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ANALYSIS OF DISPERSION MEASUREMENTS FOR THE M16A1 RIFLE WITH CHROME PLATED BORE

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This report is a result of the higher than expected wear out rate of barrels used on the M16A1 rifle during its use in Vietnam. The wear out rate was due to the normal mechanical erosion plus the corrosive effect of the Vietnam environment. To correct this problem, it was decided to chrome plate the bore of all replacement barrels. The sample barrels selected from three manufacturers were fired until they were worn out with accuracy checks taken after each thousand rounds fired. The average value of the

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FOREWORD

The research discussed in this report was accomplished as part of the Product/Production Engineering Graduate Program conducted jointly by USAMC Intern Training Center and Texas A&M University. As such, the ideas, concepts and results herein presented are those of the author and do not necessarily reflect approval or acceptance by the Department of the Army.

This report has been reviewed and is approved for release. For further information on this project contact: Professor T. F. Howie, USAMC-ITC-PPE, Red River Army Depot, Texarkana, Texas 75501.

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extreme spread measure of dispersion was used to establish acceptance and rejection criteria for new barrels and to establish the amount corresponding to a worn out barrel.

It is the purpose of this report to analyze the data collected to determine if the extreme spread is the most reliable predictor of barrel serviceability, of the four measure of dispersion recorded. These were the extreme vertical, the extreme horizontal, the extreme spread, and the mean radius.

It is the conclusion of this report that the mean radius is probably preferable to the extreme spread. However, the data collected has many random properties which prevented a definite conclusion being obtained.

ACKNOWLEDGEMENTS

I would like to extend my appreciation to Mr. Tom Nathan and Mr. Dan Turk of Rock Island Arsenal for their help in this effort. I would also like to thank Dr. J. W. Foster for his help and advice on this report.

During the course of this work, the author was employed by the U.S. Army as a career intern in the AMC Product/Production Engineering Graduate Program. He is grateful to the U.S. Army for the opportunity to participate in this program.

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CHAPTER I

INTRODUCTION

Origin of Problem

The improvement of the effectiveness of the individual soldier has been a motivating force behind improvement and modifications of his weapons for centuries. This has continued to the present with modifications to the M16A1 rifle used by troops in Vietnam.

One of the latest developments is the chrome plating of the bore of the M16A1 rifle. This modification was developed in response to the barrel failure rate encountered during the rifles use in Vietnam. The failure rate was due to corrosion caused by the environment in which the rifle was placed, and the erosion of the bore, especially the height of the lands near the breech of the barrel. The erosion was caused by a combination of high temperature from the burning of the nitrocellulose powder, the mechanical rubbing of the projectiole on the lands of the riflings, and the cutting effect of gases moving at high velocities. When the charge detonates the temperature may reach 2500° Centigrade. This heat tends to burn out the carbon from the steel which softens it. By chrome plating the bore, it is expected that the corrosion problem will be eliminated, and a significant reduction in the amount of erosion will be realized.

Problem Definition

Chrome plating the bore of small caliber weapons is relatively new and little is known about the effect of the plating on the accuracy of, and the expected life of, the barrel. However, it was felt that a new erosion penetration gage would be required to allow for the effect of the plating and the expected differences in the wear characteristics. This is a tool used in the field to determine the accuracy and serviceability of M16A1 rifles. To calibrate a new erosion penetration gage, a test program (Number TPR-SAL-73-P025) was initiated at Rock Island Arsenal.

The barrels used in this test are samples from three manufacturers. These are Colt which provided the complete rifle, Maremont which provided only replacement barrels, and General Motors which provided the upper receiver along with its barrels. The three manufacturers are coded C, M, and GM respectively. The weapons were fired for accuracy and cleaned after each thousand rounds fired. The accuracy check consisted of firing ten rounds at each of three targets for each rifle. The range used for the accuracy check was 100 yards. The person firing the rifle used a bench rest technique with both the rifle muzzle and his elbow supported. The accuracy data is recorded in Table A-1 of Appendix A. It includes the measurements of the extreme spread, the extreme horizontal, the extreme vertical, and the mean radius obtained from each target. Data from barrels exposed only to ball type ammunition are used in this report. However, data on barrels exposed to tracer type ammunition are available. The firing rates were not the same for all the barrels used in this report. Half of the barrels were fired at a rate of 60 rounds per minute while the other half were fired at a rate of 100 rounds per minute. After each 100 rounds fired the barrels were cooled to ambient temperature by forced air cooling for not less than ten minutes.

In the performance of this test, limits were set based on the extreme spread measure of dispersion. For a new barrel to be accepted the average value of the extreme spread obtained from the three targets had to be less than five inches, if not the barrel was replaced. During the running of the test a barrel was assumed worn out when the average value of the extreme spread reached seven or more inches. The averaged value was used to reduce the effect of a set of extreme points which could be caused by either bad ammunition or human error of the tester.

It is the purpose of this report to analyze the data collected during this test to determine if the measure of dispersion used is the most reliable predictor of the precision of these barrels. Precision is used rather than accuracy because according to Grubbs (2)* precision refers to the dispersion of the bullets about their own mean or center of impact, whereas accuracy includes not only the round-to-round precision but also the closeness of the mean or center of impact to the aiming point on the target.

Approach to Solution

The first step towards a solution to this problem is to establish the desired approach. To do this a clear understanding of the meaning of "most reliable predictor" is a necessity. The meaning of "most reliable predictor" in this report is that measure of dispersion whose difference between its upper and lower probability limits is the smallest with respect to the total number of rounds fired.

The upper and lower probability limits are determined for each measure of dispersion using that measure's critical value. A measure's critical value is defined as that numerical value which indicates the barrel is no longer serviceable. The critical value of each measure is calculated such that it represents the expected value for that measure when the critical value of the extreme spread is equal to seven inches. As previously mentioned, this is the value used by the arsenal during testing to indicate when a barrel was no longer accurate enough to remain in

*Numbers in parentheses refer to numbered references in the List of References.

service.

The probability limits for each measure of dispersion can only be established after the form of the distribution has been identified. The assumption is made that the distribution of the sample data at each thousand rounds fired and for each measure of dispersion came from a population that is normally distributed. This assumption is checked using Lilliefors' test statistic.

If the above assumption is correct, the upper and lower probability limits can be calculated from a table of tolerance factors for normal distributions. These limits can then be projected to a total number of rounds fired. The difference is calculated by subtracting the value of rounds fired corresponding to the upper limit from the value of rounds fired corresponding to the lower limit. The measure of dispersion with the smallest difference is the "most reliable predictor" of the ones tested for the M16A1 rifle with chrome plated bores.

The literature review, Chapter II, contains a review of Lilliefors' test statistic used in the test for normality and an explanation of the four measures of dispersion and their interrelationship. Chapter III contains the results obtained using Lilliefors' test statistic to test the normality of the distributions and the conclusions reached for each measure of dispersion at each thousand rounds fired. The procedure used to establish the upper and lower probability limits for each measure is discussed in Chapter IV. The conclusions and recommendations are stated in the last chapter, Chapter V.

CHAPTER II

LITERATURE REVIEW

Measures of Dispersion

When a rifle or other small arms weapon is fired at a vertical target a two-dimensional pattern of impact points results which are scattered depending on the round-to-round aiming error and the normal ballistic dispersion. This two-dimensional shot pattern produces various measures of dispersion.

The various measures described in Grubbs (2) include the extreme horizontal dispersion (EH), the extreme vertical dispersion (EV), the mean horizontal deviation, the mean vertical deviation, the radial standard deviation, the mean radius (MR), and the extreme spread (ES). This report is concerned with four of these measures EH, EV, ES, and MR.

The EH and the EV are the simplest and the easiest to measure. Projecting impact points on to a x and y graph gives each point a horizontal and a vertical value. EH is the difference between the greatest and the least values of the x co-ordinate, and the EV is the difference between the greatest and least values of the y co-ordinate. It should be noted that these measures of dispersions are univariate or one directional.

Another measure which uses the extreme points is the ES. This measure is the maximum distance between all possible pairs of impact points. If n is used to denote the number of rounds fired at a target and X_i is the horizontal measurement and Y_i is the vertical measurement of a general impact point and if j and k represent the pair of points that are the maximum distance apart then ES is equal to

$$\sqrt{(X_j - X_k)^2 + (Y_j - Y_k)^2} \quad \text{where } j \neq k.$$

This measure of dispersion is also known as the bivariate range.

The MR is defined as the mean of the radial distance from the observed center of impact to the individual points of impact on the target. The observed center of impact is the mean of the horizontal values and the mean of the vertical values. If X_i and Y_i represent the horizontal and vertical components of a general impact point and n is the number of impact points then MR can be calculated by

$$\frac{1}{n}\sum_{i=1}^{n}\sqrt{(X_i - \bar{X})^2 + (Y_i - \bar{Y})^2}\ .$$

For each of these measures of dispersion Grubbs (2) has tables giving the mean and standard deviation values for various sample sizes. The mean and standard deviation values given in these tables are in terms of a population standard deviation of unity. When these amounts are multiplied by the population mean and standard deviation, or an estimate of it, the expected mean and standard deviation values for the respective measures are obtained. Since the tabular values are all multipliers of the same quantity, they provide by themselves the ratio of the measures magnitude. The article by Harrison (4) lists examples illustrating the above procedure.

Test of Normality

The assumption that the data for each thousand rounds is normally distributed is checked by a test described in Mann et.al. (5) using the Lilliefor test statistic. The hypothesis tested is that the distribution is normally distributed with unknown mean and variance. This test statistic estimates the function using unbiased estimates of the true mean and standard deviation. The computing form of Lilliefors' test statistic is

$$Dn = \max_{1 \leq i \leq n} (d_i). \qquad (1)$$

The value of d_i is obtained by

$$d_i = \max \left[F(x_i;\bar{x},s) - \frac{(i-1)}{n},\ \frac{i}{n} - F(x_i;\bar{x},s) \right]. \qquad (2)$$

$\bar{x}$ and s are unbiased estimates of the population mean and standard deviation. $F(x;\bar{x},s)$ is the cumulative standard normal distribution function Φ (Y), with Y equal to $(x - \bar{x})/s$. If the value of Dn exceeds the critical value in Table 1 corresponding to the sample size used and the significance level desired then the hypothesis is rejected.

TABLE 1

Critical Values of Dn Corresponding to Test Significance Level

Sample Size n	Significance Level .20	.15	.10	.05	.01
4	.300	.319	.352	.381	.417
6	.265	.277	.294	.319	.364
8	.233	.244	.261	.285	.331
10	.215	.224	.239	.258	.294
12	.199	.212	.223	.242	.275
14	.183	.194	.207	.227	.261
16	.173	.182	.195	.213	.250
18	.166	.173	.184	.200	.239
20	.160	.166	.174	.190	.231
30	.131	.136	.144	.161	.187
Over 30	$\frac{.736}{n^{\frac{1}{2}}}$	$\frac{.768}{n^{\frac{1}{2}}}$	$\frac{.805}{n^{\frac{1}{2}}}$	$\frac{.886}{n^{\frac{1}{2}}}$	$\frac{1.031}{n^{\frac{1}{2}}}$

These values tabulated by Lilliefors are based on a Monte Carlo simulation using a sample size of 1,000. The values have been subjected to some smoothing.

Chapter III explains how the Lilliefor test statistic is used and contains the results of the normality test based on this test statistic.

CHAPTER III

NORMALITY TEST

Lilliefors' test statistic given by Equation 1, on page 9, is used to test the assumption that the distribution of the sample data at each thousand rounds fired and for each measure of dispersion came from a population that is normally distributed. The data tested is that of Table A-2. This data is obtained by averaging the data for each barrel supplied by the arsenal, Table A-1. Averaged data is used to correspond with the limits established by the arsenal. The three values of MR for barrel GM5 at 1,000 rounds fired are 0.84, 0.82, and 0.70. The average MR value for this barrel is 0.786. This averaged value becomes one data point on the MR distribution at 1,000 rounds fired.

The Lilliefor test statistic requires the data points of each distribution be normalized which requires the mean ($\bar{X}$) and the sample standard deviation (s) for each distribution. The $\bar{X}$ and the s values are calculated using Equations 3 and 4 respectively.

$$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{N} \qquad (3)$$

$$s = \sqrt{\frac{\sum_{i=1}^{n} (X_i - \bar{X})^2}{N - 1}} \qquad (4)$$

X_i is the value of the ith data point and N is the total number of data points. N for this report is equal to twelve. The sum of the MR values for zero rounds fired from Table A-2 is 14.255. This value divided by N is 1.188 which is the $\overline{X}$ value listed in Table A-6. The value of s, Equation 4, is calculated in a similar manner. The values of $\overline{X}$ and s for each distribution and for each measure of dispersion are listed by total number of rounds fired in Tables A-3 thru A-6. Normalization is accomplished by subtracting the $\overline{X}$ value of the distribution from the value of the data point and dividing the result by s. The resulting solution is called the z value.

The normalized value, or z value, is converted to a normal value by using a table of cumulative probabilities for the Normal Distribution found in Duncan (1). Equation 2 is calculated by setting the value obtained from this table equal to the $F(x_i;\overline{x},s)$ terms. After calculating all the d_i terms, Dn of Equation 1 is simply the maximum d_i value obtained. The value of Dn is compared to the critical value of Table 1 corresponding to the sample size and significance level desired.

Tables A-7 thru A-10 contain the z values, their corresponding cumulative normal values, and the two values used to obtain each d_i value. Tables 2 thru 5 list the Dn values for each measure and compares the Dn value with the

TABLE 2

Dn Values for Extreme Vertical

Rounds Fired	Dn Values	Greater than Critical Value Yes	No
0.	.09853		X
1000.	.17393		X
2000.	.15043		X
3000.	.20043	X	
4000.	.16836		X
5000.	.11576		X
6000.	.13066		X
7000.	.14853		X
8000.	.18403		X
9000.	.15283		X
10000.	.09616		X
11000.	.14893		X
12000.	.27933	X	

TABLE 3

Dn Values for Extreme Horizontal

Rounds Fired	Dn Values	Greater than Critical Value Yes	No
0.	.20100	X	
1000.	.13383		X
2000.	.14583		X
3000.	.18066		X
4000.	.14540		X
5000.	.14653		X
6000.	.12893		X
7000.	.26600	X	
8000.	.17556		X
9000.	.16503		X
10000.	.10193		X
11000.	.21733	X	
12000.	.15609		X

TABLE 4

Dn Values for Extreme Spread

Rounds Fired	Dn Values	Greater than Critical Value Yes	No
0.	.18679		X
1000.	.13549		X
2000.	.17146		X
3000.	.16553		X
4000.	.15336		X
5000.	.14599		X
6000.	.10826		X
7000.	.25216	X	
8000.	.15973		X
9000.	.14870		X
10000.	.14320		X
11000.	.15506		X
12000.	.17943		X

TABLE 5

Values for Mean Radius

Rounds Fired	Dn Values	Greater than Critical Value Yes	No
0.	.12686		X
1000.	.17896		X
2000.	.18546		X
3000.	.20966	X	
4000.	.16780		X
5000.	.18013		X
6000.	.13996		X
7000.	.27226	X	
8000.	.15436		X
9000.	.17663		X
10000.	.13716		X
11000.	.11733		X
12000.	.14736		X

critical value. The critical value from Table 1 for a sample of size twelve and a significance level of 0.20 is .199.

To illustrate how the values for the above tables are obtained, a value of MR at 1,000 rounds fired will be examined. This value is found in Table A-10. The z value, column one, for the eleventh data point is 0.6990 which converts to a normal value, column two, equal to 0.7377. The d_1 value is equal to the maximum of 0.7377 minus (11-1)/12, or 11/12 minus 0.7377. The first calculation, column three, is negative since 10/12 is larger than 0.7377 and is equal to -0.095. The value in the fourth column is positive since 11/12 is larger than 0.7377 and is equal to 0.17896. This value is d_1 for this data point and in this case is also equal to the Dn value shown in Table 6 for this distribution.

The test results shown in Tables 2 thru 5 clearly indicate that for 83% of the distributions the hyrothesis that they came from a normally distributed population could not be rejected. On the basis of the results of this test it is decided that the distributions represent samples from a population that is normally distributed.

Chapter IV discusses the method used to establish the probability limits and the results obtained using these limits.

CHAPTER IV

ESTABLISHING LIMITS

Since the distributions are normally distributed the upper and lower probability limits can be established with respect to the critical value for each measure of dispersion. The critical value of the averaged ES is set equal to 7.00 inches. This is the value used during testing to determine when a barrel was worn out; it is used here to calculate the corresponding expected values for the other measures. These calculated expected values are the critical values for the respective measures, and they are calculated in Appendix B. The critical values of EV and EH are the same since the assumption is made in Grubbs (2) that the true or population standard deviation in the horizontal and vertical directions are equal. The critical value of EV and EH is 5.66 inches while the MR critical value is 2.19 inches.

The lower and upper probability limits are determined by Equations 5 and 6 respectively.

$$\text{Lower Limit} \quad P((1 - \alpha) < (\bar{x} + Ks)) = \gamma \quad (5)$$

$$\text{Upper Limit} \quad P((1 - \alpha) > (\bar{x} - Ks)) = \gamma \quad (6)$$

$\bar{x}$ and s are defined by Equations 3 and 4 on page 11. α, γ, and K are the alpha, gamma, and tolerance factor values obtained from the table of factors for normal distributions for the one-sided test compiled by Hald (3). Table 6 is an extraction from this table for a sample size equal to twelve.

TABLE 6

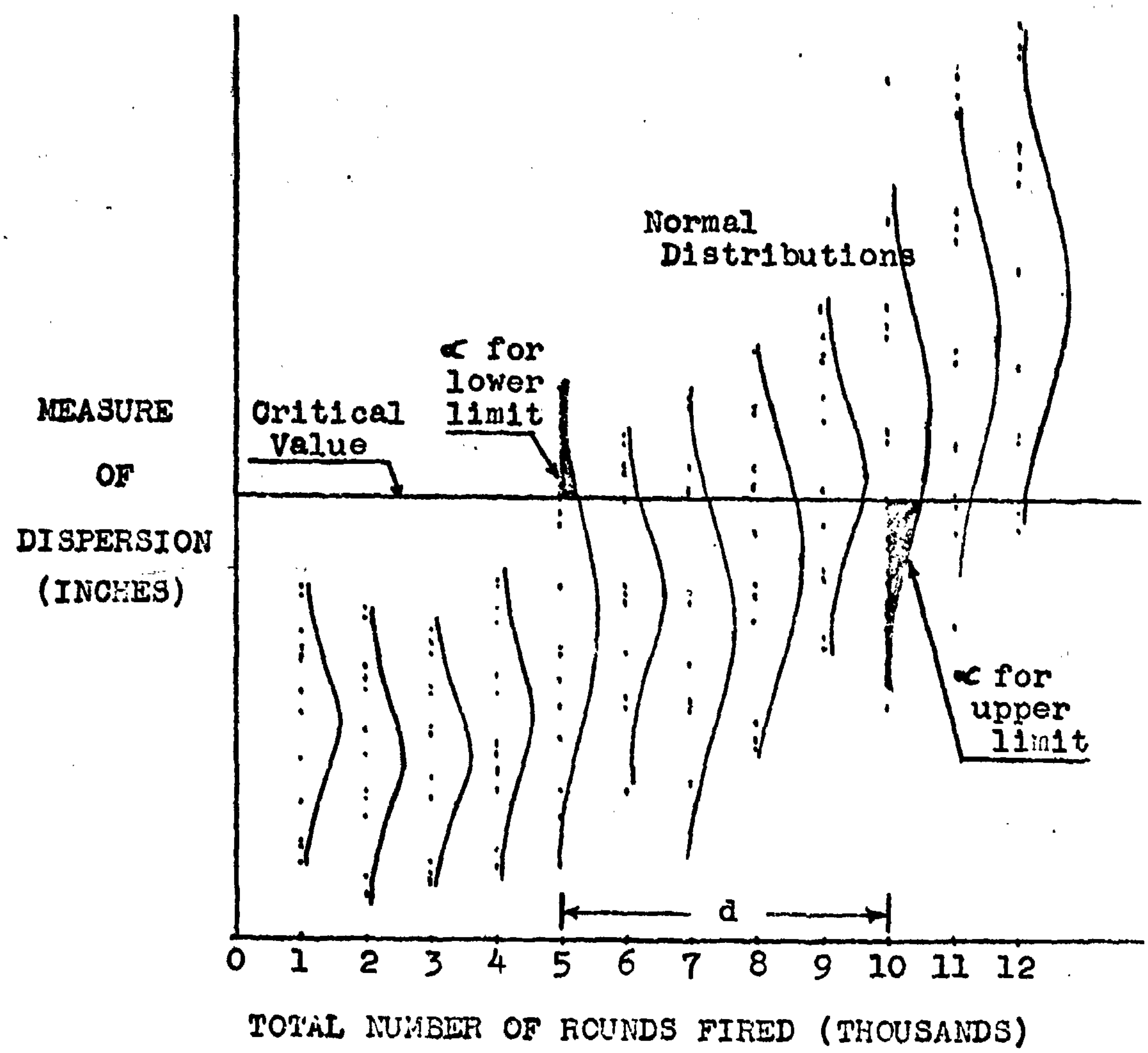
Tolerance Factor Values
for Sample Size = 12

Gamma	Alpha	K
.95	.01	3.747
.95	.10	2.210
.95	.25	1.366
.90	.01	3.371
.90	.10	1.966
.90	.25	1.188
.75	.01	2.851
.75	.10	1.624
.75	.25	0.933

Alpha represents that proportion of a distribution which is either greater than or less than the critical value depending on the limit under consideration as indicated in Figure 1.

Gamma is the level of significance or the amount of risk that can be tolerated is equal to one minus gamma. The smaller gamma becomes the lower the significance of the test and the higher the risk becomes of making an incorrect decision.

Calculations of $\bar{x} + Ks$ and $\bar{x} - Ks$ are made by holding



Plot of a General Measure of Dispersion verus
Total Number of Rounds Fired

Figure 1

the value of gamma and allowing the alpha and K values to vary. Then a different value of gamma is selected and the process is repeated. These calculations are made for each distribution of each measure of dispersion. The results of these calculations are contained in Tables A-11 thru A-14. The lower limit for any measure of dispersion is the total number of rounds fired corresponding to the first distribution whose $\bar{x}$ + Ks value is equal to or greater than the critical value for that measure. For the general measure of dispersion shown in Figure 1, the lower limit occurs at 5,000 rounds fired. The upper limit is the same except $\bar{x}$ + Ks is changed to $\bar{x}$ - Ks and occurs at 10,000 rounds fired in Figure 1.

