August 30, 1960.

Mr. C. R. Hutchcroft:

Subject: Donovan Willow Preparation of Asbestos Fibers

Studies conducted during 1958 indicated that the efficiency of the Donovan willow in the preparation of different Chrysotile fibers varies considerably, and is dependent on both the fiber grade and the fiber source. Since we are currently using six hairpins in the willow at Plant 1, and an average of 18 hairpins in the willows at our pipe plants, the attached study was undertaken to determine the effect of different numbers of hairpins in the preparation of various Chrysotile and Blue fibers as a possible means of increasing their relative strength.

The results of this study indicate that the use of 32 hairpins instead of the present 18 is the most economical for the preparation of pipe fibers, and that the use of 48 hairpins instead of the present six is the most economical for willow preparations at Plant 1. Based on the improved relative strengths obtained with increased preparation, a saving of approximately $200,000 per year would be realized in pipe manufacture, and a saving of approximately $32,000 per year would be realized in the operation of No. 4 Machine, Plant 1. Although this increased preparation would, to some degree, decrease filterability and increase water retention, changes in these characteristics should not drastically affect machine operation.

In addition to the savings from more efficient preparation, there are indications that our fibers, on the average, have been upgraded over the past several years. As a result of this upgrading, an additional decrease in raw material cost of approximately $100,000 per year would be realized in pipe manufacture, and approximately $11,000 per year in the operation of No. 4 Machine, Plant 1.

J A Malone

J. A. Malone

JAM/mdt

Subject:
Denovan Willow Preparation
of Asbestos Fibers

Project 4.1.L
J. A. Malone

Studies conducted during 1958 indicated that the efficiency of the Denovan willow in the preparation of different Chrysotile fibers varies considerably, and is dependent on both the fiber grade and the fiber source. In particular it was noted that the preparation of Cassiar AK with 18 hairpins increased the relative strength by only four per cent, while the same preparation increased the relative strength of Cassiar AC and C&G 3 by an average of 16 per cent, and the relative strength of Bell 4K and C&G 5 by an average of 24 per cent. Since we are currently using six pins in the willow at Plant 1, 18 pins in the willows at Plants 8 and 9, and 21 pins in the willow at Plant 6 (see Appendix I), it appeared desirable to investigate the effect of different numbers of hairpins in the preparation of various Chrysotile and Blue fibers as a possible means of increasing their relative strength.

In this study of willow preparations, Cassiar fiber (grades AC, AK, and AX), C&G fiber (grades 3, 4, and 5), Bell fiber (grades 4K and 6D), and Blue fiber (BT/AC and NC-300) were chosen for test as being representative of the principal asbestos producing areas from which we are currently purchasing. All fibers were evaluated for relative strength, water retention characteristics, filterability, length distribution, dust content, surface area, and buoyancy in the as received state, and after preparation in the Denovan willow with 12, 24, and 48 hairpins (see Appendix II on test procedures). The results obtained are listed in Tables I and II, and are shown graphically in Figures 1 through 30. All preparations were carried out at the standard willow speed of 1250 revolutions per minute and a feed rate of approximately 2000 pounds per hour, using standard hairpins (see Note, Appendix I) which had been conditioned in regular production for approximately 120 hours.

As indicated in Figures 1, 2, 3, and 10, the Cassiar fibers and NC-300 Blue respond similarly to willow preparation in that the relative strength increases rapidly up to about 24 hairpins, reaches its maximum at about 30 hairpins, and thereafter decreases. Reference to Figures 4 through 9 indicates that for the C&G and Bell fibers and for BT/AC Blue, the relative strength increases rapidly up to about 12 hairpins, and thereafter continues to increase gradually up to 48 hairpins.

In terms of fiber filterability and water retention characteristics, the following changes occur in the hairpin ranges indicated:

	Average Decrease in Fiber Filterability			
	0 to 12 pins	12 to 24 pins	24 to 36 pins	36 to 48 pins
Chrysotile Fibers	8	2	2	2
Blue Fibers	15	2	5	12

	Average Increase in Per Cent Water Held after Filtration			
	0 to 12 pins	12 to 24 pins	24 to 36 pins	36 to 48 pins
Chrysotile Fibers	4	1	3	7
Blue Fibers	12	4	11	32

	Average Increase in Per Cent Water Held after Pressing			
	0 to 12 pins	12 to 24 pins	24 to 36 pins	36 to 48 pins
Chrysotile Fibers	2	0	0	0
Blue Fibers	6	1	3	5

Note: zero hairpins - fiber as received

Through the entire range of preparation, there is a continual reduction in the length of all fibers, as indicated by the Clark Fraction 1 weight per cent and the dust content, although only in the case of the Blue fibers, and possibly the C&G 4 and Bell 4K, is the change in dust content truly significant (see Figures 11 through 20). Through the entire range of preparation, there is also a continual increase in the openness of all fibers, as indicated by the surface area and the buoyancy (see Figures 21 through 30).

A cost analysis of the relative strength results for pipe fibers, based on the 1960 allocations (see Appendices III through V), indicates that under the conditions of the present study, optimum operation of the Denovan willow is obtained on the average with about 35 hairpins (see Figure 31). A cost analysis based on the preliminary 1961 requirements also indicates that optimum operation is obtained with about 35 hairpins. In actual production, the use of 32 hairpins, with eight in each stage, would be the most practical, and would give essentially the same results as those obtained with 35. Disregarding the effect of sluggers and hairpin arrangement, a saving in raw material cost of approximately $200,000 per year would result from the use of 32 hairpins instead of the present average of about 18. Further, an additional decrease in raw material cost of approximately $100,000 per year would result from the revised relative strength values obtained in the present study.

Although the use of 32 hairpins would, to some degree, decrease filterability and increase water retention, changes in these characteristics are on the average at a minimum in the 18 to 32 pin range, and should not drastically affect machine operation. In this regard, it is recommended that the number of hairpins in the Denovan willows be increased stepwise, by first going to 24 (with six in each stage), and then 32 (with eight in each stage), so that the plants can become accustomed to any changes in machine operation which [illegible]. It should be noted that the willow stages at Plants [illegible] and 9 are drilled for a maximum of six pins, and that only the willow stages at Plant 8 are drilled for 12. It is recommended that all plants proceed at once to obtain stages similar to those at Plant 8, so that advantage can be taken, at the earliest possible date, of the higher relative strength values obtained with increased fiber preparation. The Engineering Department has estimated that stages similar to those at Plant 8 can be purchased for about $500 per mill, and that the cost of installation would be about $200 to $300 per mill.

A cost analysis of the relative strength results for Bell 4K and Bell 6D, based on the anticipated 1960 usage of these fibers in Apac, Linabestos, Sheetflextos, and Monobestos 6X at Plant 1 (see Appendices III through V), is shown graphically in Figure 3[illegible]. As indicated, a saving in raw material cost of approximately $16,000 per year would result from the use of 24 hairpins instead of the present six, while a saving of approximately $32,000 per year would result from the use of 48 hairpins. Further, an additional decrease in raw material cost of approximately $11,000 per year would result from the revised relative strength values obtained for Bell 4K and Bell 6D in the present study.

Although the use of 24 to 48 hairpins would, to some degree, decrease filterability and increase water retention, changes in these characteristics should not drastically affect machine operation. In this regard, it is recommended that the number of hairpins in the Plant 1 willow be increased stepwise, by first going to 24, and then increasing the number to 32, 40, and finally 48, so that the plant can become accustomed to any changes in machine operation which might occur.

It should be emphasized that the present cost analyses are based, in the case of pipe fibers, on the 1960 allocations and, in the case of No. 4 Machine, Plant 1, on the anticipated 1960 usage of Bell 4K and Bell 6D in Apac, Linabestos, Sheetflextos, and Monobestos 6X. As the availability of certain fibers changes, so also will the number of hairpins for optimum willow operation. In conclusion, it should be especially emphasized that each additional hairpin in the 18 to 32 pin range represents an average saving in pipe manufacture of about $14,000 per year, and that each additional hairpin in the six to 48 pin range represents an average saving in the operation of No. 4 Machine, Plant 1 of about $800 per year.

Table III Denovan Willow Preparations

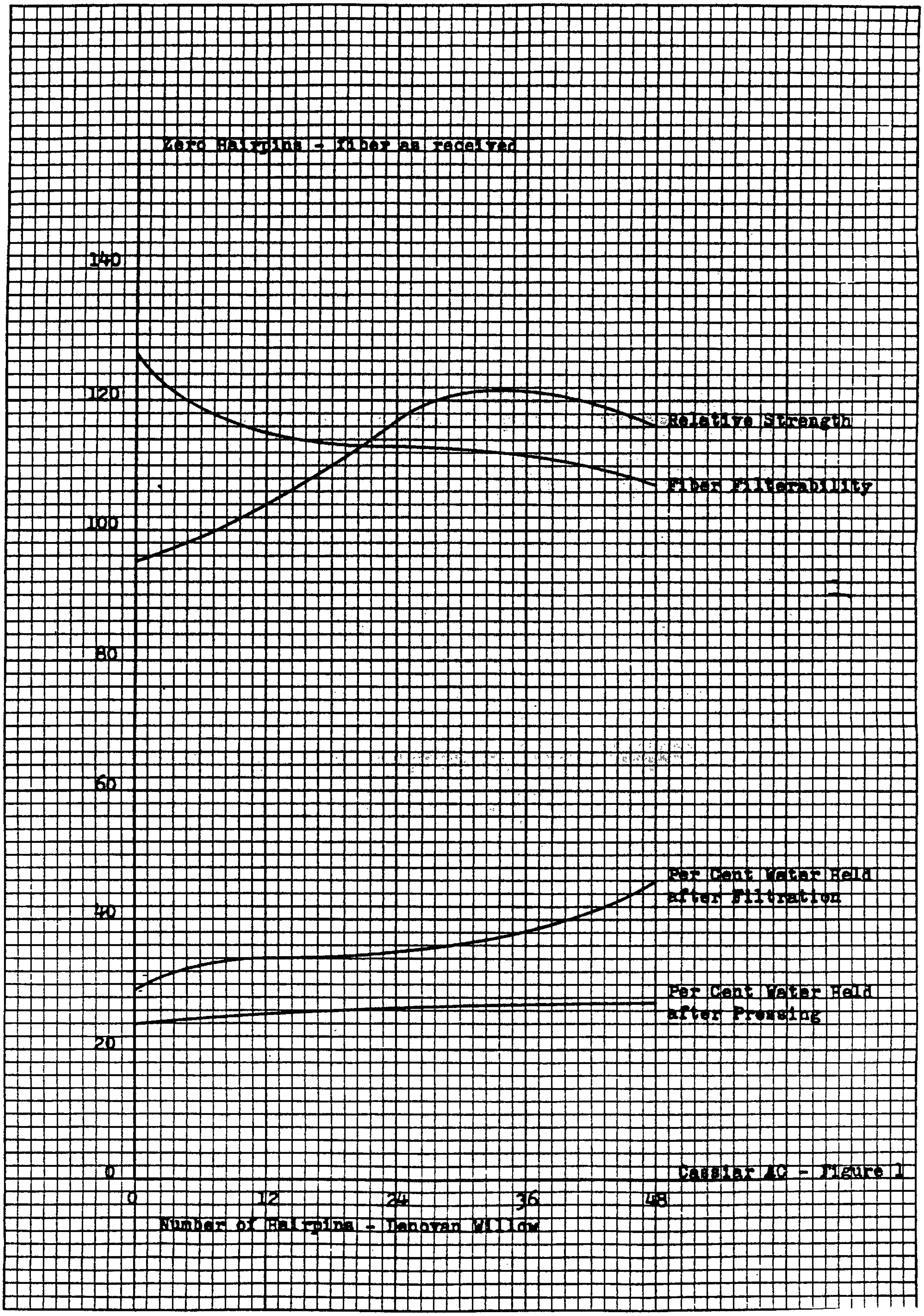
	Cassiar AC	Cassiar AK	Cassiar AX	C&G 3	C&G 4	C&G 5	Bell 4K	Bell 6D	BT/AG Blue	NC-300 Blue
Relative Strength										
As Received	95	96	66	86	63	43	62	42	57	31
Willowed 3-3-3-3	104	98	85	106	78	54	83	48	102	63
Willowed 6-6-6-6	117	108	87	107	81	58	87	49	105	72
Willowed 12-12-12-12	116	104	83	114	83	62	96	53	113	71
Filtering Time - Sec.										
As Received	49	57	55	42	53	61	54	73	48	48
Willowed 3-3-3-3	44	46	52	41	49	61	54	72	38	41
Willowed 6-6-6-6	44	45	45	41	46	51	49	62	35	38
Willowed 12-12-12-12	33	35	39	32	36	43	35	51	22	21
% Water after Filtration										
As Received	29	31	29	36	32	31	41	43	31	29
Willowed 3-3-3-3	34	37	34	43	36	34	44	43	44	39
Willowed 6-6-6-6	35	37	36	43	37	35	45	46	48	42
Willowed 12-12-12-12	46	52	48	45	47	48	59	55	89	87
% Water after Pressing										
As Received	24	25	23	27	24	23	25	24	25	25
Willowed 3-3-3-3	26	26	25	29	26	26	28	26	31	30
Willowed 6-6-6-6	26	27	25	29	26	26	28	26	32	30
Willowed 12-12-12-12	27	27	25	29	26	26	28	27	40	37
Fiber Filterability										
As Received	127	109	96	123	105	85	79	23	114	119
Willowed 3-3-3-3	115	103	89	111	94	71	76	22	100	104
Willowed 6-6-6-6	113	101	86	106	93	69	75	22	97	103
Willowed 12-12-12-12	107	96	84	98	90	66	73	21	77	89
Surface Area - sq. cm/gram										
As Received	2500	3100	4200	4100	3900	4300	5800	10,800	3000	3200
Willowed 3-3-3-3	5600	6700	6000	7200	6400	6900	9500	13,000	6700	7200
Willowed 6-6-6-6	6000	7600	6300	8200	6700	7100	10,400	13,200	7700	8000
Willowed 12-12-12-12	7300	8800	7000	9200	8200	8300	11,000	13,500	11,900	10,200
Buoyancy										
As Received	52	44	40	98	60	34	57	49	61	64
Willowed 3-3-3-3	88	79	50	124	79	47	80	53	119	120
Willowed 6-6-6-6	93	82	59	134	82	50	89	55	142	139
Willowed 12-12-12-12	116	112	70	163	89	50	118	55	187	179

Note: Fibers passed through Denovan willow with the number of hairpins in each stage as indicated. The lower the Fiber Filterability, the slower the rate of filtration.

Table IV - Denovan Willow Preparations (Clark Classifier)

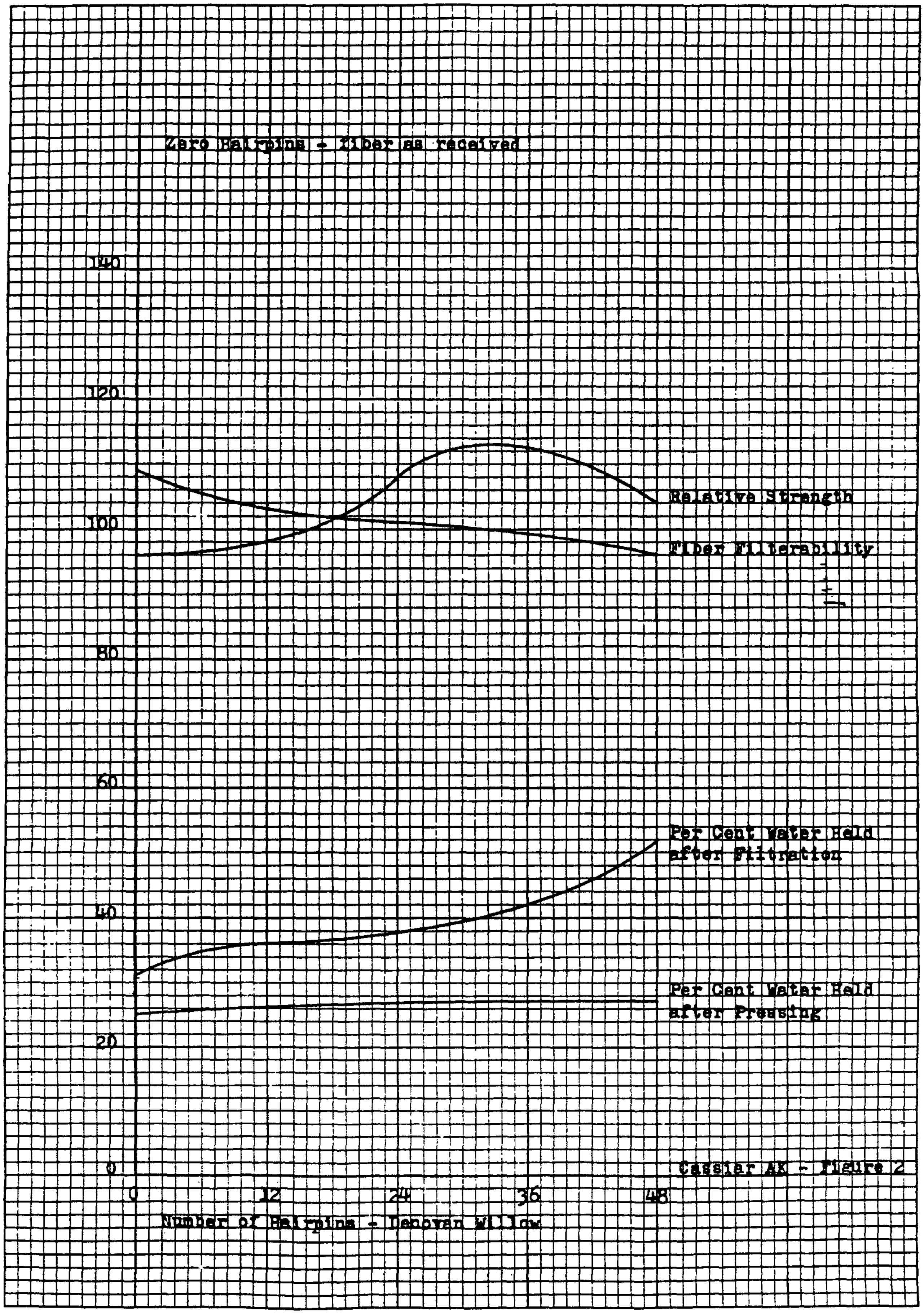
	Cassiar AC	Cassiar AK	Cassiar AX	C&G 3	C&G 4	C&G 5	Bell 4K	Bell 6D	BT/AC Blue	NC-300 Blue
As Received										
Fraction 1	25.1	14.2	6.9	22.5	11.1	10.0	24.4	4.1	51.9	40.5
Fraction 2	20.5	16.0	7.1	27.9	12.3	5.7	18.1	3.3	14.0	13.9
Fraction 3	29.9	29.9	42.8	22.8	34.0	24.8	21.8	17.6	15.8	19.3
Fraction 4	9.3	11.7	19.4	6.8	14.2	22.5	7.5	17.6	5.4	8.2
Dust (-100 mesh)	15.2	28.2	23.8	20.0	28.4	37.0	28.2	57.4	12.9	18.1
Willowed 3-3-3-3										
Fraction 1	16.5	5.3	2.5	13.2	4.9	6.0	13.7	2.1	33.9	15.8
Fraction 2	24.0	20.0	4.5	29.5	10.0	3.3	22.2	2.5	17.9	20.1
Fraction 3	36.0	38.0	46.0	28.6	40.8	27.9	27.0	17.3	22.6	28.3
Fraction 4	9.5	11.5	21.6	8.0	14.7	24.0	8.3	18.2	8.8	13.2
Dust (-100 mesh)	14.0	25.2	25.4	20.7	29.6	38.8	28.8	59.9	16.8	22.6
Willowed 6-6-6-6										
Fraction 1	12.6	5.1	3.5	10.7	4.0	5.4	10.6	2.4	27.2	12.8
Fraction 2	26.4	18.9	4.6	27.9	10.0	4.5	20.4	3.1	19.4	21.2
Fraction 3	38.4	38.9	44.1	32.7	43.3	29.3	28.5	16.3	25.4	27.6
Fraction 4	10.0	12.1	22.5	8.9	14.5	23.6	9.3	19.5	8.6	13.3
Dust (-100 mesh)	12.6	25.0	25.3	19.8	28.2	37.2	31.2	58.7	19.4	25.1
Willowed 12-12-12-12										
Fraction 1	12.5	5.0	3.1	9.4	3.3	4.5	9.9	2.0	23.7	8.4
Fraction 2	22.3	17.2	4.1	26.8	7.5	3.4	18.8	1.9	20.1	16.4
Fraction 3	39.2	37.3	45.6	32.8	40.3	26.7	30.8	16.1	24.5	28.0
Fraction 4	11.7	12.8	22.8	9.1	16.2	26.7	9.5	20.0	9.9	16.9
Dust (-100 mesh)	14.3	27.7	24.4	21.9	32.7	38.7	31.0	60.0	21.8	30.3

Note: Fibers passed through Denovan willow with the number of hairpins in each stage as indicated. All results expressed as weight percents.



