

IIC/TEFO
INTERLABORATORY TRIAL (2)

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DATE: NOVEMBER 1986
CLASSIFICATION: FABRICS/KNITTED/PROPERTIES
KEY WORDS: SINGLE JERSEY, SINGLES YARN, TWO-FOLD YARN, COURSES, WALES,
REFERENCE STATE

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1. INTRODUCTION

In continuation of our STARFISH user-centre agreement with TEFO, and following on from their measurements of extensibility made on a series of 14 gauge 1 x 1 rib fabrics, a second series of fabrics were sent to TEFO in November 1984. This second series consisted of 20 qualities (4 yarns x 5 stitch lengths) of single jersey fabric knitted from singles yarns, and the equivalent 20 qualities knitted from two-fold yarns. All the fabrics had been dyed to a medium shade on a Thies R-Jet 95 and finished tubular, as part of the project K1.

TEFO made measurements of extensibility at two different loads, 0.15N/cm and 0.3N/cm on the fabrics as received (before wash) and after one and five cycles of washing and tumble drying. Details of the project and an analysis of the results will form the subject of a later report.

In addition to the measurements of extensibility, however, TEFO also made estimates of the number of courses and wales in the reference state. A comparison of this data with that obtained from our own laboratory provides an indication of the correlation between the two laboratories.

2. TEST METHODS

Although as far as we are aware the conditions of washing/rinsing and tumble drying were equivalent between the two laboratories, there were some differences in the methods used to measure courses and wales.

At TEFO, estimates of courses and wales were made on the fabric tubes prepared for the measurement of extensibility on the rack. Five tubes (replications) were prepared for each sample and four sets of measurements for courses and wales were made on each tube, two each on the front and back, making a total of 20 measurements each for courses and wales per sample.

Estimates for courses and wales were made by making two marks 10cm apart, either along a course or along a wale, on the before wash samples and counting the number of stitches between the marks. Figures 1 and 2 illustrate diagrammatically the location of the measuring marks on the tube. After relaxation of the tubular samples to the reference state the distances between the marks were remeasured. Estimates of the number of courses and wales per 10cm in the reference state were then made by calculation, according to the change in length between the pairs of marks.

After relaxation of the fabric tubes, the seam forming the tube had become displaced (Figure 2) due to spirality. The angle of displacement or skew was also measured and recorded.

At IIC, courses and wales are counted directly on the single layer, flat specimens prepared for the standard relaxation procedure. Two estimates are made for both courses and wales on each of the five replications, selected at

random, giving a total of 10 measurements each for courses and wales per sample.

The angle of spirality in the fabric is determined on the same replications, both before and after relaxation to the reference state, by measuring the angle between the wales and a line drawn perpendicular to courses. Again, measurements are made at random 5 per replication making a total of 25 measurements per sample.

3. RESULTS

Tables 1-4 give the relevant test data for all the samples measured by IIC and TEFO. Average Tex and stitch length results as measured by IIC are also included. Values for courses and wales are given per cm; stitches per sq.cm are calculated from courses and wales.

In Tables 1 and 3 (IIC results) spirality angles measured before and after relaxation are given and the change in angle (AW-BW) have been calculated.

Tables 5 and 6 summarise the results of the statistical analysis for the fabrics knitted from singles yarns and two-fold yarns, respectively.

Figures 3 to 22 illustrate the results for fabrics knitted from singles yarns, and Figures 23 to 42 illustrate the results for fabrics from two-fold yarns.

4. DISCUSSION

4.1. Fabrics Knitted from Singles Yarns

4.1.1. Dimensions

An analysis of the results for courses, wales and stitches, using students t, indicates statistically significant differences between the mean results obtained by IIC and TEFO for wales at the 5% level, and stitches at the 1% level. There is no statistically significant difference between the two laboratory estimates for courses.

In all three cases however, the correlation coefficients are very good, indicating a high degree of correlation between the two laboratories.

An examination of Figures 3 to 20 also suggests that although there may be statistically significant differences between the two laboratories, in practical terms the differences are probably insignificant. For example, where comparatively large discrepancies exist between the two laboratories, the existing STARFISH 84 regressions line tends to fall between the points. This suggests that the database would be improved by averaging the two sets of results. In particular, the existing STARFISH equation for wales does not describe the data from Ne 1/16 and Ne 1/24 yarns as precisely as that from Ne 1/28 and Ne 1/32. This could well be due to bias which has been introduced by

the apparently high floating data points which can be observed in IIC's measured data for the finer yarns.

4.1.2. Spirality and Skew

Although the measurements of spirality (IIC) and skew (TEFO) are not directly comparable, it is interesting to examine the degree of correlation between the two data sets.

Figure 21 illustrates the correlation between the angle of spirality in the reference state and the angle of skew, and Figure 22 compares the difference in spiral angle (AW-BW) with skew. Correlation coefficients and students t statistics are given in Table 5.

Spirality AW is statistically significantly different from skew, although regression analysis using the model $y = a+bx$ gives a reasonable level of correlation.

Comparison of the results obtained by taking the difference in spiral angle (AW-BW) with skew however indicate that they are not significantly different, although this is presumably due to the large degree of scatter in the results, but the correlation coefficient is poor.

4.2. Fabrics Knitted from Two-Fold Yarns

4.2.1. Dimensions

Similarly to the results obtained from an analysis of the data on singles yarn fabrics, statistically significant differences can be found between the two laboratories for the fabrics produced from two-fold yarns. Statistically significant differences at the 0.1% level were calculated for both courses and wales, but as the mean differences were in opposite directions there was no significant difference between the two estimates for stitches.

Correlation coefficients are again very high and an examination of Figures 23 to 40 also suggests that the differences are probably not of practical significance.

Comparison of the two data sets with the existing STARFISH 84 regression lines also suggest that averaging the data from both laboratories would improve the accuracy of the data base.

4.2.2. Spirality/Skew

Figures 41 and 42 illustrate the relationship between spirality (IIC) and skew (TEFO). Correlation coefficients and students t statistics are give in Table 6.

Unlike the results from the fabrics from singles yarns there is no correlation between the two data sets, which are also statistically significantly different from each other. This is confirmed by an examination of the figures.

5. CONCLUSIONS

Given that the methods for estimating courses and wales in the reference state are different between the two laboratories, and also that the samples measured by TEFO have been subjected to stretching on the rack between relaxation cycles, the estimates made by both laboratories are in remarkably good agreement.

Statistically significant differences can be calculated but on average the actual mean differences are so low as to be probably insignificant in practice.

It also appears from a visual examination of the data compared to the existing STARFISH 84 regression curves that averaging the two sets of results would actually improve the reliability of the data base.

On the basis of this series of results, therefore, it would appear that we can be reasonably confident that measurements made of courses and wales in the reference state by TEFO will be both compatible with and highly correlated to our own.

The comparison of spirality and skew, although interesting, is in this context not significant. Since these measurements were made, TEFO have installed a new piece of equipment - a digitiser - which should allow accurate measurement of the angle of spirality as defined by IIC to be made very easily at the same time as shrinkage results are calculated.

A comparison of results obtained by TEFO using the digitiser with IIC's existing method will form the subject of a future interlaboratory trial.

IIC/TEFO INTER-LABORATORY TRIAL

SINGLE JERSEY FABRICS : STANDARD SINGLES YARNS

FINISH : Jet Dyed (R-Jet 95) Tubular

IIC TEST DATA : Measured in the REFERENCE STATE

Sample Ref.No.	avTex	avSL	C/cm	W/cm	Ssqcm	Spiral BW	Spiral AW	Spiral AW-BW
18/1-16/344	35.16	0.342	17.5	12	210	1.1	8.1	7
18/1-16/362	35.16	0.357	16.1	11.33	182.4	0.5	10.2	9.6
18/1-16/380	35.16	0.375	15.07	10.97	165.3	2.9	8.6	5.7
18/1-16/399	35.16	0.392	14.1	10.53	148.5	1.9	9.2	7.3
18/1-16/419	35.16	0.414	13.6	10.1	137.4	1.2	13.5	12.4
24/1-24/306	22.95	0.302	18.43	13.7	252.5	2.3	10.1	7.8
24/1-24/321	22.95	0.313	17.73	12.97	230	3.3	13.3	10
24/1-24/337	22.95	0.331	16.63	12.57	209	0.9	13.5	12.6
24/1-24/354	22.95	0.35	15.73	12.33	194	3.9	17.1	13.2
24/1-24/372	22.95	0.365	14.73	11.87	174.8	3.2	19.3	16.1
24/1-32A/276	17.49	0.276	20.4	15.4	314.2	1.8	13.6	11.8
24/1-32A/291	17.49	0.289	19.07	14.7	280.3	0.1	15.8	15.7
24/1-32A/306	17.49	0.302	17.63	14.7	259.2	3.3	18.2	14.9
24/1-32A/321	17.49	0.313	16.53	13.53	223.7	9.8	23.4	13.5
24/1-32A/337	17.49	0.331	15.7	13.77	216.2	3.6	20.3	16.6
28/1-40/246	14.11	0.247	21.63	17.33	374.8	3.7	13.7	9.9
28/1-40/259	14.11	0.259	21.1	16.43	346.7	3.1	15.6	12.5
28/1-40/273	14.11	0.271	19.93	15.97	318.3	5.9	18.2	12.3
28/1-40/287	14.11	0.286	18.47	16	295.5	3.5	19.3	15.8
28/1-40/301	14.11	0.299	17.53	15.6	273.5	5.9	24	18.1

- =====
1) avTex = Tex averaged over Stitch Length
2) avSL = Stitch Length averaged over Tex
3) Spiral AW-BW = Difference between spiral angles measured Before and After relaxation to the Reference State

IIC/TEFO INTER-LABORATORY TRIAL

SINGLE JERSEY FABRICS : STANDARD SINGLES YARNS

FINISH : Jet Dyed (R-Jet 95) Tubular

TEFO TEST DATA : Measured in the REFERENCE STATE

Sample Ref.No.	C/cm	W/cm	Ssqcm	Skew
18/1-16/344	17.21	11.76	202.4	6.5
18/1-16/362	16.1	11.36	182.9	6.6
18/1-16/380	15.25	11	167.8	7.8
18/1-16/399	14.17	10.61	150.3	9.1
18/1-16/419	13.5	10.12	136.6	11.8
24/1-24/306	18.43	13.75	253.4	9.4
24/1-24/321	17.69	12.86	227.5	11.5
24/1-24/337	16.56	12.58	208.3	12.4
24/1-24/354	15.49	12.29	190.4	13.7
24/1-24/372	14.71	11.9	175	14.9
24/1-32A/276	20.07	15.26	306.3	11.4
24/1-32A/291	19.03	14.56	277.1	13
24/1-32A/306	17.7	14.3	253.1	14.4
24/1-32A/321	16.91	13.49	228.1	16.6
24/1-32A/337	15.96	13.29	212.1	16
28/1-40/246	21.92	17.02	373.1	11.3
28/1-40/259	20.62	16.56	341.5	12.2
28/1-40/273	19.48	15.82	308.2	13
28/1-40/287	18.19	15.64	284.5	14.7
28/1-40/301	17.27	14.75	254.7	14.7

=====

1)Skew = Tefo's measurement of the angle between seam and edge

IIC/TEFO INTER-LABORATORY TRIAL

SINGLE JERSEY FABRICS : TWOFOLD YARNS
FINISH : Jet Dyed (R-Jet 95) Tubular

IIC TEST DATA : Measured in the REFERENCE STATE

Sample Ref.No.	avTex	avSL	C/cm	W/cm	Ssqcm	Spiral BW	Spiral AW	Spiral AW-BW
18/2-32/344	36.88	0.339	17.03	11.83	201.5	0.8	-2.3	-3.1
18/2-32/362	36.88	0.356	15.83	11.33	179.4	0.1	-4.9	-5
18/2-32/380	36.88	0.37	15.13	10.6	160.4	-1.1	-5	-3.9
18/2-32/399	36.88	0.39	13.97	10.03	140.1	0.7	-4.5	-5.2
18/2-32/419	36.88	0.411	13.27	9.97	132.3	-3.7	-5.2	-1.5
24/2-48/306	24.09	0.3	18.17	13.63	247.7	1.5	-2.7	-4.2
24/2-48/321	24.09	0.315	17.07	12.83	219	0.9	-1.6	-2.5
24/2-48/337	24.09	0.33	15.87	12.57	199.5	0.7	-3.1	-3.7
24/2-48/354	24.09	0.349	15.13	12.13	183.5	-0.5	-1.3	-0.8
24/2-48/372	24.09	0.367	14.33	11.53	165.2	-1.7	-2.1	-0.4
24/2-64/276	17.93	0.274	20.23	14.97	302.8	0	-4	-4
24/2-64/291	17.93	0.287	18.2	14.03	255.3	-3.1	-5.5	-2.4
24/2-64/306	17.93	0.3	17.37	14.03	243.7	0.9	-3.3	-4.2
24/2-64/321	17.93	0.315	16.57	13.2	218.7	-0.4	-3	-2.6
24/2-64/337	17.93	0.33	15.37	12.43	191	-0.8	-3.6	-2.8
28/2-80/246	14.28	0.242	22.1	17.07	377.2	1.9	-5.8	-7.6
28/2-80/259	14.28	0.255	20.8	16.43	341.7	-1.1	-4.9	-3.7
28/2-80/273	14.28	0.266	18.9	15.9	300.5	5.5	-1.9	-7.4
28/2-80/287	14.28	0.28	17.73	15.3	271.3	1.3	-3.9	-5.1
28/2-80/301	14.28	0.298	17.13	14.13	242	1.3	-2.8	-4.1

1)avTex = Tex averaged over Stitch Length

2)avSL = Stitch Length averaged over Tex

3)Spiral AW-BW = Difference between spiral angles measured Before and After relaxation to the Reference State.