Figure 1 is a plot of a general measure of dispersion verus the total number of rounds fired. The shaded area is equal to alpha. The relationships depicted are those of the alpha value to the critical value and those of the upper and lower limits to the total number of rounds fired.

The calculation of $\bar{x}$ - Ks for the upper limit exceeds the critical value of all the measures of dispersion used in this report for only one combination of gamma and alpha values. The gamma value is .75 which is the least significant figure tabled and the alpha value is .25 which is the largest proportion of the distribution tabled. To keep the probabilities of Equations 5 and 6 on page 18 equal, the gamma value for determining the lower limit is held at .75 while the alpha value is allowed to vary. Using higher values of gamma would only tend to separate the lower and upper limits for some of the measures of dispersion. For instance, if gamma is allowed to equal .95 the lower limit for the EH, the ES, and the MR is equal to 4,000 rounds fired. If this value of gamma was used, it would be necessary to find a way of comparing the two different levels of significance before the value of d, the difference between the upper and lower limits, could be calculated. The difference values for gamma equal to .75 are shown in Table 7.

TABLE 7

Comparison of Limit Differences
Gamma = .75

Measure of Dispersion	Alpha	Upper Limit	Lower Limit	Difference d
EV	.01	11,000	4,000	7,000
EH	.01	11,000	5,000	6,000
ES	.01	10,000	4,000	6,000
MR	.01	10,000	5,000	5,000
EV	.10	11,000	6,000	5,000
EH	.10	11,000	5,000	6,000
ES	.10	10,000	5,000	5,000
MR	.10	10,000	6,000	4,000
EV	.25	11,000	8,000	3,000
EH	.25	11,000	6,000	5,000
ES	.25	10,000	7,000	3,000
MR	.25	10,000	7,000	3,000

The results shown in Table 7 indicate that for gamma equal to .75 and for alpha equal to either .01 or .10 the smallest difference obtained is for the MR measure of dispersion. When alpha is equal to .25 the results are inconclusive.

Chapter V contains the conclusions and recommendations arrived at as a result of this study.

CHAPTER V

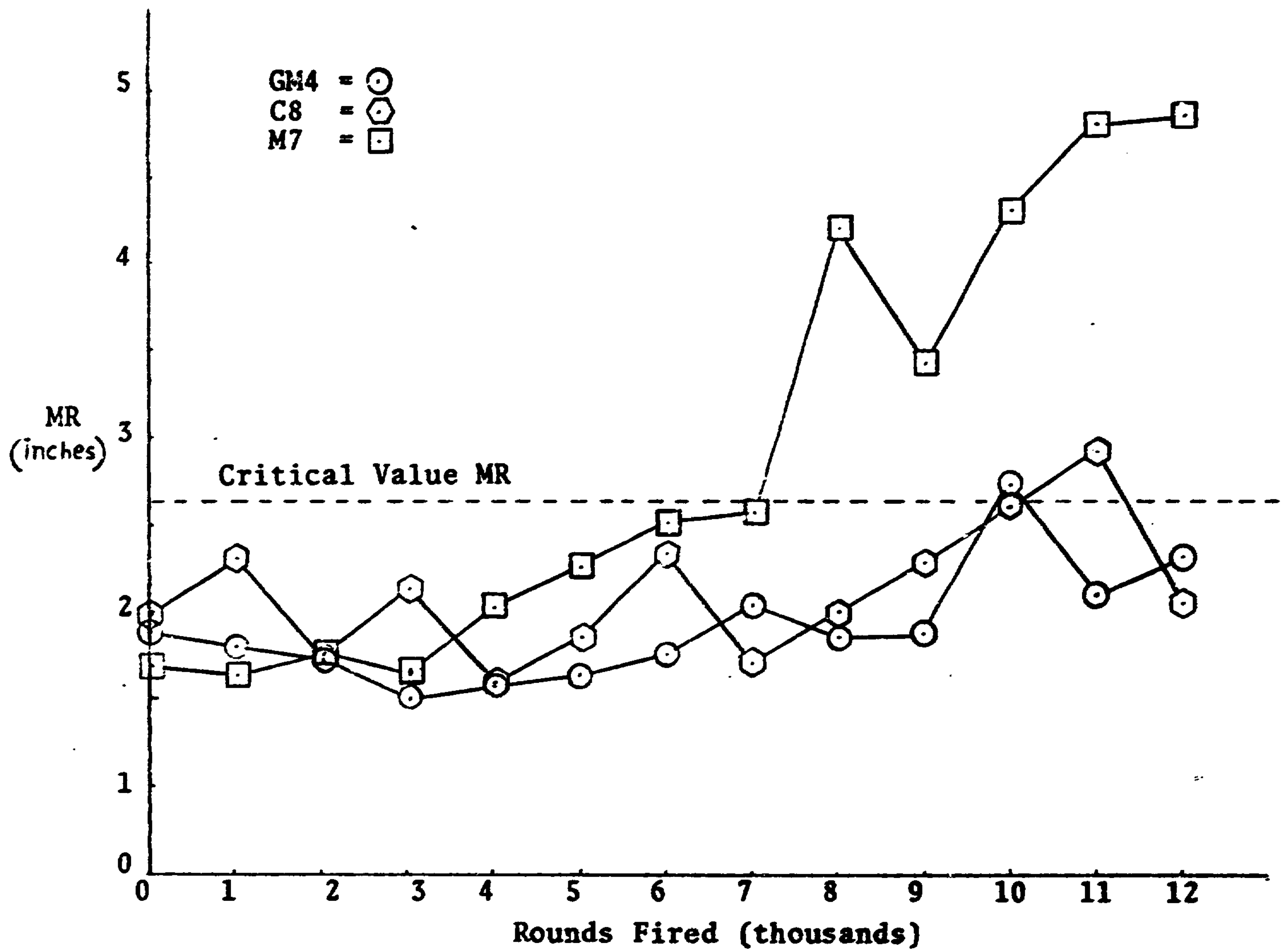
CONCLUSIONS AND RECOMMENDATIONS

The first significant conclusion indicated by this study is that the average of dispersion patterns tend to be normally distributed. Of the 48 distributions tested, the hypothesis that the samples came from a population that was normally distributed could not be rejected in 83% of the cases. Of the rejections 37% occurred for distributions at 7,000 rounds fired. This indicates that some unknown influence was at work during the accuracy checks at 7,000 rounds fired.

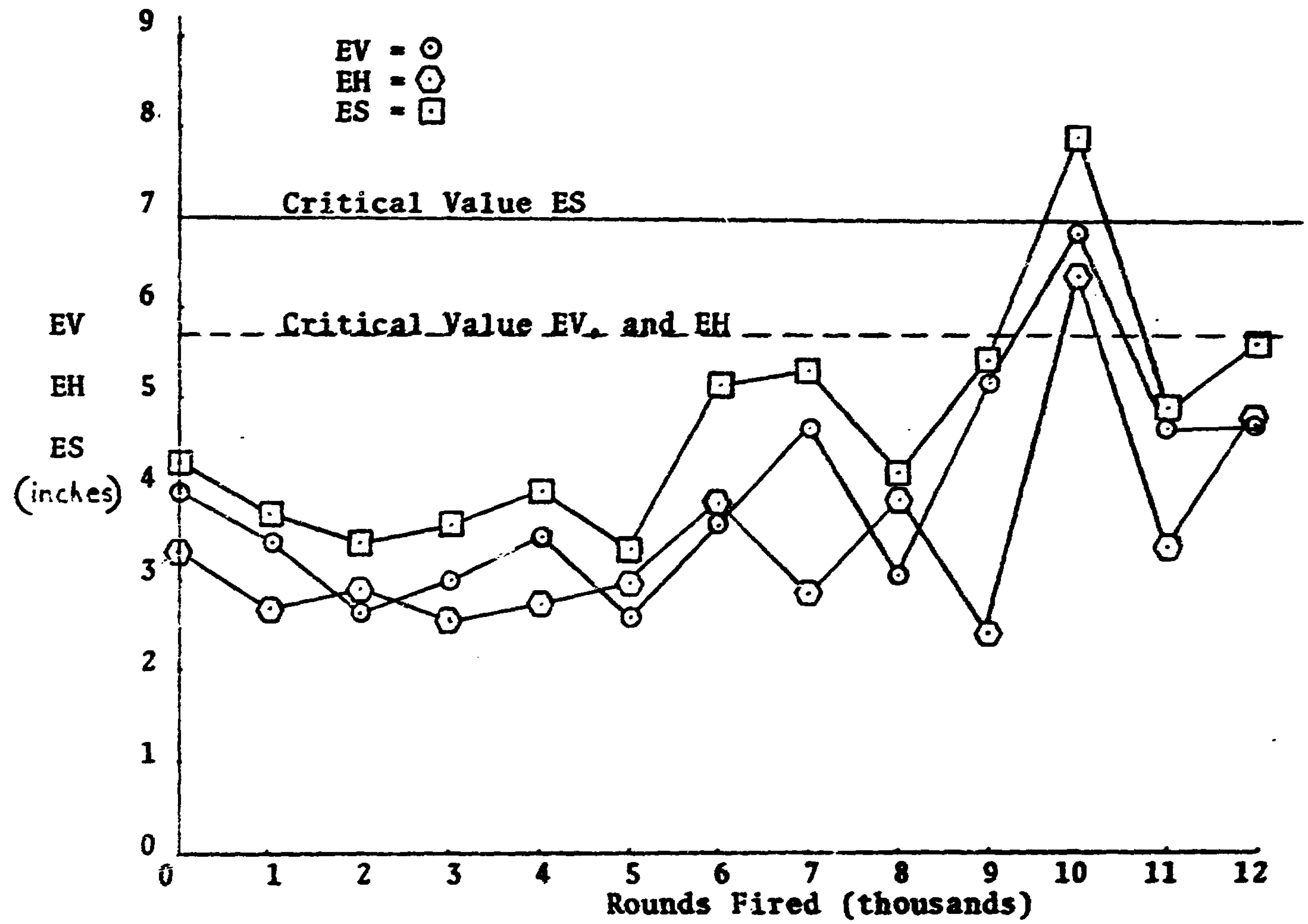
The unknown influence could have originated in several ways. One possibility is fatique of the marksman performing the test. Also it is not known if more than one marksman was used during the testing program. If a different marksman fired the accuracy checks for the 7,000 rounds fired test, this would influence the distribution. These problems apply equally to all the data collect. It is recommended that a bench vice system be designed to reduce the possibility of human error since the accuracy of interest is that associated with the serviceability of the barrel and not the ability of a marksman.

The conclusion reached in Chapter IV that the MR is the most reliable predictor of accuracy when alpha is equal to .01 or .10 is only true if the data on which the conclusion is based is good data. As already mentioned there is some doubt the data is good due to the way it was collected. Another problem with the data is that it is not complete for all barrels tested. A plot of the averaged MR data for three barrels is found in Figure 2. From this it is determined that at least one and probably two of the barrels are not worn out. This is one reason the calculations of $\bar{x}$ - Ks for the upper limit in Chapter IV only exceeded the critical values when gamma was equal to .75 and alpha was equal to .25. The test had to become unrestrictive enough to allow for the data of the good barrels.

Figures 3 thru 5 are graphs of the three extreme measures of dispersion, the EV, the EH, and the ES, for the same barrels as graphed in Figure 2. Barrel number GM4 is graphed in Figure 3. All three measures show the same information as obtained from Figure 2 for this barrel. Figure 4 contains the graphs for barrel number M7. The disconnected lines are the results of data points having values greater than could be represented on the graph. Although two of the extreme measures indicate the barrel is worn out at 7,000 rounds fired, all the measures including the MR of Figure 2 agree that by 8,000 rounds the barrel is worn out. Figure 5 is the same graphs for barrel number C8. The three extreme measures for this barrel do not agree. The EV, the

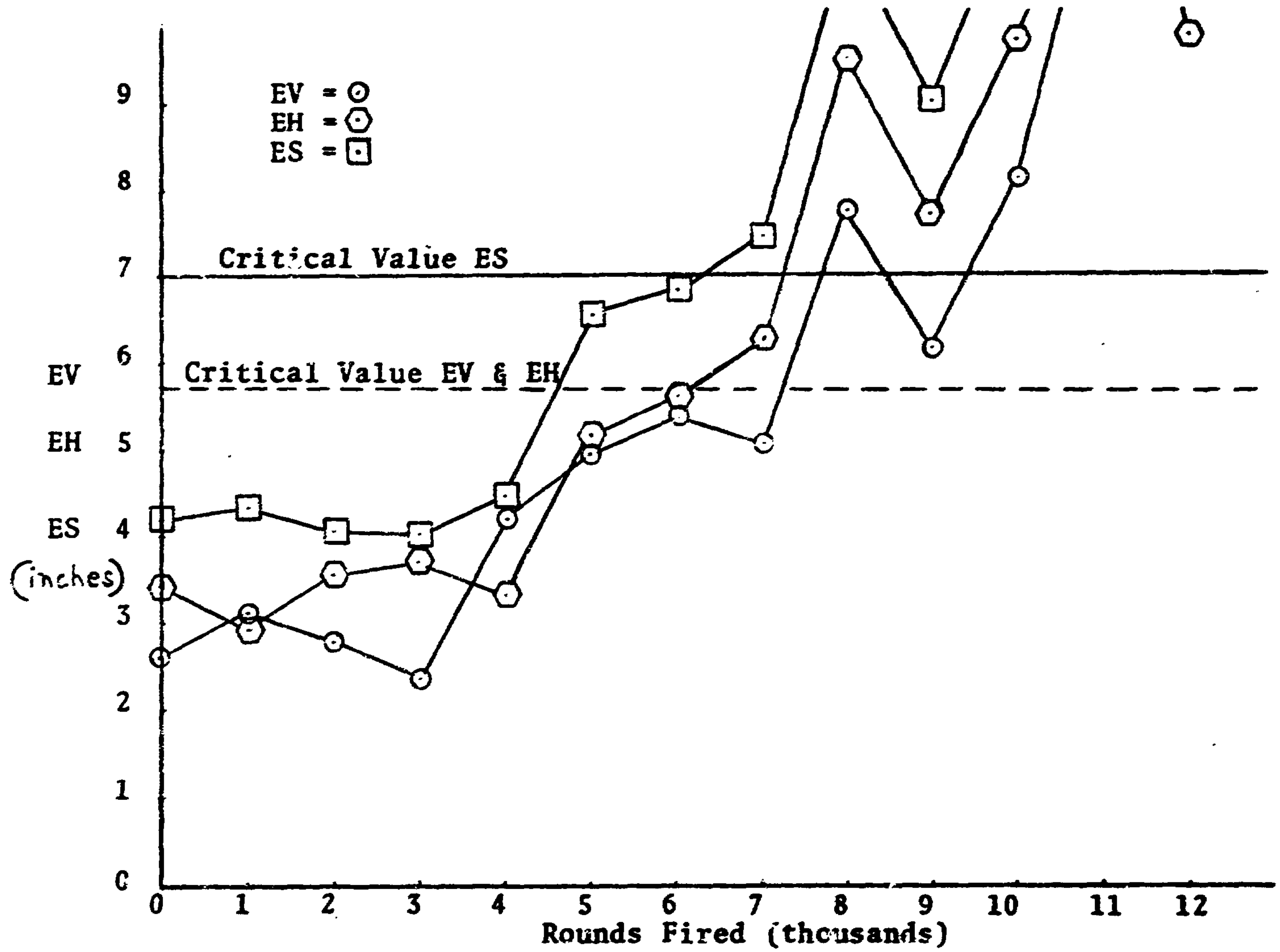


Plot of MR for GM4, C8, and M7 verus Rounds Fired
Figure 2



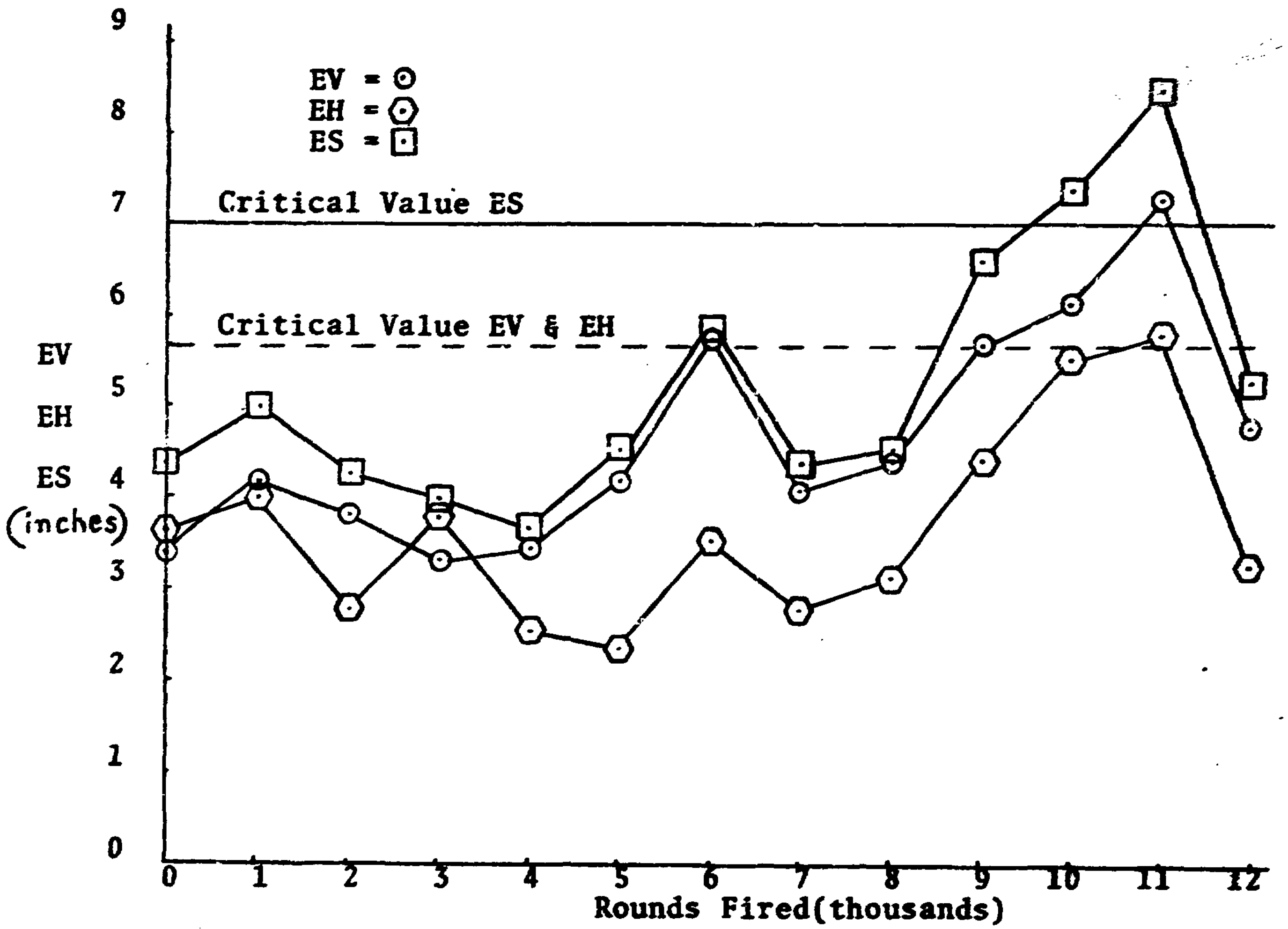
Plot of GM4 verus Rounds Fired

Figure 3



Plot of M7 verus Rounds Fired

Figure 4



Plot of C8 verus Rounds Fired

Figure 5

ES, and the EH indicate respectively that the barrel is worn out at 9,000, 10,000, and 11,000 rounds fired. The MR indicates that only the value at 11,000 rounds fired is greater than the critical value. Which is the correct value? It is impossible to tell from the data collected. Perhaps the best conclusion is that the barrel is not yet worn out and the values obtained at 11,000 rounds fired is due to the random property of the data. It is recommended that the test on any one barrel not be terminated until a trend is established that clearly indicates the barrel is worn out and that the random property is not the reason for terminating the test.

The barrels used in this test were samples from three manufacturers and are coded GM, C, and M. Table 8 is instructive as a means of comparing the different manufacturers. The second column is the number of barrels that have MR values greater than the critical value. Column three contains the manufacturers code and the serial numbers of the barrels whose MR valulo is smaller than the critical value. One manufacturers code, M, is conspicuously absent from column three from 8,000 rounds fired on. It is concluded from this table that either the barrels produced by this manufacturer are of inferior quality or there is a high correlation between the rate at which a barrel wears out and the associated hardware supplied with the barrel.

TABLE 8

Comparison of Manufacturers

Rounds Fired	Number of Bad Barrels	Good Barrels
7,000	2	GM4, GM5, GM7, GM8, C4, C5, C7, C8, M5, M7
8,000	5	GM4, GM5, GM7, GM8, C4, C5, C8
9,000	8	GM4, GM5, C4, C8
10,000	10	C5, C8
11,000	10	GM4, C4
12,000	9	GM4, GM5, C8

APPENDIXES

APPENDIX A

TABLES AND FIGURES

Abbreviations used in this appendix are:

EV	Extreme Vertical
EH	Extreme Horizontal
ES	Extreme Spread
MR	Mean Radius
RDS. FIRED	Rounds Fired
MFG	Manufacturers Code and Barrel Serial Number.