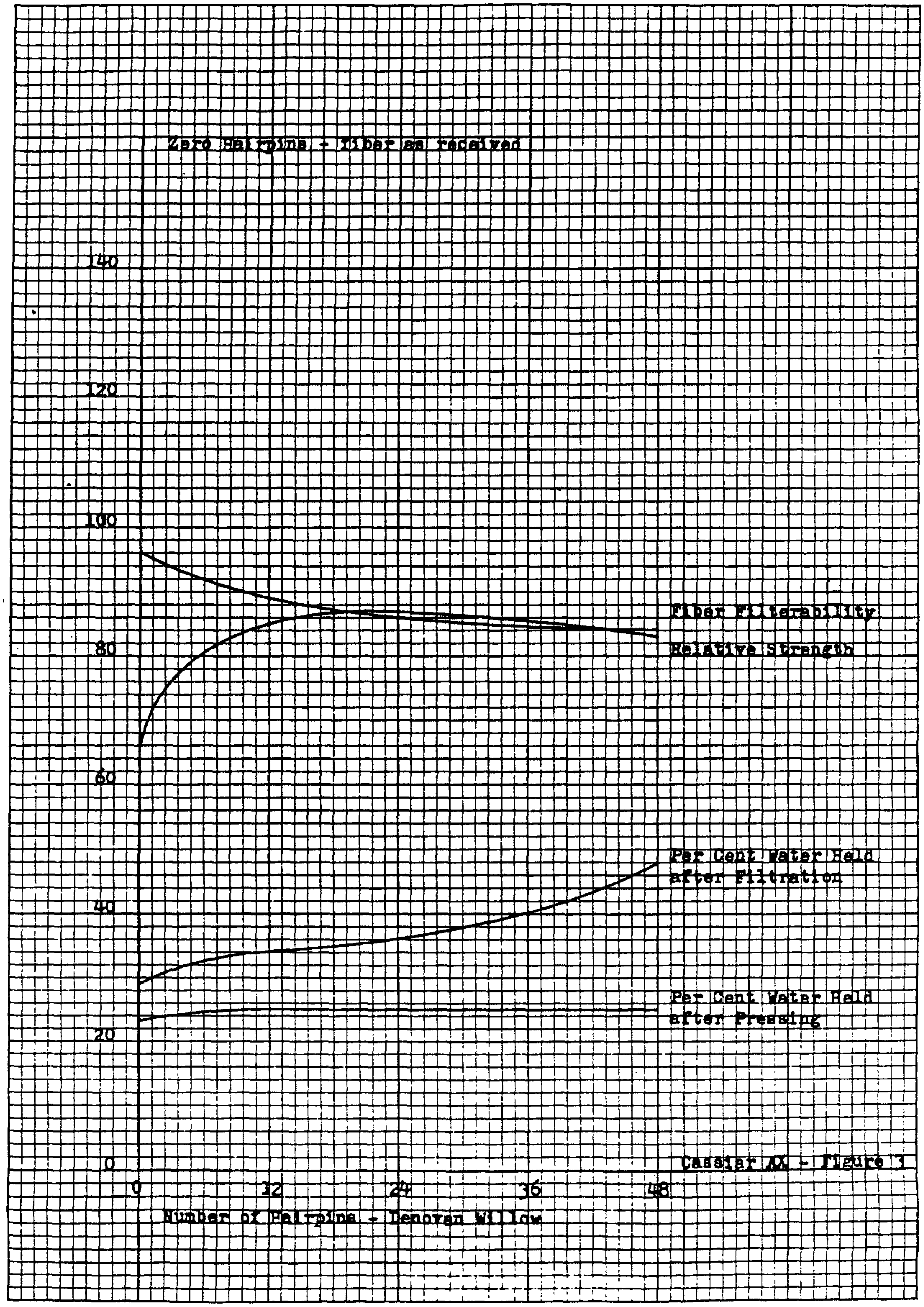
Zero Hairpins - fiber as received
140
120
100
80
60
40
20
0
Relative Strength
Fiber Filterability
Per Cent Water Held
after Filtration
Per Cent Water Held
after Pressing
Cassiar AC - Figure 1
0
12
24
36
48
Number of Hairpins - Donovan Willow

CTD000930



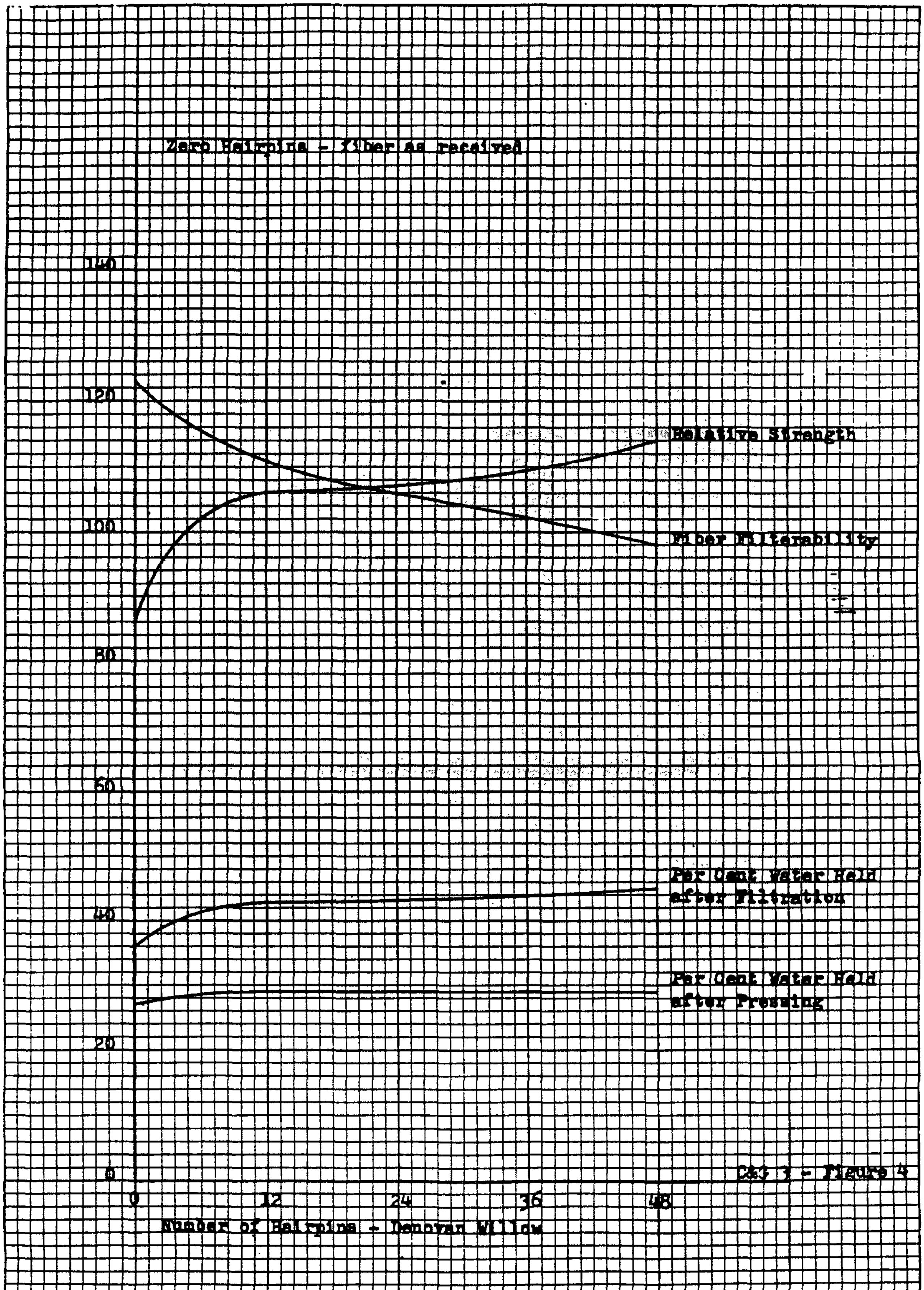
Zero Hairpins - Fiber as received
140
120
100
80
60
40
20
0
0
12
24
36
48
Number of Hairpins - Donovan Willow
Relative Strength
Fiber Filterability
Per Cent Water Held after Filtration
Per Cent Water Held after Pressing
Cassiar AK - Figure 2

CTD000931

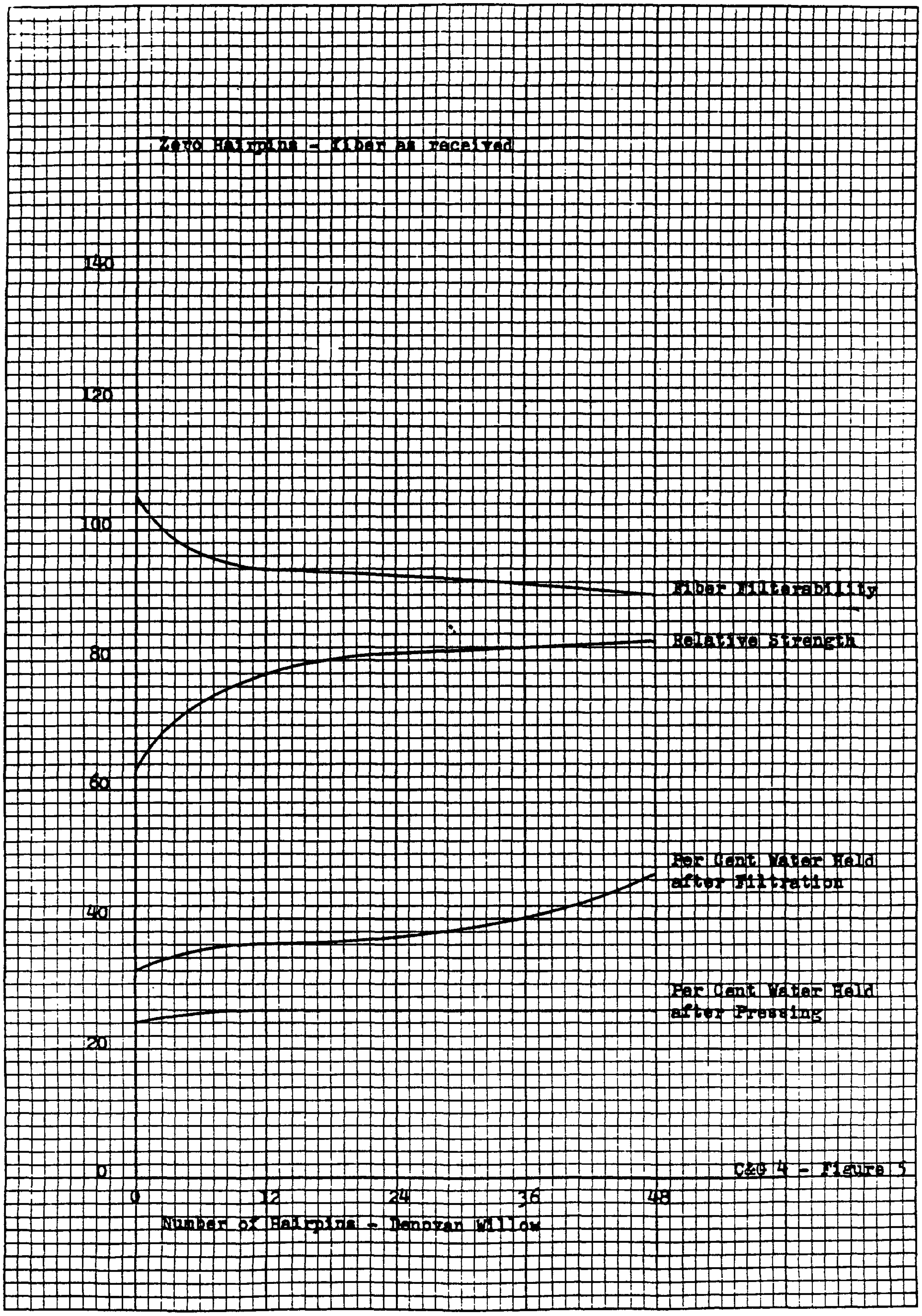


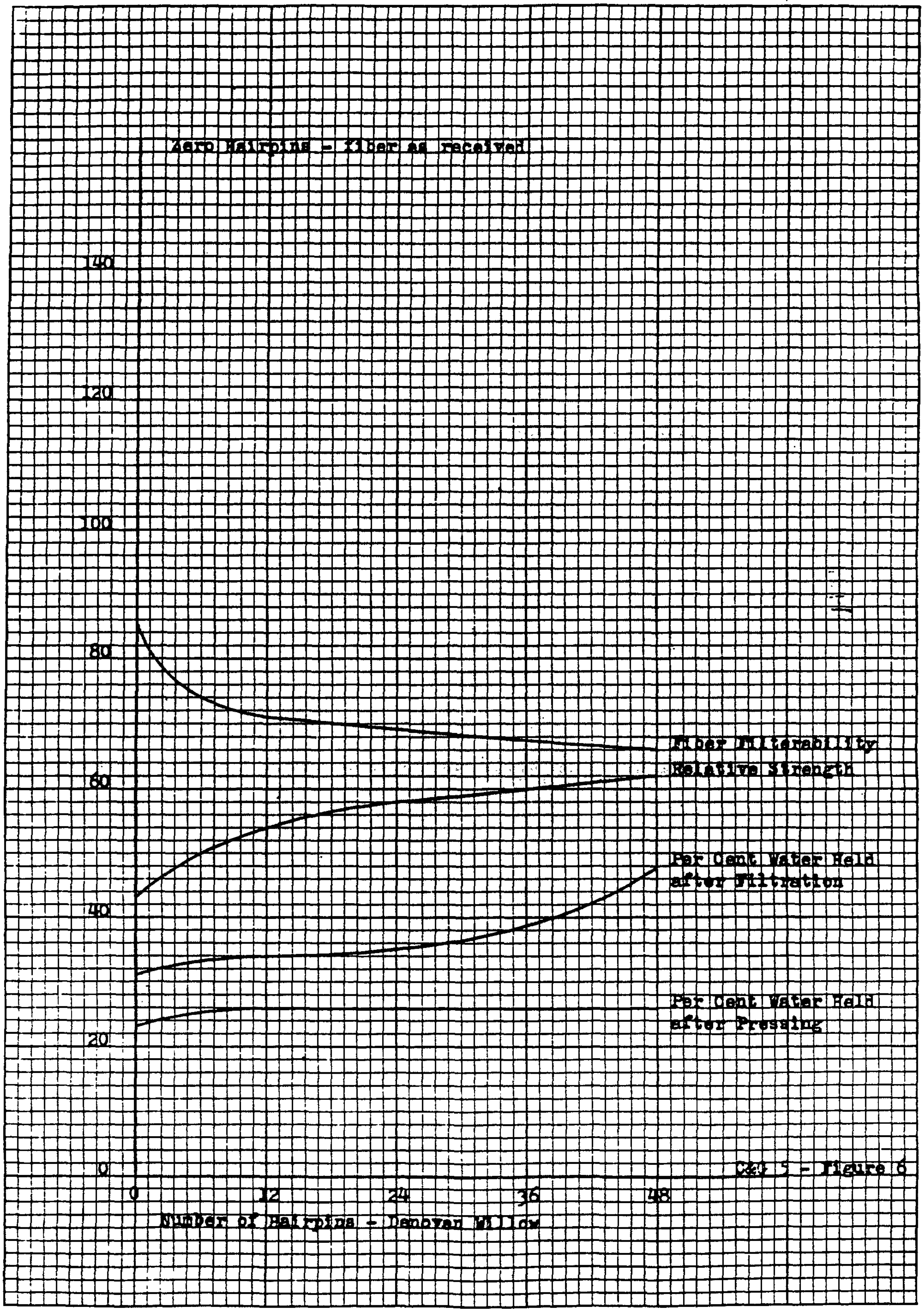
Zero Hairpins - Fiber as received
140
120
100
80
60
40
20
0
0
12
24
36
48
Number of Hairpins - Donovan Willow
Fiber Filterability
Relative Strength
Per Cent Water Held after Filtration
Per Cent Water Held after Pressing
Cassiar AX - Figure 3

