle of spirality, AW	22.29	23.02	20.00
Width, BW	87.90	87.27	86.37
Yarn strength, BW	152.63	147.07	149.25
Yarn strength, AW	143.73	133.02	145.19
Yarn extension at break, BW	7.40	6.77	7.12
Yarn extension at break, AW	7.41	7.11	7.15
Yarn count (tex), BW	11.66	11.86	11.73
Yarn count (tex), AW	11.64	11.48	11.44
Thickness, BW	546.40	554.20	552.90
Thickness, AW	708.20	737.40	730.90
Turns per metre	1192.00	1103.50	1104.50

LAB REF N°	PROCESS SEQUENCE N°	QUALITY	TARGETS C/3 WIDTH	WIDTH BEFORE KUSTER EXTRACTION	C/3 BEFORE KIEFER DRYER	C/3 AFTER KIEFER DRYER	WIDTH BEFORE KIEFER DRYER	WIDTH AFTER KIEFER DRYER
17	17				42	46		134
21	21	24/22/337	44 152	123				
22	22	28/38/273	56 152	126				
37	221C	28/34R/264	59 154	138				
38	222C	28/34R/277	55 160	132				
34	223C	28/30R/270	58 160	138				
23	23	24/24/321	49 160	135	36/37	41		135
24	24	24/28/337	45 160	132				
25	25	24/28S/337	45 160	132				
26	26	28/38/267	53 160	134				
27	27	24/24/337	44 160	137	35/36	40		150
28	28	24/28/354	42 160	131				
39	281C	28/34R/290	53 165	137				
35	282C	28/30C/284	55 165	144				
29	29	24/28S/354	42 168	136	29/30	34/35		137
30	30	28/38/301	49 168	134	36	41		147
31	31	24/24/354	43 168	139	31/32	36		144
32	32	24/128S/322	39 168	138		31		144
33	33	24/24/372	41 168	141		32		142
36	33C	28/30R/277	52 170	143				