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A comparison of the cylinder power and axis resulting from the modification of the gross opthalmometer cylinder by combining it with the hypothetical internal astigmatism with the clinically acceptable cylinder habitually worn by the subject

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Abstract

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A COMPARISON OF THE CYLINDER POWER AND AXIS RESULTING FROM THE MODIFICATION OF THE GROSS OPHTHALMOMETER CYLINDER BY COMBINING IT WITH THE HYPOTHETICAL INTERNAL ASTIGMATISM WITH THE CLINICALLY ACCEPTABLE CYLINDER HABITUALLY WORN BY THE SUBJECT

Clinical Year Thesis

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We also wish to express our gratitude to Dr. Jack T. Robinson, Dr. Wayne B. Ketchner, and Dr. Ronald E. Wolff for their original subject data.

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INTRODUCTION

Problem:

This study is a second approach to the problem undertaken by Jack Robinson, Wayne Ketchner, and Ronald Wolff for their clinical year thesis, May, 1959. The purpose of this study was to determine how the gross ophthalmometer cylinder, when modified by combining it with the hypothetical internal astigmatism of -.25 x 90, -.50 x 90, and -.75 x 90, compared to the habitual cylinder being worn satisfactorily by the subjects. Secondly, the average deviation of the cylinder axis as computed from the data of our predecessors. From this information a comparison of the modifications of the ophthalmometer cylinder could be made as to their relative validity in predicting a clinically acceptable cylinder from the opthalmometer findings. Finally, we compared the statistical data presented by our predecessors with those determined by this study.

PROCEDURE

The data for this thesis was that compiled by our predecessors. The ophthalmometer findings were taken by the same clinican on the Bausch and Lomb Keratometer. Findings were taken only on patients reporting that they were satisfactorily wearing their habitual cylinder. The findings were then grouped according to the power of the habitual cylinders ranging from -.25D to -1.00D in .12D steps, and from -1.00D to -3.00D in .25D steps. The following is an explanation of the method of application of the three previously mentioned modifications.

The graphical method was used in computing the resultant cylinder power and axis.

The graphical method:

1. Transpose the combination so that both cylinders are of the same sign.
2. By subtraction, determine the angle between the two cylinders. If this exceeds 90^{o} transpose to its other sphero-cylinder form.
3. Multiply this angle by two and then subtract it from 180^{o}.
4. Lay off the angle found in 3 with a protractor.

5. Label one side of this angle with the appropriate number of units in one of the cylinders with the axis as given and do the same for the other side of the angle with the other cylinder.
6. Complete the triangle by joining the two ends of the angle. This now gives the cylinder equivalent by scalar quantity.
7. Using a protractor measure the other two angles of the triangle, remembering that the three angles total 180°.
8. Divide each of these two angles by two.
9. By adding the numbers obtained in 8 above to one of the axes of the given cylinders, or by subtraction from the other the same result is obtained. This result is the axis of the resultant cylinder.

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. -.25 X 90	Net Cyl. -.50 X 90	Net Cyl. -.75 X 90
10	F	-.25 X 100	43.62 @ 170 44.25 @ 80	-.62 X 170	-.37 X 164	-.25 X 145	-.25 X 115
10	F	-.25 X 155	43.75 @ 170 44.00 @ 80	-.25 X 170	-.12 X 129	-.25 X 99	-.50 X 95
77	M	-.25 X 140	43.62 @ 5 44.62 @ 95	-1.00 X 5	-.75 X 7	-.50 X 10	-.25 X 19
51	M	-.25 X 165	42.87 @ 175 44.00 @ 85	-1.12 X 175	-.87 X 173	-.62 X 171	-.37 X 165
23	M	-.25 X 157	41.75 @ 155 42.25 @ 180	-.50 X 155	-.37 X 140	-.37 X 112	-.62 X 110
28	M	-.25 X 90	43.37 @ 90 43.25 @ 180	-.12 X 90	-.37 X 90	-.62 X 90	-.87 X 90
13	M	-.25 X 105	44.75 @ 40 44.62 @ 130	-.12 X 130	-.37 X 102	-.50 X 97	-.75 X 95
13	M	-.25 X 45	44.50 @ 155 44.37 @ 65	-.12 X 65	-.37 X 83	-.62 X 86	-.87 X 87
19	M	-.25 X 90	41.50 @ 6 41.75 @ 96	-.25 X 6	Sphere	-.25 X 84	-.50 X 87
19	M	-.25 X 65	41.62 @ 171 42.25 @ 81	-.62 X 171	-.25 X 167	-.12 X 134	-.25 X 169
58	M	-.25 X 120	44.62 @157 45.25 @ 67	-.62 X 157	-.50 X 146	-.50 X 131	-.50 X 118
58	M	-.25 X 80	44.25 @ 164 44.87 @ 74	-.62 X 164	-.37 X 160	-.25 X 142	-.25 X 112

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. -.25 X 90	Net Cyl. -.50 X 90	Net Cyl. -.75 X 90
23	M	-.25 X 75	43.00 @ 166 43.50 @ 76	-.50 X 166	-.25 X 155	-.25 X 128	-.50 X 109
23	M	-.25 X 140	43.50 @ 162 44.50 @ 72	-1.00 X 162	-.87 X 157	-.62 X 149	-.62 X 138
18	F	-.25 X 85	43.25 @ 136 43.37 @ 46	-.12 X 136	-.25 X 124	-.50 X 97	-.75 X 94
58	M	-.25 X 180	43.50 @ 165 45.00 @ 75	-1.50 X 165	-1.25 X 162	-1.12 X 159	-.87 X 153
54	M	-.25 X 115	41.62 @ 163 41.87 @ 73	-.25 X 163	-.12 X 128	-.37 X 103	-.50 X 99
54	M	-.25 X 75	41.62 @ 175 42.62 @ 85	-1.00 X 175	-.75 X 173	-.50 X 170	-.25 X 162
47	F	-.25 X 105	41.75 @ 180 42.62 @ 90	-.87 X 180	-.62 X 180	-.37 X 180	-.12 X 180
42	M	-.25 X 105	41.37 @ 85 41.12 @ 175	-.25 X 175	Sphere	-.25 X 95	-.50 X 93
26	F	-.25 X 135	44.25 @ 155 44.50 @ 65	-.25 X 155	-.25 X 124	-.37 X 115	-.62 X 98
20	F	-.37 X 175	44.25 @ 175 44.62 @ 85	-.37 X 175	-.12 X 166	-.12 X 105	-.37 X 95
55	F	-.37 X 165	43.37 @ 150 44.25 @ 60	-.87 X 150	-.75 X 142	-.62 X 133	-.62 X 122

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. -.25 X 90	Net Cyl. -.50 X 90	Net Cyl. -.75 X 90
55	F	-.37 X 30	43.50 @ 10 44.50 @ 100	-1.00 X 10	-.75 X 14	-.50 X 19	-.37 X 32
45	F	-.37 X 65	43.87 @ 171 44.50 @ 81	-.62 X 171	-.37 X 165	-.25 X 147	-.25 X 115
21	F	-.37 X 95	41.75 @ 180 43.25 @ 90	-1.50 X 180	-1.25 X 180	-1.00 X 180	-.75 X 180
34	F	-.37 X 107	43.12 @ 180 44.12 @ 90	-.75 X 180	-.50 X 180	-.25 X 180	Sphere
31	F	-.37 X 50	45.00 @ 90 44.50 @ 180	-.50 X 180	-.25 X 180	Sphere	-.25 X 90
42	M	-.37 X 15	43.75 @ 180 44.50 @ 90	-.75 X 180	-.50 X 180	-.25 X 180	Sphere
26	M	-.50 X 75	44.12 @ 42 42.00 @ 132	-.12 X 132	-.25 X 103	-.50 X 97	-.75 X 95
21	M	-.50 X 60	44.50 @ 10 44.87 @ 100	-.37 X 10	-.12 X 26	-.25 X 71	-.37 X 81
15	F	-.50 X 7	45.12 @ 172 46.12 @ 82	-1.00 X 172	-.75 X 169	-.50 X 165	-.37 X 154
27	M	-.50 X 112.	43.37 @ 32 42.75 @ 122	-.62 X 122	-.75 X 113	-1.00 X 108	-1.12 X 104
18	F	-.50 X 180	41.62 @ 170 42.75 @ 80	-1.12 X 170	-.87 X 167	-.62 X 162	-.50 X 155

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. -.25 X 90	Net Cyl. -.50 X 90	Net Cyl. -.75 X 90
48	F	-.50 X 172	43.50 @ 172 44.37 @ 82	-.87 X 172	-.62 X 169	-.37 X 162	-.25 X 145
27	M	-.50 X 180	44.25 @ 170 45.12 @ 80	-.87 X 170	-.62 X 166	-.50 X 158	-.37 X 142
18	F	-.50 X 75	43.25 @ 180 43.75 @ 90	-.50 X 180	-.25 X 180	Sphere	-.25 X 90
32	F	-.50 X 165	44.50 @ 150 45.62 @ 60	-1.12 X 150	-1.00 X 144	-1.00 X 137	-1.00 X 129
58	M	-.50 X 176	43.25 @ 180 44.62 @ 90	-1.37 X 180	-1.12 X 180	-.87 X 180	-.62 X 180
28,	F	-.50 X 15	44.75 @ 180 46.62 @ 90	-1.87 X 180	-1.62 X 180	-1.37 X 180	-1.12 X 180
20	F	-.50 X 165	46.25 @ 180 45.25 @ 90	-1.00 X 90	-1.25 X 90	-1.50 X 90	-1.75 X 90
19	M	-.50 X 73	42.62 @ 40 42.00 @ 130	-.62 X 130	-.75 X 120	-.87 X 112	-1.00 X 108
72	F	-.50 X 165	46.00 @ 180 46.50 @ 90	-.50 X 180	-.25 X 180	Sphere	-.25 X 90
39	F	-.50 X 110	43.00 @ 180 44.00 @ 90	-1.00 X 180	-.75 X 180	-.50 X 180	-.25 X 180
9	M	-.50 X 170	42.25 @ 170 43.00 @ 80	-.75 X 170	-.50 X 165	-.37 X 155	-.25 X 130

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. -.25 X 90	Net Cyl. -.50 X 90	Net Cyl. -.75 X 90
20	F	-.62 X 175	44.37 @ 175 44.87 @ 85	-.50 X 175	-.25 X 170	-.12 X 134	-.25 X 99
23	M	-.62 X 170	42.00 @ 177 43.12 @ 87	-1.12 X 177	-.87 X 176	-.62 X 175	-.37 X 171
21	F	-.62 X 85	41.75 @ 180 42.50 @ 90	-.75 X 180	-.50 X 180	-.25 X 180	Sphere
18	F	-.62 X 115	45.00 @ 180 44.00 @ 90	-1.00 X 90	-1.25 X 90	-1.50 X 90	-1.75 X 90
19	F	-.62 X 180	49.00 @ 175 49.50 @ 85	-.50 X 175	-.25 X 170	Sphere	-.25 X 99
42	M	-.62 X 5	44.00 @ 180 44.50 @ 90	-.50 X 180	-.25 X 180	Sphere	-.25 X 90
34	F	-.62 X 175	44.50 @ 90 44.25 @ 180	-.25 X 180	Sphere	-.25 X 90	-.50 X 90
34	F	-.62 X 175	44.50 @ 90 44.25 @ 180	-.25 X 180	Sphere	-.25 X 90	-.50 X 90
48	F	-.75 X 20	44.62 @ 4 45.12 @ 94	-.50 X 4	-.25 X 8	-.12 X 45	-.25 X 82
81	F	-.75 X 180	43.25 @ 164 44.62 @ 74	-1.37 X 164	-1.12 X 161	-1.00 X 156	-.87 X 150
38	F	-.75 X 80	45.87 @ 142 44.75 @ 52	-1.12 X 52	-1.25 X 58	-1.37 X 63	-1.50 X 67