CTD000932

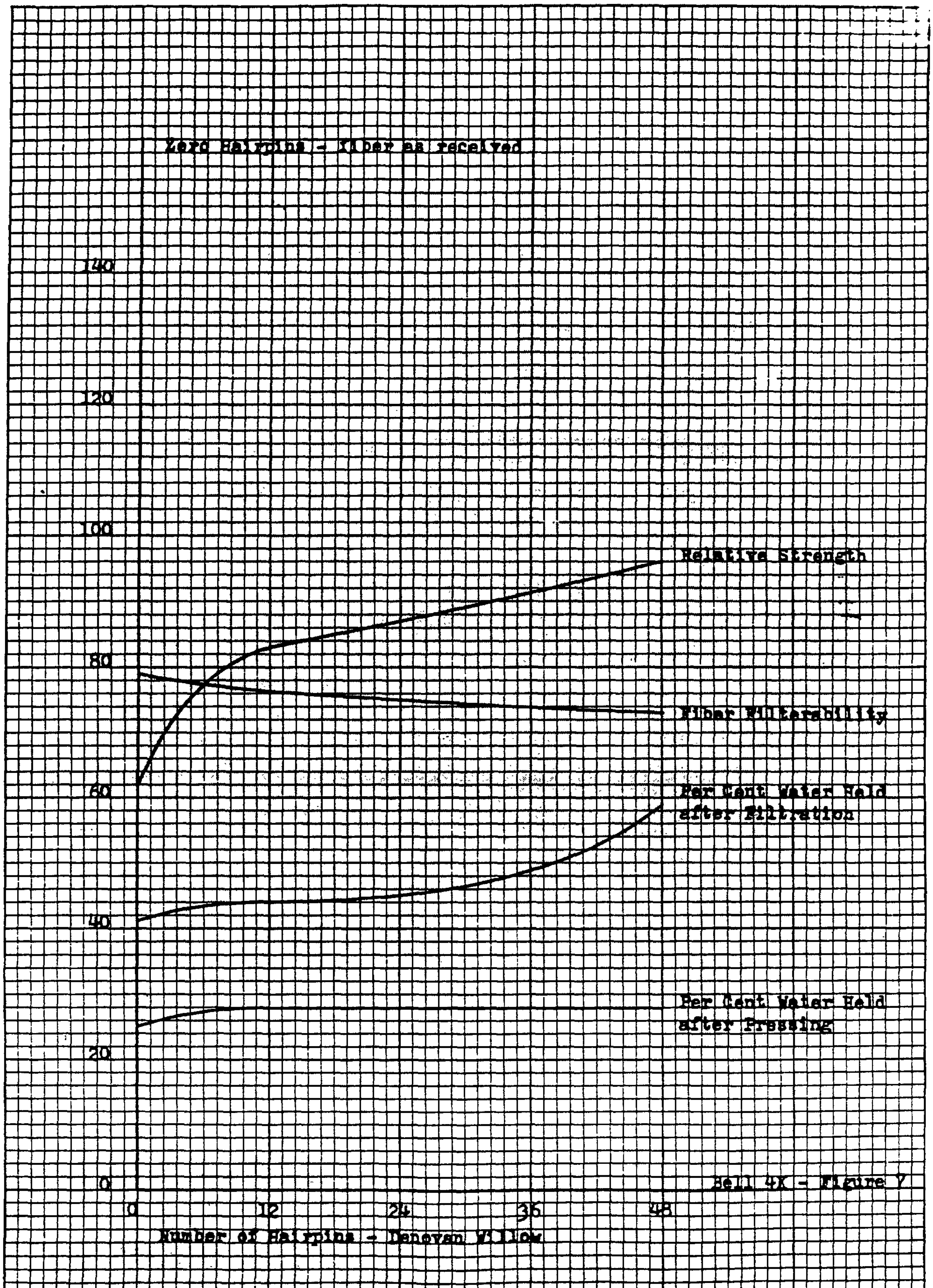

Zero Hairpins - fiber as received
140
120
100
80
60
40
20
0
Relative Strength
Fiber Filterability
Per Cent Water Held
after Filtration
Per Cent Water Held
after Pressing
C&S 3 - Figure 4
0
12
24
36
48
Number of Hairpins - Donovan Willow

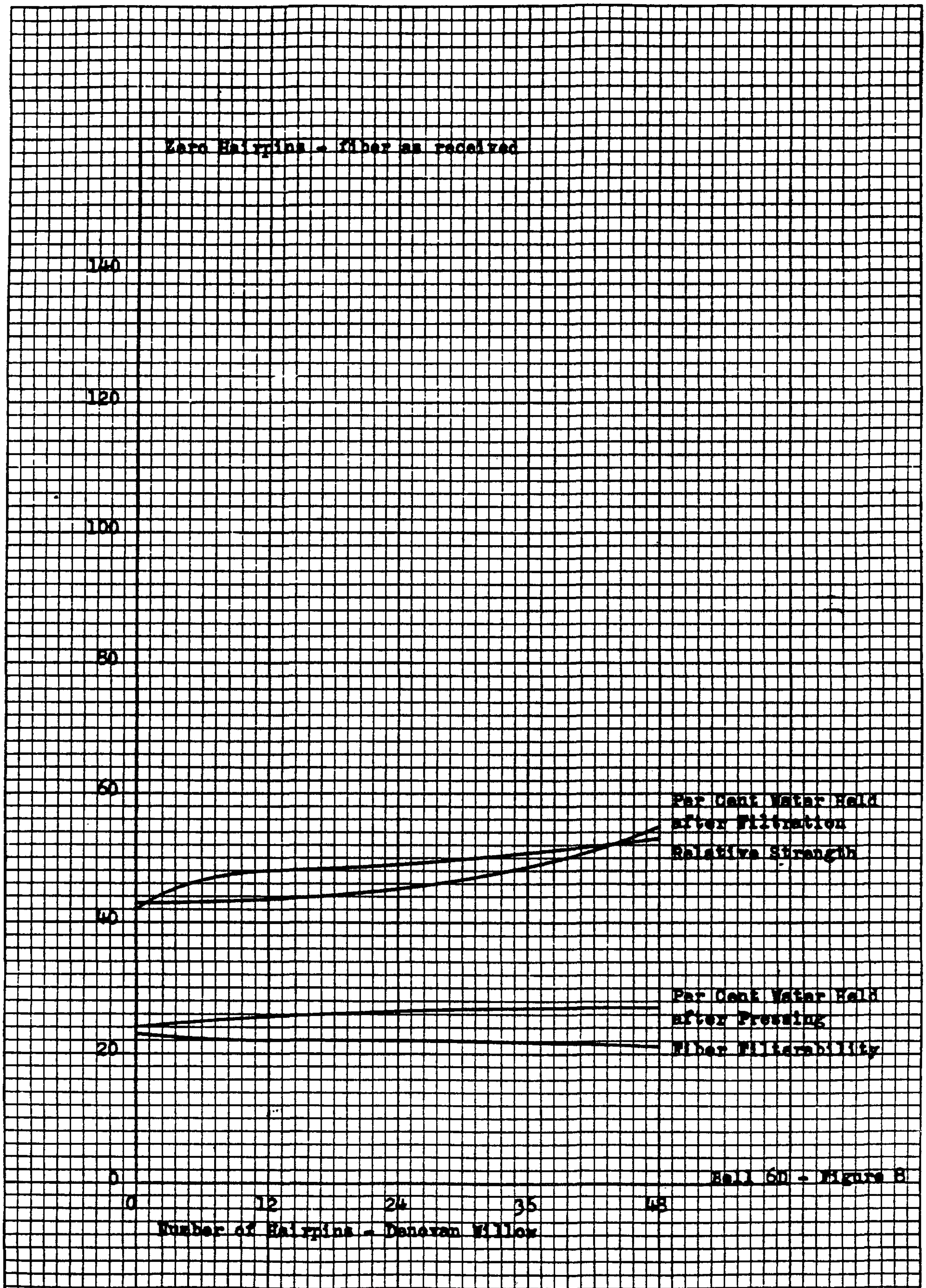
CTD000933


Zero Hairpins - Fiber as received
140
120
100
80
60
40
20
0
Fiber Filterability
Relative Strength
Per Cent Water Held after Filtration
Per Cent Water Held after Pressing
C&G 4 - Figure 5
0
12
24
36
48
Number of Hairpins - Donovan Willow

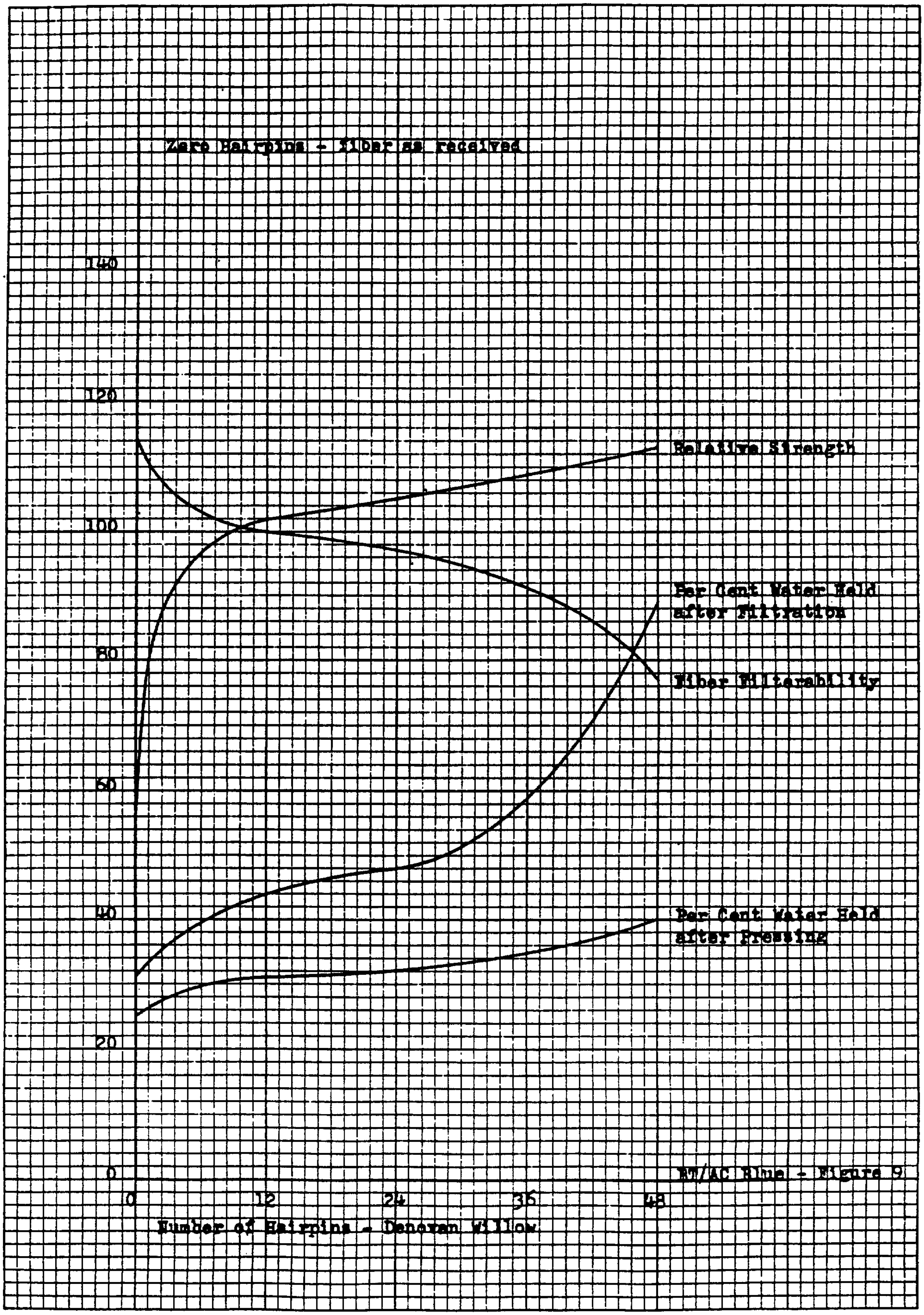

Zero Hairpins - fiber as received
140
120
100
80
60
40
20
0
Fiber Filterability
Relative Strength
Per Cent Water Held
after Filtration
Per Cent Water Held
after Pressing
C&G 5 - Figure 6
0
12
24
36
48
Number of Hairpins - Donovan Willow

CTD000935

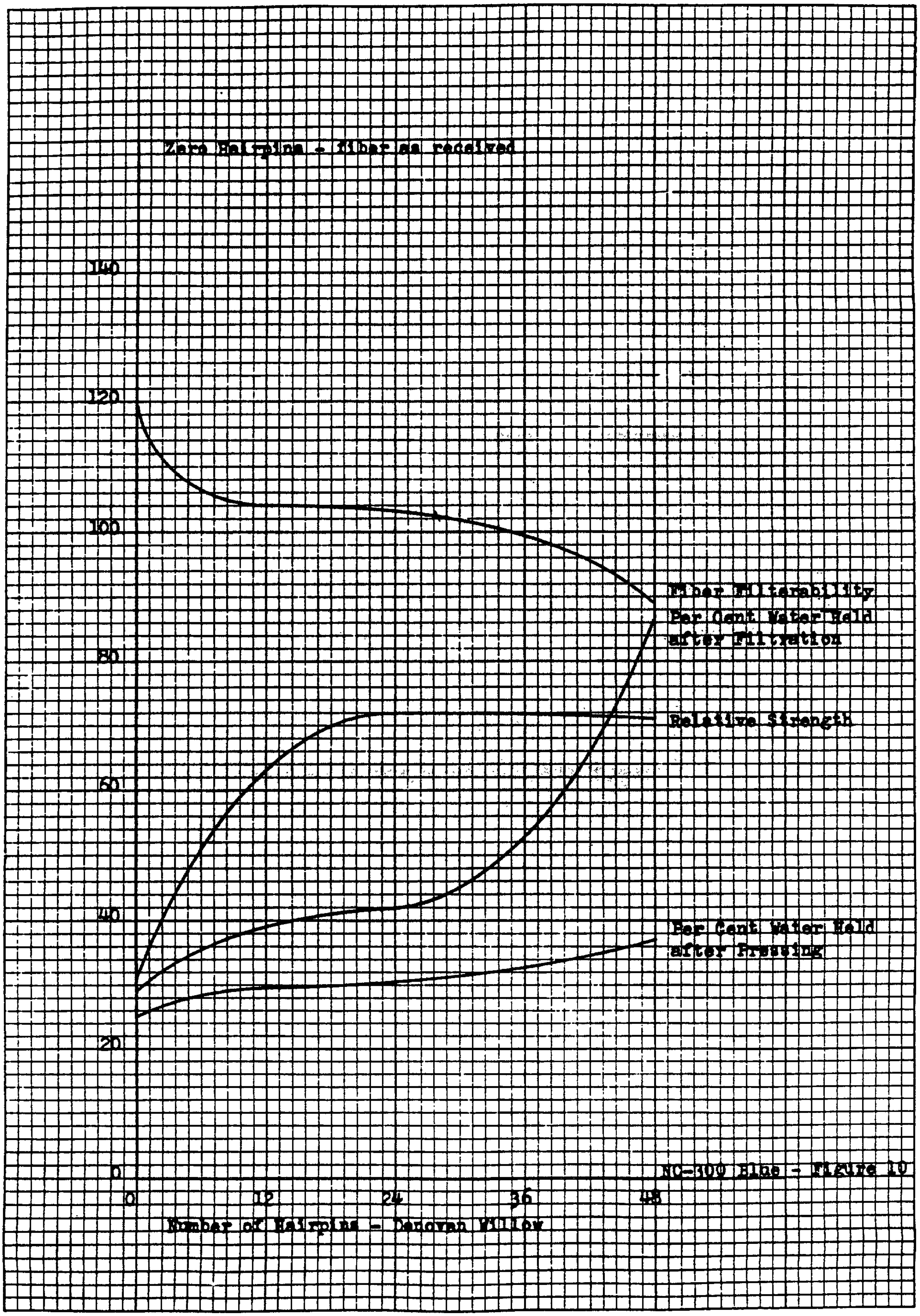

Zero Hairpins - Fiber as received
140
120
100
80
60
40
20
0
0
12
24
36
48
Relative Strength
Fiber Filterability
Per Cent Water Held after Filtration
Per Cent Water Held after Pressing
Bell 4X - Figure V
Number of Hairpins - Donovan Willow



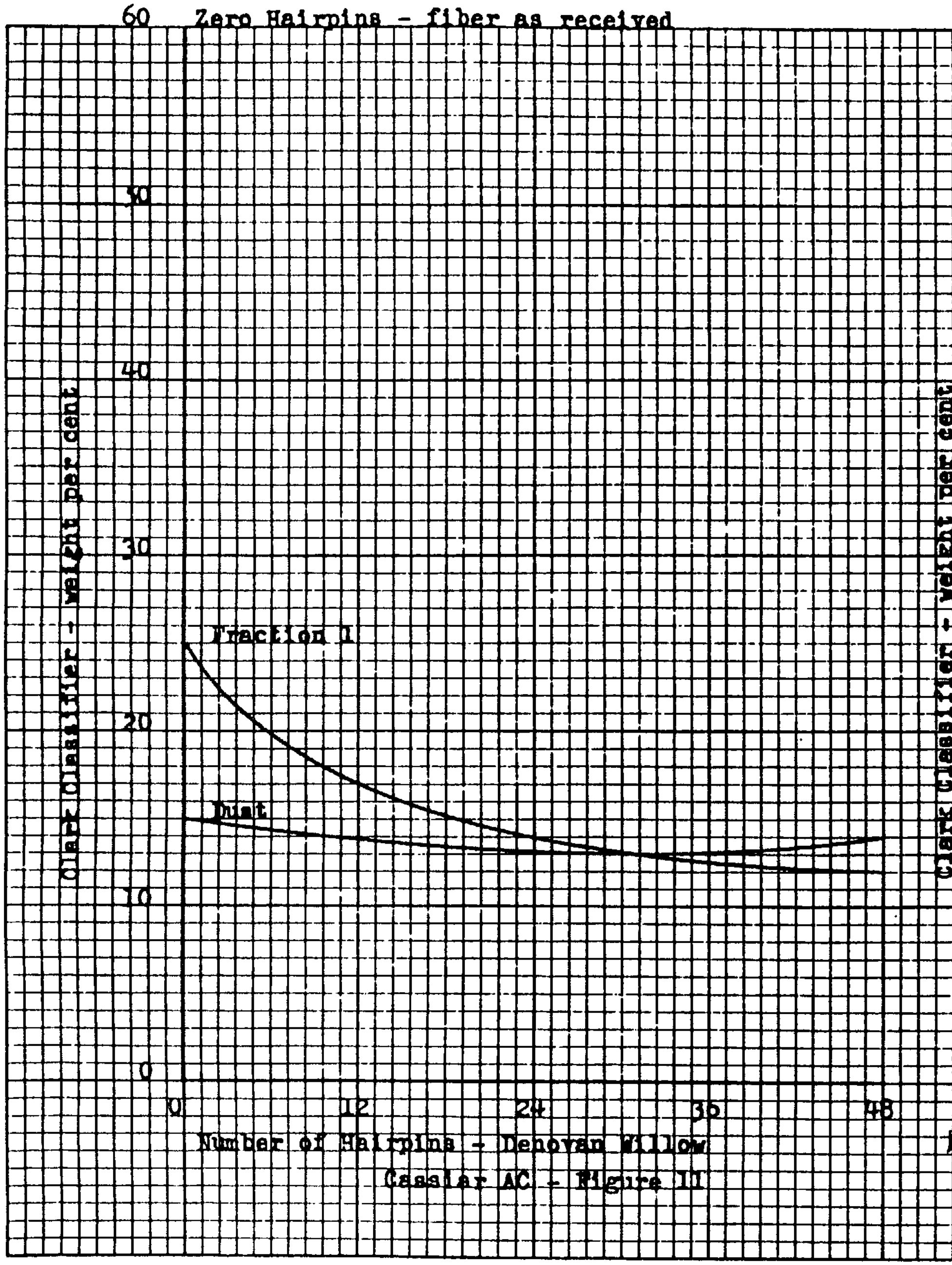
Zero Hairpins - fiber as received
140
120
100
80
60
40
20
0
Per Cent Water Held
after Filtration
Relative Strength
Per Cent Water Held
after Pressing
Fiber Filterability
Ball 60 - Figure 8
0
12
24
36
48
Number of Hairpins - Donovan Willow



