

The Development of a Low-Shrink Cotton Lacoste Fabric for
Fred Perry Sportswear (UK) Limited

Final report of the project carried out during the period
March-October 1989

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INTRODUCTION

In February of this year, IIC was invited to attend a meeting held at the offices of Westertex (Loughborough) Limited to discuss the performance requirements of the standard Fred Perry lacoste fabric.

At this meeting which had been arranged at the suggestion of Westertex, were representatives of Fred Perry Sportswear (UK) Limited, Kingsly Knight Limited (knitters), Derbyshire Textiles Limited (garment makers-up), Westertex (Loughborough) Limited (dyers and finishers) and IIC.

The purpose of the meeting was to discuss the improvement in fabric and garment performance with a view to Fred Perry Sportswear (UK) Limited supplying the American market.

The distinctive and well-known Fred Perry fabric has been manufactured and processed with little change in the UK for many years and has been produced both for the home market and for export.

Fred Perry shirts on sale in the USA have been almost entirely manufactured in the USA but recent events have led to Fred Perry Sportswear (UK) Limited being offered the chance to supply the American market.

The performance of the UK-produced fabric and garments, particularly in respect of dimensional stability is currently not acceptable to the American market place in view of the predominance in the USA of the domestic tumble dryer.

In order to secure the American contract there was a need for the performance to be considerably improved and it was in this context that IIC was invited to the meeting to determine whether we could make a contribution in this respect.

2. BACKGROUND

To meet demand, the UK production of the Fred Perry sportshirt is undertaken by a number of garment manufacturers who in turn use fabric knitted by several knitting companies. The dyeing and finishing is also carried out by several companies on a commission basis.

The present fabric which has largely remained unchanged for many years is produced on 18 gauge single jersey machines from 1/16's Ne combed yarns knitted to a stitch length of 0.393 cm.

The Fred Perry lacoste structure consists of:

1. xxxxxx - feeder 1, all knit
2. .x.x.x - feeder 2, tuck/knit
3. xxxxxx - feeder 3, all knit
4. x.x.x. - feeder 4, knit/tuck

The fabric is finished to an approximate width of 36-37" and a cell density of 13/14 per 3cm (one cell corresponds to four courses). This gives average finished weights of approximately 210 gsm (whites) to 220 gsm (deeps).

Typically, fabric shrinkage performance has been in the range 14-19% length, 2-5% width when tested to a test procedure based on tumble drying.

To overcome this difficulty, the garments have been labelled with laundering instructions which specify line or flat drying and have tended to be cut generously to make some allowance for this potential for shrinkage.

Commercial pressures in respect of maintaining fabric weight and width have largely predominated, with the result that the finisher has had little incentive or indeed scope to improve shrinkage performance. In order to improve the shrinkage performance, the finisher would need to deliver the fabric with a higher area weight which would result in fewer garments being produced from a given length of fabric.

In order to maintain fabric weight and width whilst at the same time improving shrinkage performance necessitates a change in the basic fabric construction.

IIC through its work in connection with the STARFISH project has considerable experience and expertise in this area and for this reason was invited to participate in the February meeting.

The outcome was that IIC was invited to submit a plan of work with the aim of re-engineering the Fred Perry lacoste fabric so that it can be finished to lower levels of residual shrinkage whilst maintaining the desired weight and width.

3. PLAN OUTLINE

There are two main knitting parameters which have a direct influence on the relationship between finished fabric weight and shrinkage performance. These are the count of yarn used and the tightness of the knitting. As well as the two properties mentioned, they also have an influence on width, appearance, spirality and the ability of the dyer/finisher to physically produce a dimensionally stable fabric.

The proposed plan outlined the production of a range of fabric qualities where the yarn count and tightness of knitting was systematically changed. These were to be dyed and finished through the best available finishing procedures and finally evaluated to determine whether any of the new qualities would meet the requirements of weight width, appearance and shrinkage performance.

The retention of appearance is of considerable importance since it is recognised that the distinctive "diamond" effect gives the Fred Perry shirt a clear advantage over competition and must be maintained.

Regarding garment dimensional stability, the original requirement voiced at the February meeting was for maximum shrinkage of 4% in both length and width to a tumble dry shrinkage test. These figures apparently originated in the USA.

A subsequent evaluation of competitive garments purchased in the USA showed this to be unrealistic and IIC suggested that the target should be to produce FABRIC with maximum shrinkage values of 8% x 8% to a single-cycle tumble dry test.

Garment shrinkage should then be slightly lower than this and in IIC's considered view would be entirely satisfactory. In fact, it was pointed out that there was a risk of producing too low a residual shrinkage for two main reasons:

1. the fabric could lose some of its properties due to the risk of bagging and lack of snap-back,
2. a low shrinkage to a tumble dry test could, under different laundering conditions, become an extension, resulting in the garment getting bigger.

On the basis of the project proposal, IIC was awarded a contract to plan and oversee a project with the aim of producing an alternative fabric construction and to establish a specification for the new fabric which could be issued to all the suppliers.

4. FABRIC KNITTING

The knitting plan and the knitting operations are described in an IIC internal report which is given as Appendix 1.

5. WET-PROCESSING AND FINISHING OPERATIONS

At the outset it is worth stating that the standard Fred Perry fabric is recognised within the trade as being an extremely difficult fabric to process from a number of different standpoints. One of these is the difficulty encountered when trying to consolidate the fabric structure which is essential in order to obtain low residual shrinkage. Even when processed on equipment which will produce low residual shrinkage on other fabric constructions, such as plain single jersey, 1 x 1 rib or interlock, the lacoste structure shows some resistance to consolidation.

