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THESIS

PROBABILITY LIMITS OF $\overline{X}$ CHART FOR NON-NORMAL DISTRIBUTION

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A Thesis Submitted in Partial Fulfillment of
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Inaccurate control limits of a Shewhart chart can be occurred by inspecting the small number of subgroups and ignoring the assumption of normality. The purpose of this thesis is to advise a better way of using the probability limit control chart for data that are not normally distributed. The interested distribution is gamma distribution which is commonly found in product life. The purposed probability limit control chart considerations for average include recognition of the degree of skewness and kurtosis. It has been shown that the control chart for process average can be constructed by applying the probability limits, as related to skewness and kurtosis. The results show that the proposed control chart performs efficiently and effectively when the degree of skewness is larger than 1.5 and the degree of kurtosis is larger than 6.38. In addition, the application of the proposed probability limit will also be enable the manufacturers to employ the control chart appropriately.

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Nuttinee Hoontrakoon

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LIST OF FIGURES

LIST OF ABBREVIATIONS

α	=	type I error or producer's risk
β	=	type II error or customer's risk
k	=	distance of control limit
CL	=	center line
UCL	=	upper control limit
LCL	=	lower control limit
$\overline{\overline{X}}$	=	average of subgroup mean
$\hat{\sigma}$	=	estimator of standard deviation (σ)
σ	=	standard deviation
$\sigma_{\overline{X}}$	=	sample error or standard deviation of the average
n	=	sample size
ARL	=	average run length
c, k	=	values specify a member of the family of Burr's distribution
M	=	mean for a given c and k of the fitted Burr's distribution.
S	=	standard deviation for a given c and k of the fitted Burr's distribution.
μ	=	mean of the process
$\overline{R}$	=	average range
d_2	=	correction factor for the non-normal and normal case
p_L	=	probability of detecting a shift on lower control limit
p_U	=	probability of detecting a shift on upper control limit
α_3'	=	estimated values of skewness in Burr's table
α_4'	=	estimated values of kurtosis in Burr's table
$\overline{X}$	=	sample mean
δ	=	the shift in mean in units of process standard deviation
γ_1	=	shape parameter
γ_2	=	scale parameter
α_3	=	skewness

LIST OF ABBREVIATIONS (Continued)

α_4 = kurtosis

PROBABILITY LIMITS OF $\overline{X}$ CHART FOR NON-NORMAL DISTRIBUTION

INTRODUCTION

In recent years, the competition in manufacturing industries has been increasing in both the domestic and external markets. A significant factor that makes a company competitive in the market is the quality of the product (Yuth, 2005). In order to meet quality product, processes must be capable of operating with very little variability in the product's characteristics (Montgomery, 2005). It is generally agreed that the quality of the product represents one of the major areas reflecting reliability, especially for an organization or production unit. The quality of the product also represents an essential factor in the organization's growth. Therefore, the thought of quality is highly important (Leonard, 2007). The quality of the product should be considered and controlled at every step such as raw materials, production and final inspection (Yuth, 2005).

According to a customer point of view, the customer decides to pay money for a product based on many factors such as appearance, suitability for use, and the product durability. Appearance may be the first attraction, but the durability is also one of the significant factors. The issue of long-lived product does not depend on a customer's use. The issue of long-lived product depends on manufacturer and should be realized. Long-lived product also plays a role in reliability of the manufacturer. The consideration of formulating long-live product then belongs to the producer's function. Moreover, the producer maintains level of quality in terms of product life; the quality would be passed along if the product can be used longer than it is guaranteed. Therefore, the manufacturer must find the appropriate level of quality and maintain that level. The benefit of this attempt would belong to both producers and customers.

According to this fact, one of the manufacturer's obligations is to find a tool for monitoring the process to maintain standards in the production line. The first step for building the quality of the product is that the manufacturer must have the specifications of the product and using statistical tools to monitor and control their quality characteristics. The most effective tools used in industry are control charts. In quality control, there are two little different systems of control. The first one of these is designed at setting the control limits at 3-sigma which is called Shewhart $\overline{X}$ chart (3σ control chart). The other system for setting control limits is the concept of probability limit. In practice, when using a Shewhart chart, considered data are based on the assumption of normality which is a general concept of the statistical process control (SPC) (Yourstone and Zimmer, 1992). The merit of the normal assumption is that it is widely observed distribution. However, the merit of the normal assumption rests on the skewness and kurtosis in the data as well as the sample size on which the average is based.

This research has paid attention to the life of product. Gamma distribution is a scope of studying, since it is commonly found in many industries. The gamma distribution is the distribution with right skewed. In this form, examples of its use include queuing models, the flow of items through manufacturing and distribution processes and the load on web servers and the many and varied forms of telecom exchange (www.netMBA.com). However, when one considers about life of the product, the manufacturer prefers to provide good quality in terms of using product for long period. The process with right skewed been shifted lower causes life of product shorter and the manufacturer must remove the variation promptly. This variation causes internal failure cost. The lower control limit should be observed closely to reduce cost of scrap in this situation. In order to detect that shift quickly to maintain the quality of the production line, the probability of detecting the lower shift should be high. However, the increasing probability of detect the shift could affect the shutting down the process. The criteria for setting the probability to detect shifts are different in another situation. This research provides three interesting cases; cost of scrap towards positive shift is equal to negative shift, cost of scrap towards positive shift is more expensive than negative shift and cost of scrap towards positive shift is less expensive than negative shift. Therefore, the objective of this research is to provide an approach to construct probability control limits for each three cases regarding of the degree of skewness and kurtosis.

OBJECTIVES

The specific objectives of this study are as follows:

1. To simplify the lower control limit and upper control limit formulas of $\overline{X}$ chart differ from Yourstone and Zimmer's when the data are gamma consider cost of scrap.

2. To compare the effectiveness of the proposed probability limit control chart with Shewhart $\overline{X}$ chart and the asymmetrical chart when the data are gamma distribution.

Research framework

1. Data used in this research are simulated by using ARENA. The data considered here have gamma distribution with different skewness (0.25, 0.50, 1.00, 1.50, 2.00, 2.50) and kurtosis.

2. The data generated have subgroups (m) of 10, 15, 20, 25 of sample size (*n*) of 4 and 5 where γ_2 = 1, 5, 10 since these distributions are commonly found in many general industries.

3. The ARL is computed under the condition that a process average increase $\delta\sigma$ (δ = 0, ±0.5, ±1.0, ±1.5, ±2.0, ±2.5).

LITERATURE REVIEW

Burrows (1962) studied the effect of skewed distributions on $\overline{X}$ charts using the Pearson systems of distributions and simulation. He found that for distributions that are moderately skewed, there is sufficient departure from the stated ARLs using the normal distribution to cause some doubts in the blanket use of the normal assumption.

Burr (1967) examined the effects and proposed new $\overline{X}$ charts based on non-normality by using the Burr distribution to modify the usual symmetrical control limit constants. He expressed that $\overline{X}$ and R control charts depend on the use of certain constants in the calculation of control limits. These constants have been calculated on the assumption that the distribution of the parent population is normal, but measurable quality characteristics often have non-normal distributions. Therefore, he takes quite a large amount of non-normality to modify the control chart constants and concur that the tables of control chart constants of non-normal populations in his research are quite robust relative to non-normality.

Hillier (1964) explained a method for setting small sample probability limits for the Shewhart average and range based on the sample mean $\overline{X}$ and average range $\overline{R}$. He also expressed that, for sound statistical reasons, control limits should be based on at least 25 subgroups of five observations each. Thus, regardless of the size of the sample, these limits provide the specified probability of a type I error. Therefore, the charts may be applied reliably with these limits as soon as required after initiating the inspection of in-control process.

Mitra (1998) explained the concept of constructing probability limits control chart as

$$CL = E(\hat{\theta})$$

$$UCL = E(\hat{\theta}) + k\sigma(\hat{\theta})$$

$$LCL = E(\hat{\theta}) - k\sigma(\hat{\theta})$$

, where $\hat{\theta}$ is the estimator of a quality characteristic of interest θ. The E($\hat{\theta}$) represents the mean, and $\sigma(\hat{\theta})$ is the standard deviation of estimator. The *k* represents the number of standard deviations of the sample statistic that the control limits are placed from the center line. The selection of *k* is based on a desired probability of the sample statistic falling outside the control limits when the process is in control, therefore the value of *k* and the control limits can be found for any desired probability. The choice of *k* is also influenced by how significant practitioner considers the impact of type I error (false alarm rate) and type II error (consumer's risk). Simple probability control limit can be calculated by

$$CL = \overline{\overline{X}}$$

$$UCL = \overline{\overline{X}} + Z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}}$$

$$LCL = \overline{\overline{X}} - Z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}}$$

, where

n - sample size

$\overline{\overline{X}}$ - average of subgroup mean

σ - process standard deviation

α - type I error.

Montgomery (2005) stated that quality control deal with type I error (producer's risk) and type II error (consumer's risk) and also explained the influences of *k* to both type I error and type II error. For a common choice *k* = 3, it is founded that the probability of an observation falling out side control limits is equal to 0.0027. To reduce the probability of a type I error, the control limits could be placed sufficiently far apart, say 4 or 5 standard deviation on each side of the center line, but doing so affects the probability of making a type II error. As the probability of a type

I error decreases, the probability of a type II error increases. Thus, moving the control limits or choosing k has the effect on the probability of the two types of errors.

Pornchamai (2002) studied the efficiency of control charts for mean of skewed populations. Four methods for establishing a control limit are the Shewhart method, the Hodge-Lehmann method, the Bootstrap method, and the Weighted Variance method. The efficiency of each method is considered by their Average Run Lengths (ARLs). The method having least ARL is considered to be the best.

Phairoj (2003) examined the effects of failure to meet the assumption of normality on the target control chart when data are gamma and beta distributed with 3, 5 and 7 sample sizes of 25 subgroups by using Minitab and Arena for generating data and testing Kolmogorov-Sminov. He considered the effects of failure to meet the assumption of normality on the chart by comparing the difference of type II error and Average Run Lengths (ARLs).

Schilling and Nelson (1976) also studied the effect of non-normality on the control limits of $\overline{X}$ charts using uniform distributions, a right triangular distribution, and a gamma distribution. Schilling and Nelson concluded that for 2-sigma limits sample sizes of three or less are sufficient to achieve less than a 5% risk of false signal for all of the distributions studied. For 3-sigma limits sample sizes of four or more are sufficient to achieve less than a 1.4% risk of false signal for all of the distributions studied here. Their conclusion equivalent Shewhart's original assumption that with samples of four or more, normal theory is satisfactory.

Yourstone and Zimmer (1992) studied the effect of non-normality on the control chart for average and modified new control chart by considering Average Run Lengths (ARLs). They concluded that skewness and kurtosis affect the performance of the control chart for average; the risk of type I error increases when kurtosis is large and when kurtosis is not large the ARL decreased obviously. This causes wrong decision-making. They construct asymmetrical control chart by using Burr's distribution to reduce wrong decision-making.

$$F(y) = 1 - (1 + y^c)^{-k} \quad y \geq 0$$
$$= 0 \quad y \leq 0 \tag{1}$$

, where c and $k \geq 1$ are real numbers. To determine the control limits, the estimated values for the skewness (α_3) and kurtosis (α_4) of the sample averages are computed. Using the values of skewness and kurtosis table in Burr's table (1942), can be used to determine *c, k, M, S* (where *M* is the mean of (1) and *S* is the standard deviation of (1) for a given *c, k*).

Once the specific cumulative density function (CDF) *F* in (1) has been established in terms of *c* and *k*, the control limits are determined as probability limits of the distribution. That is the upper control limit (UCL) and lower control limit (LCL) are found from F(UCL) = p_U and F(LCL) = p_L. As part of the analysis of the determination of control limits, the $\overline{X}$ values are transformed in terms of the different mean and standard deviation, *M* and *S,* of the distribution *F* in (1) with the specified α_3 and α_4. Also, the *Y* values are changed to $\overline{X}$ values and replace the *Y* by y_L for LCL and by y_U for UCL. According to this analysis, the distribution is approximated by the appropriate member of the Burr family of distribution with parameters *c, k, M*, and *S*.

Let the quantities μ and σ are usually unknown and estimated from the precontrol analysis, thus the estimators of μ and σ are taken to be $\overline{\overline{X}}$ and $\overline{R}/d_2$ ($\hat{\sigma}$). This case the equations can be written

$$CL = \overline{\overline{X}} \tag{2}$$

$$UCL = \overline{\overline{X}} + \left(\frac{1}{d_2 s}[(1-p_U)^{-\frac{1}{k}} - 1]^{\frac{1}{c}} - \frac{M}{d_2 S}\right)\overline{R}/\sqrt{n} \tag{3}$$

$$LCL = \overline{\overline{X}} - \left(\frac{M}{d_2 S} - \frac{1}{d_2 s}[(1-p_L)^{-\frac{1}{k}} - 1]^{\frac{1}{c}}\right)\overline{R}/\sqrt{n} \tag{4}$$

, where the values of *c, k* are determined from table in Burr's table (1967) regarding of the estimated values of skewness (α_3) and kurtosis (α_4). These *c* and *k* values specify a member of the family of Burr's distribution, which approximate the observed empirical. That is, if the values of skewness ($\acute{\alpha}_3$) and kurtosis ($\acute{\alpha}_4$) of a distribution are in the range of coved by Burr's distribution, that distribution can be approximated by a member of Burr family. The M and S are mean and standard deviation in Burr's table (1942) for a given c and k of the fitted Burr's distribution. The p_L is the lower control limit probability and p_U is the upper control limit probability. The p_L is small and p_U is large as p_L = 0.00135 and p_U = 0.99865 comparable to 3σ limits. The d_2 is the usual correction factor which, for the non-normal case, can be obtained from Burr's table (1967).

Theory and Principle

Constructing probability limit control chart

According to the previous idea**,** this leads to the original idea of setting control chart that is called the probability limit, asymmetrical control chart. The situation is different for skewed data. For normal data, the probability of $\overline{X}$ falling between the limit is 0.9973 or outside the limits is 0.0027. However, the probability of $\overline{X}$ outside the limits will not be 0.0027, since the data is quite skewed with the long tail distribution. The probability of point falling outside the limit must be predetermined, but it is not easy to find the exact value. The proposed probability limit control chart is based on the original concept developed by Dr. Walter A. Shewhart and the chart in this research can be calculated by the equation below

$$CL = \overline{\overline{X}} \quad (5)$$

$$UCL = \overline{\overline{X}} + Z_{p_U} \frac{\sigma}{\sqrt{n}} \quad (6)$$

$$LCL = \overline{\overline{X}} - Z_{p_L} \frac{\sigma}{\sqrt{n}} \quad (7)$$

, where

n - sample size

$\overline{\overline{X}}$ - average of subgroup mean

$\sigma_{\overline{X}}$ - sample standard deviation ($\frac{\sigma}{\sqrt{n}}$)

p_U - probability of detecting a shift on lower control limit

p_L - probability of detecting a shift on lower control limit

Since X is not normal distribution, the quantity $d_2 = \overline{R}/\sigma$ or the relative range is not needed (Montgomery: 2003). Cowden also states that, constructing a control chart for means, the estimates of parameters should be obtained from variation within samples.

The estimator of σ can be the standard deviation or the range of the observation within each. Therefore, in this research, the estimator of σ is considered to be the sample standard deviation. The probability of detecting the point outside the upper and lower limit is varied. Since there is no specific table for Z_{p_L} and Z_{p_U} of gamma distribution, this research holds out for obtaining the value from cumulative standard normal distribution. Since it is also easy to obtain the value and people are used to it.

Probability limit of detecting the observation out-side the control chart is *p*. Let's C_L and C_U is the cost of scrap or rework when the process shifted towards the lower control limit and upper control limit, respectively. Reducing those costs, the control chart must be able to detect a shift promptly. Therefore, the producer can shut down the process before it produces defective goods to the market.

According to Gram-Charlier adjustment; first for skewness, second for kurtosis and with adjustments involving higher moments; these adjustments are obtained by multiplying a given derivative $f^{(r)}(z)$ of the normal curve by a coefficient C_r which involves α value of the same order α_r. Therefore, this seems to be the relationship of the area of the normal curve and the coefficient C_r. However, it is not worth while to go beyond the fourth moment. It is known that skewness and kurtosis of normal distribution are equal to 0 and 3. Since this research would use the cumulative probability of the normal distribution, the skewness and kurtosis are thought as the relationship of the probability of the normal distribution based on the idea of Gram-Charlier. However, it is uncomplicated.

Cowden (1957) states that the x distribution derives its shape from the "causes". If the causal distributions are skewed, so is the x distribution, but the kurtosis of the x distribution is smaller relative to that of the causal distribution. To find the lower probability limit, the relating coefficient to the degree of skewness and kurtosis in this research are made by dividing skewness by kurtosis. This coefficient is multiplied by the area at Z-value, and let define this value as the effects of departure from normality of the area at Z. This value is added by the area of that Z-value.

For $C_L > C_U$, the gamma distribution of skewness (α_3) and kurtosis (α_4) with sample average $\overline{\overline{X}}$ and sample standard deviation $\hat{\sigma}$ of sample size *n*. At the probability of α, the coefficient can be calculated by

$$\text{Effects of departure from normality} = \frac{\alpha_3}{\alpha_4}\alpha \tag{8}$$

, therefore

$$p_L = \alpha + \frac{\alpha_3}{\alpha_4}\alpha . \tag{9}$$

The lower control limit seems to be narrower. The value of *Z* would be varied from -0.25, -0.5, -0.75, …, -3. Since, the distribution is right skewed. The upper probability limit is computed differently by

$$p_U = \alpha - \frac{\alpha_3}{\alpha_4}\alpha . \tag{10}$$

For example, skewness = 0.25 and kurtosis = 3.09, at *Z* = -0.25 and α = 0.401294 (Montgomery, 2003), this case applies p_L = 0.43376 and p_U = 0.36883.

For $C_L < C_U$, the idea of cost of scrap is also considered. Therefore, the probability of detecting positive shift should be higher than negative shift ($p_L < p_U$). The p_L and p_U are calculated in an opposite fashion by

$$p_L = \alpha - \frac{\alpha_3}{\alpha_4}\alpha \tag{11}$$

$$p_U = \alpha + \frac{\alpha_3}{\alpha_4}\alpha . \tag{12}$$

For example, the similar case applies p_L = 0.36883 and p_U = 0.43378.

At last, when costs are equal ($C_L = C_U$), the probability of both shifts should be equal ($p_L = p_U$).

$$p_L = p_U = \alpha + \frac{\alpha_3}{\alpha_4}\alpha \qquad (13)$$

Performance measurement

Since the control chart are constructed, the performance of the control chart can be measured in different ways; average run lengths (ARL), two types of error (type I error and type II error) and average time to signal (ATS). The effective control chart can be used to indicate a signal quickly when a process is out of control and provides information that is useful in improving the process. The popular performance measurement is average run lengths which is the average number of points plotted on the chart until an out-of-control signal is obtained. The average time to signal is the average time requires detecting a shift. The average run length is called ARL_0 when the process is in control.

$$ARL_0 = \frac{1}{\alpha} \qquad (14)$$

, where α is the probability of reaching a conclusion that the process is out of control when it is really in control. This error is also called Producer’s risk because the manufacturer believes that the process does not work properly, therefore the manufacturer decides to shut it down and then provides the verification that causes the delay and unnecessary cost. For a process out-of-control, we prefer this number to be small because an observation plotted outside the control limits represents a false alarm.

When the process is out of control, the ARL is used as

$$ARL_1 = \frac{1}{1-\beta} \qquad (15)$$

, where β is the probability of reaching a conclusion that the process is in control when it is really out of control. The control chart cannot detect the signal when the process does not work properly; the risk belongs to the customer that is called Customer's risk. The customer believes that he receives the quality products although the process works improperly. For an out-of-control process, it is desirable for this number to be small because we want to detect the out-of-control condition as soon as possible (Montgomery, 2003; Mitra, 1998).

For the reason that the process average μ and σ are unknown; the estimators of those values are $\overline{\overline{X}}$ and $\hat{\sigma}$ as defined at the beginning of each control chart. When the in control process has been shifted to new value $\overline{\overline{X}} + \delta\hat{\sigma}$, type I error ($\alpha$) and type II ($\beta$) of the proposed probability limit control chart and Shewhart $\overline{X}$ chart can be calculated by

$$\alpha = P(\overline{X} \geq UCL \mid CL = \overline{\overline{X}}) + P(\overline{X} \leq LCL \mid CL = \overline{\overline{X}}) \qquad (16)$$

$$\beta = P(LCL \leq \overline{X} \leq UCL \mid CL = \overline{\overline{X}} + \delta\hat{\sigma}) . \qquad (17)$$

For the purpose of computing type I error and type II error for the nonsymmetrical case of Yourstone and Zimmer, the transformation has to be made from $\overline{X}$ to Y and $F_Y(y)$ need to be assessed (equation (1)). According to the Yourstone and Zimmer's theory, let $\overline{X}$ is sample mean. Also, let μ is the in-control mean and σ is the process standard deviation. The $\mu' = \mu + \delta\sigma$ is the process mean when the process mean has shifted.

$$\frac{(Y - M)}{S} = \frac{\overline{X} - (\mu + \delta\sigma)}{\sigma / \sqrt{n}} \qquad (18)$$

$$Y = \frac{S(\overline{X} - \mu - \delta\sigma)\sqrt{n}}{\sigma} + M \qquad (19)$$

The estimators of μ and σ are taken to be $\overline{X}$ and $\overline{R}/d_2$ ($\hat{\sigma}$). In this case, the factor d_2 is for non-normal case from Burr's table (Burr, 1962). Thus, the above equation becomes

$$Y = \frac{S(\overline{X} - \overline{\overline{X}} - \delta\hat{\sigma})}{\hat{\sigma}}\sqrt{n} + M \ . \tag{20}$$

Therefore, type I and type II error can be calculated by replacing y with $y_{U\delta}$ and $y_{L\delta}$ in Burr's distribution (1).

$$\begin{aligned}\beta &= P(LCL \le \overline{X} \le UCL \,|\, CL = \overline{\overline{X}} + \delta\hat{\sigma}) \\ &= P(\overline{X} \le UCL) - P(\overline{X} \le LCL) \\ &= F(y_{U\delta}) - F(y_{L\delta}) \qquad (21)\end{aligned}$$

$$\begin{aligned}\alpha &= P(\overline{X} \ge UCL \,|\, CL = \overline{\overline{X}}) + P(\overline{X} \le LCL \,|\, CL = \overline{\overline{X}}) \\ &= [1 - P(\overline{X} \le UCL] + P(\overline{X} \le LCL) \\ &= 1 - F(y_{U\delta}) + F(y_{L\delta}) \qquad (22)\end{aligned}$$

According to Yourstone and Zimmer, the type I error and type II error can be computed by replacing $\overline{X}$ with LCL of (4) and UCL of (3) in the transformation (20), thus $y_{U\delta}$ and $y_{L\delta}$ is given by

$$y_{U\delta} = \frac{S\left[UCL - (\overline{\overline{X}} + \delta\hat{\sigma})\right]\sqrt{n}}{\hat{\sigma}} + M \tag{23}$$

$$y_{L\delta} = \frac{S\left[LCL - (\overline{\overline{X}} + \delta\hat{\sigma})\right]\sqrt{n}}{\hat{\sigma}} + M \ . \tag{24}$$

Therefore, after substituting UCL and LCL, the $y_{U\delta}$ and $y_{L\delta}$ of nonsymmetrical control chart become

$$y_{U\delta} = \frac{S\sqrt{n}}{\hat{\sigma}}\left[\overline{\overline{X}} + (\frac{1}{d_2 s}[(1-p_U)^{-\frac{1}{k}} - 1]^{\frac{1}{c}} - \frac{M}{d_2 S})\overline{R}\big/\sqrt{n} - (\overline{\overline{X}} + \delta\hat{\sigma})\right] + M \qquad (25)$$

$$y_{L\delta} = \frac{S\sqrt{n}}{\hat{\sigma}}\left[\overline{\overline{X}} - (\frac{M}{d_2 S} - \frac{1}{d_2 s}[(1-p_L)^{-\frac{1}{k}} - 1]^{\frac{1}{c}})\overline{R}\big/\sqrt{n} - (\overline{\overline{X}} + \delta\hat{\sigma})\right] + M\ . \qquad (26)$$

The $F(y_{U\delta})$ and $F(y_{L\delta})$ of nonsymmetrical control chart become

$$F(y_{U\delta}) = 1 - \frac{1}{\left[1 + \left\{\frac{S\sqrt{n}}{\hat{\sigma}}\left[\overline{\overline{X}} + (\frac{1}{d_2 S}[(1-p_U)^{\frac{-1}{k}} - 1]^{\frac{1}{c}} - \frac{M}{d_s S})\overline{R}\big/\sqrt{n} - (\overline{\overline{X}} + \delta\hat{\sigma})\right] + M\right\}^c\right]^k} \qquad (27)$$

$$F(y_{L\delta}) = 1 - \frac{1}{\left[1 + \left\{\frac{S\sqrt{n}}{\hat{\sigma}}\left[\overline{\overline{X}} - (\frac{M}{d_2 S} - \frac{1}{d_2 S}[(1-p_U)^{\frac{-1}{k}} - 1]^{\frac{1}{c}})\overline{R}\big/\sqrt{n} - (\overline{\overline{X}} + \delta\hat{\sigma})\right] + M\right\}^c\right]^k} \qquad (28)$$

, where $y_{U\delta}$ and $y_{L\delta}$ in equation (25) and (26) are greater than zero ($y_{U\delta} > 0$ and $y_{L\delta} > 0$). If not then $F(y_{U\delta}) = 0$ or $F(y_{L\delta}) = 0$.

MATERIALS AND METHODS

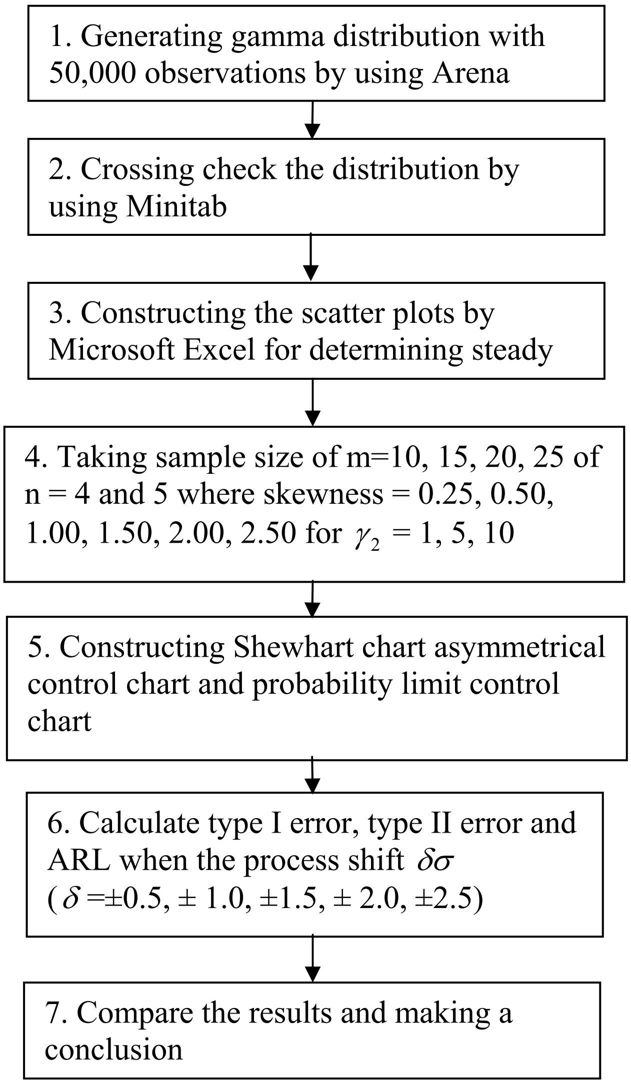
Materials

1. Microcomputer 16 bits with Microsoft Windows 95 (OSC-2), Windows 98, Windows ME, NT 4.0 (Service Pack 5 or later), Windows 2000, Windows XP
2. Software: Arena: software used for generating the statistical data and MINITAB
3. Printer
4. Calculator

Methods

The study was conducted as the following:

1. Simulate data by using Arena
2. Cross check the distribution by using Minitab
3. Construct the scatter plot by excel for determining steady state
4. Generate data
5. Construct the proposed probability limit control chart, Shewhart $\overline{X}$ chart and asymmetrical control chart
6. Calculate type I error, type II error and ARL
7. Compare the results by considering ARL
8. Conclusion and recommendation
9. Report the results in writing



Information of methods

1. Simulate data by Arena

The simulation can be performed by using Arena Software as the parameter in the Table 1 of Appendix A. Each data generation has the degree of skewness and kurtosis in the Table 1 of Appendix A. The simulation by Arena Software in the research is used for generating a sample N = 50,000 with γ_2 = 1, 5, 10 of uncorrelated variables to reach the degree of skewness and kurtosis of the gamma distribution in the Table 1 of Appendix A.

2. Fit the distribution of the data with the gamma distribution by providing the individual distribution identification of Minitab. The condition is that the p-value of the data must be greater than 0.05. If not then, the data are not gamma distributed.

3. Construct the scatter plot by Microsoft Excels for determining the steady state.

4. Take the sample size of 4 and 5 with subgroup of 10, 15, 20, and 25.

4.1 Take sample size of 4 and 5 from data where γ_2 = 1, γ_2 = 5, γ_2 = 10. Each sample size has subgroup of 10, 15, 20, and 25.

4.2 The degree of skewness in each sample set data are 0.25, 0.5, 1.00, 1.50, 2.00, 2.5 and different kurtosis.

5. Construct probability limit control chart, Shewhart chart and the asymmetrical control chart as the previous theory. Each type of chart is studied under three different cases of cost of scrap: $C_L = C_U$, $C_L > C_U$, and $C_L > C_U$.
Where

C_L = cost of scrap towards negative shift,
C_U = cost of scrap towards positive shift.