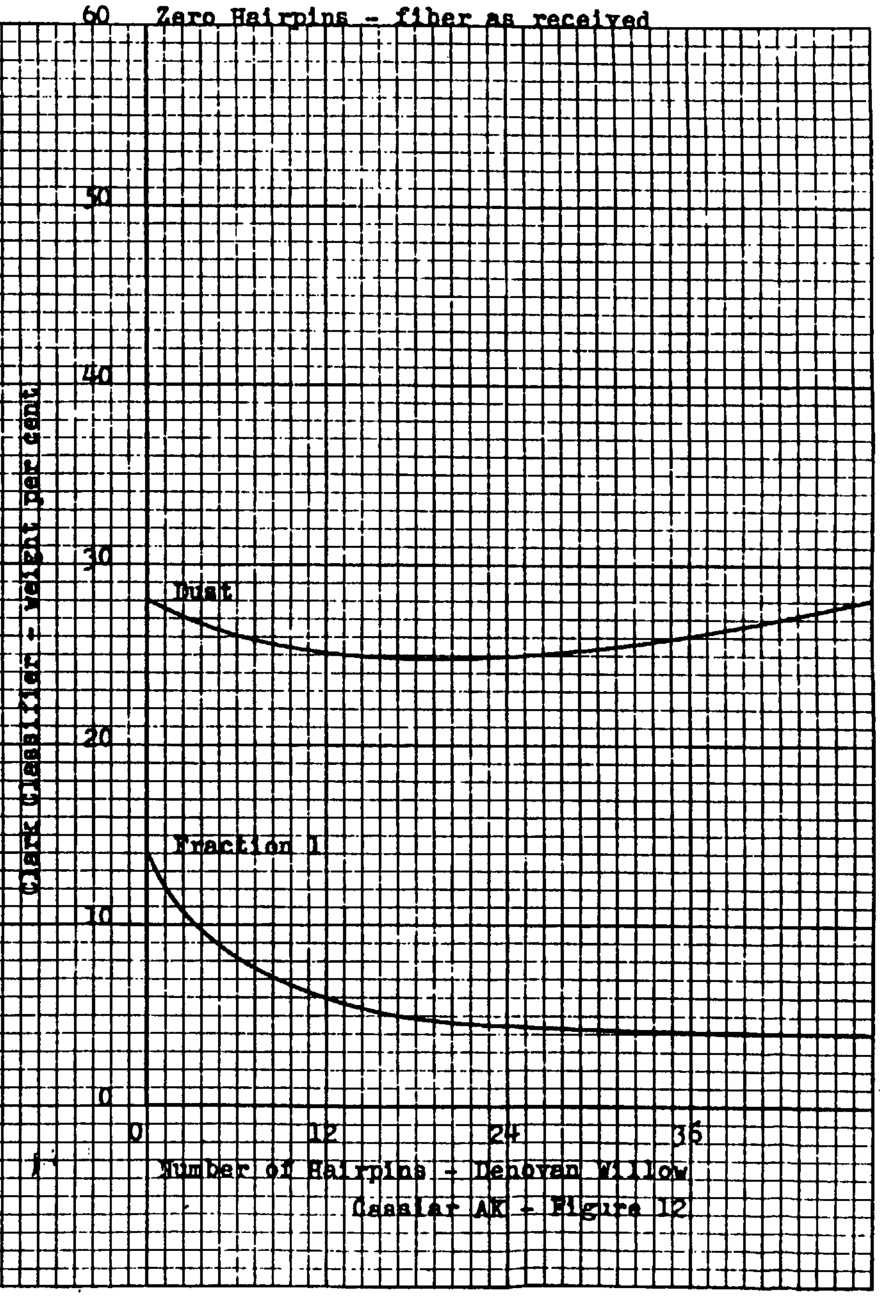
Zero Hairpins - Fiber as received
140
120
100
80
60
40
20
0
0
12
24
36
48
Number of Hairpins - Donovan Willow
Relative Strength
Per Cent Water Held after Filtration
Fiber Filterability
Per Cent Water Held after Pressing
BT/AC Blue - Figure 9


Zero Hairpins - fiber as received
140
120
100
80
60
40
20
0
0
12
24
36
48
Fiber Filterability
Per Cent Water Held
after Filtration
Relative Strength
Per Cent Water Held
after Pressing
NC-300 Blue - Figure 10
Number of Hairpins - Donovan Willow