IIC/TEFO INTER-LABORATORY TRIAL

SINGLE JERSEY FABRICS : TWOFOLD YARNS

FINISH : Jet Dyed (R-Jet 95) Tubular

TEFO TEST DATA : Measured in the REFERENCE STATE

Sample Ref.No.	C/cm	W/cm	Ssqcm	Skew
18/2-32/344	16.98	11.87	201.6	-2.6
18/2-32/362	15.75	11.45	180.3	-4.3
18/2-32/380	14.9	10.93	162.9	-3
18/2-32/399	14.01	10.57	148.1	-1.8
18/2-32/419	13.21	10.13	133.8	-1.4
24/2-48/306	18.05	13.37	241.3	-1.3
24/2-48/321	16.92	13.02	220.3	-1.4
24/2-48/337	15.73	12.78	201	0.1
24/2-48/354	14.7	12.26	180.2	1.1
24/2-48/372	14.05	11.42	160.5	-0.2
24/2-64/276	19.85	15.08	299.3	-0.6
24/2-64/291	18.15	14.77	268.1	0.5
24/2-64/306	17.07	14.37	245.3	-0.2
24/2-64/321	16.43	13.45	221	-0.3
24/2-64/337	15.38	12.87	197.9	-1
28/2-80/246	21.75	17.12	372.4	-2.5
28/2-80/259	20.37	16.64	339	-2.1
28/2-80/273	18.74	16.25	304.5	-1
28/2-80/287	17.35	15.69	272.2	-0.3
28/2-80/301	16.76	14.62	245	-1.7

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 1) Skew = Tefo's measurement of the angle between seam and edge

IIC/TEFO INTER-LABORATORY COMPARISON

STUDENTS T STATISTIC FOR N = 20
DEGREES OF FREEDOM = 19

95% = 2.093 *
99% = 2.861 **
99.9% = 3.883 ***

SINGLE JERSEY : SINGLES YARN : FINISH R-JET 95, TUBULAR
IIC/TEFO Measured in the REFERENCE STATE

Sample Ref.No.	Mean Difference	t	r sq
Courses/cm	-0.0675	1.2255	0.9896
Wales/cm	-0.144	2.6236 *	0.9892
Stitches/cm ²	-3.6428	2.8886 **	0.9945
Spiral/Skew	-0.097	0.2462	0.7608
AW-BW			
Spiral/Skew	-3.198	6.3102 ***	0.8739
AW			

TABLE 6

Table 6

IIC/TEFO INTER-LABORATORY COMPARISON

STUDENTS T STATISTIC FOR N = 20
DEGREES OF FREEDOM = 19

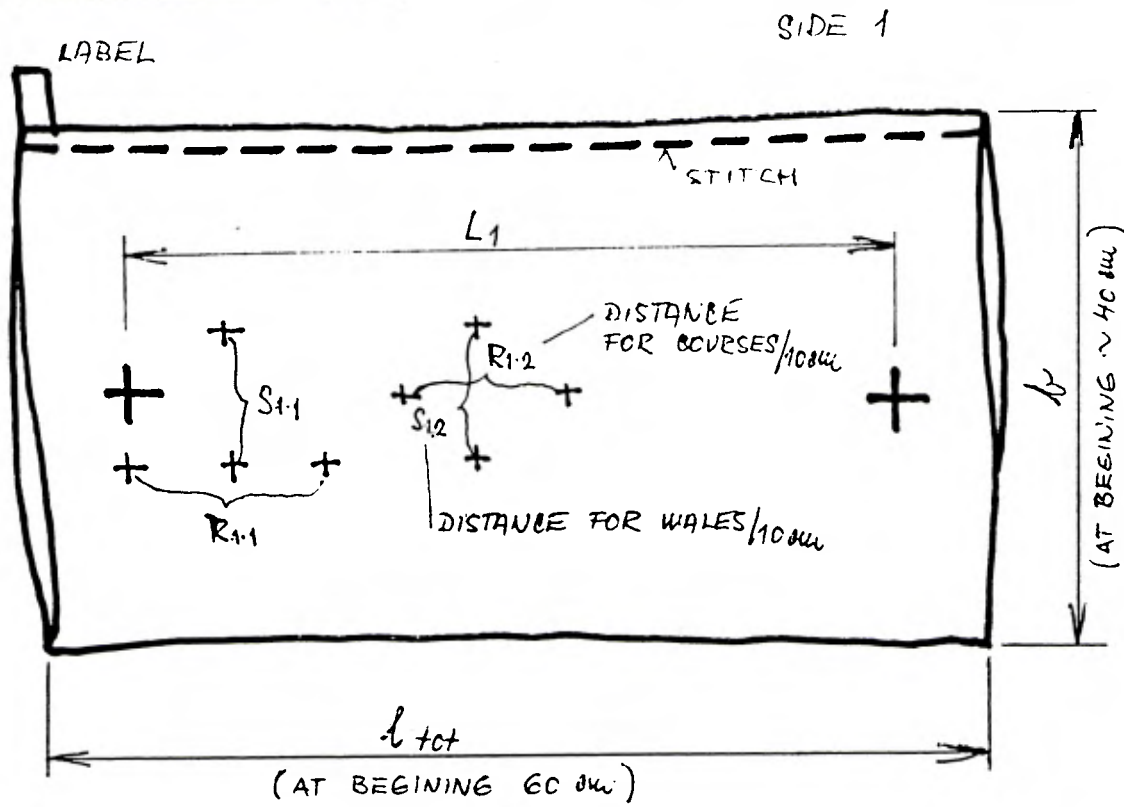
95% = 2.093 *
99% = 2.861 **
99.9% = 3.883 ***

SINGLE JERSEY : TWOFOLD YARN : FINISH R-JET 95, TUBULAR
IIC/TEFO Measured in the REFERENCE STATE

Sample Ref.No.	Mean Difference	t	r sq
Courses/cm	-0.2025	5.8164 ***	0.9964
Wales/cm	0.236	4.4892 ***	0.9878
Stitches/cm ²	1.0853	1.0132	0.9952
Spiral/Skew	2.5195	6.2745 ***	0.1864
AW-BW			
Spiral/Skew	2.374	7.1255 ***	0.1622
AW			

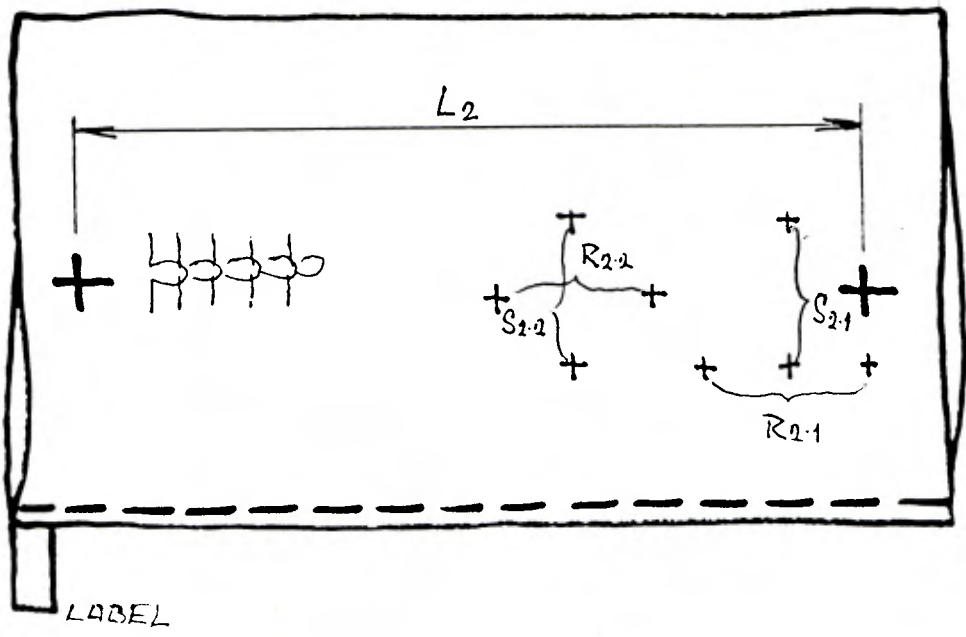
SHAPE OF SAMPLE

FIGURE 1

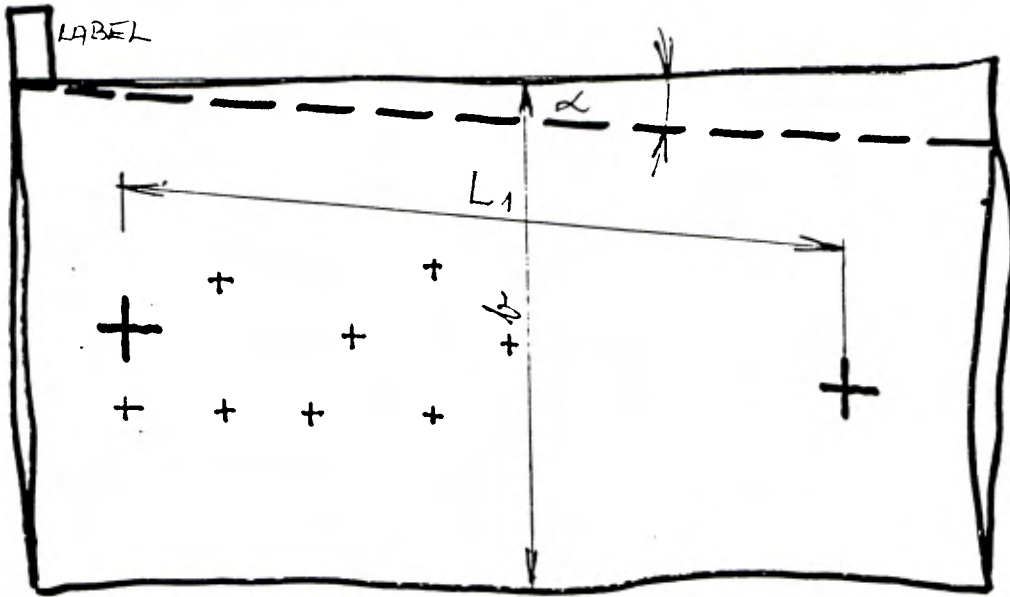


5 SAMPLES OF EACH QUALITY

SIDE 2

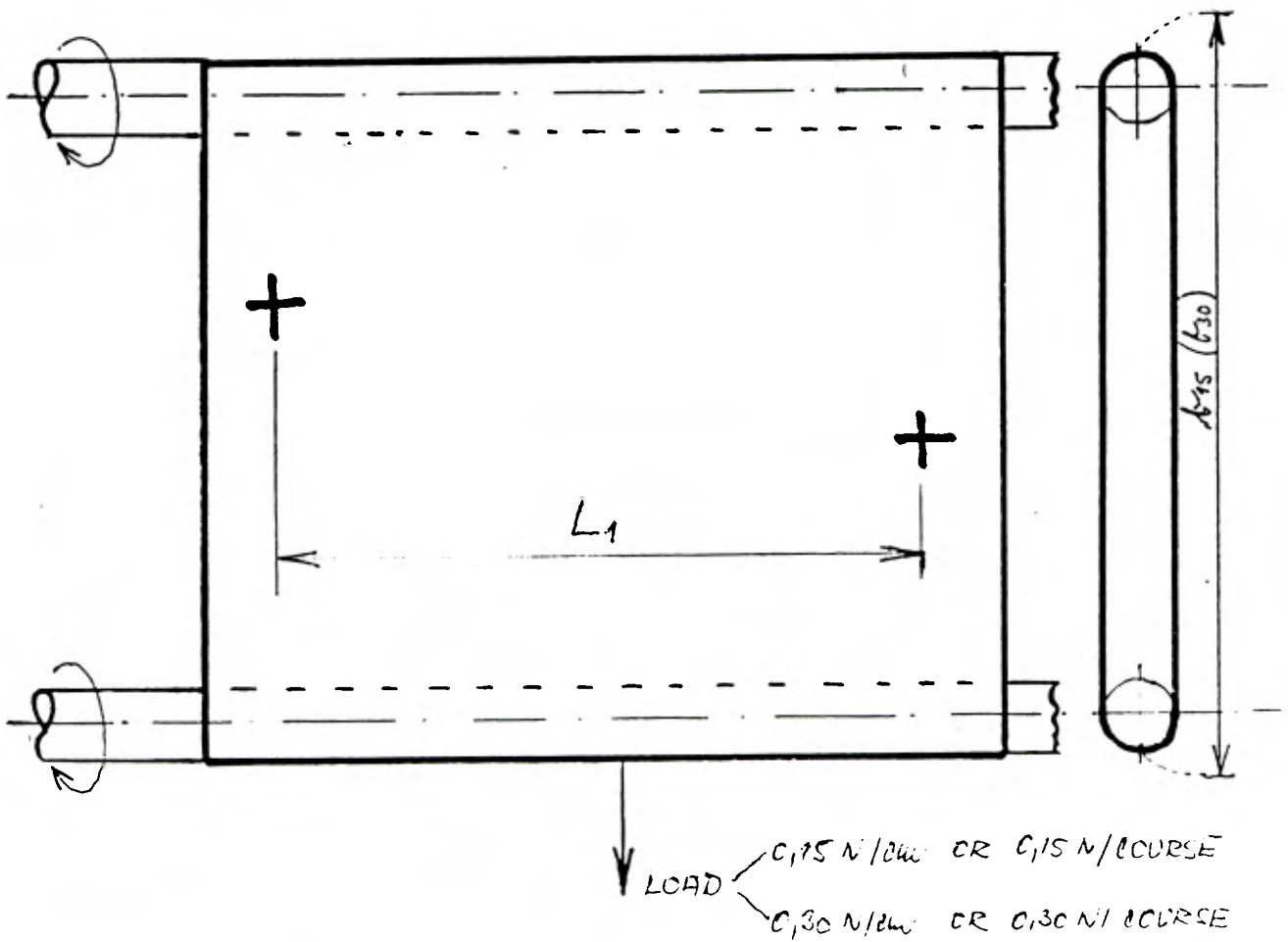


SHAPE OF SAMPLE AFTER WASH (SINGLE JERSEY)