TABLE A-1

DATA OBTAINED FROM ARSENAL

EV	EH	ES	MR	RDS. FIRED	MFG
4.12	3.14	4.20	1.47	0.	GM4
4.31	3.87	5.13	1.57	0.	GM4
3.35	2.98	3.58	1.09	0.	GM4
2.59	2.04	2.74	0.77	0.	GM5
3.45	2.22	3.53	0.95	0.	GM5
3.13	3.15	3.72	1.14	0.	GM5
4.15	3.72	4.27	1.52	0.	GM7
2.60	2.70	2.75	1.07	0.	GM7
4.37	3.35	4.38	1.31	0.	GM7
3.74	2.45	4.11	1.09	0.	GM8
5.45	2.11	5.62	1.22	0.	GM8
3.64	4.07	4.30	1.42	0.	GM8
3.20	2.18	3.26	1.01	0.	C4
2.83	3.91	3.91	1.12	0.	C4
7.21	3.19	7.22	1.94	0.	C4
3.79	2.01	4.00	1.01	0.	C5
2.74	1.83	3.06	0.93	0.	C5
3.44	2.93	3.80	1.32	0.	C5
2.89	1.71	3.03	0.83	0.	C7
1.81	0.85	1.83	0.55	0.	C7
1.37	2.54	2.65	0.93	0.	C7
4.68	3.77	5.58	1.71	0.	C8
2.35	2.66	2.91	1.08	0.	C8
3.26	4.44	4.58	1.65	0.	C8
2.34	2.77	3.17	1.01	0.	M4
1.83	3.09	3.40	0.93	0.	M4
2.57	3.59	3.93	1.38	0.	M4
3.64	3.93	4.09	1.27	0.	M5
2.08	2.58	2.98	0.96	0.	M5
2.84	2.06	2.93	0.99	0.	M5
3.70	3.04	4.79	1.07	0.	M7
1.80	4.35	4.40	1.25	0.	M7
2.50	3.00	3.47	1.19	0.	M7
2.56	3.78	4.10	1.38	0.	M8
2.35	2.19	2.48	1.02	0.	M8
5.91	3.07	6.05	1.63	0.	M8
3.99	2.65	4.14	1.30	1000.	GM4
2.89	1.93	3.16	1.02	1000.	GM4
3.38	3.54	3.73	1.59	1000.	GM4

TABLE A-1 (Continued)

DATA OBTAINED FROM ARSENAL

EV	EH	ES	MR	RDS. FIRED	MFG
3.35	1.50	3.36	0.84	1000.	GM5
2.37	2.04	2.72	0.82	1000.	GM5
2.20	1.90	2.27	0.70	1000.	GM5
3.17	4.11	4.15	1.33	1000.	GM7
3.19	2.48	3.98	1.18	1000.	GM7
4.11	4.22	4.87	1.50	1000.	GM7
3.70	2.86	4.18	1.54	1000.	GM8
2.48	2.77	3.40	1.33	1000.	GM8
3.80	1.86	3.81	1.28	1000.	GM8
2.94	2.41	3.33	1.05	1000.	C4
5.09	4.00	5.79	1.39	1000.	C4
2.06	2.49	2.86	0.96	1000.	C4
2.56	2.50	2.95	1.09	1000.	C5
3.38	3.20	3.38	1.19	1000.	C5
4.31	3.37	4.46	1.46	1000.	C5
4.38	3.49	4.83	1.61	1000.	C7
2.35	3.30	3.97	1.23	1000.	C7
4.33	3.08	4.66	1.25	1000.	C7
4.23	3.51	4.48	1.56	1000.	C8
4.87	4.19	5.40	1.94	1000.	C8
3.39	4.35	5.10	1.90	1000.	C8
2.40	1.98	2.58	0.81	1000.	M4
1.96	2.22	2.38	0.88	1000.	M4
2.97	2.16	3.13	0.95	1000.	M4
2.07	3.11	3.11	0.92	1000.	M5
4.26	3.28	4.88	0.98	1000.	M5
1.65	2.94	2.96	0.84	1000.	M5
2.16	3.86	4.42	1.15	1000.	M7
5.70	2.89	6.17	1.49	1000.	M7
1.57	2.12	2.49	0.76	1000.	M7
4.08	2.84	4.30	1.25	1000.	M8
1.35	1.93	2.15	0.66	1000.	M8
2.94	2.54	3.15	0.96	1000.	M8
2.49	2.68	2.95	1.12	2000.	GM4
3.16	2.27	3.38	1.25	2000.	GM4
2.36	3.79	3.94	1.29	2000.	GM4
3.18	4.26	4.40	1.14	2000.	GM5
4.89	3.10	5.21	1.29	2000.	GM5
4.99	2.57	4.99	1.44	2000.	GM5

TABLE A-1 (Continued)

DATA OBTAINED FROM ARSENAL

EV	EH	ES	MR	RDS. FIRED	MFG
2.17	2.07	2.41	0.89	2000.	GM7
3.11	2.14	3.15	1.11	2000.	GM7
3.81	3.20	4.71	1.20	2000.	GM7
3.38	2.68	3.77	1.14	2000.	GM8
4.26	3.49	4.34	1.44	2000.	GM8
3.20	3.19	3.43	1.29	2000.	GM8
1.95	2.02	2.02	0.79	2000.	C4
2.91	2.81	3.46	1.20	2000.	C4
4.04	3.39	4.07	1.33	2000.	C4
3.25	2.47	3.58	1.22	2000.	C5
1.59	3.17	3.19	0.92	2000.	C5
2.49	2.33	2.96	1.11	2000.	C5
2.56	3.05	3.31	1.17	2000.	C7
2.31	2.75	3.30	1.00	2000.	C7
2.35	2.88	3.58	1.00	2000.	C7
1.78	1.64	1.97	0.66	2000.	C8
3.96	3.04	4.14	1.38	2000.	C8
5.57	3.71	6.69	1.65	2000.	C8
3.45	3.42	3.85	1.43	2000.	M4
2.80	3.43	4.43	1.15	2000.	M4
2.88	2.23	2.91	1.04	2000.	M4
3.19	1.06	3.19	0.96	2000.	M5
2.77	2.95	3.05	1.14	2000.	M5
4.12	3.40	4.93	1.40	2000.	M5
2.34	4.63	4.74	1.17	2000.	M7
2.72	2.49	3.36	1.04	2000.	M7
3.32	3.64	4.23	1.53	2000.	M7
1.91	2.73	2.82	0.80	2000.	M8
3.65	1.96	3.70	0.94	2000.	M8
4.13	3.47	4.35	1.52	2000.	M8
4.22	3.66	5.17	1.27	3000.	GM4
1.52	2.10	2.16	0.72	3000.	GM4
3.26	1.94	3.50	0.98	3000.	GM4
5.09	1.73	5.10	1.53	3000.	GM5
3.05	1.67	3.08	1.00	3000.	GM5
5.57	2.54	5.61	1.62	3000.	GM5
2.70	3.30	3.67	1.09	3000.	GM7
2.27	1.50	2.34	0.85	3000.	GM7
2.81	4.07	4.13	1.54	3000.	GM7

TABLE A-1 (Continued)

DATA OBTAINED FROM ARSENAL

EV	EH	ES	MR	RDS. FIRED	MFG
4.26	2.89	4.26	1.40	3000.	GM8
4.80	2.63	4.91	1.52	3000.	GM8
4.81	2.41	4.85	1.18	3000.	GM8
1.89	2.59	2.59	0.89	3000.	C4
3.41	2.97	3.99	1.31	3000.	C4
3.66	4.29	4.58	1.51	3000.	C4
3.23	3.56	4.26	1.16	3000.	C5
3.87	2.33	3.91	1.27	3000.	C5
2.80	2.25	3.01	0.89	3000.	C5
1.87	2.12	2.81	0.80	3000.	C7
3.89	2.75	3.90	1.11	3000.	C7
5.15	3.24	5.21	1.60	3000.	C7
3.09	2.83	3.19	1.30	3000.	C8
2.83	2.76	2.96	1.33	3000.	C8
4.09	5.79	5.86	1.49	3000.	C8
2.53	2.49	3.37	0.85	3000.	M4
2.14	3.15	3.22	1.13	3000.	M4
2.65	5.11	5.49	1.52	3000.	M4
3.81	3.20	4.12	1.32	3000.	M5
1.24	2.43	2.44	0.82	3000.	M5
3.48	3.05	3.66	1.11	3000.	M5
2.54	2.93	3.27	1.08	3000.	M7
2.91	5.28	5.85	1.36	3000.	M7
1.67	3.08	3.11	0.92	3000.	M7
2.18	2.47	2.59	0.85	3000.	M8
4.83	3.24	5.24	1.51	3000.	M8
1.85	2.76	2.78	0.81	3000.	M8
3.61	1.71	3.83	0.94	4000.	GM4
3.10	3.51	4.38	1.04	4000.	GM4
3.70	3.03	3.71	1.21	4000.	GM4
5.02	1.43	5.18	1.06	4000.	GM5
3.11	4.01	4.26	1.51	4000.	GM5
2.11	2.70	2.73	1.04	4000.	GM5
4.15	3.72	4.27	1.52	4000.	GM7
2.60	2.70	2.75	1.07	4000.	GM7
4.37	3.35	4.38	1.31	4000.	GM7
3.79	2.76	4.05	1.22	4000.	GM8
5.60	5.56	6.02	2.20	4000.	GM8
5.19	2.72	5.36	1.64	4000.	GM8

TABLE A-1 (Continued)

DATA OBTAINED FROM ARSENAL

EV	EH	ES	MR	RDS. FIRED	MFG
2.49	2.00	2.67	0.75	4000.	C4
2.89	3.00	3.28	1.28	4000.	C4
4.31	2.07	4.56	1.26	4000.	C4
6.00	2.85	6.15	1.48	4000.	C5
1.85	3.79	3.98	0.98	4000.	C5
4.10	4.35	5.73	1.19	4000.	C5
3.33	2.47	3.50	1.21	4000.	C7
3.59	4.38	5.16	1.73	4000.	C7
1.61	2.02	2.44	0.78	4000.	C7
3.49	2.19	3.56	1.09	4000.	C8
2.59	2.22	2.90	0.84	4000.	C8
4.27	3.28	4.67	1.36	4000.	C8
4.80	2.88	5.00	1.53	4000.	M4
5.88	3.83	5.92	1.77	4000.	M4
3.22	8.70	9.28	2.03	4000.	M4
4.31	4.92	6.54	1.65	4000.	M5
6.15	2.91	6.15	1.64	4000.	M5
3.54	2.46	3.64	1.29	4000.	M5
2.52	2.50	2.69	1.19	4000.	M7
6.03	4.13	6.28	1.77	4000.	M7
4.05	3.45	4.44	1.54	4000.	M7
4.32	2.39	4.85	1.23	4000.	M8
4.53	2.44	4.82	1.20	4000.	M8
6.39	3.91	6.50	1.81	4000.	M8
2.44	2.93	3.08	1.12	5000.	GM4
2.33	3.26	3.26	1.16	5000.	GM4
3.10	2.70	3.71	1.10	5000.	GM4
3.51	3.43	4.80	1.48	5000.	GM5
4.31	3.88	5.75	1.76	5000.	GM5
5.53	4.85	6.77	2.26	5000.	GM5
2.06	3.77	4.19	0.93	5000.	GM7
4.81	4.36	5.82	1.70	5000.	GM7
2.25	5.08	5.23	1.64	5000.	GM7
3.60	3.21	3.90	1.09	5000.	GM8
4.36	3.57	4.36	1.47	5000.	GM8
3.26	1.77	3.27	1.02	5000.	GM8
3.02	3.55	4.07	1.33	5000.	C4
2.51	4.31	4.32	1.20	5000.	C4
1.93	2.90	2.93	1.00	5000.	C4

TABLE A-1 (Continued)

DATA OBTAINED FROM ARSENAL

EV	EH	ES	MR	RDS. FIRED	MFG
3.28	2.50	3.42	1.36	5000.	C5
3.34	4.53	5.02	1.66	5000.	C5
3.06	4.28	4.44	1.30	5000.	C5
3.22	2.96	3.62	1.28	5000.	C7
5.73	3.25	5.83	1.24	5000.	C7
3.14	5.20	5.21	1.76	5000.	C7
3.61	2.86	4.19	1.51	5000.	C8
5.03	2.45	5.34	1.19	5000.	C8
3.91	1.80	4.13	1.29	5000.	C8
5.22	5.81	7.70	2.34	5000.	M4
4.44	4.96	6.25	1.71	5000.	M4
6.22	3.83	6.28	1.76	5000.	M4
4.13	4.96	5.89	1.82	5000.	M5
4.28	3.74	5.03	1.54	5000.	M5
4.72	2.46	4.81	1.39	5000.	M5
3.51	6.05	6.05	1.50	5000.	M7
6.19	5.38	7.37	1.97	5000.	M7
5.25	4.10	6.35	1.77	5000.	M7
2.24	4.43	4.59	1.11	5000.	M8
5.99	5.37	7.38	1.94	5000.	M8
3.22	8.42	8.54	2.73	5000.	M8
4.67	2.42	5.24	1.13	6000.	GM4
4.17	3.26	4.20	1.19	6000.	GM4
2.09	5.80	6.12	1.40	6000.	GM4
4.42	2.67	5.14	1.43	6000.	GM5
5.20	3.93	5.32	1.63	6000.	GM5
4.31	1.36	4.41	1.29	6000.	GM5
4.93	4.73	5.51	1.71	6000.	GM7
3.15	5.30	6.16	1.41	6000.	GM7
3.[illegible]	5.8[illegible]	5.89	2.09	6000.	GM7
5.56	3.60	5.71	1.83	6000.	GM8
3.91	6.09	6.82	1.58	6000.	GM8
5.52	4.53	5.56	2.08	6000.	GM8
4.34	3.06	4.41	1.49	6000.	C4
4.46	5.20	[illegible].33	1.57	6000.	C4
3.81	4.21	4.60	1.56	6000.	C4
2.51	2.29	2.91	0.90	6000.	C5
4.01	3.86	5.22	1.49	6000.	C5
4.14	3.08	4.49	1.50	6000.	C5

TABLE A-1 (Continued)

DATA OBTAINED FROM ARSENAL

EV	EH	ES	MR	RDS. FIRED	MFG
3.63	2.00	3.90	1.17	6000.	C7
8.67	7.03	9.45	3.04	6000.	C7
6.02	9.31	9.32	2.41	6000.	C7
4.32	2.94	4.41	1.60	6000.	C8
6.53	3.89	6.63	2.25	6000.	C8
6.55	3.86	6.63	1.67	6000.	C8
2.91	4.43	5.01	1.25	6000.	M4
8.78	6.79	8.80	3.11	6000.	M4
5.35	4.99	7.30	1.77	6000.	M4
3.51	1.97	3.59	1.16	6000.	M5
5.61	5.12	7.51	2.11	6000.	M5
3.60	5.98	6.05	1.83	6000.	M5
5.53	4.69	5.86	1.62	6000.	M7
7.16	5.59	8.18	2.35	6000.	M7
3.65	6.67	6.68	2.02	6000.	M7
3.07	3.37	4.42	1.62	6000.	M8
6.37	1.75	6.46	1.66	6000.	M8
4.00	7.79	7.79	2.01	6000.	M8
3.56	3.41	4.43	1.40	7000.	GM4
3.03	2.57	3.95	1.25	7000.	GM4
7.52	2.64	7.52	1.99	7000.	GM4
4.53	2.77	5.07	1.49	7000.	GM5
6.37	3.68	6.38	1.72	7000.	GM5
3.61	4.32	4.65	1.35	7000.	GM5
2.37	3.21	3.74	1.07	7000.	GM7
3.80	4.13	4.69	1.65	7000.	GM7
5.54	5.47	6.27	1.67	7000.	GM7
2.94	2.93	3.39	1.19	7000.	GM8
4.21	3.53	4.60	1.49	7000.	GM8
4.22	3.90	4.49	1.36	7000.	GM8
3.59	4.36	4.47	1.48	7000.	C4
2.60	3.17	3.19	0.96	7000.	C4
3.35	5.57	5.85	1.61	7000.	C4
2.07	3.35	3.57	1.06	7000.	C5
2.57	2.44	3.53	1.06	7000.	C5
4.44	5.34	5.35	1.74	7000.	C5
1.51	4.16	4.23	1.29	7000.	C7
3.72	2.72	4.24	1.41	7000.	C7
4.91	6.58	7.45	2.01	7000.	C7

TABLE A-1 (Continued)

DATA OBTAINED FROM ARSENAL

EV	EH	ES	MR	RDS. FIRED	MFG
1.52	3.69	3.99	1.00	7000.	C8
3.93	4.04	4.48	1.40	7000.	C8
2.92	4.64	4.65	1.20	7000.	C8
6.57	9.28	9.40	3.42	7000.	M4
5.52	9.29	9.46	2.87	7000.	M4
6.01	6.62	7.03	2.57	7000.	M4
3.92	3.67	5.37	1.62	7000.	M5
4.33	4.72	5.64	1.88	7000.	M5
4.00	5.95	6.49	2.09	7000.	M5
2.36	5.69	5.75	1.52	7000.	M7
7.49	4.26	7.79	2.21	7000.	M7
5.55	9.08	9.08	2.45	7000.	M7
6.37	6.70	6.76	1.93	7000.	M8
4.78	8.29	8.30	2.36	7000.	M8
8.26	8.44	10.68	2.72	7000.	M8
3.26	3.97	4.02	1.44	8000.	GM4
2.66	3.04	3.42	1.16	8000.	GM4
3.23	4.69	5.12	1.46	8000.	GM4
4.47	3.01	4.57	1.50	8000.	GM5
2.64	3.34	3.55	1.27	8000.	GM5
3.64	5.22	5.54	1.84	8000.	GM5
4.70	4.34	5.18	1.63	8000.	GM7
6.09	7.34	7.81	2.52	8000.	GM7
6.58	4.66	6.90	1.97	8000.	GM7
4.03	3.06	4.07	1.47	8000.	GM8
6.07	4.08	6.48	1.75	8000.	GM8
9.83	6.60	11.49	2.53	8000.	GM8
3.18	2.28	3.82	1.08	8000.	C4
4.72	1.75	4.83	1.56	8000.	C4
6.67	6.32	7.60	2.09	8000.	C4
4.50	2.18	4.55	1.34	8000.	C5
3.75	4.14	5.19	1.50	8000.	C5
2.83	4.34	4.44	1.40	8000.	C5
2.81	4.12	4.27	1.50	8000.	C7
7.00	8.63	8.67	2.59	8000.	C7
8.28	4.52	8.82	2.63	8000.	C7
4.05	4.10	4.11	1.66	8000.	C8
4.82	2.63	4.84	1.32	8000.	C8
4.52	2.72	4.62	1.48	8000.	C8

TABLE A-1 (Continued)

DATA OBTAINED FROM ARSENAL

EV	EH	ES	MR	RDS. FIRED	MFG
4.60	7.79	8.00	2.43	8000.	M4
6.50	8.52	8.67	3.18	8000.	M4
7.09	5.19	8.03	2.05	8000.	M4
4.24	6.07	6.85	2.37	8000.	M5
7.78	4.55	8.05	2.34	8000.	M5
7.17	7.02	8.07	2.75	8000.	M5
6.74	10.91	12.26	3.77	8000.	M7
6.88	7.46	10.15	3.38	8000.	M7
9.77	10.55	10.56	3.93	8000.	M7
6.65	8.34	8.64	2.10	8000.	M8
4.93	7.50	7.84	3.04	8000.	M8
8.26	3.77	8.65	2.54	8000.	M8
3.87	1.65	3.90	1.18	9000.	GM4
6.00	2.55	6.51	1.43	9000.	GM4
5.70	3.04	5.90	1.48	9000.	GM4
3.21	1.83	3.42	1.02	9000.	GM5
4.94	4.57	5.01	1.97	9000.	GM5
6.02	4.72	6.75	2.23	9000.	GM5
5.26	4.53	5.58	2.08	9000.	GM7
6.20	13.21	13.24	4.08	9000.	GM7
4.21	8.53	8.76	2.33	9000.	GM7
3.87	6.80	7.07	2.21	9000.	GM8
7.36	7.87	10.45	2.65	9000.	GM8
6.76	3.33	7.32	2.00	9000.	GM8
3.74	2.55	3.77	1.26	9000.	C4
3.83	3.44	4.63	1.56	9000.	C4
6.86	5.55	6.91	2.18	9000.	C4
4.48	4.72	5.52	1.55	9000.	C5
10.67	6.66	11.03	3.02	9000.	C5
7.13	6.19	7.55	2.37	9000.	C5
6.00	4.92	6.89	1.89	9000.	C7
7.64	7.22	8.30	2.91	9000.	C7
6.53	4.84	6.81	2.26	9000.	C7
2.19	4.17	4.30	0.94	9000.	C8
8.65	4.87	8.85	2.37	9000.	C8
6.32	4.19	6.75	2.02	9000.	C8
4.89	8.31	8.41	3.13	9000.	M4
7.39	6.10	7.63	2.93	9000.	M4
7.19	9.05	9.07	2.90	9000.	M4

TABLE A-1 (Continued)

DATA OBTAINED FROM ARSENAL

EV	EH	ES	MR	RDS. FIRED	MFG
5.98	6.07	7.24	2.00	9000.	M5
8.12	7.69	9.12	2.71	9000.	M5
4.68	5.40	5.83	1.88	9000.	M5
5.33	9.91	10.88	3.37	9000.	M7
7.82	9.37	9.93	3.77	9000.	M7
5.50	4.00	6.58	1.62	9000.	M7
7.17	5.97	7.65	2.09	9000.	M8
11.37	9.35	11.42	3.55	9000.	M8
8.59	8.07	8.89	2.97	9000.	M8
4.05	2.12	4.53	1.34	10000.	GM4
7.65	5.72	7.66	1.93	10000.	GM4
8.80	11.25	12.01	3.41	10000.	GM4
7.31	5.14	8.26	2.22	10000.	GM5
10.35	7.61	10.91	3.29	10000.	GM5
6.99	5.50	8.10	2.40	10000.	GM5
6.05	8.24	8.55	2.85	10000.	GM7
3.01	7.87	7.99	2.06	10000.	GM7
8.48	6.97	8.68	2.89	10000.	GM7
5.14	6.72	6.83	2.37	10000.	GM8
6.86	8.22	9.20	2.83	10000.	GM8
11.44	6.54	11.86	3.07	10000.	GM8
5.24	3.07	5.38	1.48	10000.	C4
3.62	5.96	5.98	2.05	10000.	C4
5.43	15.44	15.57	3.92	10000.	C4
4.51	3.41	5.05	1.35	10000.	C5
3.79	5.94	6.23	1.84	10000.	C5
6.39	10.32	10.35	3.19	10000.	C5
9.32	5.08	9.89	2.45	10000.	C7
11.53	11.75	13.97	4.65	10000.	C7
7.12	8.00	8.26	2.85	10000.	C7
5.89	2.59	5.93	1.62	10000.	C8
6.57	5.50	7.44	2.13	10000.	C8
6.02	8.62	8.94	2.54	10000.	C8
6.09	5.21	6.46	2.38	10000.	M4
4.90	10.63	10.76	3.05	10000.	M4
8.76	7.74	9.37	2.90	10000.	M4
4.05	7.68	7.73	2.21	10000.	M5
8.28	8.80	8.90	3.18	10000.	M5
9.25	11.37	12.25	4.01	10000.	M5

TABLE A-1 (Continued)