CTD000939

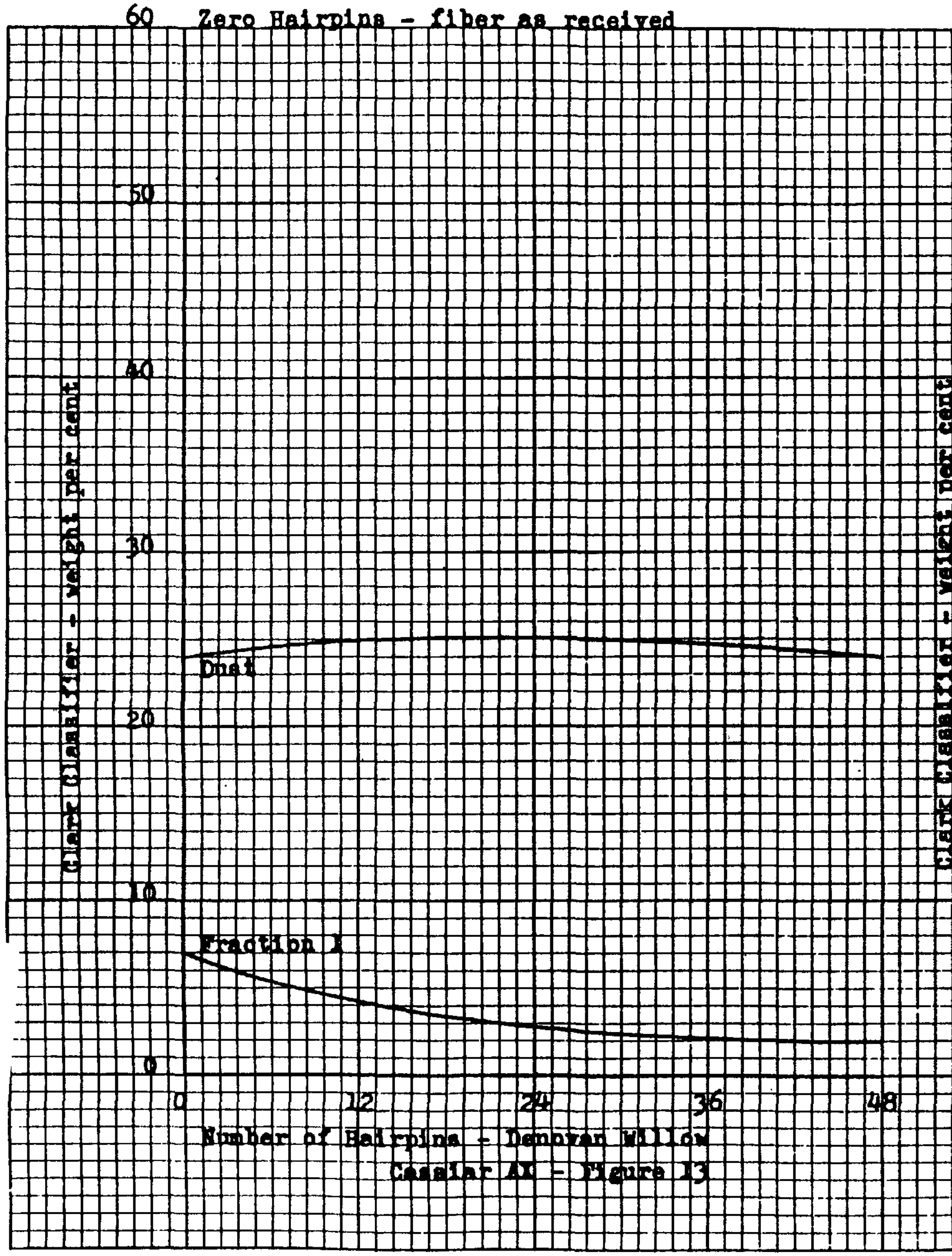


Cassiar AC - Figure 11

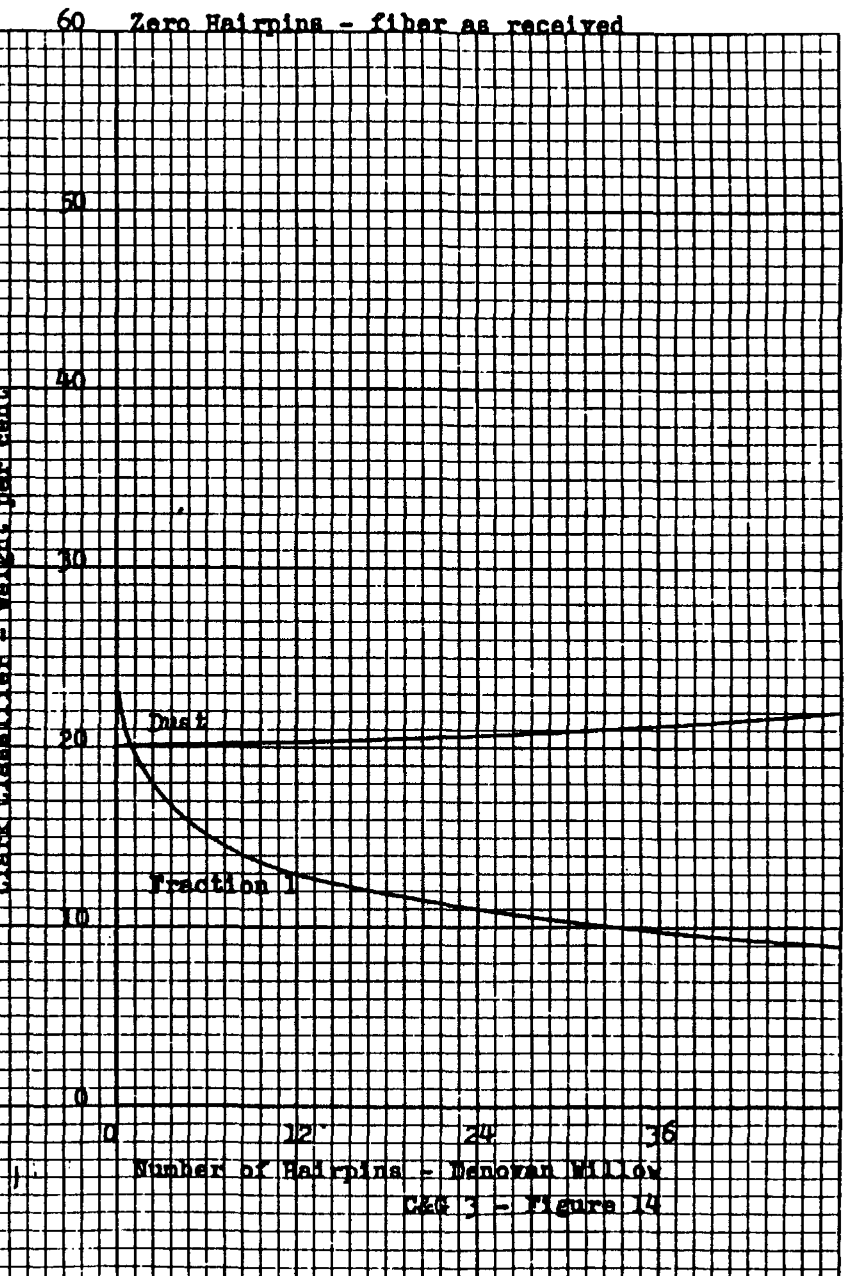


Cassiar AK - Figure 12

CTD000940

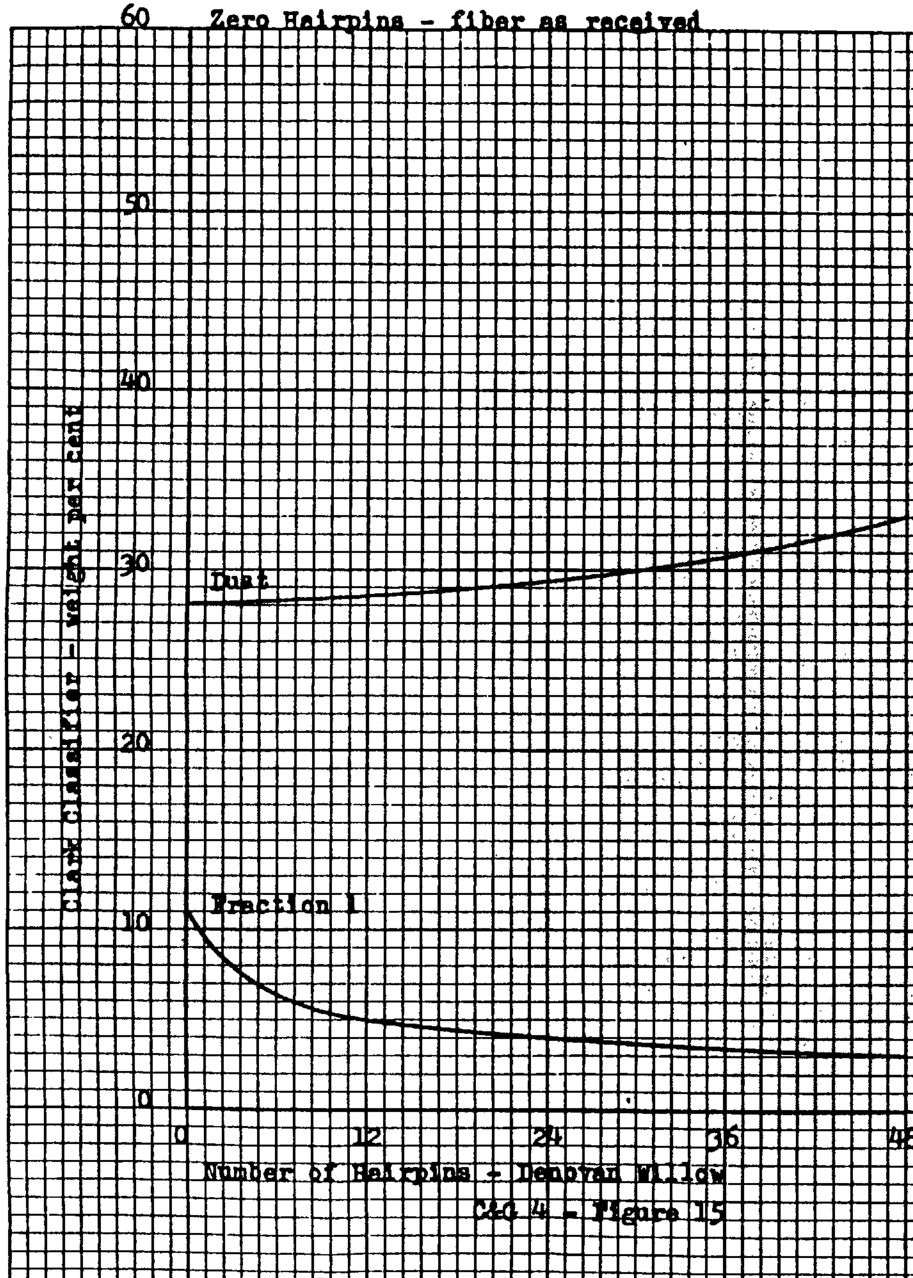


Cassiar AX - Figure 13

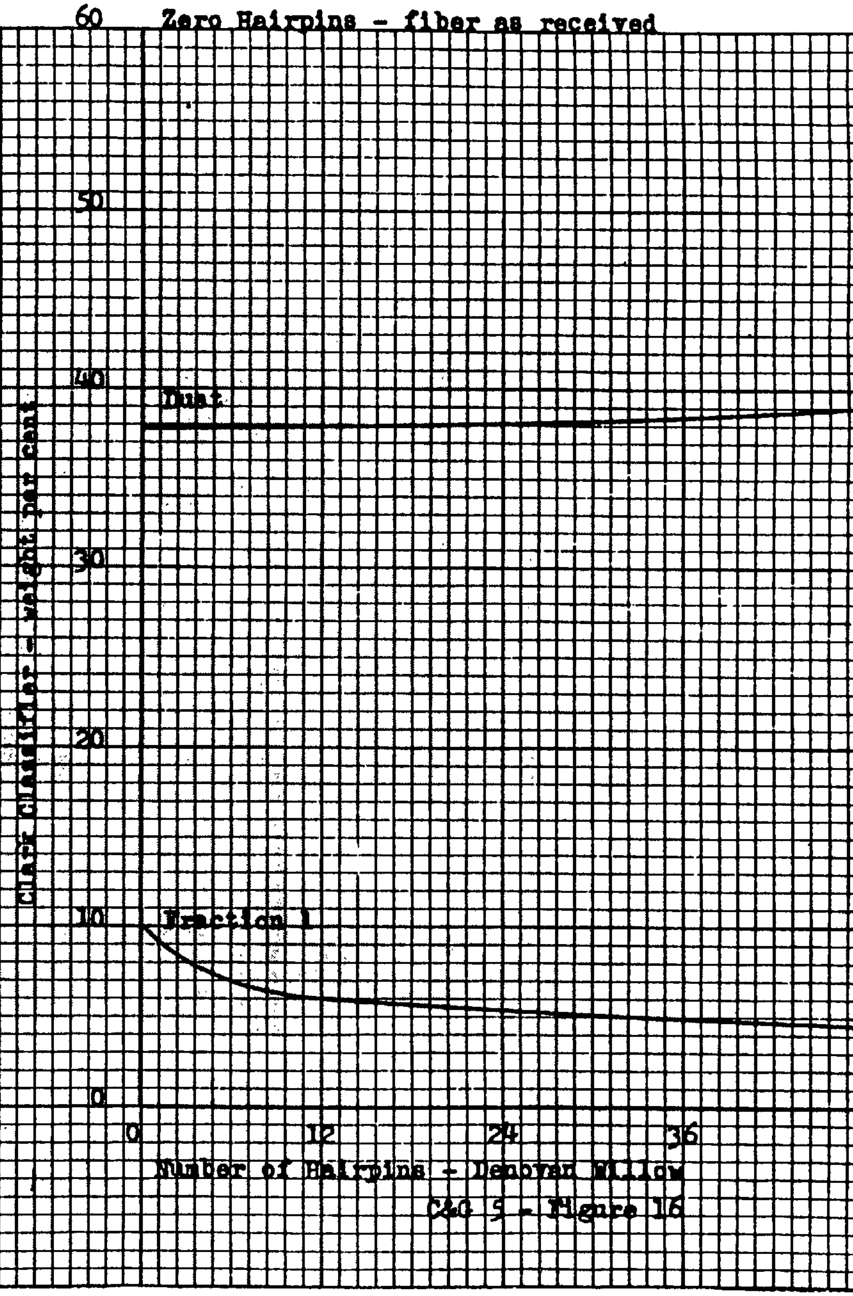


C&G 3 - Figure 14

CTD000941

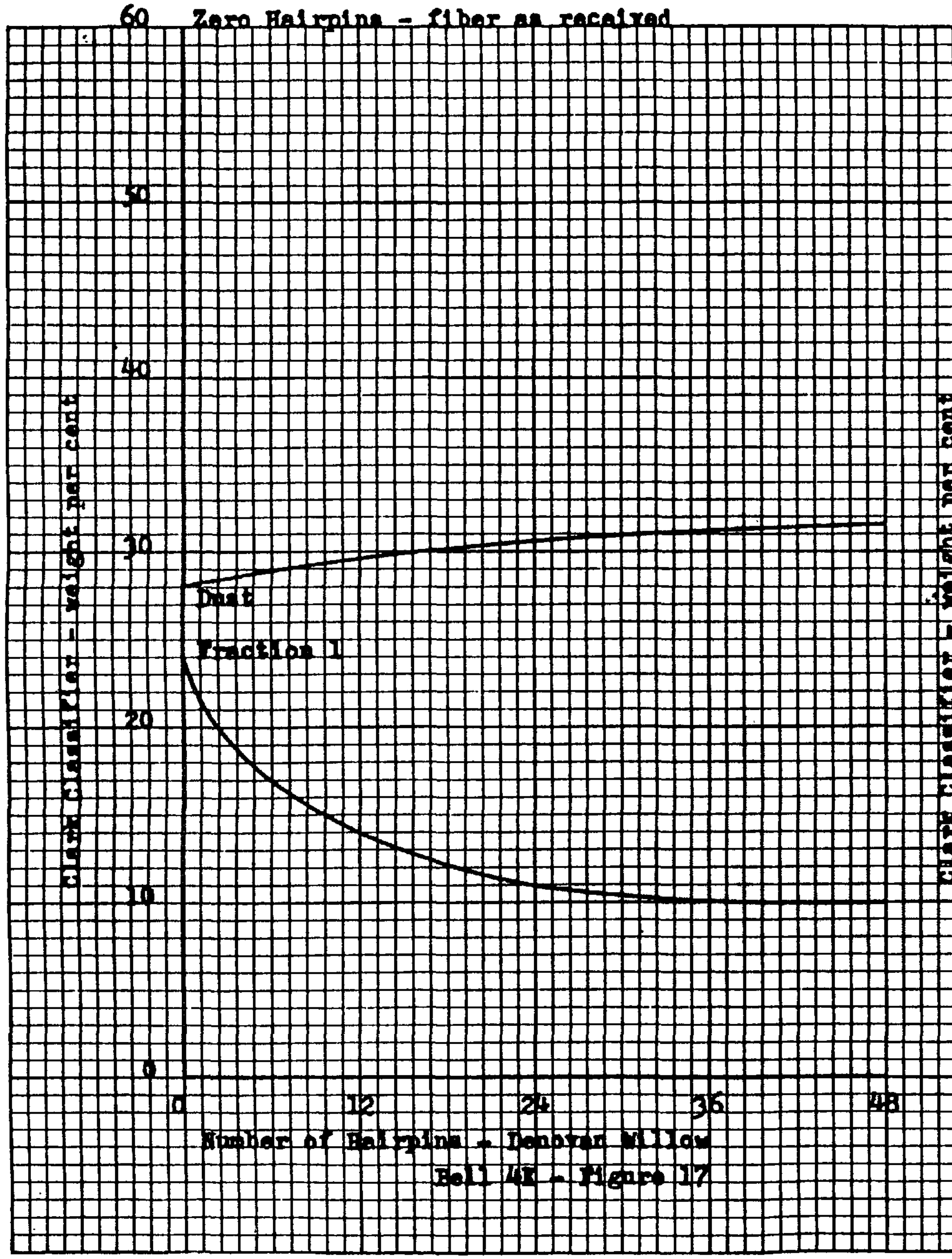


C&G 4 - Figure 15

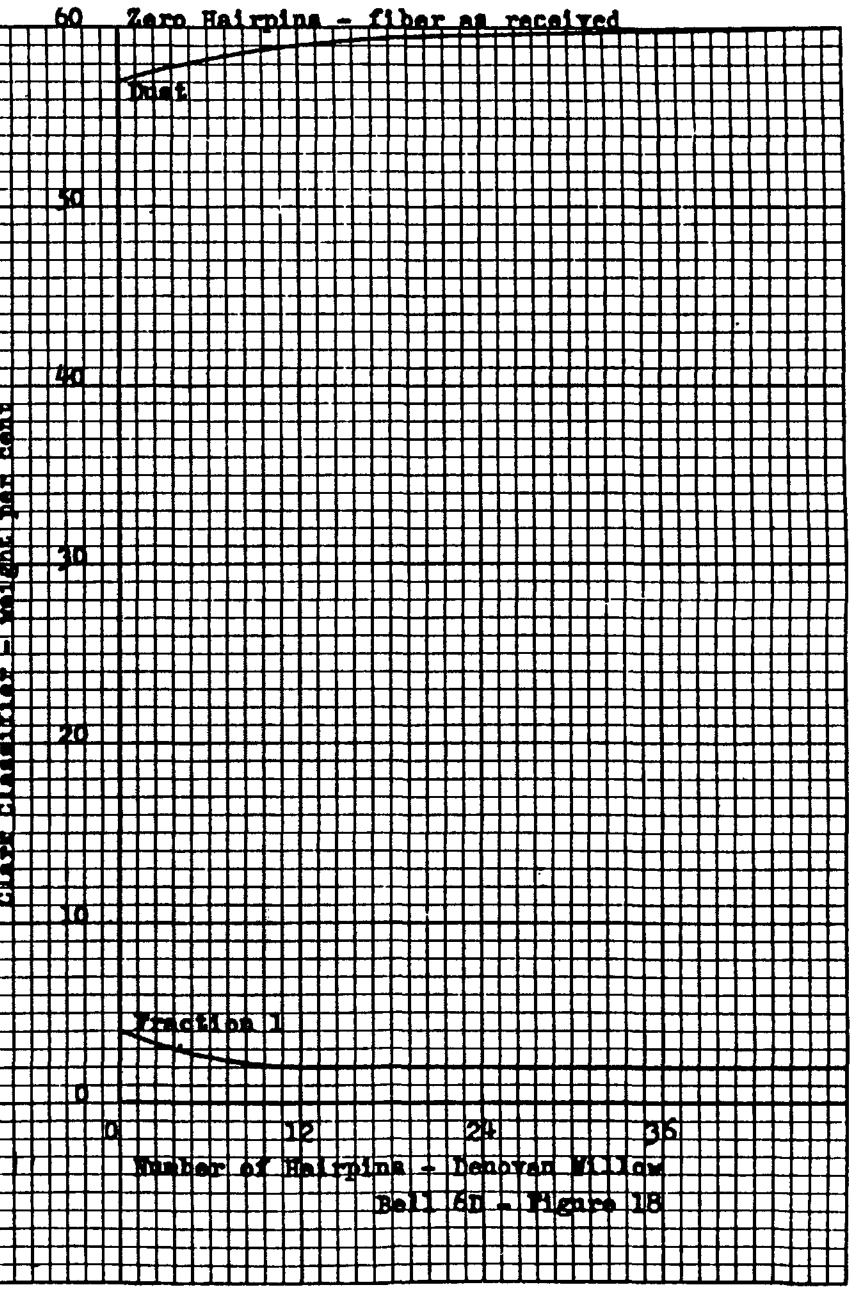


C&G 5 - Figure 16

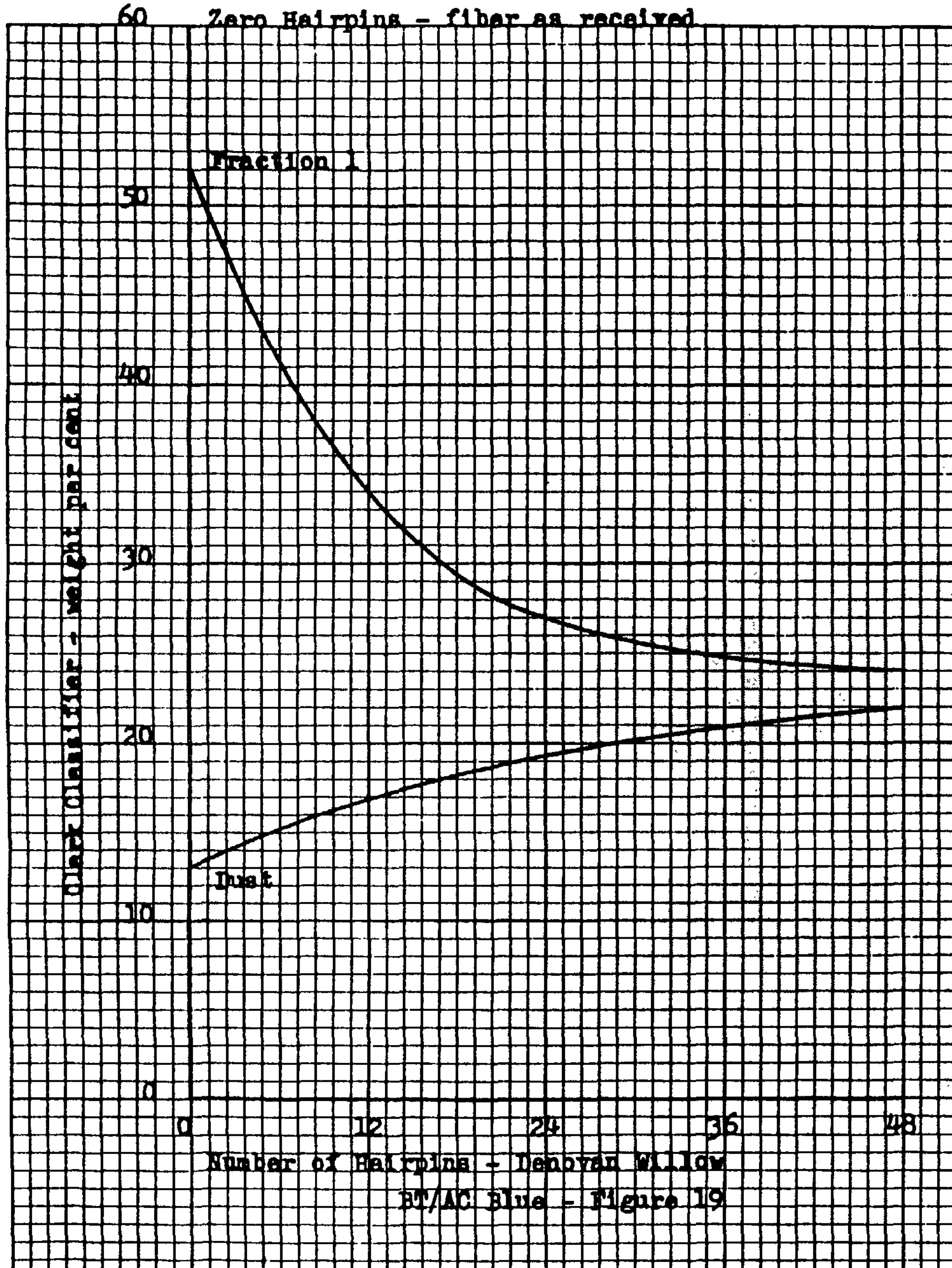
CTD000942



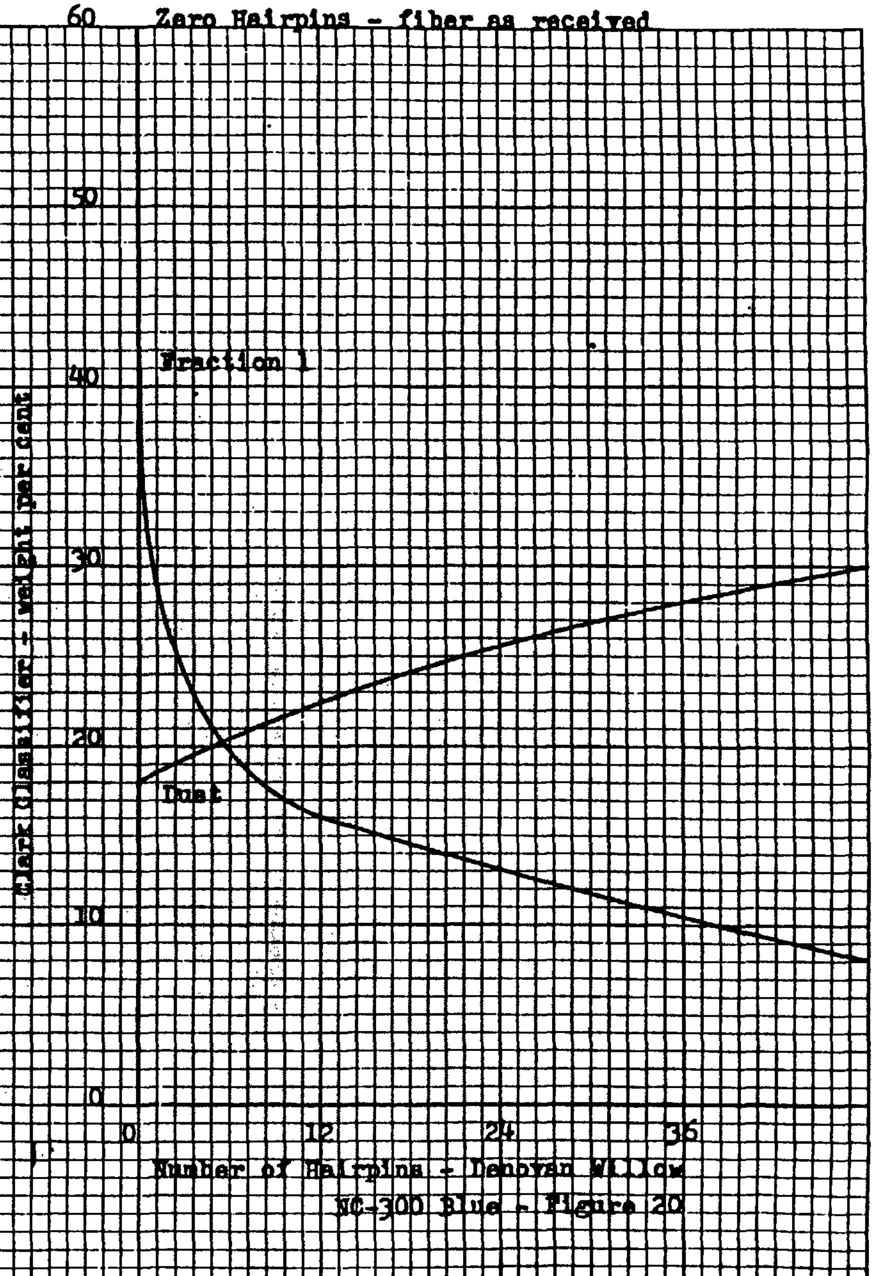
Bell 4E - Figure 17



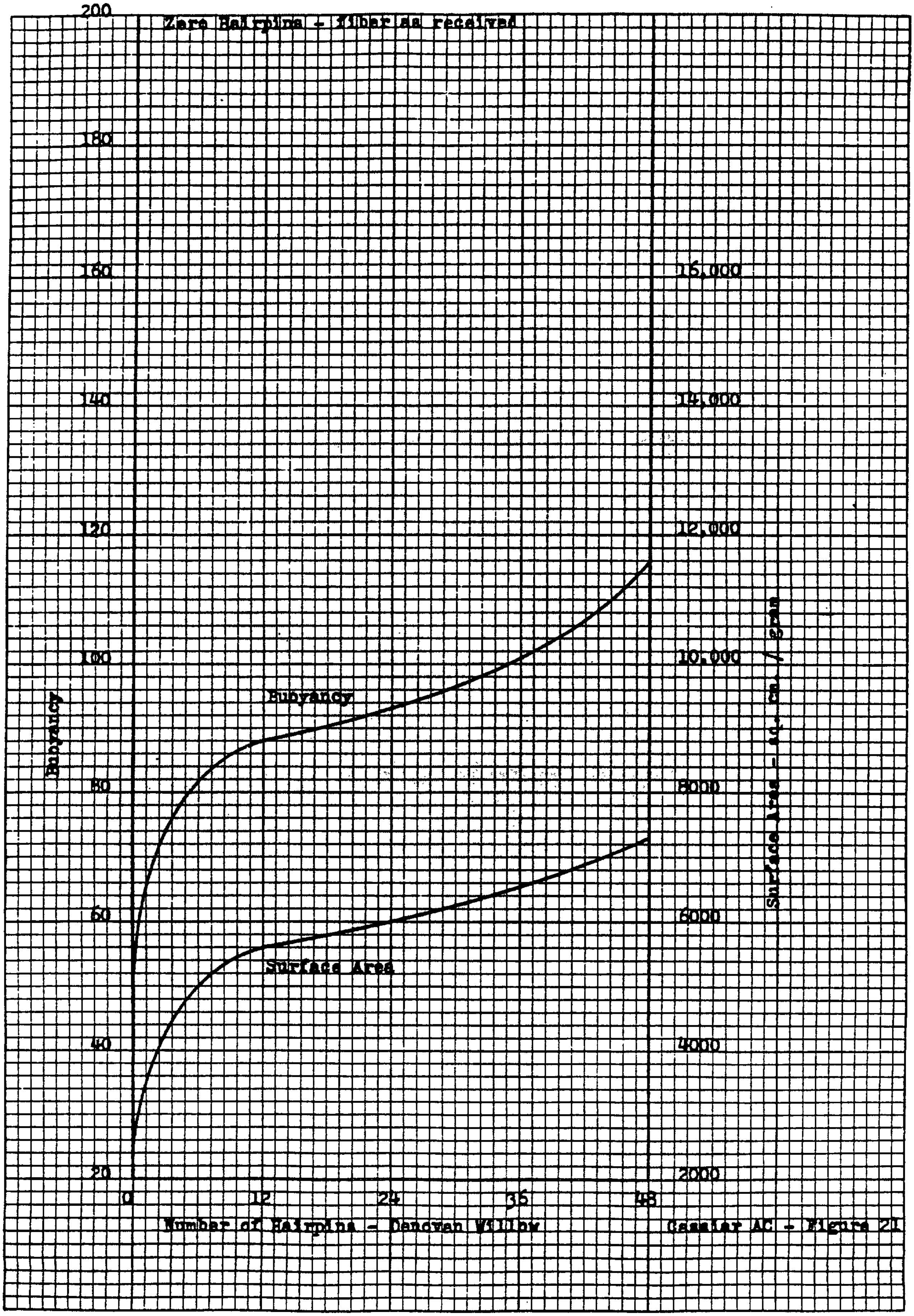
Bell 6D - Figure 18



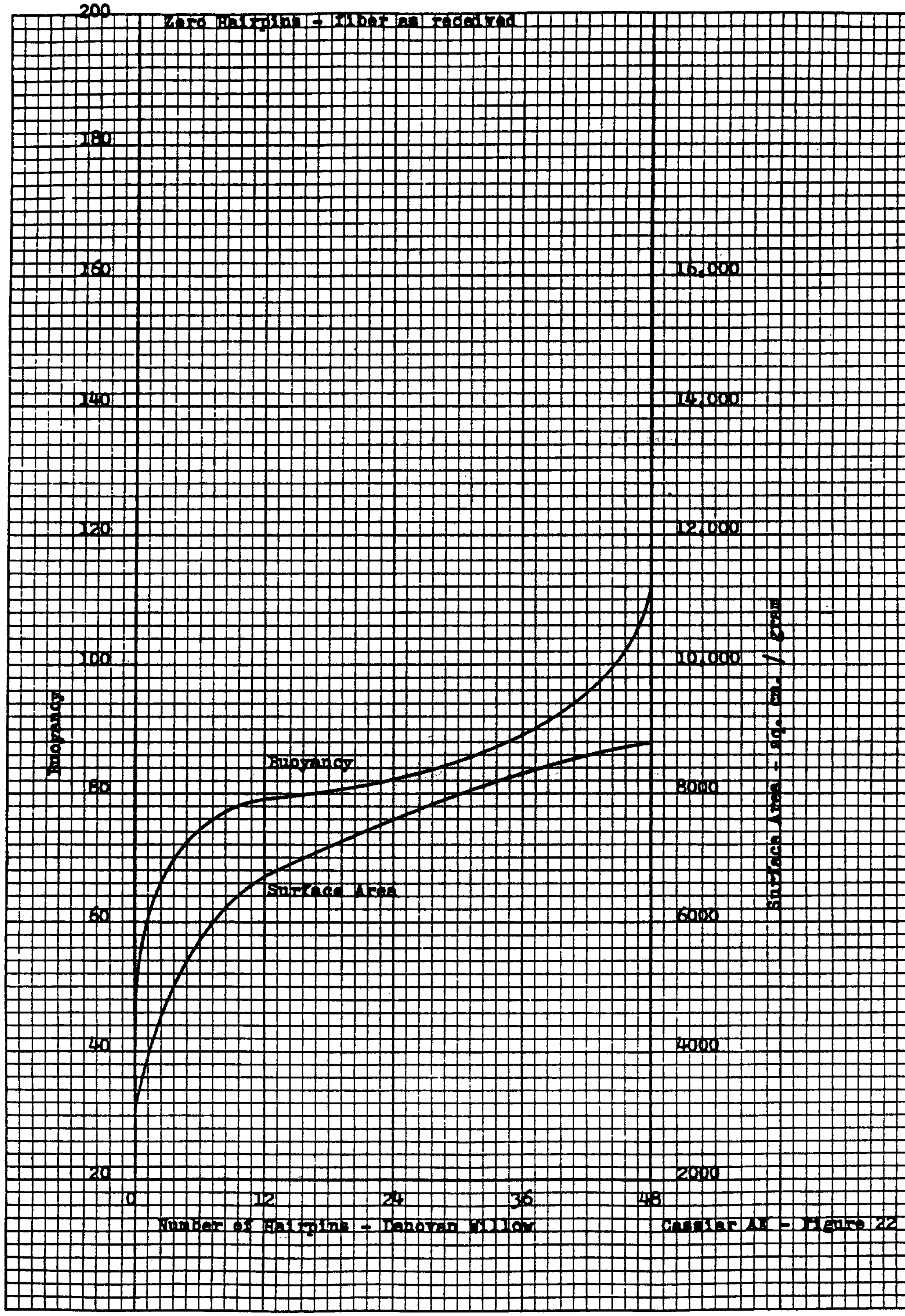
BT/AC Blue - Figure 19



NC-300 Blue - Figure 20

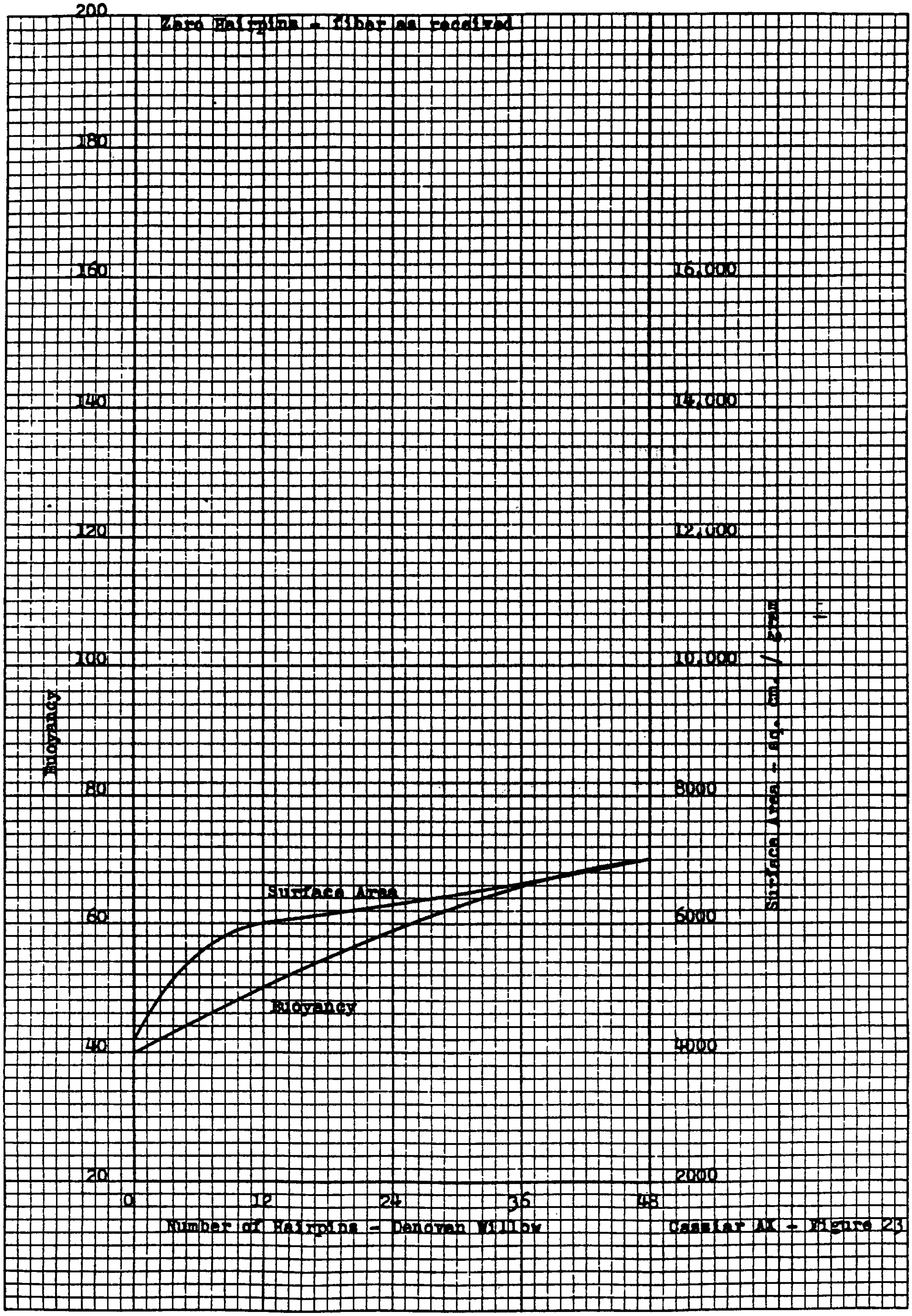


Cassiar AC - Figure 21



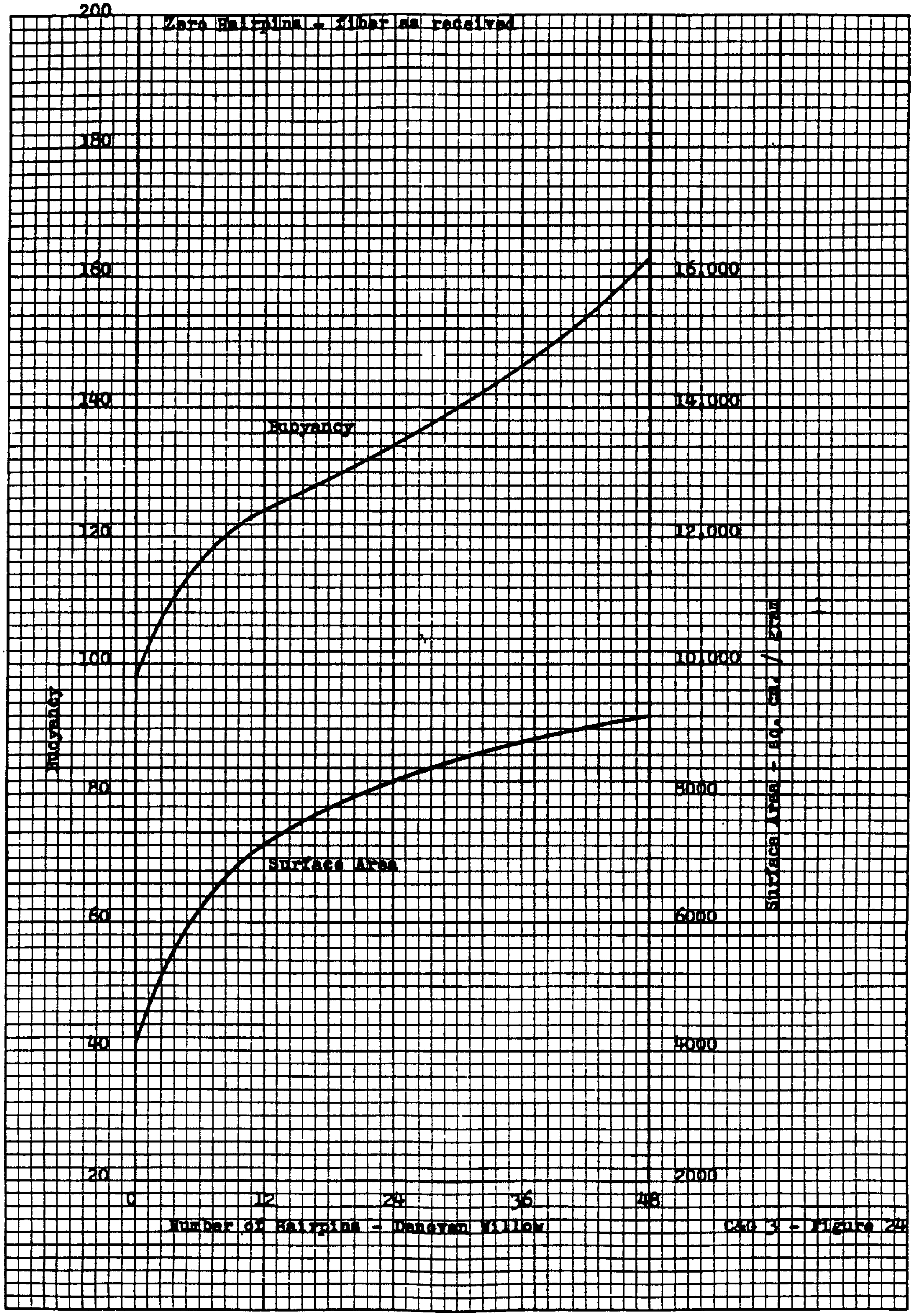
Zero Hairpins - fiber as received