α - ANGLE OF SPIRALITY

MEASUREMENT OF EXTENSIBILITY ON STRÄCKBÄNK



IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

FIGURE 3

Finish R-Jet 95 : Singles Yarn

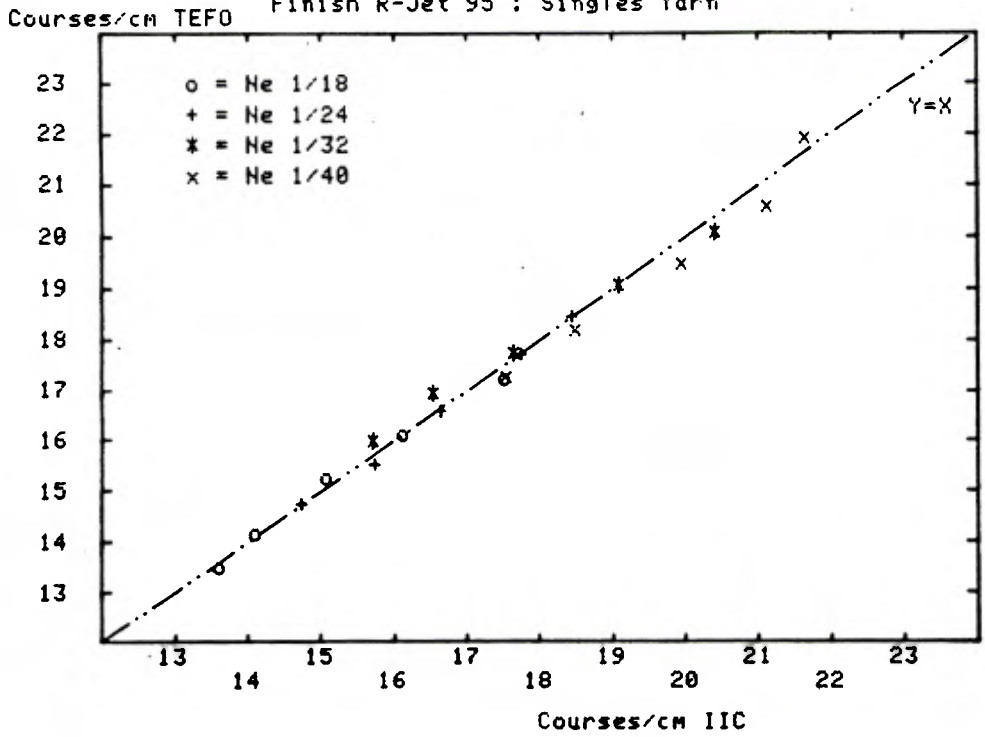
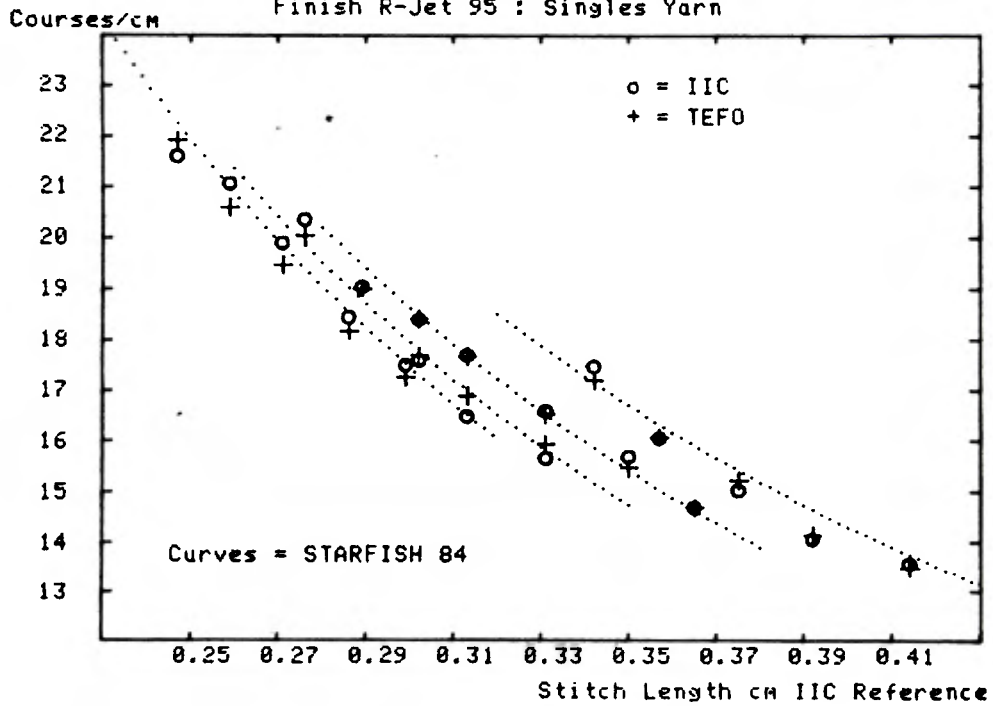


FIGURE 4

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Singles Yarn



IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Singles Yarn

Courses/cm

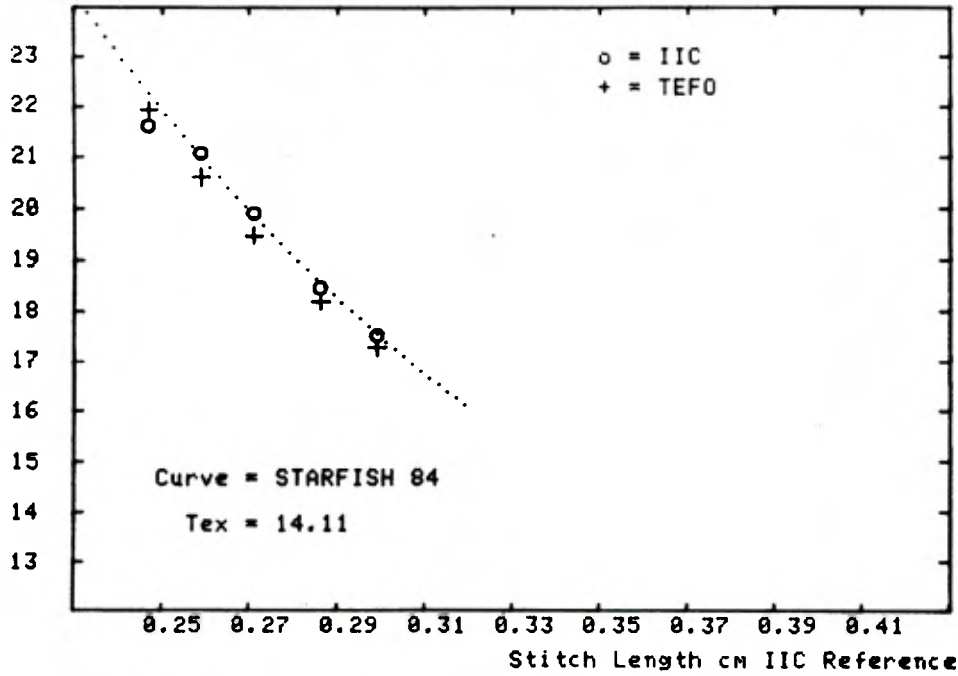


FIGURE 5

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Singles Yarn

Courses/cm

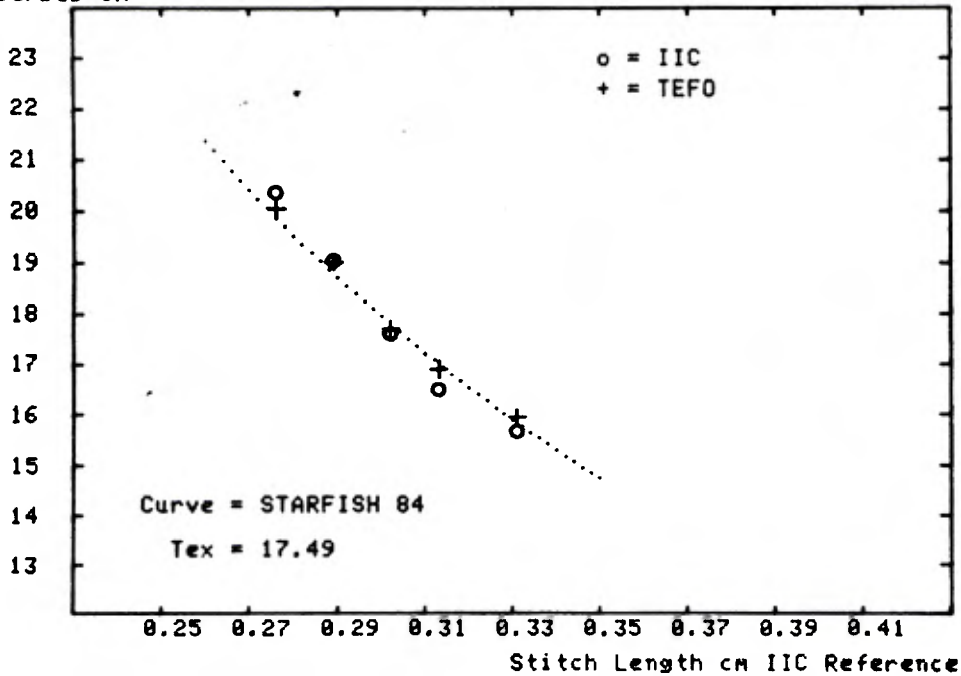
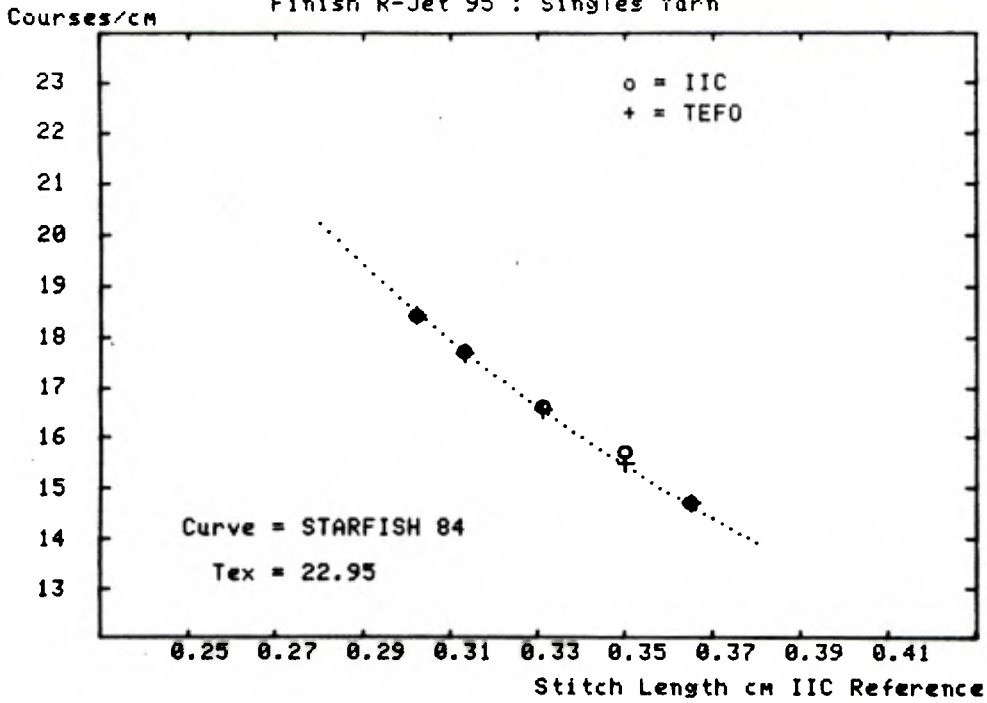