This phenomena is also apparent when trying to assess shrinkage. Unlike some structures, it takes quite a number of cycles of washing/tumble drying for the lacoste fabric to attain its Reference State (state of minimum internal energy).

Westertex (Loughborough) Limited are the major dyer/finisher in the UK of the Fred Perry fabric. Although they are probably as well equipped as any company in the UK to process the fabric they were aware that better equipment and techniques were available and made a commitment to re-equip with whatever machinery was required to enable them to obtain the best possible fabric performance and appearance.

Discussions between Westertex and IIC revealed that both parties had similar views on how the problem should be tackled even though, at this time, the necessary equipment was not available in the UK.

Westertex, with the backing of IIC, proposed that the fifteen trial qualities should be part processed at Westertex on what was considered to be perfectly adequate equipment but that additional processing should be carried out at the factory in Germany which was equipped with the latest state of the art machinery.

The reason for this was two-fold. Firstly, the best possible result would be obtained and secondly, since Westertex could be involved in considerable capital expenditure, they wanted to ensure that the right equipment was being considered.

Fred Perry agreed to the proposal and plans were drawn up to process the fifteen trial pieces of fabric.

IIC has considerable experience in carrying out trials on multi-quality batches where finishing targets are not available to the dyer/finisher. Using test data obtained from the greige fabrics, provisional processing information was determined which enabled the fifteen different qualities to be processed in a logical and manageable sequence.

The sixteen trial pieces (one piece of standard fabric included) were winch bleached and part processed at Westertex under the supervision of IIC personnel. In-process measurements were recorded at all stages and every operation was observed in order to determine the effect on the fabric dimensions of each individual processing stage.

During the additional processing at the factory in Germany, IIC personnel were also present and supervised the operation to ensure that the fabrics were optimally finished.

The only operation which could not be carried out in Germany was the final calendering and this was carried out on the Weiss calender at Westertex.

Representative samples were then removed from the sixteen fabrics and submitted to the IIC laboratory for full testing.

The compressive shrinking process also known as compacting is a technique which can also be used to consolidate the fabric structure.

To complete the evaluation it was considered essential to at least carry out a cursory investigation of the process to determine whether the technique was a viable alternative to the one already carried out.

IIC obtained the co-operation of Meridian Dyers who operate such a machine, to carry out compaction trials on part of each of the sixteen trial fabrics.

These trials again were carried out under IIC supervision and compacted samples were submitted to the IIC laboratory for full evaluation.

6. COMMENTS AND OBSERVATIONS

1. All of the fifteen new qualities can be knitted satisfactorily under commercial conditions with very low fault rates.
2. The part-processing carried out at Westertex highlighted the need for additional processing if the target shrinkage performance levels were to be achieved.
3. The additional processing carried out in Germany demonstrated that the target performance levels could be achieved on many of the fifteen variants.
4. Some of the improvements achieved by the additional processing in Germany were eroded once the fabrics were calendered on a standard calendering machine. Although this was expected to some degree, the actual loss of courses (length stretching) was considerably worse than had been feared and highlighted the criticality of the calendering operation.

5. Although compaction enabled target performance levels to be achieved, this was at the expense of fabric appearance and handle which was considered to be unacceptable by the marketing people.
6. Evaluation of the test data showed that although target performance had not been achieved with any of the trial fabrics (except the compacted samples) the shrinkage performance figures were considerably better than anything produced before in the UK and gave grounds for considerable optimism that the adopted approach was correct and that the desired shrinkage targets were achievable.
7. A clear indication was obtained that fabrics with the longer stitch lengths gave the worse performance and that this should be given serious consideration when appraisal of the fabrics was being made.

7. FABRIC SELECTION

At a meeting held at the Fred Perry head office in July, swatches of the fifteen new qualities were shown for evaluation together with the relevant test data.

Table 1 gives the test results of the fabrics processed at Westertex and in Germany and Table 2 of the fabrics which were additionally compacted at Meridian. Table 3 gives the projections which should be achieved if the performance targets of 8% length and 8% width to a single cycle tumble dry test was attained.

At the meeting, three possible contenders were selected as being possibilities on which further trials should be carried out. All of the other qualities were rejected on the grounds of being too heavy or through unacceptable appearance.

The three contenders were:

Quality 1 Yarn 1/20's Ne SL 0.306 cm

Projected weight - 221 gsm
Projected width - 80.2 cms

Quality 2 Yarn 1/20's Ne SL 0.323 cms

Projected weight - 214 gsm
Projected width - 82.4

Quality 9 Yarn 1/18's Ne SL 0.355 cms

Projected weight - 218 gsm
Projected width - 89.8

At the meeting it was decided that trial garments should be made up from the three qualities in order to obtain a better assessment.

These were made up at the Fred Perry Leicester factory and sample garments were tested for shrinkage performance by the Westertex laboratory. Their report is given as Appendix 2.

On the basis of the trials carried out in Germany, Westertex placed firm orders for a number of pieces of new equipment and planned that these would be

installed and commissioned in time for the second phase of the exercise. This phase was to have been the knitting and processing of larger quantities of the three chosen quantities.

Commercial pressures associated with the lead time required to ensure that garments were in the shops in the USA by January 1st 1990 dictated that the second phase of development had to be amended.

Marketing staff in conjunction with colleagues in the USA were forced to make a decision regarding which fabric would be used for the USA launch.