The following flowchart are steps for constructing the probability limit control chart and the asymmetrical control chart based on the Yourstone and Zimmer's theory; however the equation (3) and (4) is the last part of the determination of control limits. Therefore, one can only determine α_3 and α_4 to specify *M, S* for a given *c, k* from Burr's table and then specify the p_U and p_L for constructing the control chart.

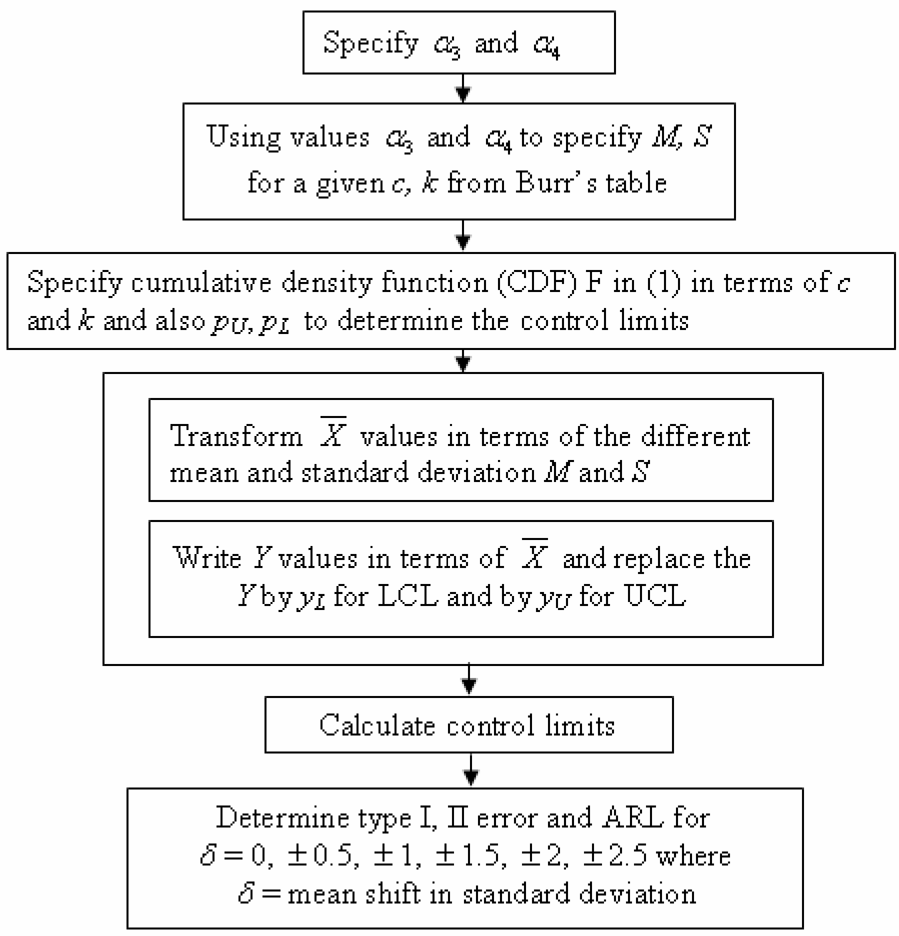


Figure 1 Steps for constructing the asymmetrical control chart based on Yourstone and Zimmer's theory

The lower and upper control limits are the values that can be found from p_U and p_L where p_L is small and p_U is large. The probability limits of the standard limit are always 0.00135 based on Dr. Walter Shewhart's theory, because the standard limit becomes the probability limit control chart if the probability limit is adjustable. For the probability limits of the asymmetrical control chart comparable to the standard limit is always p_U = 0.00135 and p_L = 0.99865.

Note: Case p_U and p_L for the asymmetrical control chart has the same value of the probability limit control chart.

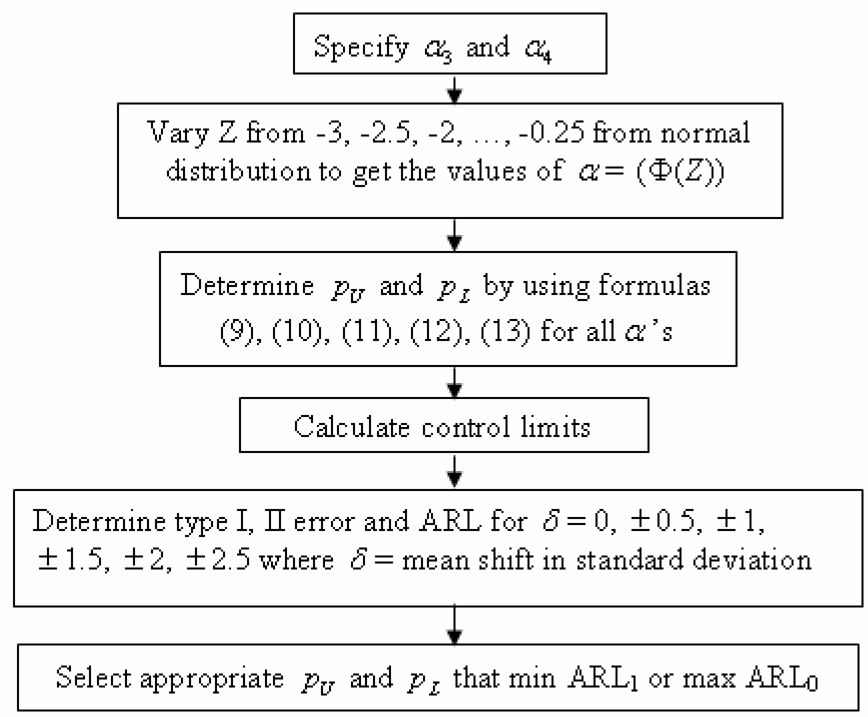


Figure 2 Steps for constructing the probability limit control chart

6. Calculate type I error, type II error and ARL.

The shifts in the mean of the data are measured in units of the process standard deviation. The type I error, type II error, and ARL are computed under the condition that the process average increases $\delta\sigma$ (δ = 0, ±0.5, ±1.0, ±1.5, ±2.0, ±2.5).

7. Compare the result by considering ARL.

8. Make conclusions and recommendations.

RESULTS AND DISCUSSION

Results

The purpose of this research is simplify the lower control limit and upper control limit formulas of $\overline{X}$ chart differ from Yourstone and Zimmer's by comparing the proposed probability limit control chart with Shewhart $\overline{X}$ chart and the asymmetrical control chart when the data are gamma distributed where skewness values are varied as 0.25, 0.50, 1.00, 1.50, 2.00, 2.50. This research also considers cost of scrap under three different circumstances: $C_L = C_U$, $C_L > C_U$, and $C_L > C_U$.

The data in this research are simulated by performing Arena Software. Each data generation has the degree of skewness and kurtosis in the Table 1 of Appendix A. The simulation by Arena Software in the research is used for generating a sample N = 50,000 with γ_2 = 1, 5, 10 of uncorrelated variables to reach the degree of skewness and kurtosis of gamma distribution. The data are fitted for gamma distribution by providing individual distribution identification of Minitab. The condition is that the p-value of the data must be greater than 0.05. If not then, the data are not gamma distributed. The results of individual distribution identification by Minitab are provided in Table 1 – Table 3.

Table 1 The results of individual distribution identification for gamma distribution when $\gamma_2 = 1$

skewness (α_3)	kurtosis (α_4)	mean	standard deviation	p-value
0.25	3.09	64.01	8.00	>0.25
0.50	3.38	16.01	4.00	>0.25
1.00	4.50	4.00	2.00	>0.25
1.50	6.38	1.77	1.32	>0.25
2.00	9.00	1.00	1.00	0.14

Table 1 (Continued)

skewness (α_3)	kurtosis (α_4)	mean	standard deviation	p-value
2.50	12.38	0.64	0.79	>0.25

Note: If p-value is greater than 0.05 then the data are distributed as test assumption.

Table 2 The results of individual distribution identification for gamma distribution when γ_2 = 5

skewness (α_3)	kurtosis (α_4)	mean	standard deviation	p-value
0.25	3.09	319.97	39.93	0.21
0.50	3.38	80.11	19.98	0.10
1.00	4.50	19.91	9.97	>0.25
1.50	6.38	8.93	6.65	>0.25
2.00	9.00	5.01	5.06	>0.25
2.50	12.38	3.20	3.98	>0.25

Note: If p-value is greater than 0.05 then the data are distributed as test assumption.

Table 3 The results of individual distribution identification for gamma distribution when γ_2 = 10

skewness (α_3)	kurtosis (α_4)	mean	standard deviation	p-value
0.25	3.09	639.94	79.86	0.21
0.50	3.38	160.21	39.97	0.13
1.00	4.50	39.97	19.97	>0.25
1.50	6.38	17.76	13.27	0.10
2.00	9.00	10.07	10.06	>0.25
2.50	12.38	6.38	7.93	>0.25

Note: If p-value is greater than 0.05 then the data are distributed as test assumption.

The data are analyzed for the steady state and taken the sample size of 4 and 5 with subgroup size of 10, 15, 20, and 25. The results of used data are in Appendix A. from Appendix Table A2-Appendix Table A13.

The performance measurement is the ARL which is the average number of points plotted on the chart until an out-of-control signal is detected. The control chart that has ability to detect a shift rapidly is an efficient control chart, but when the process is in control, the ARL should be large. Since this research also considers cost of scrap, the results will be separated in to three cases.

1. $C_L = C_U$
2. $C_L > C_U$
3. $C_L < C_U$

The C_L is the cost of scrap towards a negative shift and C_U is the cost of scrap towards a positive shift. For $C_L = C_U$, the cost of scrap towards both negative shifts and positive shifts are equal and the shifts on both sides are important, therefore, the probability of detecting the shifts on both sides must be equal. Second, $C_L > C_U$, the cost of scrap towards the negative shifts is more expensive than the positive shifts. Therefore, the probability of detecting the negative shifts must be larger than the positive shifts in order to detect the negative shifts faster than the positive shifts. On the contrary, $C_L < C_U$, the probability of detecting the positive shifts must be larger than the negative shifts. However, the shifts on both sides must be detected promptly. Each case also studies the factors of sample mean, sample size, subgroup, skewness and kurtosis. The comparisons are separated; the proposed probability limit chart and Shewhart $\overline{X}$ chart, the proposed probability limit chart and the asymmetrical control chart. Next step is constructing Shewhart $\overline{X}$ chart, the proposed probability limit control chart and the asymmetrical control chart. Each control chart can be calculated by the equations below.

Shewhart $\overline{X}$ chart

$$CL = \overline{\overline{X}}$$

$$UCL = \overline{\overline{X}} + Z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}}$$

$$LCL = \overline{\overline{X}} - Z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}}$$

Probability limit control chart

$$CL = \overline{\overline{X}}$$

$$UCL = \overline{\overline{X}} + Z_{p_U} \frac{\sigma}{\sqrt{n}}$$

$$LCL = \overline{\overline{X}} - Z_{p_L} \frac{\sigma}{\sqrt{n}}$$

Asymmetrical control chart

$$CL = \overline{\overline{X}}$$

$$UCL = \overline{\overline{X}} + (\frac{1}{d_2 s}[(1-p_U)^{-\frac{1}{k}} - 1]^{\frac{1}{c}} - \frac{M}{d_2 S})\overline{R}/\sqrt{n}$$

$$LCL = \overline{\overline{X}} - (\frac{M}{d_2 S} - \frac{1}{d_2 s}[(1-p_L)^{-\frac{1}{k}} - 1]^{\frac{1}{c}})\overline{R}/\sqrt{n}$$

where n is the sample size.

$\overline{\overline{X}}$ is average of subgroup mean.

$\sigma_{\overline{X}}$ is standard error or the standard deviation of the average.

$\hat{\sigma}$ is estimator of process standard deviation (σ).

p_U is the probability of detecting a shift on upper control limit.

p_L is the probability of detecting a shift on lower control limit.

c, k are values specify a member of the family of Burr's distribution.

M is mean for a given c and k of the fitted Burr's distribution.

S is the standard deviation for a given c and k of the fitted Burr's distribution.

To illustrate the method clearly, the following examples are provided for $C_L = C_U$ where the data are in Appendix Table A2 of Appendix A. Therefore, $m = 10$, $n = 4$, $\beta = 1$, $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, $\overline{\overline{X}} = 65.71$, $\overline{R} = 15.97$ are applied.

Example Construct Shewhart $\overline{X}$ chart, the proposed probability limit chart and the asymmetrical control chart for $C_L = C_U$ where m = 10, $n = 4$, $\gamma_2 = 1$, $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, $\overline{\overline{X}} = 65.71$, $\overline{R} = 15.97$ and $Z = -0.25$

Shewhart $\overline{X}$ chart (S.C.)

$$CL = \overline{\overline{X}} = 65.71$$

$$UCL = \overline{\overline{X}} + Z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}} = 65.71 + 3\left(\frac{15.97}{2.059 \times \sqrt{4}}\right) = 77.35$$

$$LCL = \overline{\overline{X}} - Z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}} = 65.71 - 3\left(\frac{15.97}{2.059 \times \sqrt{4}}\right) = 54.07$$ (n = 4; $d_2 = 2.059$)

the Proposed probability limit control chart (P.C.)

The equation (13) are applied for calculating p_L and p_U of $C_L = C_U$. When $Z = -0.25$, $\alpha = 0.401294$.

$$p_L = p_U = \alpha + \frac{\alpha_3}{\alpha_4}\alpha = 0.401294 + \frac{0.25}{3.09}(0.401294) = 0.36883$$

$$Z_{p_U} = 0.33496$$

$$Z_{p_L} = -0.33496$$

$$CL = \overline{\overline{X}} \qquad = 65.71$$

$$UCL = \overline{\overline{X}} + Z_{p_U}\frac{\sigma}{\sqrt{n}} = 65.71 + 0.33496(\frac{8.31}{\sqrt{4}}) = 67.10$$

$$LCL = \overline{\overline{X}} - Z_{p_L}\frac{\sigma}{\sqrt{n}} = 65.71 - 0.33496(\frac{8.31}{\sqrt{4}}) = 64.31$$

, where the value of Z is first -0.25 and will be varied from -0.25, -0.5, -0.75, …, -3. The p_L and p_U for this case ($C_L = C_U$) can be calculated by using the equation (13).

the Asymmetrical control chart (A.C.)

$$CL = \overline{\overline{X}}$$

$$UCL = \overline{\overline{X}} + (\frac{1}{d_2 s}[(1-p_U)^{-\frac{1}{k}} - 1]^{\frac{1}{c}} - \frac{M}{d_2 S})\overline{R}/\sqrt{n}$$

$$LCL = \overline{\overline{X}} - (\frac{M}{d_2 S} - \frac{1}{d_2 s}[(1-p_L)^{-\frac{1}{k}} - 1]^{\frac{1}{c}})\overline{R}/\sqrt{n}$$

Table 4 The value of *c, k, M, S,* and d_2 for constructing asymmetrical control chart

α_3	α_4	C	K	M	S	d_2	
						$n = 4$	$n = 5$
0.25	3.09	4	6	0.75550	0.16234	2.06	2.32
0.50	3.38	3	6	0.51088	0.20220	2.05	2.31
1.00	4.50	2	7	0.35435	0.20274	2.00	2.26
1.50	6.37	2	4	0.49087	0.30393	1.95	2.21
2.00	9.00	2	3	0.58905	0.39118	1.89	2.15
2.50	12.38	2	3	0.58905	0.39118	1.89	2.15

According to the case above α_3= 0.25, α_4= 3.09 and n = 4, the value of c = 4, k = 6, M = 0.75550, S = 0.16234 and d_2 = 2.06. The probability limit is $p_L = p_U$ = 0.36883 (page 26) for the same values of p_L and p_U of the proposed method. To illustrate in this case, p_L = 0.00135 and p_U = 0.99865 will be applied if it is compared to 3σ limits. The d_2 is the usual correction factor for the non-normal case. It seems that the correction factor d_2 for non-normal does not differ to the one for normal distribution based on the α_3= 0.25 and α_4= 3.09. The reason is that the degree of skewness and kurtosis of the illustration are very close to the normal distribution (α_3= 0, α_4= 3). Whenever the degree of skewness and kurtosis is not close to the normal distribution, the factor d_2 for non-normal case differs to the one for normal case.

$$CL = 65.71$$

$$UCL = 65.71 + (\frac{1}{2.06 \times 0.16234}[(1-0.99865)^{-\frac{1}{6}} - 1]^{\frac{1}{4}} - \frac{0.75550}{2.06 \times 0.16234})15.97/\sqrt{4}$$
$$= 76.10$$

$$LCL = 65.71 - (\frac{0.75550}{2.06 \times 0.16234} - \frac{1}{2.06 \times 0.16234}[(1-0.00135)^{-\frac{1}{6}} - 1]^{\frac{1}{4}})15.97/\sqrt{4}$$
$$= 50.59$$

For $C_L > C_U$ and $C_L < C_U$, the Shewhart $\overline{X}$ chart and the asymmetrical control chart can be constructed in a similar fashion. For the proposed probability limit, $C_L > C_U$, the p_L and p_U are calculated by the equation (9) and (10) orderly. For $C_L > C_U$, the p_L and p_U are calculated by the equation (11) and (12) orderly. Next step is calculating ARL for the Shewhart $\overline{X}$ chart, the proposed probability limit control chart and the asymmetrical control chart.

Example Calculating ARL of Shewhart $\overline{X}$ chart, the proposed probability limit chart and the asymmetrical control chart for $C_L = C_U$ where m = 10, n = 4, β = 1,

α_3= 0.25, α_4= 3.09, $\overline{\overline{X}} = 65.71$, $\sigma_{\overline{X}} = 8.31$, $\overline{R}$= 15.97

Shewhart $\overline{X}$ chart (S.C.)

$$\hat{\sigma} = \frac{\overline{R}}{d_2} = \frac{15.97}{2.059} = 7.758$$

the Proposed probability limit chart (P.C.)

$$\hat{\sigma} = 8.307$$

the Asymmetrical control chart (A.C.)

$$\hat{\sigma} = \frac{\overline{R}}{d_2} = \frac{15.97}{2.060} = 7.754$$

The shifts in the mean are measured in units of the process standard deviation and can be calculated as $\overline{\overline{X}} \pm \delta\hat{\sigma}$ (mean shift). For example $\delta = 0$ and $\delta = 0.5$ in Table 5.

Table 5 Mean shift of the control charts $\overline{\overline{X}} \pm \delta\hat{\sigma}$

shift(δ)	P.C.	S.C.	A.C.
0	65.71	65.71	65.71
0.5	69.58	61.56	69.58

For Shewhart $\overline{X}$ chart, when the process is in control, the α is calculated as

$$\delta = 0;\ \alpha = P(Z \geq \frac{UCL - \overline{\overline{X}}}{\hat{\sigma}/\sqrt{n}}) + P(Z \leq \frac{LCL - \overline{\overline{X}}}{\hat{\sigma}/\sqrt{n}})$$

$$= P(Z \geq \frac{77.35 - 65.71}{7.758/\sqrt{4}}) + P(Z \leq \frac{54.09 - 65.71}{7.758/\sqrt{4}})$$

$$= (1\text{-}0.998650) + 0.001350 = 0.0027.$$

When the process is out of control, the β is calculated as

$$\delta = 0.5\,;\ \beta = P(Z \le \frac{UCL - \overline{\overline{X}}}{\hat{\sigma}/\sqrt{n}}) - P(Z \le \frac{LCL - \overline{\overline{X}}}{\hat{\sigma}/\sqrt{n}})$$

$$= P(Z \le \frac{77.35 - 69.58}{7.758/\sqrt{4}}) - P(Z \le \frac{54.09 - 69.58}{7.758/\sqrt{4}})$$

= 0.977250 – 0.00003 = 0.9772.

For the Proposed probability limit chart, when the process is in control, the α is calculated as

$$\delta = 0\,;\ \alpha = P(Z \ge \frac{UCL - \overline{\overline{X}}}{\sigma/\sqrt{n}}) + P(Z \le \frac{LCL - \overline{\overline{X}}}{\sigma/\sqrt{n}})$$

$$= P(Z \ge \frac{67.10 - 65.71}{8.307/\sqrt{4}}) + P(Z \le \frac{64.31 - 65.71}{8.307/\sqrt{4}})$$

= (1-0.631173) + 0.368826 = 0.7377.

When the process is out of control, the β is calculated as

$$\delta = 0.5\,;\ \beta = P(Z \le \frac{UCL - \overline{\overline{X}}}{\sigma/\sqrt{n}}) - P(Z \le \frac{LCL - \overline{\overline{X}}}{\sigma/\sqrt{n}})$$

$$= P(Z \le \frac{67.10 - 69.86}{8.307/\sqrt{4}}) - P(Z \le \frac{64.31 - 69.86}{8.307/\sqrt{4}})$$

= 0.253013 – 0.090944 = 0.1621.

For the Asymmetrical control chart, UCL and LCL are calculated on page 28. The $y_{U\delta}$ and $y_{L\delta}$ can be calculated by the equation (25) and (26). When the process is in control, the α is calculated as

$\delta = 0$;

$$y_{U\delta} = \frac{S\left[UCL - (\overline{\overline{X}} + \delta\hat{\sigma})\right]\sqrt{n}}{\hat{\sigma}} + M = \frac{0.16234[76.10 - 65.71]\sqrt{4}}{7.754} + 0.7555 = 0.328563$$

$$y_{L\delta} = \frac{S\left[LCL - (\overline{\overline{X}} + \delta\hat{\sigma})\right]\sqrt{n}}{\hat{\sigma}} + M = \frac{0.16234[50.59 - 65.71]\sqrt{4}}{7.754} + 0.7555 = 0.122499$$

$$F(y_{U\delta}) = 1 - \frac{1}{\left[1 + 0.328563^4\right]^6} = 0.067158$$

$$F(y_{L\delta}) = 1 - \frac{1}{\left[1 + 0.122499^4\right]^6} = 0.001350.$$

The α of the asymmetrical control chart can be calculated by the equation (22)

$$\alpha = 1 - F(y_{U\delta}) + F(y_{L\delta}) = 1 - 0.067158 + 0.001350 = 0.9342$$

When the process is in control, the $y_{U\delta}$ and $y_{L\delta}$ also can be calculated by the equation (25) and (26) and the β is calculated as

$\delta = 0.5$;

$$y_{U\delta} = \frac{S\left[UCL - (\overline{\overline{X}} + \delta\hat{\sigma})\right]\sqrt{n}}{\hat{\sigma}} + M = \frac{0.16234[76.10 - 69.58]\sqrt{4}}{7.754} + 0.7555 = 0.205915$$

$$y_{L\delta} = \frac{S\left[LCL - (\overline{\overline{X}} + \delta\hat{\sigma})\right]\sqrt{n}}{\hat{\sigma}} + M = \frac{0.16234[50.59 - 69.58]\sqrt{4}}{7.754} + 0.7555 = -0.039840$$

$$F(y_{U\delta}) = 1 - \frac{1}{\left[1 + 0.205915^4\right]^6} = 0.010719\ .$$

According to the theory that $y_{U\delta}$ and $y_{L\delta}$ in the equation (25) and (26) are greater than zero ($y_{U\delta} > 0$ and $y_{L\delta} > 0$). If not then $F(y_{U\delta}) = 0$ or $F(y_{L\delta}) = 0$. Therefore,

$$F(y_{L\delta}) = 0$$

When the process is out of control, the β of the asymmetrical control chart can be calculated by the equation (21).

$$\beta = F(y_{U\delta}) - F(y_{L\delta}) = 0.010719 - 0 = 0.0107$$

Table 6 Comparing β of the Probability Limit Chart (P.C.), Shewhart Chart (S.C.) and the Asymmetrical Control Chart (A.C.) when γ_2 = 1, m = 10, n = 4, α_3= 0.25, α_4= 3.09, $\overline{\overline{X}} = 65.71$, $\sigma_{\overline{X}} = 8.31$, $\overline{R}$= 15.97

shift(δ)	P.C.	S.C.	A.C.
2.5	0.0000	0.0228	0.0000
2	0.0001	0.1587	0.0000
1.5	0.0034	0.5000	0.0000
1	0.0382	0.8413	0.0003
0.5	0.1621	0.9772	0.0107
0	0.2623	0.9973	0.0658
-0.5	0.1621	0.9772	0.1777
-1	0.0382	0.8413	0.2512
-1.5	0.0034	0.5000	0.1790
-2	0.0001	0.1587	0.0541
-2.5	0.0000	0.0228	0.0027

Therefore, when the process is in control, the ARL can be calculated as

$$\text{ARL}_0 = \frac{1}{\alpha}$$

When the process is in control, the ARL can be calculated as

$$\text{ARL}_1 = \frac{1}{1-\beta}$$

Shewhart $\overline{X}$ chart

$\delta = 0$; ARL$_0$ = $\frac{1}{0.0027} = 370.3938$

$\delta = 0.5$; ARL$_1$ = $\frac{1}{1-0.9772} = 43.8947$

the Proposed probability limit chart

$\delta = 0$; ARL$_0$ = $\frac{1}{0.7377} = 1.3557$

$\delta = 0.5$; ARL$_1$ = $\frac{1}{1-0.1621} = 1.1934$

the Asymmetrical control chart

$\delta = 0$; ARL$_0$ = $\frac{1}{0.9342} = 1.0704$

$\delta = 0.5$; ARL$_1$ = $\frac{1}{1-0.0107} = 1.0108$

Table 7 Comparing ARL of the Probability Limit Chart (P.C.), Shewhart Chart (S.C.) and the Asymmetrical Control Chart (A.C.) when γ_2 = 1, m = 10, n =4, α_3 = 0.25, α_4 = 3.09, $\overline{\overline{X}} = 65.71$, $\overline{R}$ = 15.97

shift(δ)	P.C.	S.C.	A.C.
2.5	2	2	2
2	2	2	2
1.5	2	2	2
1	2	7	2
0.5	2	44	2

Table 7 (Continued)

shift(δ)	P.C.	S.C.	A.C.
0	2	370	2
-0.5	2	44	2
-1	2	7	2
-1.5	2	2	2
-2	2	2	2
-2.5	2	2	2

The above calculation can be computed in a similar fashion for the next two cases; $C_L > C_U$, $C_L < C_U$. Except the p_L and p_U of $C_L > C_U$ are adjusted by the equation (9) and (10) as it has demonstrated in case $C_L > C_U$. The p_L and p_U of $C_L < C_U$ are adjusted by the equation (11) and (12) as it has demonstrated in case $C_L > C_U$.

Discussion

The data are generated from gamma distribution. The sample size is 4 and 5 with subgroup of 10, 15, 20, and 25 where the scale parameter (γ_2) = 1, 5, 10 and each case has skewness (α_3) = 0.25, 0.50, 1.00, 1.50, 2.00, 2.50. The shifts in the mean of the data (δ) are measured in units of the process standard deviation. The ARLs are computed under the condition that a process average is increased by $\delta\sigma$ (δ = 0, ±0.5, ±1.0, ±1.5, ±2.0, ±2.5). Since the ARL is the average number of subgroup taken before a subgroup indicates an out-of-control condition, the ARLs will be rounded up. Therefore, the ARLs with four decimals in the appendices will be round up and become an integer based on the SPC concept during the discussion.

Besides, the probability limits of the asymmetrical control chart comparable with Shewhart control chart are hold constant at p_L = 0.00135 and p_U = 0.99865. It is found that 38 percents win the proposed method and 64 percents win Shewhart control chart. The percentage of tie Shewhart control chart is 27 percents and 45 percents tie the proposed method. The percentage of loss Shewhart control chart is 16 percents and 9 percents loss the proposed method. However, the research also provides an experiment in case that the value of p_L and p_U for the asymmetrical control chart has the same values of the proposed method, it is found that the asymmetrical control chart that has the same values of p_L and p_U of the proposed method can win the proposed method by 91 percents and 9 percents loss. If one is not care the complexity of the ARLs formulas of the asymmetrical control chart, one can applied this control chart instead of the proposed method and Shewhart control chart. The compensation of the complexity of the ARLs formulas of the asymmetrical control chart is that the asymmetrical control chart can provide 91 percent shorter ARL_1 than the proposed method. However, there is a limitation that is the asymmetrical control chart are generally applicable to situations where the data are such that the sample averages are not normally distributed and can be approximated by a member of the Burr family; that is , any distribution whose coefficients of skewness and kurtosis are in the Burr distribution. Therefore, the proposed method becomes one choice to break down this limitation.

Although, the similar values of p_L and p_U of the asymmetrical control chart and the proposed method can make the asymmetrical control chart providing shorter ARL_1, in practical, if the probability limits of the asymmetrical control chart is p_L = 0.00135 and p_U = 0.99865, the proposed method can sometimes provide shorter ARL_1 than the asymmetrical control chart. Therefore, the next sections are the results of the control charts when the value of p_L and p_U of the asymmetrical control chart are fixed at p_L = 0.00135 and p_U = 0.99865.

1. $C_L = C_U$

1.1 Scale parameter (γ_2)

Comparing ARL values of the proposed probability limit chart, Shewhart control chart and the asymmetrical control chart when the sample mean is changed; scale parameter (γ_2) = 1, 5 and 10 for $C_L = C_U$. Table 8 presents the examples of ARLs of γ_2 = 1, 5 and 10 when n = 4, m = 10, α_3 = 0.25, α_4 = 3.09 and $p_L = p_U$ = 0.00124. It is noticeable that even though the sample mean is changed and construct the probability limit chart; the ARLs of the proposed method do not change when γ_2 is increased. The probability limit chart can work more effectively and efficiently than Shewhart control chart when $\delta = 0$ since the ARL_0 of the proposed method is larger than the ARL of Shewhart control chart; 404 (P.C.) and 370 (S.C.), for example γ_2 = 1 in Table 8. However, when the process is getting out of control and δ = -0.5, 0.5, the proposed method rather provides larger ARL_1 than Shewhart chart; 47 (P.C.) and 44 (S.C.).

Each level of p_L and p_U of the proposed method provides the different results, therefore the discussions of ARLs between the proposed method and the asymmetrical control chart is not as similar as the comparison of the proposed method and Shewhart control chart. The comparison between the proposed method and the asymmetrical control chart will be discussed in section 1.2.