FIGURE 6

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Singles Yarn

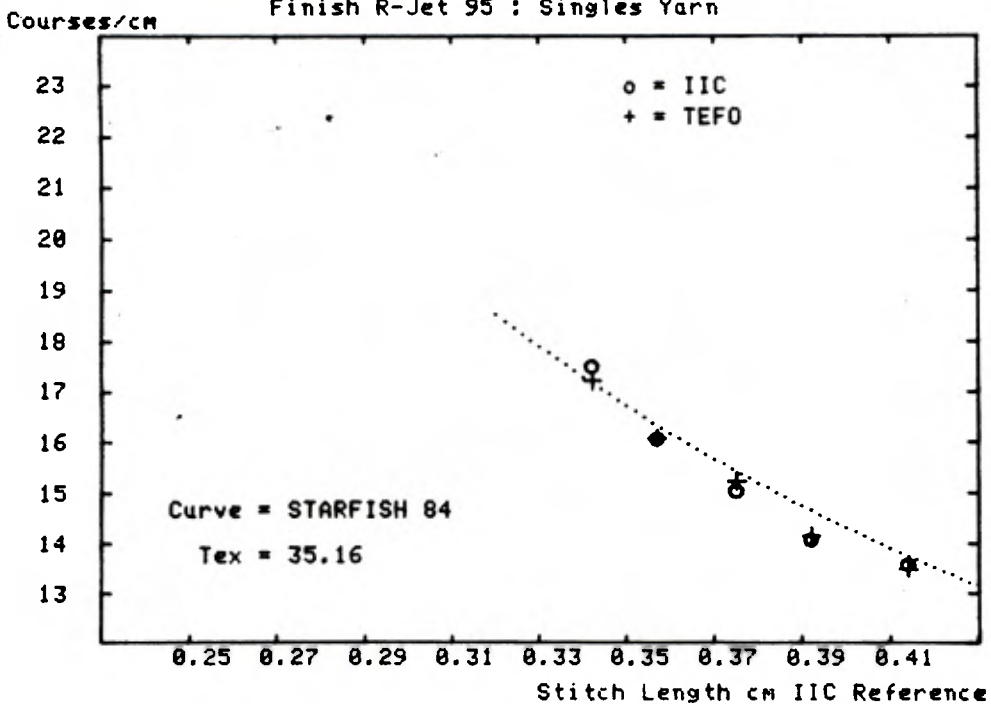
FIGURE 7



IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Singles Yarn

FIGURE 8



IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Singles Yarn

FIGURE 9

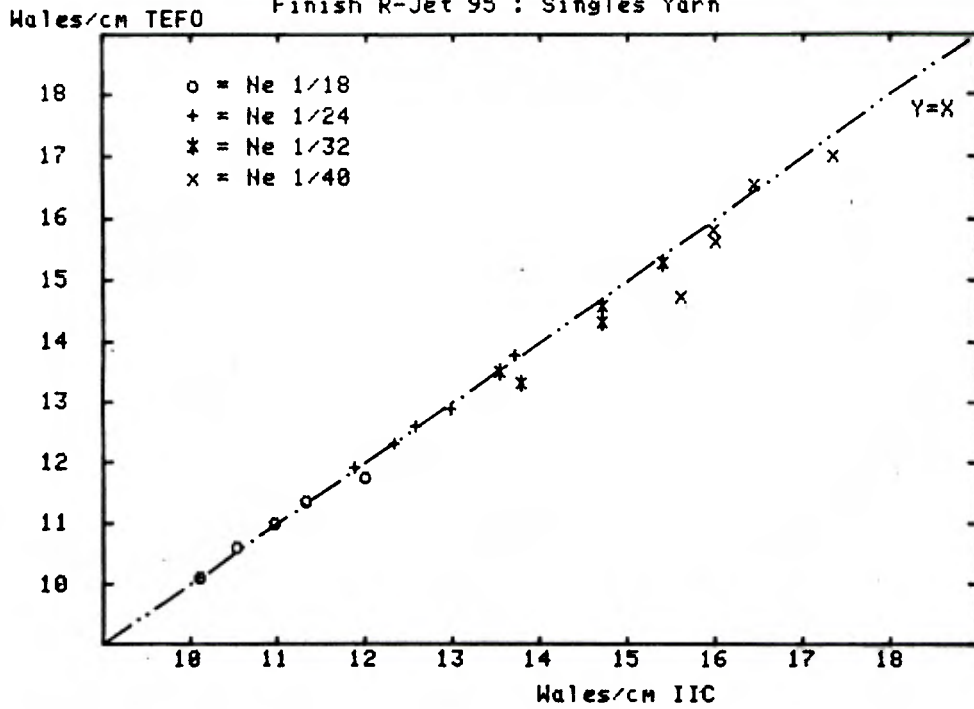
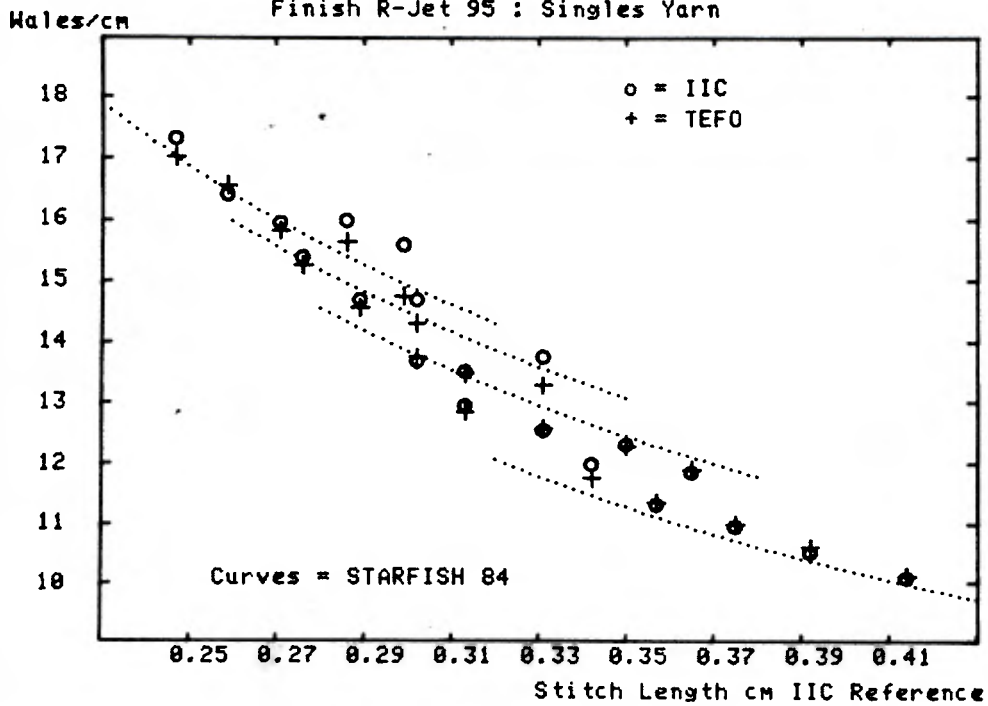


FIGURE 10

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Singles Yarn



IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Singles Yarn

Hales/cm

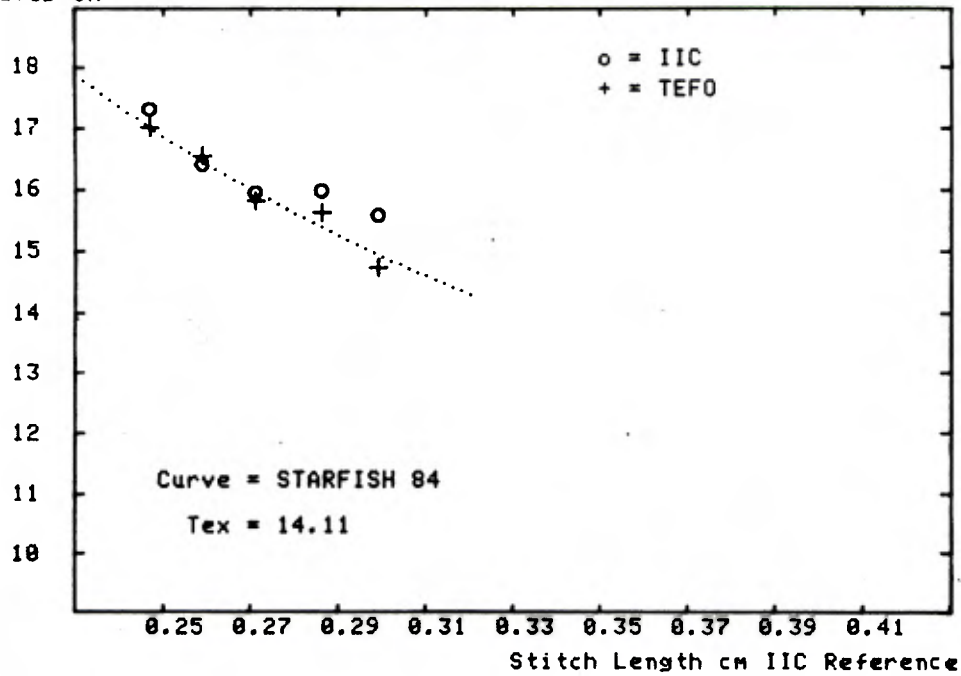


FIGURE 11

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Singles Yarn

Hales/cm

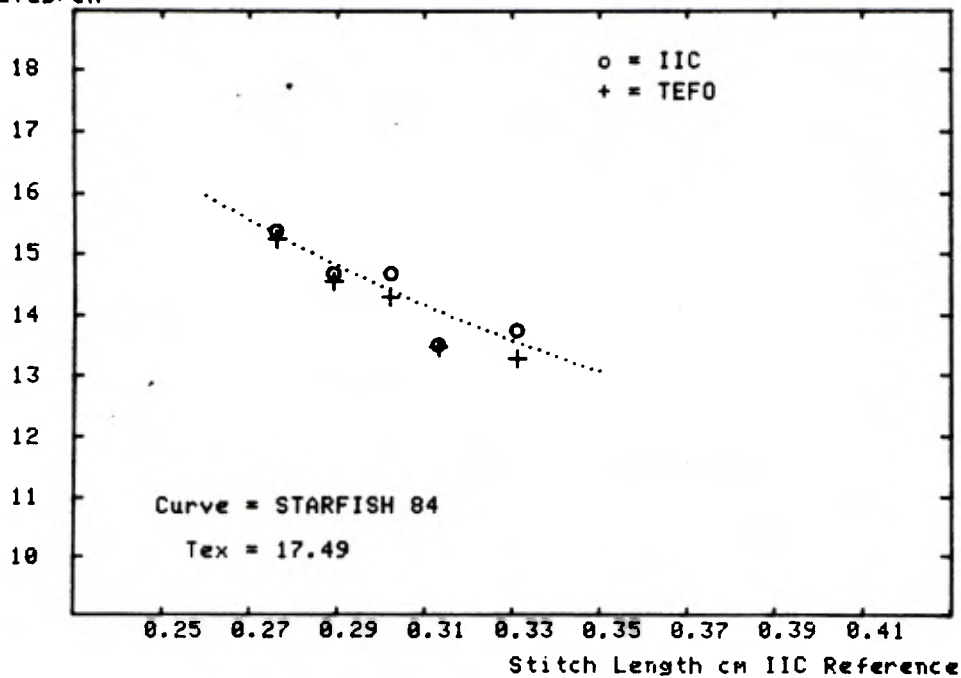


FIGURE 12

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Singles Yarn

Hales/cm

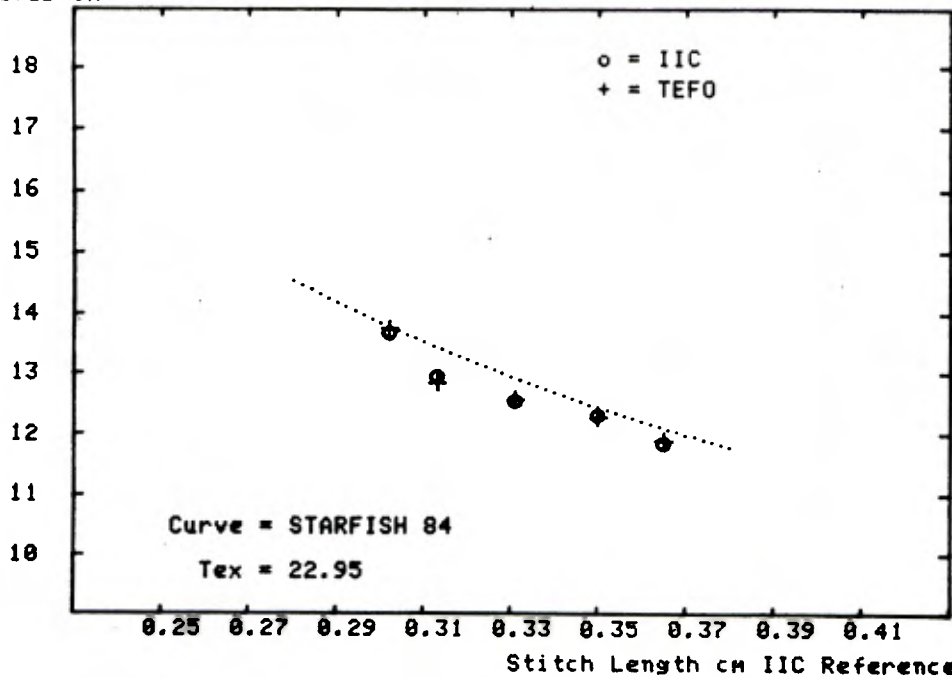


FIGURE 13

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Singles Yarn

Hales/cm

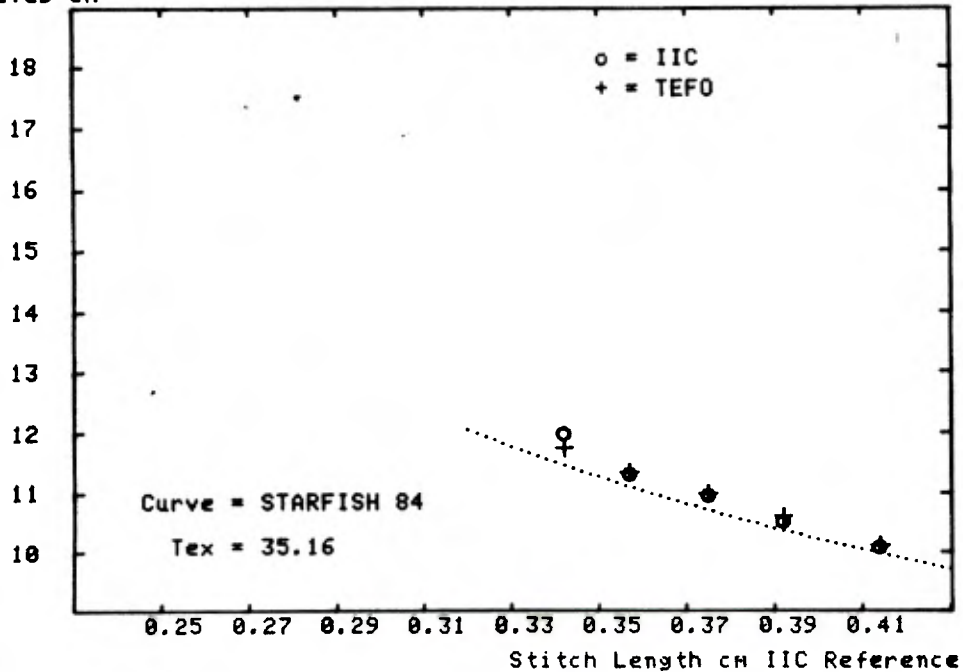
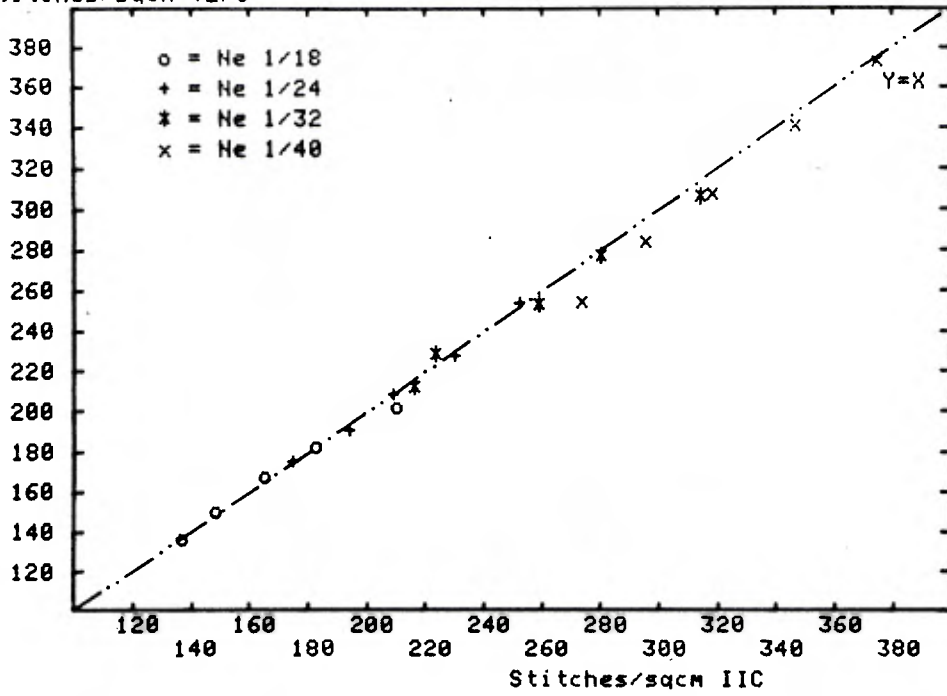


FIGURE 14

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Stitches/sqcm TEFO Finish R-Jet 95 : Singles Yarn

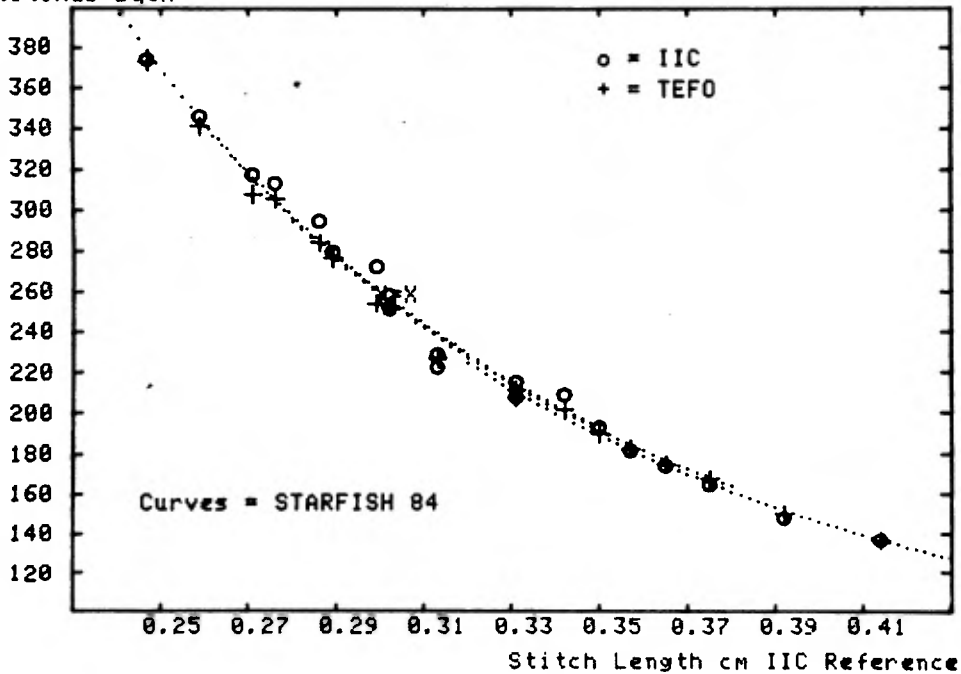
FIGURE 15



IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Stitches/sqcm Finish R-Jet 95 : Singles Yarn