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. -.25 X 90	Net Cyl. -.50 X 90	Net Cyl. -.75 X 90
21	M	-.75 X 155	43.12 @ 160 44.00 @ 70	-.87 X 160	-.75 X 154	-.62 X 143	-.50 X 130
21	M	-.75 X 10	43.25 @ 175 44.00 @ 85	-.75 X 175	-.50 X 172	-.25 X 163	-.12 X 133
52	F	-.75 X 3	42.37 @ 170 44.37 @ 80	-2.00 X 170	-1.75 X 168	-1.62 X 167	-1.37 X 165
77	M	-.75 X 95	44.00 @ 5 43.62 @ 95	-.37 X 95	-.50 X 104	-.62 X 113	-.87 X 119
21	M	-.75 X 78	44.75 @ 170 45.25 @ 80	-.50 X 170	-.25 X 162	-.12 X 132	-.37 X 100
68	F	-.75 X 45	44.12 @ 180 44.50 @ 90	-.37 X 180	-.12 X 180	-.12 X 90	-.37 X 90
21	F	-.75 X 180	42.62 @ 180 44.00 @ 90	-1.37 X 180	-1.12 X 180	-.87 X 180	-.62 X 180
21	F	-.75 X 5	42.37 @ 170 44.25 @ 80	-1.87 X 120	-2.00 X 116	-2.12 X 114	-2.37 X 115
45	F	-.75 X 15	44.25 @ 3 46.75 @ 93	-2.50 X 3	-2.25 X 3	-2.00 X 4	-1.75 X 4
31	M	-.75 X 10	43.37 @ 10 43.62 @ 100	-.37 X 10	-.25 X 18	-.12 X 62	-.37 X 75
17	M	-.75 X 120	45.50 @ 140 45.75 @ 50	-.25 X 140	-.25 X 115	-.50 X 104	-.75 X 99

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. -.25 X 90	Net Cyl. -.50 X 90	Net Cyl. -.75 X 90
17	M	-.75 X 30	44.87 X 9 46.25 X 99	-1.37 X 9	-1.25 X 10	-1.00 X 13	-.75 X 118
20	F	-.87 X 165	45.00 X 156 46.87 X 66	-1.87 X 156	-1.75 X 153	-1.62 X 149	-1.50 X 145
20	F	-.87 X 10	44.75 X 180 46.50 X 90	-1.75 X 180	-1.50 X 180	-1.25 X 180	-1.00 X 180
65	F	-.87 X 180	42.50 X 5 44.12 X 95	-1.62 X 5	-1.37 X 180	-1.12 X 180	-.87 X 180
13	F	-.87 X 80	45.87 X 180 45. 37 X 90	-.50 X 90	-.75 X 90	-1.00 X 90	-1.25 X 90
48	M	-.87 X 5	39.12 X 175 40.87 X 86	-1.75 X 1.75	-1.50 X 174	-1.25 X 173	-1.00 X 171
68	F	-.87 X 135	42.00 X 180 43.75 X 90	-1.75 X 180	-1.50 X 180	-1.25 X 180	-1.00 X 180
58	F	-1.00 X 10	43.75 X 178 45.12 X 88	-1.37 X 178	-1.12 X 177	-.87 X 177	-.62 X 176
45	F	-1.00 X 113	47.12 X 120 48.12 X 30	-1.00 X 120	-1.12 X 115	-1.37 X 112	-1.50 X 107
35	M	-1.00 X 165	43.50 X 180 45.00 X 90	-1.50 X 180	-1.25 X 180	-1.00 X 180	-.75 X 180

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. -.25 X 90	Net Cyl. -.50 X 90	Net Cyl. -.75 X 90
15	M	-1.00 X 83	42.75 X 180 42.50 X 90	-.25 X 90	-.50 X 90	-.75 X 90	-1.00 X 90
15	F	-1.00 X 180	44.75 X 2 46.00 X 92	-1.25 X 2	-1.00 X 180	-.75 X 180	-.50 X 180
27	M	-1.00 X 180	43.75 X 180 45.12 X 90	-1.37 X 180	-1.12 X 180	-.87 X 180	-.62 X 180
21	M	-1.00 X 76	45.00 X 30 45.37 X 1.20	-.38 X 30	-.25 X 61	-.50 X 75	-.62 X 81
32	M	-1.00 X 90	45.25 X 85 45.75 X 175	-.50 X 85	-.75 X 90	-1.00 X 90	-.1.00 X 90
32	M	-1.00 X 90	45.75 X 90 46.00 X 180	-.25 X 90	-.50 X 90	-.75 X 90	-1.00 X 90
80	F	-1.00 X 105	43.87 X 165 44.50 X 75	-.62 X 165	-.50 X 156	-.37 X 147	-.25 X 126
34	M	-1.00 X 110	46.50 X 10 46.37 X 100	-.12 X 100	-.37 X 94	-.62 X 92	-.87 X 91
18	F	-1.00 X 72	41.87 X 73 42.12 X 163	-.25 X 73	-.50 X 94	-.75 X 82	-1.00 X 86
35	M	-1.25 X 25	43.75 X 175 45.25 X 85	-1.50 X 175	-1.25 X 180	-1.00 X 180	-.75 X 180
58	F	-1.25 X 175	43.50 X 167 45.62 X 99	-2.12 X 167	-1.87 X 165	-1.62 X 163	-1.50 X 160

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. -.25 X 90	Net Cyl. -.50 X 90	Net Cyl. -.75 X 90
19	M	-1.25 X 125	41.00 X 4 42.50 X 94	-1.50 X 4	-1.25 X 180	-1.00 X 180	-.75 X 180
38	F	-1.25 X 105	46.00 X 28 45.25 X 118	-.75 X 118	-.87 X 112	-1.12 X 107	-1.37 X 104
36	M	-1.25 X 85	47.25 X 52 46.00 X 142	-1.25 X 142	-1.37 X 42	-1.50 X 52	-1.62 X 56
20	F	-1.25 X 175	46.87 X 90 45.25 X 180	-1.62 X 180	-1.37 X 180	-1.12 X 180	-.87 X 180
13	F	-1.25 X 95	45.75 X 180 45.25 X 90	-.50 X 90	-.75 X 90	-1.00 X 90	-1.25 X 90
26	M	-1.50 X 90	43.12 X30 43.00 X 120	-.12 X 120	-.37 X 60	-.62 X 95	-.87 X 93
29	F	-1.50 X 180	42.62 X 170 44.75 X 80	-2.12 X 170	-1.87 X 168	-1.62 X 167	-1.50 X 165
32	F	-1.50 X 165	42.50 X 175 42.87 X 85	-.37 X 175	-.12 X 180	-.12 X 180	-.25 X 180
48	M	-1.50 X 170	39.25 X 168 41.50 X 78	-2.87 X 168	-2.00 X 166	-1.75 X 165	-1.62 X 162
56	F	-1.50 X 30	43.37 X 31 40. 50 X 121	-2.87 X 121	-3.12 X 119	-3.25 X 117	-3.37 X 115

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. -.25 X 90	Net Cyl. -.50 X 90	Net Cyl. -.75 X 90
51	F	-1.50 X 175	43.25 X 180 44.50 X 90	-1.25 X 180	-1.00 X 180	-.75 X 180	-.50 X 180
51	M	-1.50 X 170	43.75 X 180 44.50 X 90	-.75 X 180	-.50 X 180	-.25 X 180	Sphere
27	M	-1.50 X170	42.25 X 170 44.00 X 80	-1.75 X 170	-1.50 X 168	-1.25 X 166	-1.12 X 163
81	F	-1.75 X 152	44.37 X 165 44.75 X 75	-.37 X 165	-.25 X 135	-.25 X 95	-.37 X 108
65	F	-1.75 X 174	42.75 X 180 43.75 X 90	-1.00 X 180	-.75 X 180	-.50 X 180	-.25 X 180
29	F	-1.75 X 175	42.75 X 175 44.87 X 85	-2.12 X 175	-2.00 X 174	-1.75 X 173	-1.50 X 172
48	M	-1.75 X 90	44.87 X 6 43.50 X 96	-1.37 X 96	-1.62 X 91	-1.87 X 91	-2.12 X 94
48	M	-1.75 X 90	44.00 X 25 42.62 X 115	-1.37 X 115	-1.62 X 112	-1.75 X 109	-2.00 X 98
81	F	-1.75 X 152	44.37 X 165 44.75 X 75	-.37 X 165	-.25 X 135	-.25 X 95	-.37 X 108
52	F	-1.75 X 178	42.75 X 180 43.62 X 90	-.87 X 180	-.62 X 180	-.37 X 180	-.12 X 180
18	F	-1.75 X 180	41.37 X 180 42.87 X 90	-1.50 X 180	-1.25 X 180	-1.00 X 180	-.75 X 180

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. -.25 X 90	Net Cyl -.50 X 90	Net Cyl -.75 X 90
23	F	-2.00 X 180	45.50 X 90 43.37 X 180	-2.12 X 180	-1.87 X 180	-1.62 X 180	-1.37 X 180
29	F	-2.00 X 180	44.87 X 180 46.00 X 90	-1.12 X 180	-.87 X 180	-.62 X 180	-.37 X 180
14	M	-2.00 X 106	43.87 X 120 45.25 X 30	-1.37 X 120	-1.50 X 116	-1.75 X 112	-1.87 X 110
67	F	-2.00 X 180	42.00 X 180 45.00 X 90	-3.00 X 180	-2.75 X 180	-2.50 X 180	-2.25 X 180
47	F	-2.00 X 85	46.75 X 90 47.25 X 180	-.50 X 90	-.75 X 90	-1.00 X 90	-1.25 X 90
53	M	-2.00 X 178	43.62 X 180 46.00 X 90	-2.37 X 180	-2.12 X 180	-1.87 X 180	-1.62 X 180
34	M	-2.50 X 5	44.25 X 5 46.00 X 105	-2.50 X 5	-2.25 X 5	-2.00 X 6	-1.75 X 7
55	M	-2.25 X 3	41.50 X 180 43.75 X 90	-2.25 X 180	-2.00 X 180	-1.75 X 180	-1.50 X 180
48	F	-2.25 X 85	42.50 X 90 44.00 X 180	-1.50 X 90	-1.75 X 90	-2.00 X 90	-2.25 X 90
48	F	-2.25 X 92	43.50 X 178 42.25 X 88	--.25 X 88	-1.50 X 90	-1.75 X 90	-2.00 X 90
32	F	-2.25 X 180	43.50 X 178 45.25 X 88	-1.75 X 178	-1.62 X 180	-1.37 X 180	-1.12 X 180
56	M	-2.25 X 10	41.50 X 180 43.50 X 90	-2.00 X 180	-1.75 X 180	-1.50 X 180	-1.25 X 180

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. -.25 X 90	Net Cyl. -.50 X 90	Net Cyl. -.75 X 90
34	M	-2.50 X 165	44.25 X 170 46.75 X 80	-2.50 X 170	-2.25 X 168	-2.00 X 167	-1.87 X 166
83	F	-2.50 X 90	42.75 X 90 44.25 X 180	-1.50 X 90	-1.75 X 90	-2.00 X 90	-2.25 X 90
49	F	-2.50 X 180	43.50 X 3 47.00 X 93	-3.50 X 3	-3.25 X 2	-3.12 X 2	-2.75 X 2
54	F	-2.50 X 5	44.50 X 90 42.50 X 180	-2.00 X 180	-1.75 X 180	-1.50 X 180	-1.25 X 180
25	M	-2.50 X 15	40.75 X 9 44.25 X 99	-3.37 X 169	-3.25 X 9	-3.00 X 11	-2.87 X 11
25	M	-2.50 X 175	41.00 X 169 44.37 X 79	-3.37 X 169	-2.12 X 168	-2.62 X 167	-2.75 X 166
5	M	-2.75 X 180	44.75 X 180 48.50 X 90	-3.75 X 180	-3.50 X 180	-3.25 X 180	-3.00 X 180
49	F	-2.75 X 180	43.50 X 180 47.00 X 90	-3.50 X 180	-3.25 X 180	-3.00 X 180	-2.75 X 180
55	M	-2.75 X 180	41.50 X 180 43.75 X 90	-2.25 X 180	-2.00 X 180	-1.75 X 180	-1.50 X 180
36	M	-2.75 X 75	41.50 X 60 44.00 X 150	-2.50 X 60	-2.62 X 62	-2.75 X 65	-3.00 X 66
53	F	-2.75 X 165	42.00 X 90 44.25 X 180	-2.25 X 90	-2.50 X 90	-2.75 X 90	-3.00 X 90
25	M	-2.75 X 10	42.50 X 180 45.00 X 90	-2.50 X 180	-2.25 X 180	-2.00 X 180	-1.75 X 180