DATA OBTAINED FROM ARSENAL

EV	EH	ES	MR	RDS. FIRED	MFG
8.11	11.50	14.07	3.68	10000.	M7
7.97	11.06	11.63	3.81	10000.	M7
8.41	6.94	9.31	3.93	10000.	M7
7.72	7.91	8.96	3.39	10000.	M8
7.42	5.55	7.44	2.24	10000.	M8
6.09	7.45	7.59	3.09	10000.	M8
6.86	4.00	7.08	1.94	11000.	GM4
2.81	1.62	3.07	1.05	11000.	GM4
4.30	4.52	4.52	1.75	11000.	GM4
6.56	4.26	6.56	2.46	11000.	GM5
8.93	5.58	8.99	3.20	11000.	GM5
5.17	5.09	5.71	2.00	11000.	GM5
5.22	7.48	9.02	2.48	11000.	GM7
12.99	9.41	14.22	4.13	11000.	GM7
10.57	8.18	12.34	3.70	11000.	GM7
4.50	6.98	7.76	2.63	11000.	GM8
7.71	8.75	9.59	2.74	11000.	GM8
10.02	9.07	12.64	3.57	11000.	GM8
4.08	1.99	4.18	1.17	11000.	C4
5.85	3.80	6.05	1.91	11000.	C4
3.85	5.86	6.28	1.54	11000.	C4
7.04	5.48	7.18	2.25	11000.	C5
9.40	10.00	11.54	3.88	11000.	C5
9.09	9.96	12.18	3.20	11000.	C5
9.56	4.91	10.19	2.59	11000.	C7
6.57	7.21	8.82	3.24	11000.	C7
11.22	8.29	11.75	3.87	11000.	C7
6.54	3.35	6.59	2.01	11000.	C8
5.40	8.36	8.70	2.77	11000.	C8
10.01	5.87	10.30	2.49	11000.	C8
8.02	9.74	12.43	4.17	11000.	M4
6.59	9.59	10.96	3.68	11000.	M4
10.07	7.12	10.86	3.15	11000.	M4
6.83	8.85	8.86	3.85	11000.	M7
9.37	23.19	23.78	7.61	11000.	M7
5.72	11.21	11.86	3.23	11000.	M8
16.69	16.62	21.15	5.32	11000.	M8
14.28	12.98	15.32	4.66	11000.	M8
5.39	8.54	8.71	2.96	11000.	M5

TABLE A-1 (Continued)

DATA OBTAINED FROM ARSENAL

EV	EH	ES	MR	RDS. FIRED	MFG
8.52	7.31	10.56	3.14	11000.	M5
7.70	11.76	12.59	3.80	11000.	M5
10.12	5.63	10.97	4.13	11000.	M7
4.53	3.46	5.07	1.43	12000.	GM4
4.49	5.61	5.67	1.78	12000.	GM4
5.23	5.31	6.16	2.19	12000.	GM4
3.63	2.34	3.96	1.39	12000.	GM5
5.98	6.31	7.50	2.46	12000.	GM5
9.20	7.45	9.23	2.53	12000.	GM5
11.47	15.30	17.41	4.84	12000.	GM7
9.25	10.30	11.58	3.74	12000.	M7
11.71	5.10	11.85	3.40	12000.	GM7
7.62	12.32	12.74	3.91	12000.	GM8
10.49	8.53	12.25	3.72	12000.	GM8
8.30	16.31	18.30	4.74	12000.	GM8
4.06	5.50	5.70	2.08	12000.	C4
8.44	7.56	9.80	3.29	12000.	C4
6.55	11.58	12.17	3.34	12000.	C4
6.43	3.95	6.76	1.97	12000.	C5
4.78	5.71	5.92	2.17	12000.	C5
7.42	7.18	8.57	2.67	12000.	C5
5.43	6.55	6.96	2.52	12000.	C7
8.17	7.57	8.99	3.61	12000.	C7
4.72	8.68	9.07	2.90	12000.	C7
8.30	3.44	8.34	1.91	12000.	C8
2.48	3.24	3.90	1.27	12000.	C8
3.60	3.17	3.60	1.49	12000.	C8
7.63	8.71	10.40	3.68	12000.	M4
9.88	8.08	10.14	4.04	12000.	M4
7.78	10.99	11.90	3.56	12000.	M4
5.82	6.80	8.95	2.[illegible]5	12000.	M5
6.35	12.74	13.35	3.88	12000.	M5
5.81	8.43	8.69	2.83	12000.	M5
13.11	9.34	15.69	4.33	12000.	M7
10.20	7.61	10.72	3.56	12000.	M7
13.54	12.73	16.71	5.18	12000.	M7
11.59	12.26	12.83	4.21	12000.	M8
13.23	9.35	13.34	4.28	12000.	M8
16.73	12.07	17.13	5.01	12000.	M8

TABLE A-2

DATA AFTER AVERAGING

EV	EH	ES	MR	RDS. FIRED	MFG
3.926	3.329	4.303	1.376	0.	GM4
3.056	2.470	3.329	0.953	0.	GM5
3.706	3.256	3.799	1.300	0.	GM7
4.276	2.876	4.676	1.243	0.	GM8
4.413	3.093	4.796	1.356	0.	C4
3.323	2.256	3.620	1.086	0.	C5
2.023	1.700	2.503	0.769	0.	C7
3.429	3.623	4.356	1.480	0.	C8
2.246	3.150	3.500	1.106	0.	M4
2.853	2.856	3.333	1.073	0.	M5
2.666	3.463	4.220	1.170	0.	M7
3.606	3.013	4.210	1.343	0.	M8
3.420	2.706	3.676	1.303	1000.	GM4
2.640	1.813	2.783	0.786	1000.	GM5
3.489	3.603	4.333	1.336	1000.	GM7
3.326	2.496	3.796	1.383	1000.	GM8
3.363	2.966	3.993	1.133	1000.	C4
3.416	3.023	3.596	1.246	1000.	C5
3.686	3.289	4.486	1.363	1000.	C7
4.163	4.016	4.993	1.799	1000.	C8
2.443	2.119	2.696	0.879	1000.	M4
2.659	3.110	3.649	0.913	1000.	M5
3.143	2.956	4.359	1.133	1000.	M7
2.789	2.436	3.199	0.956	1000.	M8
2.670	2.913	3.423	1.220	2000.	GM4
4.353	3.309	4.866	1.289	2000.	GM5
3.030	2.470	3.423	1.066	2000.	GM7
3.613	3.119	3.846	1.289	2000.	GM8
2.966	2.740	3.183	1.106	2000.	C4
2.443	2.656	3.243	1.083	2000.	C5
2.406	2.893	3.396	1.056	2000.	C7
3.769	2.796	4.266	1.230	2000.	C8
3.043	3.026	3.730	1.206	2000.	M4
3.360	2.470	3.723	1.166	2000.	M5
2.793	3.586	4.110	1.246	2000.	M7
3.230	2.719	3.623	1.086	2000.	M8
3.000	2.566	3.610	0.990	3000.	GM4
4.569	1.980	4.596	1.383	3000.	GM5
2.593	2.956	3.379	1.160	3000.	GM7

TABLE A-2 (Continued)

DATA AFTER AVERAGING

EV	EH	ES	MR	RDS. FIRED	MFG
4.623	2.643	4.673	1.366	3000.	GM8
2.986	3.283	3.720	1.236	3000.	C4
3.300	2.713	3.726	1.106	3000.	C5
3.636	2.703	3.973	1.170	3000.	C7
3.336	3.793	4.003	1.373	3000.	C8
2.440	3.583	4.026	1.166	3000.	M4
2.843	2.893	3.406	1.083	3000.	M5
2.373	3.763	4.076	1.120	3000.	M7
2.953	2.823	3.536	1.056	3000.	M8
3.470	2.750	3.973	1.063	4000.	GM4
3.413	2.713	4.056	1.203	4000.	GM5
3.706	3.256	3.799	1.300	4000.	GM7
4.860	3.679	5.143	1.686	4000.	GM8
3.230	2.356	3.503	1.096	4000.	C4
3.983	3.663	5.286	1.216	4000.	C5
2.843	2.956	3.700	1.240	4000.	C7
3.449	2.563	3.710	1.096	4000.	C8
4.633	5.136	6.733	1.776	4000.	M4
4.666	3.429	5.443	1.526	4000.	M5
4.199	3.360	4.470	1.500	4000.	M7
5.079	2.913	5.390	1.413	4000.	M8
2.623	2.963	3.349	1.126	5000.	GM4
4.449	4.053	5.773	1.833	5000.	GM5
3.039	4.403	5.079	1.423	5000.	GM7
3.740	2.849	3.843	1.193	5000.	GM8
2.486	3.586	3.773	1.176	5000.	C4
3.226	3.769	4.293	1.440	5000.	C5
4.030	3.803	4.886	1.426	5000.	C7
4.183	2.369	4.553	1.330	5000.	C8
5.293	4.866	6.743	1.936	5000.	M4
4.376	3.719	5.243	1.583	5000.	M5
4.983	5.176	6.590	1.746	5000.	M7
3.816	6.073	6.836	1.926	5000.	M8
3.643	3.826	5.186	1.240	6000.	GM4
4.643	2.653	4.956	1.450	6000.	GM5
3.969	5.303	5.853	1.736	6000.	GM7
4.996	4.739	6.029	1.830	6000.	GM8
4.203	4.156	4.780	1.539	6000.	C4
3.553	3.076	4.206	1.296	6000.	C5

TABLE A-2 (Continued)

DATA AFTER AVERAGING

EV	EH	ES	MR	RDS. FIRED	MFG
6.106	6.113	7.556	2.206	6000.	C7
5.800	3.563	5.890	1.840	6000.	C8
5.680	5.403	7.036	2.043	6000.	M4
4.240	4.356	5.716	1.700	6000.	M5
5.446	5.649	6.906	1.996	6000.	M7
4.480	4.303	6.223	1.763	6000.	M8
4.703	2.873	5.300	1.546	7000.	GM4
4.836	3.590	5.366	1.519	7000.	GM5
3.903	4.269	4.900	1.463	7000.	GM7
3.789	3.453	4.159	1.346	7000.	GM8
3.180	4.366	4.503	1.349	7000.	C4
3.026	3.710	4.150	1.286	7000.	C5
3.380	4.486	5.306	1.569	7000.	C7
2.789	4.123	4.373	1.200	7000.	C8
6.033	8.396	8.630	2.953	7000.	M4
4.083	4.779	5.833	1.863	7000.	M5
5.133	6.343	7.540	2.059	7000.	M7
6.470	7.809	8.579	2.336	7000.	M8
3.050	3.900	4.186	1.353	8000.	GM4
3.583	3.856	4.553	1.536	8000.	GM5
5.789	5.446	6.630	2.039	8000.	GM7
6.643	4.579	7.346	1.916	8000.	GM8
4.856	3.450	5.416	1.576	8000.	C4
3.693	3.553	4.726	1.413	8000.	C5
6.029	5.756	7.253	2.240	8000.	C7
4.463	3.150	4.523	1.486	8000.	C8
6.063	7.166	8.233	2.553	8000.	M4
6.396	5.880	7.656	2.486	8000.	M5
7.796	9.640	10.989	3.693	8000.	M7
6.613	6.536	8.376	2.560	8000.	M8
5.190	2.413	5.436	1.363	9000.	GM4
4.723	3.706	5.060	1.740	9000.	GM5
5.223	8.756	9.193	2.830	9000.	GM7
5.996	6.000	8.280	2.286	9000.	GM8
4.810	3.846	5.103	1.666	9000.	C4
7.426	5.856	8.033	2.313	9000.	C5
6.723	5.059	7.333	2.353	9000.	C7
5.720	4.409	6.633	1.776	9000.	C8
6.489	7.819	8.370	2.986	9000.	M4

TABLE A-2 (Continued)

DATA AFTER AVLRAGING

EV	EH	ES	MR	RDS. FIRED	MFG
6.260	6.386	7.396	2.196	9000.	M5
6.216	7.760	9.130	2.920	9000.	M7
9.043	7.796	9.319	2.869	9000.	M8
6.833	6.363	8.066	2.226	10000.	GM4
8.216	6.083	9.090	2.636	10000.	GM5
5.846	7.693	8.406	2.600	10000.	GM7
7.813	7.159	9.296	2.756	10000.	GM8
4.763	8.156	8.976	2.483	10000.	C4
4.896	6.556	7.210	2.126	10000.	C5
9.323	8.276	10.706	3.316	10000.	C7
6.159	5.569	7.436	2.096	10000.	C8
6.583	7.859	8.863	2.776	10000.	M4
7.193	9.283	9.626	3.133	10000.	M5
8.163	9.833	11.670	3.806	10000.	M7
7.076	6.970	7.996	2.906	10000.	M8
4.663	3.380	4.890	1.580	11000.	GM4
6.886	4.976	7.086	2.553	11000.	GM5
9.593	8.356	11.860	3.436	11000.	GM7
7.409	8.266	9.996	2.980	11000.	GM8
4.593	3.883	5.503	1.539	11000.	C4
8.510	8.480	10.299	3.110	11000.	C5
9.116	6.803	10.253	3.233	11000.	C7
7.316	5.859	8.530	2.423	11000.	C8
8.226	8.816	11.416	3.666	11000.	M4
7.306	14.416	14.833	4.896	11000.	M5
12.120	12.713	15.059	4.313	11000.	M7.
8.780	8.233	11.373	3.690	11000.	M8
4.750	4.793	5.633	1.799	12000.	GM4
6.269	5.366	6.896	2.126	12000.	GM5
10.810	10.233	13.613	3.993	12000.	GM7
8.803	12.386	14.430	4.123	12000.	GM8
6.349	8.213	9.223	2.903	12000.	C4
6.210	5.613	7.083	2.269	12000.	C5
6.106	7.599	8.340	3.010	12000.	C7
4.793	3.283	5.279	1.556	12000.	C8
8.430	9.226	10.813	3.760	12000.	M4
5.993	9.323	10.329	2.920	12000.	M5
12.283	9.893	14.373	4.356	12000.	M7
13.850	11.226	14.433	4.500	12000.	M8

TABLE A-3

Mean and Standard Deviation Values for

EXTREME VERTICAL EV

ROUNDS FIRED	MEAN VALUES	STANDARD DEVIATIONS
0.	3.29358	0.75446
1000.	3.21141	0.49859
2000.	3.13966	0.56928
3000.	3.22099	0.73957
4000.	3.96091	0.72090
5000.	3.85366	0.88271
6000.	4.72991	0.86645
7000.	4.27708	1.18023
8000.	5.41449	1.46613
9000.	6.15158	1.21650
10000.	6.90532	1.36501
11000.	7.87649	2.06214
12000.	7.88716	2.99285

TABLE A-4

Mean and Standard Deviation Values for

EXTREME HORIZONTAL EH

ROUNDS FIRED	MEAN VALUES	STANDARD DEVIATIONS
0.	2.92374	0.54759
1000.	2.87774	0.61492
2000.	2.89141	0.33023
3000.	2.97491	0.53693
4000.	3.23116	0.73615
5000.	3.96908	1.04389
6000.	4.42833	1.05860
7000.	4.84974	1.74627
8000.	5.24266	1.90772
9000.	5.86716	1.96797
10000.	7.48332	1.28400
11000.	7.84841	3.27115
12000.	8.09616	2.80799

TABLE A-5

Mean and Standard Deviation Values for

EXTREME SPREAD ES

ROUNDS FIRED	MEAN VALUES	STANDARD DEVIATIONS
0.	3.88708	0.66193
1000.	3.79658	0.68898
2000.	3.73599	0.46460
3000.	3.89366	0.41985
4000.	4.60049	0.99100
5000.	5.08008	1.19869
6000.	5.86141	0.98670
7000.	5.71991	1.63234
8000.	6.65724	2.05358
9000.	7.44049	1.57217
10000.	8.94507	1.29313
11000.	10.09149	3.20995
12000.	10.03707	3.50412

TABLE A-6

Mean and Standard Deviation Values for

MEAN RADIUS MR

ROUNDS FIRED	MEAN VALUES	STANDARD DEVIATIONS
0.	1.18791	0.20223
1000.	1.18583	0.28171
2000.	1.17024	0.08741
3000.	1.18408	0.15026
4000.	1.34291	0.23679
5000.	1.51149	0.29097
6000.	1.71991	0.29565
7000.	1.70741	0.51601
8000.	2.07091	0.68424
9000.	2.27483	0.55655
10000.	2.73833	0.50489
11000.	3.11824	1.00051
12000.	3.10958	1.02740

TABLE A-7

Lilliefor Test Values for EV

ROUNDS FIRED = 0.

EXTREME VERTICAL EV

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.68400	0.04610	0.04610	0.03723
-1.38800	0.08260	-0.00073	0.08406
-0.83100	0.20300	0.03633	0.04700
-0.58300	0.28000	0.02999	0.05333
-0.31400	0.37680	0.04346	0.03986
0.03800	0.51520	0.09853	-0.01519
0.17900	0.57100	0.07099	0.01233
0.41400	0.66060	0.07726	0.00606
0.54600	0.70740	0.04073	0.04260
0.83800	0.79890	0.04889	0.03443
1.30200	0.90350	0.07016	0.01316
1.48300	0.93100	0.01433	0.06900

TABLE A-7 (Continued)

Lilliefor Test Values for EV

ROUNDS FIRED = 1000.

EXTREME VERTICAL EV

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.54100	0.06170	0.06170	0.02163
-1.14600	0.12590	0.04256	0.04076
-1.10700	0.13420	-0.03246	0.11580
-0.84700	0.19850	-0.05150	0.13483
-0.13700	0.44550	0.11216	-0.02883
0.22900	0.59060	0.17393	-0.09059
0.30400	0.61940	0.11939	-0.03606
0.41000	0.65910	0.07576	0.00756
0.41600	0.66210	-0.00456	0.08790
0.55600	0.71090	-0.03910	0.12243
0.95100	0.82920	-0.00413	0.08746
1.90800	0.97180	0.05513	0.02820

TABLE A-7 (Continued)

Lilliefor Test Values for EV

ROUNDS FIRED = 2000.

EXTREME VERTICAL EV

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.28800	0.10060	0.10060	-0.01726
-1.22300	0.11060	0.02726	0.05606
-0.82500	0.20470	0.03803	0.04530
-0.60800	0.27160	0.02159	0.06173
-0.30500	0.38020	0.04686	0.03646
-0.19200	0.42390	0.00723	0.07610
-0.16900	0.43290	-0.06710	0.15043
0.15800	0.56280	-0.02053	0.10386
0.38700	0.65060	-0.01606	0.09940
0.83100	0.79700	0.04699	0.03633
1.10500	0.86540	0.03206	0.05126
2.13100	0.98340	0.06673	0.01660

TABLE A-7 (Continued)

Lilliefor Test Values for EV

ROUNDS FIRED = 3000.

EXTREME VERTICAL EV

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.14600	0.12590	0.12590	-0.04256
-1.05600	0.14550	0.06216	0.02116
-0.84900	0.19520	0.02853	0.05480
-0.51100	0.30470	0.05469	0.02863
-0.36200	0.35870	0.02536	0.05796
-0.31700	0.37560	-0.04106	0.12440
-0.29800	0.38290	-0.11710	0.20043
0.10600	0.54220	-0.04113	0.12446
0.15500	0.56160	-0.10506	0.18840
0.56100	0.71260	-0.03740	0.12073
1.82200	0.96580	0.13246	-0.04913
1.89500	0.97130	0.05463	0.02870

TABLE A-7 (Continued)

Lilliefor Test Values for EV

ROUNDS FIRED = 4000.

EXTREME VERTICAL EV

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.55000	0.06060	0.06060	0.02273
-1.01300	0.15550	0.07216	0.01116
-0.76000	0.22360	0.05693	0.02640
-0.71000	0.23890	-0.01110	0.09443
-0.68000	0.24830	-0.08503	0.16836
-0.35300	0.36310	-0.05356	0.13690
0.03000	0.51200	0.01199	0.07133
0.33000	0.62930	0.04596	0.03736
0.93200	0.82430	0.15763	-0.07429
0.97600	0.83600	0.08599	-0.00266
1.24700	0.89380	0.06046	0.02286
1.55000	0.93940	0.02273	0.06060

TABLE A-7 (Continued)

Lilliefor Test Values for EV

ROUNDS FIRED = 5000.

EXTREME VERTICAL EV

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.54900	0.06070	0.06070	0.02263
-1.39400	0.08170	-0.00163	0.08496
-0.92200	0.17830	0.01163	0.07170
-0.71100	0.23860	-0.01140	0.09473
-0.12800	0.44910	0.11576	-0.03243
-0.04200	0.48320	0.06653	0.01680
0.19900	0.57890	0.07889	0.00443
0.37300	0.64540	0.06206	0.02126
0.59100	0.72270	0.05603	0.02730
0.67400	0.74980	-0.00020	0.08353
1.27900	0.89950	0.06616	0.01716
1.63000	0.94840	0.03173	0.05160

TABLE A-7 (Continued)

Lilliefor Test Values for EV

ROUNDS FIRED = 6000.

EXTREME VERTICAL EV

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.35800	0.08720	0.08720	-0.00386
-1.25400	0.10490	0.02156	0.06176
-0.87800	0.19000	0.02333	0.06000
-0.60800	0.27160	0.02159	0.06173
-0.56500	0.28600	-0.04733	0.13066
-0.28800	0.38670	-0.02996	0.11330
-0.10000	0.46020	-0.03980	0.12313
0.30700	0.62060	0.03726	0.04606
0.82600	0.79560	0.12893	-0.04559
1.09600	0.86340	0.11339	-0.03006
1.23500	0.89160	0.05826	0.02506
1.58800	0.94390	0.02723	0.05610

TABLE A-7 (Continued)

Lilliefor Test Values for EV

ROUNDS FIRED = 7000.

EXTREME VERTICAL EV

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.26000	0.10380	0.10380	-0.02046
-1.06000	0.14460	0.06126	0.02206
-0.92900	0.17650	0.00983	0.07350
-0.76000	0.22360	-0.02640	0.10973
-0.41300	0.33980	0.00646	0.07686
-0.31600	0.37600	-0.04066	0.12400
-0.16400	0.43480	-0.06520	0.14853
0.36000	0.64060	0.05726	0.02606
0.47300	0.68190	0.01523	0.06810
0.72500	0.76580	0.01580	0.06753
1.48700	0.93150	0.09816	-0.01483
1.85800	0.96840	0.05173	0.03160

TABLE A-7 (Continued)

Lilliefor Test Values for EV

ROUNDS FIRED = 8000.

EXTREME VERTICAL EV

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.61200	0.05350	0.05350	0.02983
-1.24900	0.10580	0.02246	0.06086
-1.17400	0.12020	-0.04646	0.12980
-0.64800	0.25850	0.00849	0.07483
-0.38000	0.35200	0.01866	0.06466
0.25500	0.60070	0.18403	-0.10069
0.41900	0.66240	0.16239	-0.07906
0.44200	0.67070	0.08736	-0.00403
0.66900	0.74830	0.08163	0.00170
0.81700	0.79300	0.04299	0.04033
0.83700	0.79870	-0.03463	0.11796
1.62400	0.94780	0.03113	0.05220

TABLE A-7 (Continued)

Lilliefor Test Values for EV

ROUNDS FIRED = 9000.