FIGURE 16



IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

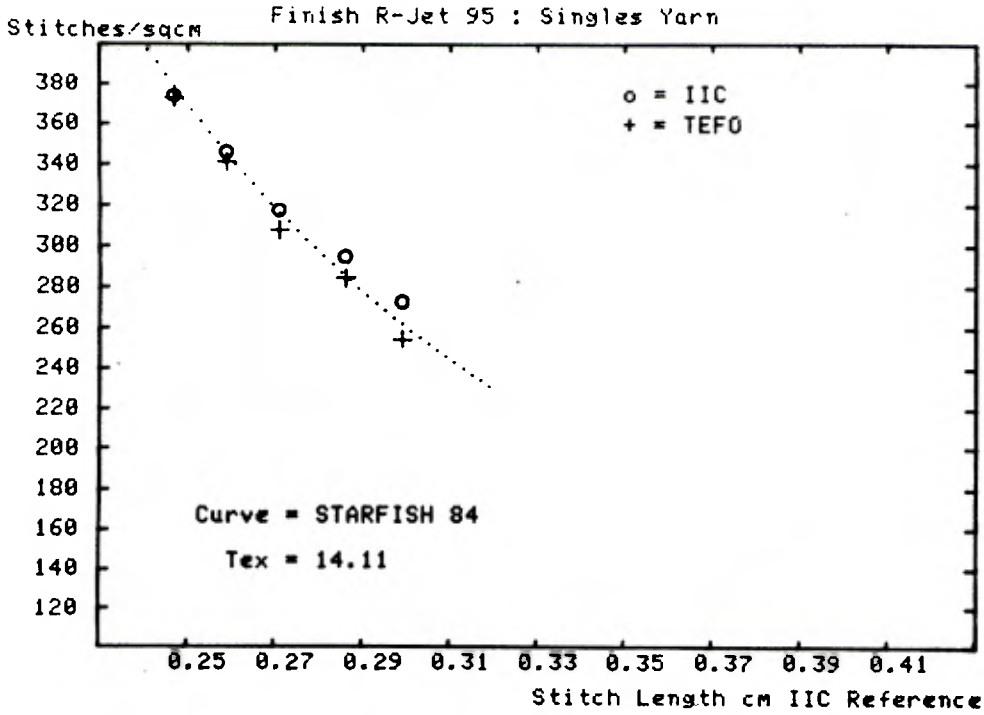


FIGURE 17

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

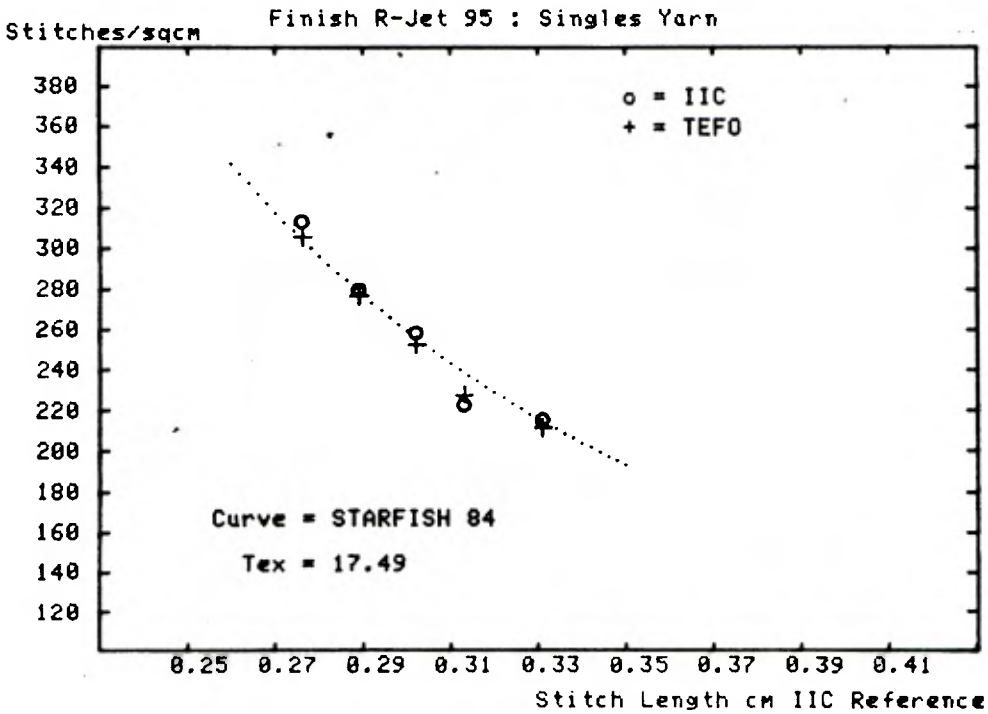


FIGURE 18

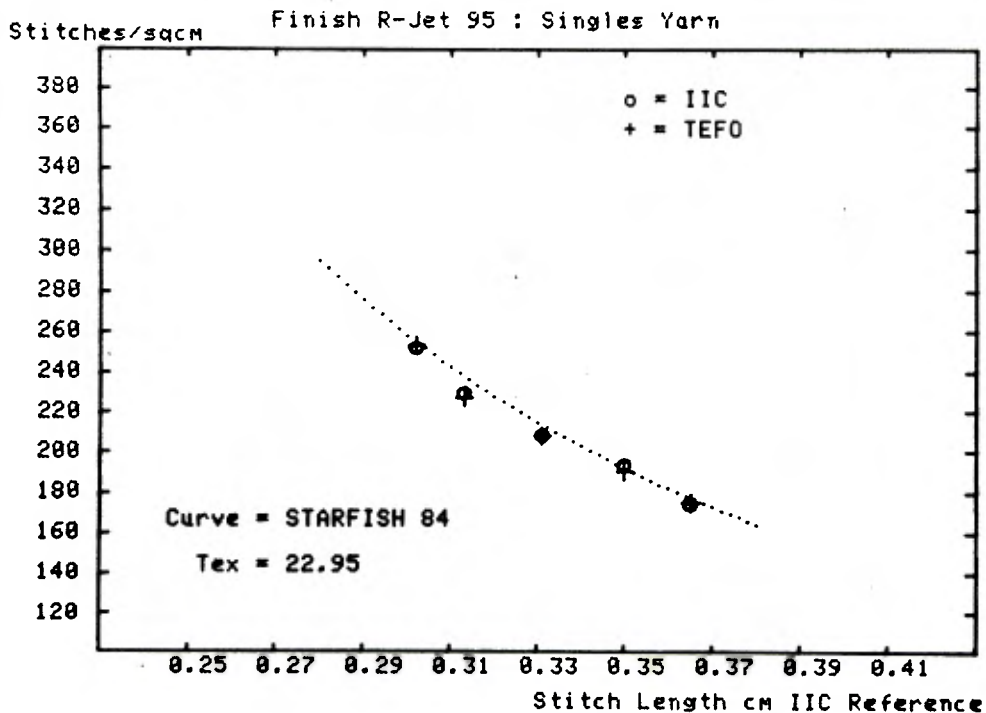
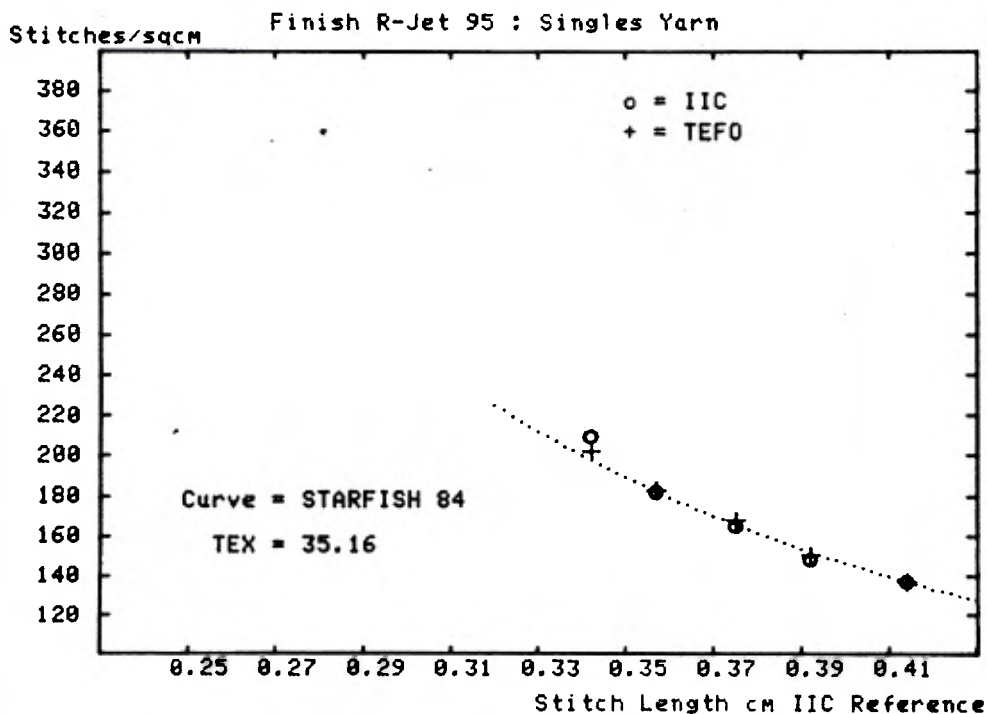