The fabric chosen was quality 9 which was made from 1/18's Ne yarn knitted to a stitch length of 0.355 cms. The main reason for this choice was that this quality was considered to be the best in terms of retention of fabric appearance.

It must be stated however that this decision was taken against the advice of IIC who pointed out that the relatively long stitch length would mean that the finisher could have difficulty in achieving performance consistently.

Arrangements were made to knit 600kg of quality 9 and this was commenced on September 5th 1989 when IIC staff visited Kinglsey Knight and supervised the adjustments to the knitting machine to ensure that the fabric being produced was within the specified tolerances.

8. BULK PROCESSING

The 600kg of quality 9 was dyed to three shades during the week commencing Monday 18th September. the processing was carried out on the new equipment and was observed by IIC personnel, measurements being taken at key stages in the processing sequence.

Targets calculated from the processing of the initial sixteen trial pieces were used to optimise machine conditions. Considering that the machinery had only just been commissioned and that the expected teething problems did indeed occur, the fabric was nevertheless processed very satisfactorily and in general, targets were achieved.

The final calendering operation was carried out in Switzerland on a limited quantity of each shade. This was done on one of the latest available machines and again an IIC staff member was present. This trial was carried out to enable Westertex to take a decision on whether to purchase one of these machines since the earlier trials had highlighted the criticality of the calendering stage. On the basis of these trials which confirmed that the fabrics could be calendered without losing courses, Westertex duly ordered a machine.

9. SPECIFICATIONS

On the basis of the work described in this report a provisional specification is proposed for the new fabric. This may have to be amended once the fabric is in full production and more experience and feed-back is available.

Basic Construction

The fabric is a four-feeder repeat pattern.

Feeder 1 xxxxxx All Knit
Feeder 2 x.x.x. Knit and Tuck
Feeder 3 xxxxxx All Knit
Feeder 4 .x.x.x Tuck and Knit

Yarns: 100% combed cotton
Count: Singles 18'scc \pm 2.5%
Twist Factor: $3.8 \pm 5\%$ (633 turns per metre) "Z" twist
Single-end strength - average 15g/Tex (minimum 13g/Tex)
Spliced and waxed on cone.

Knitting

Machine: 18 gauge
Stitch length: $0.355\text{cm} \pm 1.5\%$
Knitting tension: 3-5g

Details to be recorded on piece ticket:

- machine number
- number of needles

Finished Fabric

Courses - 16.5-17 repeats/3cm (66-68 courses/3cm)
Wales: 25-26/3cm
Width: for 1500 needle machine. 87-90cms (34.25"-35.5")
Weight: 210gsm $\pm 5\%$ (whites & pales) - 225gsm $\pm 5\%$ (deeps)
(conditioned)

Shrinkage: (60°C wash followed by a 90 min tumble dry)
Average 8% length 8% width

10 RECOMMENDATIONS

Throughout this fabric development exercise, all knitting and finishing operation were carried out under the direct supervision of IIC personnel.

Under careful scrutiny such as this, the objective has been achieved and a new fabric specification has been written. Under commercial conditions the new quality will be manufactured by more than one supplier. This will involve the use of yarn from different spinners, the use of different knitting machines and also different finishing equipment. This will inevitably result in increased variability which if not minimised could result in serious quality variations.

Although some variability is inevitable and unavoidable it can be contained if adequate quality control procedures are instigated.

We would therefore recommend that:

- yarn supplies should be monitored for at the very least count variation,
- stitch length should be regularly monitored on the knitting machine and occasionally by extraction of yarn from the fabric. The use of an electric instrument such as a Welmstar run-in meter would enable the

machines to be set accurately and to be monitored on a regular basis to ensure that they remain set on quality over long periods of time.

- finished fabric should be checked at the making-up factory prior to laying and cutting for area weight, cell density and width. This is in addition to the testing which should have been carried out by the dyer/finisher before delivery.

The purpose of this exercise has been to produce garments which will perform satisfactorily to a relatively severe laundering procedure.

The operations described in this report have been essentially aimed at ensuring that the performance and specification of the fabric is correct.

Garment performance however is also largely determined by what subsequently happens in the garment manufacturing operations. Because the fabric has been essentially pre-shrunk and is in a relatively relaxed state it is also very sensitive to tensions which may be applied during making-up.

It is therefore recommended that a critical look be taken at the existing making-up procedures to determine whether any operation is having the effect of stretching fabric in either length or width (air blowing or pressure etc).

Once this has been done and procedures possibly amended to minimise fabric distortion it is further recommended that a specification be made relating to course (cell) and wale densities of the finished garment since this can be related (once feed-back is obtained) to garment shrinkage performance.

Non-Compacted Fabrics**Table 1**

| Quality | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | |
|-------------|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|
| Yarn Ne | 20 | | 20 | | 18 | | 16 | | 18 | | 20 | | 20 | | 16 | |
| St.L. cms | 0.306 | | 0.323 | | 0.323 | | 0.323 | | 0.339 | | 0.339 | | 0.355 | | 0.339 | |
| Weight gsm | 225 | | 214 | | 240 | | 272 | | 231 | | 201 | | 197 | | 252 | |
| Width cm | 77.6 | | 80 | | 80.8 | | 81.5 | | 82.5 | | 82.9 | | 83.4 | | 85.2 | |
| Shrinkage % | L W | | L W | | L W | | L W | | L W | | L W | | L W | | L W | |
| (1W+TD) | 9.8 | 4.5 | 11.3 | 4.9 | 9.8 | 4.2 | 8.5 | 3.8 | 9.9 | 4.6 | 12.1 | 5.5 | 13.1 | 3.8 | 10 | 4.1 |
| (5W+5TD) | 12.9 | 5.1 | 14.3 | 5.8 | 12.6 | 4.9 | 10.8 | 4.5 | 13.4 | 5.7 | 15.4 | 5.9 | 17.8 | 3.8 | 12.4 | 4.4 |