200
180
160
140
120
100
80
60
40
20
16,000
14,000
12,000
10,000
8000
6000
4000
2000
Buoyancy
Surface Area
Buoyancy
Surface Area - sq. cm. / gram
0
12
24
36
48
Number of Hairpins - Donovan Willow
Cassier AK - Figure 22

CTD000946

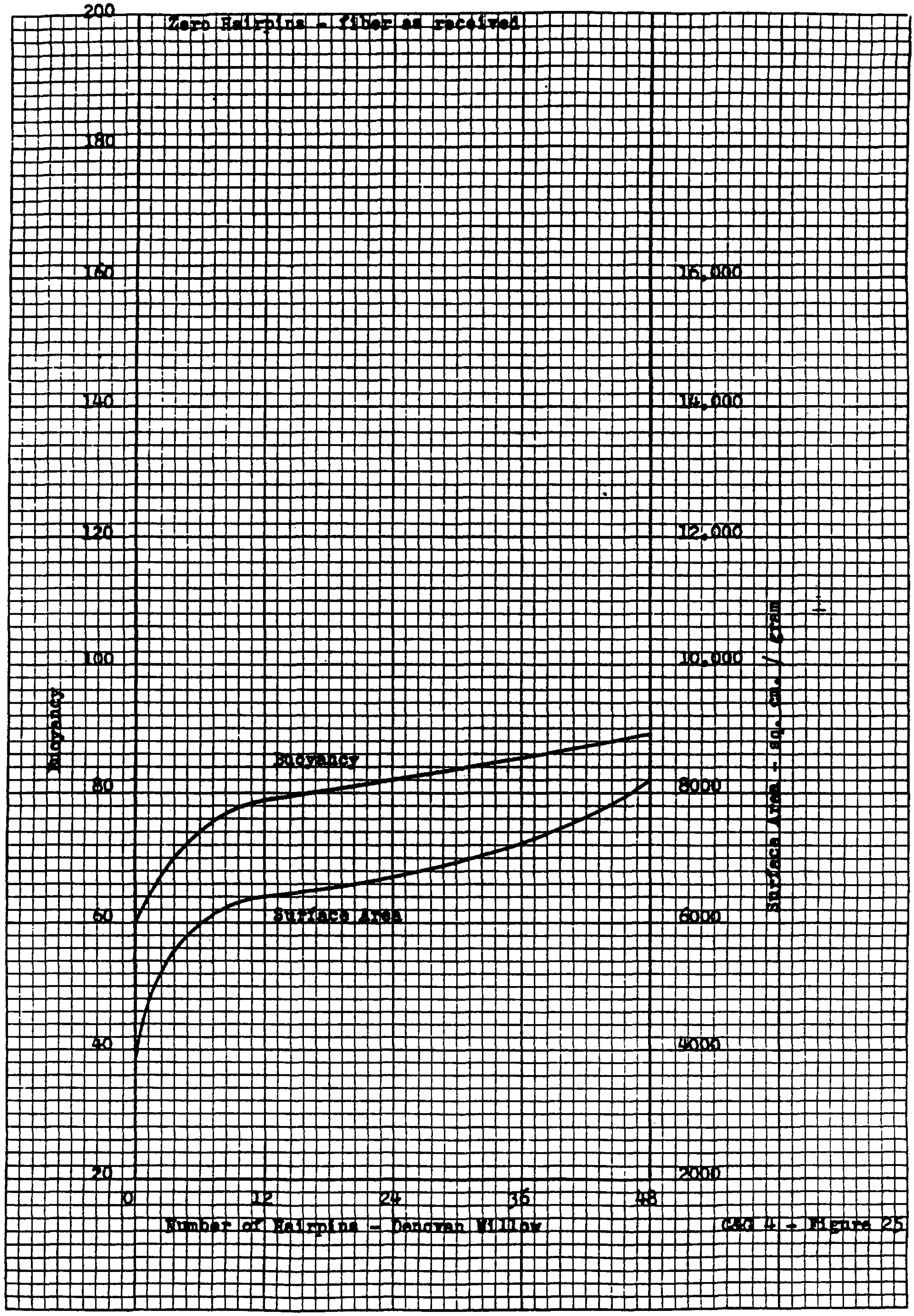


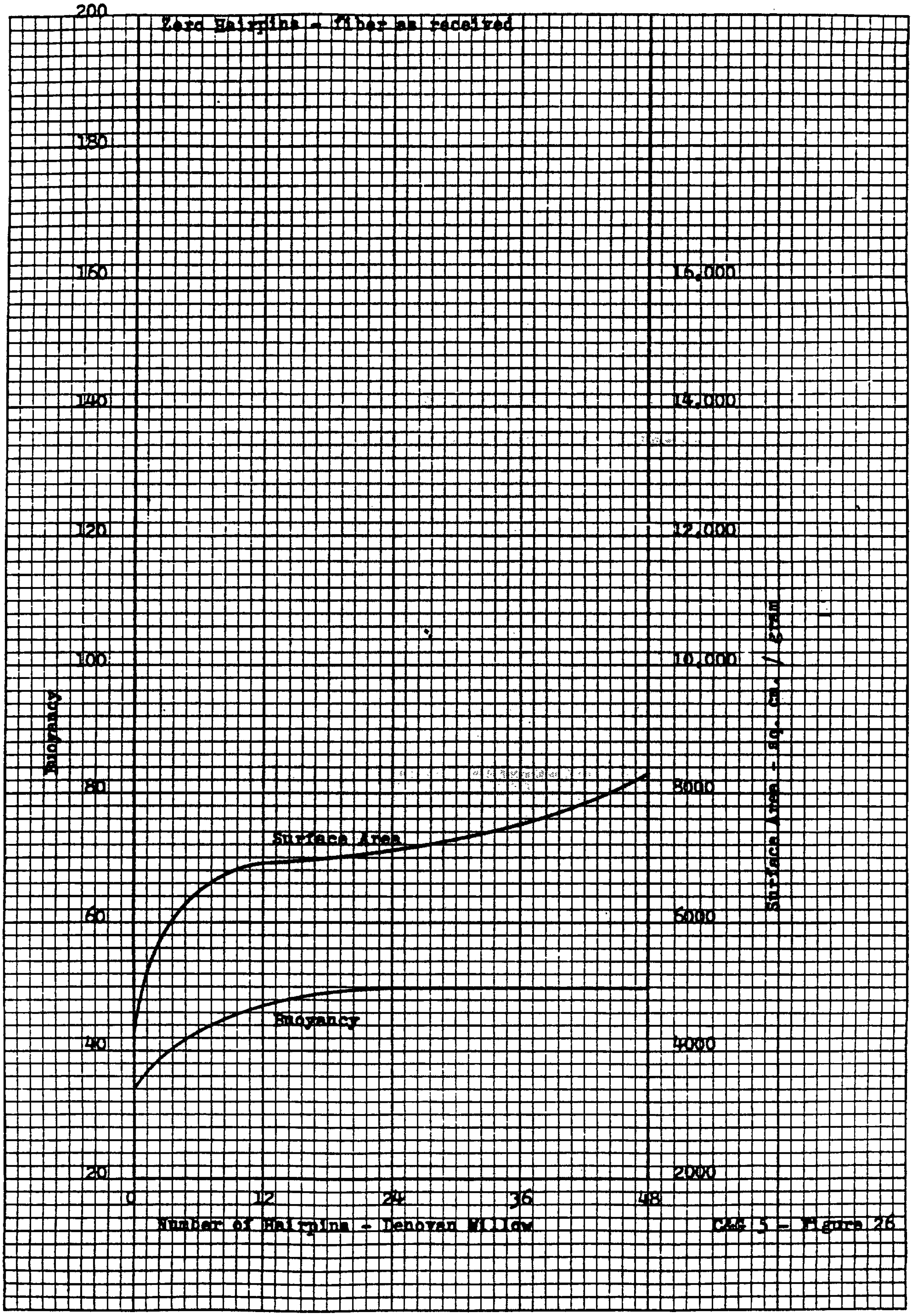
Zero Hairpins - fiber as received
Buoyancy
200
180
160
140
120
100
80
60
40
20
16,000
14,000
12,000
10,000
8000
6000
4000
2000
Surface Area - sq. cm. / gram
Surface Area
Buoyancy
0
12
24
36
48
Number of Hairpins - Donovan Willow
Cassiar AX - Figure 23

CTD000947


Zero Hairpins - fiber as received
Buoyancy
Surface Area
Buoyancy
Surface Area - sq. cm. / gram
200
180
160
140
120
100
80
60
40
20
16,000
14,000
12,000
10,000
8000
6000
4000
2000
0
12
24
36
48
Number of Hairpins - Danevan Willow
C&G 3 - Figure 24