FIGURE 20



IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

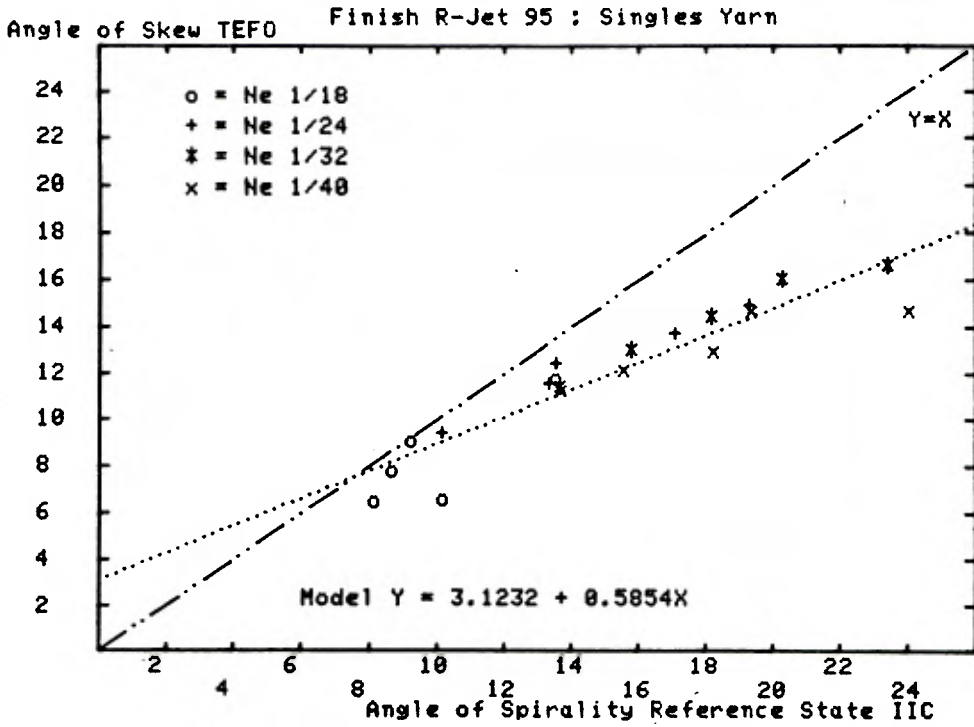


FIGURE 21

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

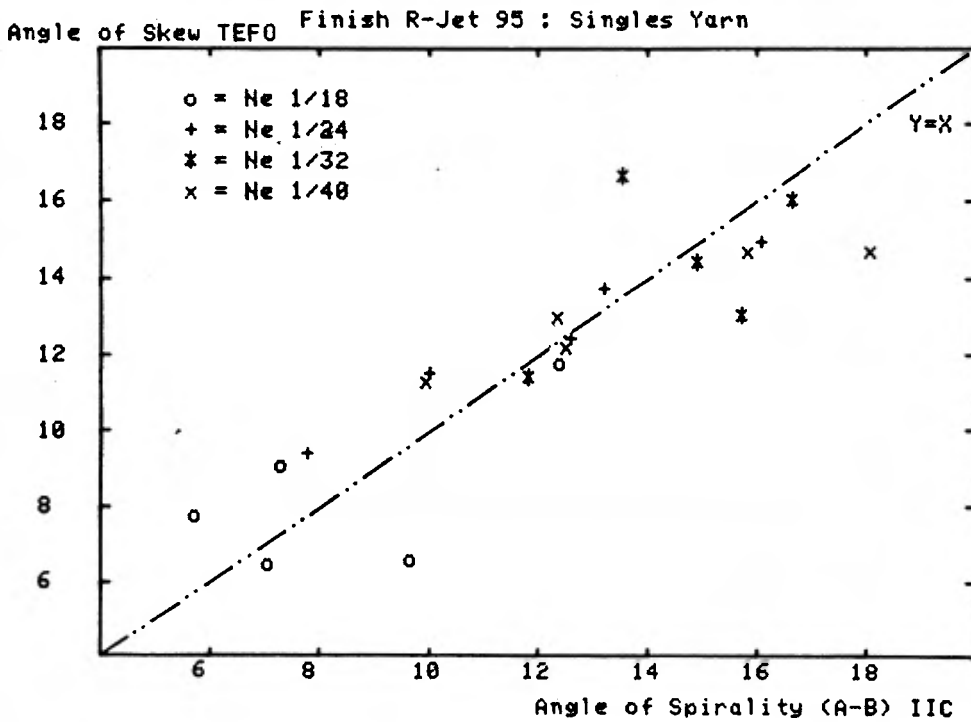


FIGURE 22

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Twofold Yarn

Courses/cm TEFO

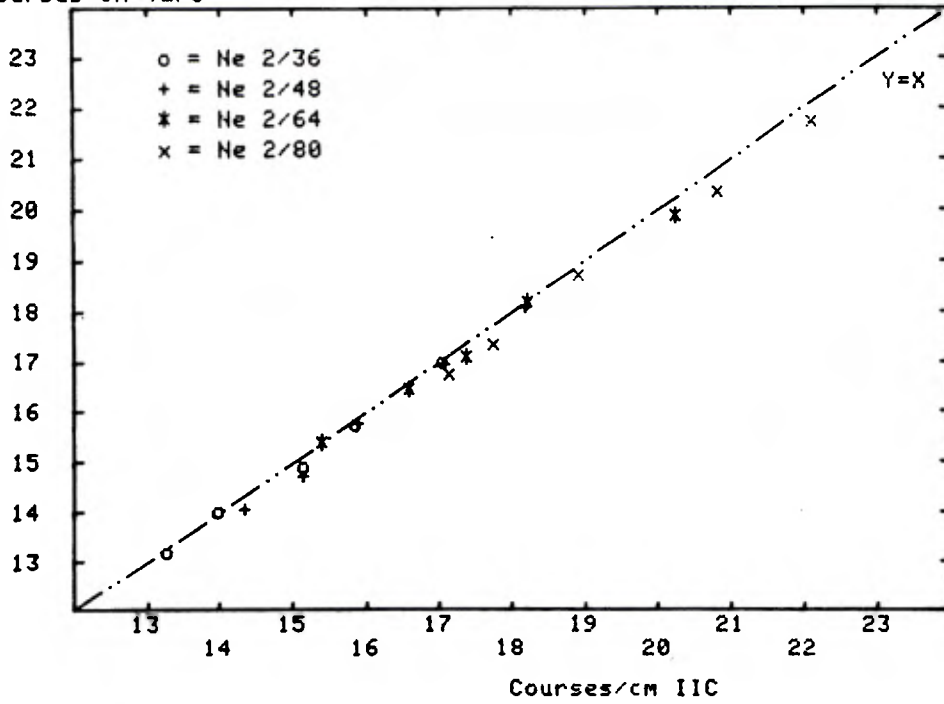


FIGURE 23

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Twofold Yarn

Courses/cm

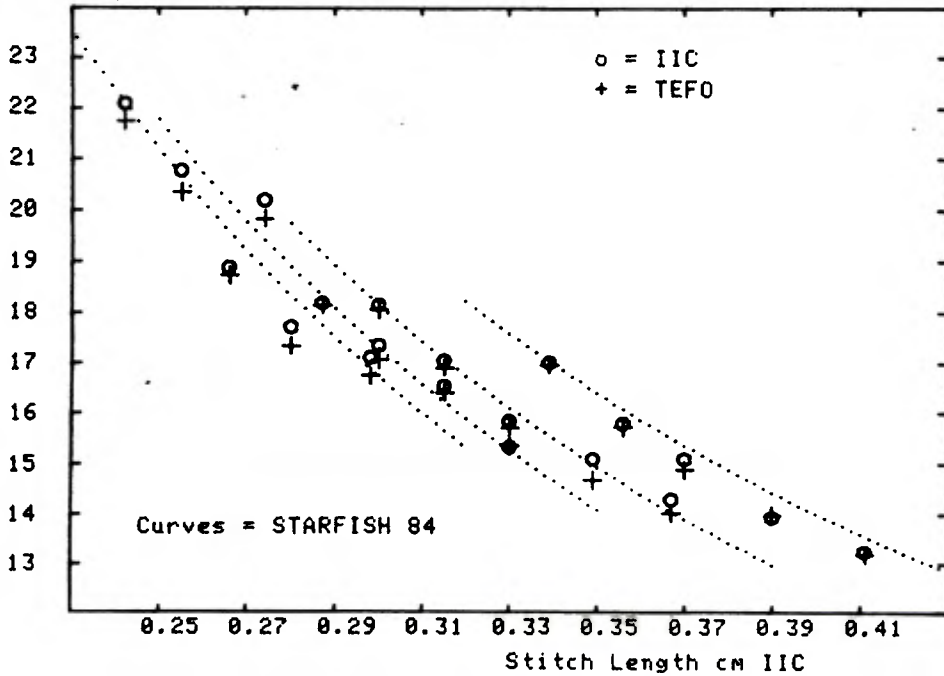


FIGURE 24

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Twofold Yarn

FIGURE 25

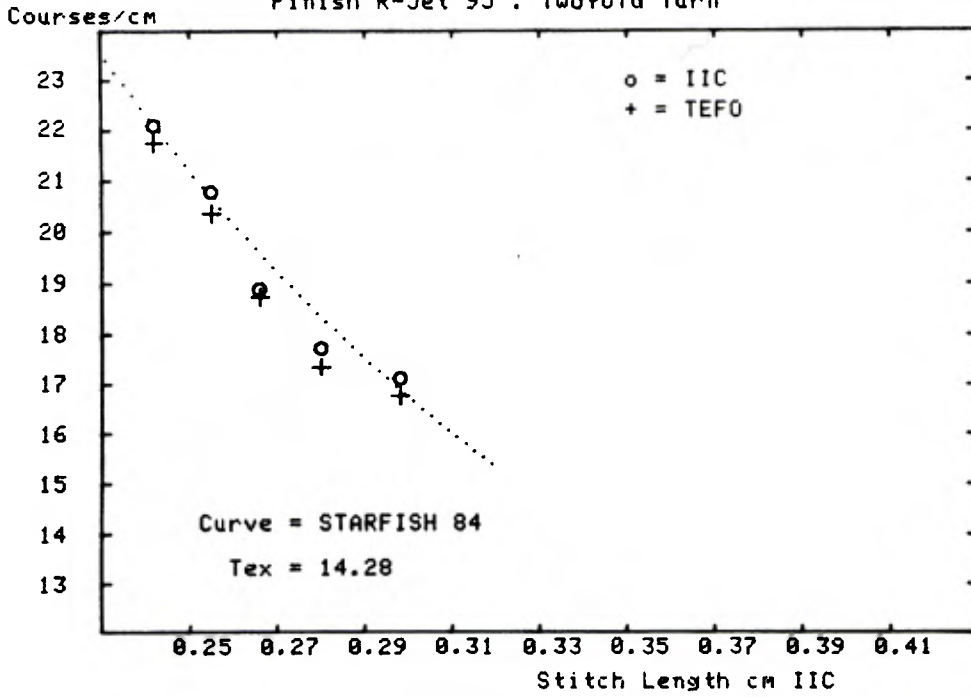
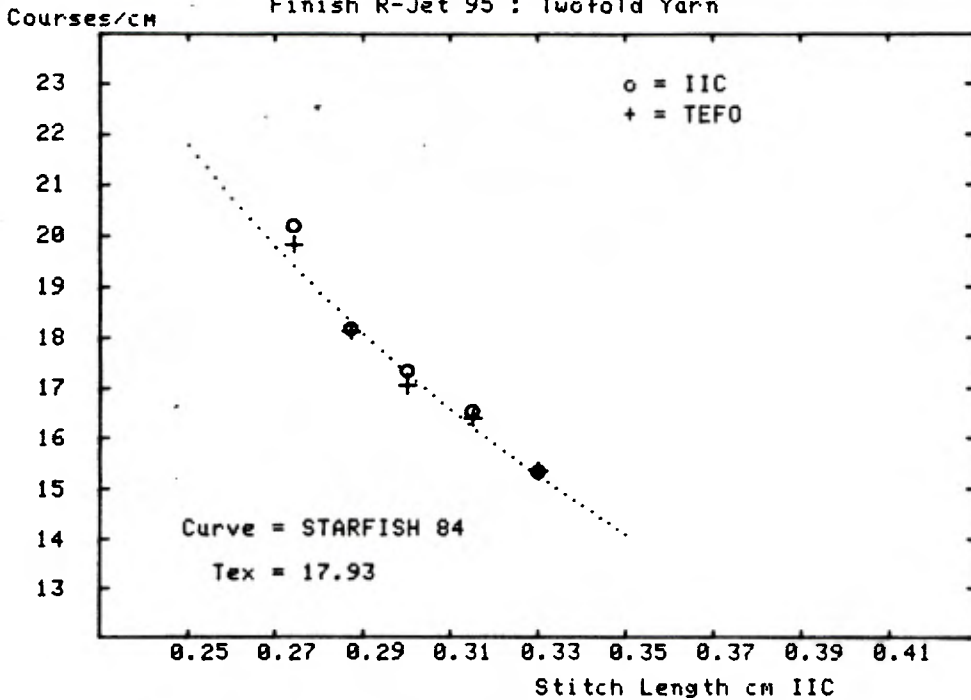