Non-Compacted Fabrics**Table 1** Cont'd

| Quality | 9 | | 10 | | 11 | | 12 | | 13 | | 14 | | 15 | | 16 | |
|-------------|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|
| Yarn Ne | 18 | | 16 | | 20 | | 18 | | 16 | | 18 | | 16 | | 16 | |
| St.L. cms | 0.355 | | 0.355 | | 0.370 | | 0.370 | | 0.370 | | 0.388 | | 0.388 | | 0.395 | |
| Weight gsm | 218 | | 249 | | 176 | | 198 | | 232 | | 189 | | 219 | | 211 | |
| Width cm | 85.7 | | 86.4 | | 86.9 | | 88.8 | | 88.3 | | 91.4 | | 92.4 | | 94.9 | |
| Shrinkage % | L W | | L W | | L W | | L W | | L W | | L W | | L W | | L W | |
| (1W+TD) | 11.6 | 4.8 | 10.4 | 3.9 | 15.8 | 4.5 | 14.0 | 4.1 | 11.5 | 3.7 | 15.8 | 4.9 | 13.3 | 4.1 | 13.9 | 5.0 |
| (5W+5TD) | 14.4 | 5.0 | 13.1 | 4.2 | 20.2 | 4.7 | 17.6 | 5.2 | 15.3 | 4.4 | 20.0 | 5.0 | 17.2 | 4.8 | 18.3 | 4.9 |

Compacted FabricsTable 2

| Quality | 1C | | 2C | | 3C | | 4C | | 5C | | 6C | | 7C | | 8C | |
|------------------------|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|
| Yarn Ne | 20 | | 20 | | 18 | | 16 | | 18 | | 20 | | 20 | | 16 | |
| St.L. cms | 0.306 | | 0.323 | | 0.323 | | 0.323 | | 0.339 | | 0.339 | | 0.355 | | 0.339 | |
| Weight gsm | 228 | | 215 | | 236 | | 269 | | 225 | | 200 | | 189 | | 257 | |
| Width cm | 80 | | 83 | | 84 | | 84 | | 85 | | 85.5 | | 86.5 | | 87 | |
| Shrinkage % (1W+TD) | L | W | L | W | L | W | L | W | L | W | L | W | L | W | L | W |
| | 8.4 | 6.5 | 7.9 | 8.5 | 7.8 | 7.0 | 7.3 | 6.3 | 9.6 | 7.0 | 8.5 | 8.0 | 12.8 | 5.6 | 8.2 | 5.6 |

Compacted FabricsTable 2 Cont'd

| Quality | 9C | | 10C | | 11C | | 12C | | 13C | | 14C | | 15C | | 16C | |
|------------------------|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|
| Yarn Ne | 18 | | 16 | | 20 | | 18 | | 16 | | 18 | | 16 | | 16 | |
| St.L. cms | 0.355 | | 0.355 | | 0.370 | | 0.370 | | 0.370 | | 0.388 | | 0.388 | | 0.395 | |
| Weight gsm | 212 | | 242 | | 181 | | 202 | | 237 | | 196 | | 224 | | 214 | |
| Width cm | 88.5 | | 88.5 | | 91 | | 90.5 | | 91 | | 93 | | 95 | | 98.5 | |
| Shrinkage % (1W+TD) | L | W | L | W | L | W | L | W | L | W | L | W | L | W | L | W |
| | 11.1 | 6.0 | 8.3 | 5.7 | 10.1 | 7.3 | 10.5 | 8.0 | 9.3 | 6.5 | 10.0 | 6.6 | 8.5 | 7.0 | 9.1 | 9.0 |

Projections

Table 3

| Quality | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|------------------------|----------------|----------------|-------|-------|-------|-------|-------|-------|
| Yarn Ne | 20 | 20 | 18 | 16 | 18 | 20 | 20 | 16 |
| St.L. cms | 0.306 | 0.323 | 0.323 | 0.323 | 0.339 | 0.339 | 0.355 | 0.339 |
| Weight gsm | 221 | 214 | 235 | 263 | 228 | 204 | 198 | 247 |
| Width cm | 80.2 | 82.4 | 83.7 | 84.8 | 85.2 | 84.9 | 86.8 | 88.4 |
| Shrinkage % (1W+TD) | L W 8% x 8% | L W 8% x 8% | L W | L W | L W | L W | L W | L W |

Projections

Table 3 Cont'd

| Quality | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|------------------------|----------------|-------|-------|-------|-------|-------|-------|-------|
| Yarn Ne | 18 | 16 | 20 | 18 | 16 | 18 | 16 | 16 |
| St.L. cms | 0.355 | 0.355 | 0.370 | 0.370 | 0.370 | 0.388 | 0.388 | 0.395 |
| Weight gsm | 218 | 245 | 1835 | 201 | 230 | 197 | 221 | 216 |
| Width cm | 88.3 | 89.8 | 89.8 | 92.1 | 92.0 | 94.0 | 95.9 | 97.6 |
| Shrinkage % (1W+TD) | L W 8% x 8% | L W | L W | L W | L W | L W | L W | L W |

A P P E N D I X 1

KNITTING OF DEVELOPMENT FABRICS FOR THE FRED PERRY (UK) PROJECT

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DATE: MAY 1989
CLASSIFICATION: FABRICS/KNITTED/PRODUCTION
KEY WORDS: SINGLE JERSEY, FRED PERRY, LACOSTE, GREIGE

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|----------|---|
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1. INTRODUCTION

This project resulted from a request from Fred Perry Sportswear (UK) Limited requesting IIC to assist in developing a fabric with improved shrinkage performance on their recognised Fred Perry Lacoste structure.