EXTREME VERTICAL EV

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.17400	0.12050	0.12050	-0.03716
-1.10200	0.13530	0.05196	0.03136
-0.79000	0.21480	0.04813	0.03520
-0.76300	0.22270	-0.02730	0.11063
-0.35400	0.36170	0.02836	0.05496
-0.12700	0.44950	0.03283	0.05050
0.05200	0.52070	0.02069	0.06263
0.08900	0.53550	-0.04783	0.13116
0.27700	0.60910	-0.05756	0.14090
0.46900	0.68050	-0.06950	0.15283
1.04700	0.85240	0.01906	0.06426
2.37600	0.99120	0.07453	0.00880

TABLE A-7 (Continued)

Lilliefor Test Values for EV

ROUNDS FIRED = 10000.

EXTREME VERTICAL EV

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.56900	0.05830	0.05830	0.02503
-1.47200	0.07050	-0.01283	0.09616
-0.77600	0.21890	0.05223	0.03110
-0.54600	0.29260	0.04259	0.04073
-0.23600	0.40670	0.07336	0.00996
-0.05200	0.47930	0.06263	0.02070
0.12500	0.54980	0.04979	0.03353
0.21000	0.58320	-0.00013	0.08346
0.66400	0.74670	0.08003	0.00330
0.92100	0.82150	0.07149	0.01183
0.96000	0.83150	-0.00183	0.08516
1.77100	0.96170	0.04503	0.03830

TABLE A-7 (Continued)

Lilliefor Test Values for EV

ROUNDS FIRED = 11000.

EXTREME VERTICAL EV

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.59200	0.05570	0.05570	0.02763
-1.55800	0.05960	-0.02373	0.10706
-0.48000	0.31560	0.14893	-0.06559
-0.27600	0.39130	0.14129	-0.05796
-0.27100	0.39320	0.05986	0.02346
-0.22600	0.41060	-0.00606	0.08940
0.16900	0.56710	0.06709	0.01623
0.30700	0.62060	0.03726	0.04606
0.43800	0.66930	0.00263	0.08070
0.60100	0.72610	-0.02390	0.10723
0.83200	0.79730	-0.03603	0.11936
2.05700	0.98010	0.06343	0.01990

TABLE A-7 (Continued)

Lilliefor Test Values for EV

ROUNDS FIRED = 12000.

EXTREME VERTICAL EV

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.04800	0.14730	0.14730	-0.06396
-1.03300	0.15080	0.06746	0.01586
-0.63200	0.26370	0.09703	-0.01369
-0.59500	0.27590	0.02589	0.05743
-0.56000	0.28770	-0.04563	0.12896
-0.54000	0.29460	-0.12206	0.20540
-0.51300	0.30400	-0.19600	0.27933
0.18100	0.57180	-0.01153	0.09486
0.30600	0.62020	-0.04646	0.12980
0.97600	0.83550	0.08549	-0.00216
1.46800	0.92890	0.09556	-0.01223
1.99200	0.97680	0.06013	0.02320

TABLE A-8

Lilliefor Test Values for EH

ROUNDS FIRED = 0.

EXTREME HORIZONTAL EH

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-2.23400	0.01310	0.01310	0.07023
-1.21900	0.11140	0.02806	0.05526
-0.82800	0.20390	0.03723	0.04610
-0.12300	0.45100	0.20100	-0.11766
-0.08700	0.46530	0.13196	-0.04863
0.16200	0.56440	0.14773	-0.06439
0.30900	0.62130	0.12129	-0.03796
0.41300	0.66020	0.07686	0.00646
0.60600	0.72770	0.06103	0.02230
0.74000	0.77040	0.02039	0.06293
0.98400	0.83750	0.00416	0.07916
1.27600	0.89900	-0.01766	0.10100

TABLE A-8 (Continued)

Lilliefor Test Values for EH

ROUNDS FIRED = 1000.

EXTREME HORIZONTAL EH

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.73100	0.04170	0.04170	0.04163
-1.23300	0.10880	0.02546	0.05786
-0.71800	0.23640	0.06973	0.01360
-0.62000	0.26760	0.01760	0.06573
-0.27900	0.39010	0.05676	0.02656
0.12700	0.55050	0.13383	-0.05049
0.14300	0.55690	0.05689	0.02643
0.23600	0.59330	0.00996	0.07336
0.37700	0.64690	-0.01976	0.10310
0.66300	0.74800	-0.00200	0.08533
1.17900	0.88080	0.04746	0.03586
1.85100	0.96790	0.05123	0.03210

TABLE A-8 (Continued)

Lilliefor Test Values for EH

ROUNDS FIRED = 2000.

EXTREME HORIZONTAL EH

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.27600	-1.84600	-1.84600	1.92933
-1.27600	0.10100	0.01766	0.06566
-0.71200	0.10100	-0.06566	0.14900
-0.52200	0.23830	-0.01170	0.09503
-0.45800	0.30080	-0.03253	0.11586
-0.28800	0.32350	-0.09316	0.17650
0.00400	0.38670	-0.11330	0.19663
0.06500	0.50160	-0.08173	0.16506
0.40700	0.52590	-0.14076	0.22410
0.68900	0.65760	-0.09240	0.17573
1.26400	0.68750	-0.14583	0.22916
2.10300	0.89700	-0.01966	0.10300

TABLE A-8 (Continued)

Lilliefor Test Values for EH

ROUNDS FIRED = 3000.

EXTREME HORIZONTAL EH

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
0.98220	0.03250	0.03250	0.05083
-0.75800	0.22420	0.14086	-0.05753
-0.61500	0.26920	0.10253	-0.01919
-0.50400	0.30710	0.05710	0.02623
-0.48500	0.31380	-0.01953	0.10286
-0.28100	0.38930	-0.02736	0.11070
-0.15100	0.44000	-0.06000	0.14333
-0.03500	0.48600	-0.09733	0.18066
0.57100	0.71600	0.04933	0.03400
1.12800	0.87030	0.12029	-0.03696
1.46200	0.92820	0.09486	-0.01153
1.51700	0.93530	0.01863	0.06470

TABLE A-8 (Continued)

Lilliefor Test Values for EH

ROUNDS FIRED = 4000.

EXTREME HORIZONTAL EH

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.18800	0.11740	0.11740	-0.03406
-0.90700	0.18220	0.09886	-0.01553
-0.70300	0.24140	0.07473	0.00860
-0.65300	0.25680	0.00679	0.07653
-0.43200	0.33290	-0.00043	0.08376
-0.37300	0.35460	-0.06206	0.14540
0.03300	0.51320	0.01319	0.07013
0.17500	0.56950	-0.01363	0.09716
0.26800	0.60560	-0.06106	0.14440
0.58600	0.72100	-0.02900	0.11233
0.60800	0.72840	-0.10493	0.18826
2.58700	0.99510	0.07843	0.00490

TABLE A-8 (Continued)

Lilliefor Test Values for EH

ROUNDS FIRED = 5000.

EXTREME HORIZONTAL EH

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.53200	0.06280	0.06280	0.02053
-1.07200	0.14420	0.06086	0.02246
-0.96300	0.16780	0.00113	0.08220
-0.36600	0.35720	0.10719	-0.02386
-0.23900	0.40560	0.07226	0.01106
-0.19100	0.42430	0.00763	0.07570
-0.15900	0.43680	-0.06320	0.14653
0.08000	0.53190	-0.05143	0.13476
0.41500	0.66470	-0.00196	0.08530
0.85900	0.80480	0.05479	0.02853
1.15600	0.87620	0.04286	0.04046
2.01500	0.97800	0.06133	0.02200

TABLE A-8 (Continued)

Lilliefor Test Values for EH

ROUNDS FIRED = 6000.

EXTREME HORIZONTAL EH

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.67700	0.04680	0.04680	0.03653
-1.27700	0.10080	0.01746	0.06586
-0.81700	0.20700	0.04033	0.04300
-0.56800	0.28500	0.03499	0.04833
-0.25700	0.39860	0.06526	0.01806
-0.11800	0.45300	0.03633	0.04700
-0.06800	0.47290	-0.02710	0.11043
0.29300	0.61520	0.03186	0.05146
0.82600	0.79560	0.12893	-0.04559
0.92000	0.82120	0.07119	0.01213
1.15300	0.87550	0.04216	0.04116
1.59100	0.94420	0.02753	0.05580

TABLE A-8 (Continued)

Lilliefor Test Values for EH

ROUNDS FIRED = 7000.

EXTREME HORIZONTAL EH

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.13100	0.12900	0.12900	-0.04566
-0.79900	0.21220	0.12886	-0.04553
-0.72100	0.23550	0.06883	0.01450
-0.65200	0.25720	0.00719	0.07613
-0.41600	0.33870	0.00536	0.07796
-0.33200	0.36990	-0.04676	0.13010
-0.27700	0.39080	-0.10920	0.19253
-0.20800	0.41760	-0.16573	0.24906
-0.04000	0.48400	-0.18266	0.26600
0.85500	0.80370	0.05369	0.02963
1.69400	0.95490	0.12156	-0.03823
2.03000	0.97880	0.06213	0.02120

TABLE A-8 (Continued)

Lilliefor Test Values for EH

ROUNDS FIRED = 8000.

EXTREME HORIZONTAL EH

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.09600	0.13660	0.13660	-0.05326
-0.93900	0.17390	0.09056	-0.00723
-0.88500	0.18800	0.02133	0.06200
-0.72600	0.23390	-0.01610	0.09943
-0.70300	0.24110	-0.09223	0.17556
-0.34700	0.36430	-0.05236	0.13570
0.10600	0.54220	0.04219	0.04113
0.26900	0.60600	0.02266	0.06066
0.33400	0.63080	-0.03586	0.11920
0.67700	0.75080	0.00079	0.08253
1.00800	0.84330	0.00996	0.07336
2.30500	0.98940	0.07273	0.01060

TABLE A-8 (Continued)

Lilliefor Test Values for EH

ROUNDS FIRED = 9000.

EXTREME HORIZONTAL EH

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.75500	0.03970	0.03970	0.04363
-1.09800	0.13610	0.05276	0.03056
-1.02700	0.15220	-0.01446	0.09780
-0.74000	0.22960	-0.02040	0.10373
-0.10500	0.45820	0.12486	-0.04153
-0.00500	0.49800	0.08133	0.00200
0.06700	0.52270	0.02269	0.06063
0.26300	0.60370	0.02036	0.06296
0.96100	0.83170	0.16503	-0.08169
0.98000	0.83650	0.08649	-0.00316
0.99100	0.83910	0.00576	0.07756
1.46700	0.92880	0.01213	0.07120

TABLE A-8 (Continued)

Lilliefor Test Values for EH

ROUNDS FIRED = 10000.

EXTREME HORIZONTAL EH

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.49000	0.06810	0.06810	0.01523
-1.09000	0.13790	0.05456	0.02876
-0.87200	0.19160	0.02493	0.05840
-0.72200	0.23520	-0.01480	0.09813
-0.39900	0.34500	0.01166	0.07166
-0.25200	0.40070	-0.01596	0.09930
0.16300	0.56480	0.06479	0.01853
0.29200	0.61490	0.03156	0.05176
0.52300	0.69950	0.03283	0.05050
0.61700	0.73140	-0.01860	0.10193
1.40100	0.91940	0.08606	-0.00273
1.82900	0.96700	0.05033	0.03300

TABLE A-8 (Continued)

Lilliefor Test Values for EH

ROUNDS FIRED = 11000.

EXTREME HORIZONTAL EH

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.36600	0.08590	0.08590	-0.00256
-1.21200	0.11270	0.02936	0.05396
-0.87800	0.19000	0.02333	0.06000
-0.60800	0.27160	0.02159	0.06173
-0.31900	0.37490	0.04156	0.04176
0.11700	0.54660	0.12993	-0.04659
0.12700	0.55050	0.05049	0.03283
0.15500	0.56160	-0.02173	0.10506
0.19300	0.57650	-0.09016	0.17350
0.29500	0.61600	-0.13400	0.21733
1.48700	0.93150	0.09816	-0.01483
2.00700	0.97760	0.06093	0.02240

TABLE A-8 (Continued)

Lilliefor Test Values for EH

ROUNDS FIRED = 12000.

EXTREME HORIZONTAL EH

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.714	0.04320	0.04320	0.04013
-1.176	0.11980	0.03646	0.04686
-0.972	0.16550	-0.00116	0.08450
-0.884	0.18830	-0.06170	0.14503
-0.177	0.42980	0.09646	-0.01313
0.041	0.51640	0.09973	-0.01639
0.402	0.65610	0.15609	-0.07276
0.436	0.66860	0.08526	-0.00193
0.639	0.73830	0.07163	0.01170
0.760	0.77640	0.02639	0.05693
1.114	0.87370	0.04036	0.04296
1.527	0.94810	0.03143	0.05190

TABLE A-9

Lilliefor Test Values for ES

ROUNDS FIRED = 0.

EXTREME SPREAD ES

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-2.09000	0.01830	0.01830	0.06503
-0.84300	0.18970	0.10636	-0.02303
-0.83700	0.20130	0.03463	0.04870
-0.58400	0.27960	0.02959	0.05373
-0.40300	0.34350	0.01016	0.07316
-0.13300	0.44710	0.03043	0.05290
0.48700	0.68680	0.18679	-0.10346
0.50200	0.69220	0.10886	-0.02553
0.62800	0.73500	0.06833	0.01500
0.70800	0.76050	0.01049	0.07283
1.19100	0.88320	0.04986	0.03346
1.37300	0.91520	-0.00146	0.08480

TABLE A-9 (Continued)

Lilliefor Test Values for ES

ROUNDS FIRED = 1000.

EXTREME SPREAD ES

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.59700	0.05510	0.05510	0.02823
-1.47100	0.07070	-0.01263	0.09596
-0.86700	0.19300	0.02633	0.05700
-0.29100	0.38550	0.13549	-0.05216
-0.21400	0.41520	0.08186	0.00146
-0.17500	0.43050	0.01383	0.06950
0.00000	0.50000	0.00000	0.08333
0.28500	0.61220	0.02886	0.05446
0.77800	0.78170	0.11503	-0.03169
0.81600	0.79270	0.04269	0.04063
1.00000	0.84130	0.00796	0.07536
1.73600	0.95870	0.04203	0.04130

TABLE A-9 (Continued)

Lilliefor Test Values for ES

ROUNDS FIRED = 2000.

EXTREME SPREAD ES

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.14100	0.12690	0.12690	-0.04356
-1.01700	0.15460	0.07126	0.01206
-0.70100	0.24170	0.07503	0.00830
-0.64500	0.25950	0.00949	0.07383
-0.64500	0.25950	-0.07383	0.15716
-0.23300	0.40780	-0.00886	0.09220
-0.02600	0.48960	-0.01640	0.09373
-0.01200	0.49520	-0.08813	0.17146
0.22600	0.58940	-0.07726	0.16060
0.77100	0.77970	0.02969	0.05363
1.09300	0.86270	0.02936	0.05396
2.33100	0.99010	0.07343	0.00990

TABLE A-9 (Continued)

Lilliefor Test Values for ES

ROUNDS FIRED = 3000.

EXTREME SPREAD ES

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.22500	0.11020	0.11020	-0.02686
-1.16100	0.12280	0.03946	0.04386
-0.85100	0.19740	0.03073	0.05260
-0.6[illegible]500	0.24990	-0.00010	0.08343
-0.41300	0.33980	0.00646	0.07686
-0.39900	0.34490	-0.07176	0.15510
0.18800	0.57450	0.07449	0.00883
0.26000	0.60260	0.01926	0.06406
0.31500	0.62360	-0.04306	0.12640
0.43400	0.66780	-0.08220	0.16553
1.67200	0.95270	0.11936	-0.03603
1.85600	0.96830	0.05163	0.03170

TABLE A-9 (Continued)

Lilliefor Test Values for ES

ROUNDS FIRED = 4000.

EXTREME SPREAD ES

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.10700	0.13420	0.13420	-0.05086
-0.90600	0.18190	0.09856	-0.01523
-0.89800	0.18460	0.01793	0.06540
-0.80600	0.20960	-0.04040	0.12373
-0.63300	0.26330	-0.07003	0.15336
-0.54900	0.29150	-0.12516	0.20850
-0.13100	0.44790	-0.05210	0.13543
0.54700	0.70780	0.12446	-0.04113
0.69100	0.75520	0.08853	-0.00519
0.79600	0.78690	0.03689	0.04643
0.85000	0.80230	-0.03103	0.11436
2.15100	0.98420	0.06753	0.01580

TABLE A-9 (Continued)

Lilliefor Test Values for ES

ROUNDS FIRED = 5000.

EXTREME SPREAD ES

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.44400	0.07430	0.07430	0.00903
-1.09000	0.13790	0.05456	0.02876
-1.03200	0.15100	-0.01566	0.09900
-0.65600	0.25590	0.00589	0.07743
-0.43900	0.33060	-0.00273	0.08606
-0.16100	0.43600	0.01933	0.06400
0.00000	0.50000	0.00000	0.08333
0.13500	0.55370	-0.02963	0.11296
0.57800	0.71830	0.05163	0.03170
1.25900	0.89600	0.14599	-0.06266
1.38700	0.91750	0.08416	-0.00083
1.46400	0.92840	0.01173	0.07160

TABLE A-9 (Continued)

Lilliefor Test Values for ES

ROUNDS FIRED = 6000.

EXTREME SPREAD ES

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.67700	0.04680	0.04680	0.03653
-1.09500	0.13680	0.05346	0.02986
-0.91700	0.17960	0.01293	0.07040
-0.68400	0.24700	-0.00300	0.08633
-0.14700	0.44160	0.10826	-0.02493
-0.00800	0.49680	0.08013	0.00320
0.02800	0.51120	0.01119	0.07213
0.16900	0.56710	-0.01623	0.09956
0.36600	0.64280	-0.02366	0.10720
1.05800	0.85490	0.10489	-0.02156
1.19000	0.88300	0.04966	0.03366
1.71700	0.95700	0.04033	0.04300

TABLE A-9 (Continued)

Lilliefor Test Values for ES

ROUNDS FIRED = 7000.

EXTREME SPREAD ES

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-0.96100	0.16820	0.16820	-0.08486
-0.95600	0.16950	0.08616	-0.00283
-0.82500	0.20470	0.03803	0.04530
-0.74500	0.22810	-0.02190	0.10523
-0.50200	0.30780	-0.02553	0.10886
-0.25700	0.39860	-0.01806	0.10140
-0.25300	0.40010	-0.09990	0.18323
-0.21600	0.41450	-0.16883	0.25216
0.06900	0.52750	-0.13916	0.22250
1.11500	0.86750	0.11749	-0.03416
1.75100	0.96000	0.12666	-0.04333
1.78200	0.96260	0.04593	0.03740

TABLE A-9 (Continued)

Lilliefor Test Values for ES

ROUNDS FIRED = 8000.

EXTREME SPREAD ES

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.20300	0.11450	0.11450	-0.03116
-1.03900	0.14940	0.06606	0.01726
-1.02400	0.15290	-0.01376	0.09710
-0.94000	0.17360	-0.07640	0.15973
-0.60400	0.27290	-0.06043	0.14376
-0.01300	0.49480	0.07813	0.00520
0.29000	0.61410	0.11409	-0.03076
0.33500	0.63120	0.04786	0.03546
0.48600	0.68650	0.01983	0.06350
0.76700	0.77850	0.02849	0.05483
0.83600	0.79840	-0.03493	0.11826
2.10900	0.98250	0.06583	0.01750

TABLE A-9 (Continued)

Lilliefor Test Values for ES

ROUNDS FIRED = 9000.

EXTREME SPREAD ES

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.51400	0.06500	0.06500	0.01833
-1.48600	0.06860	-0.01473	0.09806
-1.27400	0.10130	-0.06536	0.14870
-0.51300	0.30400	0.05399	0.02933
-0.06800	0.47290	0.13956	-0.05623
-0.02800	0.48880	0.07213	0.01120
0.37600	0.64650	0.14650	-0.06316
0.53300	0.70290	0.11956	-0.03623
0.59100	0.72270	0.05603	0.02730
1.07400	0.85860	0.10859	-0.02526
1.11400	0.86730	0.03396	0.04936
1.19400	0.88380	-0.03286	0.11620

TABLE A-9 (Continued)

Lilliefor Test Values for ES

ROUNDS FIRED = 10000.

EXTREME SPREAD ES

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.34100	0.08990	0.08990	-0.00656
-1.16600	0.12180	0.03846	0.04486
-0.73300	0.23180	0.06513	0.01820
-0.67900	0.24960	-0.00040	0.08373
-0.41600	0.33870	0.00536	0.07796
-0.06300	0.47490	0.05823	0.02510
0.02300	0.50920	0.00919	0.07413
0.11200	0.54460	-0.03873	0.12206
0.27100	0.60680	-0.05986	0.14320
0.52600	0.70390	-0.04610	0.12943
1.36100	0.91330	0.07996	0.00336
2.10700	0.98240	0.06573	0.01760

TABLE A-9 (Continued)

Lilliefor Test Values for ES

ROUNDS FIRED = 11000.

EXTREME SPREAD ES

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.62000	0.05260	0.05260	0.03073
-1.42900	0.07650	-0.00683	0.09016
-0.93600	0.17460	0.00793	0.07540
-0.48600	0.31350	0.06350	0.01983
-0.02900	0.48840	0.15506	-0.07173
0.05000	0.51990	0.10323	-0.01989
0.06400	0.52550	0.02549	0.05783
0.39900	0.65500	0.07166	0.01166
0.41200	0.65980	-0.00686	0.09020
0.55000	0.70880	-0.04120	0.12453
1.47700	0.93020	0.09686	-0.01353
1.54700	0.93900	0.02233	0.06100

TABLE A-9 (Continued)

Lilliefor Test Values for ES

ROUNDS FIRED = 12000.

EXTREME SPREAD ES

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.35700	0.08740	0.08740	-0.00406
-1.25600	0.10450	0.02116	0.06216
-0.89600	0.18510	0.01843	0.06490
-0.84300	0.19970	-0.05030	0.13363
-0.48400	0.31420	-0.01913	0.10246
-0.23200	0.40820	-0.00846	0.09180
0.08300	0.53310	0.03309	0.05023
0.22100	0.58750	0.00416	0.07916
1.02000	0.84610	0.17943	-0.09609
1.23700	0.89200	0.14199	-0.05866
1.25300	0.89490	0.06156	0.02176
1.25400	0.89510	-0.02156	0.10490

TABLE A-10

Lilliefor Test Values for MR

ROUNDS FIRED = 0.