FIGURE 26

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Twofold Yarn



IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Twofold Yarn

Courses/cm

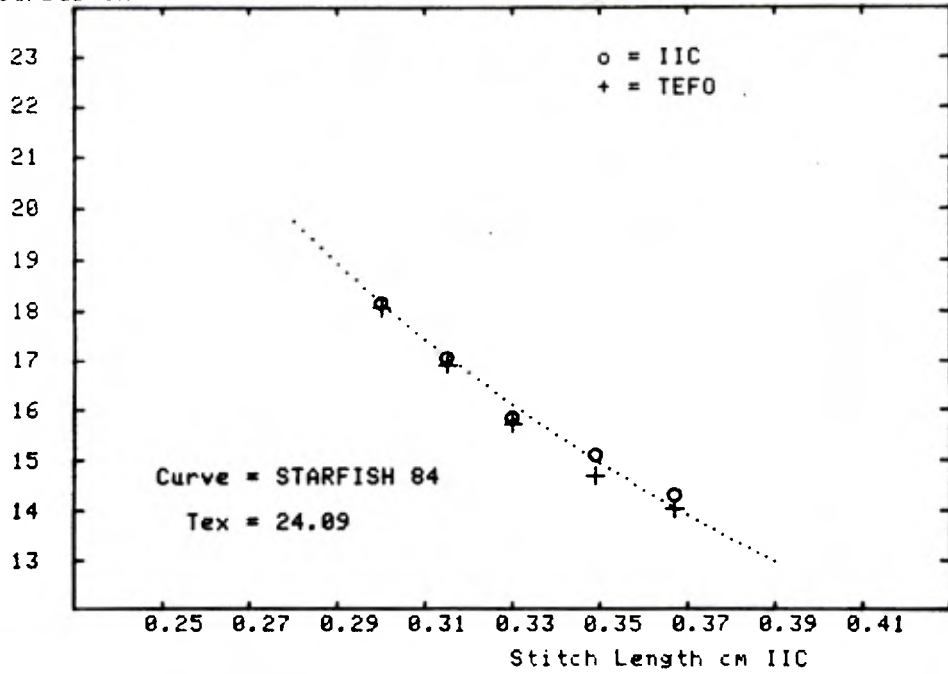


FIGURE 27

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Twofold Yarn

Courses/cm

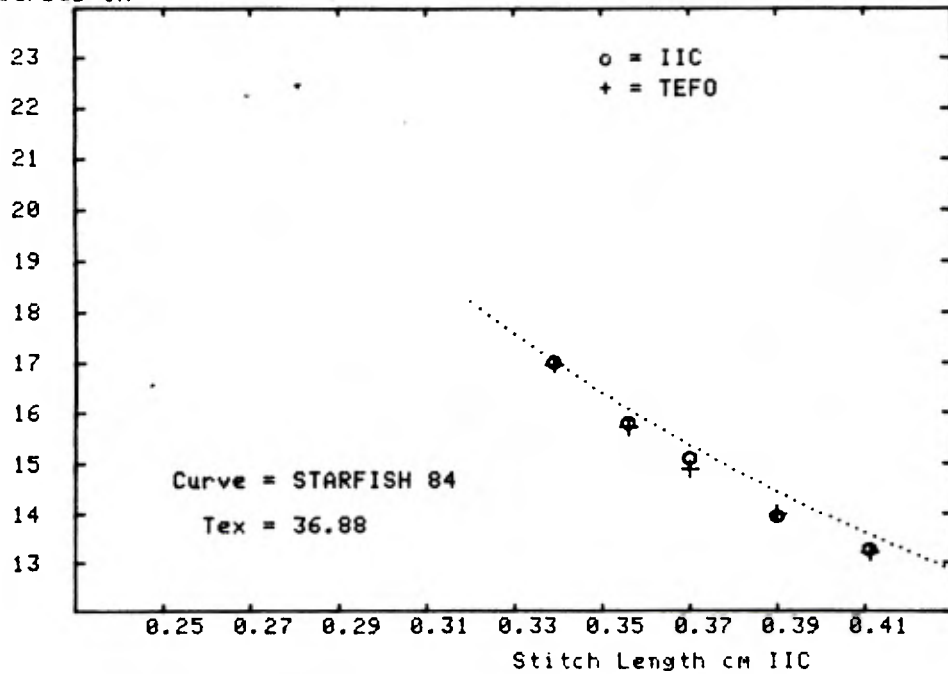


FIGURE 28

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Twofold Yarn

Wales/cm TEFO

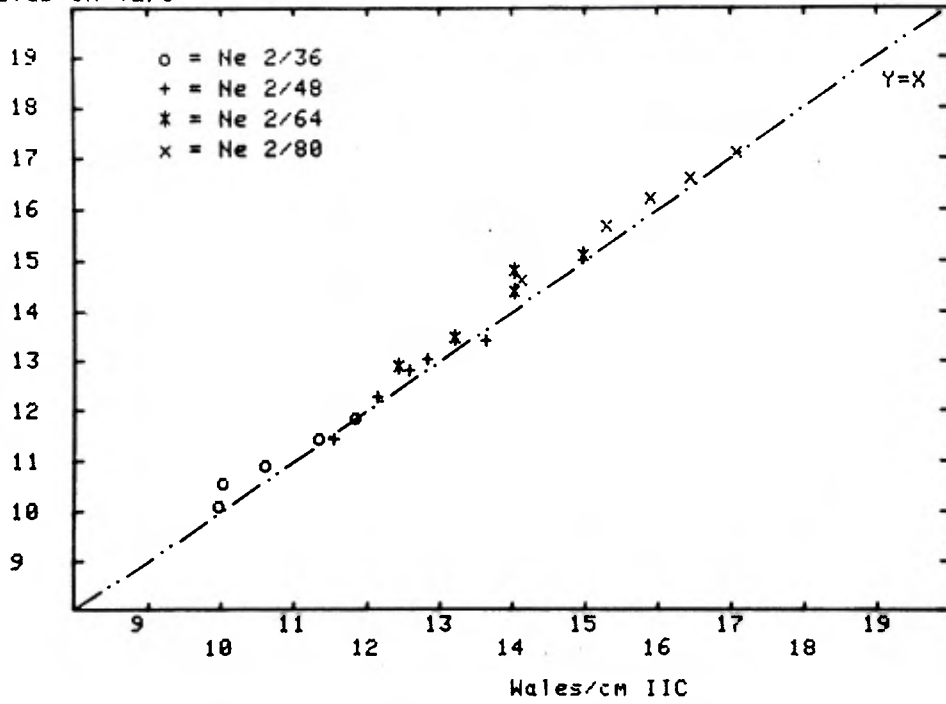


FIGURE 29

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Twofold Yarn

Wales/cm

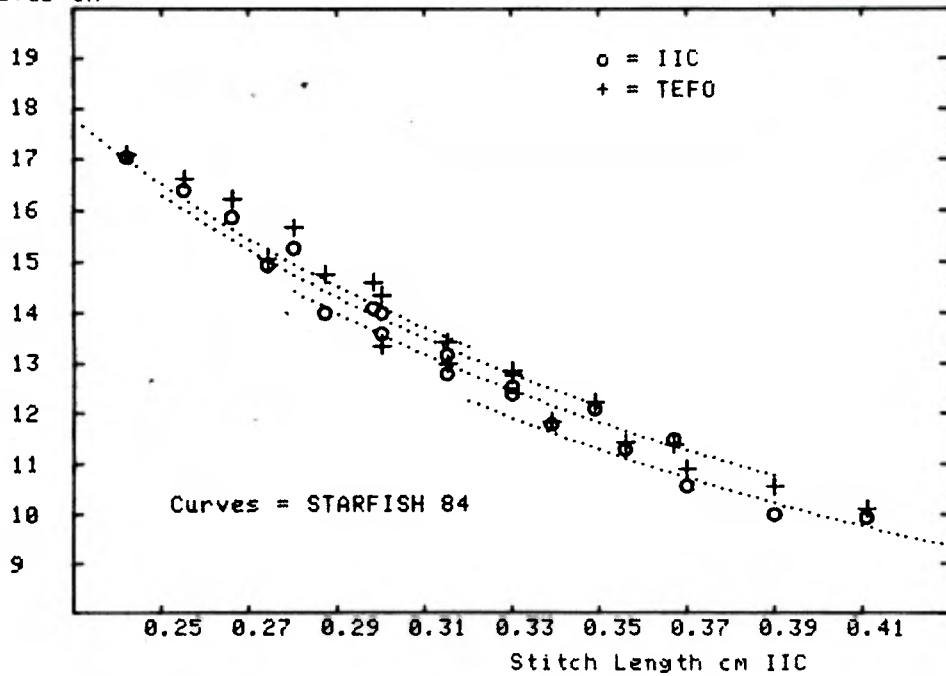


FIGURE 30

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Twofold Yarn

FIGURE 31

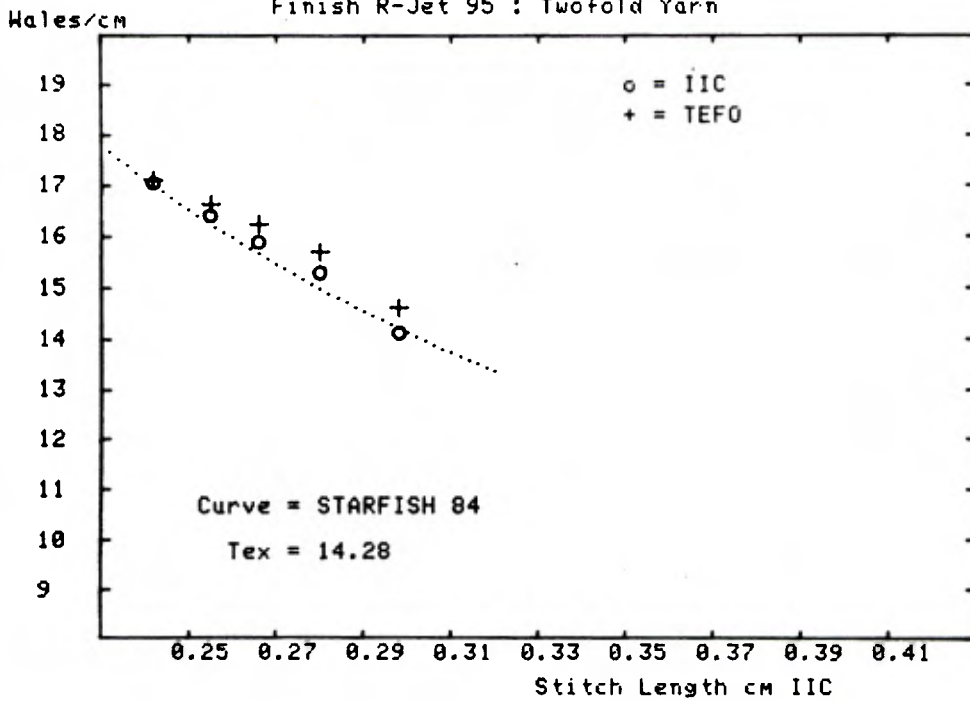
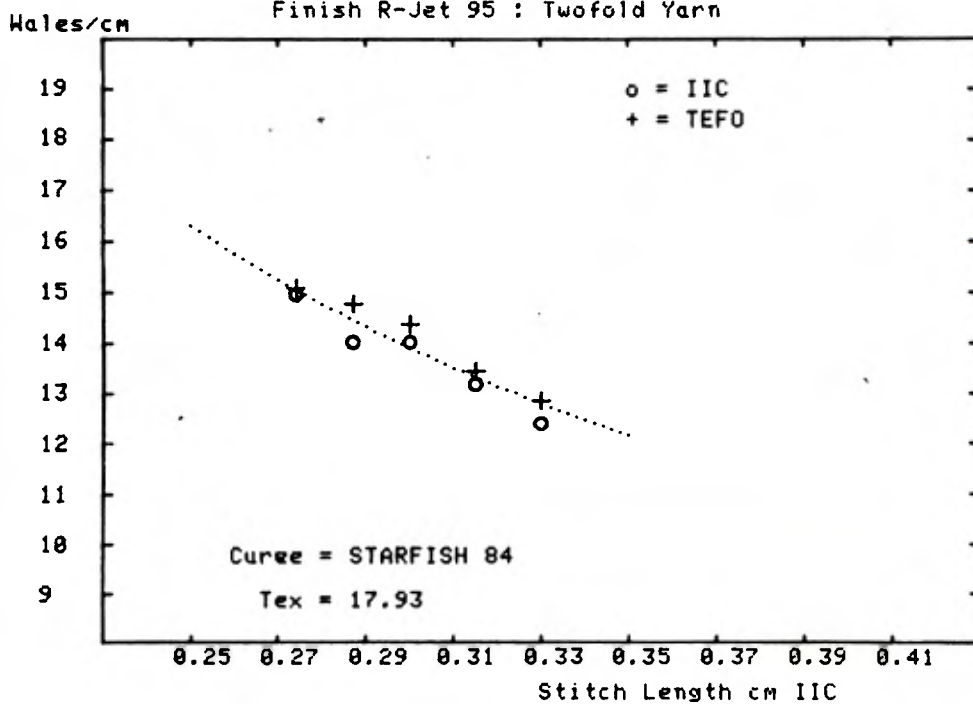


FIGURE 32

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Twofold Yarn



IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Twofold Yarn

FIGURE 33

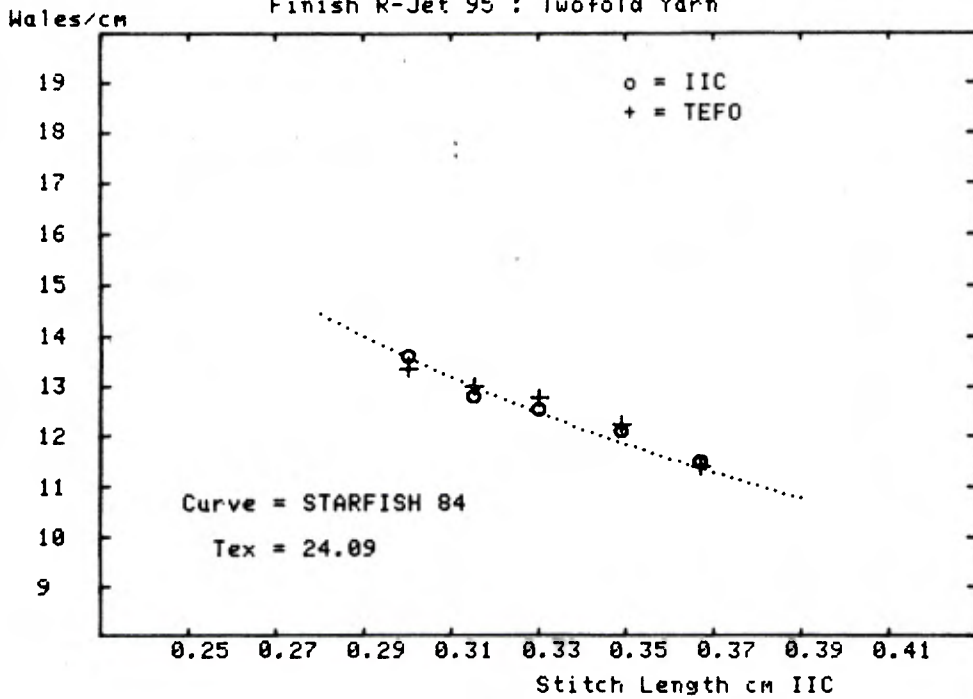
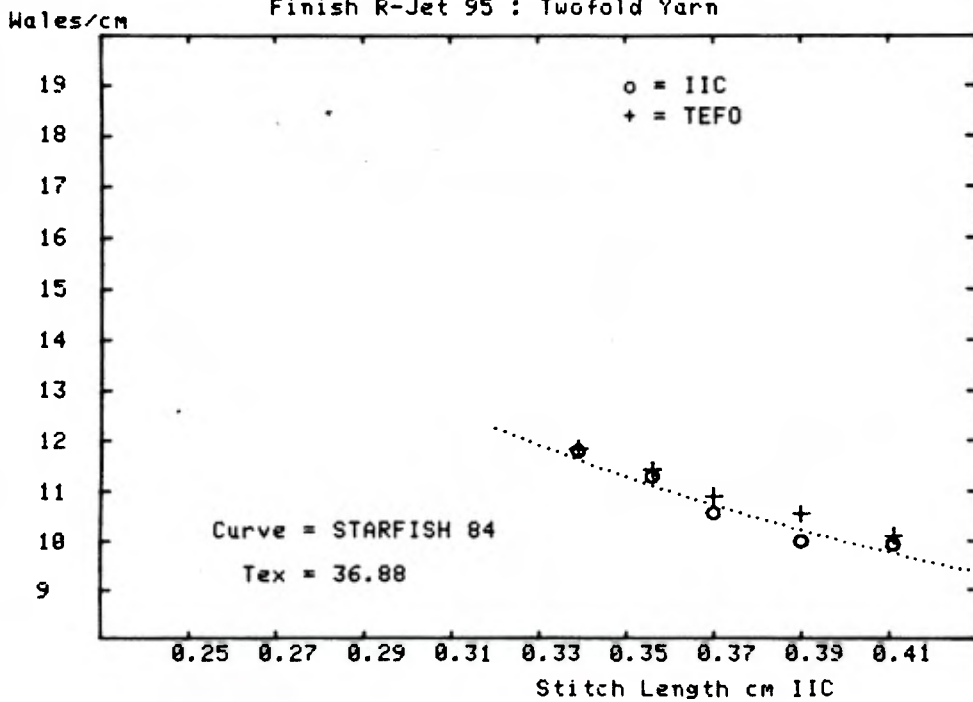


FIGURE 34

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Twofold Yarn



IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Stitches/sqcm TEFO Finish R-Jet 95 : Twofold Yarn

FIGURE 35

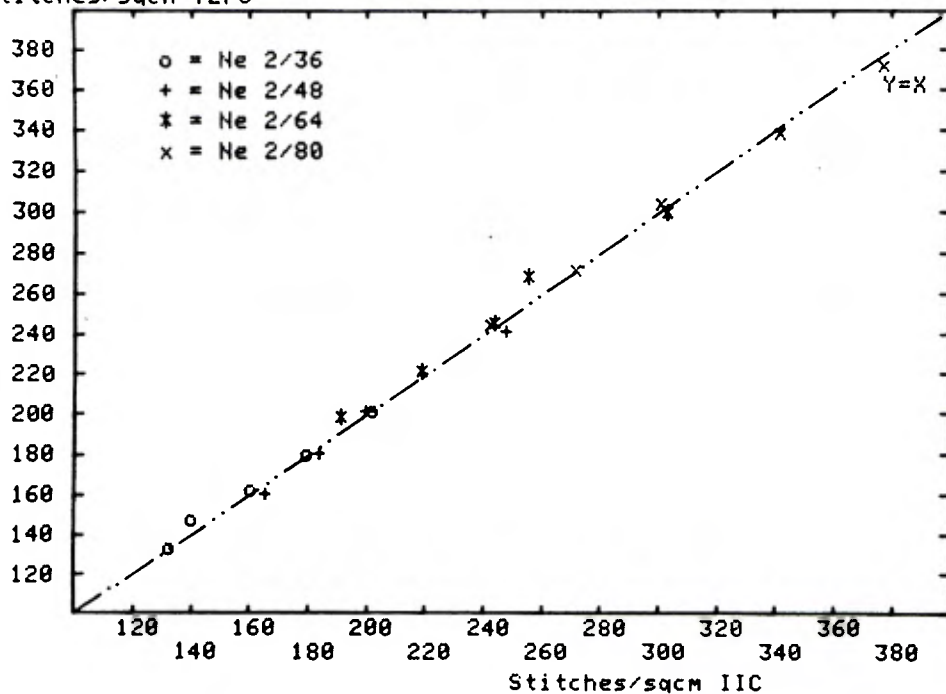
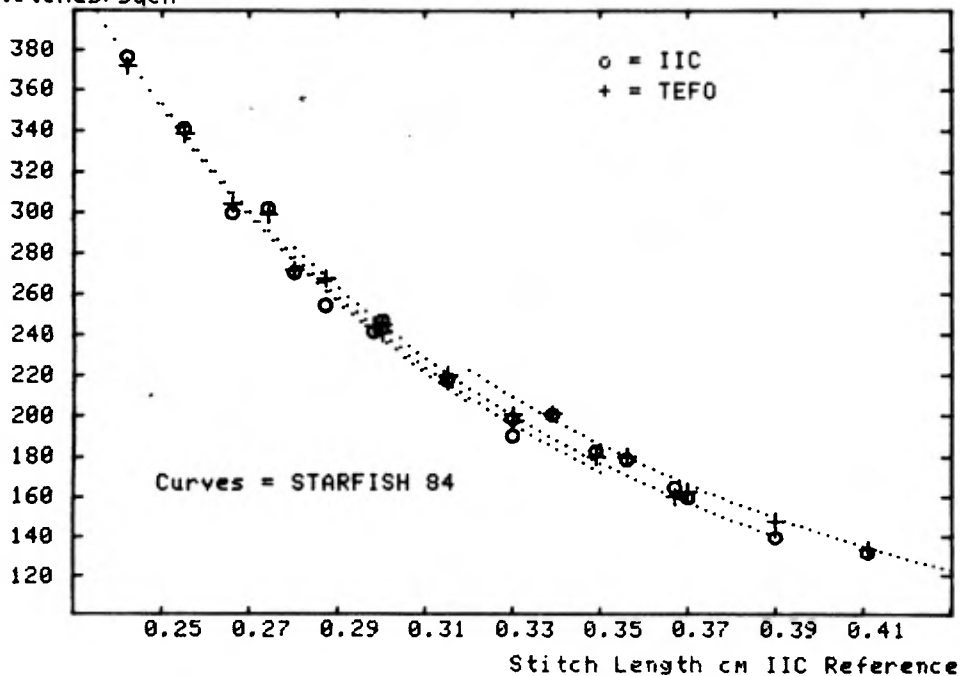