The presents structure consists of an 18 gauge fabric knitted from 1/16's Ne combed yarn with a stitch length of 0.393 cms.

Currently, fabric shrinkages of approximately 12-14% in length and 10-12% in width are being recorded. A prime requirement of this study is to obtain the improvement in performance but not to increase the fabric weight and therefore to meet this requirement it is necessary to re-engineer the fabric.

2. PLAN OUTLINE

In order to reduce shrinkages whilst maintaining the desired weight it is necessary to change both yarns and knitted stitch lengths. Three counts of yarn were therefore selected:

1/16's, 1/18's, 1/20's cc - all supplied by Gugelmann of Switzerland.

The Fred Perry Lacoste structure is as follows:

1. xxxxxx - feeder 1, all knit
2. .x.x.x - feeder 2, tuck/knit
3. xxxxxx - feeder 3, all knit
4. x.x.x. - feeder 4, knit/tuck

The amount of yarn going into each course was kept constant, i.e. a 1:1 ratio, in order to minimise the number of variables in the exercise.

2.1 The knitting plan consists of the 3 yarn counts over 5 stitch lengths.

| | <u>STITCH LENGTH/CMS</u> | | | | |
|---------|--------------------------|-------|-------|-------|-------|
| 1/16 Ne | 0.323 | 0.339 | 0.355 | 0.370 | 0.388 |
| 1/18 Ne | 0.323 | 0.339 | 0.355 | 0.370 | 0.388 |
| 1/20 Ne | 0.306 | 0.323 | 0.339 | 0.355 | 0.370 |

The division between stitch length is approximately 5%.

3. KNITTING DETAILS

The actual knitting of these fabrics took place at the firm of Kingsly Knight Limited in Leicester between 10-15th April 1989. Only one machine was used for this exercise, a Monarch 18 gauge, Model RX-3S, 26"

diameter with 1500 needles. The machine had 78 feeders but for this construction only 76 were in use. A machine speed of 30 rpm was maintained throughout the exercise.

The yarn feed was through two trip tapes with two adjoining feeders on each tape, i.e. feed 1 and 2 = tape 1, feed 3 and 4 = tape 2, etc.

3.1 Yarn Measurements During Knitting

Measurement of the actual amount of yarn going into the fabric was made using a Welmstar run-in meter, Model RS 100, and all the yarns were set to 5 grams tension throughout the exercise.

3.2 Comments on the Knitting

The knitting was completed exactly as described in the knitting plan and the tightest stitch length achieved with each yarn was considered to be close to the tightest commercial possible with this particular construction on this particular knitting machine.

Warning: The stitch length of 0.306 on the 1/20 Ne could only be achieved with good combed yarn on a well maintained knitting machine. The yarns used in this exercise were very even and gave no trouble at all during the whole of the exercise and a very low fault rate resulted. Each piece was made to an approximate length of 50 metres. This metreage is necessary as the finishing techniques have yet to be established and adjustments have to be made during final processing. The total weight of greige fabric produced was 265.15 kilograms.

3.3 Piece Code: Each piece is marked with the machine gauge, the yarn count, and the stitch length in cms. i.e. 18/1-16/323. Decode: 18 gauge machine, 1/16 Ne yarn, stitch length 0.323 cms. (See production sheet [Table 1]).

4. TESTING

4.1 Yarns

The yarn test results are shown in Figure 1 and indicate that the yarn counts were quite close to the nominal stipulated counts. Single end strengths indicate a good staple length and the coefficient of friction suggests quite good waxing. The overall consensus from these results would be that all the yarns were of a high standard.

4.2 Greige Fabric Testing

The test results are shown in Figure 2 and show that the stitch lengths as measured on the knitting machine were very close to those obtained in our laboratory using the Shirley Crimp Tester.

These results have been plotted and show a good correlation between the two methods of measuring (Figure 3).

The courses given are the actual courses and not visible courses.

Date: 10-15 April 1989

MACHINE SPEED 30 rpm
 MACHINE GAUGE 18
 MONARCH RX-3S

Needles = 1500
 Diameter = 26"

78 Feeders
 76 In use

PRODUCTION SHEET

FRED PERRY LACOSTE

| Piece No. | T.F. | Courses off m/c per 3cms | Revs produced | Piece weight in kilos | Measured course length in cms | Remarks |
|-------------|-------|--------------------------|---------------|-----------------------|-------------------------------|---------------------|
| 18/1-16/323 | 18.80 | 69 | 1513 | 20.9 | 485 | Width on m/c 89 cms |
| 18/1-16/339 | 17.92 | 60 | 1315 | 18.85 | 509 | 88 |
| 18/1-16/355 | 17.11 | 58 | 1271 | 19.50 | 532 | 87 |
| 18/1-16/370 | 16.42 | 56 | 1227 | 19.65 | 556 | 86 |
| 18/1-16/388 | 15.66 | 52 | 1140 | 18.55 | 582 | 86 |
| 18/1-18/323 | 17.73 | 67 | 1469 | 18.20 | 485 | 88 |
| 18/1-18/339 | 16.90 | 60 | 1315 | 17.10 | 509 | 88 |
| 18/1-18/355 | 16.13 | 58 | 1271 | 17.30 | 532 | 87 |
| 18/1-18/370 | 15.48 | 56 | 1227 | 17.50 | 556 | 86 |
| 18/1-18/388 | 14.76 | 52 | 1140 | 17.00 | 582 | 86 |
| 18/1-20/306 | 17.76 | 76 | 1666 | 17.50 | 459 | 87 |
| 18/1-20/323 | 16.82 | 68 | 1491 | 16.60 | 465 | 86 |
| 18/1-20/339 | 16.03 | 60 | 1315 | 15.40 | 509 | 85 |
| 18/1-20/355 | 15.30 | 58 | 1271 | 15.50 | 532 | 85 |
| 18/1-20/370 | 14.69 | 56 | 1227 | 15.60 | 556 | 85 |