MEAN RADIUS MR

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-2.07100	0.01920	0.01920	0.06413
-1.16100	0.12280	0.03946	0.04386
-0.56800	0.28500	0.11833	-0.03499
-0.50300	0.30750	0.05749	0.02583
-0.40500	0.34280	0.00946	0.07386
-0.08800	0.46490	0.04823	0.03510
0.27200	0.60720	0.10719	-0.02386
0.55400	0.71020	0.12686	-0.04353
0.76600	0.77820	0.11153	-0.02819
0.83100	0.79130	0.04129	0.04203
0.93000	0.82380	-0.00953	0.09286
1.44400	0.92570	0.00903	0.07430

TABLE A-10 (Continued)

Lilliefor Test Values for MR

ROUNDS FIRED = 1000.

MEAN RADIUS MR

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.41900	0.07800	0.07800	0.00533
-1.08900	0.13810	0.05476	0.02856
-0.96800	0.16650	-0.00016	0.08350
-0.81500	0.20750	-0.04250	0.12583
-0.18700	0.42590	0.09256	-0.00923
-0.18700	0.42590	0.00923	0.07410
0.21300	0.58440	0.08439	-0.00106
0.41500	0.66100	0.07766	0.00566
0.53300	0.70290	0.03623	0.04710
0.62800	0.73500	-0.01500	0.09833
0.69900	0.73770	-0.09563	0.17896
2.17600	0.98520	0.06853	0.01480

TABLE A-10 (Continued)

Lilliefor Test Values for MR

ROUNDS FIRED = 2000.

MEAN RADIUS MR

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.30600	0.09580	0.09580	-0.01246
-1.19200	0.13750	0.05416	0.02916
-0.99800	0.15920	-0.00746	0.09080
-0.96300	0.16780	-0.08220	0.16553
-0.73500	0.23120	-0.10213	0.18546
-0.04800	0.48090	0.06423	0.01910
0.40800	0.65840	0.15839	-0.07506
0.56900	0.71540	0.13206	-0.04873
0.68300	0.75270	0.08603	-0.00269
0.86600	0.80670	0.05669	0.02663
1.35800	0.91280	0.07946	0.00386
1.35800	0.91280	-0.00386	0.08720

TABLE A-10 (Continued)

Lilliefor Test Values for MR

ROUNDS FIRED = 3000.

MEAN RADIUS MR

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.48900	0.06820	0.06820	0.01513
-0.98300	0.16280	0.07946	0.00386
-0.77500	0.21910	0.05243	0.03090
-0.59900	0.27460	0.02459	0.05873
-0.49100	0.31170	-0.02163	0.10496
-0.18400	0.42700	0.01033	0.07300
-0.13800	0.44510	-0.05490	0.13823
-0.10800	0.45700	-0.12633	0.20966
0.39800	0.65470	-0.01196	0.09530
1.39600	0.91860	0.16859	-0.08526
1.45000	0.92650	0.09316	-0.00983
1.52700	0.93660	0.01993	0.06340

TABLE A-10 (Continued)

Lilliefor Test Values for MR

ROUNDS FIRED = 4000.

MEAN RADIUS MR

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.18200	0.11860	0.11860	-0.03526
-1.04200	0.14880	0.06546	0.01786
-1.04200	0.14880	-0.01786	0.10120
-0.59000	0.27760	0.02759	0.05573
-0.53500	0.29640	-0.03693	0.12026
-0.43400	0.33220	-0.08446	0.16780
-0.18100	0.42820	-0.07180	0.15513
0.29500	0.61600	0.03266	0.05066
0.66300	0.74640	0.07973	0.00360
0.77300	0.78040	0.03039	0.05293
1.44800	0.92620	0.09286	-0.00953
1.82800	0.96620	0.04953	0.03380

TABLE A-10 (Continued)

Lilliefor Test Values for MR

ROUNDS FIRED = 5000.

MEAN RADIUS MR

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.32400	0.09280	0.09280	-0.00946
-1.15300	0.12440	0.04106	0.04226
-1.09400	0.13640	-0.03026	0.11360
-0.62300	0.26660	0.01659	0.06673
-0.30400	0.38060	0.04726	0.03606
-0.29300	0.38480	-0.03186	0.11520
-0.24500	0.40320	-0.09680	0.18013
0.24500	0.59680	0.01346	0.06956
0.80500	0.78960	0.12293	-0.03960
1.10400	0.86520	0.11519	-0.03186
1.42400	0.92280	0.08946	-0.00613
1.45800	0.92760	0.01093	0.07240

TABLE A-10 (Continued)

Lilliefor Test Values for MR

ROUNDS FIRED = 6000.

MEAN RADIUS MR

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.62300	0.05230	0.05230	0.03103
-1.43300	0.07600	-0.00733	0.09066
-0.91200	0.18090	0.01423	0.06910
-0.61100	0.27060	0.02059	0.06273
-0.06700	0.47330	0.13996	-0.05663
0.05400	0.52150	0.10483	-0.02149
0.14500	0.55770	0.05769	0.02563
0.37200	0.64500	0.06166	0.02166
0.40600	0.65760	-0.00906	0.09240
0.93300	0.82460	0.07459	0.00873
1.09200	0.86250	0.02916	0.05416
1.64400	0.94990	0.03323	0.05010

TABLE A-10 (Continued)

Lilliefor Test Values for MR

ROUNDS FIRED = 7000.

MEAN RADIUS MR

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-0.98300	0.16280	0.16280	-0.07946
-0.81600	0.20730	0.12396	-0.04063
-0.70000	0.24200	0.07533	0.00800
-0.69400	0.24390	-0.00610	0.08943
-0.47300	0.31810	-0.01523	0.09856
-0.36500	0.35750	-0.05916	0.14250
-0.31200	0.37750	-0.12250	0.20583
-0.26800	0.39440	-0.18893	0.27226
0.30100	0.61830	-0.04836	0.13170
0.68100	0.75200	0.00199	0.08133
1.21800	0.88840	0.05506	0.02826
2.41300	0.99200	0.07533	0.00800

TABLE A-10 (Continued)

Lilliefor Test Values for MR

ROUNDS FIRED = 8000.

MEAN RADIUS MR

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.04900	0.14710	0.14710	-0.06376
-0.96100	0.16830	0.08496	-0.00163
-0.85400	0.19660	0.02993	0.05340
-0.78100	0.21740	-0.03260	0.11593
-0.72300	0.23490	-0.09843	0.18176
-0.22600	0.41050	-0.00616	0.08950
-0.04600	0.48160	-0.01840	0.10173
0.24700	0.59750	0.01416	0.06916
0.60600	0.72770	0.06103	0.02230
0.70400	0.75920	0.00919	0.07413
0.71400	0.76230	-0.07103	0.15436
2.37000	0.99110	0.07443	0.00890

TABLE A-10 (Continued)

Lilliefor Test Values for MR

ROUNDS FIRED = 9000.

MEAN RADIUS MR

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.65600	0.04890	0.04890	0.03443
-1.10500	0.13460	0.05126	0.03206
-0.97100	0.16580	-0.00086	0.08420
-0.90600	0.18250	-0.06750	0.15083
-0.14300	0.44310	0.10976	-0.02643
0.02000	0.50800	0.09133	-0.00799
0.06900	0.52750	0.02749	0.05583
0.14100	0.55610	-0.02723	0.11056
1.00800	0.84330	0.17663	-0.09330
1.07900	0.85970	0.10969	-0.02636
1.17100	0.87920	0.04586	0.03746
1.29100	0.90170	-0.01496	0.09830

TABLE A-10 (Continued)

Lilliefor Test Values for MR

ROUNDS FIRED = 10000.

MEAN RADIUS MR

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.27200	0.10170	0.10170	-0.01836
-1.21200	0.11270	0.02936	0.05396
-1.01400	0.15530	-0.01136	0.09470
-0.50500	0.30680	0.05679	0.02653
-0.27300	0.39240	0.05906	0.02426
-0.20200	0.41990	0.00323	0.08010
0.03400	0.51360	0.01359	0.06973
0.07400	0.52950	-0.05383	0.13716
0.33200	0.63010	-0.03656	0.11990
0.78100	0.78260	0.03259	0.05073
1.14400	0.87360	0.04026	0.04306
2.11400	0.98280	0.06613	0.01720

TABLE A-10 (Continued)

Lilliefor Test Values for MR

ROUNDS FIRED = 11000.

MEAN RADIUS MR

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.57800	0.05740	0.05740	0.02593
-1.53700	0.06220	-0.02113	0.10446
-0.69400	0.24390	0.07723	0.00610
-0.56400	0.28640	0.03639	0.04693
-0.13800	0.44510	0.11176	-0.02843
-0.00800	0.49680	0.08013	0.00320
0.11400	0.54540	0.04539	0.03793
0.31700	0.62440	0.04106	0.04226
0.54700	0.70780	0.04113	0.04220
0.57100	0.71600	-0.03400	0.11733
1.19400	0.88380	0.05046	0.03286
1.77600	0.96210	0.04543	0.03790

TABLE A-10 (Continued)

Lilliefor Test Values for MR

ROUNDS FIRED = 12000.

MEAN RADIUS MR

Z VALUES	NORMAL VALUES	NORMAL-(I-1)/N	I/N-NORMAL
-1.51200	0.06550	0.06550	0.01783
-1.27500	0.10120	0.01786	0.06546
-0.95700	0.16930	0.00263	0.08070
-0.81600	0.20670	-0.04330	0.12663
-0.20100	0.42070	0.08736	-0.00403
-0.18400	0.42700	0.01033	0.07300
-0.09600	0.46180	-0.03820	0.12153
0.63300	0.73070	0.14736	-0.06403
0.85900	0.80500	0.13833	-0.05499
0.98600	0.83790	0.06789	-0.00456
1.21300	0.88750	0.05416	0.02916
1.35300	0.91200	-0.00466	0.08800

TABLE A-11

Tolerance Values for EV

EXTREME VERTICAL EV

ROUNDS FIRED 0.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.4665	6.1205
0.95	0.10	1.6262	4.9609
0.95	0.25	2.2629	4.3241
0.90	0.01	0.7502	5.8368
0.90	0.10	1.8103	4.7768
0.90	0.25	2.3972	4.1898
0.75	0.01	1.1426	5.4445
0.75	0.10	2.0683	4.5188
0.75	0.25	2.5896	3.9974

TABLE A-11 (Continued)

Tolerance Values for EV

EXTREME VERTICAL EV

ROUNDS FIRED 1000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	1.3431	5.0796
0.95	0.10	2.1095	4.3133
0.95	0.25	2.5303	3.8924
0.90	0.01	1.5306	4.8921
0.90	0.10	2.2311	4.1916
0.90	0.25	2.6190	3.8037
0.75	0.01	1.7899	4.6329
0.75	0.10	2.4016	4.0211
0.75	0.25	2.7462	3.6766

TABLE A-11 (Continued)

Toleramoe Values for EV

EXTREME VERTICAL EV

ROUNDS FIRED 2000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	1.0065	5.2727
0.95	0.10	1.[illegible]815	4.3977
0.95	0.25	2.3620	3.9173
0.90	0.01	1.2205	5.0587
0.90	0.10	2.0204	4.2588
0.90	0.25	2.4633	3.8159
0.75	0.01	1.5166	4.7627
0.75	0.10	2.2151	4.0641
0.75	0.25	2.6085	3.6708

TABLE A-11 (Continued)

Tolerance Values for EV

EXTREME VERTICAL EV

ROUNDS FIRED 3000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.4498	5.9921
0.95	0.10	1.5865	4.8554
0.95	0.25	2.2107	4.2312
0.90	0.01	0.7278	5.7140
0.90	0.10	1.7669	4.6749
0.90	0.25	2.3423	4.0996
0.75	0.01	1.1124	5.3295
0.75	0.10	2.0199	4.4220
0.75	0.25	2.5309	3.9110

TABLE A-11 (Continued)

Tolerance Values for EV

EXTREME VERTICAL EV

ROUNDS FIRED 4000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	1.2596	6.6621
0.95	0.10	2.3677	5.5541
0.95	0.25	2.9761	4.9456
0.90	0.01	1.5307	6.3910
0.90	0.10	2.5436	5.3782
0.90	0.25	3.1044	4.8173
0.75	0.01	1.9056	6.0162
0.75	0.10	2.7901	5.1316
0.75	0.25	3.2883	4.6335

TABLE A-11 (Continued)

Tolerance Values for EV

EXTREME VERTICAL EV

ROUNDS FIRED 5000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.5461	7.1611
0.95	0.10	1.9028	5.8044
0.95	0.25	2.6478	5.0594
0.90	0.01	0.8780	6.8292
0.90	0.10	2.1182	5.5890
0.90	0.25	2.8050	4.9023
0.75	0.01	1.3370	6.3702
0.75	0.10	2.4201	5.2871
0.75	0.25	3.0300	4.6772

TABLE A-11 (Continued)

Tolerance Values for EV

EXTREME VERTICAL EV

ROUNDS FIRED 6000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	1.4833	7.9765
0.95	0.10	2.8150	6.6447
0.95	0.25	3.5463	5.9134
0.90	0.01	1.8090	7.6507
0.90	0.10	3.0264	6.4333
0.90	0.25	3.7005	5.7592
0.75	0.01	2.2596	7.2001
0.75	0.10	3.3227	6.1370
0.75	0.25	3.9215	5.5383

TABLE A-11 (Continued)

Tolerance Values for EV

EXTREME VERTICAL EV

ROUNDS FIRED 7000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	-0.1452	8.6994
0.95	0.10	1.6687	6.8853
0.95	0.25	2.6648	5.8892
0.90	0.01	0.2985	8.2556
0.90	0.10	1.9567	6.5974
0.90	0.25	2.8749	5.6791
0.75	0.01	0.9122	7.6419
0.75	0.10	2.3603	6.1937
0.75	0.25	3.1759	5.3782

TABLE A-11 (Continued)

Tolerance Values for EV

EXTREME VERTICAL EV

ROUNDS FIRED 8000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	-0.0791	10.9081
0.95	0.10	2.1743	8.6546
0.95	0.25	3.4117	7.4172
0.90	0.01	0.4721	10.3568
0.90	0.10	2.5320	8.2969
0.90	0.25	3.6727	7.1562
0.75	0.01	1.2345	9.5944
0.75	0.10	3.0334	7.7955
0.75	0.25	4.0465	6.7824

TABLE A-11 (Continued)

Tolerance Values for EV

EXTREME VERTICAL EV

ROUNDS FIRED 9000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	1.5933	10.7098
0.95	0.10	3.4630	8.8400
0.95	0.25	4.4898	7.8133
0.90	0.01	2.0507	10.2524
0.90	0.10	3.7599	8.5432
0.90	0.25	4.7063	7.5967
0.75	0.01	2.6833	9.6198
0.75	0.10	4.1759	8.1271
0.75	0.25	5.0165	7.2865

TABLE A-11 (Continued)

Tolerance Values for EV

EXTREME VERTICAL EV

ROUNDS FIRED 10000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	1.7906	12.0200
0.95	0.10	3.8886	9.9220
0.95	0.25	5.0407	8.7699
0.90	0.01	2.3038	11.5067
0.90	0.10	4.2217	9.5889
0.90	0.25	5.2836	8.5269
0.75	0.01	3.0136	10.7969
0.75	0.10	4.6885	9.1221
0.75	0.25	5.6317	8.1788

TABLE A-11 (Continued)

Tolerance Values for EV

EXTREME VERTICAL EV

ROUNDS FIRED 11000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.1496	15.6033
0.95	0.10	3.3191	12.4338
0.95	0.25	5.0596	10.6933
0.90	0.01	0.9249	14.8279
0.90	0.10	3.8223	11.9306
0.90	0.25	5.4266	10.3263
0.75	0.01	1.9973	13.7556
0.75	0.10	4.5275	11.2254
0.75	0.25	5.9525	9.8004

TABLE A-11 (Continued)

Tolerance Values for EV

EXTREME VERTICAL EV

ROUNDS FIRED 12000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	-3.3270	19.1013
0.95	0.10	1.2729	14.5013
0.95	0.25	3.7989	11.9753
0.90	0.01	-2.2017	17.9760
0.90	0.10	2.0032	13.7711
0.90	0.25	4.3316	11.4426
0.75	0.01	-0.6454	16.4197
0.75	0.10	3.0267	12.7475
0.75	0.25	5.0948	10.6794

TABLE A-12

Tolerance Values for EH

EXTREME HORIZONTAL EH

ROUNDS FIRED 0.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.8719	4.9755
0.95	0.10	1.7135	4.1339
0.95	0.25	2.1757	3.6717
0.90	0.01	1.0778	4.7696
0.90	0.10	1.8471	4.0003
0.90	0.25	2.2732	3.5742
0.75	0.01	1.3625	4.4849
0.75	0.10	2.0344	3.8130
0.75	0.25	2.4128	3.4346

TABLE A-12 (Continued)

Tolerance Values for EH

EXTREME HORIZONTAL EH

ROUNDS FIRED 1000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.5736	5.1818
0.95	0.10	1.5187	4.2367
0.95	0.25	2.0377	3.7177
0.90	0.01	0.8048	4.9506
0.90	0.10	1.6688	4.0866
0.90	0.25	2.1472	3.6082
0.75	0.01	1.1245	4.6309
0.75	0.10	1.8791	3.8763
0.75	0.25	2.3040	3.4514

TABLE A-12 (Continued)

Tolerance Values for EH

EXTREME HORIZONTAL EH

ROUNDS FIRED 2000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	1.6540	4.1288
0.95	0.10	2.1615	3.6212
0.95	0.25	2.4403	3.3425
0.90	0.01	1.7781	4.0046
0.90	0.10	2.2421	3.5406
0.90	0.25	2.4990	3.2837
0.75	0.01	1.9499	3.8329
0.75	0.10	2.3551	3.4277
0.75	0.25	2.5833	3.1995

TABLE A-12 (Continued)

Tolerance Values for EH

EXTREME HORIZONTAL EH

ROUNDS FIRED 3000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.9555	4.9943
0.95	0.10	1.7838	4.1659
0.95	0.25	2.2387	3.7111
0.90	0.01	1.1581	4.7916
0.90	0.10	1.9153	4.0344
0.90	0.25	2.3346	3.6151
0.75	0.01	1.4384	4.5114
0.75	0.10	2.0996	3.8501
0.75	0.25	2.4720	3.4777

TABLE A-12 (Continued)

Tolerance Values for EH

EXTREME HORIZONTAL EH

ROUNDS FIREL 4000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.4727	5.9895
0.95	0.10	1.6042	4.8580
0.95	0.25	2.2255	4.2367
0.90	0.01	0.7495	5.7127
0.90	0.10	1.7838	4.6784
0.90	0.25	2.3566	4.1057
0.75	0.01	1.1323	5.3299
0.75	0.10	2.0356	4.4266
0.75	0.25	2.5443	3.9179

TABLE A-12 (Continued)

Tolerance Values for EH

EXTREME HORIZONTAL EH

ROUNDS FIRED 5000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.0575	7.8805
0.95	0.10	1.6620	6.2760
0.95	0.25	2.5431	5.3950
0.90	0.01	0.4501	7.4880
0.90	0.10	1.9167	6.0213
0.90	0.25	2.7289	5.2092
0.75	0.01	0.9929	6.9452
0.75	0.10	2.2737	5.6643
0.75	0.25	2.9951	4.9430

TABLE A-12 (Continued)

Tolerance Values for EH

EXTREME HORIZONTAL EH

ROUNDS FIRED 6000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.4617	8.3949
0.95	0.10	2.0888	6.7678
0.95	0.25	2.9822	5.8743
0.90	0.01	0.8597	7.9968
0.90	0.10	2.3471	6.5095
0.90	0.25	3.1707	5.6859
0.75	0.01	1.4102	7.4464
0.75	0.10	2.7091	6.1475
0.75	0.25	3.4406	5.4160

TABLE A-12 (Continued)

Tolerance Values for EH

EXTREME HORIZONTAL EH

ROUNDS FIRED 7000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	-1.6935	11.3930
0.95	0.10	0.9904	8.7090
0.95	0.25	2.4643	7.2351
0.90	0.01	-1.0369	10.7364
0.90	0.10	1.4165	8.2829
0.90	0.25	2.7751	6.9243
0.75	0.01	-0.1288	9.8283
0.75	0.10	2.0136	7.6856
0.75	0.25	3.2204	6.4790

TABLE A-12 (Continued)

Tolerance Values for EH

EXTREME HORIZONTAL EH

ROUNDS FIRED 8000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	-1.9055	12.3909
0.95	0.10	1.0265	9.4587
0.95	0.25	2.6367	7.8486
0.90	0.01	-1.1882	11.6736
0.90	0.10	1.4920	8.9932
0.90	0.25	2.9762	7.5090
0.75	0.01	-0.1962	10.6815
0.75	0.10	2.1445	8.3408
0.75	0.25	3.4627	7.0225

TABLE A-12 (Continued)

Tolerance Values for EH

EXTREME HORIZONTAL EH

ROUNDS FIRED 9000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	-1.5068	13.2411
0.95	0.10	1.5179	10.2163
0.95	0.25	3.1789	8.5554
0.90	0.01	-0.7668	12.5011
0.90	0.10	1.9981	9.7361
0.90	0.25	3.5292	8.2051
0.75	0.01	0.2564	11.4778
0.75	0.10	2.6711	9.0631
0.75	0.25	4.0310	7.7032

TABLE A-12 (Continued)

Tolerance Values for EH

EXTREME HORIZONTAL EH

ROUNDS FIRED 10000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	2.6721	12.2944
0.95	0.10	4.6456	10.3209
0.95	0.25	5.7293	9.2372
0.90	0.01	3.1549	11.8116
0.90	0.10	4.9589	10.0076
0.90	0.25	5.9579	9.0087
0.75	0.01	3.8226	11.1440
0.75	0.10	5.3981	9.5685
0.75	0.25	6.2853	8.6813

TABLE A-12 (Continued)

Tolerance Values for EH

EXTREME HORIZONTAL EH

ROUNDS FIRED 11000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	-4.4086	20.1054
0.95	0.10	0.6191	15.0776
0.95	0.25	3.3800	12.3168
0.90	0.01	-3.1786	18.8754
0.90	0.10	1.4173	14.2795
0.90	0.25	3.9622	11.7345
0.75	0.01	-1.4776	17.1744
0.75	0.10	2.5360	13.1607
0.75	0.25	4.7964	10.9004

TABLE A-12 (Continued)

Tolerance Values for EH

EXTREME HORIZONTAL EH

ROUNDS FIRED 12000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	-2.4253	18.6177
0.95	0.10	1.8904	14.3018
0.95	0.25	4.2604	11.9318
0.90	0.01	-1.3695	17.5619
0.90	0.10	2.5756	13.6166
0.90	0.25	4.7602	11.4320
0.75	0.01	0.0905	16.1017
0.75	0.10	3.5359	12.6563
0.75	0.25	5.4763	10.7160