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TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. -.25 X 90	Net Cyl. -.50 X 90	Net Cyl. -.75 X 90
13	M	-3.00 X 180	40:75 X 180 43.75 X 90	-3.00 X 180	-2.75 X 180	-2.50 X 180	-2.25 X 180
9	M	-3.00 X 20	44.87 X 111 41.75 X 21	-3.12 X 21	-2.87 X 23	-2.75 X 24	-2.62 X 27
10	M	-3.00 X 60	43:50 X 37 46.00 X 127	-2.50 X 37	-2.50 X 40	-2.37 X 43	-2.37 X 46
34	F	-3.00 X 115	45.50 X 90 48.25 X 180	-2.75 X 90	-3.00 X 90	-3.25 X 90	-3.50 X 90
59	F	-3.00 X 135	45.00 X 145 47.00 X 55	-2.00 X 145	-2.00 X 141	-1.87 X 137	-1.87 X 134
37	F	-3.00 X 170	43.87 X 160 46.87 X 20	-3.00 X 160	-2.87 X 158	-2.62 X 156	-2.37 X 153

THE STATISTICAL ANALYSIS OF THE COMPILED DATA

Each catagory of habitually worn cylinders is analyzed as a unit with respect to each of the three modifications. The central value used in this study was the MEAN, calculated in the conventional manner by using the formula $\left(\frac{\Sigma X}{N}\right)$. The STANDARD DEVIATION was likewise calculated in the conventional manner by using the formula $\sqrt{\frac{\Sigma x^2}{N}}$, x being X - M. If the mean cylinder is found to lie within one probable error (.6745 x standard deviation) of the habitually worn cylinder it is considered significant on a group basis. The use of the probable error allows the significant limits to encompass 50% of the cases scattered symmetrically about the mean net cylinder. This statistical data was recorded on graphs for each catagory of habitual worn cylinder.

The sum of the degrees of the axis deviation from the habitually worn cylinder for the individual subjects within each category was divided by the number of subjects to determine an average deviation. A comparison was then made between the average deviations of this study, and those of Javal, McCulloch, and Sutcliffe of our predecessors study.

COMPARISON OF AVERAGE AXIS DEVIATION, FROM HABITUAL CYLINDER IN DEGREES, AS MODIFIED BY THE HYPOTHETICAL ASTIGMATIC FACTORS, AND THE RULES OF JAVAL, McCULLOCH, AND SUTCLIFFE.

Hab. Cyl. Power	-.25 X 90	-.50 X 90	-.75 X 90	Javal	McCulloch	Sutcliffe
-.25	35.60	31.86	33.22	37.90	28.76	28.76
-.37	43.87	52.59	48.33	52.12	44.75	44.75
-.50	27.37	25.35	33.44	28.62	28.62	28.62
-.62	22.66	54.33	62.59	27.12	68.37	68.37
-.75	23.13	26.73	30.06	26.93	25.46	25.46
-.87	14.83	15.60	16.50	14.83	14.83	14.83
-1.00	11.75	8.07	15.91	11.08	7.33	7.33
-1.25	16.43	19.51	15.00	25.28	25.28	25.28
-1.50	20.84	18.00	21.14	27.62	19.50	27.62
-1.75	8.25	18.00	13.87	20.37	14.25	20.37
-2.00	2.63	2.16	1.83	3.50	18.50	18.50
-2.25	3.66	3.50	3.33	4.33	4.33	4.33
-2.50	3.83	3.50	3.50	4.16	4.16	4.16
-2.75	16.33	15.83	15.66	16.66	16.66	16.16
-3.00	11.00	10.33	16.66	11.50	11.50	11.50

EXPLANATION OF GRAPHS

Two methods were used in plotting the graphs contained in this study. For each habitually worn cylinder category, one graph was plotted with the net cylinder as calculated by the modifications on the X-axis rounded to the nearest .12D, and the frequency of the net cylinders on the Y-axis. Each graph contains a line for each of the modifications, showing the three distributions in a manner which facilitates comparison.

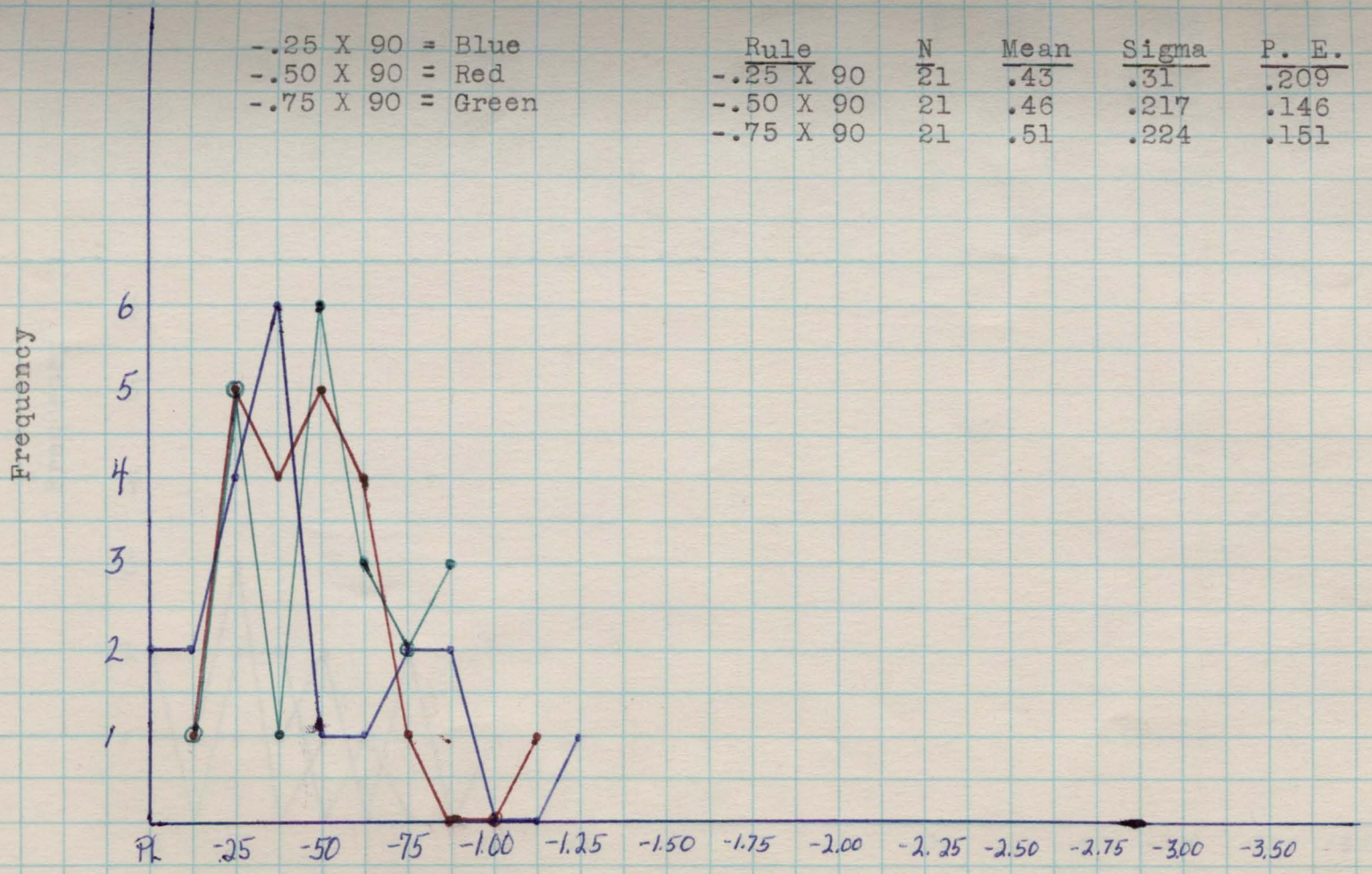
The second method of graphing the data consists of four graphs, one for each rule and the gross, plotting the entire range of habitually worn cylinders on the X-axis against the mean net cylinder on the Y-axis. The significant range of plus or minus one probable error is shaded in on each side of the mean. From these graphs one can visualize the degree of deviation from the habitually worn cylinders as it varies throughout the range.

-.25 HABITUAL CYLINDER

Showing Frequency of Net Powers

-.25 X 90 = Blue
-.50 X 90 = Red
-.75 X 90 = Green

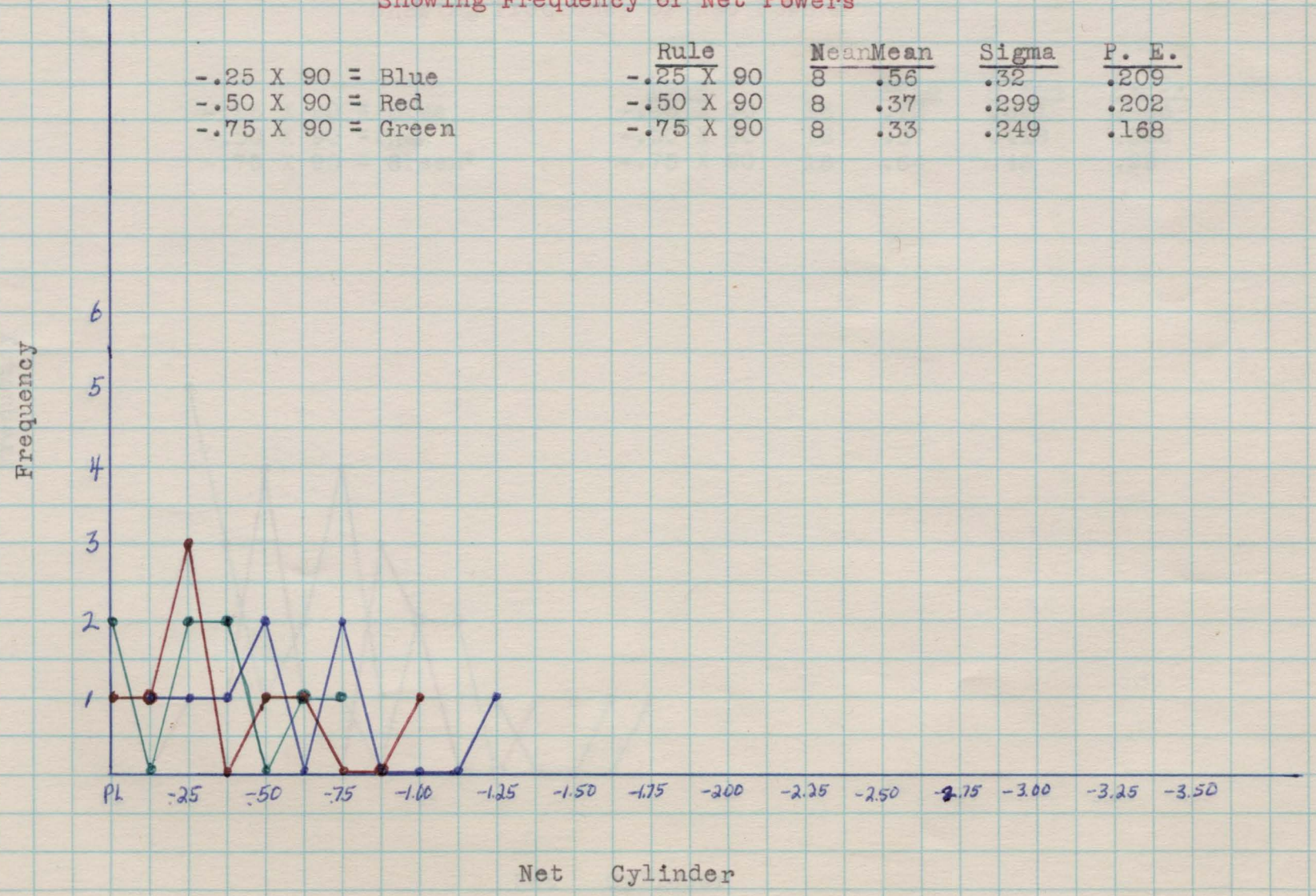
Rule	N	Mean	Sigma	P. E.
-.25 X 90	21	.43	.31	.209
-.50 X 90	21	.46	.217	.146
-.75 X 90	21	.51	.224	.151