The ARLs of the proposed probability limit chart are not impacted by the mean. Therefore, this factor can be disregarded in order to study the capability of the control charts. The scale parameter also does not influence the efficiency of the asymmetrical control chart and Shewhart control chart (Refer to Table 8). The table is shown that the length of ARLs of the asymmetrical control chart and Shewhart control chart remain as ever. As the results, changing the scale parameter in gamma distribution does not influence the efficiency of the proposed method.

Table 8 Comparing ARLs from scale parameters of the control charts $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, $\gamma_2 = 1, 5, 10$, $m = 10$, $n = 4$, $C_L = C_U$

shift (δ)	ARL of $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, $\gamma_2 = 1, 5, 10$, $m = 10$, $n = 4$								
	P.C. $p_L = p_U = 0.00124$			S.C.			A.C. $p_L = 0.99875$, $p_U = 0.00135$		
	$\gamma_2 = 1$	$\gamma_2 = 5$	$\gamma_2 = 10$	$\gamma_2 = 1$	$\gamma_2 = 5$	$\gamma_2 = 10$	$\gamma_2 = 1$	$\gamma_2 = 5$	$\gamma_2 = 10$
2.5	2	2	2	2	2	2	1	1	1
2	2	2	2	2	2	2	1	1	1
1.5	3	3	3	2	2	2	1	1	1
1	7	7	7	7	7	7	2	2	2
0.5	47	47	47	44	44	44	2	2	2
0	404	404	404	370	370	370	2	2	2
- 0.5	47	47	47	44	44	44	2	2	2
-1	7	7	7	7	7	7	2	2	2
-1.5	3	3	3	2	2	2	2	2	2
-2	2	2	2	2	2	2	2	2	2
-2.5	2	2	2	2	2	2	2	2	2

1.2 Sample size (n)

Comparing ARL values of the proposed probability limit chart, Shewhart control chart and the asymmetrical control chart when collecting more sample size is made; n = 4, 5 of $C_L = C_U$. Figure 3 presents the ARL_1 of the proposed method when n = 4, 5, $\gamma_2 = 1$, m = 10, $\alpha_3 = 0.25$, $\alpha_4 = 3.09$ and $p_L = p_U = 0.00124$. The ARL_1 of the proposed method when δ = -1.5 to -0.5 and δ = 0.5 to 1.5 are decreased but its efficiency is lack of advantage. The ARL_1 of the proposed method when δ = -0.5 and 0.5 decrease from 47 to 36.

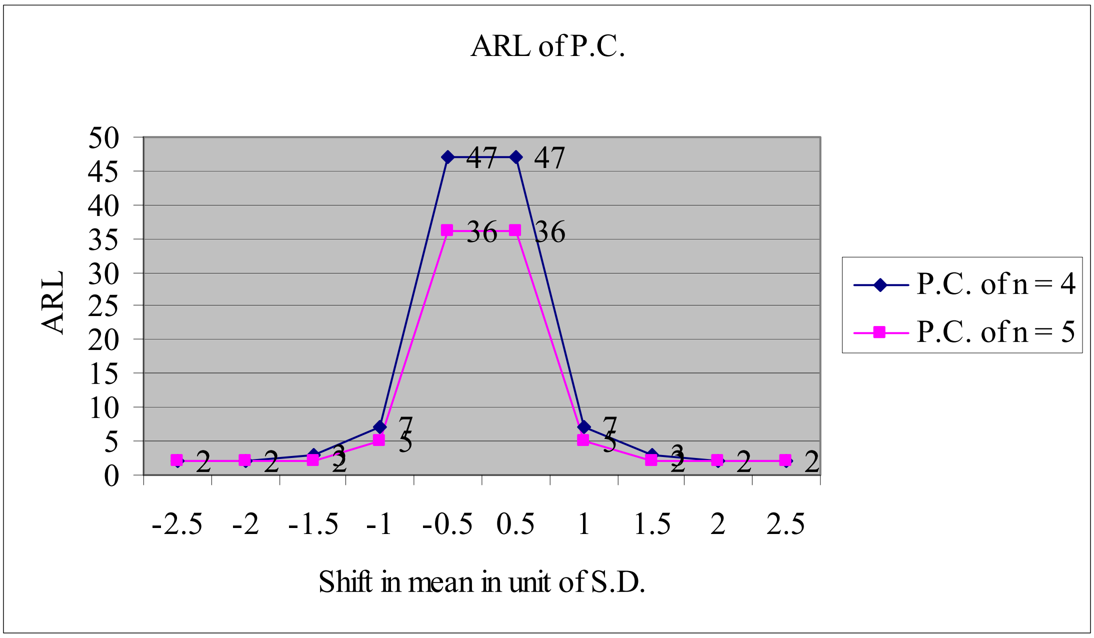


Figure 3 ARL_1 of the proposed method for $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, n = 4, 5**,** $C_L = C_U$

Figure 4 presents the ARL_1 of the proposed method and Shewhart control chart when number of sample size of both charts is four. Even though, the proposed method does not detect the shifts faster than Shewhart control chart, the proposed method can work more effectively and efficiently than Shewhart chart when $\delta = 0$. For the reason that its ARL_0 is larger than Shewhart control chart (Appendix Table B1). However, the ARL_0 of the proposed method when $\delta = 0$ does not change; 404 (Appendix Table B1 and C1), even though the sample size is increased.

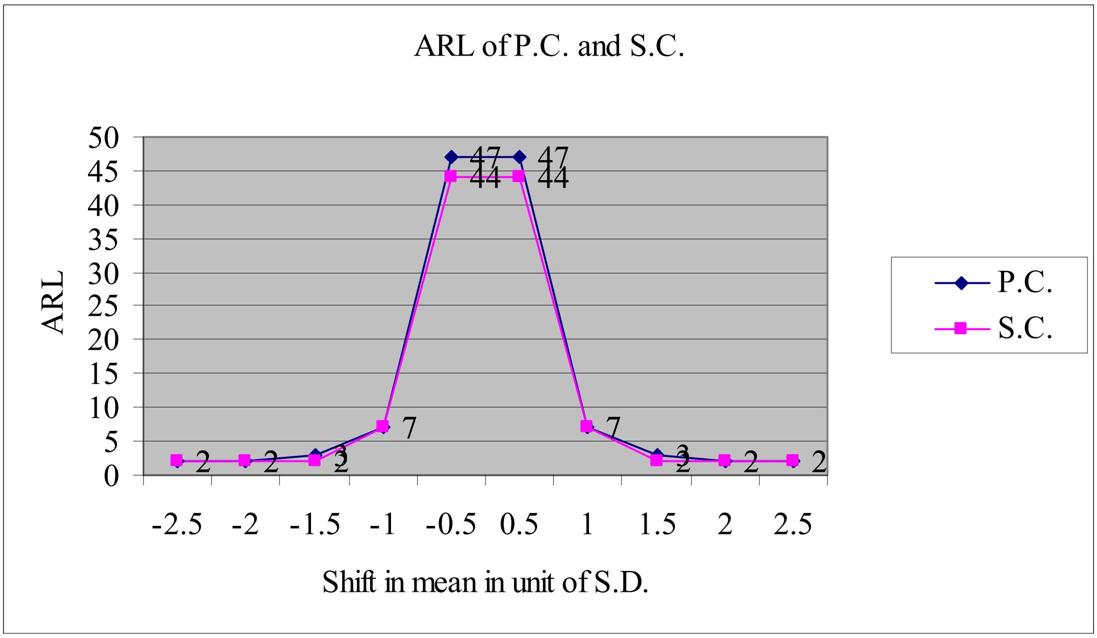


Figure 4 ARL_1 of the proposed method and Shewhart control chart for α_3 = 0.25 α_4 = 3.09, $C_L = C_U$

Since the scale parameter has no effect on the proposed method and the asymmetrical control chart, therefore, the scale parameter can be ignored. The comparisons between the proposed method and the asymmetrical control chart are different to Shewhart control chart. The proposed method does not detect all shifts as fast as the asymmetrical control chart. However, there are cases that smaller out-of-control ARLs (ARL_1) and larger in control ARLs (ARL_0) are provided by the proposed method. The results are concluded in Table 12 for n = 4 and Table 13 for n = 5. The p_L and p_U are separated by the degree of skewness and kurtosis. Table 9 – Table 11 are p_L and p_U profiles for each degree of skewness and kurtosis that are referred in Table 12 and Table 13.

Table 9 p_L and p_U profiles for $C_L = C_U$, $\alpha_3 = 1.5$, $\alpha_4 = 6.38$

Case No.	$p_L = p_U$	Case No.	$p_L = p_U$
1	0.30695	7	0.03064
2	0.23600	8	0.01740
3	0.17335	9	0.00935
4	0.12135	10	0.00475
5	0.08081	11	0.00228
6	0.05110	12	0.00103

Table 10 p_L and p_U profiles for $C_L = C_U$, $\alpha_3 = 2.0$, $\alpha_4 = 9.0$

Case No.	$p_L = p_U$	Case No.	$p_L = p_U$
1	0.31212	7	0.03116
2	0.23997	8	0.01769
3	0.17627	9	0.00951
4	0.12340	10	0.00483
5	0.08217	11	0.00232
6	0.05196	12	0.00105

Table 11 p_L and p_U profiles for $C_L = C_U$, $\alpha_3 = 2.5$, $\alpha_4 = 12.38$

Case No.	$p_L = p_U$	Case No.	$p_L = p_U$
1	0.32026	7	0.03197
2	0.24623	8	0.01816
3	0.18086	9	0.00976
4	0.12662	10	0.00496
5	0.08432	11	0.00238
6	0.05332	12	0.00108

Table 12 Comparing average run length of the proposed method to the asymmetrical control chart for $C_L = C_U$, $n = 4$

shift (δ)	$\alpha_3 = 1.5$, $\alpha_4 = 6.38$ Case No. in Table 9												$\alpha_3 = 2$, $\alpha_4 = 9$ Case No. in Table 10												$\alpha_3 = 2.5$, $\alpha_4 = 12.38$ Case No. in Table 11											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
2.5																																				
2																																				
1.5													*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	
1	*	*	*	*	*	*	*						*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	
0.5	*	*	*	*	*								*	*	*	*	*	*	*	*					*	*	*	*	*	*	*	*				
0					*	*	*	*	*	*	*	*								*	*	*	*	*								*	*	*	*	*
-0.5	*	*	*										*	*	*										*	*	*									
-1																																				
-1.5																																				
-2																																				
-2.5																																				

* represents that the proposed method is more efficient than the asymmetrical control chart.

Table 13 Comparing average run length of the proposed method to the asymmetrical control chart for $C_L = C_U$, $n = 5$

shift (δ)	$\alpha_3 = 1.5,\ \alpha_4 = 6.38$ Case No. in Table 9												$\alpha_3 = 2,\ \alpha_4 = 9$ Case No. in Table 10												$\alpha_3 = 2.5,\ \alpha_4 = 12.38$ Case No. in Table 11											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
2.5																																				
2																																				*
1.5													*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
1													*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	
0.5	*	*	*	*	*								*	*	*	*	*	*	*	*					*	*	*	*	*	*	*	*	*			
0					*	*	*	*	*	*	*	*								*	*	*	*	*								*	*	*	*	*
-0.5	*	*	*										*	*	*										*	*	*	*								
-1																																				
-1.5																																				
-2																																				
-2.5																																				

* represents that the proposed method is more efficient than the asymmetrical control chart.

The above tables present the comparison of the proposed method with the asymmetrical control chart with sample size of 4 and 5. The stars in Table 12 and Table 13 represent the cases that the proposed method can reduce ARL_1 and can detect the mean shifts faster than the asymmetrical control chart. According to Table 12 based on the probability limit in table 9, the proposed method drives more effectively of detecting the shifts by only 17 percents. However, the percents win becomes 29 percents and 30 percents when the degree of skewness is 2 and 2.5 orderly. The proposed method can detect the mean shifts faster than the asymmetrical control chart when the degree of skewness is greater than 1.5 and kurtosis is greater than 6.38. The percents win can reach to 48 percents if the sample size becomes five for skewness of 2.0 and 46 percents for skewness of 2.5. Table 14 presents the comparisons between the propose method and the asymmetrical control charts and Shewhart control chart in terms of percents.

Table 14 Percentage of win, tie, and loss of P.C. with A.C. for $C_L = C_U$

α_3	α_4	$n = 4$			$n = 5$		
		% win	% tie	% loss	% win	% tie	% loss
0.25	3.09	0	43	57	8	37	55
		(34)	(55)	(11)	(34)	(56)	(10)
0.50	3.38	0	33	67	0	9	91
		(34)	(55)	(11)	(6)	(9)	(85)
1.00	4.50	0	33	67	0	27	73
		(34)	(53)	(13)	(34)	(56)	(10)
1.50	6.38	17	54	29	0	51	49
		(34)	(53)	(13)	(34)	(55)	(11)
2.00	9.00	29	52	19	48	51	1
		(34)	(53)	(13)	(34)	(56)	(10)
2.50	12.38	30	52	18	46	53	1
		(34)	(53)	(13)	(34)	(56)	(10)

(xx) % compare P.C. with S.C.

According to the results between the proposed method and the asymmetrical control chart, the proposed method will be more efficient and effective than the asymmetrical control chart when the degree of skewness is greater than 1.5 and kurtosis is greater than 6.38 by 25.5 percents for the sample size of 4 and 35.5 percent for the sample size of 5. However, the proposed method and the asymmetrical control chart are not dominated, if the mean shifts are greater than 1.5 (Appendix B13-B24 and C13-C24). For the lower degree of skewness and kurtosis, the asymmetrical control chart can detect the mean shifts faster than the proposed method. However, if collecting more sample size is performed, the ability of detecting the negative mean shifts of both control charts are not dominated for the degree of skewness is 0.25 and kurtosis is 3.09.

1.3 Subgroup (*m*)

Comparing ARL value of the proposed method, Shewhart control chart and the asymmetrical control chart when collecting more subgroup is performed; m = 10, 15, 20, 25 for $C_L = C_U$. Table 15 presents the examples of ARLs when m = 10, 15, 20, 25 $\gamma_2 = 1$, $n = 4$, $\alpha_3 = 0.25$, $\alpha_4 = 3.09$ and $p_L = p_U = 0.00124$. The ARLs value of the proposed method does not change. According to the assumption of control chart for normality, the number of subgroup must be equal or larger than 25. For the asymmetrical chart, therefore, the number of subgroup smaller than 25 (m = 10, 15, 20, 25) are experimented for all three cases.

The efficiency of the proposed method does not increase when the subgroup is increased, similarly, the asymmetrical control chart does not detect the mean shifts faster. The ARL_0 of the proposed method when δ = -2.5 to -0.5 and δ = 2.5 to 0.5 do not decrease and the proposed method does not detect the mean shifts as fast as Shewhart control chart. This phenomenon also has been presented in Table 15. However, the proposed method can work more effectively and efficiently than Shewhart chart when $\delta = 0$.

Table 15 ARL of $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, $\gamma_2 = 1$, m = 10, 15, 20, 25, n = 4

shift (δ)	P.C. $p_L = p_U = 0.00124$				S.C. $p_L = p_U = 0.00135$				A.C. $p_L = 0.00135$, $p_U = 0.00124$			
	m = 10	m = 15	m = 20	m = 25	m = 10	m = 15	m = 20	m = 25	m = 10	m = 15	m = 20	m =25
2.5	2	2	2	2	2	2	2	2	1	1	1	1
2	2	2	2	2	2	2	2	2	1	1	1	1
1.5	3	3	3	3	2	2	2	2	1	1	1	1
1	7	7	7	7	7	7	7	7	2	2	2	2
0.5	47	47	47	47	44	44	44	44	2	2	2	2
0	404	404	404	404	370	370	370	370	2	2	2	2
-0.5	47	47	47	47	44	44	44	44	2	2	2	2
-1	7	7	7	7	7	7	7	7	2	2	2	2
-1.5	3	3	3	3	2	2	2	2	2	2	2	2
-2	2	2	2	2	2	2	2	2	2	2	2	2
-2.5	2	2	2	2	2	2	2	2	2	2	2	2

Since increasing number of subgroup does not increase the efficiency of the proposed method, the results of comparison between the proposed probability limit control chart and the asymmetrical control chart can be concluded as the Table 12 and Table 13. According to Table 15, it is noticeable that the larger ARL_0 and smaller ARL_1 can not be obtained by collecting more number of subgroup. Therefore, one can save time and cost of collecting data by collecting small subgroup.

1.4 Skewness (α_3) and kurtosis (α_4)

Comparing ARL values of the proposed probability limit chart, Shewhart control chart and the asymmetrical control chart when the degree of skewness and kurtosis are increased for $C_L = C_U$. According to the ARLs in Appendix Table B1 - Appendix Table B24, the degree of skewness and kurtosis α_3= 0.5, 1.0, 1.5, 2.0, 2.5, α_4= 3.09, 4.5, 6.38, 9.00, 12.38 are consider for the ARL_1, the ARL_1 of the proposed method becomes larger when skewness is increased to 1.5 (kurtosis = 6.38) and then becomes smaller when skewness is greater than 1.5 (kurtosis = 6.38). The phenomenon has been occurred similarly to Shewhart and the asymmetrical chart.

The capability of detecting both negative mean shifts and positive mean shifts by the proposed method are simultaneous. In a nature of control chart, the better control chart of this case should detect the negative shifts as fast as the positive shifts. When the negative and positive mean shifts is larger than 1, the ability of the proposed method and Shewhart are not dominated when the degree of skewness is 0.25 and kurtosis is 3.09.

One can apply the p_L and p_U by considering from the degree of skewness and kurtosis in the Table 16. For example, α_3= 0.25, α_4= 3.09 and $C_L = C_U$, the most convenient ARL_0 is obtained by $p_L = p_U$ = 0.00124 and likewise $p_L = p_U$ = 0.36883 for the ARL_1.

Table 16 p_L and p_U profiles for $C_L = C_U$

α_3	α_4	ARL$_0$		ARL$_1$	
		p_L	p_U	p_L	p_U
0.25	3.09	0.00124	0.00124	0.36883	0.36883
0.5	3.38	0.00115	0.00115	0.34193	0.34193
1	4.5	0.00105	0.00105	0.31212	0.31212
1.5	6.38	0.00103	0.00103	0.30695	0.30695
2	9	0.00105	0.00105	0.31212	0.31212
2.5	12.38	0.00108	0.00108	0.32026	0.32026

The proposed method would be more efficient and effective than the asymmetrical control chart when the skewness is greater than 1.5 and kurtosis is greater than 6.38. For the lower degree of skewness and kurtosis the performance would be as be similar to the asymmetrical control chart.

2. $C_L > C_U$

Comparing the results in this case, the cost of scrap towards the negative mean shifts is more expensive than the positive mean shifts. The efficient control chart and appropriate p_L and p_U should detect the negative mean shifts faster than detecting the positive mean shifts. It is found that the rank of p_L and p_U can result to the efficient of detecting the shift in mean in standard deviation units, therefore the efficient of the proposed method could not be determined while another factors is being considerated. The efficient of detecting the positive mean shifts could be as promptly as negative mean shifts even if one of the considered factors is hold constant. The discussions in this case are, therefore, unlike to the previous case. The ranks of appropriate p_L and p_U are determined concurrently with degree of skewness and kurtosis.

2.1 Scale parameter (γ_2)

Comparing ARL values of the proposed probability limit chart, Shewhart control chart and the asymmetrical control chart when the sample mean is increased; scale parameter (γ_2) = 1, 5 and 10 for $C_L > C_U$. Table 17 presents the examples of ARLs of γ_2 = 1, 5 and 10 when n = 4, m = 10, α_3 = 0.25, α_4= 3.09 and p_L = 0.00146 p_U= 0.00124. It is noticeably that even though the sample mean changes and construct the proposed method; the ARLs of the proposed method do not change when γ_2 is increased. The results also occur in the same way for Shewhart control chart and the asymmetrical control chart. This phenomenon has been shown in Table 17.

The ARL does not change when γ_2 increases. This is because the ARL are not impact by the mean; however, it is impacted by the degree of skewness. According to the theory, normal distribution has no shape parameter, so their shape is fixed and only its location or its scale or both can change. It follows that the skewness and kurtosis of normal distribution are constants, as skewness and kurtosis are independent of location and scale parameters. Therefore, changing scale parameter in gamma distribution does not influence the degree of skewness and kurtosis, only the mean of distribution will change

As the results, changing scale parameter in gamma distribution does not impact the efficiency of the proposed method. The scale parameter also does not influence the efficiency of the asymmetrical control chart and Shewhart control chart (Refer to Table 17). The table is shown that the length of ARLs of the asymmetrical control chart and Shewhart control chart remain as ever Therefore, this factor can be disregarded in order to study the capability of the control chart.

Table 17 Comparing ARLs from scale parameters of the control charts $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, $\gamma_2 = 1, 5, 10$, $m = 10$, $n = 4$, $C_L > C_U$

shift (δ)	ARL of $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, $\gamma_2 = 1, 5, 10$, $m = 10$, $n = 4$								
	P.C. $p_L = 0.00146$, $p_U = 0.00124$			S.C.			A.C. $p_L = 0.99875$, $p_U = 0.00135$		
	$\gamma_2 = 1$	$\gamma_2 = 5$	$\gamma_2 = 10$	$\gamma_2 = 1$	$\gamma_2 = 5$	$\gamma_2 = 10$	$\gamma_2 = 1$	$\gamma_2 = 5$	$\gamma_2 = 10$
2.5	2	2	2	2	2	2	1	1	1
2	2	2	2	2	2	2	1	1	1
1.5	3	3	3	2	2	2	1	1	1
1	7	7	7	7	7	7	2	2	2
0.5	47	47	47	44	44	44	2	2	2
0	370	370	370	370	370	370	2	2	2
- 0.5	42	42	42	44	44	44	2	2	2
-1	7	7	7	7	7	7	2	2	2
-1.5	2	2	2	2	2	2	2	2	2
-2	2	2	2	2	2	2	2	2	2
-2.5	2	2	2	2	2	2	2	2	2

2.2 Sample size (n)

Comparing ARL values of the proposed method, Shewhart control chart and the asymmetrical control chart when the sample size is increased; n = 4, 5 of $C_L > C_U$. Figure 5 presents the examples of ARLs when n = 4, 5 γ_2 = 1, m = 10, α_3 = 0.25, α_4 = 3.09, p_L = 0.00146, and p_U = 0.00124. The proposed method of n = 5 can detect the shifts at δ = -1 to -0.5 and δ = 1 to 0.5 faster. The ARL_1 of the proposed method when δ = -1 to -0.5 and δ = 0.5 to 1.5 decrease. The ARL_1 of the proposed method when δ = -0.5 decreases from 42 of n = 4 to 32 of n = 5. However, in Figure 6, the proposed method can detect the negative mean shifts faster than the positive mean shifts while Shewhart control chart can detect the negative mean shifts slower than the proposed method. The ARL_0 of the proposed method when δ = 0 does not improve; 370 (Appendix D1 and E1), even though the sample size is increased.

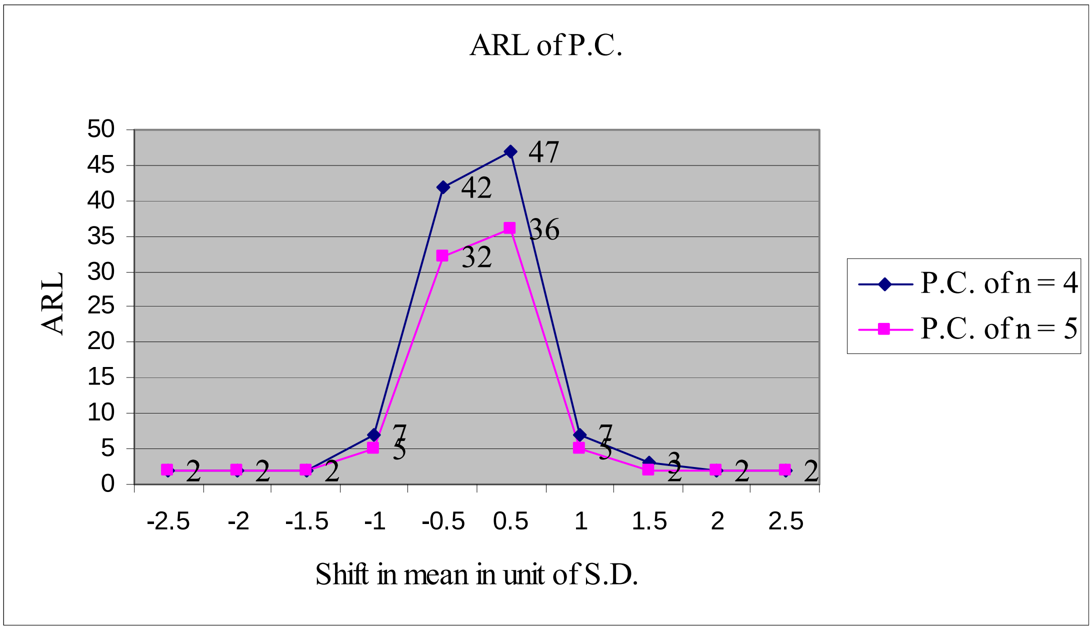


Figure 5 ARL_1 of the proposed method for α_3 = 0.25, α_4 = 3.09, n = 4, 5**,** $C_L > C_U$

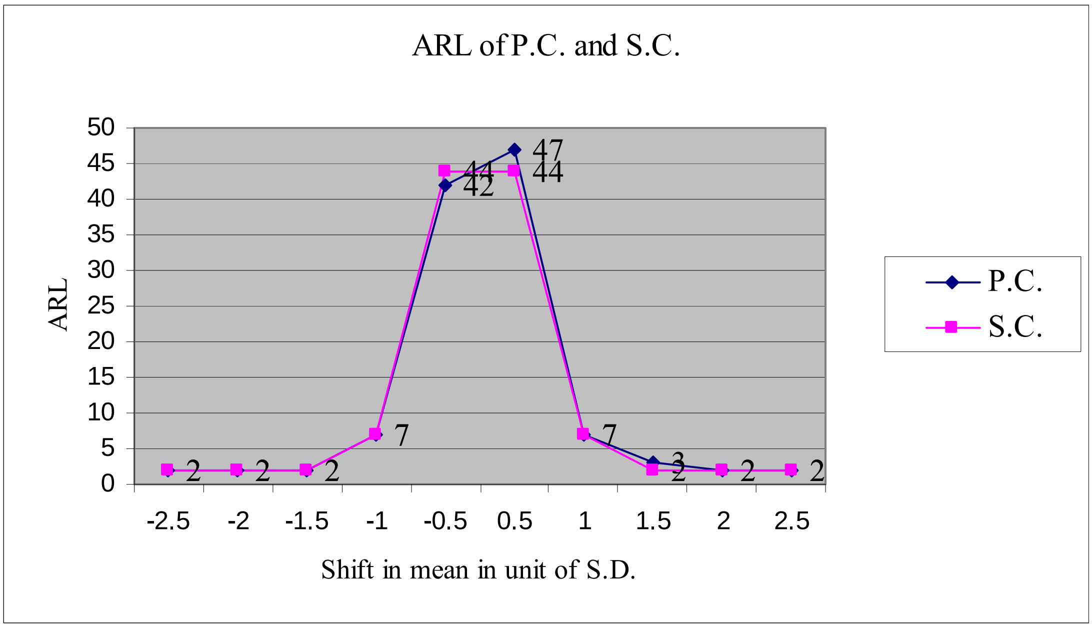


Figure 6 ARL$_1$ of the proposed method and Shewhart control chart for α_3 = 0.25 α_4 = 3.09, n = 4, $C_L > C_U$

According to section 2.1, the scale parameter has no effect on the proposed method and the asymmetrical control chart. Therefore, the scale parameter can be ignored. The proposed method does not detect all shifts as fast as the asymmetrical control chart. However, there are cases that smaller out-of-control ARLs (ARL$_1$) and larger in control ARLs (ARL$_0$) are provided. The results are concluded in Table 21 for n = 4 and Table 22 for n = 5. The p_L and p_U are separated by the degree of skewness and kurtosis. Table 18 – Table 20 are p_L and p_U profiles for each degree of skewness and kurtosis that will be referred in Table 21 and Table 22.

Table 18 p_L and p_U profiles for $C_L > C_U$, $\alpha_3 = 1.5$, $\alpha_4 = 6.38$

Case No.	p_L	p_U	Case No.	p_L	p_U
1	0.49564	0.30695	7	0.04948	0.03064
2	0.38108	0.23600	8	0.02810	0.01740
3	0.27991	0.17335	9	0.01510	0.00935
4	0.19596	0.12135	10	0.00767	0.00475
5	0.13049	0.08081	11	0.00368	0.00228
6	0.08251	0.05110	12	0.00167	0.00103

Table 19 p_L and p_U profiles for $C_L > C_U$, $\alpha_3 = 2.0$, $\alpha_4 = 9.0$

Case No.	p_L	p_U	Case No.	p_L	p_U
1	0.490470	0.312117	7	0.048961	0.031157
2	0.377101	0.239974	8	0.027806	0.017695
3	0.276989	0.176266	9	0.014941	0.009508
4	0.193912	0.123399	10	0.007590	0.004830
5	0.129128	0.082172	11	0.003642	0.002318
6	0.081653	0.051961	12	0.001650	0.001050

Table 20 p_L and p_U profiles for $C_L > C_U, \alpha_3 = 2.5$, $\alpha_4 = 12.38$

Case No.	p_L	p_U	Case No.	p_L	p_U
1	0.48233	0.32026	7	0.04815	0.03197
2	0.37084	0.24623	8	0.02734	0.01816
3	0.27239	0.18086	9	0.01469	0.00976
4	0.19069	0.12662	10	0.00746	0.00496
5	0.12698	0.08432	11	0.00358	0.00238
6	0.08030	0.05332	12	0.00162	0.00108

Table 21 Comparing average run length of the proposed method to the asymmetrical control chart for $C_L > C_U$, $n = 4$

shift (δ)	$\alpha_3 = 1.5,\ \alpha_4 = 6.38$ Case No. in Table 18												$\alpha_3 = 2,\ \alpha_4 = 9$ Case No. in Table 19												$\alpha_3 = 2.5,\ \alpha_4 = 12.38$ Case No. in Table 20											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
2.5																																				
2																																				
1.5													*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	
1	*	*	*	*	*	*	*						*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	
0.5	*	*	*	*	*								*	*	*	*	*	*	*	*					*	*	*	*	*	*	*	*				
0						*	*	*	*	*	*	*								*	*	*	*	*								*	*	*	*	*
-0.5	*	*	*	*									*	*	*	*									*	*	*									
-1																																				
-1.5																																				
-2																																				
-2.5																																				

* represents that the proposed method is more efficient than the asymmetrical control chart.