General Comments:

1. yarns from Gugelmann, Switzerland (combed)
2. each piece approximately 50 metres long
3. no cutting line in fabric
4. 5g tension on yarn during knitting

$$TF = \sqrt{\frac{\text{TEX}}{\text{Stitch length cms}}}$$

TABLE 1

FRED FERRY

GUGELMAN YARN

| SAMPLE NO. | 16 ^s | 18 ^s | 20 ^s |
|-----------------------------------|-----------------|-----------------|-----------------|
| Yarn count (Tex) | 37.21 | 32.95 | 29.94 |
| Twist (turns per metre) | 588 | 657 | 699 |
| Single end strength (g) | 598.92 | 521.82 | 466.39 |
| Extension at break (%) | 6.88 | 6.66 | 6.58 |
| Coefficient of friction (μ) | 0.16 | 0.16 | 0.15 |
| Yarn count (Ne) | 15.87 | 17.92 | 19.73 |
| Turns per inch | 14.94 | 16.69 | 17.74 |
| Twist Factor - alpha Tex | 35.87 | 37.71 | 38.22 |
| Twist Factor - English | 3.75 | 3.94 | 3.99 |
| Tenacity (g./Tex) | 16.10 | 15.84 | 15.58 |

Table

Fred Perry - Greige Fabrics

GREY

| | 16/323 | 16/339 | 16/355 | 16/370 | 16/386 | 18/323 | 18/339 | 18/355 | 18/370 | 18/386 |
|--------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Length shrinkage (%), 5x | 16.65 | 18.29 | 20.87 | 23.67 | 25.31 | 17.45 | 20.55 | 23.03 | 25.01 | 26.51 |
| Width shrinkage (%), 5x | 19.86 | 18.61 | 16.49 | 15.12 | 13.20 | 20.08 | 19.89 | 18.08 | 16.17 | 13.29 |
| Weight (gsm), AW | 340.25 | 329.17 | 322.91 | 313.48 | 300.35 | 306.55 | 301.05 | 288.38 | 280.51 | 269.24 |
| Courses per 3cm, BW | 74.60 | 69.70 | 63.60 | 59.40 | 56.10 | 73.50 | 67.40 | 62.10 | 58.20 | 53.00 |
| Courses per 3cm, AW | 90.00 | 84.60 | 81.20 | 78.00 | 74.80 | 90.50 | 86.00 | 81.70 | 78.00 | 74.00 |
| Wales per 3cm, BW | 23.65 | 23.30 | 23.00 | 22.00 | 22.70 | 23.80 | 23.25 | 23.10 | 22.90 | 22.95 |
| Wales per 3cm, AW | 29.40 | 28.25 | 27.00 | 26.00 | 25.85 | 29.65 | 29.20 | 28.05 | 26.90 | 26.35 |
| Stitch length (mm) BW | 3.24 | 3.41 | 3.56 | 3.71 | 3.89 | 3.24 | 3.39 | 3.54 | 3.72 | 3.87 |
| Stitch length (mm) AW | 3.18 | 3.34 | 3.49 | 3.64 | 3.79 | 3.20 | 3.35 | 3.51 | 3.66 | 3.81 |
| Angle of spirality, BW | 5.29 | 6.35 | 7.04 | 7.98 | 9.04 | 7.40 | 8.65 | 9.83 | 10.46 | 9.99 |
| Angle of spirality, AW | 4.79 | 5.11 | 5.21 | 5.76 | 6.60 | 5.66 | 5.93 | 7.20 | 7.72 | 8.25 |

NOTES

5x after 5 machine wash (60 deg.C.)/tumble dry cycles

BW as received (before wash)

AW after 5 wash/tumble dry cycles (after wash)

Table

Fred Perry - Greige Fabrics

GREY

| | 20/306 | 20/323 | 20/339 | 20/355 | 20/370 |
|--------------------------|--------|--------|--------|--------|--------|
| Length shrinkage (%), 5x | 16.87 | 20.95 | 22.16 | 23.98 | 26.28 |
| Width shrinkage (%), 5x | 23.52 | 21.53 | 20.39 | 18.00 | 17.40 |
| Weight (gsm), AW | 291.73 | 280.14 | 272.01 | 265.69 | 256.77 |
| Courses per 3cm, BW | 80.00 | 71.20 | 66.20 | 62.00 | 56.90 |
| Courses per 3cm, AW | 95.70 | 90.00 | 86.10 | 82.10 | 79.10 |
| Wales per 3cm, BW | 23.90 | 23.85 | 23.15 | 23.50 | 22.55 |
| Wales per 3cm, AW | 30.95 | 30.15 | 28.90 | 28.50 | 27.55 |
| Stitch length (mm) BW | 3.07 | 3.23 | 3.38 | 3.56 | 3.71 |
| Stitch length (mm) AW | 3.01 | 3.17 | 3.31 | 3.48 | 3.63 |
| Angle of spirality, BW | 5.89 | 7.05 | 7.33 | 10.00 | 10.25 |
| Angle of spirality, AW | 6.43 | 6.84 | 7.34 | 8.45 | 9.51 |