-.37 HABITUAL CYLINDER

Showing Frequency of Net Powers

	Rule	Mean	Mean	Sigma	P. E.
-.25 X 90 = Blue	-.25 X 90	8	.56	.32	.209
-.50 X 90 = Red	-.50 X 90	8	.37	.299	.202
-.75 X 90 = Green	-.75 X 90	8	.33	.249	.168

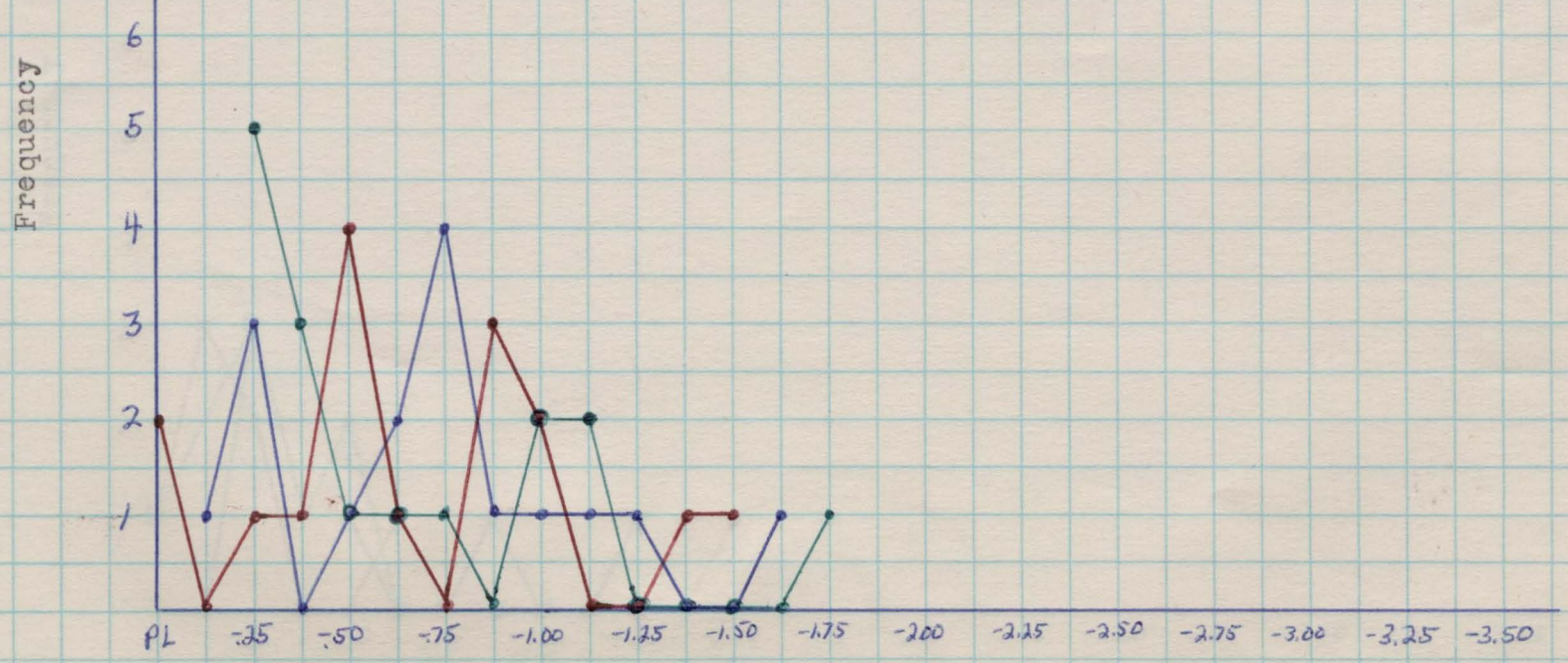


-.50 HABITUAL CYLINDER

Showing Frequency of Net Powers

-.25 X 90 = Blue
-.50 X 90 = Red
-.75 X 90 = Green

Rule	N	Mean	Sigma	P. E.
-.25 X 90	16	.72	.391	.263
-.50 X 90	16	.67	.418	.362
-.75 X 90	16	.64	.43	.29

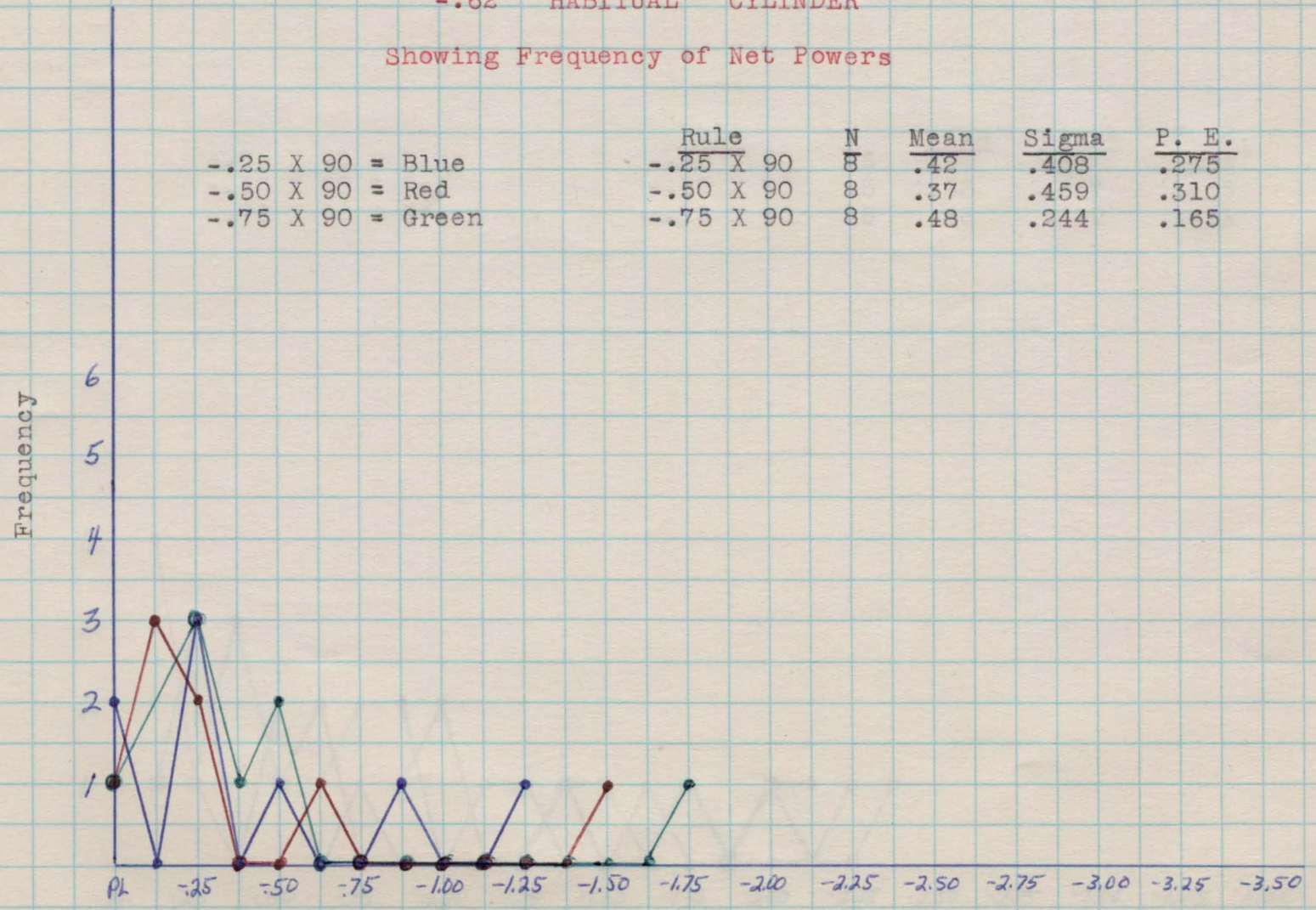


-.62 HABITUAL CYLINDER

Showing Frequency of Net Powers

-.25 X 90 = Blue
-.50 X 90 = Red
-.75 X 90 = Green

Rule	N	Mean	Sigma	P. E.
-.25 X 90	8	.42	.408	.275
-.50 X 90	8	.37	.459	.310
-.75 X 90	8	.48	.244	.165

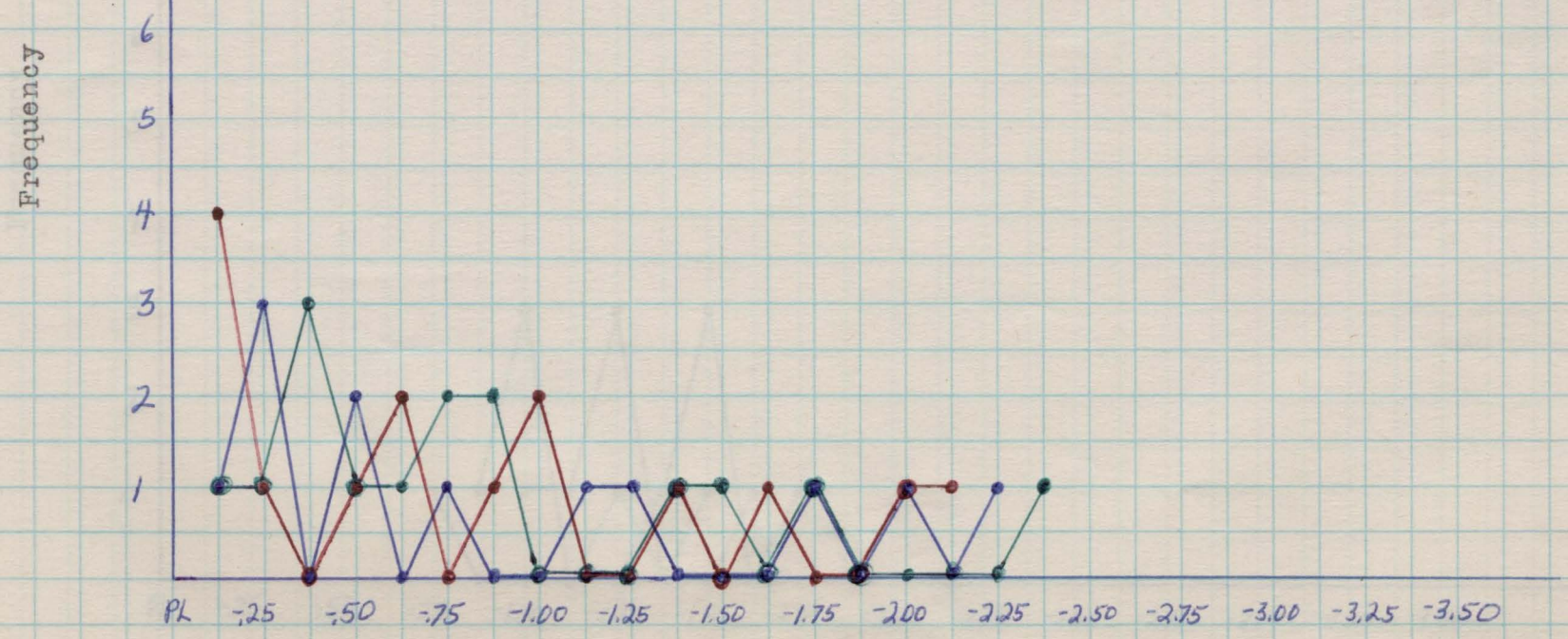


-.75 HABITUAL CYLINDER

Showing Frequency of Net Powers

-.25 X 90 = Blue
-.50 X 90 = Red
-.75 X 90 = Green

Rule	N	Mean	Sigma	P. E.
-.25 X 90	15	.91	.67	.451
-.50 X 90	15	.83	.657	.443
-.75 X 90	15	.86	.609	.411