Table 22 Comparing average run length of the proposed method to the asymmetrical control chart for $C_L > C_U$, $n = 5$

shift (δ)	$\alpha_3 = 1.5,\ \alpha_4 = 6.38$ Case No. in Table 18												$\alpha_3 = 2,\ \alpha_4 = 9$ Case No. in Table 19												$\alpha_3 = 2.5,\ \alpha_4 = 12.38$ Case No. in Table 20											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
2.5																																				
2																																				
1.5													*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1													*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	
0.5	*	*	*	*	*																*	*	*	*										*	*	*
0						*	*	*	*	*	*	*	*	*	*	*	*	*	*						*	*	*	*	*	*	*					
-0.5	*	*	*	*	*								*	*	*	*	*								*	*	*	*								
-1																																				
-1.5																																				
-2																																				
-2.5																																				

* represents that the proposed method is more efficient than the asymmetrical control chart.

The above tables present the comparison of the proposed method and the asymmetrical control chart for various shifts in the standard deviation when $C_L > C_U$. The stars in Tables 21 and Table 22 represent that proposed method can reduce ARL_1 and can detect the shifts more effectively than the asymmetrical control chart. The proposed method can detect the mean shifts more effectively than the asymmetrical control chart when the degree of skewness is greater than 1.5 and kurtosis is greater than 6.38.

Table 23 Percentage of win, tie, and loss of P.C. with A.C. for $C_L > C_U$

α_3	α_4	$n = 4$			$n = 5$		
		% win	% tie	% loss	% win	% tie	% loss
0.25	3.09	8	46	46	1	93	6
		(34)	(56)	(10)	(1)	(98)	(1)
0.50	3.38	8	36	56	8	30	62
		(35)	(55)	(10)	(34)	(57)	(9)
1.00	4.50	8	36	56	8	30	62
		(35)	(55)	(10)	(34)	(57)	(9)
1.50	6.38	17	55	28	13	51	36
		(35)	(55)	(10)	(34)	(56)	(10)
2.00	9.00	30	54	16	31	55	14
		(35)	(55)	(10)	(34)	(57)	(9)
2.50	12.38	30	55	15	31	55	14
		(35)	(55)	(10)	(34)	(57)	(9)

(xx) % compare P.C. with S.C.

According to the results between the proposed method and the asymmetrical control chart, the Table 23 are shown that the proposed method will be more efficient and effective than the asymmetrical control chart when the skewness is greater than 1.5 and kurtosis is greater than 6.38. However, Table 21-Table 22, the asymmetrical control chart and the proposed method are not dominated if the negative and positive mean shifts are greater than 1.5 (Appendix F13-F24 and G13-G24). For the lower degree of skewness and kurtosis, the asymmetrical control chart can detect the mean shifts faster than the proposed method.

2.3 Subgroup (*m*)

Comparing ARL values of the proposed probability limit chart, Shewhart control chart and the asymmetrical control chart when collecting more subgroup is made; m = 10, 15, 20, 25 for $C_L > C_U$. Figure 7 presents the examples of ARLs when m = 10, 15, 20, 25, $\gamma_2 = 1$, $n = 4$, $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, $p_L = 0.00146$ and $p_U = 0.00124$. The following graph presents the ARL values; the ARL values of the proposed method do not change, similarly, the asymmetrical control chart does not detect the mean shifts faster.

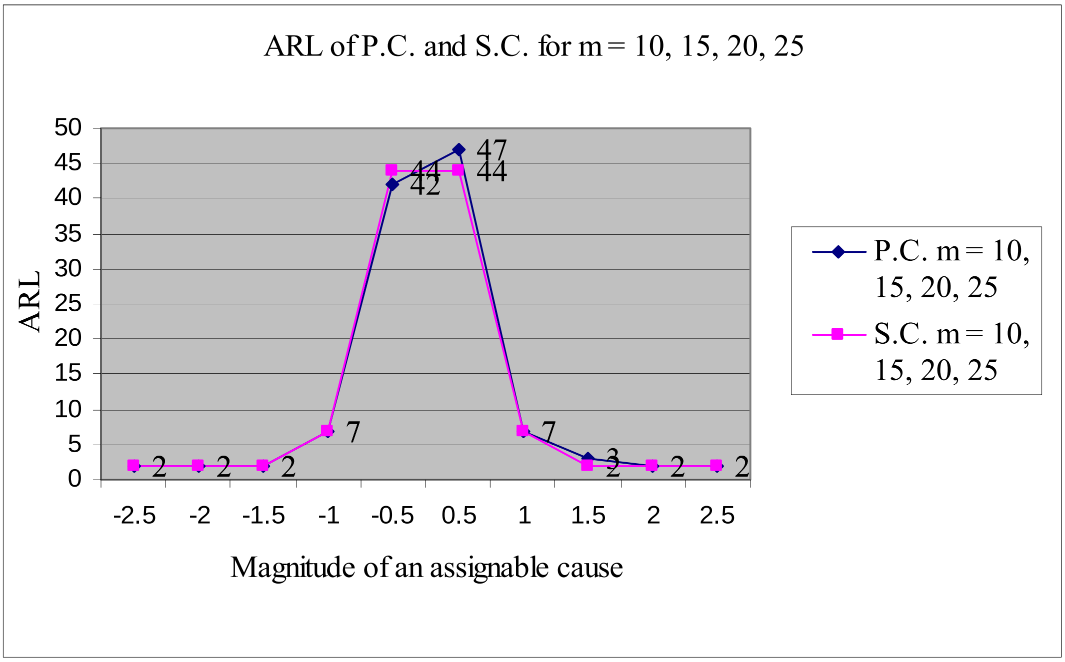


Figure 7 ARL_1 of the proposed method and Shewhart control chart for $\alpha_3 = 0.25$ $\alpha_4 = 3.09$, m = 10, 15, 20, 25, $C_L > C_U$

The ARL_1 of the proposed method when δ = -2.5 to -0.5 and δ = 2.5 to 0.5 do not decrease. Therefore, the proposed method does not detect the shifts faster, even though the number of subgroup is increased. This phenomenon has been presented in Appendix Table H2.

Since increasing number of subgroup does not increase the efficiency of the proposed method, the result of comparison between the proposed probability limit control chart and the asymmetrical control chart can be concluded as in the Table 21 and Table 22. According to the assumption of normality for constructing the control chart, the number of subgroup must be at least 25. Therefore, one can construct the probability limit control chart by collecting small subgroup to save cost and time of quality control process.

2.4 Skewness (α_3) and kurtosis (α_4)

Comparing ARL values of the proposed probability limit chart, Shewhart control chart and the asymmetrical control chart when the degree of skewness and kurtosis are increased for $C_L > C_U$. According to the Appendix Table F1 – Appendix Table F24, α_3= 0.25, 0.5, 1.0, 1.5, 2.0, 2.5, α_4= 3.09, 4.5, 6.38, 9.00, 12.38 are consider for the ARL_1, the ARL_1 of the proposed method becomes larger when skewness is increased to 1.5 (kurtosis = 6.38) and then becomes smaller when skewness is greater than 1.5 (kurtosis = 6.38). The phenomenon has been occurred similarly to Shewhart and the asymmetrical chart.

When the degree of skewness is 0.25 (kurtosis = 3.09) and the mean shifts on both side are larger than 1, the ability of the proposed method and Shewhart control chart are not dominated. In a nature of control chart, the better control chart for this case should detect the negative mean shifts faster than the positive mean shifts. The p_L and p_U with a star in Table 24 to 29 are values that can detect the negative mean shifts faster than the positive mean shifts for the degree of skewness and kurtosis. However, the proposed method can detect the shifts better than Shewhart control chart.

Table 24 p_L and p_U profiles for $C_L > C_U$, $\alpha_3 = 0.25$, $\alpha_4 = 3.09$

Case No.	p_L	p_U	Case No.	p_L	p_U
1	0.43376	0.36883	7	0.04330	0.03682
2	0.33350	0.28357	8	0.02459 *	0.02091 *
3	0.24496	0.20829	9	0.01321 *	0.01124 *
4	0.17149	0.14582	10	0.00671 *	0.00571 *
5	0.11420	0.09710	11	0.00322 *	0.00274 *
6	0.07221	0.06140	12	0.00146 *	0.00124 *

* represents the values of p_L and p_U that can detect the negative mean shifts faster than the positive mean shifts, otherwise the positive and negative shifts are detected simultaneously.

Table 25 p_L and p_U profiles for $C_L > C_U$, $\alpha_3 = 0.5$, $\alpha_4 = 3.38$

Case No.	p_L	p_U	Case No.	p_L	p_U
1	0.46066	0.34193	7	0.04599 *	0.03413 *
2	0.35418	0.26290	8	0.02612 *	0.01938 *
3	0.26015	0.19310	9	0.01403 *	0.01042 *
4	0.18212	0.13519	10	0.00713 *	0.00529 *
5	0.12128	0.09002	11	0.00342 *	0.00254 *
6	0.07669 *	0.05692 *	12	0.00155 *	0.00115 *

* represents the values of p_L and p_U that can detect the negative mean shifts faster than the positive mean shifts, otherwise the positive and negative shifts are detected simultaneously.

Table 26 p_L and p_U profiles for $C_L > C_U$, $\alpha_3 = 1.0$, $\alpha_4 = 4.5$

Case No.	p_L	p_U	Case No.	p_L	p_U
1	0.49047	0.31212	7	0.04896 *	0.03116 *
2	0.37710	0.23997	8	0.02781 *	0.01769 *
3	0.27699	0.17627	9	0.01494 *	0.00951 *
4	0.19391	0.12340	10	0.00759 *	0.00483 *
5	0.12913	0.08217	11	0.00364 *	0.00232 *
6	0.08165 *	0.05196 *	12	0.00165 *	0.00105 *

* represents the values of p_L and p_U that can detect the negative mean shifts faster than the positive mean shifts, otherwise the positive and negative shifts are detected simultaneously.

Table 27 p_L and p_U profiles for $C_L > C_U$, $\alpha_3 = 1.5$, $\alpha_4 = 6.38$

Case No.	p_L	p_U	Case No.	p_L	p_U
1	0.49564	0.30695	7	0.04948 *	0.03064 *
2	0.38108	0.23600	8	0.02810 *	0.01740 *
3	0.27991	0.17335	9	0.01510 *	0.00935 *
4	0.19596	0.12135	10	0.00767 *	0.00475 *
5	0.13049	0.08081	11	0.00368 *	0.00228 *
6	0.08251 *	0.05110 *	12	0.00167 *	0.00103 *

* represents the values of p_L and p_U that can detect the negative mean shifts faster than the positive mean shifts, otherwise the positive and negative shifts are detected simultaneously.

Table 28 p_L and p_U profiles for $C_L > C_U$, $\alpha_3 = 2.0$, $\alpha_4 = 9.0$

Case No.	p_L	p_U	Case No.	p_L	p_U
1	0.49047	0.31212	7	0.04896 *	0.03116 *
2	0.37710	0.23997	8	0.02781 *	0.01770 *
3	0.27699	0.17627	9	0.01494 *	0.00951 *
4	0.19391 *	0.12340 *	10	0.00759 *	0.00483 *
5	0.12913 *	0.08217 *	11	0.00364 *	0.00232 *
6	0.08165 *	0.05196 *	12	0.00165 *	0.00105 *

* represents the values of p_L and p_U that can detect the negative mean shifts faster than the positive mean shifts, otherwise the positive and negative shifts are detected simultaneously.

Table 29 p_L and p_U profiles for $C_L > C_U$, $\alpha_3 = 2.5$, $\alpha_4 = 12.38$

Case No.	p_L	p_U	Case No.	p_L	p_U
1	0.48233	0.32026	7	0.04815 *	0.03197 *
2	0.37084	0.24623	8	0.02734 *	0.01816 *
3	0.27239	0.18086	9	0.01469 *	0.00976 *
4	0.19069 *	0.12662 *	10	0.00746 *	0.00496 *
5	0.12698 *	0.08432 *	11	0.00358 *	0.00238 *
6	0.08030 *	0.05332*	12	0.00162 *	0.00108 *

* represents the values of p_L and p_U that can detect the negative mean shifts faster than the positive mean shifts, otherwise the positive and negative shifts are detected simultaneously.

3. $C_L < C_U$

Comparing the results in this case, the cost of scrap towards the negative mean shifts are less expensive than the positive mean shifts. The positive mean shifts of the process are more drastic than the negative mean shifts. However, the mean shifts on both sides must be detected promptly. The efficient control charts with the appropriate p_L and p_U should detect the positive mean shifts faster than detecting the negative shifts. It is found that the rank of p_L and p_U can result to the efficient of detecting the shift in mean in standard deviation units, therefore the efficiency of the proposed method could not be determined while another factors is being considerated. The efficiency of detecting the positive mean shifts could be as deliberated as the negative shifts even if one of the considered factors is hold constant. The discussions in this case are, therefore, alike to the previous case. The ranks of appropriate p_L and p_U are determined concurrently with degree of skewness and kurtosis.

3.1 scale parameter (γ_2)

Comparing ARL values of the proposed probability limit chart, Shewhart control chart and the asymmetrical control chart when the scale parameter is increased; (γ_2) = 1, 5 and 10 for $C_L < C_U$. Table 30 presents the examples of ARLs of γ_2 = 1, 5 and 10 when n = 4, m = 10, α_3 = 0.25, and α_4 = 3.09. The ARL does not change when γ_2 increases. This is because the ARL are not impact by the mean; however, it is impacted by the degree of skewness. It follows that the skewness and kurtosis of normal distribution are constants, as skewness and kurtosis are independent of scale parameters. Therefore, changing scale parameter in gamma distribution does not influence the degree of skewness and kurtosis, only the mean of distribution will change

Table 30 Comparing ARLs from scale parameters of the control charts α_3 = 0.25, α_4 = 3.09, γ_2 = 1, 5, 10, m = 10, n = 4, $C_L < C_U$

shift (δ)	ARL of α_3 = 0.25, α_4 = 3.09, γ_2 = 1, 5, 10, m = 10, n = 4								
	P.C. p_L = 0.00124, p_U = 0.00146			S.C.			A.C. p_L = 0.99875, p_U = 0.00135		
	γ_2 = 1	γ_2 = 5	γ_2 = 10	γ_2 = 1	γ_2 = 5	γ_2 = 10	γ_2 = 1	γ_2 = 5	γ_2 = 10
2.5	2	2	2	2	2	2	1	1	1
2	2	2	2	2	2	2	1	1	1
1.5	2	2	2	2	2	2	1	1	1
1	7	7	7	7	7	7	2	2	2
0.5	42	42	42	44	44	44	2	2	2
0	370	370	370	370	370	370	2	2	2
- 0.5	47	47	47	44	44	44	2	2	2
-1	7	7	7	7	7	7	2	2	2
-1.5	3	3	3	2	2	2	2	2	2
-2	2	2	2	2	2	2	2	2	2
-2.5	2	2	2	2	2	2	2	2	2

It is noticeably that even though the sample mean changes and construct the proposed method; the ARLs of the proposed method do not change when γ_2 increases. The results also occur in the same way for Shewhart control chart and the asymmetrical control chart. This phenomenon has been shown in Table 30.

As the results, changing scale parameter in gamma distribution does not impact the efficiency of the proposed method. The ARLs of the proposed probability limit chart are not impacted by the scale parameter. Therefore, this factor can be disregarded in order to study the capability of the control charts.

3.2 sample size (n)

Comparing ARL values of the proposed probability limit chart, Shewhart control chart and the asymmetrical control chart when collecting more sample size is made; n = 4, 5 for $C_L < C_U$.

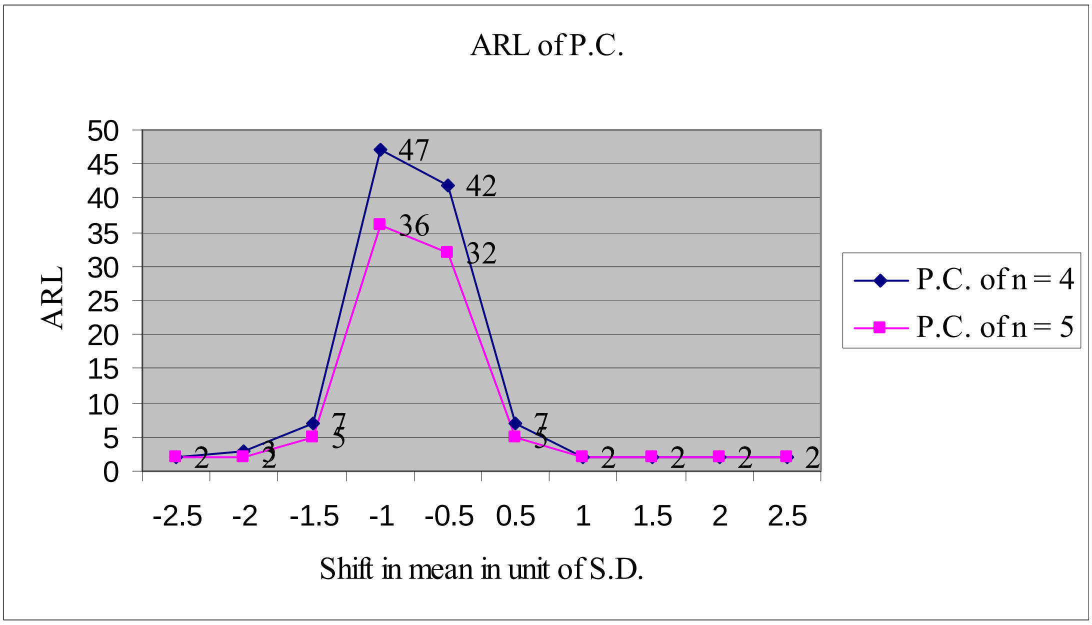


Figure 8 ARL$_1$ of the proposed method for $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, n = 4, 5**,** $C_L < C_U$

Figure 8 presents the examples of ARLs when n = 4, 5 γ_2 = 1, m = 10, α_3 = 0.25, α_4 = 3.09, p_L = 0.00124, and p_U = 0.00146. The proposed method of n = 5 can detect the shifts at δ = -1 to -0.5 and δ = 1 to 0.5 faster. The ARLs of the proposed method when δ = -1 to -0.5 and δ = 1.5 to 0.5 decrease. The ARL of the proposed method when δ = 0.5 decreases from 42 of n = 4 to 32 of n = 5. However, in Figure 9, the propose method can detect the positive mean shifts faster than the negative mean shifts while Shewhart control chart can detect the positive mean shifts slower than the proposed method. The ARL of the proposed method when δ = 0 does not improve; 370, even though the sample size is increased.

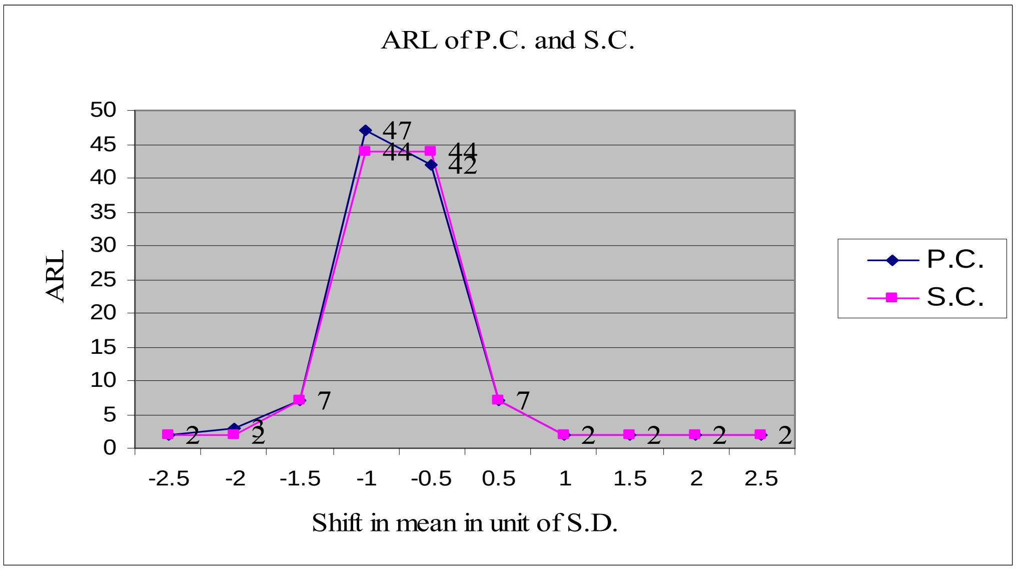


Figure 9 ARL_1 of the proposed method and Shewhart control chart for α_3 = 0.25 α_4 = 3.09, n = 4, $C_L < C_U$

Comparing the proposed method to the asymmetrical control chart, there are cases that smaller out of control ARLs (ARL_1) and larger in control ARLs (ARL_0) are provided by the proposed method. The results are concluded in Table 31 for n = 4 and Table 32 for n = 5. The p_L and p_U are separated by the degree of skewness and kurtosis. Table 28 – Table 30 are p_L and p_U profiles for each degree of skewness and kurtosis that will be referred in Table 31 and Table 32.

Table 31 p_L and p_U profiles for $C_L < C_U$, $\alpha_3 = 1.5$, $\alpha_4 = 6.38$

Case No.	p_L	p_U	Case No.	p_L	p_U
1	0.30695	0.49564	7	0.03064	0.04948
2	0.23600	0.38108	8	0.01740	0.02810
3	0.17335	0.27991	9	0.00935	0.01510
4	0.12135	0.19596	10	0.00475	0.00767
5	0.08081	0.13049	11	0.00228	0.00368
6	0.05110	0.08251	12	0.00103	0.00167

Table 32 p_L and p_U profiles for $C_L < C_U$, $\alpha_3 = 2.0$, $\alpha_4 = 9.0$

Case No.	p_L	p_U	Case No.	p_L	p_U
1	0.31212	0.49047	7	0.03116	0.04896
2	0.23997	0.37710	8	0.01770	0.02781
3	0.17627	0.27699	9	0.00951	0.01494
4	0.12340	0.19391	10	0.00483	0.00759
5	0.08217	0.12913	11	0.00231	0.00364
6	0.05196	0.08165	12	0.00105	0.00165

Table 33 p_L and p_U profiles for $C_L < C_U$, $\alpha_3 = 2.5$, $\alpha_4 = 12.38$

Case No.	p_L	p_U	Case No.	p_L	p_U
1	0.32026	0.48233	7	0.03197	0.04815
2	0.24623	0.37084	8	0.01816	0.02735
3	0.18086	0.27239	9	0.00976	0.01469
4	0.12662	0.19069	10	0.00496	0.00746
5	0.08432	0.12699	11	0.00238	0.00358
6	0.05332	0.08030	12	0.00108	0.00162

Table 34 Comparing average run length of the proposed method to the asymmetrical control chart for $C_L < C_U$, $n = 4$

shift	$\alpha_3 = 1.5,\ \alpha_4 = 6.38$ Case No. in Table 31												$\alpha_3 = 2,\ \alpha_4 = 9$ Case No. in Table 32												$\alpha_3 = 2.5,\ \alpha_4 = 12.38$ Case No. in Table 33											
(δ)	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
2.5																																				
2																																				
1.5													*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1	*	*	*	*	*	*	*	*					*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	
0.5	*	*	*	*	*	*							*	*	*	*	*	*	*	*	*				*	*	*	*	*	*	*	*	*			
0									*	*	*	*	*	*	*	*	*	*	*						*	*	*	*	*	*	*					
-0.5	*	*	*										*	*	*										*	*	*									
-1																																				
-1.5																																				
-2																																				
-2.5																																				

* represents that the proposed method is more efficient than the asymmetrical control chart.

Table 35 Comparing average run length of the proposed method to the asymmetrical control chart for $C_L < C_U$, $n = 5$

shift	α_3 = 1.5, α_4 = 6.38 Case No. in Table 34												α_3 = 2, α_4 = 9 Case No. in Table 35												α_3 = 2.5, α_4 = 12.38 Case No. in Table 36											
(δ)	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
2.5																																				
2																																				
1.5													*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1													*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	
0.5	*	*	*	*	*								*	*	*	*	*	*	*	*	*				*	*	*	*	*	*	*	*	*			*
0					*	*	*	*	*	*	*	*								*	*	*	*	*								*	*	*	*	
-0.5	*	*	*	*									*	*	*	*									*	*	*	*								
-1																																				
-1.5																																				
-2																																				
-2.5																																				

* represents that the proposed method is more efficient than the asymmetrical control chart.

The above tables present the comparison of the proposed method and the asymmetrical control chart for various shifts in the standard deviation when $C_L < C_U$. Table 36 presents the percentages of win, the percentages of tie and the percentages of loss of the proposed method. At the degree of skewness 1.5 (kurtosis = 6.38), the proposed method can detect the mean shifts more effectively than the asymmetrical control chart 18 percents. When the degree of skewness is larger than 1.5 and kurtosis is larger than 6.38, the proposed method begins to detect the shifts faster than the asymmetrical control chart. However, the asymmetrical control chart and the proposed method are not dominated; if the negative and positive mean shifts are greater than 1.5 and skewness is 1.5 (kurtosis = 6.38). For the lower degree of skewness and kurtosis, the asymmetrical control chart can detect the mean shifts faster than the proposed method.

Table 36 Percentage of win, tie, and loss of P.C. with A.C. for $C_L < C_U$

α_3	α_4	$n = 4$			$n = 5$		
		% win	% tie	% loss	% win	% tie	% loss
0.25	3.09	8	45	47	8	39	53
		(34)	(56)	(10)	(34)	(57)	(9)
0.50	3.38	8	36	57	8	30	62
		(35)	(55)	(10)	(34)	(57)	(9)
1.00	4.50	8	36	56	8	30	62
		(35)	(55)	(10)	(34)	(57)	(9)
1.50	6.38	18	54	28	13	51	36
		(35)	(55)	(10)	(34)	(56)	(10)
2.00	9.00	30	53	17	31	53	16
		(35)	(55)	(10)	(34)	(57)	(9)
2.50	12.38	30	53	17	31	53	16
		(35)	(55)	(10)	(34)	(57)	(9)

(xx) % compare P.C. with S.C.

3.3 Subgroup (m)

Comparing ARL values of the proposed probability limit chart, Shewhart control chart and the asymmetrical control chart when the number of subgroup is increased; m = 10, 15, 20, 25 of $C_L < C_U$. Refer to Appendix Table H3, the ARLs when m = 10, 15, 20, 25, $\gamma_2 = 1$, $n = 4$, $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, $p_L = 0.00124$, and $p_U = 0.00146$. Similarly, to the previous cases, $C_L = C_U$ and $C_L = C_{U,}$ the ARL values of the proposed method, the asymmetrical control chart and Shewhart chart do not change does not detect the mean shifts faster even though the subgroup is increased. Therefore, collecting more subgroup is not needed for detecting the mean shifts faster for $C_L < C_U$. This phenomenon has been presented in Appendix Table H3.

According to the assumption of normality for constructing the control chart, the number of subgroup must be at least 25. As an increasing number of subgroup does not increase the efficiency of the proposed method, the result of comparison between the proposed probability limit control chart and the asymmetrical control chart can be concluded in Table 34 and Table 35. Therefore, the similar action can be applied for constructing the asymmetrical chart. One can construct the probability limit control chart by collecting the subgroup of 10.

3.4 skewness (α_3) and kurtosis (α_4)

Comparing ARL values of the proposed probability limit chart, Shewhart control chart and the asymmetrical control chart when the degree of skewness and kurtosis are increased for $C_L < C_U$. According to the Appendix Table D1 – Appendix Table D4, α_3= 0.25, 0.5, 1.0, 1.5, 2.0, 2.5, α_4= 3.09, 4.5, 6.38, 9.00, 12.38 are consider for the ARL_1, the ARL_1 of the proposed method becomes larger when skewness is increased to 1.5 (kurtosis = 6.38) and then becomes smaller when skewness is greater than 1.5 (kurtosis = 6.38). The phenomenon has been occurred similarly to Shewhart control chart and the asymmetrical chart.

When the degree of skewness is 0.25 and kurtosis is 3.09 and the mean shifts on both side are larger than 1, the ability of the proposed method and Shewhart control chart are not dominated. In a nature of control chart, the better control chart for this case should detect the positive mean shifts faster than the negative mean shifts. The p_L and p_U with a star in Table 37 to 42 are values of p_L and p_U that can detect the positive mean shifts faster than the negative mean shifts for the degree of skewness and kurtosis. However, the proposed method can detect the shifts better than Shewhart control chart.

Table 37 p_L and p_U profiles for $C_L < C_U$, $\alpha_3 = 0.25$, $\alpha_4 = 3.09$

Case No.	p_U	p_L	Case No.	p_U	p_L
1	0.43376	0.36883	7	0.04330	0.03682
2	0.33350	0.28357	8	0.02459 *	0.02091 *
3	0.24496	0.20829	9	0.01321 *	0.01124 *
4	0.17149	0.14582	10	0.00671 *	0.00571 *
5	0.11420	0.09710	11	0.00322 *	0.00274 *
6	0.07221	0.06140	12	0.00146 *	0.00124 *

* represents the values of p_L and p_U that can detect the positive mean shifts faster than the negative mean shifts, otherwise the positive and negative shifts are detected simultaneously.

Table 38 p_L and p_U profiles for $C_L < C_U$, $\alpha_3 = 0.5$, $\alpha_4 = 3.38$

Case No.	p_U	p_L	Case No.	p_U	p_L
1	0.46066	0.34193	7	0.04599	0.03413
2	0.35418	0.26290	8	0.02612 *	0.01938 *
3	0.26015	0.19310	9	0.01403 *	0.01042 *
4	0.18212	0.13519	10	0.00713 *	0.00529 *

Table 38 (Continued)

Case No.	p_U	p_L	Case No.	p_U	p_L
5	0.12128	0.09002	11	0.00342 *	0.00254 *
6	0.07669	0.05692	12	0.00155 *	0.00115 *

* represents the values of p_L and p_U that can detect the positive mean shifts faster than the negative mean shifts, otherwise the positive and negative shifts are detected simultaneously.