TABLE A-13

Tolerance Values for ES

EXTREME SPREAD ES

ROUNDS FIRED 0.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	1.4068	6.3673
0.95	0.10	2.4242	5.3499
0.95	0.25	2.9828	4.7912
0.90	0.01	1.6557	6.1184
0.90	0.10	2.5857	5.1884
0.90	0.25	3.1007	4.6734
0.75	0.01	1.9999	5.7742
0.75	0.10	2.8121	4.9620
0.75	0.25	3.2694	4.5046

TABLE A-13 (Continued)

Tolerance Values for ES

EXTREME SPREAD ES

ROUNDS FIRED 1000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	1.2149	6.3782
0.95	0.10	2.2739	5.3192
0.95	0.25	2.8554	4.7377
0.90	0.01	1.4739	6.1191
0.90	0.10	2.4420	5.1511
0.90	0.25	2.9780	4.6150
0.75	0.01	1.8322	5.7608
0.75	0.10	2.6776	4.9154
0.75	0.25	3.1537	4.4394

TABLE A-13 (Continued)

Tolerance Values for ES

EXTREME SPREAD ES

ROUNDS FIRED 2000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	1.9201	5.5518
0.95	0.10	2.6650	4.8069
0.95	0.25	3.0740	4.3979
0.90	0.01	2.1023	5.3695
0.90	0.10	2.7832	4.6887
0.90	0.25	3.1602	4.3117
0.75	0.01	2.3543	5.1176
0.75	0.10	2.9490	4.5229
0.75	0.25	3.2838	4.1881

Table A-13 (Continued)

Tolerance Values for ES

EXTREME SPREAD ES

ROUNDS FIRED 3000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	2.3204	5.4668
0.95	0.10	2.9657	4.8215
0.95	0.25	3.3201	4.4671
0.90	0.01	2.4783	5.3089
0.90	0.10	3.0682	4.7190
0.90	0.25	3.3948	4.3924
0.75	0.01	2.6966	5.0906
0.75	0.10	3.2118	4.5755
0.75	0.25	3.5019	4.2853

TABLE A-13 (Continued)

Tolerance Values for ES

EXTREME SPREAD ES

ROUNDS FIRED 4000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.8871	8.3138
0.95	0.10	2.4103	6.7906
0.95	0.25	3.2467	5.9542
0.90	0.01	1.2598	7.9411
0.90	0.10	2.6521	6.5488
0.90	0.25	3.4231	5.7778
0.75	0.01	1.7751	7.4258
0.75	0.10	2.9911	6.2098
0.75	0.25	3.6758	5.5251

TABLE A-13 (Continued)

Tolerance Values for ES

EXTREME SPREAD ES

ROUNDS FIRED 5000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.5885	9.5715
0.95	0.10	2.4309	7.7291
0.95	0.25	3.4426	6.7174
0.90	0.01	1.0392	9.1208
0.90	0.10	2.7234	7.4367
0.90	0.25	3.6560	6.5041
0.75	0.01	1.6626	8.4975
0.75	0.10	3.1334	7.0267
0.75	0.25	3.9616	6.1984

TABLE A-13 (Continued)

Tolerance Values for ES

EXTREME SPREAD ES

ROUNDS FIRED 6000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	2.1642	9.5585
0.95	0.10	3.6808	8.0420
0.95	0.25	4.5135	7.2092
0.90	0.01	2.5352	9.1875
0.90	0.10	3.9215	7.8012
0.90	0.25	4.6892	7.0336
0.75	0.01	3.0483	8.6745
0.75	0.10	4.2590	7.4638
0.75	0.25	4.9408	6.7820

TABLE A-13 (Continued)

Tolerance Values for ES

EXTREME SPREAD ES

ROUNDS FIRED 7000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	-0.3964	11.8363
0.95	0.10	2.1124	9.3273
0.95	0.25	3.4901	7.9496
0.90	0.01	0.2172	11.2225
0.90	0.10	2.5107	8.9291
0.90	0.25	3.7806	7.6591
0.75	0.01	1.0661	10.3737
0.75	0.10	3.0689	8.3708
0.75	0.25	4.1969	7.2428

TABLE A-13 (Continued)

Tolerance Values for ES

EXTREME SPREAD ES

ROUNDS FIRED 8000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	-1.0375	14.3520
0.95	0.10	2.1188	11.1956
0.95	0.25	3.8520	9.4624
0.90	0.01	-0.2653	13.5798
0.90	0.10	2.6199	10.6945
0.90	0.25	4.2175	9.0969
0.75	0.01	0.8024	12.5120
0.75	0.10	3.3222	9.9922
0.75	0.25	4.7412	8.5732

TABLE A-13 (Continued)

Tolerance Values for ES

EXTREME SPREAD ES

ROUNDS FIRED 9000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	1.5495	13.3314
0.95	0.10	3.9659	10.9149
0.95	0.25	5.2929	9.5880
0.90	0.01	2.1407	12.7402
0.90	0.10	4.3496	10.5313
0.90	0.25	5.5727	9.3082
0.75	0.01	2.9582	11.9227
0.75	0.10	4.8872	9.9937
0.75	0.25	5.9736	8.9073

TABLE A-13 (Continued)

Tolerance Values for ES

EXTREME SPREAD ES

ROUNDS FIRED 10000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	4.0997	13.7904
0.95	0.10	6.0872	11.8029
0.95	0.25	7.1786	10.7114
0.90	0.01	4.5859	13.3042
0.90	0.10	6.4027	11.4873
0.90	0.25	7.4088	10.4813
0.75	0.01	5.2583	12.6317
0.75	0.10	6.8450	11.0451
0.75	0.25	7.7385	10.1515

TABLE A-13 (Continued)

Tolerance Values for ES

EXTREME SPREAD ES

ROUNDS FIRED 11000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	-1.9362	22.1192
0.95	0.10	2.9974	17.1855
0.95	0.25	5.7066	14.4762
0.90	0.01	-0.7292	20.9122
0.90	0.10	3.7807	16.4022
0.90	0.25	6.2780	13.9049
0.75	0.01	0.9399	19.2430
0.75	0.10	4.8785	15.3044
0.75	0.25	7.0966	13.0863

TABLE A-13 (Continued)

Tolerance Values for ES

EXTREME SPREAD ES

ROUNDS FIRED 12000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	-3.0928	23.1670
0.95	0.10	2.2929	17.7812
0.95	0.25	5.2504	14.8237
0.90	0.01	-1.7753	21.8494
0.90	0.10	3.1479	16.9261
0.90	0.25	5.8741	14.1999
0.75	0.01	0.0468	20.0273
0.75	0.10	4.3463	15.7277
0.75	0.25	6.7677	13.3064

TABLE A-14

Tolerance Values for MR

MEAN RADIUS MR

ROUNDS FIRED 0.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.4301	1.9456
0.95	0.10	0.7409	1.6348
0.95	0.25	0.9116	1.4641
0.90	0.01	0.5061	1.8696
0.90	0.10	0.7903	1.5855
0.90	0.25	0.9476	1.4281
0.75	0.01	0.6113	1.7644
0.75	0.10	0.8594	1.5163
0.75	0.25	0.9992	1.3766

TABLE A-14 (Continued)

Tolerance Values for MR

MEAN RADIUS MR

ROUNDS FIRED 1000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.1302	2.2414
0.95	0.10	0.5632	1.8084
0.95	0.25	0.8010	1.5706
0.90	0.01	0.2361	2.1354
0.90	0.10	0.6319	1.7396
0.90	0.25	0.8511	1.5205
0.75	0.01	0.3826	1.9890
0.75	0.10	0.7283	1.6433
0.75	0.25	0.9229	1.4486

TABLE A-14 (Continued)

Tolerance Values for MR

MEAN RADIUS MR

ROUNDS FIRED 2000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.8427	1.4977
0.95	0.10	0.9770	1.3634
0.95	0.25	1.0508	1.2896
0.90	0.01	0.8755	1.4649
0.90	0.10	0.9983	1.3421
0.90	0.25	1.0664	1.2740
0.75	0.01	0.9210	1.4194
0.75	0.10	1.0282	1.3122
0.75	0.25	1.0886	1.2518

TABLE A-14 (Continued)

Tolerance Values for MR

MEAN RADIUS . MR

ROUNDS FIRED 3000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.6959	1.6721
0.95	0.10	0.8962	1.4719
0.95	0.25	1.0061	1.3620
0.90	0.01	0.7449	1.6231
0.90	0.10	0.9279	1.4401
0.90	0.25	1.0293	1.3388
0.75	0.01	0.8127	1.5554
0.75	0.10	0.9725	1.3956
0.75	0.25	1.0625	1.3056

TABLE A-14 (Continued)

Tolerance Values for MR

MEAN RADIUS MR

ROUNDS FIRED 4000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.4556	2.2301
0.95	0.10	0.8195	1.8662
0.95	0.25	1.0194	1.6663
0.90	0.01	0.5446	2.1411
0.90	0.10	0.8773	1.8084
0.90	0.25	1.0616	1.6242
0.75	0.01	0.6678	2.0180
0.75	0.10	0.9583	1.7274
0.75	0.25	1.1219	1.5638

TABLE A-14 (Continued)

Tolerance Values for MR

MEAN RADIUS MR

ROUNDS FIRED 5000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.4212	2.6017
0.95	0.10	0.8684	2.1545
0.95	0.25	1.1140	1.9089
0.90	0.01	0.5306	2.4923
0.90	0.10	0.9394	2.0835
0.90	0.25	1.1658	1.8571
0.75	0.01	0.6819	2.3410
0.75	0.10	1.0389	1.9840
0.75	0.25	1.2400	1.7829

TABLE A-14 (Continued)

Tolerance Values for MR

MEAN RADIUS MR

ROUNDS FIRED 6000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.6120	2.8277
0.95	0.10	1.0665	2.3733
0.95	0.25	1.3160	2.1237
0.90	0.01	0.7232	2.7165
0.90	0.10	1.1386	2.3011
0.90	0.25	1.3686	2.0711
0.75	0.01	0.8769	2.5628
0.75	0.10	1.2397	2.2000
0.75	0.25	1.4440	1.9957

TABLE A-14 (Continued)

Tolerance Values for MR

MEAN RADIUS MR

ROUNDS FIRED 7000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	-0.2261	3.6409
0.95	0.10	0.5670	2.8478
0.95	0.25	1.0025	2.4122
0.90	0.01	-0.0320	3.4469
0.90	0.10	0.6929	2.7219
0.90	0.25	1.0943	2.3204
0.75	0.01	0.2362	3.1785
0.75	0.10	0.8694	2.5454
0.75	0.25	1.2259	2.1888

TABLE A-14 (Continued)

Tolerance Values for MR

MEAN RADIUS MR

ROUNDS FIRED 8000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	-0.4929	4.6347
0.95	0.10	0.5587	3.5831
0.95	0.25	1.1362	3.0056
0.90	0.01	-0.2356	4.3775
0.90	0.10	0.7256	3.4161
0.90	0.25	1.2580	2.8838
0.75	0.01	0.1201	4.0217
0.75	0.10	0.9596	3.1821
0.75	0.25	1.4325	2.7093

TABLE A-14 (Continued)

Tolerance Values for MR

MEAN RADIUS MR

ROUNDS FIRED 9000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.2119	4.3377
0.95	0.10	1.0581	3.4915
0.95	0.25	1.5227	3.0268
0.90	0.01	0.4189	4.1307
0.90	0.10	1.1924	3.3572
0.90	0.25	1.6207	2.9288
0.75	0.01	0.7052	3.8444
0.75	0.10	1.3807	3.1689
0.75	0.25	1.7611	2.7884

TABLE A-14 (Continued)

Tolerance Values for MR

MEAN RADIUS MR

ROUNDS FIRED 10000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	0.8465	4.6301
0.95	0.10	1.6225	3.8541
0.95	0.25	2.0486	3.4280
0.90	0.01	1.0363	4.4403
0.90	0.10	1.7457	3.7309
0.90	0.25	2.1385	3.3381
0.75	0.01	1.2988	4.1777
0.75	0.10	1.9183	3.5582
0.75	0.25	2.2672	3.2093

TABLE A-14 (Continued)

Tolerance Values for MR

MEAN RADIUS MR

ROUNDS FIRED 11000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	-0.6306	6.8671
0.95	0.10	0.9071	5.3293
0.95	0.25	1.7515	4.4849
0.90	0.01	-0.2544	6.4909
0.90	0.10	1.1512	5.0852
0.90	0.25	1.9296	4.3068
0.75	0.01	0.2657	5.9707
0.75	0.10	1.4934	4.7430
0.75	0.25	2.1847	4.0517

TABLE A-14 (Continued)

Tolerance Values for MR

MEAN RADIUS MR

ROUNDS FIRED 12000.

GAMMA	ALPHA	XBAR-KS	XBAR+KS
0.95	0.01	-0.7400	6.9592
0.95	0.10	0.8390	5.3801
0.95	0.25	1.7061	4.5130
0.90	0.01	-0.3537	6.5729
0.90	0.10	1.0897	5.1294
0.90	0.25	1.8890	4.3301
0.75	0.01	0.1804	6.0387
0.75	0.10	1.4410	4.7780
0.75	0.25	2.1510	4.0681

EV VS RDSFIR

PLOT OF EV VS RDSFIR
FOR ALL DATA POINTS

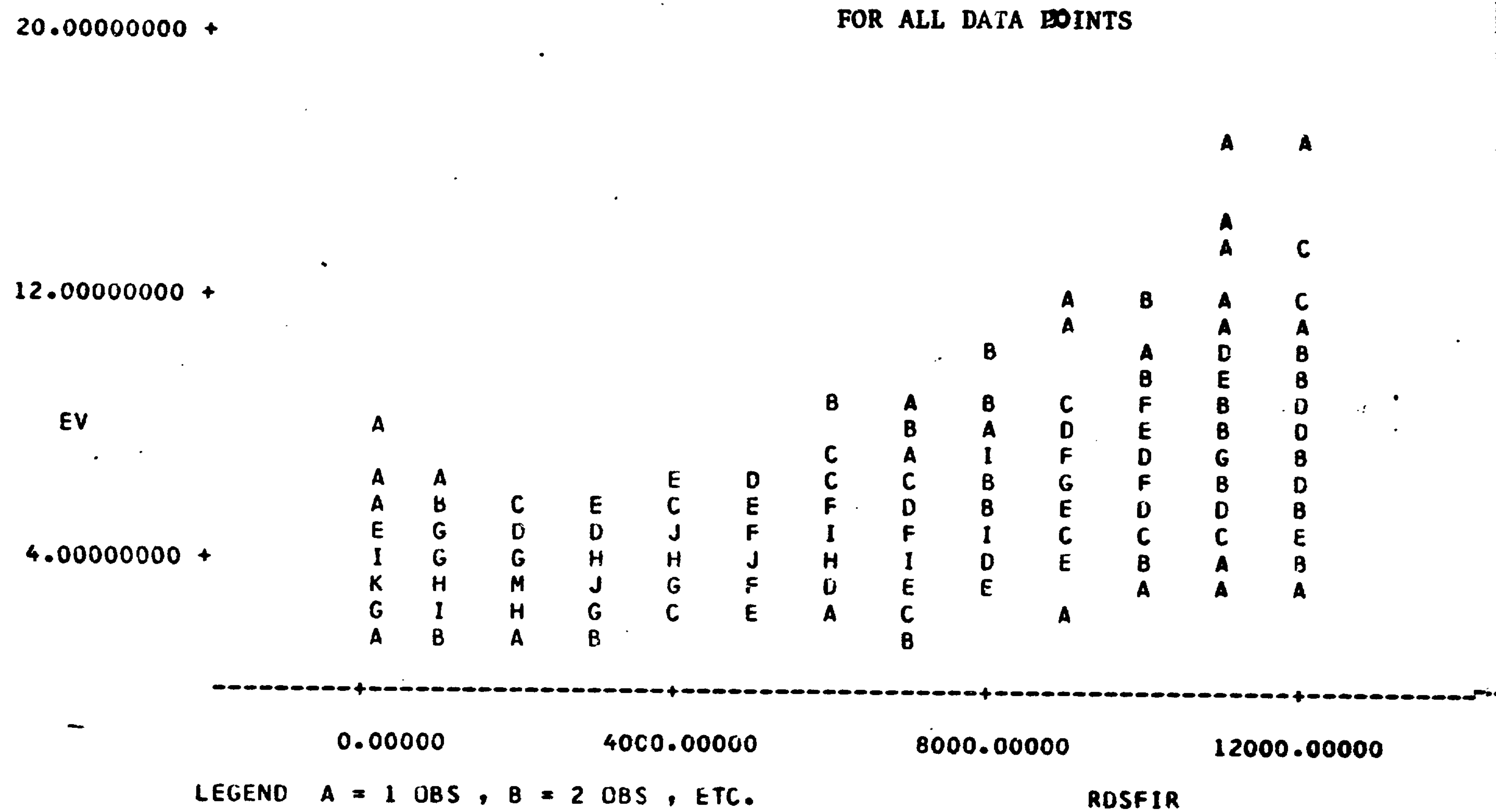


Figure A-1

EH VS RDSFIR

PLOT OF EH VS RDSFIR
FOR ALL DATA POINTS

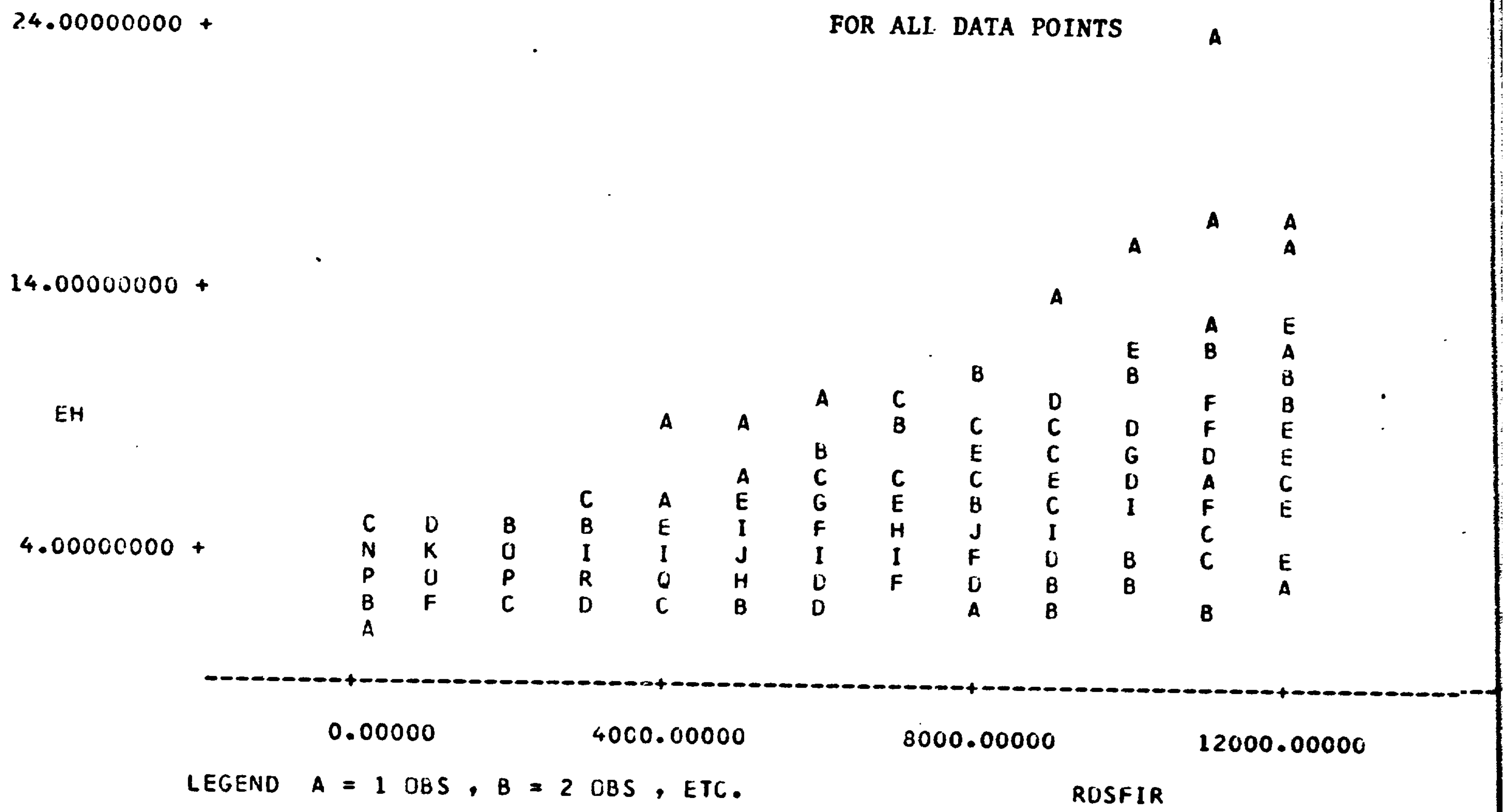
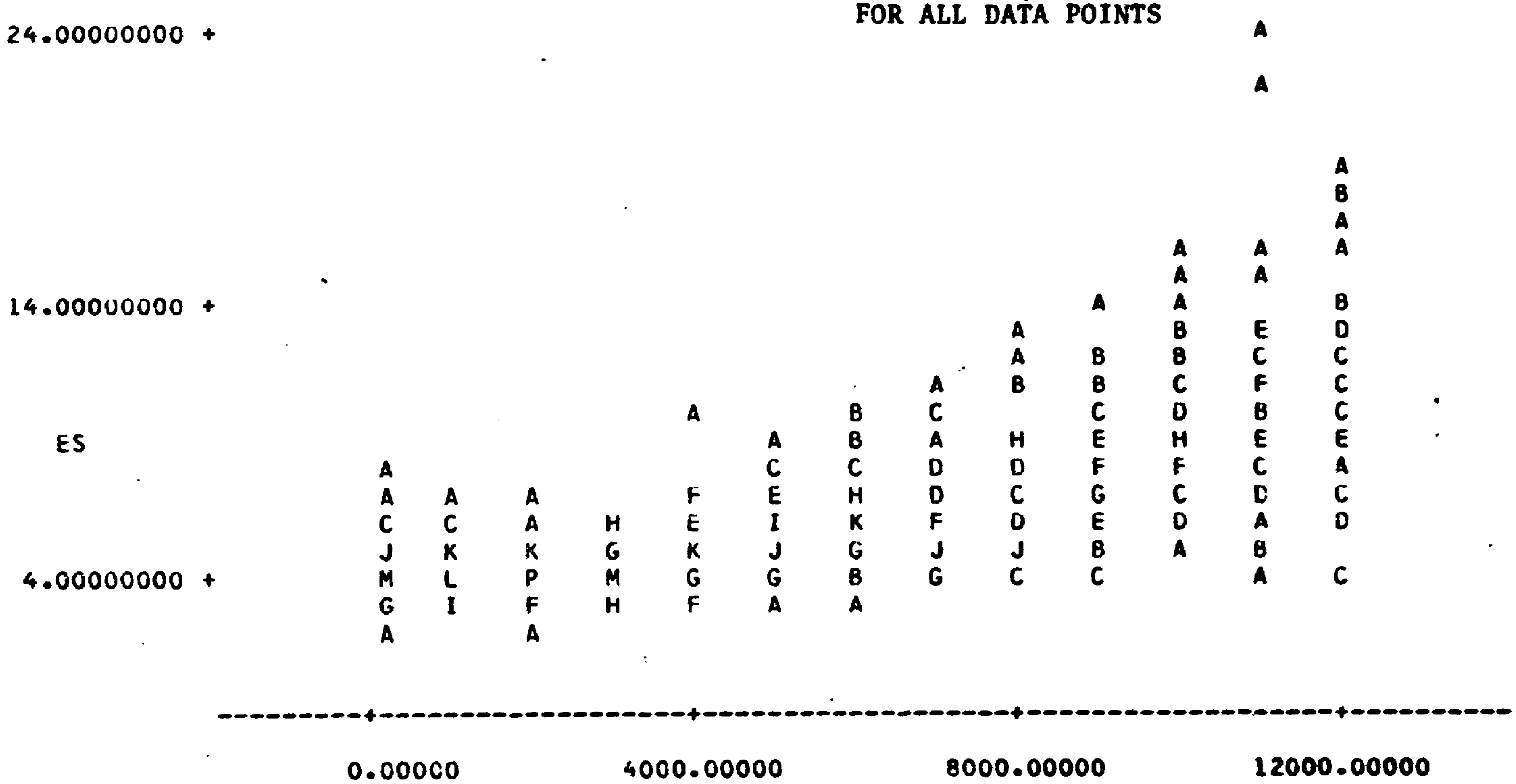