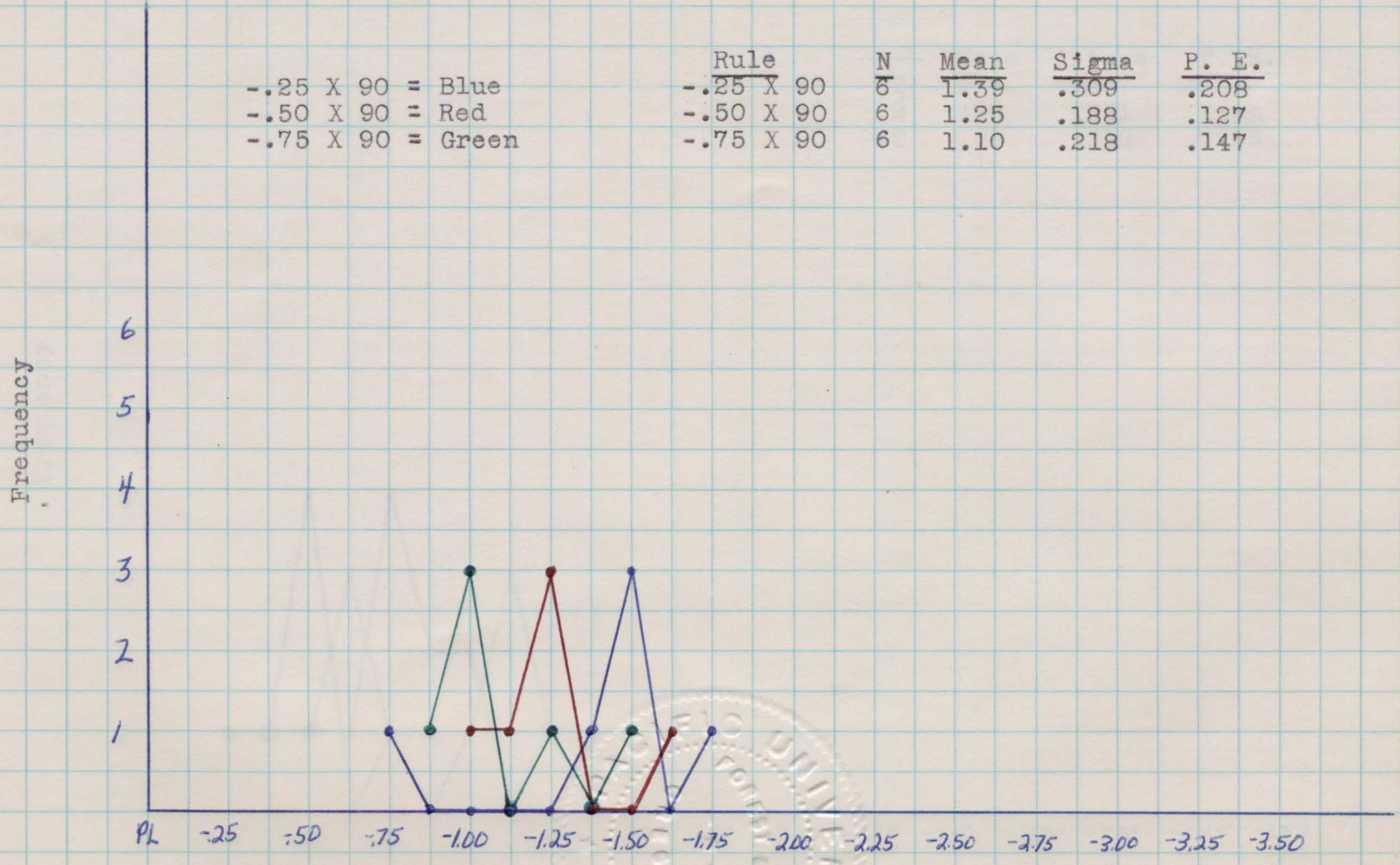


-.87 HABITUAL CYLINDER

Showing Frequency of Net Powers

-.25 X 90 = Blue
-.50 X 90 = Red
-.75 X 90 = Green

Rule	N	Mean	Sigma	P. E.
-.25 X 90	6	1.39	.309	.208
-.50 X 90	6	1.25	.188	.127
-.75 X 90	6	1.10	.218	.147

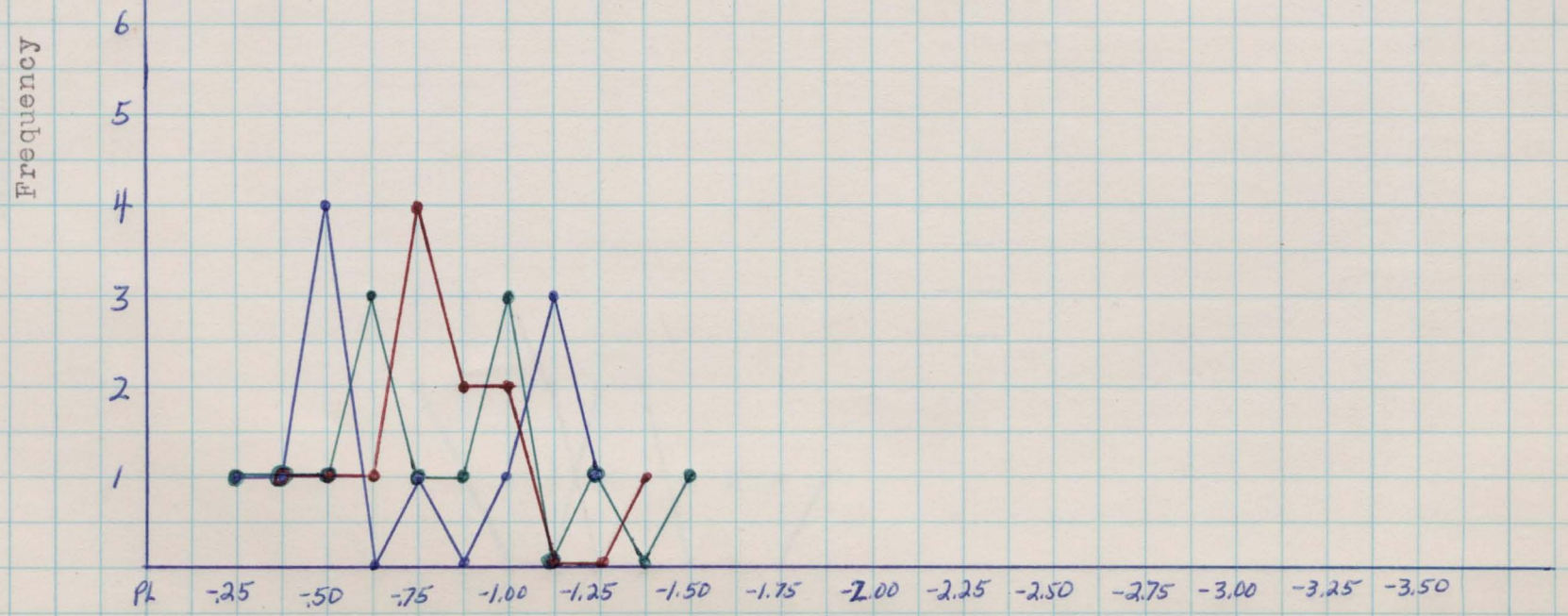


-1.00 HABITUAL CYLINDER

Showing Frequency of Net Power

-.25 X 90 = Blue
-.50 X 90 = Red
-.75 X 90 = Green

Rule	N	Mean	Sigma	P. E.
-.25 X 90	12	.75	.337	.227
-.50 X 90	12	.80	.251	.169
-.75 X 90	12	.83	.319	.2215

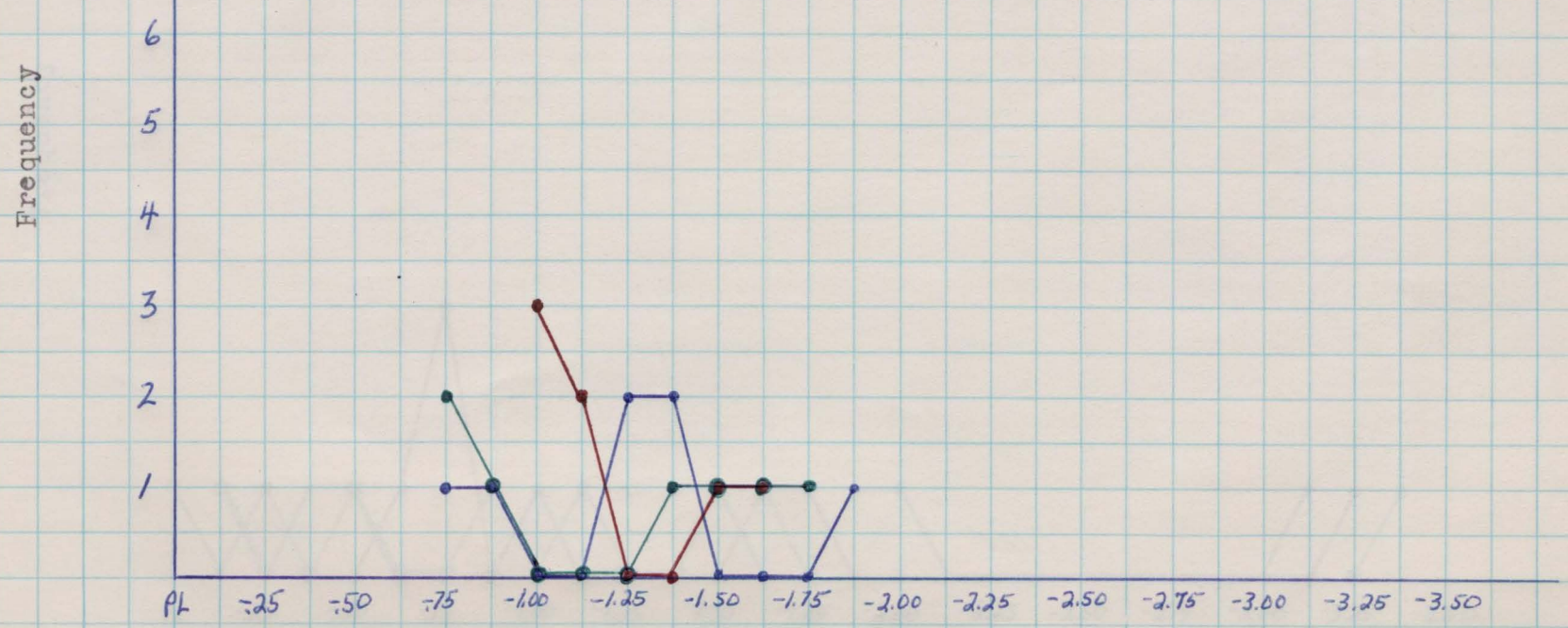


-1.25 HABITUAL CYLINDER

Showing Frequency of Net Powers

-.25 X 90 = Blue
-.50 X 90 = Red
-.75 X 90 = Green

Rule	N	Mean	Sigma	P. E.
-.25 X 90	7	1.25	.339	.228
-.50 X 90	7	1.19	.239	.161
-.75 X 90	7	1.23	.397	.289