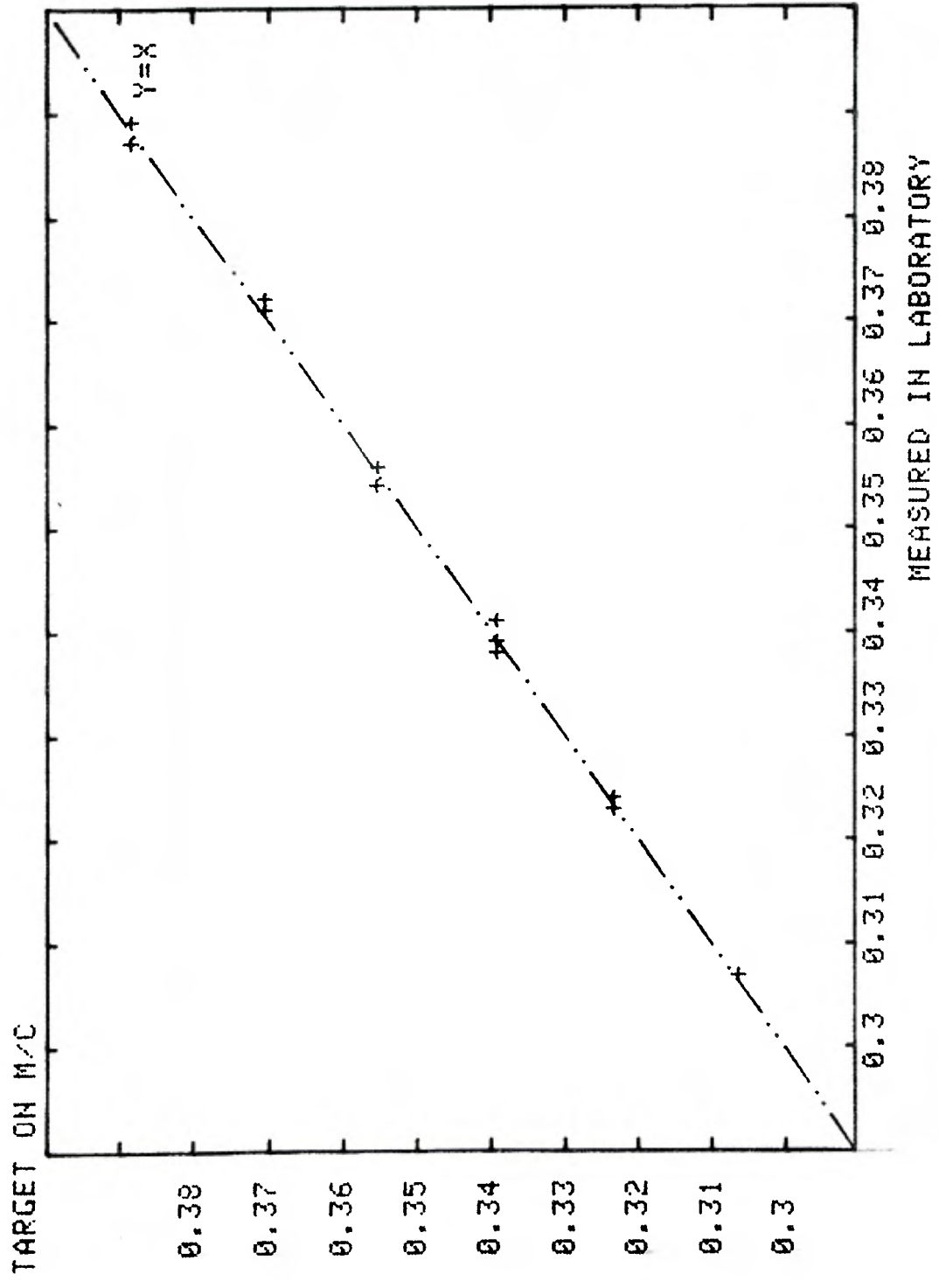
NOTES

5x after 5 machine wash (60 deg.C.)/tumble dry cycles

BW as received (before wash)

AW after 5 wash/tumble dry cycles (after wash)

STITCH LENGTHS AS SET ON MACHINE AND MEAS. IN LAB AT I.I.C



LABORATORY REPORT

TEST REPORT: 5.DATE: 2nd August 1989TITLE: PERFORMANCE TESTS ON FRED PERRY GARMENTS.FROM: COLETTETO: MR R. HAWKES.

The garments were washed at 60°C and flat dried. Then measured. Then they were wet out tumbled for 90 minutes and measured. After this they were rinsed (to wet out) and tumbled for 90 minutes four more times and measured on the fifth.