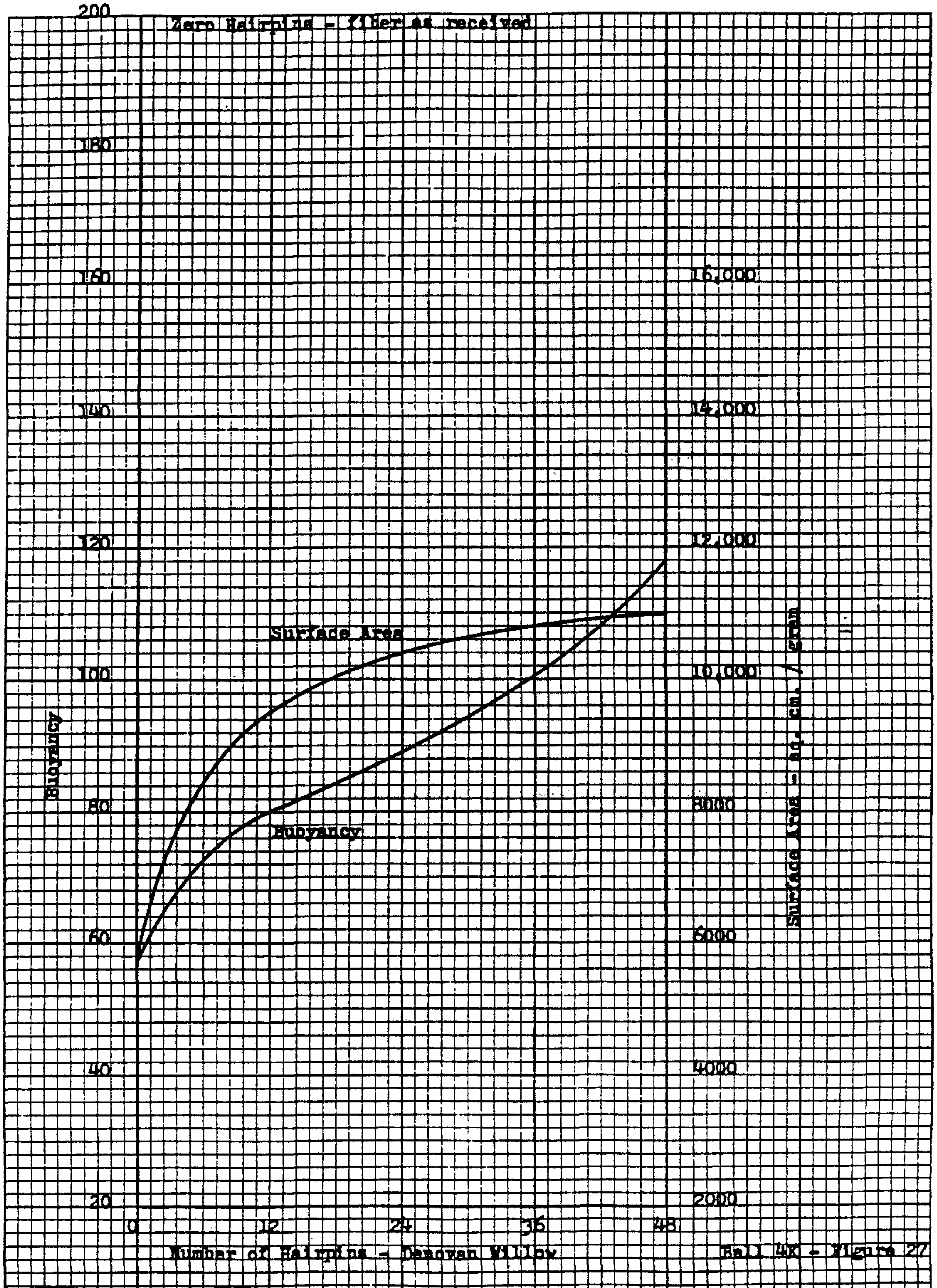
CTD000948


Zero Hairpins - fiber as received
200
180
160
140
120
100
80
60
40
20
16,000
14,000
12,000
10,000
8000
6000
4000
2000
Buoyancy
Buoyancy
Surface Area
Surface Area - sq. cm. / gram
0
12
24
36
48
Number of Hairpins - Donovan Willow
C&G 4 - Figure 25

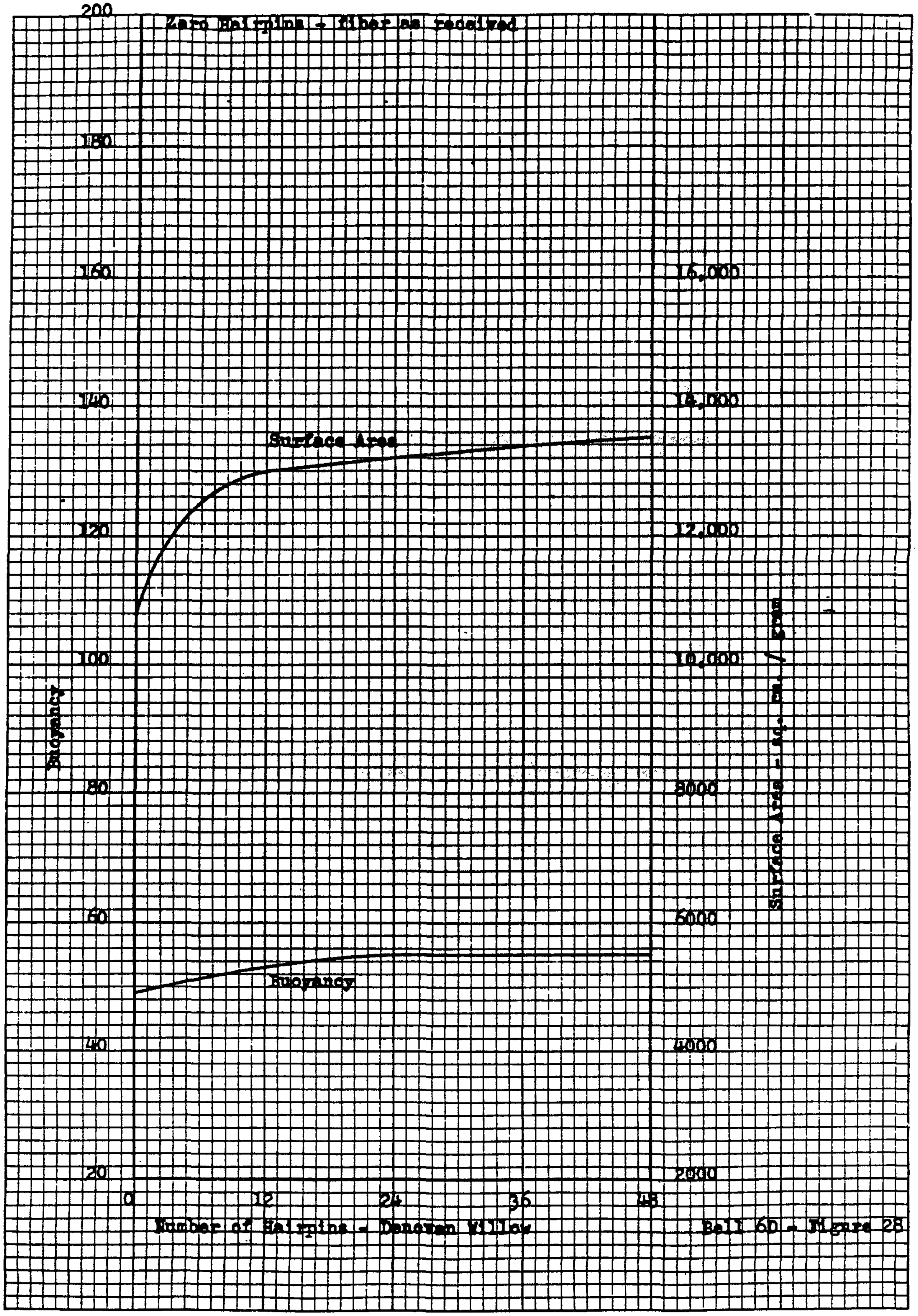


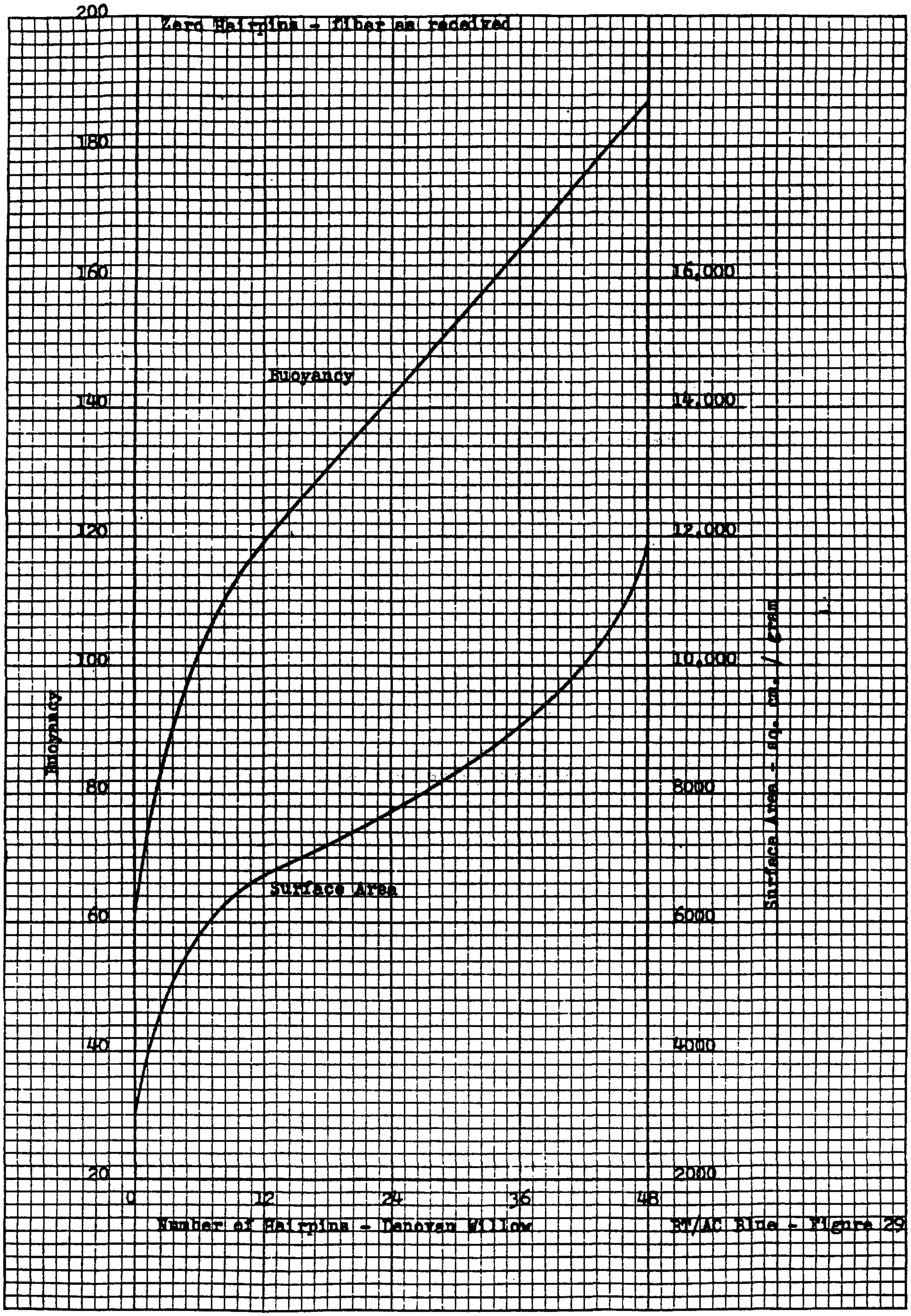
Zero Hairpins - fiber as received
200
180
160
140
120
100
80
60
40
20
Buoyancy
16,000
14,000
12,000
10,000
8000
6000
4000
2000
Surface Area - sq. cm. / gram
Surface Area
Buoyancy
0
12
24
36
48
Number of Hairpins - Denovan Willow
C&G 5 - Figure 26

CTD000950

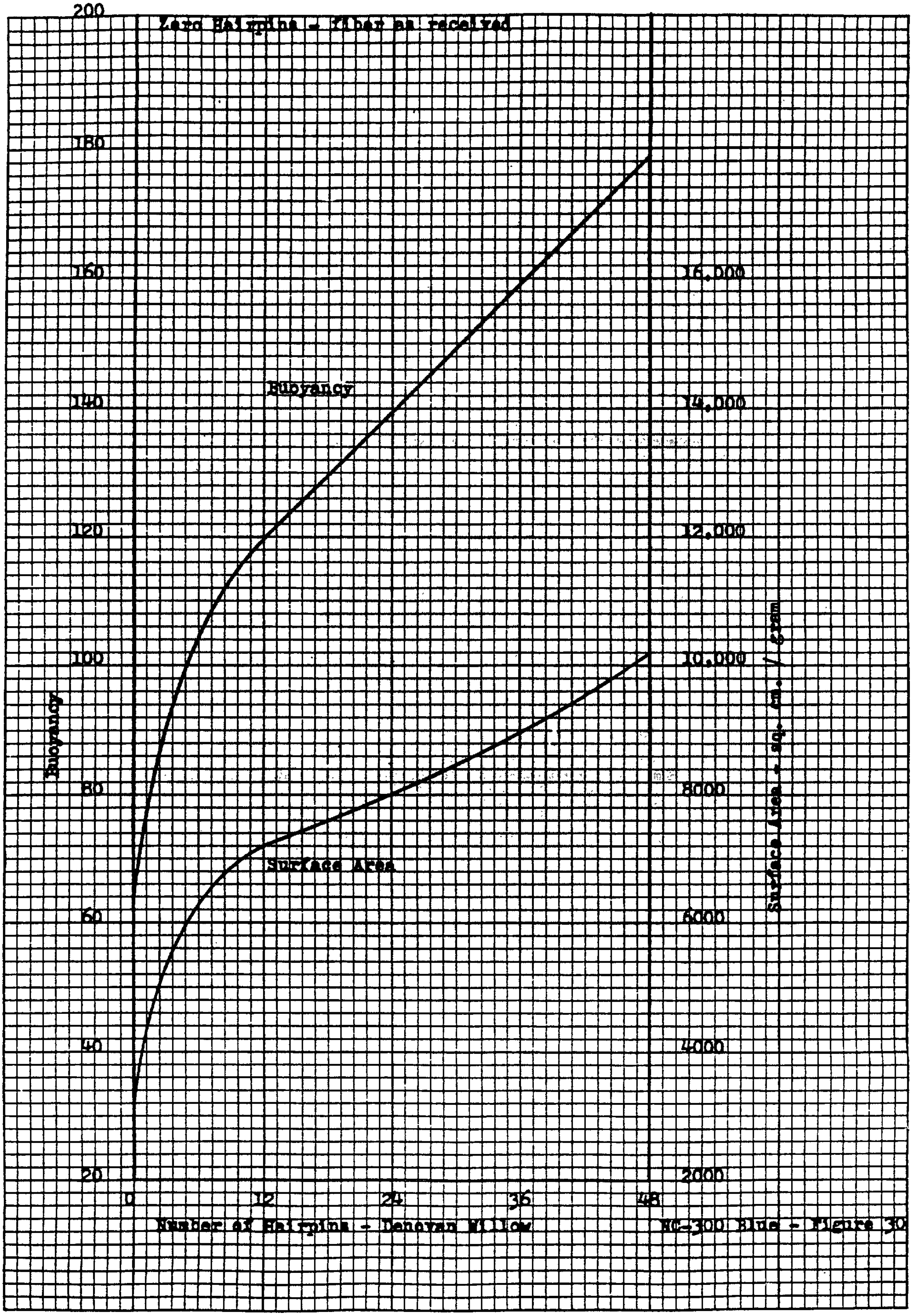

Zero Hairpins - fiber as received
Surface Area
Buoyancy
Buoyancy
Surface Area - sq. cm. / gram
200
180
160
140
120
100
80
60
40
20
16,000
14,000
12,000
10,000
8000
6000
4000
2000
0
12
24
36
48
Number of Hairpins - Donovan Willow
Ball 4K - Figure 27

CTD000951


Zero Hairpins - fiber as received
200
180
160
140
120
100
80
60
40
20
16,000
14,000
12,000
10,000
8000
6000
4000
2000
Surface Area
Buoyancy
Buoyancy
Surface Area - sq. cm. / gram
0
12
24
36
48
Number of Hairpins - Donovan Willow
Ball 6D - Figure 28


Zero Hairpins - fiber as received
Buoyancy
Surface Area
Buoyancy
Surface Area - sq. cm. / gram
Number of Hairpins - Donovan Willow
200
180
160
140
120
100
80
60
40
20
0
12
24
36
48
16,000
14,000
12,000
10,000
8000
6000
4000
2000
BT/AC Blue - Figure 29

CTD000953



Zero Hairpins - fiber as received
Buoyancy
Surface Area
Buoyancy
200
180
160
140
120
100
80
60
40
20
Surface Area - sq. cm. / gram
16,000
14,000
12,000
10,000
8000
6000
4000
2000
0
12
24
36
48
Number of Hairpins - Donovan Willow
NC-300 Blue - Figure 30

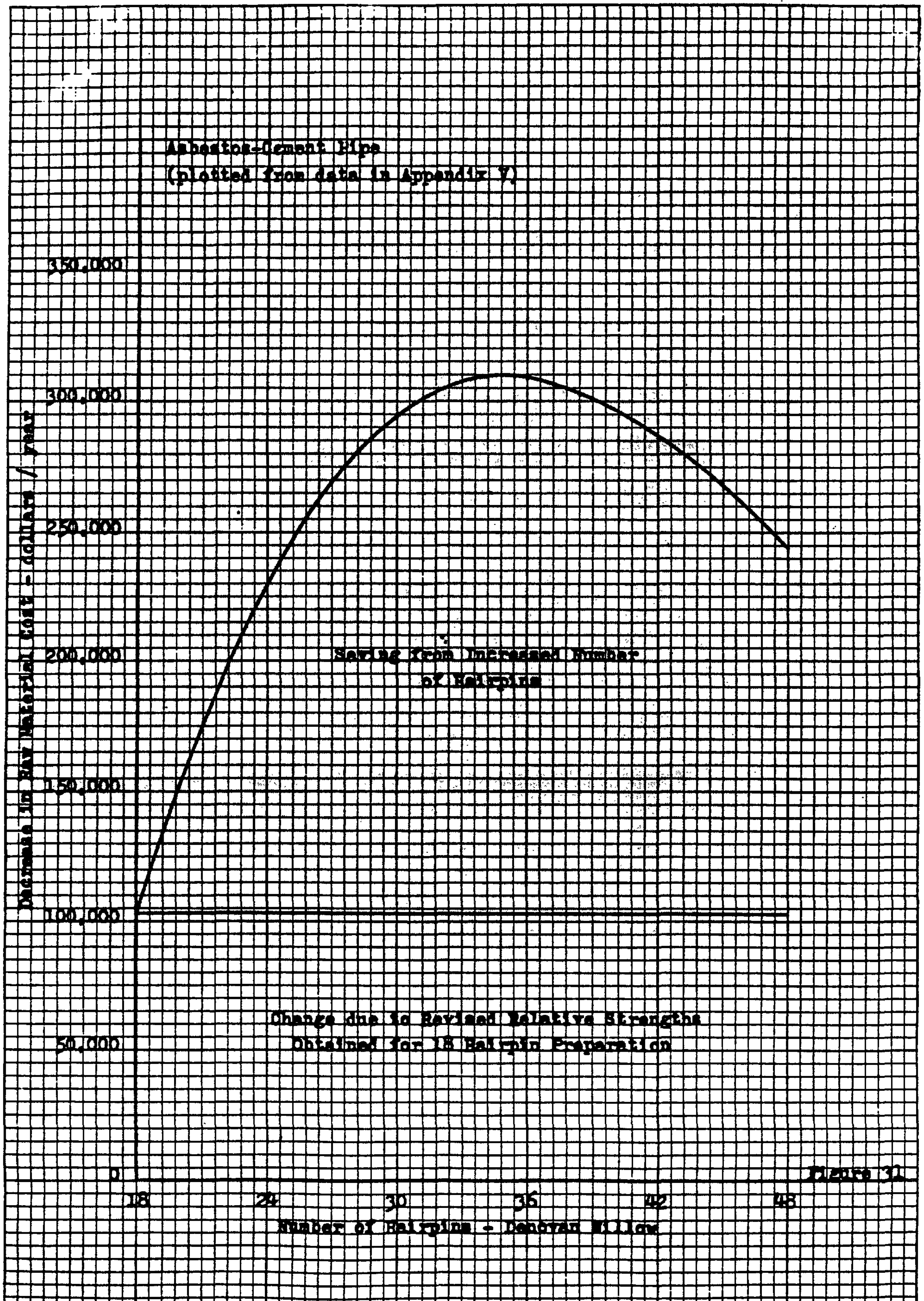
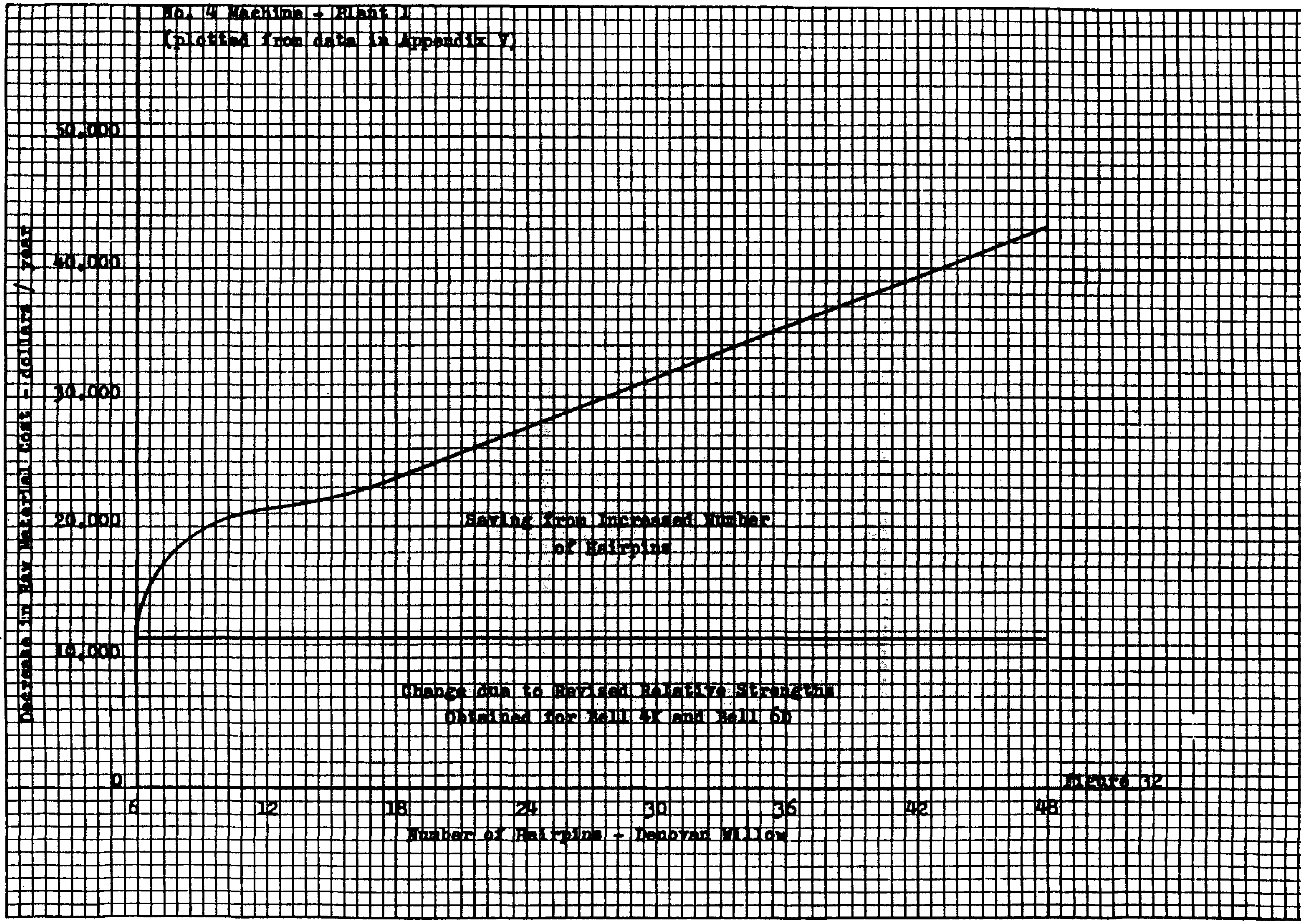