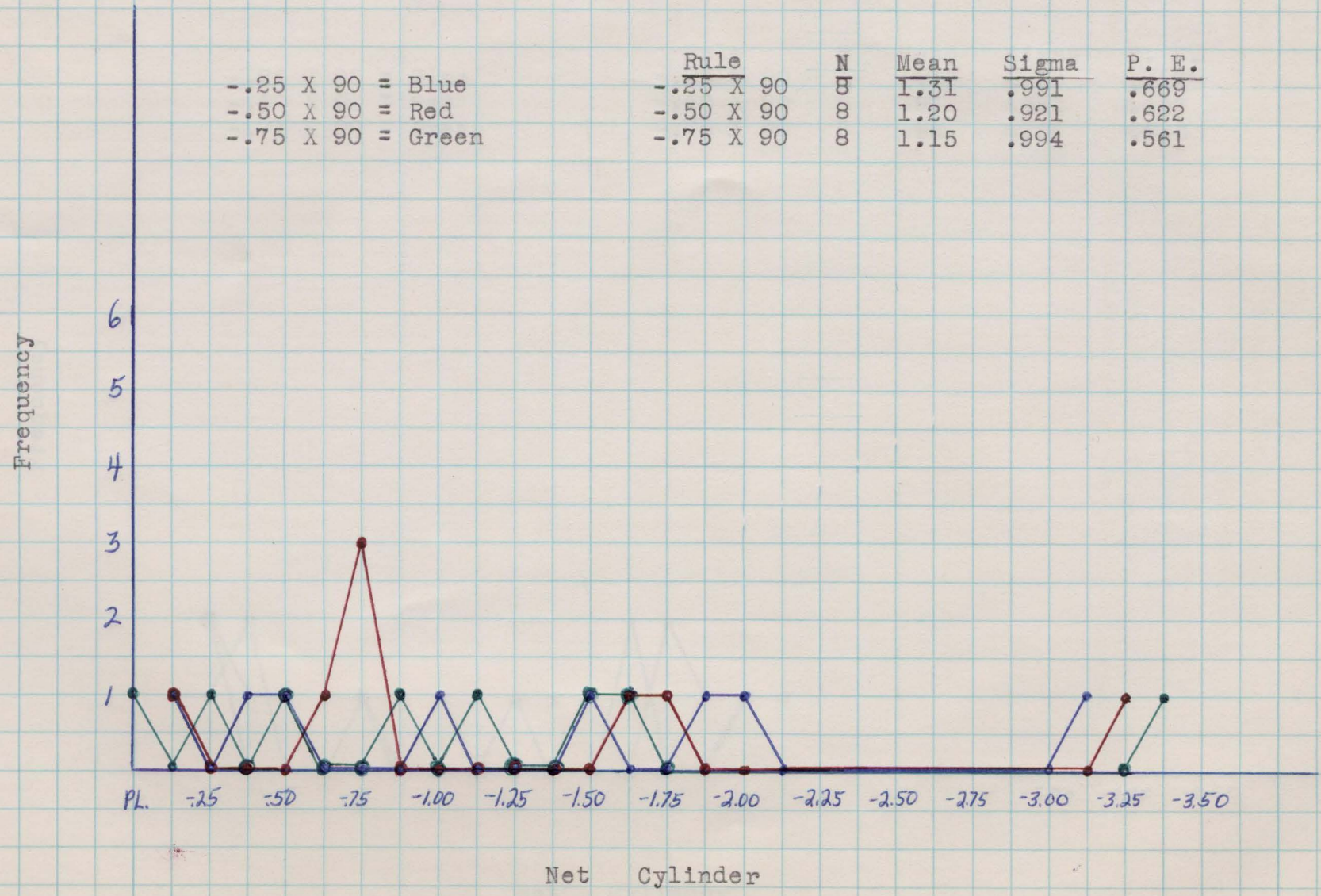


-1.50 HABITUAL CYLINDER

Showing Frequency of Net Powers

-.25 X 90 = Blue
-.50 X 90 = Red
-.75 X 90 = Green

Rule	N	Mean	Sigma	P. E.
-.25 X 90	8	1.31	.991	.669
-.50 X 90	8	1.20	.921	.622
-.75 X 90	8	1.15	.994	.561

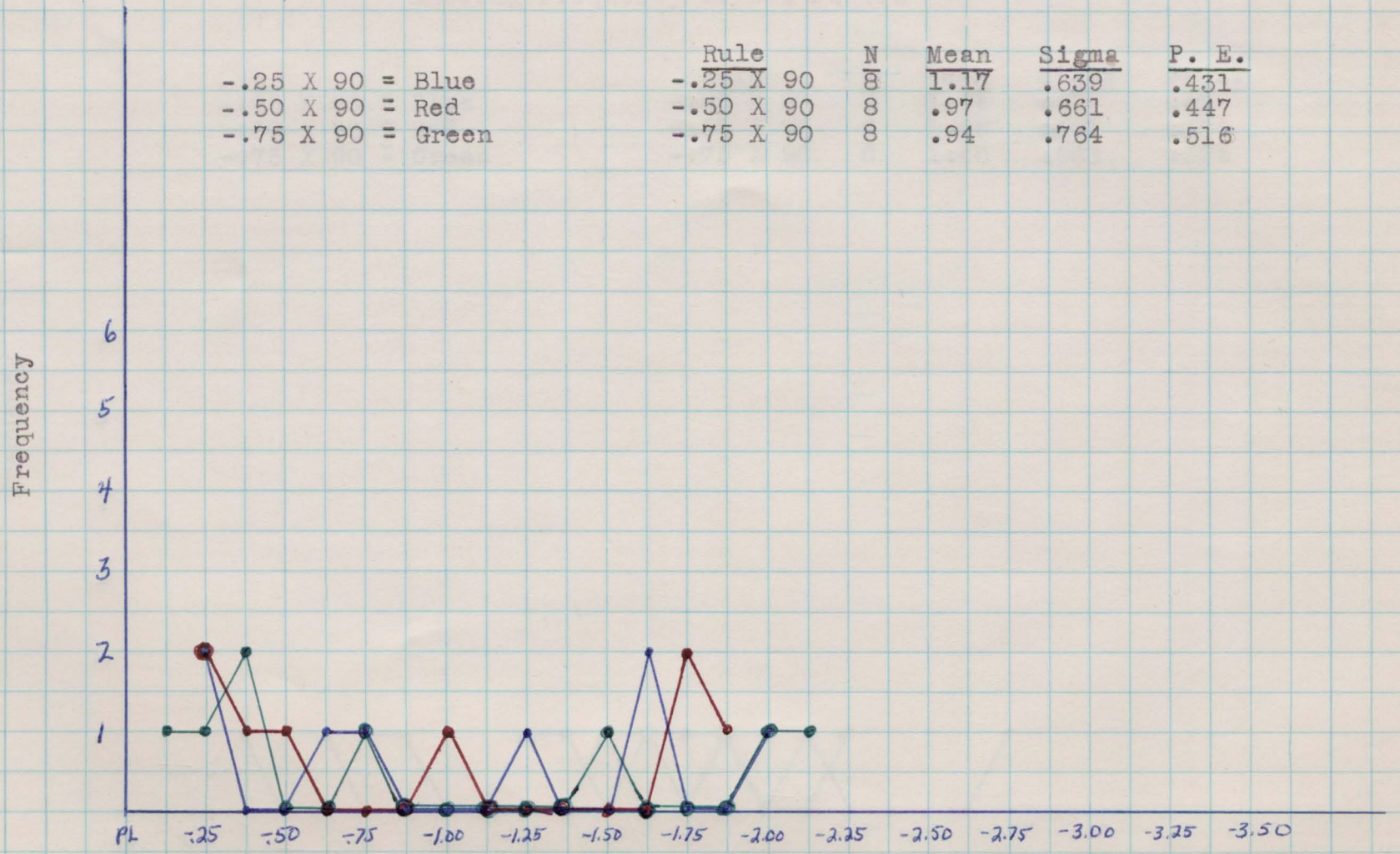


-1.75 HABITUAL CYLINDER

Showing Frequency of Net Powers

-.25 X 90 = Blue
-.50 X 90 = Red
-.75 X 90 = Green

Rule	N	Mean	Sigma	P. E.
-.25 X 90	8	1.17	.639	.431
-.50 X 90	8	.97	.661	.447
-.75 X 90	8	.94	.764	.516

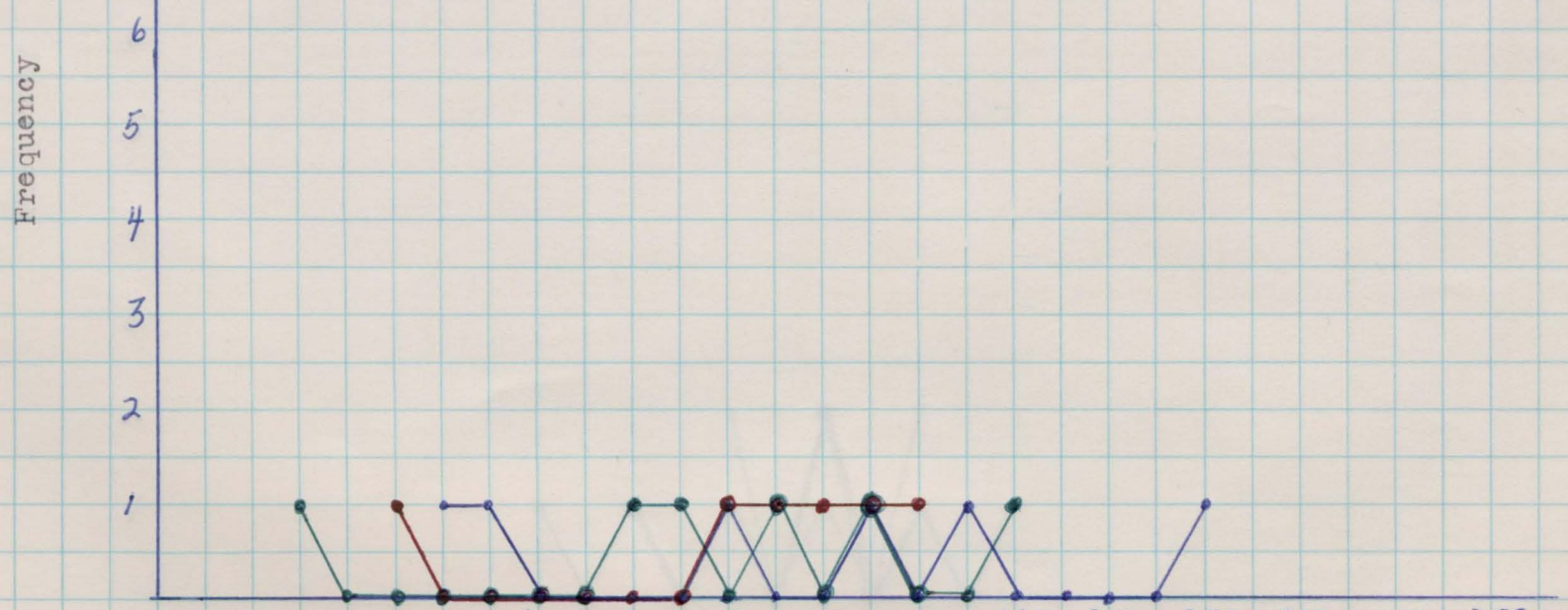


Net Cylinder

-2.00 HABITUAL CYLINDER

Showing Frequency of Net Powers

	Rule	N	Mean	Sigma	P.E.
-.25 X 90 = Blue	-.25 X 90	6	1.64	.697	.47
-.50 X 90 = Red	-.50 X 90	6	1.56	.451	.304
-.75 X 90 = Green	-.75 X 90	6	1.46	.583	.394