Table 39 p_L and p_U profiles for $C_L < C_U$, $\alpha_3 = 1.0$, $\alpha_4 = 4.5$

Case No.	p_U	p_L	Case No.	p_U	p_L
1	0.49047	0.31212	7	0.04896*	0.03116*
2	0.37710	0.23997	8	0.02781 *	0.01769 *
3	0.27699	0.17627	9	0.01494 *	0.00951 *
4	0.19391	0.12340	10	0.00759 *	0.00483 *
5	0.12913	0.08217	11	0.00364 *	0.00232 *
6	0.08165 *	0.05196*	12	0.00165 *	0.00105*

* represents the values of p_L and p_U that can detect the positive mean shifts faster than the negative mean shifts, otherwise the positive and negative shifts are detected simultaneously.

Table 40 p_L and p_U profiles for $C_L < C_U$, $\alpha_3 = 1.5$, $\alpha_4 = 6.38$

Case No.	p_U	p_L	Case No.	p_U	p_L
1	0.49564	0.30695	7	0.04948 *	0.03064 *
2	0.38108	0.23600	8	0.02810 *	0.01740 *
3	0.27991	0.17335	9	0.01510 *	0.00935 *
4	0.19596	0.12135	10	0.00767 *	0.00475 *
5	0.13049	0.08081	11	0.00368 *	0.00228 *
6	0.08251 *	0.05110 *	12	0.00167 *	0.00103 *

* represents the value of p_L and p_U that can detect the positive mean shifts faster than the negative mean shifts, otherwise the positive and negative shifts are detected simultaneously.

Table 41 p_L and p_U profiles for $C_L < C_U$, $\alpha_3 = 2.0$, $\alpha_4 = 9.0$

Case No.	p_U	p_L	Case No.	p_U	p_L
1	0.49047	0.31212	7	0.04896 *	0.03116 *
2	0.37710	0.23997	8	0.02781 *	0.01770 *
3	0.27699	0.17627	9	0.01494 *	0.00951 *
4	0.19391	0.12340	10	0.00759 *	0.00483 *
5	0.12913	0.08217	11	0.00364 *	0.00232 *
6	0.08165 *	0.05196 *	12	0.00165 *	0.00105 *

* represents the values of p_L and p_U that can detect the positive mean shifts faster than the negative mean shifts, otherwise the positive and negative shifts are detected simultaneously.

Table 42 p_L and p_U profiles for $C_L < C_U$, $\alpha_3 = 2.5$, $\alpha_4 = 12.38$

Case No.	p_U	p_L	Case No.	p_U	p_L
1	0.48233	0.32026	7	0.04815 *	0.03197 *
2	0.37084	0.24623	8	0.02734 *	0.01816 *
3	0.27239	0.18086	9	0.01469 *	0.00976 *
4	0.19069	0.12662	10	0.00746 *	0.00496 *
5	0.12698	0.08432	11	0.00358 *	0.00238 *
6	0.08030 *	0.05332 *	12	0.00162 *	0.00108 *

* represents the values of p_L and p_U that can detect the positive mean shifts faster than the negative mean shifts, otherwise the positive and negative shifts are detected simultaneously.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This study has presented the concepts of using the probability limit control chart considered the degree of skewness and kurtosis for controlling the process average. The shifts in the mean of the data (δ) are measured in units of the process standard deviation. The ARLs are computed under the condition that a process average is increased by $\delta\sigma$ (δ = 0, ±0.5, ±1.0, ±1.5, ±2.0, ±2.5). The results of the study indicate that in the probability limit control chart is not impacted by subgroup and scale parameter of gamma distribution. The factors that should be considered for using the probability limit control chart are sample size, skewness, and kurtosis.

The research provides an experiment in case that the value of p_L and p_U for the asymmetrical control chart are hold constant at p_L = 0.00135 and p_U = 0.99865 and has the same values of the proposed method, it is found that the asymmetrical control chart with constant p_L and p_U is 38 percents win the proposed method and 64 percents win Shewhart control chart. The percentage of tie Shewhart control chart is 27 percents and 45 percents tie the proposed method. The percentage of loss Shewhart control chart is 16 percents and 9 percents loss the proposed method. The compensation of the complexity of the ARLs formulas of the asymmetrical control chart is that the asymmetrical control chart can provide 70 percents shorter ARL_1 than the proposed method and Shewhart control chart. However, there is a limitation that is the asymmetrical control chart are generally applicable to situations where the data are such that the sample averages are not normally distributed and can be approximated by a member of the Burr family; that is, any distribution whose coefficients of skewness and kurtosis are in the Burr distribution. Therefore, the proposed method becomes one choice to break down this limitation.

Although, the similar values of p_L and p_U of the asymmetrical control chart and the proposed method can make the asymmetrical control chart providing shorter

ARL_1, in practical, if the probability limits of the asymmetrical control chart is p_L = 0.00135 and p_U = 0.99865, the proposed method can sometimes provide shorter ARL_1 than the asymmetrical control chart.

1. Sample size (n)

For $C_L = C_U$, collecting more sample size for employing the proposed method is not a significant factor for the better performance of the proposed method comparing with Shewhart chart and the asymmetrical control chart. As a conclusion, detecting the shifts at -0.5 and 0.5 promptly can be performed reasonably by increasing sample size, otherwise is unnecessary. The proposed method drives more effectively of detecting the shifts by 24.5 to 26.79 percents comparing with the Shewhart control chart. Similarly, $C_L > C_U$ and $C_L < C_U$ when there is not a process shift, the proposed method can work well by not increasing the sample size. The proposed method of $C_L > C_U$ performs more effectively by 24.83 to 31.4 percents and by 19.33 to 31.4 percents for $C_L < C_U$ if collecting more sample size is performed. However, it is unnecessary to collect more sample size for reduce ARL_1 or shorten the time of detecting the negative mean shifts greater than 1 of $C_L > C_U$ and also not necessary for detecting the positive mean shifts greater than 1 of $C_L < C_U$.

Therefore, collecting more sample size is reasonably made in order to shorten the time of detecting the mean shift of -0.5 and 0.5 for $C_L = C_U$. The same idea is possibly made to shorten the time of detecting the negative mean shifts greater than 1 of $C_L > C_U$ and for the positive mean shifts greater than 1 of $C_L < C_U$.

2. Skewness (α_3) and kurtosis (α_4)

Applying the proposed method to $C_L > C_U$ and $C_L < C_U$, the effect of the degree of skewness and kurtosis can be reduced. The ability of keeping the small ARL_1 can not be dominated by the degree of skewness more than 1.5 and kurtosis more than 6.38. Similarly, the ability of keeping the length of ARL_0 is not influenced even though the degree of skewness and kurtosis are increased. However, the consequence of $C_L = C_U$ differs with the proceedings; the ability of keeping the length ARL_0 of the proposed method is decreased, if the degree of skewness is over 1.5 and kurtosis is over 6.37. However, for $C_L = C_U$, the ARL_1 is not increased even though the degree of skewness and kurtosis is increased. Therefore, the ability of detecting the positive mean shifts and the negative mean shifts for $C_L = C_U$ is not impacted if the degree of skewness is over 1.5, and kurtosis is over 6.37.

As the conclusion has previous discussed, in the production process, the manufacturer must pay attention on the quality of the product to prevent the poor quality products getting in to the market. The manufacturer also attempts to manage well for the work in processes since every step in the production can affect to the others processes. The manufacturer needs a signal as soon as possible when the process is not capable in operation, but also does not want to waste the time of producing product if everything is in control. The following tables present the conclusion of ARLs of the proposed method, Shewhart chart and the asymmetrical control chart when the process is in control and begins to get out-of-control on both the negative mean shifts and positive mean shifts (Table 39 for $C_L = C_U$, Table 40 for $C_L > C_U$, Table 41 for $C_L < C_U$). Applying the proposed method to the degree of skewness and kurtosis are concluded and the applications are separated by the cost of scrap in the process.

Table 43 Comparing average run length of the proposed method to Shewhart chart and the asymmetrical control chart for $C_L = C_U$

shift(δ)	$\alpha_3 = 0.25$ $\alpha_4 = 3.09$			$\alpha_3 = 0.5$ $\alpha_4 = 3.38$			$\alpha_3 = 1$ $\alpha_4 = 4.5$			$\alpha_3 = 1.5$ $\alpha_4 = 6.38$			$\alpha_3 = 2$ $\alpha_4 = 9$			$\alpha_3 = 2.5$ $\alpha_4 = 12.38$		
	P.C.	S.C.	A.C.	P.C.	S.C.	A.C.	P.C.	S.C.	A.C.	P.C.	S.C.	A.C.	P.C.	S.C.	A.C.	P.C.	S.C.	A.C.
2.5			*			*			*	*			*,**			*		
2			*			*			*									
1.5			*										*			*		
1	**		*	**		*	**		*	*,**			*,**			*,**		
0.5	**		*	**		*	**		*	*,**			*,**			*,**		
0		*			*			*			*			*			*	
-0.5	**		*	**		*	**		*	**			*,**			*,**		
-1	**		*	**		*	**		*	**			**			**		
-1.5																		
-2						*			*									
-2.5						*			*				*,**			*		

** represents that P.C. is more efficient than S.C. * represents that P.C.is more efficient than A.C.

Leaving three rows blank represents that ARL values of three control charts are similar.

Table 44 Comparing average run length of the proposed method to Shewhart chart and the asymmetrical control chart for $C_L > C_U$

shift(δ)	$\alpha_3 = 0.25$ $\alpha_4 = 3.09$			$\alpha_3 = 0.5$ $\alpha_4 = 3.38$			$\alpha_3 = 1$ $\alpha_4 = 4.5$			$\alpha_3 = 1.5$ $\alpha_4 = 6.38$			$\alpha_3 = 2$ $\alpha_4 = 9$			$\alpha_3 = 2.5$ $\alpha_4 = 12.38$		
	P.C.	S.C.	A.C.	P.C.	S.C.	A.C.	P.C.	S.C.	A.C.	P.C.	S.C.	A.C.	P.C.	S.C.	A.C.	P.C.	S.C.	A.C.
2.5			*			*			*	*,**			*,**			*,**		
2			*			*				*,**								
1.5			*										*			*		
1	**		*	**		*	**		*	*,**			*,**			*,**		
0.5	**		*	**		*	**		*	*,**			*,**			*,**		
0		*			*			*			*			*			*	
-0.5	**		*	**		*	**		*	*,**			*,**			*,**		
-1	**		*	**		*	**		*	**			*,**			**		
-1.5									*									
-2						*			*	*,**			*,**			*,**		
-2.5						*			*	**			*,**			*,**		

** represents that P.C. is more efficient than S.C. * represents that P.C.is more efficient than A.C.

Leaving three rows blank represents that ARL values of three control charts are similar.

Table 45 Comparing average run length of the proposed method to Shewhart chart and the asymmetrical control chart for $C_L < C_U$

shift(δ)	$\alpha_3 = 0.25$, $\alpha_4 = 3.09$			$\alpha_3 = 0.5$, $\alpha_4 = 3.38$			$\alpha_3 = 1$, $\alpha_4 = 4.5$			$\alpha_3 = 1.5$, $\alpha_4 = 6.38$			$\alpha_3 = 2$, $\alpha_4 = 9$			$\alpha_3 = 2.5$, $\alpha_4 = 12.38$		
	P.C.	S.C.	A.C.	P.C.	S.C.	A.C.	P.C.	S.C.	A.C.	P.C.	S.C.	A.C.	P.C.	S.C.	A.C.	P.C.	S.C.	A.C.
2.5			*			*			*	**			*,**			*		
2			*			*			*	*,**			*,**					
1.5			*										*			*		
1	**		*	**		*	**		*	**			*,**			*,**		
0.5	**		*	**		*	**		*	*,**			*,**			*,**		
0		*			*			*			*			*			*	
-0.5	**		*	**		*	**		*	*,**			*,**			*,**		
-1	**		*	**		*	**		*	**			**			**		
-1.5																		
-2						*			*	*,**			*,**					
-2.5						*			*	**			*,**			*		

** represents that P.C. is more efficient than S.C. * represents that P.C.is more efficient than A.C.

Leaving three rows blank represents that ARL values of three control charts are similar.

According to the conclusion tables, the asymmetrical control chart can have a chance of detecting the mean shifts faster than the proposed method and Shewhart control chart and the ability of detecting the mean shifts of the control chart can be the same by 20 percents of the cases. At the degree of skewness equal to 0.25 and the negative mean shifts larger than 1.5, the proposed method, Shewhart control chart and the asymmetrical control chart can not be dominate. Therefore, those control charts provide the same ARL_1 values. Moreover, the asymmetrical control chart detects the mean shifts promptly if the degree of skewness is less than 1.5 and kurtosis is less than 6.38. Fifty-five percents of the cases the proposed method can detect the mean shifts faster than Shewhart control chart but the asymmetrical control chart can detect the mean shifts faster than Shewhart control chart by 64 percents (27 % tie and 9% loss). However, the proposed method can detect the mean shifts faster than the asymmetrical control chart when the degree of skewness are larger than 1.5 and kurtosis is larger than 6.38 by 27 percents. As a conclusion, the proposed method can be well employed than the asymmetrical control chart if the degree of skewness and kurtosis is higher than 1.5 or kurtosis is higher than 6.38 and asymmetrical control chart can be better employed than Shewhart control chart. The asymmetrical control chart and Shewhart control chart can detect the negative mean shift as fast as the proposed method if the skewness is 0.25 and kurtosis is 3.09.

Recommendations

Considering the ARLs when both cost of scrap towards positive and negative are equal. The effective control chart must have an ability to detect the negative shifts as promptly as the negative mean shifts. When the process is out of control, the proposed method can be employed more efficiently than Shewhart control chart and the asymmetrical control chart based on the results. For $C_L > C_U$, the asymmetrical control chart is the effective of detecting the negative mean shifts. In a nature of control chart, the better control chart should detect the negative mean shifts faster than detecting the positive shifts if $C_L > C_U$. Therefore, the positive mean shift must be detected faster than the negative mean shifts if $C_L < C_U$. For $C_L < C_U$, the proposed method is an effective chart of detecting the positive mean shifts based on the previous discussions. As a result, $C_L < C_U$, the proposed method provides more benefits to the user than the asymmetrical control chart when the probability limits of the asymmetrical control chart are held constant, because the proposed method can provide the signal of the positive mean shift more promptly than the negative mean shift while the asymmetrical control chart can not do so. The user can also save cost and time of collecting data by taking small subgroup size did not affect the ARLs. Moreover, the asymmetrical control chart can be applied to the data that can be approximated by Burr's distribution. Therefore, this is the limitation of an employing the asymmetrical control chart. The asymmetrical control chart will be useless if the data can not be approximated by Burr's distribution. However, when p_L and p_U of the asymmetrical control chart has the same value of the proposed method, there is not any case that the proposed method can win the asymmetrical control chart.

Consequently, the quality manager can calculate the degree of skewness and kurtosis of the data and apply the probability limit control chart. However, the proposed method is recommended to be employed based on the results and conclusion, since the performance of the proposed method could be different, if it is applied to another situation that is excluded in the research. Further study, the proposed method could be experimented in an actual production process, different kinds of quality characteristics and also to other process distribution. One could continue the exploring by applying the proposed method with the degree of skewness that is larger than 2.0 and kurtosis is larger than 12.38 and also could study an innovative condition for determining the probability limit of the probability limit control chart and attempt to reduce the limitation of the proposed method. Moreover, one could apply the proposed method to the range chart.

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APPENDICES

Appendix A

Generating Data and Used Data

Appendix Table A1 Parameter of gamma distribution

skewness	kurtosis	shape parameter (α)	scale parameter (β)
0.25	3.09	64.00	1.00
0.50	3.38	16.00	1.00
1.00	4.50	4.00	1.00
1.50	6.38	1.78	1.00
2.00	9.00	1.00	1.00
2.50	12.38	0.64	1.00
0.25	3.09	64.00	5.00
0.50	3.38	16.00	5.00
1.00	4.50	4.00	5.00
1.50	6.38	1.78	5.00
2.00	9.00	1.00	5.00
2.50	12.38	0.64	5.00
0.25	3.09	64.00	10.00
0.50	3.38	16.00	10.00
1.00	4.50	4.00	10.00
1.50	6.38	1.78	10.00
2.00	9.00	1.00	10.00
2.50	12.38	0.64	10.00

Appendix Table A2 The results of taking sample data when γ_2 = 1, m = 10

n	α_3	α_4	$\overline{\overline{X}}$	$\sigma_{\overline{X}}$	$\overline{R}$
4	0.25	3.09	65.71	8.31	15.97
	0.50	3.38	16.66	4.31	7.11
	1.00	4.50	4.01	1.46	2.72
	1.50	6.37	1.92	1.44	2.81
	2.00	9.00	0.94	1.07	2.09
	2.50	12.38	0.87	0.98	1.92
5	0.25	3.09	62.08	6.97	13.62
	0.50	3.38	15.80	3.78	9.01
	1.00	4.50	4.08	1.90	4.32
	1.50	6.37	1.65	1.30	3.00
	2.00	9.00	0.90	0.97	2.01
	2.50	12.38	0.64	0.63	1.50

Appendix Table 3 The results of taking sample data when γ_2 = 1, m = 15

n	α_3	α_4	$\overline{\overline{X}}$	$\sigma_{\overline{X}}$	$\overline{R}$
4	0.25	3.09	63.26	9.03	19.45
	0.50	3.38	16.40	3.78	7.73
	1.00	4.50	4.09	1.87	3.88
	1.50	6.37	1.91	1.38	2.64
	2.00	9.00	0.88	0.90	1.66
	2.50	12.38	0.67	0.87	1.66
5	0.25	3.09	64.64	7.87	19.20
	0.50	3.38	16.52	4.26	10.18
	1.00	4.50	4.22	2.19	4.54
	1.50	6.37	2.18	1.46	3.29

Appendix Table A3 (Continued)

n	α_3	α_4	$\overline{\overline{X}}$	$\sigma_{\overline{X}}$	$\overline{R}$
	2.00	9.00	0.88	0.93	2.10
	2.50	12.38	0.74	0.90	1.68

Appendix Table A4 The results of taking sample data when γ_2 = 1, m = 20

n	α_3	α_4	$\overline{\overline{X}}$	$\sigma_{\overline{X}}$	$\overline{R}$
4	0.25	3.09	64.87	8.11	16.36
	0.50	3.38	15.64	3.81	8.39
	1.00	4.50	4.20	2.11	4.10
	1.50	6.37	1.69	2.11	2.78
	2.00	9.00	1.12	0.99	1.77
	2.50	12.38	0.62	0.68	1.29
5	0.25	3.09	63.98	8.68	20.79
	0.50	3.38	16.44	3.77	9.31
	1.00	4.50	4.22	1.89	4.40
	1.50	6.37	1.82	1.41	3.15
	2.00	9.00	0.98	0.97	2.09
	2.50	12.38	0.67	0.77	1.69

Appendix Table A5 The results of taking sample data when γ_2 = 1, m = 25

n	α_3	α_4	$\overline{\overline{X}}$	$\sigma_{\overline{X}}$	$\overline{R}$
4	0.25	3.09	63.05	7.20	15.05
	0.50	3.38	16.03	3.82	8.42
	1.00	4.50	4.22	2.19	3.99
	1.50	6.37	1.96	1.45	2.81
	2.00	9.00	0.89	0.94	1.73
	2.50	12.38	0.62	0.68	1.32
5	0.25	3.09	63.49	7.91	18.54
	0.50	3.38	15.78	3.58	8.24
	1.00	4.50	3.89	1.87	4.34
	1.50	6.37	1.77	1.22	2.54
	2.00	9.00	0.93	0.89	1.91
	2.50	12.38	0.66	0.78	1.66

Appendix Table A6 The results of taking sample data when γ_2 = 5, m = 10

n	α_3	α_4	$\overline{\overline{X}}$	$\sigma_{\overline{X}}$	$\overline{R}$
4	0.25	3.09	315.43	42.81	315.43
	0.50	3.38	78.54	19.76	78.54
	1.00	4.50	20.60	10.38	20.60
	1.50	6.37	8.85	6.88	8.85
	2.00	9.00	5.16	6.00	5.16
	2.50	12.38	4.35	6.08	4.35
5	0.25	3.09	62.08	6.97	62.08
	0.50	3.38	15.80	3.78	15.80
	1.00	4.50	4.08	1.90	4.08
	1.50	6.37	1.65	1.30	1.65

Appendix Table A6 (Continued)

n	α_3	α_4	$\bar{\bar{X}}$	$\sigma_{\bar{X}}$	$\bar{R}$
5	2.00	9.00	0.90	0.97	0.90
	2.50	12.38	0.64	0.63	0.64

Appendix Table A7 The results of taking sample data when γ_2 = 5, m = 15

n	α_3	α_4	$\bar{\bar{X}}$	$\sigma_{\bar{X}}$	$\bar{R}$
4	0.25	3.09	311.36	42.81	90.26
	0.50	3.38	76.46	22.48	42.26
	1.00	4.50	21.55	11.35	20.91
	1.50	6.37	8.10	5.56	11.77
	2.00	9.00	5.31	4.97	9.26
	2.50	12.38	3.29	4.58	7.24
5	0.25	3.09	315.58	40.61	88.45
	0.50	3.38	80.56	18.55	43.35
	1.00	4.50	20.58	10.71	22.92
	1.50	6.37	8.40	6.35	14.65
	2.00	9.00	4.91	4.39	10.28
	2.50	12.38	3.24	4.28	8.30

Appendix Table A8 The results of taking sample data when γ_2 = 5, m = 20

n	α_3	α_4	$\overline{\overline{X}}$	$\sigma_{\overline{X}}$	$\overline{R}$
4	0.25	3.09	328.45	34.77	63.09
	0.50	3.38	79.06	17.57	34.83
	1.00	4.50	18.55	9.71	19.55
	1.50	6.37	10.20	9.71	14.88
	2.00	9.00	5.27	4.56	9.16
	2.50	12.38	2.48	3.69	5.87
5	0.25	3.09	327.07	36.02	82.41
	0.50	3.38	77.47	18.93	44.69
	1.00	4.50	20.05	10.79	23.97
	1.50	6.37	10.25	7.08	16.40
	2.00	9.00	5.66	5.38	11.64
	2.50	12.38	2.81	3.95	7.63

Appendix Table A9 The results of taking sample data when γ_2 = 5, m = 25

n	α_3	α_4	$\overline{\overline{X}}$	$\sigma_{\overline{X}}$	$\overline{R}$
4	0.25	3.09	317.97	37.64	83.22
	0.50	3.38	78.58	19.91	41.68
	1.00	4.50	20.52	11.44	21.07
	1.50	6.37	8.72	6.67	12.50
	2.00	9.00	5.51	5.49	10.84
	2.50	12.38	3.74	4.69	8.80
5	0.25	3.09	316.65	37.84	85.87
	0.50	3.38	82.38	22.46	52.29
	1.00	4.50	18.74	10.23	22.73
	1.50	6.37	9.19	6.74	13.82

Appendix Table A9 (Continued)

n	α_3	α_4	$\overline{\overline{X}}$	$\sigma_{\overline{X}}$	$\overline{R}$
	2.00	9.00	5.29	5.52	11.23
	2.50	12.38	3.63	4.88	9.04

Appendix Table A10 The results of taking sample data when γ_2 = 10, m = 10

n	α_3	α_4	$\overline{\overline{X}}$	$\sigma_{\overline{X}}$	$\overline{R}$
4	0.25	3.09	630.87	85.61	172.02
	0.50	3.38	164.18	39.42	84.36
	1.00	4.50	43.11	20.53	40.68
	1.50	6.37	18.55	15.52	31.84
	2.00	9.00	10.98	10.52	21.56
	2.50	12.38	6.65	7.94	13.64
5	0.25	3.09	622.63	81.74	187.70
	0.50	3.38	161.53	39.09	92.49
	1.00	4.50	42.19	20.19	45.14
	1.50	6.37	19.65	16.47	37.60
	2.00	9.00	10.23	9.82	22.68
	2.50	12.38	5.91	7.32	12.91

Appendix Table A11 The results of taking sample data when γ_2 = 10, m = 15

n	α_3	α_4	$\overline{\overline{X}}$	$\sigma_{\overline{X}}$	$\overline{R}$
4	0.25	3.09	622.72	85.62	180.52
	0.50	3.38	157.89	39.30	76.71
	1.00	4.50	42.20	19.97	44.38
	1.50	6.37	19.66	15.02	34.11
	2.00	9.00	9.82	11.97	19.17
	2.50	12.38	8.71	10.35	19.64
5	0.25	3.09	631.17	81.22	176.89
	0.50	3.38	158.04	39.54	95.35
	1.00	4.50	41.03	19.26	42.39
	1.50	6.37	18.78	13.60	31.36
	2.00	9.00	10.85	11.83	24.63
	2.50	12.38	8.71	9.71	20.49

Appendix Table A12 The results of taking sample data when γ_2 = 10, m = 20

n	α_3	α_4	$\overline{\overline{X}}$	$\sigma_{\overline{X}}$	$\overline{R}$
4	0.25	3.09	656.90	69.53	126.18
	0.50	3.38	156.49	38.67	77.14
	1.00	4.50	40.72	18.61	37.38
	1.50	6.37	17.34	18.61	24.78
	2.00	9.00	12.50	12.87	25.39
	2.50	12.38	6.88	7.36	13.99
5	0.25	3.09	654.15	72.04	164.81
	0.50	3.38	160.53	39.63	87.07
	1.00	4.50	41.67	19.73	49.77
	1.50	6.37	17.25	12.59	30.04

Appendix Table A12 (Continued)

n	α_3	α_4	$\bar{\bar{X}}$	$\sigma_{\bar{X}}$	$\bar{R}$
5	2.00	9.00	11.38	12.20	24.81
	2.50	12.38	6.28	7.13	15.75

Appendix Table A13 The results of taking sample data when γ_2 = 10, m = 25

n	α_3	α_4	$\bar{\bar{X}}$	$\sigma_{\bar{X}}$	$\bar{R}$
4	0.25	3.09	635.95	75.28	166.45
	0.50	3.38	160.00	35.22	62.91
	1.00	4.50	39.48	18.77	41.20
	1.50	6.37	18.42	14.57	30.02
	2.00	9.00	9.76	9.96	18.51
	2.50	12.38	6.13	6.83	12.73
5	0.25	3.09	633.31	75.69	171.73
	0.50	3.38	154.10	37.27	88.48
	1.00	4.50	38.10	18.15	42.13
	1.50	6.37	19.34	15.91	34.77
	2.00	9.00	10.36	10.48	22.31
	2.50	12.38	7.25	8.76	16.10