Figure 31

CTD000955


No. 4 Machine - Plant 1
(plotted from data in Appendix V)
Decrease in Raw Material Cost - dollars / year
50,000
40,000
30,000
20,000
10,000
0
Saving from Increased Number
of Hairpins
Change due to Revised Relative Strengths
Obtained for Bell 4X and Bell 6D
6
12
18
24
30
36
42
48
Number of Hairpins - Denovan Willow
Figure 32

Appendix I

Denovan Willow Pin Arrangements

Plant 1 (6 pins total)

Three hairpins in the second and fourth stages.

Plant 6 (21 pins total)

Three sluggers in the first stage, six hairpins in each of the three lower stages.

Plant 8 (18 pins total)

Six hairpins in each of the three lower stages.

Plant 9 (18 pins total)

Three sluggers in the first stage, three hairpins in the second stage, six hairpins in each of the two lower stages.

Note: Hairpins constructed of 1 x 5/8 x 26 inch bar bent uniformly to 3/4 inch radius.

Sluggers constructed of 1 x 2 x 13½ inch bar drilled with one inch hole 12 inches from end.

A. C. P. A. Evaluation

In this evaluation, 150 gram test cakes containing 51 per cent cement, 34 per cent pulverized silica, and 15 per cent fiber are prepared by mixing the dry materials with a specified amount of water, under controlled conditions, and filtering the resulting slurry in a Buchner funnel. The time from vacuum application to the point where the water seal between cake and funnel is broken (as indicated by a decrease in the filtering vacuum) is taken as the filtering time. The filtered weight is determined, the cake pressed at 500 pounds per square inch, and the pressed weight recorded. The samples are then cured for a minimum of 16 hours, under controlled humidity conditions, and are finally autoclaved for 20 hours, using saturated steam. After curing, the cakes are dried to constant weight and then tested in flexure. From the average breaking load, the reinforcing characteristics of the fiber being evaluated, relative to standard C&G 3 as 100, are determined and expressed as relative strength.

(a) Relative Strength

The relative strength has its application in effectiveness of furnish calculations. These calculations can best be illustrated by the following example:

The relative strength of a blend containing 100 pounds of Cassiar AC (relative strength 110), 500 pounds of C&G 4 (relative strength 80), and 400 pounds of NC-300 Blue (relative strength 70) is:

$$\frac{(100)\ (110) + (500)\ (80) + (400)\ (70)}{(1000)} = 79.0$$

In a furnish containing 16.0 per cent of this blend, the effectiveness of furnish would be:

$$(79.0)\ (16.0) = 1264$$

Recent studies have indicated that the relative strength values obtained by the A.C.P.A. method are accurate to within plus or minus four strength units.

(b) Filtering Time

Since the end of filtration is taken to the point at which a decrease in the filtering vacuum occurs (caused by loss of the water seal around the cake edge), and is not based on the time required to remove a specified amount of water, it is dependent not only on the rate at which water is removed from the asbestos-cement slurry, but also on the water retention properties of the fiber used. Consequently, without the per cent water remaining after filtration, the filtering time has no definite meaning.

(c) Filtered Weight

The filtered weight, in terms of the per cent water held after filtration, indicates the water retention properties of the fiber used. This value permits an estimate of the moisture content of the wet machine film after passage over the vacuum box.

(d) Pressed Weight

The pressed weight, in terms of the per cent water held after pressing, is an indication of the resistance to water removal under pressure. The value is a guide as to the moisture content of the rolled product in wet machine operation and as to the moisture content of pressed sheets.

Clark Classifier

The Clark classifier consists of a semicircular tub divided into four main compartments, in each of which is a circular screen driven by a geared motor. The rim of each screen consists of a brass strip which forms a seal by rotating between the slit edges of a piece of soft rubber tubing mounted on the inside of the tub. By means of a constant head box, water is passed thru the classifier at a specified rate. In each compartment the incoming water is directed to the bottom of the tub by means of a weir and baffle. The consequent motion of the water serves to keep the fibers from settling and to present them regularly to the rotating screens. To further minimize the effect of settling, each compartment is equipped with a water nozzle which provides additional agitation.

In operation, discs containing 1/4 inch and 1/8 inch circular perforations and screens of 30 and 100 mesh are employed, with duplicate runs being made on five gram samples. After classification, the individual fractions are collected and the weight per cents determined, with the dust (-100 mesh material) being obtained by difference. Since the Clark apparatus classifies according to length, with the longer fibers being held in the first compartment, in general, the higher the Fraction 1 weight percent, the longer the fiber.

Although the Clark classifier results are reported to the closest 0.1 per cent, differences of less than two per cent cannot be considered truly significant.

Fiber Filterability

In the fiber filterability test, 30 grams of fiber are stirred with 500 milliliters of water and the resulting slurry is poured into a standard sieve (a 4-1/2 inch, 50 mesh sieve is used for three and four grade fibers and Blue; an eight inch, 60 mesh sieve is used for five, six, and seven grade fibers). Water is then added in spray form until a definite liquid height is reached, and the number of seconds is determined for a specified volume of water to pass thru the asbestos mat. Using the 60 mesh sieve as a basis, the fiber filterability is calculated as the ratio of the filtering time for standard C-7 B to the filtering time for the fiber being evaluated, expressed as a percentage. This fiber filterability figure permits an estimate of the pickup rate on the wet machine cylinders, with lower filterability figures indicating a slower rate.

Surface Area

The apparatus employed for the determination of surface area (specific surface) is a Rigden air permeability system of the type used by T.B.A. in the evaluation of textile fibers. Basically, the operation depends on the resistance to air flow offered by a fiber, with this resistance increasing with openness and dust content and decreasing with length. In this respect, when interpreting surface area data, the specific surface of a fiber relative to its openness must be considered in the light of both the dust content and the length.

Buoyancy

In the buoyancy test, which is run in duplicate, one gram of fiber is mixed with 250 milliliters of water in a stoppered graduate by oscillating 40 complete times in one minute. The fiber is then allowed to settle undisturbed for one hour at the end of which time the volume of the fiber column is read in milliliters. Although no general correlations have been established, this buoyancy figure, for an individual fiber, is a reasonable indication of the degree of preparation. In general, the higher the buoyancy, the more highly prepared the fiber.

As an aid to the use of data obtained from the foregoing tests, the following discussion of fiber characteristics, with reference to their effect on product quality and machine operation in the various manufacturing processes, is included:

Asbestos-Cement Pipe

In the selection of fibers for use in the manufacture of asbestos-cement pipe, the relative strength, average length, and dust content, and the filtration and water retention characteristics of the fibers are of primary importance. It is necessary to use an effectiveness of furnish which will meet the specified strength requirements, and it is desirable, for wet strength, to have a long fiber end and a low dust content. Further, from the point of view of production rate and pipe formation, it is also desirable to use fast filtering fibers of low water retention. In this regard, experience has indicated that the presence of Blue fiber allows for the use of higher rollup pressures in the manufacture of asbestos-cement pipe without distorting or deforming the pipe during build-up.

Although long fibers of low dust content contribute towards [illegible] in both the wet and cured states, it should be noted that such fibers have high water retentions and tend to decrease pipe density. Likewise, although highly opened fibers also contribute towards product strength, such fibers filter slowly, have high water retentions, and also tend to decrease pipe density.

<u>Shingles and Flat Sheets</u>

In the selection of fibers for use in the manufacture of shingles and flat sheets, the relative strength, average length, and dust content, and the filtration and water retention characteristics of the fibers are of primary importance. It is necessary to use an effectiveness of furnish which will meet the specified strength requirements, and it is desirable to have a long fiber end and a low dust content, so as to minimize cracking in the wet and finished states. Further, from the point of view of production rate, it is also desirable to use fast filtering fibers of low water retention. In the case of veneer furnishes, however, the use of short, highly opened fibers is preferable, since such fibers give a more uniform appearance to pressed surfaces.

<u>Corrugated</u>

In the selection of fibers for use in the manufacture of corrugated, the relative strength, average length, dust content, and water retention characteristics of the fibers are of primary importance. It is necessary to use an effectiveness of furnish which will meet the specified strength requirements, and it is desirable to have a long fiber end, a low dust content, and a relatively high water retention in the unformed sheet so that cracking does not occur during the forming operation.

<u>Monobestos</u>

In the selection of fibers for use in the manufacture of Monobestos, the average length and dust content, and the filtration and water retention characteristics of the fibers are of primary importance. Fast filtering fibers of low water retention not only increase production rates, but also minimize warpage by giving more uniform sheet densities. Further, although increased length and decreased dust content contribute towards high water retention, they do tend to increase filtration rates and to minimize cracking by providing more strength in the wet and semicured states.

Asbestos Paper

In the selection of fibers for use in the manufacture of asbestos paper, the average length, dust content, and openness of the fibers are of primary importance. In general, the longer the fibers and the lower the dust content, the greater the tensile, tear, and bursting strengths and the more flexible the paper. Further, although an increase in openness appears to have a negligible effect on tear strength and flexibility, it does increase the tensile and bursting strengths. It should be noted, however, that increased openness as well as increased dust content and decreased length, contribute towards poor filtration rates, low porosity, and poor absorption characteristics.

Millboard

In the selection of fibers for use in the manufacture of Millboard, the fiber reinforcement and openness, and the filtration and water retention characteristics are of primary importance. It is necessary to use a furnish which will meet the specified strength requirements, and it is desirable, from the point of view of production rate and sheet formation, to use fast filtering fibers of low water retention. Although increased openness contributes towards better fiber reinforcement, it also decreases filtration rates, increases water retention, and tends to decrease sheet density.

Sheet Packing

In the selection of fibers for use in the manufacture of sheet packing, the average length, dust content, and openness of the fibers are of primary importance. In general, the longer and more open the fibers, and the lower the dust content, the greater the tensile strength. It should be noted, however, that with this increase in tensile strength, there is also a tendency to decrease sheet density.

Appendix III

Allocation of Fiber for Pipe Manufacture - 1960

Cassiar AC	972 tons
Cassiar AK	3756 tons
Cassiar AX	1776 tons
C&G 3	1572 tons
C&G 4	2412 tons
C&G 5	2316 tons
BT/AC Blue	750 tons
NC-300 Blue	2850 tons
Griqualand Blue	600 tons

L 6300
M 4188
S 2316
Blue 4200
Tot 17,004

Note: Blue fiber tonnage based on 1960 contracts.

Anticipated Usage of Fiber for No. 4 Machine, Plant 1 - 1960

Bell 4K	462 tons
Bell 6D	920 tons
Bell 7D	462 tons
Bell 7M	612 tons

Note: Anticipated usage based on Apac, Linabestos, Sheetflextos, and Monobestos 6X.

Appendix IV

Following are the relative strengths obtained for the fibers evaluated in the present study, together with the relative strengths currently being used for these fibers:

Fiber	Current Relative Strength	Relative Strength (Figures 1 through 10) 6 pins	12 pins	18 pins	24 pins	30 pins	36 pins	42 pins	48 p
Cassiar AC	122	--	--	110	117	121	121	120	11[illegible]
Cassiar AK	100	--	--	101	108	113	113	109	10[illegible]
Cassiar AX	86	--	--	87	87	86	85	84	8[illegible]
C&G 3	105	--	--	106	107	108	109	111	11[illegible]
C&G 4	75	--	--	80	81	81	82	82	8[illegible]
C&G 5	56	--	--	57	58	59	60	61	6[illegible]
Bell 4K	76	77	83	85	87	89	91	94	9[illegible]
Bell 6D	42	47	48	48	49	50	51	52	5[illegible]
BT/AC	101	--	--	103	105	107	109	111	11[illegible]
NC-[illegible]9 NC-300	62	--	--	70	72	72	72	72	7[illegible]

Note: (1) Current relative strength for Bell 6D based on as received fiber; current relative strength for C&G 5 and BT/AC Blue based on preparation with three sluggers and 18 hairpins; current relative strength for all other fibers based on preparation with 18 hairpins.

(2) Increase in relative strength of Bell 6D willowed with six hairpins results from current relative strength being based on as received fiber.

Increase in relative strength of Bell 4K willowed with 18 hairpins results from improved fiber quality. Bell 4K is now less crudy and has a higher percentage of long end than in the past, thus increasing its relative strength.

Change in relative strengths of other fibers willowed with 18 hairpins results from differences in fiber quality. In particular, Cassiar AC is now more crudy and has a lower percentage of long end than in the past, thus decreasing its relative strength; C&G 4 is less crudy and has a lower dust content, thus increasing its relative strength; NC-300 Blue is less crudy, thus increasing its relative strength.

Appendix V

Based on the 1950 fiber allocations shown in Appendix III and the relative strengths shown in Appendix IV, the following changes in fiber usage and raw material cost would result from preparation with the number of hairpins indicated:

Asbestos-Cement Pipe

Fiber	Usage Change-tons/year 18 pins	24 pins	30 pins	36 pins	42 pins	48 pins
Cassiar AC	+ 106	+ 42	+ 8	+ 8	+ 16	+ 50
Cassiar AK	- 37	- 278	- 432	- 432	- 310	- [illegible]
Cassiar AX	- 20	- 20	0	+ 21	+ 42	+ [illegible]
C&G 3	- 15	- 29	- 44	- 58	- 85	- [illegible]
C&G 4	- 151	- 179	- 179	- 206	- 206	- [illegible]
C&G 5	- 41	- 80	- 118	- 154	- 190	- [illegible]
BT/AC	- 15	- 29	- 42	- 55	- 68	- [illegible]
NC-300	- 326	- 396	- 395	- 395	- 396	- 36[illegible]

Fiber	Fiber Cost Dollars/lb.	Cost Change-dollars/year 18 pins	24 pins	30 pins	36 pins	42 pins	48 pins
Cassiar AC	0.1899	+ 40,259	+ 15,952	+ 3,038	+ 3,038	+ 6,077	+ 18,990
Cassiar AK	0.1348	- 9,975	- 74,949	- 116,467	- 116,467	- 83,576	- 38,[illegible]
Cassiar AX	0.0938	- 3,752	- 3,752	0	+ 3,940	+ 7,879	+ 12,00[illegible]
C&G 3	0.1663	- 4,989	- 9,645	- 14,634	- 19,291	- 28,271	- 41,[illegible]
C&G 4	0.1232	- 37,206	- 44,106	- 44,106	- 50,758	- 50,758	- 57,155
C&G 5	0.0738	- 6,052	- 11,808	- 17,417	- 22,730	- 28,044	- 33,0[illegible]
BT/AC	0.1203	- 3,609	- 6,977	- 10,105	- 13,243	- 16,361	- 19,[illegible]
NC-300	0.1185	- 77,262	- 93,852	- 93,852	- 93,852	- 93,852	- 85,557
Net Change		-102,586	-229,137	- 293,543	- 309,353	-285,906	-244,100

Note: (1) The foregoing analysis is based on the relative strengths obtained in the present study compared to the relative strengths currently being used in effectiveness of furnish calculations (see Appendix IV).

(2) Fiber costs are actual, F. O. B. Ambler, effective April 1, 1960.

(3) Griqualand A and Griqualand RM Blue were not evaluated in the present study, and would probably contribute an additional saving.

(4) + = increase in usage and cost due to lower relative strength.
- = decrease in usage and cost due to higher relative strength.

CTD000965

No. 4 Machine - Plant 1

Fiber		Usage Decrease - tons/year							
		6 pins	12 pins	18 pins	24 pins	30 pins	36 pins	42 pins	48 pins
Bell 4K		6	39	49	58	67	76	88	96
Bell 6D		98	115	115	131	147	162	177	191

Fiber	Fiber Cost Dollars/lb	Cost Decrease - dollars/year							
		6 pins	12 pins	18 pins	24 pins	30 pins	36 pins	42 pins	48 pins
Bell 4K	0.1227	1,472	9,571	12,025	14,233	16,442	18,650	21,595	23,558
Bell 6D	0.0508	9,957	11,684	11,684	13,310	14,935	16,459	17,983	19,406
Total		11,429	21,255	23,709	27,543	31,377	35,109	39,578	42,964

Note: (1) The foregoing analysis is based on the relative strengths obtained in the present study compared to the relative strengths currently being used in effectiveness of furnish calculations (see Appendix IV).

(2) Fiber costs are actual, F.O.B. Ambler, effective April 1, 1960.

(3) Bell 7D and Bell 7M were not evaluated in the present study and might contribute an additional saving.