QUALITY ONE

| MEASUREMENT POINT | FLAT DRIED % | 1 st Tumble % | 5 th Tumble % |
|-------------------|--------------|--------------------------|--------------------------|
| 1 | -4.8 | -5.4 | -5.9 |
| 2 | -0.9 | -7.7 | -10.9 |
| 3 | -0 | -9.1 | -9.9 |
| 4 | -1.8 | -6.3 | -10.7 |
| 5 | +1.9 | -3.6 | -1.7 |
| 6 | -2.6 | -5.5 | -8.3 |
| 7 | -1.1 | -8.5 | -11.1 |

QUALITY TWO

| MEASUREMENT POINT | FLAT DRIED % | 1 st Tumble % | 5 th Tumble % |
|-------------------|--------------|--------------------------|--------------------------|
| 1 | -5.1 | -7.6 | -6.3 |
| 2 | 0 | -8.4 | -12.7 |
| 3 | -0.4 | -11.8 | -11.8 |
| 4 | -2.5 | -10.4 | -9.6 |
| 5 | +6 | -1.2 | -0.7 |
| 6 | -3.3 | -6.8 | -6.6 |
| 7 | -1.5 | -9.1 | -13.6 |

Task report 5 Continued

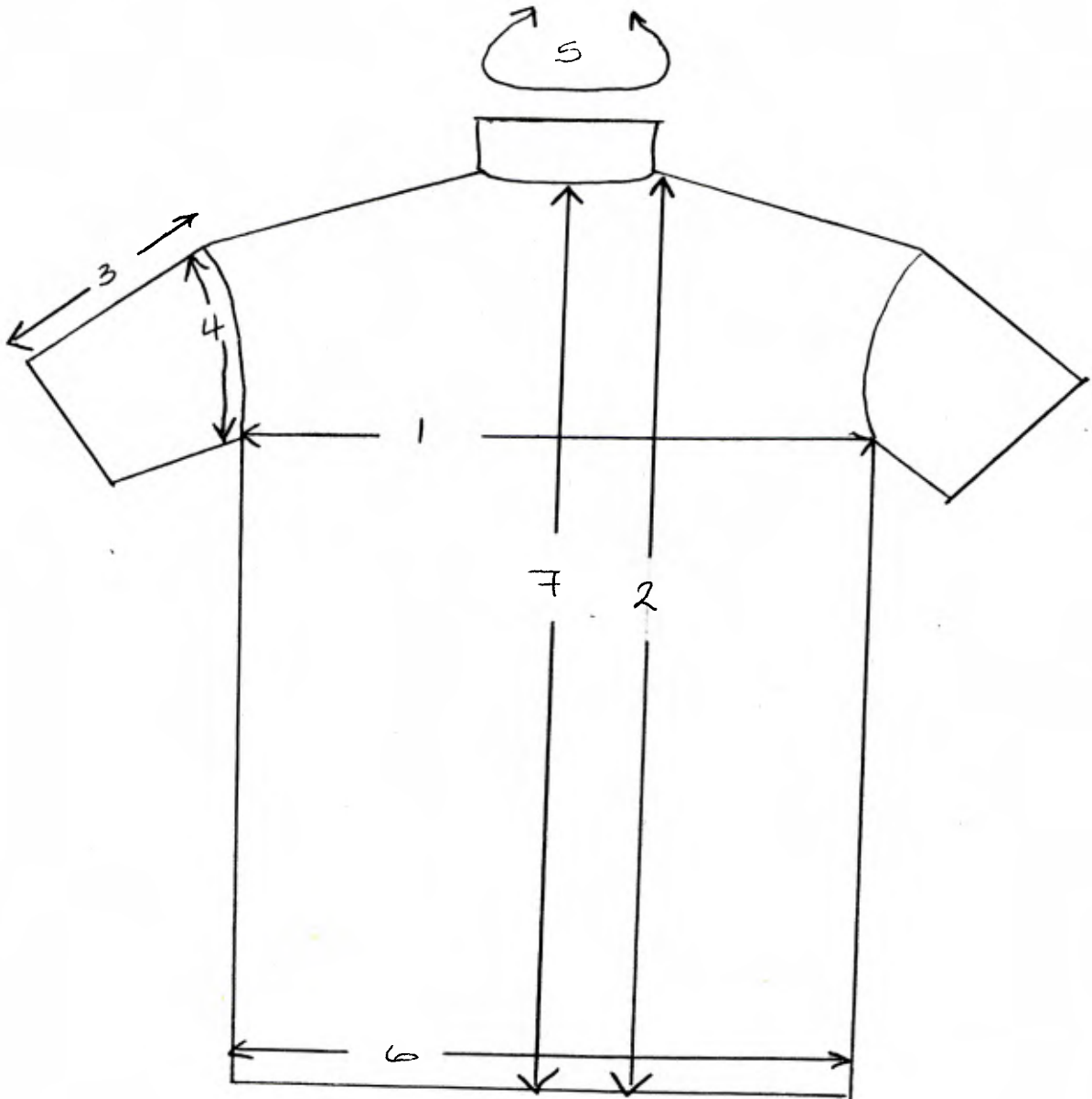
QUALITY NINE

| MEASUREMENT POINT | FLAT DRIED % | 1 st Tumble % | 5 th Tumble % |
|-------------------|--------------|--------------------------|--------------------------|
| 1 | -6.6 | -7.6 | -6.3 |
| 2 | -1.2 | -9.7 | -11.3 |
| 3 | -3.3 | -12.5 | -16.7 |
| 4 | -4.7 | -6.5 | -10.3 |
| 5 | +4.9 | -3.7 | -0.2 |
| 6 | -4.6 | -6.3 | -7.7 |
| 7 | +1.4 | -9.6 | -13.4 |

Laboratory Report 5

key for measurements.

ALL ON THE BACK OF
THE GARMENT.



- 1 chest width
- 2 Total length
- 3 Sleeve length
- 4 Arm hole length
- 5 Collar
- 6 Bottom hem
- 7 Centre back length.