FIGURE 36

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Stitches/sqcm Finish R-Jet 95 : Twofold Yarn



IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Twofold Yarn

Stitches/sqcm

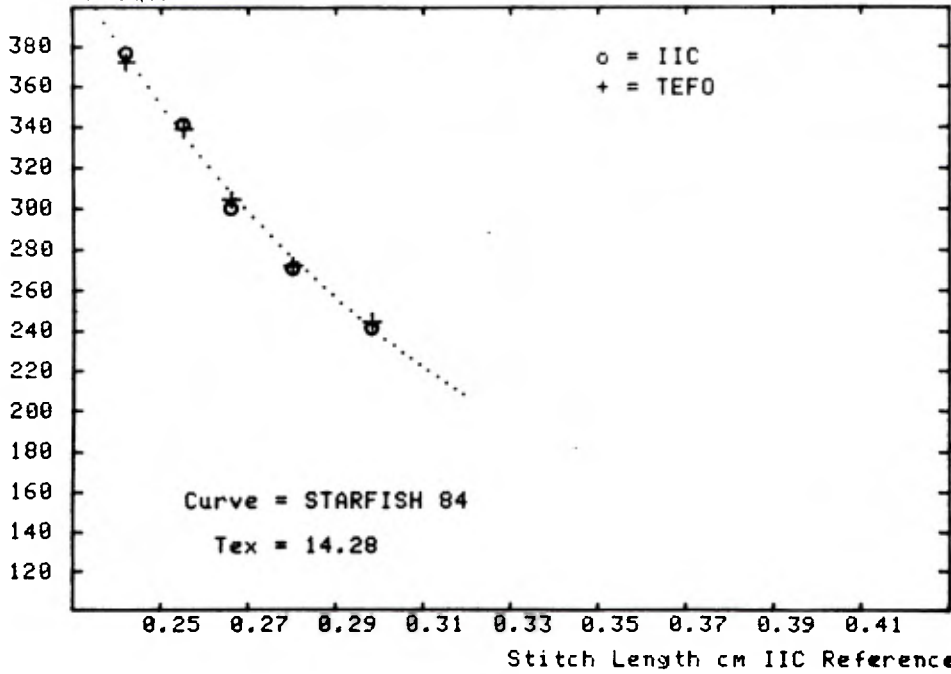


FIGURE 37

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Twofold Yarn

Stitches/sqcm

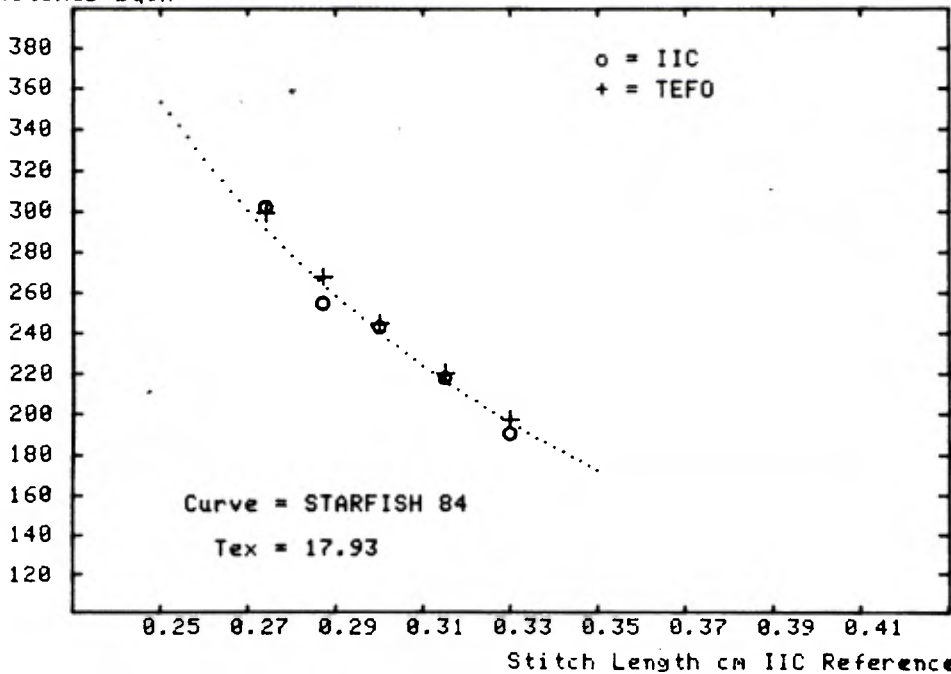


FIGURE 38

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 ; Twofold Yarn

Stitches/sqcm

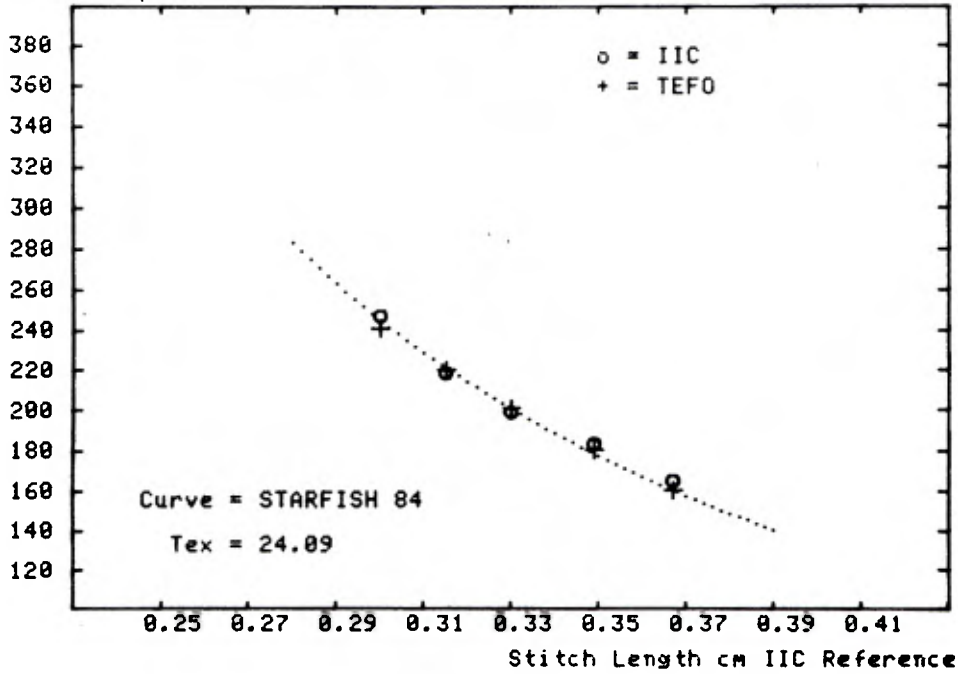


FIGURE 39

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 ; Twofold Yarn

Stitches/sqcm

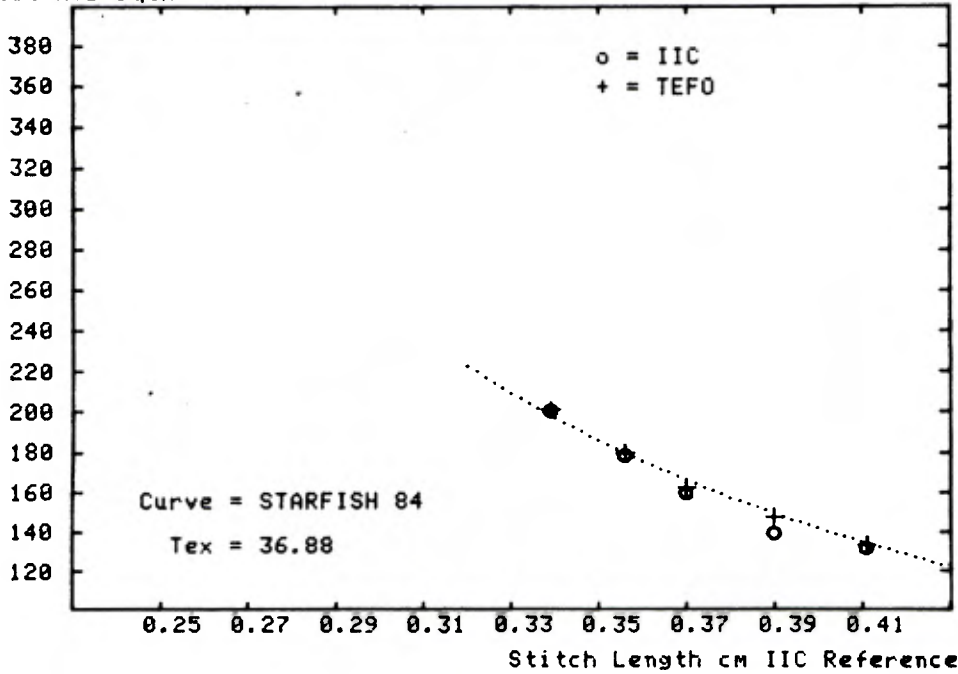


FIGURE 40

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Twofold Yarn

Angle of Skew TEFO

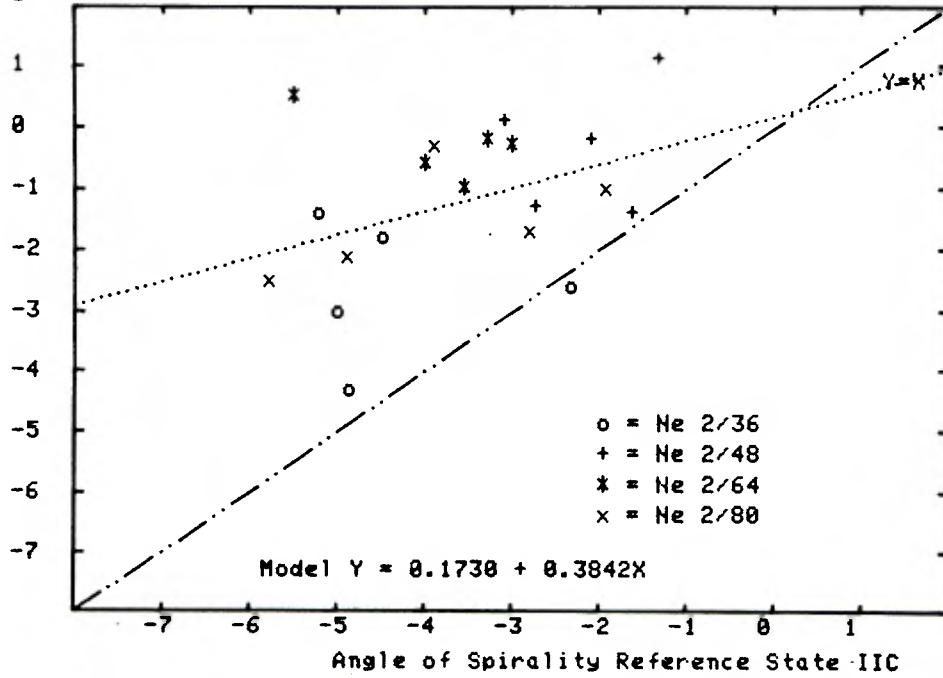


FIGURE 41

IIC/TEFO INTER-LABORATORY COMPARISON : SINGLE JERSEY

Finish R-Jet 95 : Twofold Yarn

Angle of Skew TEFO

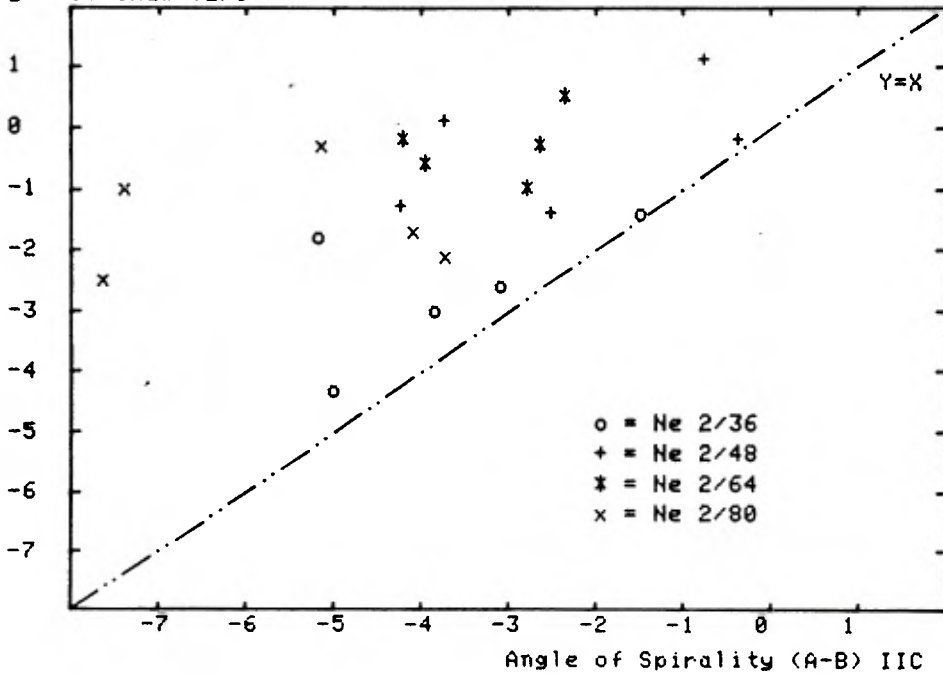


FIGURE 42