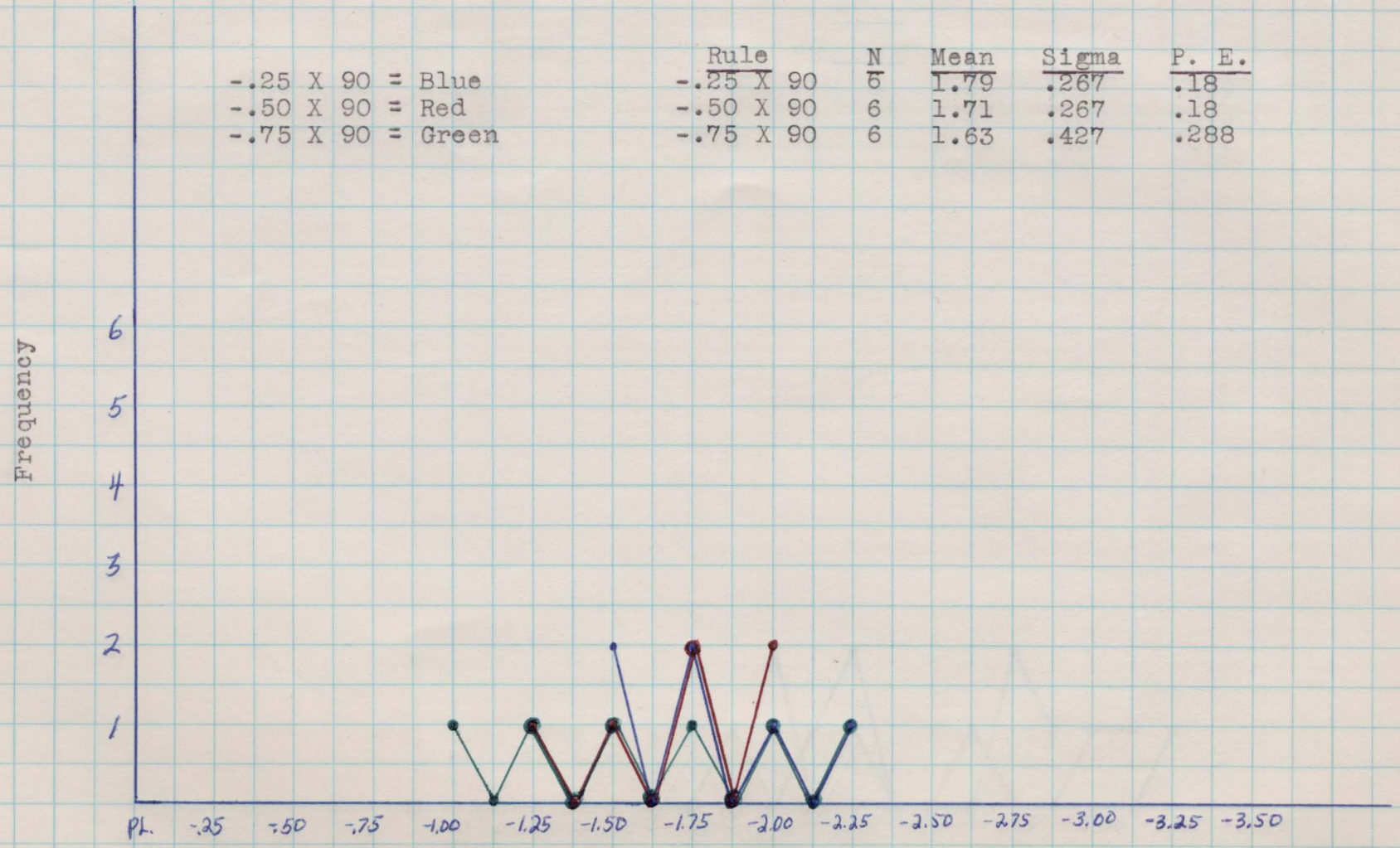


Net Cylinder

-2.25 HABITUAL CYLINDER

Showing Frequency of Net Powers

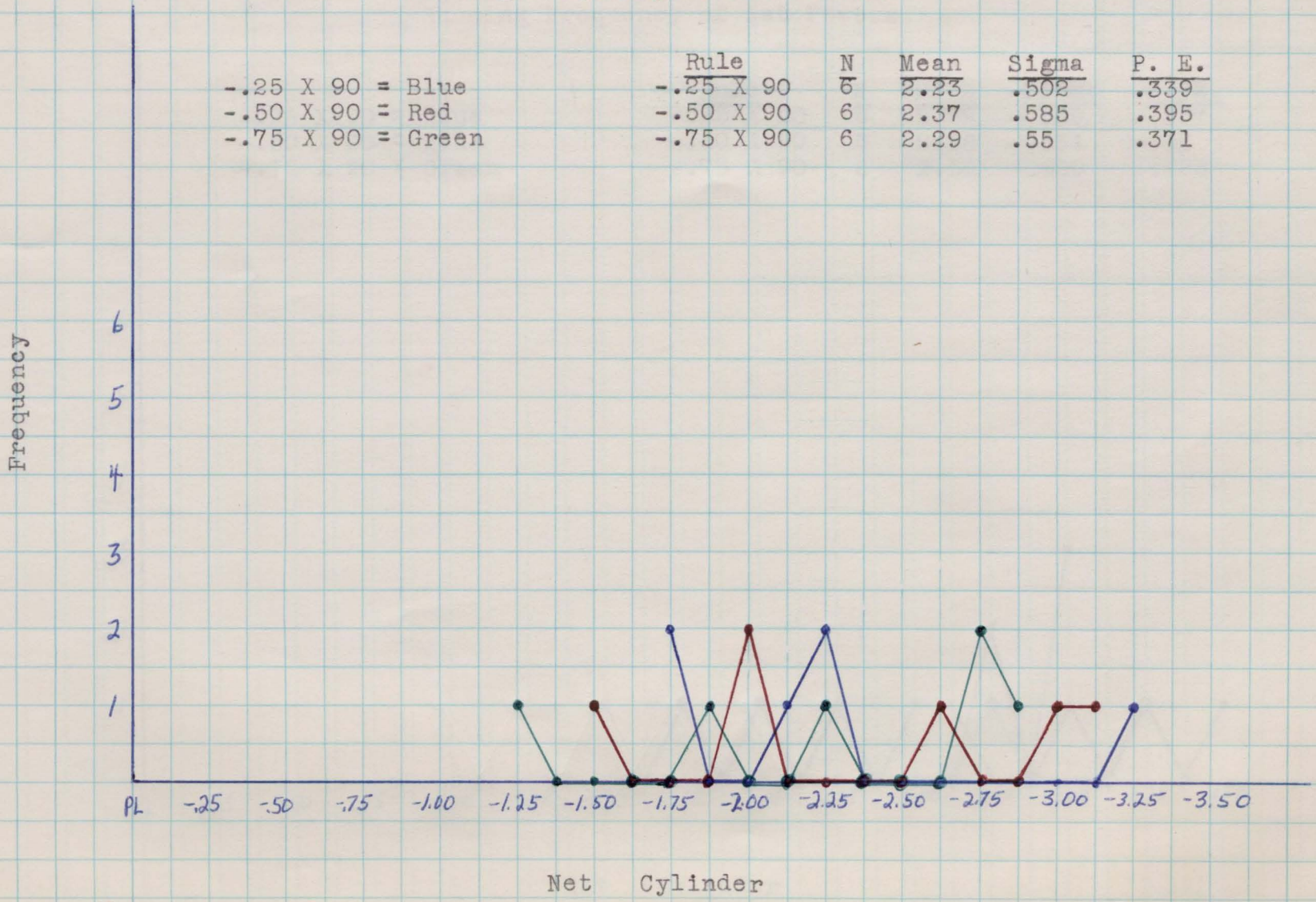
	Rule	N	Mean	Sigma	P. E.
-.25 X 90 = Blue	-.25 X 90	6	1.79	.267	.18
-.50 X 90 = Red	-.50 X 90	6	1.71	.267	.18
-.75 X 90 = Green	-.75 X 90	6	1.63	.427	.288



-2.50 HABITUAL CYLINDER

Showing Frequency of Net Powers

	Rule	N	Mean	Sigma	P. E.
-.25 X 90 = Blue	-.25 X 90	6	2.23	.502	.339
-.50 X 90 = Red	-.50 X 90	6	2.37	.585	.395
-.75 X 90 = Green	-.75 X 90	6	2.29	.55	.371

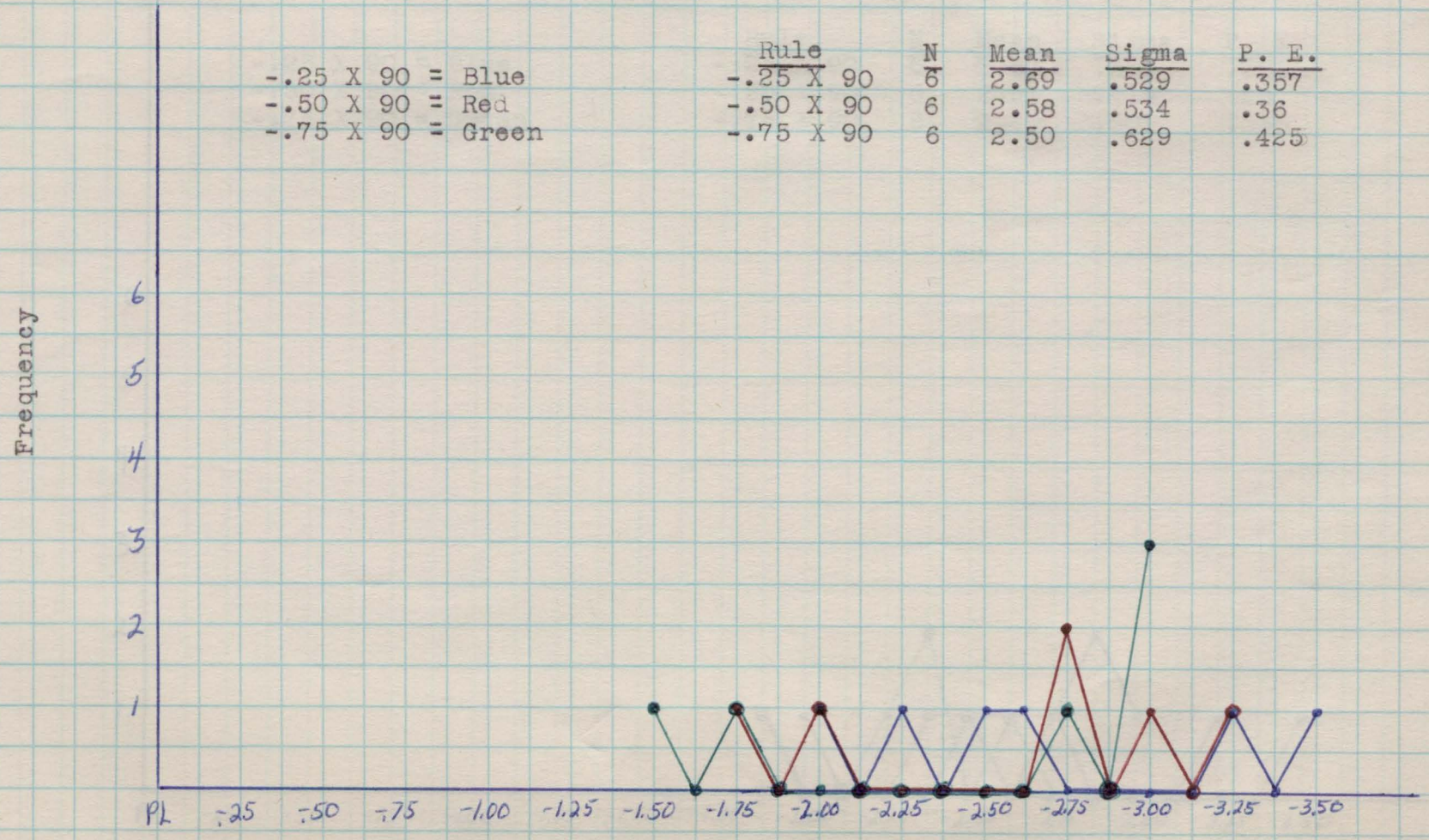


-2.75 HABITUAL CYLINDER

Showing Frequency of Net Powers

-.25 X 90 = Blue
-.50 X 90 = Red
-.75 X 90 = Green

Rule	N	Mean	Sigma	P. E.
-.25 X 90	6	2.69	.529	.357
-.50 X 90	6	2.58	.534	.36
-.75 X 90	6	2.50	.629	.425