Appendix B

Comparisons of ARL of control charts for $C_L = C_{U,}$ n = 4

Appendix Table B1 ARL of $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4

for case (1) $p_L = p_U = 0.00124$, (2) $p_L = p_U = 0.00274$, (3) $p_L = p_U = 0.0057$

shift (δ)	P.C.$^{(1)}$	S.C.	A.C. $^{(1)}$	P.C.$^{(2)}$	S.C.	A.C. $^{(2)}$	P.C.$^{(3)}$	S.C.	A.C. $^{(3)}$
2.5	1.0248	1.0233	1.0000 (1.0000)	1.0133	1.0233	1.0000 (1.0000)	1.0068	1.0233	1.0000 (1.0000)
2	1.1975	1.1886	1.0000 (1.0000)	1.1246	1.1886	1.0000 (1.0000)	1.0761	1.1886	1.0000 (1.0000)
1.5	2.0417	2.0000	1.0000 (1.0000)	1.7006	2.0000	1.0000 (1.0000)	1.4686	2.0000	1.0000 (1.0000)
1	6.5557	6.3030	1.0003 (1.000)	4.5783	6.3030	1.0003 (1.0000)	3.3540	6.3030	1.0003 (1.0000)
0.5	46.6612	43.8947	1.0108 (1.000)	26.4413	43.8947	1.0108 (1.0000)	15.8108	43.8947	1.0108 (1.0000)
0	403.0038	370.3983	1.0704 (0.9988)	182.5696	370.3983	1.0704 (0.9973)	87.6076	370.3983	1.0704 (0.9943)
-0.5	46.6612	43.8947	1.2160 (0.8295	26.4413	43.8947	1.2160 (0.9499)	15.8108	43.8947	1.2160 (0.9303)
-1	6.5557	6.3030	1.3355 (0.8295)	4.5783	6.3030	1.3355 (0.7998)	3.3540	6.3030	1.3355 (0.7658)
-1.5	2.0417	2.0000	1.2180 (0.6519)	1.7006	2.0000	1.2180 (0.6284)	1.4686	2.0000	1.2180 (0.6049)
-2	1.1975	1.1886	1.0572 (0.5450)	1.1246	1.1886	1.0572 (0.5355)	1.0761	1.1886	1.0572 (0.5268)
-2.5	1.0248	1.0233	1.0027 (0.5092)	1.0133	1.0233	1.0027 (0.5073)	1.0068	1.0233	1.0027 (0.5060)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table B2 ARL of α_3 = 0.25, α_4 = 3.09, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (4) $p_L = p_U$ = 0.01124, (5) $p_L = p_U$ = 0.02091, (6) $p_L = p_U$ = 0.03682

shift (δ)	P.C.(4)	S.C.	A.C. (4)	P.C.(5)	S.C.	A.C. (5)	P.C.(6)	S.C.	A.C. (6)
2.5	1.0033	1.0233	1.0000 (1.0000)	1.0015	1.0233	1.0000 (1.0000)	1.0007	1.0233	1.0000 (1.0000)
2	1.0449	1.1886	1.0000 (1.0000)	1.0254	1.1886	1.0000 (1.0000)	1.0137	1.1886	1.0000 (1.0000)
1.5	1.3097	2.0000	1.0000 (1.0000)	1.2010	2.0000	1.0000 (1.0000)	1.1273	2.0000	1.0000 (1.0000)
1	2.5716	6.3030	1.0003 (1.0000)	2.0579	6.3030	1.0003 (1.0000)	1.7133	6.3030	1.0003 (1.0000)
0.5	9.9620	43.8947	1.0108 (1.0000)	6.6023	43.8947	1.0108 (0.9997)	4.5926	43.8947	1.0108 (0.9988)
0	44.5020	370.3983	1.0704 (0.9889)	23.9126	370.3983	1.0704 (0.9795)	13.5803	370.3983	1.0704 (0.9654)
-0.5	9.9620	43.8947	1.2160 (0.9040)	6.6023	43.8947	1.2160 (0.8706)	4.5926	43.8947	1.2160 (0.8305)
-1	2.5716	6.3030	1.3355 (0.7287)	2.0579	6.3030	1.3355 (0.6902)	1.7133	6.3030	1.3355 (0.6527)
-1.5	1.3097	2.0000	1.2180 (0.5826))	1.2010	2.0000	1.2180 (0.5624)	1.1273	2.0000	1.2180 (0.5453)
-2	1.0449	1.1886	1.0572 (0.5194)	1.0254	1.1886	1.0572 (0.5136)	1.0137	1.1886	1.0572 (0.5093)
-2.5	1.0033	1.0233	1.0027 (0.5055)	1.0015	1.0233	1.0027 (0.5060)	1.0007	1.0233	1.0027 (0.5076)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table B3 ARL of $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4,

for case (7) $p_L = p_U = 0.06142$, (8) $p_L = p_U = 0.09710$, (9) $p_L = p_U = 0.14582$

shift (δ)	P.C.(7)	S.C.	A.C. (7)	P.C.(8)	S.C.	A.C. (8)	P.C.(9)	S.C.	A.C. (9)
2.5	1.0003	1.0233	1.0000 (1.0000)	1.0001	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)
2	1.0071	1.1886	1.0000 (1.0000)	1.0035	1.1886	1.0000 (1.0000)	1.0016	1.1886	1.0000 (1.0000)
1.5	1.0782	2.0000	1.0000 (1.0000)	1.0465	2.0000	1.0000 (1.0000)	1.0265	2.0000	1.0000 (1.0000)
1	1.4786	6.3030	1.0003 (1.0000)	1.3174	6.3030	1.0003 (1.0000)	1.2064	6.3030	1.0003 (0.9998)
0.5	3.3443	43.8947	1.0108 (0.9962)	2.5411	43.8947	1.0108 (0.9906)	2.0072	43.8947	1.0108 (0.9802)
0	8.1430	370.3983	1.0704 (0.9422)	5.1492	370.3983	1.0704 (0.9115)	3.4289	370.3983	1.0704 (0.8727)
-0.5	3.3443	43.8947	1.2160 (0.7855)	2.5411	43.8947	1.2160 (0.7385)	2.0072	43.8947	1.2160 (0.6925)
-1	1.4786	6.3030	1.3355 (0.6182)	1.3174	6.3030	1.3355 (0.5882)	1.2064	6.3030	1.3355 (0.5635)
-1.5	1.0782	2.0000	1.2180 (0.5316)	1.0465	2.0000	1.2180 (0.5212)	1.0265	2.0000	1.2180 (0.5139)
-2	1.0071	1.1886	1.0572 (0.5067)	1.0035	1.1886	1.0572 (0.5056)	1.0016	1.1886	1.0572((0.5039)
-2.5	1.0003	1.0233	1.0027 (0.5106)	1.0001	1.0233	1.0027 (0.5153)	1.0000	1.0233	1.0027 (0.5220)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table B4 ARL of α_3 = 0.25, α_4 = 3.09, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

fore case (10) $p_L = p_U = 0.20829$, (11) $p_L = p_U = 0.28357$, (12) $p_L = p_U = 0.36883$

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)
2	1.0007	1.1886	1.0000 (1.0000)	1.0003	1.1886	1.0000 (1.0000)	1.0001	1.1886	1.0000 (1.0000)
1.5	1.0145	2.0000	1.0000 (1.0000)	1.0075	2.0000	1.0000 (1.0000)	1.0034	2.0000	1.0000 (1.0000)
1	1.1300	6.3030	1.0003 (1.0000)	1.0772	6.3030	1.0003 (0.9957	1.0397	6.3030	1.0003 (0.9892)
0.5	1.6410	43.8947	1.0108 (0.9997)	1.3821	43.8947	1.0108 (0.9384)	1.1934	43.8947	1.0108 (0.9055)
0	2.4005	370.3983	1.0704 (0.9795)	1.7632	370.3983	1.0704 (0.7791)	1.3557	370.3983	1.0704 (0.7306)
-0.5	1.6410	43.8947	1.2160 (0.8706)	1.3821	43.8947	1.2160 (0.6137)	1.1934	43.8947	1.2160 (0.5836)
-1	1.1300	6.3030	1.3355 (0.6902)	1.0772	6.3030	1.3355 (0.5299)	1.0397	6.3030	1.3355 (0.5198)
-1.5	1.0145	2.0000	1.2180 (0.5624)	1.0075	2.0000	1.2180 (0.5064)	1.0034	2.0000	1.2180 (0.5055)
-2	1.0007	1.1886	1.0572 (0.5136)	1.0003	1.1886	1.0572 (0.5112)	1.0001	1.1886	1.0572 (0.5163)
-2.5	1.0000	1.0233	1.0027 (0.5060)	1.0000	1.0233	1.0027 (0.5425)	1.0000	1.0233	1.0027 (0.5569)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table B5 ARL of $\alpha_3 = 0.5$, $\alpha_4 = 3.38$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4

for case (1) $p_L = p_U = 0.00115$, (2) $p_L = p_U = 0.00254$, (3) $p_L = p_U = 0.00529$

shift (δ)	P.C.(1)	S.C.	A.C. (1)	P.C.(2)	S.C.	A.C. (2)	P.C.(3)	S.C.	A.C. (3)
2.5	1.0262	1.0233	1.0000	1.0142	1.0233	1.0000	1.0073	1.0233	1.0000
			(1.0000)			(1.0000)			(1.0000)
2	1.2058	1.1886	1.0000	1.1305	1.1886	1.0000	1.0804	1.1886	1.0000
			(1.0000)			(1.0000)			(1.0000)
1.5	2.0804	2.0000	1.0024	1.7287	2.0000	1.0024	1.4894	2.0000	1.0024
			(1.0000)			(1.0000)			(1.0000)
1	6.7925	6.3030	1.0337	4.7334	6.3030	1.0337	3.4597	6.3030	1.0337
			(1.0000)			(1.0000)			(1.0000)
0.5	49.2980	43.8947	1.1395	27.9012	43.8947	1.1395	16.6616	43.8947	1.1395
			(1.0000)			(1.0000)			(1.0000)
0	434.7036	370.3983	1.3874	196.9303	370.3983	1.3874	94.4987	370.3983	1.3874
			(0.9989)			(0.9989)			(0.9989)
-0.5	49.2980	43.8947	1.6079	27.9012	43.8947	1.6079	16.6616	43.8947	1.6079
			(0.9098)			(0.9098)			(0.9098)
-1	6.7925	6.3030	1.3098	4.7334	6.3030	1.3098	3.4597	6.3030	1.3098
			(0.6986)			(0.6986)			(0.6986)
-1.5	2.0804	2.0000	1.0329	1.7287	2.0000	1.0329	1.4894	2.0000	1.0329
			(0.5608)			(0.5608)			(0.5608)
-2	1.2058	1.1886	0.9638	1.1305	1.1886	0.9638	1.0804	1.1886	0.9638
			(0.5221)			(0.5221)			(0.5221)
-2.5	1.0262	1.0233	0.9715	1.0142	1.0233	0.9715	1.0073	1.0233	0.9715
			(0.5367)			(0.5367)			(0.5367)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table B6 ARL of $\alpha_3 = 0.5$, $\alpha_4 = 3.38$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4

for case (4) $p_L = p_U = 0.01042$, (5) $p_L = p_U = 0.01938$, (6) $p_L = p_U = 0.03413$

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0036	1.0233	1.0000 (1.0000)	1.0017	1.0233	1.0000 (1.0000)	1.0007	1.0233	1.0000 (1.0000)
2	1.0478	1.1886	1.0000 (1.0000)	1.0273	1.1886	1.0000 (1.0000)	1.0150	1.1886	1.0000 (1.0000)
1.5	1.3252	2.0000	1.0024 (1.0000)	1.2126	2.0000	1.0024 (1.0000)	1.1359	2.0000	1.0024 (1.0000)
1	2.6462	6.3030	1.0337 (1.0000)	2.1121	6.3030	1.0337 (1.0000)	1.7537	6.3030	1.0337 (1.0000)
0.5	10.4831	43.8947	1.1395 (1.0000)	6.9371	43.8947	1.1395 (1.0000)	4.8178	43.8947	1.1395 (1.0000)
0	48.0025	370.3983	1.3874 (0.9897)	25.7935	370.3983	1.3874 (0.9810)	14.6485	370.3983	1.3874 (0.9670)
-0.5	10.4831	43.8947	1.6079 (0.8476)	6.9371	43.8947	1.6079 (0.8172)	4.8178	43.8947	1.6079 (0.7827)
-1	2.6462	6.3030	1.3098 (0.6430)	2.1121	6.3030	1.3098 (0.6219)	1.7537	6.3030	1.3098 (0.6011)
-1.5	1.3252	2.0000	1.0329 (0.5406)	1.2126	2.0000	1.0329 (0.5343)	1.1359	2.0000	1.0329 (0.5289)
-2	1.0478	1.1886	0.9638 (0.5224)	1.0273	1.1886	0.9638 (0.5239)	1.0150	1.1886	0.9638 (0.5264)
-2.5	1.0036	1.0233	0.9715 (0.5483)	1.0017	1.0233	0.9715 (0.5545)	1.0007	1.0233	0.9715 (0.5621)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table B7 ARL of α_3 = 0.5, α_4 = 3.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (7) $p_L = p_U$ = 0.05692, (8) $p_L = p_U$ = 0.09002, (9) $p_L = p_U$ = 0.13519

shift (δ)	P.C.$^{(7)}$	S.C.	A.C. $^{(7)}$	P.C.$^{(8)}$	S.C.	A.C. $^{(8)}$	P.C.$^{(9)}$	S.C.	A.C. $^{(9)}$
2.5	1.0003	1.0233	1.0000 (1.0000)	1.0001	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)
2	1.0078	1.1886	1.0000 (1.0000)	1.0039	1.1886	1.0000 (1.0000)	1.0019	1.1886	1.0000 (1.0000)
1.5	1.0846	2.0000	1.0024 (1.0000)	1.0510	2.0000	1.0024 (1.0000)	1.0297	2.0000	1.0024 (1.0000)
1	1.5094	6.3030	1.0337 (1.0000)	1.3412	6.3030	1.0337 (1.0000)	1.2250	6.3030	1.0337 (1.0000)
0.5	3.5026	43.8947	1.1395 (1.0000)	2.6573	43.8947	1.1395 (0.9993)	2.0962	43.8947	1.1395 (0.9959)
0	8.7836	370.3983	1.3874 (0.9461)	5.5543	370.3983	1.3874 (0.9174)	3.6986	370.3983	1.3874 (0.8809)
-0.5	3.5026	43.8947	1.6079 (0.7454)	2.6573	43.8947	1.6079 (0.7072)	2.0962	43.8947	1.6079 (0.6702)
-1	1.5094	6.3030	1.3098 (0.5816)	1.3412	6.3030	1.3098 (0.5643)	1.2250	6.3030	1.3098 (0.5498)
-1.5	1.0846	2.0000	1.0329 (0.5249)	1.0510	2.0000	1.0329 (0.5224)	1.0297	2.0000	1.0329 (0.5217)
-2	1.0078	1.1886	0.9638 (0.5301)	1.0039	1.1886	0.9638 (0.5353)	1.0019	1.1886	0.9638 (0.5419)
-2.5	1.0003	1.0233	0.9715 (0.5713)	1.0001	1.0233	0.9715 (0.5822)	1.0000	1.0233	0.9715 (0.5949)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table B8 ARL of $\alpha_3 = 0.5$, $\alpha_4 = 3.38$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4

for case (10) $p_L = p_U = 0.19310$, (11) $p_L = p_U = 0.26290$, (12) $p_L = p_U = 0.34193$

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)
2	1.0009	1.1886	1.0000 (1.0000)	1.0004	1.1886	1.0000 (1.0000)	1.0002	1.1886	1.0000 (1.0000)
1.5	1.0167	2.0000	1.0024 (1.0000)	1.0089	2.0000	1.0024 (1.0000)	1.0045	2.0000	1.0024 (1.0000)
1	1.1447	6.3030	1.0337 (1.0000)	1.0891	6.3030	1.0337 (1.0000)	1.0499	6.3030	1.0337 (1.0000)
0.5	1.7121	43.8947	1.1395 (0.9873)	1.4415	43.8947	1.1395 (0.9712)	1.2453	43.8947	1.1395 (0.9460)
0	2.5893	370.3983	1.3874 (0.8382)	1.9019	370.3983	1.3874 (0.7918)	1.4623	370.3983	1.3874 (0.7452)
-0.5	1.7121	43.8947	1.6079 (0.6361)	1.4415	43.8947	1.6079 (0.6063)	1.2453	43.8947	1.6079 (0.5815)
-1	1.1447	6.3030	1.3098 (0.5384)	1.0891	6.3030	1.3098 (0.5302)	1.0499	6.3030	1.3098 (0.5249)
-1.5	1.0167	2.0000	1.0329 (0.5228)	1.0089	2.0000	1.0329 (0.5256)	1.0045	2.0000	1.0329 (0.5302)
-2	1.0009	1.1886	0.9638 (0.5502)	1.0004	1.1886	0.9638 (0.5600)	1.0002	1.1886	0.9638 (0.5713)
-2.5	1.0000	1.0233	0.9715 (0.6093)	1.0000	1.0233	0.9715 (0.6253)	1.0000	1.0233	0.9715 (0.6427)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table B9 ARL of $\alpha_3 = 1$, $\alpha_4 = 4.5$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4

for case (1) $p_L = p_U = 0.00105$, (2) $p_L = p_U = 0.00232$, (3) $p_L = p_U = 0.00483$

shift (δ)	P.C.(1)	S.C.	A.C. (1)	P.C.(2)	S.C.	A.C. (2)	P.C.(3)	S.C.	A.C. (3)
2.5	1.0279	1.0233	1.0000 (1.0000)	1.0153	1.0233	1.0000 (1.0000)	1.0080	1.0233	1.0000 (1.0000)
2	1.2161	1.1886	1.0068 (1.0000)	1.1380	1.1886	1.0068 (1.0000)	1.0857	1.1886	1.0068 (1.0000)
1.5	2.1285	2.0000	1.0766 (1.0000)	1.7638	2.0000	1.0766 (1.0000)	1.5154	2.0000	1.0766 (1.0000)
1	7.0910	6.3030	1.2344 (1.0000)	4.9288	6.3030	1.2344 (1.0000)	3.5927	6.3030	1.2344 (1.0000)
0.5	52.6811	43.8947	1.5118 (1.0000)	29.7727	43.8947	1.5118 (1.0000)	17.7513	43.8947	1.5118 (1.0000)
0	476.2264	370.3983	1.9611 (0.9990)	215.7410	370.3983	1.9611 (0.9977)	103.5252	370.3983	1.9611 (0.9952)
-0.5	52.6811	43.8947	1.5498 (0.7867)	29.7727	43.8947	1.5498 (0.7790)	17.7513	43.8947	1.5498 (0.7687)
-1	7.0910	6.3030	1.0681 (0.5980)	4.9288	6.3030	1.0681 (0.5949)	3.5927	6.3030	1.0681 (0.5908)
-1.5	2.1285	2.0000	0.9333 (0.5442)	1.7638	2.0000	0.9333 (0.5438)	1.5154	2.0000	0.9333 (0.5435)
-2	1.2161	1.1886	0.9211 (0.5556)	1.1380	1.1886	0.9211 (0.5565)	1.0857	1.1886	0.9211 (0.5578)
-2.5	1.0279	1.0233	0.9394 (0.5975)	1.0153	1.0233	0.9394 (0.5991)	1.0080	1.0233	0.9394 (0.6012)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table B10 ARL of α_3 = 1, α_4 = 4.5, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (4) $p_L = p_U$ = 0.00951, (5) $p_L = p_U$ = 0.01769, (6) $p_L = p_U$ = 0.03116

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0040	1.0233	1.0000 (1.0000)	1.0019	1.0233	1.0000 (1.0000)	1.0009	1.0233	1.0000 (1.0000)
2	1.0515	1.1886	1.0068 (1.0000)	1.0298	1.1886	1.0068 (1.0000)	1.0166	1.1886	1.0068 (1.0000)
1.5	1.3446	2.0000	1.0766 (1.0000)	1.2271	2.0000	1.0766 (1.0000)	1.1468	2.0000	1.0766 (1.0000)
1	2.7399	6.3030	1.2344 (1.0000)	2.1803	6.3030	1.2344 (1.0000)	1.8046	6.3030	1.2344 (1.0000)
0.5	11.1497	43.8947	1.5118 (1.0000)	7.3650	43.8947	1.5118 (1.0000)	5.1054	43.8947	1.5118 (1.0000)
0	52.5877	370.3983	1.9611 (0.9906)	28.2573	370.3983	1.9611 (0.9826)	16.0477	370.3983	1.9611 (0.9698)
-0.5	11.1497	43.8947	1.5498 (0.7555)	7.3650	43.8947	1.5498 (0.7392)	5.1054	43.8947	1.5498 (0.7199)
-1	2.7399	6.3030	1.0681 (0.5858)	2.1803	6.3030	1.0681 (0.5799)	1.8046	6.3030	1.0681 (0.5733)
-1.5	1.3446	2.0000	0.9333 (0.5431)	1.2271	2.0000	0.9333 (0.5429)	1.1468	2.0000	0.9333 (0.5429)
-2	1.0515	1.1886	0.9211 (0.5595)	1.0298	1.1886	0.9211 (0.5618)	1.0166	1.1886	0.9211 (0.5648)
-2.5	1.0040	1.0233	0.9394 (0.6040)	1.0019	1.0233	0.9394 (0.6076)	1.0009	1.0233	0.9394 (0.6122)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table B11 ARL of α_3 = 1, α_4 = 4.5, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (7) $p_L = p_U$ = 0.05196, (8) $p_L = p_U$ = 0.08217 , (9) $p_L = p_U$ = 0.12340

shift (δ)	P.C.$^{(7)}$	S.C.	A.C. $^{(7)}$	P.C.$^{(8)}$	S.C.	A.C. $^{(8)}$	P.C.$^{(9)}$	S.C.	A.C. $^{(9)}$
2.5	1.0004	1.0233	1.000 (1.0000)	1.0002	1.0233	1.000 (1.0000)	1.0001	1.0233	1.000 (1.0000)
2	1.0089	1.1886	1.0068 (1.0000)	1.0046	1.1886	1.0068 (1.0000)	1.0022	1.1886	1.0068 (1.0000)
1.5	1.0926	2.0000	1.0766 (1.0000)	1.0568	2.0000	1.0766 (1.0000)	1.0338	2.0000	1.0766 (1.0000)
1	1.5482	6.3030	1.2344 (1.0000)	1.3713	6.3030	1.2344 (1.0000)	1.2487	6.3030	1.2344 (1.0000)
0.5	3.7046	43.8947	1.5118 (1.0000)	2.8054	43.8947	1.5118 (1.0000)	2.2094	43.8947	1.5118 (1.0000)
0	9.6226	370.3983	1.9611 (0.9506)	6.0848	370.3983	1.9611 (0.9241)	4.0519	370.3983	1.9611 (0.8902)
-0.5	3.7046	43.8947	1.5498 (0.6982)	2.8054	43.8947	1.5498 (0.6749)	2.2094	43.8947	1.5498 (0.6510)
-1	1.5482	6.3030	1.0681 (0.5665)	1.3713	6.3030	1.0681 (0.5599)	1.2487	6.3030	1.0681 (0.5538)
-1.5	1.0926	2.0000	0.9333 (0.5434)	1.0568	2.0000	0.9333 (0.5445)	1.0338	2.0000	0.9333 (0.5465)
-2	1.0089	1.1886	0.9211 (0.5686)	1.0046	1.1886	0.9211 (0.5734)	1.0022	1.1886	0.9211 (0.5791)
-2.5	1.0004	1.0233	0.9394 (0.6178)	1.0002	1.0233	0.9394 (0.6245)	1.0001	1.0233	0.9394 (0.6323)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table B12 ARL of $\alpha_3 = 1,\ \alpha_4 = 4.5,\ \gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4,

for case (10) $p_L = p_U = 0.17627$, (11) $p_L = p_U = 0.23997$, (12) $p_L = p_U = 0.31212$

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)
2	1.0011	1.1886	1.0068 (1.0000)	1.0005	1.1886	1.0068 (1.0000)	1.0002	1.1886	1.0068 (1.0000)
1.5	1.0195	2.0000	1.0766 (1.0000)	1.0109	2.0000	1.0766 (1.0000)	1.0058	2.0000	1.0766 (1.0000)
1	1.1635	6.3030	1.2344 (1.0000)	1.1044	6.3030	1.2344 (1.0000)	1.0628	6.3030	1.2344 (1.0000)
0.5	1.8023	43.8947	1.5118 (1.0000)	1.5164	43.8947	1.5118 (1.0000)	1.3103	43.8947	1.5118 (0.9931)
0	2.8366	370.3983	1.9611 (0.8501)	2.0836	370.3983	1.9611 (0.8065)	1.6020	370.3983	1.9611 (0.7621)
-0.5	1.8023	43.8947	1.5498 (0.6277)	1.5164	43.8947	1.5498 (0.6065)	1.3103	43.8947	1.5498 (0.5883)
-1	1.1635	6.3030	1.0681 (0.5489)	1.1044	6.3030	1.0681 (0.5453)	1.0628	6.3030	1.0681 (0.5433)
-1.5	1.0195	2.0000	0.9333 (0.5495)	1.0109	2.0000	0.9333 (0.5535)	1.0058	2.0000	0.9333 (0.5586)
-2	1.0011	1.1886	0.9211 (0.5859)	1.0005	1.1886	0.9211 (0.5938)	1.0002	1.1886	0.9211 (0.6025)
-2.5	1.0000	1.0233	0.9394 (0.6412)	1.0000	1.0233	0.9394 (0.6511)	1.0000	1.0233	0.9394 (0.6619)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table B13 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (1) $p_L = p_U$ = 0.00103, (2) $p_L = p_U$ = 0.00228, (3) $p_L = p_U$ = 0.00475

shift (δ)	P.C.$^{(1)}$	S.C.	A.C. $^{(1)}$	P.C.$^{(2)}$	S.C.	A.C. $^{(2)}$	P.C.$^{(3)}$	S.C.	A.C. $^{(3)}$
2.5	1.0283	1.0233	1.0018 (1.0000)	1.0155	1.0233	1.0018 (1.0000)	1.0081	1.0233	1.0018 (1.0000)
2	1.2180	1.1886	1.1212 (1.0000)	1.1394	1.1886	1.1212 (1.0000)	1.0867	1.1886	1.1212 (1.0000)
1.5	2.1375	2.0000	1.4752 (1.0000)	1.7703	2.0000	1.4752 (1.0000)	1.5202	2.0000	1.4752 (1.0000)
1	7.1473	6.3030	2.2129 (1.0000)	4.9656	6.3030	2.2129 (1.0000)	3.6178	6.3030	2.2129 (1.0000)
0.5	53.3263	43.8947	3.6453 (1.0000)	30.1294	43.8947	3.6453 (1.0000)	17.9588	43.8947	3.6453 (1.0000)
0	484.2503	370.3983	6.3110 (0.9990)	219.3760	370.3983	6.3110 (0.9977)	105.2695	370.3983	6.3110 (0.9953)
-0.5	53.3263	43.8947	2.4161 (0.7559)	30.1294	43.8947	2.4161 (0.7489)	17.9588	43.8947	2.4161 (0.7397)
-1	7.1473	6.3030	1.2789 (0.5832)	4.9656	6.3030	1.2789 (0.5814)	3.6178	6.3030	1.2789 (0.5790)
-1.5	2.1375	2.0000	1.0593 (0.5708)	1.7703	2.0000	1.0593 (0.5717)	1.5202	2.0000	1.0593 (0.5730)
-2	1.2180	1.1886	1.0098 (0.6315)	1.1394	1.1886	1.0098 (0.6336)	1.0867	1.1886	1.0098 (0.6365)
-2.5	1.0283	1.0233	0.9993 (0.7220)	1.0155	1.0233	0.9993 (0.7244)	1.0081	1.0233	0.9993 (0.7277)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table B14 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (4) $p_L = p_U$ = 0.00935, (5) $p_L = p_U$ = 0.01740, (6) $p_L = p_U$ = 0.03064

shift (δ)	P.C.$^{(4)}$	S.C.	A.C.$^{(4)}$	P.C.$^{(5)}$	S.C.	A.C.$^{(5)}$	P.C.$^{(6)}$	S.C.	A.C.$^{(6)}$
2.5	1.0041	1.0233	1.0018 (1.0000)	1.0019	1.0233	1.0018 (1.0000)	1.0009	1.0233	1.0018 (1.0000)
2	1.0522	1.1886	1.1212 (1.0000)	1.0303	1.1886	1.1212 (1.0000)	1.0169	1.1886	1.1212 (1.0000)
1.5	1.3483	2.0000	1.4752 (1.0000)	1.2299	2.0000	1.4752 (1.0000)	1.1488	2.0000	1.4752 (1.0000)
1	2.7576	6.3030	2.2129 (1.0000)	2.1931	6.3030	2.2129 (1.0000)	1.8142	6.3030	2.2129 (1.0000)
0.5	11.2767	43.8947	3.6453 (1.0000)	7.4464	43.8947	3.6453 (1.0000)	5.1601	43.8947	3.6453 (1.0000)
0	53.4738	370.3983	6.3110 (0.9907)	28.7334	370.3983	6.3110 (0.9829)	16.3181	370.3983	6.3110 (0.9703)
-0.5	11.2767	43.8947	2.4161 (0.7278)	7.4464	43.8947	2.4161 (0.7134)	5.1601	43.8947	2.4161 (0.6964)
-1	2.7576	6.3030	1.2789 (0.5762)	2.1931	6.3030	1.2789 (0.5731)	1.8142	6.3030	1.2789 (0.5699)
-1.5	1.3483	2.0000	1.0593 (0.5748)	1.2299	2.0000	1.0593 (0.5773)	1.1488	2.0000	1.0593 (0.5806)
-2	1.0522	1.1886	1.0098 (0.6403)	1.0303	1.1886	1.0098 (0.6453)	1.0169	1.1886	1.0098 (0.6516)
-2.5	1.0041	1.0233	0.9993 (0.7321)	1.0019	1.0233	0.9993 (0.7376)	1.0009	1.0233	0.9993 (0.7444)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table B15 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (7) $p_L = p_U$ = 0.05110, (8) $p_L = p_U$ = 0.08081,(9) $p_L = p_U$ = 0.12135

shift (δ)	P.C.(7)	S.C.	A.C. (7)	P.C.(8)	S.C.	A.C. (8)	P.C.(9)	S.C.	A.C. (9)
2.5	1.0004	1.0233	1.0018 (1.0000)	1.0002	1.0233	1.0018 (1.0000)	1.0001	1.0233	1.0018 (1.0000)
2	1.0091	1.1886	1.1212 (1.0000)	1.0047	1.1886	1.1212 (1.0000)	1.0023	1.1886	1.1212 (1.0000)
1.5	1.0941	2.0000	1.4752 (1.0000)	1.0579	2.0000	1.4752 (1.0000)	1.0346	2.0000	1.4752 (1.0000)
1	1.5556	6.3030	2.2129 (1.0000)	1.3770	6.3030	2.2129 (1.0000)	1.2531	6.3030	2.2129 (1.0000)
0.5	3.7430	43.8947	3.6453 (1.0000)	2.8335	43.8947	3.6453 (1.0000)	2.2308	43.8947	3.6453 (1.0000)
0	9.7847	370.3983	6.3110 (0.9514)	6.1873	370.3983	6.3110 (0.9252)	4.1202	370.3983	6.3110 (0.8918)
-0.5	3.7430	43.8947	2.4161 (0.6775)	2.8335	43.8947	2.4161 (0.6572)	2.2308	43.8947	2.4161 (0.6366)
-1	1.5556	6.3030	1.2789 (0.5670)	1.3770	6.3030	1.2789 (0.5647)	1.2531	6.3030	1.2789 (0.5636)
-1.5	1.0941	2.0000	1.0593 (0.5851)	1.0579	2.0000	1.0593 (0.5908)	1.0346	2.0000	1.0593 (0.5980)
-2	1.0091	1.1886	1.0098 (0.6593)	1.0047	1.1886	1.0098 (0.6684)	1.0023	1.1886	1.0098 (0.6791)
-2.5	1.0004	1.0233	0.9993 (0.7526)	1.0002	1.0233	0.9993 (0.7620)	1.0001	1.0233	0.9993 (0.7727)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table B16 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (10) $p_L = p_U$ = 0.17335, (11) $p_L = p_U$ = 0.2360, (12) $p_L = p_U$ = 0.30695