Figure A-2

ES VS RDSFIR

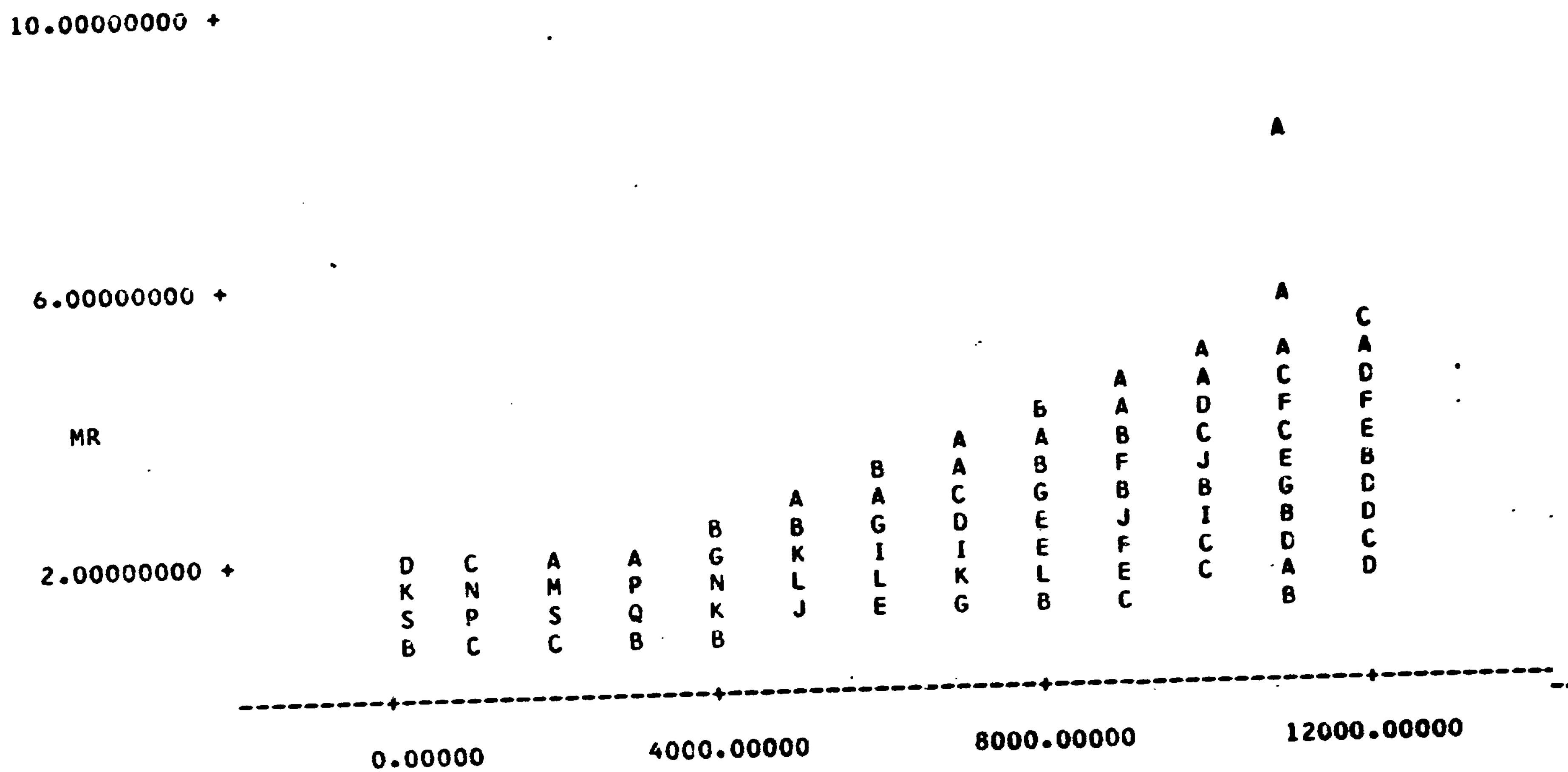
PLOT OF ES VS RDSFIR
FOR ALL DATA POINTS



LEGEND A = 1 OBS , B = 2 OBS , ETC.

Figure A-3

PLOT OF MR VS RDSFIR
FOR ALL DATA POINTS



LEGEND A = 1 OBS , B = 2 OBS , ETC.

Figure A-4

EV VS RDSFIR

PLOT OF EV VS RDSFIR
FOR AVERAGED DATA

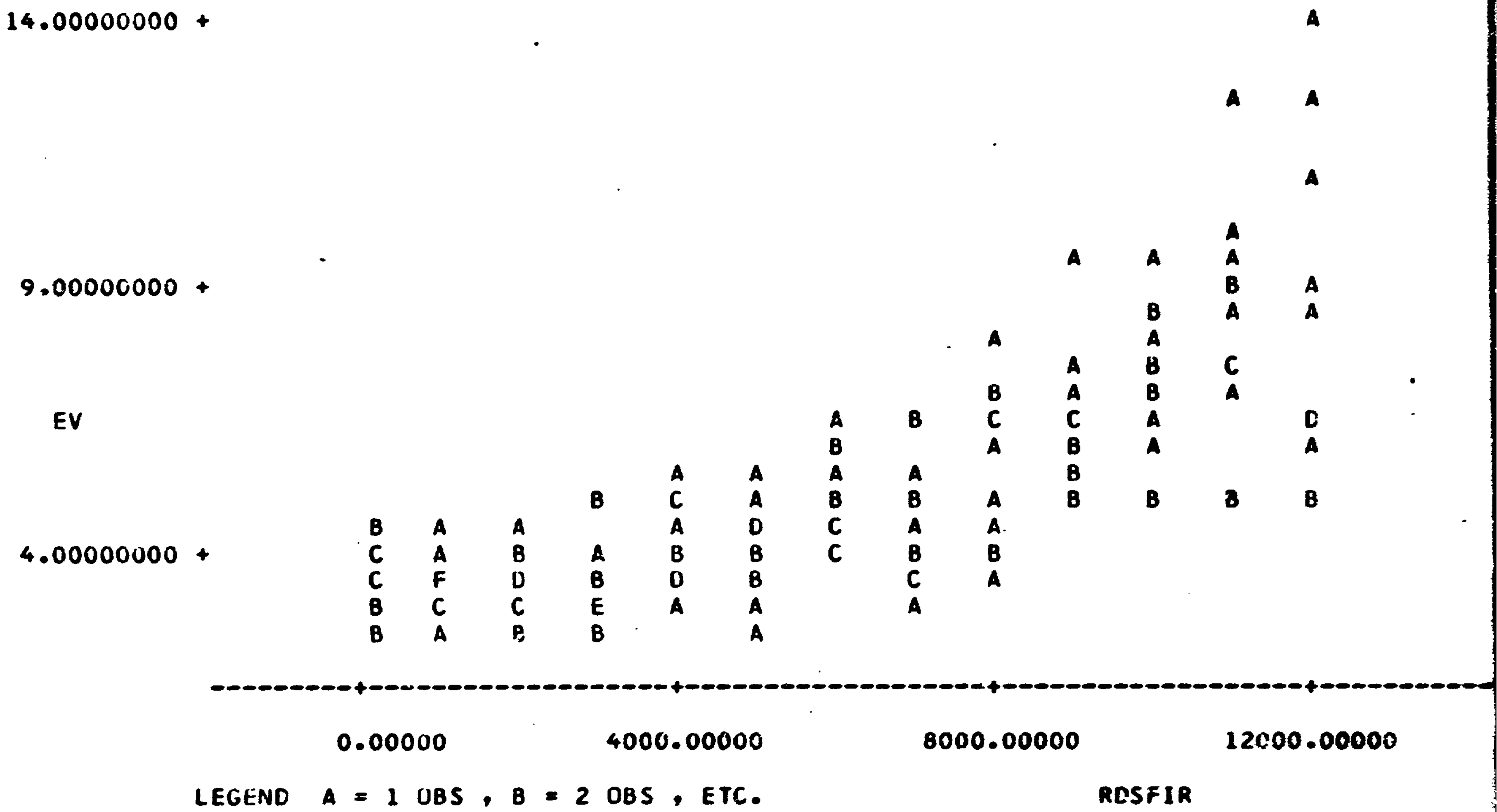


Figure A-5

EH VS RDSFIR

PLOT OF EH VS RDSFIR
FOR AVERAGED DATA

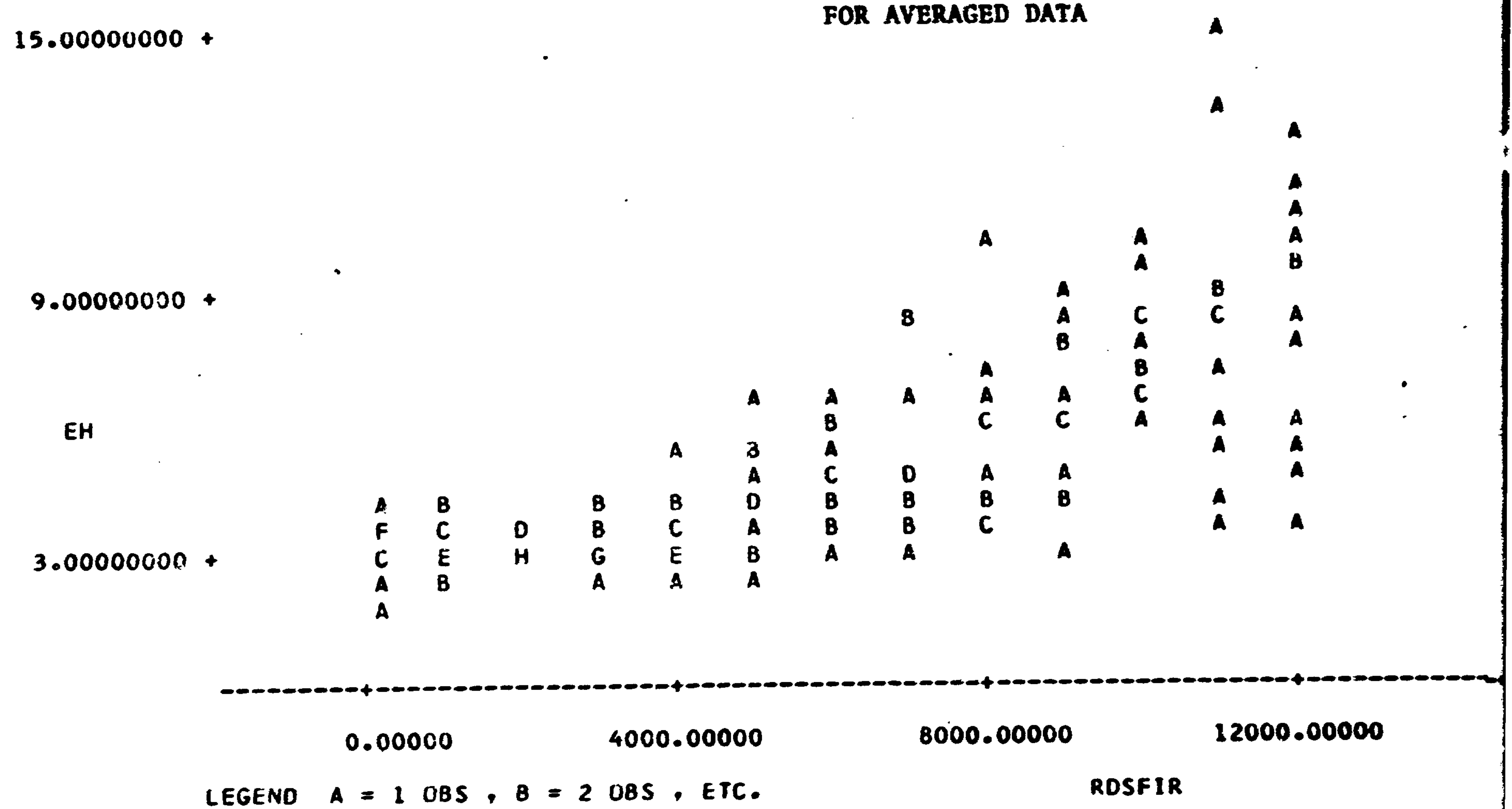


Figure A-6

ES VS RDSFIR

PLOT OF ES VS RDSFIR
FOR AVERAGED DATA

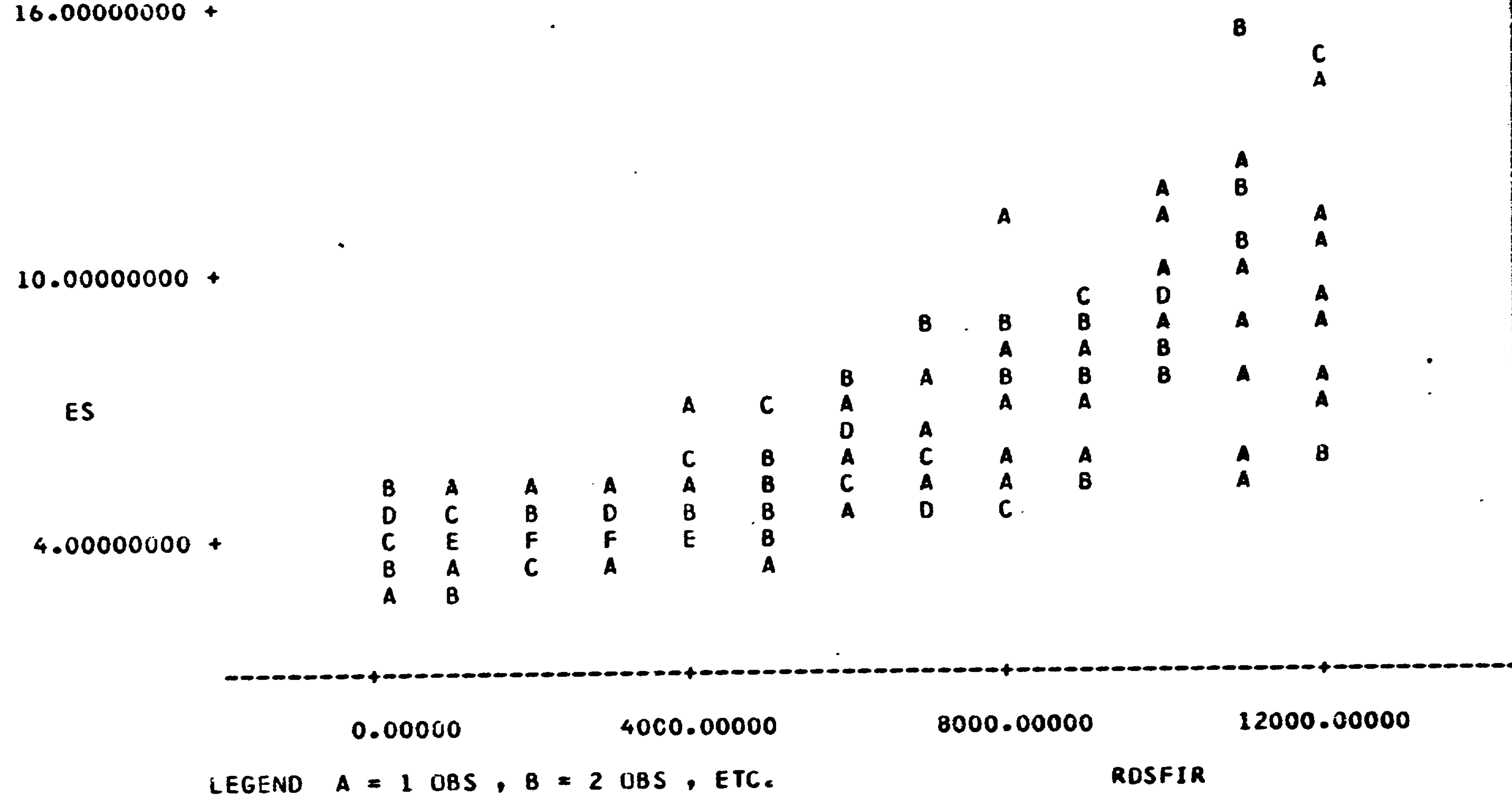


Figure A-7

MR VS RDSFIR

PLOT OF MR VS RDSFIR
FOR AVERAGED DATA

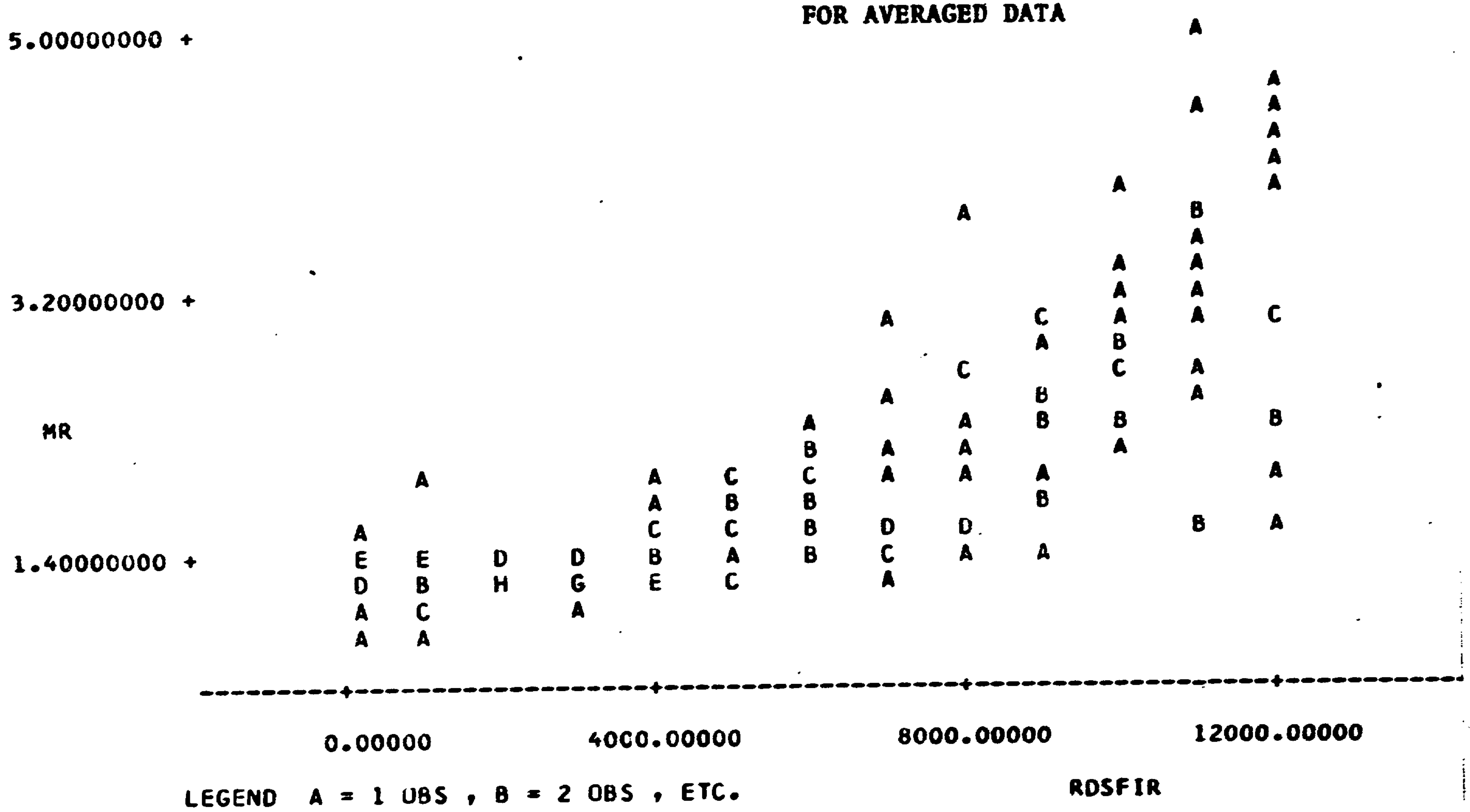


Figure A-8

APPENDIX B

Calculation of the Critical Values

When a value of a measure of dispersion is known, the expected value for any other measure can be found by multipling the known value times the ratio of mean values for the two measures. The mean value for the mean radius (MR) is equal to 1.189. The mean value for the extreme spread (ES) is 3.805, and the mean value for the extreme horizontal (EH) and the extreme vertical (EV) is 3.078. These values were extracted from Tables 2, 5, and 6 of Grubbs (4) for sample size equal to ten. The critical values used in this report are calculated below, where the known value is the limit of ES which is equal to seven inches.

$$E(MR) = 7.00\ (\ 1.189/3.806\ )$$

$$E(MR) = 2.187 \text{ inches}$$

$$E(EH) = E(EV) = 7.00\ (\ 3.078/3.805\ )$$

$$E(EH) = E(EV) = 5.663 \text{ inches}$$

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