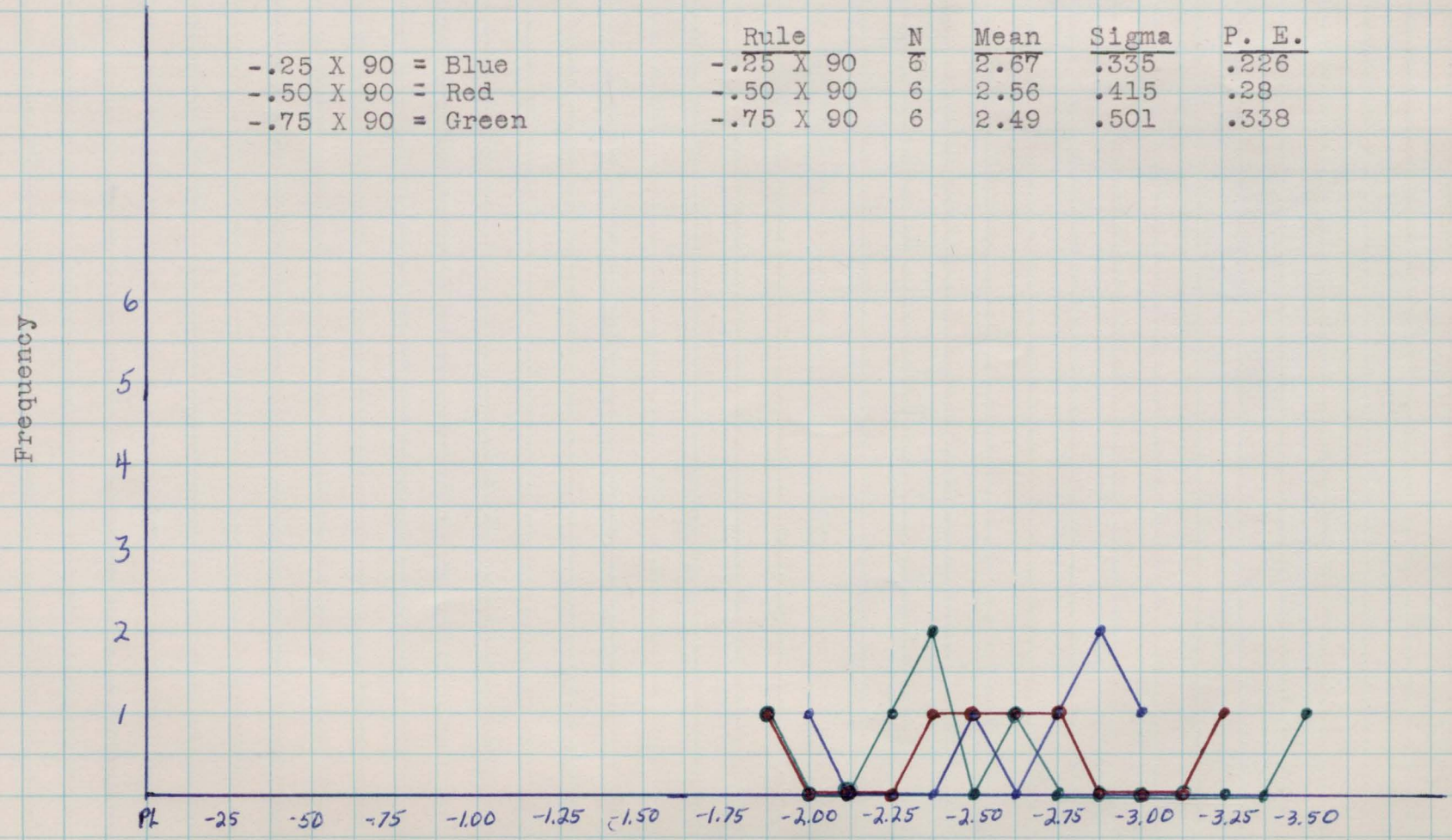


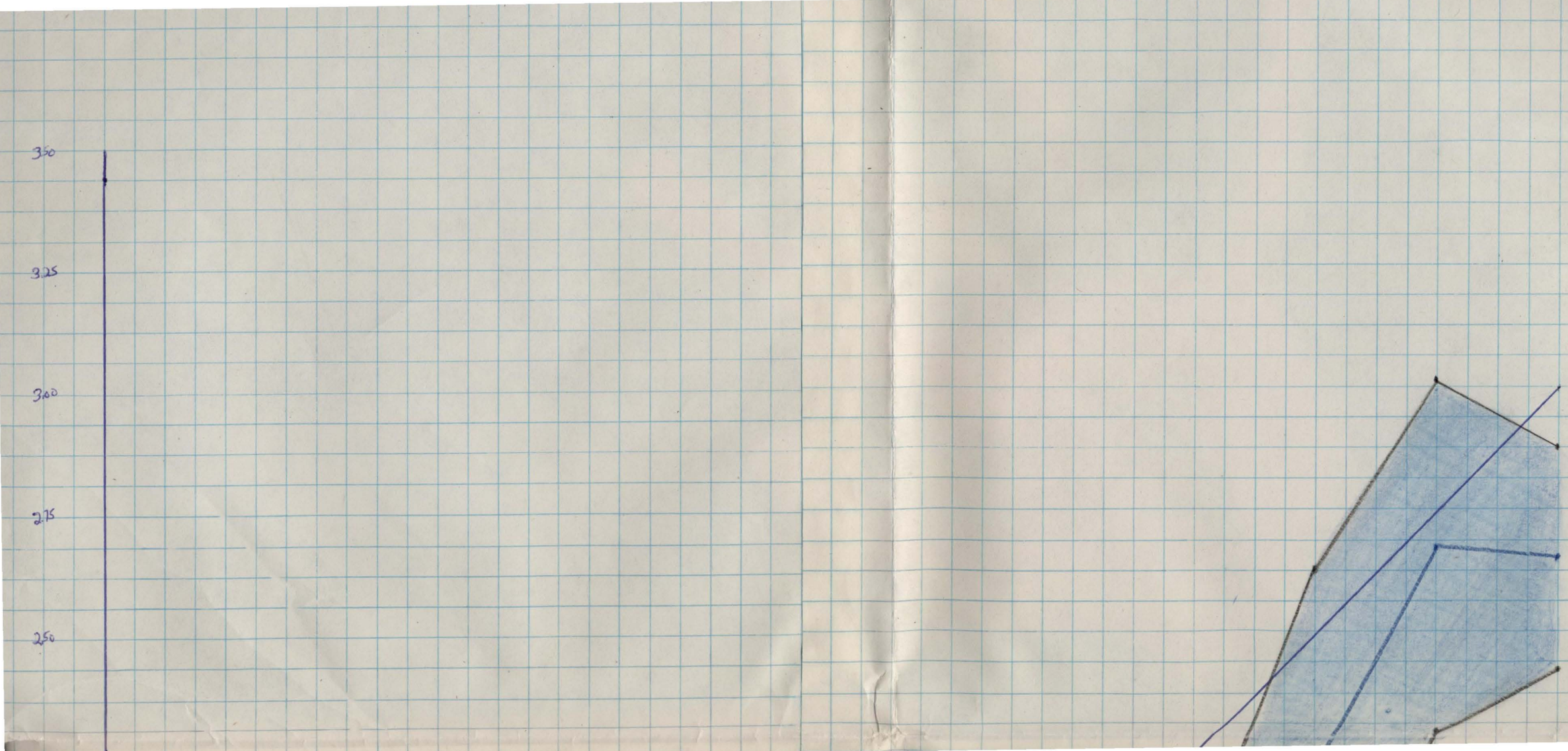
-3.00 HABITUAL CYLINDER

Showing Frequency of Net Powers

-.25 X 90 = Blue
-.50 X 90 = Red
-.75 X 90 = Green

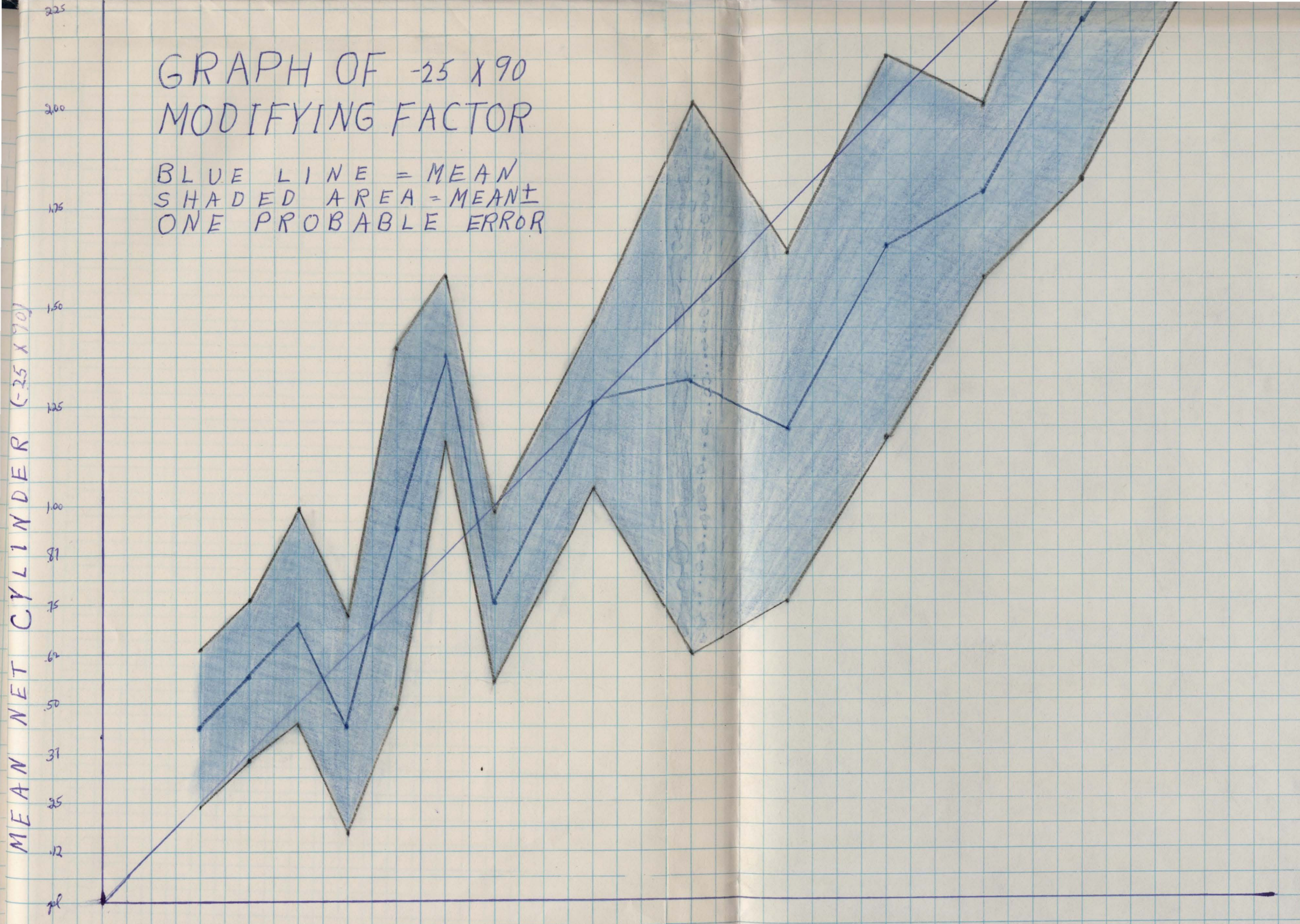
Rule	N	Mean	Sigma	P. E.
-.25 X 90	6	2.67	.335	.226
-.50 X 90	6	2.56	.415	.28
-.75 X 90	6	2.49	.501	.338




350
3.25
3.00
2.75
2.50

GRAPH OF -25 X 90 MODIFYING FACTOR

BLUE LINE = MEAN
SHADED AREA = MEAN ± ONE PROBABLE ERROR




3.50
3.25
3.00
2.75
2.50

GRAPH OF -50 X 90 MODIFYING FACTOR

RED LINE = MEAN
SHADED AREA = MEAN ± ONE PROBABLE ERROR