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0233	1.0018 (1.0000)	1.0000	1.0233	1.0018 (1.0000)	1.0000	1.0233	1.0018 (1.0000)
2	1.0011	1.1886	1.1212 (1.0000)	1.0005	1.1886	1.1212 (1.0000)	1.0002	1.1886	1.1212 (1.0000)
1.5	1.0201	2.0000	1.4752 (1.0000)	1.0113	2.0000	1.4752 (1.0000)	1.0061	2.0000	1.4752 (1.0000)
1	1.1671	6.3030	2.2129 (1.0000)	1.1073	6.3030	2.2129 (1.0000)	1.0653	6.3030	2.2129 (1.0000)
0.5	1.8194	43.8947	3.6453 (1.0000)	1.5306	43.8947	3.6453 (1.0000)	1.3226	43.8947	3.6453 (0.9999)
0	2.8844	370.3983	6.3110 (0.8523)	2.1187	370.3983	6.3110 (0.8091)	1.6290	370.3983	6.3110 (0.7651)
-0.5	1.8194	43.8947	2.4161 (0.6170)	1.5306	43.8947	2.4161 (0.5998)	1.3226	43.8947	2.4161 (0.5858)
-1	1.1671	6.3030	1.2789 (0.5638)	1.1073	6.3030	1.2789 (0.5658)	1.0653	6.3030	1.2789 (0.5697)
-1.5	1.0201	2.0000	1.0593 (0.6067)	1.0113	2.0000	1.0593 (0.6170)	1.0061	2.0000	1.0593 (0.6288)
-2	1.0011	1.1886	1.0098 (0.6912)	1.0005	1.1886	1.0098 (0.7045)	1.0002	1.1886	1.0098 (0.7188)
-2.5	1.0000	1.0233	0.9993 (0.7843)	1.0000	1.0233	0.9993 (0.7967)	1.0000	1.0233	0.9993 (0.8096)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table B17 ARL of $\alpha_3 = 2$, $\alpha_4 = 9$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4

for case (1) $p_L = p_U = 0.00105$, (2) $p_L = p_U = 0.00232$, (3) $p_L = p_U = 0.00438$

shift (δ)	P.C.(1)	S.C.	A.C. (1)	P.C.(2)	S.C.	A.C. (2)	P.C.(3)	S.C.	A.C. (3)
2.5	1.0279	1.0233	1.0914 (1.0000)	1.0153	1.0233	1.0914 (1.0000)	1.0080	1.0233	1.0914 (1.0000)
2	1.2161	1.1886	1.5687 (1.0000)	1.1380	1.1886	1.5687 (1.0000)	1.0857	1.1886	1.5687 (1.0000)
1.5	2.1285	2.0000	2.7468 (1.0000)	1.7638	2.0000	2.7468 (1.0000)	1.5154	2.0000	2.7468 (1.0000)
1	7.0910	6.3030	5.3154 (1.0000)	4.9288	6.3030	5.3154 (1.0000)	3.5927	6.3030	5.3154 (1.0000)
0.5	52.6811	43.8947	10.5919 (1.0000)	29.7727	43.8947	10.5919 (1.0000)	17.7513	43.8947	10.5919 (1.0000)
0	476.2264	370.3983	20.2987 (0.9990)	215.7410	370.3983	20.2987 (0.9977)	103.5252	370.3983	20.2987 (0.9952)
-0.5	52.6811	43.8947	2.4948 (0.7286)	29.7727	43.8947	2.4948 (0.7223)	17.7513	43.8947	2.4948 (0.7139)
-1	7.0910	6.3030	1.2670 (0.5785)	4.9288	6.3030	1.2670 (0.5778)	3.5927	6.3030	1.2670 (0.5770)
-1.5	2.1285	2.0000	1.0663 (0.6137)	1.7638	2.0000	1.0663 (0.6156)	1.5154	2.0000	1.0663 (0.6184)
-2	1.2161	1.1886	1.0188 (0.7196)	1.1380	1.1886	1.0188 (0.7224)	1.0857	1.1886	1.0188 (0.7260)
-2.5	1.0279	1.0233	1.0057 (0.8280)	1.0153	1.0233	1.0057 (0.8302)	1.0080	1.0233	1.0057 (0.8332)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table B18 ARL of $\alpha_3 = 2$, $\alpha_4 = 9$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4

for case (4) $p_L = p_U = 0.00951$, (5) $p_L = p_U = 0.01769$, (6) $p_L = p_U = 0.03116$

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0040	1.0233	1.0914 (1.0000)	1.0019	1.0233	1.0914 (1.0000)	1.0009	1.0233	1.0914 (1.0000)
2	1.0515	1.1886	1.5687 (1.0000)	1.0298	1.1886	1.5687 (1.0000)	1.0166	1.1886	1.5687 (1.0000)
1.5	1.3446	2.0000	2.7468 (1.0000)	1.2271	2.0000	2.7468 (1.0000)	1.1468	2.0000	2.7468 (1.0000)
1	2.7399	6.3030	5.3154 (1.0000)	2.1803	6.3030	5.3154 (1.0000)	1.8046	6.3030	5.3154 (1.0000)
0.5	11.1497	43.8947	10.5919 (1.0000)	7.3650	43.8947	10.5919 (1.0000)	5.1054	43.8947	10.5919 (1.0000)
0	52.5877	370.3983	20.2987 (0.9906)	28.2573	370.3983	20.2987 (0.9826)	16.0477	370.3983	20.2987 (0.9698)
-0.5	11.1497	43.8947	2.4948 (0.7033)	7.3650	43.8947	2.4948 (0.6904)	5.1054	43.8947	2.4948 (0.6753)
-1	2.7399	6.3030	1.2670 (0.5762)	2.1803	6.3030	1.2670 (0.5756)	1.8046	6.3030	1.2670 (0.5755)
-1.5	1.3446	2.0000	1.0663 (0.6221)	1.2271	2.0000	1.0663 (0.6270)	1.1468	2.0000	1.0663 (0.6333)
-2	1.0515	1.1886	1.0188 (0.7309)	1.0298	1.1886	1.0188 (0.7370)	1.0166	1.1886	1.0188 (0.7446)
-2.5	1.0040	1.0233	1.0057 (0.8370)	1.0019	1.0233	1.0057 (0.8418)	1.0009	1.0233	1.0057 (0.8476)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table B19 ARL of $\alpha_3 = 2$, $\alpha_4 = 9$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4

for case (7) $p_L = p_U = 0.05196$, (8) $p_L = p_U = 0.08217$, (9) $p_L = p_U = 0.12340$

shift (δ)	P.C.$^{(7)}$	S.C.	A.C. $^{(7)}$	P.C.$^{(8)}$	S.C.	A.C. $^{(8)}$	P.C.$^{(9)}$	S.C.	A.C. $^{(9)}$
2.5	1.0004	1.0233	1.0914 (1.0000)	1.0002	1.0233	1.0914 (1.0000)	1.0001	1.0233	1.0914 (1.0000)
2	1.0089	1.1886	1.5687 (1.0000)	1.0046	1.1886	1.5687 (1.0000)	1.0022	1.1886	1.5687 (1.0000)
1.5	1.0926	2.0000	2.7468 (1.0000)	1.0568	2.0000	2.7468 (1.0000)	1.0338	2.0000	2.7468 (1.0000)
1	1.5482	6.3030	5.3154 (1.0000)	1.3713	6.3030	5.3154 (1.0000)	1.2487	6.3030	5.3154 (1.0000)
0.5	3.7046	43.8947	10.5919 (1.0000)	2.8054	43.8947	10.5919 (1.0000)	2.2094	43.8947	10.5919 (1.0000)
0	9.6226	370.3983	20.2987 (0.9506)	6.0848	370.3983	20.2987 (0.9241)	4.0519	370.3983	20.2987 (0.8902)
-0.5	3.7046	43.8947	2.4948 (0.6586)	2.8054	43.8947	2.4948 (0.6408)	2.2094	43.8947	2.4948 (0.6229)
-1	1.5482	6.3030	1.2670 (0.5761)	1.3713	6.3030	1.2670 (0.5780)	1.2487	6.3030	1.2670 (0.5815)
-1.5	1.0926	2.0000	1.0663 (0.6411)	1.0568	2.0000	1.0663 (0.6507)	1.0338	2.0000	1.0663 (0.6620)
-2	1.0089	1.1886	1.0188 (0.7536)	1.0046	1.1886	1.0188 (0.7641)	1.0022	1.1886	1.0188 (0.7759)
-2.5	1.0004	1.0233	1.0057 (0.8544)	1.0002	1.0233	1.0057 (0.8621)	1.0001	1.0233	1.0057 (0.8705)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table B20 ARL of $\alpha_3 = 2$, $\alpha_4 = 9$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4

for case (10) $p_L = p_U = 0.17627$, (11) $p_L = p_U = 0.23997$, (12) $p_L = p_U = 0.31212$

shift (δ)	P.C.(10)	S.C.	A.C. (10)	P.C.(11)	S.C.	A.C. (11)	P.C.(12)	S.C.	A.C. (12)
2.5	1.0000	1.0233	1.0914 (1.0000)	1.0000	1.0233	1.0914 (1.0000)	1.0000	1.0233	1.0914 (1.0000)
2	1.0011	1.1886	1.5687 (1.0000)	1.0005	1.1886	1.5687 (1.0000)	1.0002	1.1886	1.5687 (1.0000)
1.5	1.0195	2.0000	2.7468 (1.0000)	1.0109	2.0000	2.7468 (1.0000)	1.0058	2.0000	2.7468 (1.0000)
1	1.1635	6.3030	5.3154 (1.0000)	1.1044	6.3030	5.3154 (1.0000)	1.0628	6.3030	5.3154 (1.0000)
0.5	1.8023	43.8947	10.5919 (1.0000)	1.5164	43.8947	10.5919 (1.0000)	1.3103	43.8947	10.5919 (1.0000)
0	2.8366	370.3983	20.2987 (0.8501)	2.0836	370.3983	20.2987 (0.8065)	1.6020	370.3983	20.2987 (0.7621)
-0.5	1.8023	43.8947	2.4948 (0.6067)	1.5164	43.8947	2.4948 (0.5933)	1.3103	43.8947	2.4948 (0.5835)
-1	1.1635	6.3030	1.2670 (0.5869)	1.1044	6.3030	1.2670 (0.5945)	1.0628	6.3030	1.2670 (0.6043)
-1.5	1.0195	2.0000	1.0663 (0.6752)	1.0109	2.0000	1.0663 (0.6900)	1.0058	2.0000	1.0663 (0.7062)
-2	1.0011	1.1886	1.0188 (0.7888)	1.0005	1.1886	1.0188 (0.8026)	1.0002	1.1886	1.0188 (0.8168)
-2.5	1.0000	1.0233	1.0057 (0.8794)	1.0000	1.0233	1.0057 (0.8885)	1.0000	1.0233	1.0057 (0.8977)

(x) represents case x^{th} at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table B21 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (1) $p_L = p_U$ = 0.00108, (2) $p_L = p_U$ = 0.00238, (3) $p_L = p_U$ = 0.00496

shift (δ)	P.C.(1)	S.C.	A.C. (1)	P.C.(2)	S.C.	A.C. (2)	P.C.(3)	S.C.	A.C. (3)
2.5	1.0274	1.0233	1.0914 (1.0000)	1.0150	1.0233	1.0914 (1.0000)	1.0078	1.0233	1.0914 (1.0000)
2	1.2131	1.1886	1.5687 (1.0000)	1.1359	1.1886	1.5687 (1.0000)	1.0842	1.1886	1.5687 (1.0000)
1.5	2.1147	2.0000	2.7468 (1.0000)	1.7538	2.0000	2.7468 (1.0000)	1.5079	2.0000	2.7468 (1.0000)
1	7.0053	6.3030	5.3154 (1.0000)	4.8727	6.3030	5.3154 (1.0000)	3.5546	6.3030	5.3154 (1.0000)
0.5	51.7027	43.8947	10.5919 (1.0000)	29.2317	43.8947	10.5919 (1.0000)	17.4364	43.8947	10.5919 (1.0000)
0	464.1226	370.3983	20.2987 (0.9989)	210.2577	370.3983	20.2987 (0.9976)	100.8940	370.3983	20.2987 (0.9951)
-0.5	51.7027	43.8947	2.4948 (0.7285)	29.2317	43.8947	2.4948 (0.7221)	17.4364	43.8947	2.4948 (0.7136)
-1	7.0053	6.3030	1.2670 (0.5785)	4.8727	6.3030	1.2670 (0.5778)	3.5546	6.3030	1.2670 (0.5770)
-1.5	2.1147	2.0000	1.0663 (0.6137)	1.7538	2.0000	1.0663 (0.6157)	1.5079	2.0000	1.0663 (0.6185)
-2	1.2131	1.1886	1.0188 (0.7197)	1.1359	1.1886	1.0188 (0.7225)	1.0842	1.1886	1.0188 (0.7262)
-2.5	1.0274	1.0233	1.0057 (0.8281)	1.0150	1.0233	1.0057 (0.8303)	1.0078	1.0233	1.0057 (0.8333)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table B22 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (4) $p_L = p_U$ = 0.00976, (5) $p_L = p_U$ = 0.01816, (6) $p_L = p_U$ = 0.03197

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0039	1.0233	1.0914 (1.0000)	1.0018	1.0233	1.0914 (1.0000)	1.0008	1.0233	1.0914 (1.0000)
2	1.0504	1.1886	1.5687 (1.0000)	1.0291	1.1886	1.5687 (1.0000)	1.0161	1.1886	1.5687 (1.0000)
1.5	1.3391	2.0000	2.7468 (1.0000)	1.2230	2.0000	2.7468 (1.0000)	1.1437	2.0000	2.7468 (1.0000)
1	2.7130	6.3030	5.3154 (1.0000)	2.1607	6.3030	5.3154 (1.0000)	1.7900	6.3030	5.3154 (1.0000)
0.5	10.9572	43.8947	10.5919 (1.0000)	7.2414	43.8947	10.5919 (1.0000)	5.0224	43.8947	10.5919 (1.0000)
0	51.2511	370.3983	20.2987 (0.9903)	27.5391	370.3983	20.2987 (0.9822)	15.6398	370.3983	20.2987 (0.9690)
-0.5	10.9572	43.8947	2.4948 (0.7028)	7.2414	43.8947	2.4948 (0.6897)	5.0224	43.8947	2.4948 (0.6745)
-1	2.7130	6.3030	1.2670 (0.5762)	2.1607	6.3030	1.2670 (0.5756)	1.7900	6.3030	1.2670 (0.5755)
-1.5	1.3391	2.0000	1.0663 (0.6223)	1.2230	2.0000	1.0663 (0.6272)	1.1437	2.0000	1.0663 (0.6336)
-2	1.0504	1.1886	1.0188 (0.7311)	1.0291	1.1886	1.0188 (0.7373)	1.0161	1.1886	1.0188 (0.7450)
-2.5	1.0039	1.0233	1.0057 (0.8372)	1.0018	1.0233	1.0057 (0.8421)	1.0008	1.0233	1.0057 (0.8479)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table B23 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (7) $p_L = p_U = 0.05332$, (8) $p_L = p_U = 0.08432$, (9) $p_L = p_U = 0.12662$

shift (δ)	P.C.(7)	S.C.	A.C. (7)	P.C.(8)	S.C.	A.C. (8)	P.C.(9)	S.C.	A.C. (9)
2.5	1.0004	1.0233	1.0914 (1.0000)	1.0001	1.0233	1.0914 (1.0000)	1.0001	1.0233	1.0914 (1.0000)
2	1.0086	1.1886	1.5687 (1.0000)	1.0044	1.1886	1.5687 (1.0000)	1.0021	1.1886	1.5687 (1.0000)
1.5	1.0903	2.0000	2.7468 (1.0000)	1.0551	2.0000	2.7468 (1.0000)	1.0326	2.0000	2.7468 (1.0000)
1	1.5371	6.3030	5.3154 (1.0000)	1.3627	6.3030	5.3154 (1.0000)	1.2419	6.3030	5.3154 (1.0000)
0.5	3.6463	43.8947	10.5919 (1.0000)	2.7627	43.8947	10.5919 (1.0000)	2.1767	43.8947	10.5919 (1.0000)
0	9.3780	370.3983	20.2987 (0.9494)	5.9301	370.3983	20.2987 (0.9222)	3.9489	370.3983	20.2987 (0.8876)
-0.5	3.6463	43.8947	2.4948 (0.6577)	2.7627	43.8947	2.4948 (0.6398)	2.1767	43.8947	2.4948 (0.6217)
-1	1.5371	6.3030	1.2670 (0.5762)	1.3627	6.3030	1.2670 (0.5782)	1.2419	6.3030	1.2670 (0.5818)
-1.5	1.0903	2.0000	1.0663 (0.6416)	1.0551	2.0000	1.0663 (0.6513)	1.0326	2.0000	1.0663 (0.6629)
-2	1.0086	1.1886	1.0188 (0.7541)	1.0044	1.1886	1.0188 (0.7648)	1.0021	1.1886	1.0188 (0.7768)
-2.5	1.0004	1.0233	1.0057 (0.8548)	1.0001	1.0233	1.0057 (0.8626)	1.0001	1.0233	1.0057 (0.8711)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table B24 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (10) $p_L = p_U$ = 0.18086, (11) $p_L = p_U$ = 0.24623, (12) $p_L = p_U$ = 0.32026

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0233	1.0914 (1.0000)	1.0000	1.0233	1.0914 (1.0000)	1.0000	1.0233	1.0914 (1.0000)
2	1.0010	1.1886	1.5687 (1.0000)	1.0005	1.1886	1.5687 (1.0000)	1.0002	1.1886	1.5687 (1.0000)
1.5	1.0187	2.0000	2.7468 (1.0000)	1.0103	2.0000	2.7468 (1.0000)	1.0054	2.0000	2.7468 (1.0000)
1	1.1581	6.3030	5.3154 (1.0000)	1.1000	6.3030	5.3154 (1.0000)	1.0591	6.3030	5.3154 (1.0000)
0.5	1.7763	43.8947	10.5919 (1.0000)	1.4949	43.8947	10.5919 (1.0000)	1.2917	43.8947	10.5919 (1.0000)
0	2.7645	370.3983	20.2987 (0.8468)	2.0306	370.3983	20.2987 (0.8024)	1.5612	370.3983	20.2987 (0.7574)
-0.5	1.7763	43.8947	2.4948 (0.6055)	1.4949	43.8947	2.4948 (0.5923)	1.2917	43.8947	2.4948 (0.5827)
-1	1.1581	6.3030	1.2670 (0.5874)	1.1000	6.3030	1.2670 (0.5953)	1.0591	6.3030	1.2670 (0.6055)
-1.5	1.0187	2.0000	1.0663 (0.6763)	1.0103	2.0000	1.0663 (0.6914)	1.0054	2.0000	1.0663 (0.7080)
-2	1.0010	1.1886	1.0188 (0.7899)	1.0005	1.1886	1.0188 (0.8038)	1.0002	1.1886	1.0188 (0.8183)
-2.5	1.0000	1.0233	1.0057 (0.8801)	1.0000	1.0233	1.0057 (0.8894)	1.0000	1.0233	1.0057 (0.8987)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix C

Comparisons of ARL of control charts for $C_L = C_U$, n = 5

Appendix Table C1 ARL of α_3 = 0.25, α_4 = 3.09, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (1) $p_L = p_U$ = 0.00124, (2) $p_L = p_U$ = 0.00274, (3) $p_L = p_U$ = 0.0057

shift (δ)	P.C.$^{(1)}$	S.C.	A.C. $^{(1)}$	P.C.$^{(2)}$	S.C.	A.C. $^{(2)}$	P.C.$^{(3)}$	S.C.	A.C. $^{(3)}$
2.5	1.0052	1.0048	1.0000 (1.0000)	1.0025	1.0048	1.0000 (1.0000)	1.0011	1.0048	1.0000 (1.0000)
2	1.0799	1.0758	1.0000 (1.0000)	1.0472	1.0758	1.0000 (1.0000)	1.0267	1.0758	1.0000 (1.0000)
1.5	1.5905	1.5665	1.0000 (1.0000)	1.3930	1.5665	1.0000 (1.0000)	1.2577	1.5665	1.0000 (1.0000)
1	4.6533	4.4953	1.0001 (1.0000)	3.4003	4.4953	1.0001 (1.0000)	2.6008	4.4953	1.0001 (1.0000)
0.5	35.4102	33.4008	1.0081 (1.0000)	20.5944	33.4008	1.0081 (1.0000)	12.6343	33.4008	1.0081 (1.0000)
0	403.0038	370.3983	1.0704 (0.9988)	182.5696	370.3983	1.0704 (0.9973)	87.6076	370.3983	1.070 (0.9943)
-0.5	35.4102	33.4008	1.2365 (0.9541)	20.5944	33.4008	1.2365 (0.9376)	12.6343	33.4008	1.2365 (0.9154)
-1	4.6533	4.4953	1.3294 (0.7860)	3.4003	4.4953	1.3294 (0.7557)	2.6008	4.4953	1.3294 (0.7223)
-1.5	1.5905	1.5665	1.1507 (0.6037)	1.3930	1.5665	1.1507 (0.5855)	1.2577	1.5665	1.1507 (0.5680)
-2	1.0799	1.0758	1.0205 (0.5219)	1.0472	1.0758	1.0205 (0.5855)	1.0267	1.0758	1.0205 (0.5124)
-2.5	1.0052	1.0048	0.9977 (0.5055)	1.0025	1.0048	0.9977 (0.5059)	1.0011	1.0048	0.9977 (0.5071)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table C2 ARL of $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

for case (4) $p_L = p_U = 0.01124$, (5) $p_L = p_U = 0.02091$, (6) $p_L = p_U = 0.03682$

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0005	1.0048	1.0000 (1.0000)	1.0002	1.0048	1.0000 (1.0000)	1.0001	1.0048	1.0000 (1.0000)
2	1.0145	1.0758	1.0000 (1.0000)	1.0075	1.0758	1.0000 (1.0000)	1.0037	1.0758	1.0000 (1.0000)
1.5	1.1654	1.5665	1.0000 (1.0000)	1.1033	1.5665	1.0000 (1.0000)	1.0624	1.5665	1.0000 (1.0000)
1	2.0766	4.4953	1.0001 (1.0000)	1.7254	4.4953	1.0001 (1.0000)	1.4866	4.4953	1.0001 (1.0000)
0.5	8.1638	33.4008	1.0081 (1.0000)	5.5462	33.4008	1.0081 (1.0000)	3.9527	33.4008	1.0081 (0.9994)
0	44.5020	370.3983	1.0704 (0.9889)	23.9126	370.3983	1.0704 (0.9999)	13.5803	370.3983	1.0704 (0.9645)
-0.5	8.1638	33.4008	1.2365 (0.8865)	5.5462	33.4008	1.2365 (0.9795)	3.9527	33.4008	1.2365 (0.8090)
-1	2.0766	4.4953	1.3294 (0.6871)	1.7254	4.4953	1.3294 (0.8507)	1.4866	4.4953	1.3294 (0.6192)
-1.5	1.1654	1.5665	1.1507 (0.5519)	1.1033	1.5665	1.1507 (0.6521)	1.0624	1.5665	1.1507 (0.5266)
-2	1.0145	1.0758	1.0205 (0.5090)	1.0075	1.0758	1.0205 (0.5379)	1.0037	1.0758	1.0205 (0.5056)
-2.5	1.0005	1.0048	0.9977 (0.5092)	1.0002	1.0048	0.9977 (0.5067)	1.0001	1.0048	0.9977 (0.5175)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table C3 ARL of $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

for case (7) $p_L = p_U = 0.06142$, (8) $p_L = p_U = 0.09710$, (9) $p_L = p_U = 0.14582$

shift (δ)	P.C.(7)	S.C.	A.C. (7)	P.C.(8)	S.C.	A.C. (8)	P.C.(9)	S.C.	A.C. (9)
2.5	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0017	1.0758	1.0000 (1.0000)	1.0008	1.0758	1.0000 (1.0000)	1.0003	1.0758	1.0000 (1.0000)
1.5	1.0363	1.5665	1.0000 (1.0000)	1.0203	1.5665	1.0000 (1.0000)	1.0108	1.5665	1.0000 (1.0000)
1	1.3229	4.4953	1.0001 (1.0000)	1.2106	4.4953	1.0001 (1.0000)	1.1340	4.4953	1.0001 (1.0000)
0.5	2.9474	33.4008	1.0081 (0.9977)	2.2918	33.4008	1.008 (0.99371)	1.8511	33.4008	1.0081 (0.9857)
0	8.1430	370.3983	1.0704 (0.9422)	5.1492	370.3983	1.0704 (0.9115)	3.4289	370.3983	1.0704 (0.8727)
-0.5	2.9474	33.4008	1.2365 (0.7634)	2.2918	33.4008	1.2365 (0.7170)	1.8511	33.4008	1.2365 (0.6728)
-1	1.3229	4.4953	1.3294 (0.5899)	1.2106	4.4953	1.3294 (0.5654)	1.1340	4.4953	1.3294 (0.5459)
-1.5	1.0363	1.5665	1.1507 (0.5180)	1.0203	1.5665	1.1507 (0.5118)	1.0108	1.5665	1.1507 (0.5079)
-2	1.0017	1.0758	1.0205 (0.5058)	1.0008	1.0758	1.0205 (0.5073)	1.0003	1.0758	1.0205 (0.5104)
-2.5	1.0000	1.0048	0.9977 (0.5245)	1.0000	1.0048	0.9977 (0.5338)	1.0000	1.0048	0.9977 (0.5459)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table C4 ARL of $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

fore case (10) $p_L = p_U = 0.20829$, (11) $p_L = p_U = 0.28357$, (12) $p_L = p_U = 0.36883$

shift (()	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0001	1.0758	1.0000 (1.0000)	1.0000	1.0758	1.0000 (1.0000)	1.0000	1.0758	1.0000 (1.0000)
1.5	1.0055	1.5665	1.0000 (1.0000)	1.0027	1.5665	1.0000 (1.0000)	1.0012	1.5665	1.0000 (1.0000)
1	1.0824	4.4953	1.0001 (0.9997)	1.0478	4.4953	1.0001 (0.9985)	1.0241	4.4953	1.0001 (0.9952)
0.5	1.5460	33.4008	1.0081 (0.9718)	1.3282	33.4008	1.0081 (0.9506)	1.1678	33.4008	1.0081 (0.9214)
0	2.4005	370.3983	1.0704 (0.8276)	1.7632	370.3983	1.0704 (0.7791)	1.3557	370.3983	1.0704 (0.7306)
-0.5	1.5460	33.4008	1.2365 (0.6331)	1.3282	33.4008	1.2365 (0.5993)	1.1678	33.4008	1.2365 (0.5721)
-1	1.0824	4.4953	1.3294 (0.5312)	1.0478	4.4953	1.3294 (0.5206)	1.0241	4.4953	1.3294 (0.5134)
-1.5	1.0055	1.5665	1.1507 (0.5059)	1.0027	1.5665	1.1507 (0.5056)	1.0012	1.5665	1.1507 (0.5067)
-2	1.0001	1.0758	1.0205 (0.5151)	1.0000	1.0758	1.0205 (0.5219)	1.0000	1.0758	1.0205 (0.5308)
-2.5	1.0000	1.0048	0.9977 (0.5611)	1.0000	1.0048	0.9977 (0.5796)	1.0000	1.0048	0.9977 (0.6015)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table C5 ARL of α_3 = 0.5, α_4 = 3.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (1) $p_L = p_U$ = 0.00115, (2) $p_L = p_U$ = 0.00254, (3) $p_L = p_U$ = 0.00529

shift (δ)	P.C.$^{(1)}$	S.C.	A.C. $^{(1)}$	P.C.$^{(2)}$	S.C.	A.C. $^{(2)}$	P.C.$^{(3)}$	S.C.	A.C. $^{(3)}$
2.5	1.0262	1.0048	1.0000 (1.0000)	1.0142	1.0048	1.0000 (1.0000)	1.0073	1.0048	1.0000 (1.0000)
2	1.2058	1.0758	1.0000 (1.0000)	1.1305	1.0758	1.0000 (1.0000)	1.0804	1.0758	1.0000 (1.0000)
1.5	2.0804	1.5665	1.0024 (1.0000)	1.7287	1.5665	1.0024 (1.0000)	1.4894	1.5665	1.0024 (1.0000)
1	6.7925	4.4953	1.0337 (1.0000)	4.7334	4.4953	1.0337 (1.0000)	3.4597	4.4953	1.0337 (1.0000)
0.5	49.2980	33.4008	1.1395 (1.0000)	27.9012	33.4008	1.1395 (1.0000)	16.6616	33.4008	1.1395 (1.0000)
0	434.7036	370.3983	1.3874 (0.9989)	196.9303	370.3983	1.3874 (0.9975)	94.4987	370.3983	1.3874 (0.9947)
-0.5	49.2980	33.4008	1.6079 (0.8875)	27.9012	33.4008	1.6079 (0.8701)	16.6616	33.4008	1.6079 (0.8482)
-1	6.7925	4.4953	1.3098 (0.6553)	4.7334	4.4953	1.3098 (0.6411)	3.4597	4.4953	1.3098 (0.6253)
-1.5	2.0804	1.5665	1.0329 (0.5384)	1.7287	1.5665	1.0329 (0.5346)	1.4894	1.5665	1.0329 (0.5308)
-2	1.2058	1.0758	0.9638 (0.5242)	1.1305	1.0758	0.9638 (0.5256)	1.0804	1.0758	0.9638 (0.5275)
-2.5	1.0262	1.0048	0.9715 (0.5614)	1.0142	1.0048	0.9715 (0.5659)	1.0073	1.0048	0.9715 (0.5716)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table C6 ARL of α_3 = 0.5, α_4 = 3.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (4) $p_L = p_U$ = 0.01042, (5) $p_L = p_U$ = 0.01938, (6) $p_L = p_U$ = 0.03413

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0036	1.0048 (1.0000)	1.0000	1.0017	1.0048	1.0048 (1.0000)	1.0007	1.0048	1.0048 (1.0000)
2	1.0478	1.0758 (1.0000)	1.0000	1.0273	1.0758	1.0758 (1.0000)	1.0150	1.0758	1.0758 (1.0000)
1.5	1.3252	1.5665 (1.0000)	1.0024	1.2126	1.5665	1.5665 (1.0000)	1.1359	1.5665	1.5665 (1.0000)
1	2.6462	4.4953 (1.0000)	1.0337	2.1121	4.4953	4.4953 (1.0000)	1.7537	4.4953	4.4953 (1.0000)
0.5	10.4831	33.4008 (1.0000)	1.1395	6.9371	33.4008	33.4008 (1.0000)	4.8178	33.4008	33.4008 (1.0000)
0	48.0025	370.3983 0.9897	1.3874	25.7935	370.3983	1.3874 0.9810	14.6485	370.3983	1.3874 0.9670
-0.5	10.4831	33.4008 0.8217	1.6079	6.9371	33.4008	1.6079 0.7909	4.8178	33.4008	1.6079 0.7566
-1	2.6462	4.4953 0.6084	1.3098	2.1121	4.4953	1.3098 0.5914	1.7537	4.4953	1.3098 0.5750
-1.5	1.3252	1.5665 0.5273	1.0329	1.2126	1.5665	1.0329 0.5244	1.1359	1.5665	1.0329 0.5224
-2	1.0478	1.0758 0.5304	0.9638	1.0273	1.0758	0.9638 0.5342	1.0150	1.0758	0.9638 0.5392
-2.5	1.0036	1.0048 0.5788	0.9715	1.0017	1.0048	0.9715 0.5874	1.0007	1.0048	0.9715 0.5978

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table C7 ARL of α_3 = 0.5, α_4 = 3.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (7) $p_L = p_U$ = 0.05692, (8) $p_L = p_U$ = 0.09002, (9) $p_L = p_U$ = 0.13519

shift (δ)	P.C.$^{(7)}$	S.C.	A.C. $^{(7)}$	P.C.$^{(8)}$	S.C.	A.C. $^{(8)}$	P.C.$^{(9)}$	S.C.	A.C. $^{(9)}$
2.5	1.0003	1.0048	1.0000 (1.0000)	1.0001	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0078	1.0758	1.0000 (1.0000)	1.0039	1.0758	1.0000 (1.0000)	1.0019	1.0758	1.0000 (1.0000)
1.5	1.0846	1.5665	1.0024 (1.0000)	1.0510	1.5665	1.0024 (1.0000)	1.0297	1.5665	1.0024 (1.0000)
1	1.5094	4.4953	1.0337 (1.0000)	1.3412	4.4953	1.0337 (1.0000)	1.2250	4.4953	1.0337 (1.0000)
0.5	3.5026	33.4008	1.1395 (1.0000)	2.6573	33.4008	1.1395 (0.9999)	2.0962	33.4008	1.1395 (0.9984)
0	8.7836	370.3983	1.3874 (0.9461)	5.5543	370.3983	1.3874 (0.9174)	3.6986	370.3983	1.3874 (0.8809)
-0.5	3.5026	33.4008	1.6079 (0.7204)	2.6573	33.4008	1.6079 (0.6842)	2.0962	33.4008	1.6079 (0.6497)
-1	1.5094	4.4953	1.3098 (0.5600)	1.3412	4.4953	1.3098 (0.5472)	1.2250	4.4953	1.3098 (0.5369)
-1.5	1.0846	1.5665	1.0329 (0.5217)	1.0510	1.5665	1.0329 (0.5224)	1.0297	1.5665	1.0329 (0.5247)
-2	1.0078	1.0758	0.9638 (0.5456)	1.0039	1.0758	0.9638 (0.5536)	1.0019	1.0758	0.9638 (0.5631)
-2.5	1.0003	1.0048	0.9715 (0.6100)	1.0001	1.0048	0.9715 (0.6240)	1.0000	1.0048	0.9715 (0.6399)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table C8 ARL of $\alpha_3 = 0.5$, $\alpha_4 = 3.38$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

for case (10) $p_L = p_U = 0.19310$, (11) $p_L = p_U = 0.26290$, (12) $p_L = p_U = 0.34193$

shift (δ)	P.C.(10)	S.C.	A.C. (10)	P.C.(11)	S.C.	A.C. (11)	P.C.(12)	S.C.	A.C. (12)
2.5	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0009	1.0758	1.0000 (1.0000)	1.0004	1.0758	1.0000 (1.0000)	1.0002	1.0758	1.0000 (1.0000)
1.5	1.0167	1.5665	1.0024 (1.0000)	1.0089	1.5665	1.0024 (1.0000)	1.0045	1.5665	1.0024 (1.0000)
1	1.1447	4.4953	1.0337 (1.0000)	1.0891	4.4953	1.0337 (1.0000)	1.0499	4.4953	1.0337 (1.0000)
0.5	1.7121	33.4008	1.1395 (0.9931)	1.4415	33.4008	1.1395 (0.9813)	1.2453	33.4008	1.1395 (0.9611)
0	2.5893	370.3983	1.3874 (0.8382)	1.9019	370.3983	1.3874 (0.7918)	1.4623	370.3983	1.3874 (0.7452)
-0.5	1.7121	33.4008	1.6079 (0.6186)	1.4415	33.4008	1.6079 (0.5919)	1.2453	33.4008	1.6079 (0.5700)
-1	1.1447	4.4953	1.3098 (0.5293)	1.0891	4.4953	1.3098 (0.5244)	1.0499	4.4953	1.3098 (0.5220)
-1.5	1.0167	1.5665	1.0329 (0.5286)	1.0089	1.5665	1.0329 (0.5341)	1.0045	1.5665	1.0329 (0.5411)
-2	1.0009	1.0758	0.9638 (0.5743)	1.0004	1.0758	0.9638 (0.5871)	1.0002	1.0758	0.9638 (0.6015)
-2.5	1.0000	1.0048	0.9715 (0.6574)	1.0000	1.0048	0.9715 (0.6763)	1.0000	1.0048	0.9715 (0.6963)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table C9 ARL of $\alpha_3 = 1$, $\alpha_4 = 4.5$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

for case (1) $p_L = p_U = 0.00105$, (2) $p_L = p_U = 0.00232$, (3) $p_L = p_U = 0.00483$

shift (δ)	P.C.$^{(1)}$	S.C.	A.C. $^{(1)}$	P.C.$^{(2)}$	S.C.	A.C. $^{(2)}$	P.C.$^{(3)}$	S.C.	A.C. $^{(3)}$
2.5	1.0279	1.0048	1.0000 (1.0000)	1.0153	1.0048	1.0000 (1.0000)	1.0080	1.0048	1.0000 (1.0000)
2	1.2161	1.0758	1.0068 (1.0000)	1.1380	1.0758	1.0068 (1.0000)	1.0857	1.0758	1.0068 (1.0000)
1.5	2.1285	1.5665	1.0766 (1.0000)	1.7638	1.5665	1.0766 (1.0000)	1.5154	1.5665	1.0766 (1.0000)
1	7.0910	4.4953	1.2344 (1.0000)	4.9288	4.4953	1.2344 (1.0000)	3.5927	4.4953	1.2344 (1.0000)
0.5	52.6811	33.4008	1.5118 (1.0000)	29.7727	33.4008	1.5118 (1.0000)	17.7513	33.4008	1.5118 (1.0000)
0	476.2264	370.3983	1.9611 (0.9990)	215.7410	370.3983	1.9611 (0.9977)	103.5252	370.3983	1.9611 (0.9952)
-0.5	52.6811	33.4008	1.5498 (0.7564)	29.7727	33.4008	1.5498 (0.7492)	17.7513	33.4008	1.5498 (0.7395)
-1	7.0910	4.4953	1.0681 (0.5761)	4.9288	4.4953	1.0681 (0.5738)	3.5927	4.4953	1.0681 (0.5709)
-1.5	2.1285	1.5665	0.9333 (0.5433)	1.7638	1.5665	0.9333 (0.5435)	1.5154	1.5665	0.9333 (0.5438)
-2	1.2161	1.0758	0.9211 (0.5727)	1.1380	1.0758	0.9211 (0.5740)	1.0857	1.0758	0.9211 (0.5757)
-2.5	1.0279	1.0048	0.9394 (0.6305)	1.0153	1.0048	0.9394 (0.6323)	1.0080	1.0048	0.9394 (0.6347)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table C10 ARL of α_3 = 1, α_4 = 4.5, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (4) p_L = p_U = 0.00951, (5) p_L = p_U = 0.01769, (6) p_L = p_U = 0.03116

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0040	1.0048	1.0000 (1.0000)	1.0019	1.0048	1.0000 (1.0000)	1.0009	1.0048	1.0000 (1.0000)
2	1.0515	1.0758	1.0068 (1.0000)	1.0298	1.0758	1.0068 (1.0000)	1.0166	1.0758	1.0068 (1.0000)
1.5	1.3446	1.5665	1.0766 (1.0000)	1.2271	1.5665	1.0766 (1.0000)	1.1468	1.5665	1.0766 (1.0000)
1	2.7399	4.4953	1.2344 (1.0000)	2.1803	4.4953	1.2344 (1.0000)	1.8046	4.4953	1.2344 (1.0000)
0.5	11.1497	33.4008	1.5118 (1.0000)	7.3650	33.4008	1.5118 (1.0000)	5.1054	33.4008	1.5118 (1.0000)
0	52.5877	370.3983	1.9611 (0.9906)	28.2573	370.3983	1.9611 (0.8501)	16.0477	370.3983	1.9611 (0.8065)
-0.5	11.1497	33.4008	1.5498 (0.9952)	7.3650	33.4008	1.5498 (0.6117)	5.1054	33.4008	1.5498 (0.5934)
-1	2.7399	4.4953	1.0681 (0.7272)	2.1803	4.4953	1.0681 (0.5442)	1.8046	4.4953	1.0681 (0.5430)
-1.5	1.3446	1.5665	0.9333 (0.5674)	1.2271	1.5665	0.9333 (0.5595)	1.1468	1.5665	0.9333 (0.5651)
-2	1.0515	1.0758	0.9211 (0.5444)	1.0298	1.0758	0.9211 (0.6103)	1.0166	1.0758	0.9211 (0.6193)
-2.5	1.0040	1.0048	0.9394 (0.5780)	1.0019	1.0048	0.9394 (0.6788)	1.0009	1.0048	0.9394 (0.6894)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table C11 ARL of $\alpha_3 = 1$, $\alpha_4 = 4.5$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

for case (7) $p_L = p_U = 0.05196$, (8) $p_L = p_U = 0.08217$, (9) $p_L = p_U = 0.12340$

shift (δ)	P.C.(7)	S.C.	A.C. (7)	P.C.(8)	S.C.	A.C. (8)	P.C.(9)	S.C.	A.C. (9)
2.5	1.0004	1.0048	1.0000 (1.0000)	1.0002	1.0048	1.0000 (1.0000)	1.0001	1.0048	1.0000 (1.0000)
2	1.0089	1.0758	1.0068 (1.0000)	1.0046	1.0758	1.0068 (1.0000)	1.0022	1.0758	1.0068 (1.0000)
1.5	1.0926	1.5665	1.0766 (1.0000)	1.0568	1.5665	1.0766 (1.0000)	1.0338	1.5665	1.0766 (1.0000)
1	1.5482	4.4953	1.2344 (1.0000)	1.3713	4.4953	1.2344 (1.0000)	1.2487	4.4953	1.2344 (1.0000)
0.5	3.7046	33.4008	1.5118 (1.0000)	2.8054	33.4008	1.5118 (1.0000)	2.2094	33.4008	1.5118 (1.0000)
0	9.6226	370.3983	1.9611 (0.9506)	6.0848	370.3983	1.9611 (0.9241)	4.0519	370.3983	1.9611 (0.8902)
-0.5	3.7046	33.4008	1.5498 (0.6745)	2.8054	33.4008	1.5498 (0.6534)	2.2094	33.4008	1.5498 (0.6320)
-1	1.5482	4.4953	1.0681 (0.5543)	1.3713	4.4953	1.0681 (0.5501)	1.2487	4.4953	1.0681 (0.5466)
-1.5	1.0926	1.5665	0.9333 (0.5486)	1.0568	1.5665	0.9333 (0.5513)	1.0338	1.5665	0.9333 (0.5549)
-2	1.0089	1.0758	0.9211 (0.5896)	1.0046	1.0758	0.9211 (0.5955)	1.0022	1.0758	0.9211 (0.6023)
-2.5	1.0004	1.0048	0.9394 (0.6533)	1.0002	1.0048	0.9394 (0.6607)	1.0001	1.0048	0.9394 (0.6692)

(x) represents case x^{th} at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table C12 ARL of $\alpha_3 = 1$, $\alpha_4 = 4.5$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

for case (10) $p_L = p_U = 0.17627$, (11) $p_L = p_U = 0.23997$, (12) $p_L = p_U = 0.31212$

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0048	1.0000	1.0000	1.0048	1.0000	1.0000	1.0048	1.0000
			(1.0000)			(1.0000)			(1.0000)
2	1.0011	1.0758	1.0068	1.0005	1.0758	1.0068	1.0002	1.0758	1.0068
			(1.0000)			(1.0000)			(1.0000)
1.5	1.0195	1.5665	1.0766	1.0109	1.5665	1.0766	1.0058	1.5665	1.0766
			(1.0000)			(1.0000)			(1.0000)
1	1.1635	4.4953	1.2344	1.1044	4.4953	1.2344	1.0628	4.4953	1.2344
			(1.0000)			(1.0000)			(1.0000)
0.5	1.8023	33.4008	1.5118	1.5164	33.4008	1.5118	1.3103	33.4008	1.5118
			(1.0000)			(1.0000)			0.9996
0	2.8366	370.3983	1.9611	2.0836	370.3983	1.9611	1.6020	370.3983	1.9611
			0.8501			0.8065			0.7621
-0.5	1.8023	33.4008	1.5498	1.5164	33.4008	1.5498	1.3103	33.4008	1.5498
			0.6117			0.5934			0.5779
-1	1.1635	4.4953	1.0681	1.1044	4.4953	1.0681	1.0628	4.4953	1.0681
			0.5442			0.5430			0.5432
-1.5	1.0195	1.5665	0.9333	1.0109	1.5665	0.9333	1.0058	1.5665	0.9333
			0.5595			0.5651			0.5718
-2	1.0011	1.0758	0.9211	1.0005	1.0758	0.9211	1.0002	1.0758	0.9211
			0.6103			0.6193			0.6292
-2.5	1.0000	1.0048	0.9394	1.0000	1.0048	0.9394	1.0000	1.0048	0.9394
			0.6788			0.6894			0.7006

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table C13 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (1) $p_L = p_U$ = 0.00103, (2) $p_L = p_U$ = 0.00228, (3) $p_L = p_U$ = 0.00475

shift (δ)	P.C.$^{(1)}$	S.C.	A.C. $^{(1)}$	P.C.$^{(2)}$	S.C.	A.C. $^{(2)}$	P.C.$^{(3)}$	S.C.	A.C. $^{(3)}$
2.5	1.0283	1.0048	1.0018 (1.0000)	1.0155	1.0048	1.0018 (1.0000)	1.0081	1.0048	1.0018 (1.0000)
2	1.2180	1.0758	1.1212 (1.0000)	1.1394	1.0758	1.1212 (1.0000)	1.0867	1.0758	1.1212 (1.0000)
1.5	2.1375	1.5665	1.4752 (1.0000)	1.7703	1.5665	1.4752 (1.0000)	1.5202	1.5665	1.4752 (1.0000)
1	7.1473	4.4953	2.2129 (1.0000)	4.9656	4.4953	2.2129 (1.0000)	3.6178	4.4953	2.2129 (1.0000)
0.5	53.3263	33.4008	3.6453 (1.0000)	30.1294	33.4008	3.6453 (1.0000)	17.9588	33.4008	3.6453 (1.0000)
0	484.2503	370.3983	6.3110 (0.9990)	219.3760	370.3983	6.3110 (0.9977)	105.2695	370.3983	6.3110 (0.9953)
-0.5	53.3263	33.4008	2.4161 (0.7250)	30.1294	33.4008	2.4161 (0.7186)	17.9588	33.4008	2.4161 (0.7102)
-1	7.1473	4.4953	1.2789 (0.5700)	4.9656	4.4953	1.2789 (0.5690)	3.6178	4.4953	1.2789 (0.5679)
-1.5	2.1375	1.5665	1.0593 (0.5867)	1.7703	1.5665	1.0593 (0.5881)	1.5202	1.5665	1.0593 (0.5901)
-2	1.2180	1.0758	1.0098 (0.6725)	1.1394	1.0758	1.0098 (0.6749)	1.0867	1.0758	1.0098 (0.6781)
-2.5	1.0283	1.0048	0.9993 (0.7769)	1.0155	1.0048	0.9993 (0.7792)	1.0081	1.0048	0.9993 (0.7823)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table C14 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (4) $p_L = p_U$ = 0.00935, (5) $p_L = p_U$ = 0.01740, (6) $p_L = p_U$ = 0.03064

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0041	1.0048	1.0018 (1.0000)	1.0019	1.0048	1.0018 (1.0000)	1.0009	1.0048	1.0018 (1.0000)
2	1.0522	1.0758	1.1212 (1.0000)	1.0303	1.0758	1.1212 (1.0000)	1.0169	1.0758	1.1212 (1.0000)
1.5	1.3483	1.5665	1.4752 (1.0000)	1.2299	1.5665	1.4752 (1.0000)	1.1488	1.5665	1.4752 (1.0000)
1	2.7576	4.4953	2.2129 (1.0000)	2.1931	4.4953	2.2129 (1.0000)	1.8142	4.4953	2.2129 (1.0000)
0.5	11.2767	33.4008	3.6453 (1.0000)	7.4464	33.4008	3.6453 (1.0000)	5.1601	33.4008	3.6453 (1.0000)
0	53.4738	370.3983	6.3110 (0.9907)	28.7334	370.3983	6.3110 (0.9829)	16.3181	370.3983	6.3110 (0.9703)
-0.5	11.2767	33.4008	2.4161 (0.6994)	7.4464	33.4008	2.4161 (0.6863)	5.1601	33.4008	2.4161 (0.6711)
-1	2.7576	4.4953	1.2789 (0.5665)	2.1931	4.4953	1.2789 (0.5652)	1.8142	4.4953	1.2789 (0.5641)
-1.5	1.3483	1.5665	1.0593 (0.5929)	1.2299	1.5665	1.0593 (0.5965)	1.1488	1.5665	1.0593 (0.6012)
-2	1.0522	1.0758	1.0098 (0.6823)	1.0303	1.0758	1.0098 (0.6878)	1.0169	1.0758	1.0098 (0.6946)
-2.5	1.0041	1.0048	0.9993 (0.7864)	1.0019	1.0048	0.9993 (0.7916)	1.0009	1.0048	0.9993 (0.7979)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table C15 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (7) $p_L = p_U$ = 0.05110, (8) $p_L = p_U$ = 0.08081,(9) $p_L = p_U$ = 0.12135

shift (δ)	P.C.[(7)]	S.C.	A.C. [(7)]	P.C.[(8)]	S.C.	A.C. [(8)]	P.C.[(9)]	S.C.	A.C. [(9)]
2.5	1.0004	1.0048	1.0018 (1.0000)	1.0002	1.0048	1.0018 (1.0000)	1.0000	1.0048	1.0018 (1.0000)
2	1.0091	1.0758	1.1212 (1.0000)	1.0047	1.0758	1.1212 (1.0000)	1.0016	1.0758	1.1212 (1.0000)
1.5	1.0941	1.5665	1.4752 (1.0000)	1.0579	1.5665	1.4752 (1.0000)	1.0265	1.5665	1.4752 (1.0000)
1	1.5556	4.4953	2.2129 (1.0000)	1.3770	4.4953	2.2129 (1.0000)	1.2064	4.4953	2.2129 (1.0000)
0.5	3.7430	33.4008	3.6453 (1.0000)	2.8335	33.4008	3.6453 (1.0000)	2.0072	33.4008	3.6453 (1.0000)
0	9.7847	370.3983	6.3110 (0.9514)	6.1873	370.3983	6.3110 (0.9252)	3.4289	370.3983	6.3110 (0.8918)
-0.5	3.7430	33.4008	2.4161 (0.6543)	2.8335	33.4008	2.4161 (0.6364)	2.0072	33.4008	2.4161 (0.6186)
-1	1.5556	4.4953	1.2789 (0.5635)	1.3770	4.4953	1.2789 (0.5637)	1.2064	4.4953	1.2789 (0.5652)
-1.5	1.0941	1.5665	1.0593 (0.6071)	1.0579	1.5665	1.0593 (0.6145)	1.0265	1.5665	1.0593 (0.6234)
-2	1.0091	1.0758	1.0098 (0.7028)	1.0047	1.0758	1.0098 (0.7125)	1.0016	1.0758	1.0098 (0.7235)
-2.5	1.0004	1.0048	0.9993 (0.8053)	1.0002	1.0048	0.9993 (0.8138)	1.0000	1.0048	0.9993 (0.8233)

(x) represents case x^{th} at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table C16 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (10) $p_L = p_U$ = 0.17335, (11) $p_L = p_U$ = 0.2360, (12) $p_L = p_U$ = 0.30695

shift (δ)	P.C.(10)	S.C.	A.C. (10)	P.C.(11)	S.C.	A.C. (11)	P.C.(12)	S.C.	A.C. (12)
2.5	1.0000	1.0048	1.0018 (1.0000)	1.0000	1.0048	1.0018 (1.0000)	1.0000	1.0048	1.0018 (1.0000)
2	1.0007	1.0758	1.1212 (1.0000)	1.0005	1.0758	1.1212 (1.0000)	1.0002	1.0758	1.1212 (1.0000)
1.5	1.0145	1.5665	1.4752 (1.0000)	1.0113	1.5665	1.4752 (1.0000)	1.0061	1.5665	1.4752 (1.0000)
1	1.1300	4.4953	2.2129 (1.0000)	1.1073	4.4953	2.2129 (1.0000)	1.0653	4.4953	2.2129 (1.0000)
0.5	1.6410	33.4008	3.6453 (1.0000)	1.5306	33.4008	3.6453 (1.0000)	1.3226	33.4008	3.6453 (1.0000)
0	2.4005	370.3983	6.3110 (0.8523)	2.1187	370.3983	6.3110 (0.8091)	1.6290	370.3983	6.3110 (0.7651)
-0.5	1.6410	33.4008	2.4161 (0.6024)	1.5306	33.4008	2.4161 (0.5885)	1.3226	33.4008	2.4161 (0.5775)
-1	1.1300	4.4953	1.2789 (0.5680)	1.1073	4.4953	1.2789 (0.5726)	1.0653	4.4953	1.2789 (0.5790)
-1.5	1.0145	1.5665	1.0593 (0.6338)	1.0113	1.5665	1.0593 (0.6457)	1.0061	1.5665	1.0593 (0.6589)
-2	1.0007	1.0758	1.0098 (0.7358)	1.0005	1.0758	1.0098 (0.7491)	1.0002	1.0758	1.0098 (0.7631)
-2.5	1.0000	1.0048	0.9993 (0.8335)	1.0000	1.0048	0.9993 (0.8442)	1.0000	1.0048	0.9993 (0.8552)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table C17 ARL of $\alpha_3 = 2$, $\alpha_4 = 9$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

for case (1) $p_L = p_U = 0.00105$, (2) $p_L = p_U = 0.00232$, (3) $p_L = p_U = 0.00438$

shift (δ)	P.C.(1)	S.C.	A.C. (1)	P.C.(2)	S.C.	A.C. (2)	P.C.(3)	S.C.	A.C. (3)
2.5	1.0060	1.0048	1.0039 (1.0000)	1.0029	1.0048	1.0039 (1.0000)	1.0013	1.0048	1.0039 (1.0000)
2	1.0885	1.0758	1.2816 (1.0000)	1.0531	1.0758	1.2816 (1.0000)	1.0307	1.0758	1.2816 (1.0000)
1.5	1.6403	1.5665	2.2166 (1.0000)	1.4297	1.5665	2.2166 (1.0000)	1.2849	1.5665	2.2166 (1.0000)
1	4.9863	4.4953	4.5269 (1.0000)	3.6255	4.4953	4.5269 (1.0000)	2.7584	4.4953	4.5269 (1.0000)
0.5	39.7674	33.4008	9.7644 (1.0000)	23.0594	33.4008	9.7644 (1.0000)	14.1004	33.4008	9.7644 (1.0000)
0	476.2264	370.3983	20.2987 (0.9990)	215.7410	370.3983	20.2987 (0.9977)	103.5252	370.3983	20.2987 (0.9952)
-0.5	39.7674	33.4008	2.1776 (0.6980)	23.0594	33.4008	2.1776 (0.6923)	14.1004	33.4008	2.1776 (0.6849)
-1	4.9863	4.4953	1.1888 (0.5756)	3.6255	4.4953	1.1888 (0.5757)	2.7584	4.4953	1.1888 (0.5761)
-1.5	1.6403	1.5665	1.0420 (0.6472)	1.4297	1.5665	1.0420 (0.6496)	1.2849	1.5665	1.0420 (0.6530)
-2	1.0885	1.0758	1.0107 (0.7735)	1.0531	1.0758	1.0107 (0.7761)	1.0307	1.0758	1.0107 (0.7796)
-2.5	1.0060	1.0048	1.0029 (0.8777)	1.0029	1.0048	1.0029 (0.8794)	1.0013	1.0048	1.0029 (0.8817)

(x) represents case x[th] at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table C18 ARL of $\alpha_3 = 2$, $\alpha_4 = 9$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

for case (4) $p_L = p_U = 0.00951$, (5) $p_L = p_U = 0.01769$, (6) $p_L = p_U = 0.03116$

shift (δ)	P.C.(4)	S.C.	A.C. (4)	P.C.(5)	S.C.	A.C. (5)	P.C.(6)	S.C.	A.C. (6)
2.5	1.0006	1.0048	1.0039 (1.0000)	1.0002	1.0048	1.0039 (1.0000)	1.0001	1.0048	1.0039 (1.0000)
2	1.0170	1.0758	1.2816 (1.0000)	1.0090	1.0758	1.2816 (1.0000)	1.0046	1.0758	1.2816 (1.0000)
1.5	1.1856	1.5665	2.2166 (1.0000)	1.1181	1.5665	2.2166 (1.0000)	1.0731	1.5665	2.2166 (1.0000)
1	2.1904	4.4953	4.5269 (1.0000)	1.8097	4.4953	4.5269 (1.0000)	1.5502	4.4953	4.5269 (1.0000)
0.5	9.0791	33.4008	9.7644 (1.0000)	6.1447	33.4008	9.7644 (1.0000)	4.3619	33.4008	9.7644 (1.0000)
0	52.5877	370.3983	20.2987 (0.9906	28.2573	370.3983	20.2987 (0.9826)	16.0477	370.3983	20.2987 (0.9698
-0.5	9.0791	33.4008	2.1776 (0.6755	6.1447	33.4008	2.1776 (0.6641)	4.3619	33.4008	2.1776 (0.6509)
-1	2.1904	4.4953	1.1888 (0.5768	1.8097	4.4953	1.1888 (0.5780)	1.5502	4.4953	1.1888 (0.5800)
-1.5	1.1856	1.5665	1.0420 (0.6574	1.1181	1.5665	1.0420 (0.6631)	1.0731	1.5665	1.0420 (0.6704)
-2	1.0170	1.0758	1.0107 (0.7841	1.0090	1.0758	1.0107 (0.7898)	1.0046	1.0758	1.0107 (0.7968)
-2.5	1.0006	1.0048	1.0029 (0.8846)	1.0002	1.0048	1.0029 (0.8883)	1.0001	1.0048	1.0029 (0.8927)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table C19 ARL of α_3 = 2, α_4 = 9, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (7) $p_L = p_U$ = 0.05196, (8) $p_L = p_U$ = 0.08217, (9) $p_L = p_U$ = 0.12340

shift (δ)	P.C.$^{(7)}$	S.C.	A.C. $^{(7)}$	P.C.$^{(8)}$	S.C.	A.C. $^{(8)}$	P.C.$^{(9)}$	S.C.	A.C. $^{(9)}$
2.5	1.0000	1.0048	1.0039	1.0000	1.0048	1.0039	1.0000	1.0048	1.0039
			(1.0000)			(1.0000)			(1.0000)
2	1.0022	1.0758	1.2816	1.0010	1.0758	1.2816	1.0005	1.0758	1.2816
			(1.0000)			(1.0000)			(1.0000)
1.5	1.0438	1.5665	2.2166	1.0254	1.5665	2.2166	1.0142	1.5665	2.2166
			(1.0000)			(1.0000)			(1.0000)
1	1.3715	4.4953	4.5269	1.2481	4.4953	4.5269	1.1631	4.4953	4.5269
			(1.0000)			(1.0000)			(1.0000)
0.5	3.2391	33.4008	9.7644	2.5085	33.4008	9.7644	2.0185	33.4008	9.7644
			(1.0000)			(1.0000)			(1.0000)
0	9.6226	370.3983	20.2987	6.0848	370.3983	20.2987	4.0519	370.3983	20.2987
			(0.9506)			(0.9241)			(0.8902)
-0.5	3.2391	33.4008	2.1776	2.5085	33.4008	2.1776	2.0185	33.4008	2.1776
			(0.6363)			(0.6211)			(0.6068)
-1	1.3715	4.4953	1.1888	1.2481	4.4953	1.1888	1.1631	4.4953	1.1888
			(0.5830)			(0.5875)			(0.5936)
-1.5	1.0438	1.5665	1.0420	1.0254	1.5665	1.0420	1.0142	1.5665	1.0420
			(0.6792)			(0.6898)			(0.7020)
-2	1.0022	1.0758	1.0107	1.0010	1.0758	1.0107	1.0005	1.0758	1.0107
			(0.8050)			(0.8144)			(0.8248)
-2.5	1.0000	1.0048	1.0029	1.0000	1.0048	1.0029	1.0000	1.0048	1.0029
			(0.8978)			(0.9035)			(0.9096)

(x) represents case xth at specified p_L and p_U. (

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table C20 ARL of $\alpha_3 = 2$, $\alpha_4 = 9$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

for case (10) $p_L = p_U = 0.17627$, (11) $p_L = p_U = 0.23997$, (12) $p_L = p_U = 0.31212$

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0048	1.0039	1.0000	1.0048	1.0039	1.0000	1.0048	1.0039
			(1.0000)			(1.0000)			(1.0000)
2	1.0002	1.0758	1.2816	1.0001	1.0758	1.2816	1.0000	1.0758	1.2816
			(1.0000)			(1.0000)			(1.0000)
1.5	1.0077	1.5665	2.2166	1.0040	1.5665	2.2166	1.0020	1.5665	2.2166
			(1.0000)			(1.0000)			(1.0000)
1	1.1049	4.4953	4.5269	1.0654	4.4953	4.5269	1.0386	4.4953	4.5269
			(1.0000)			(1.0000)			(1.0000)
0.5	1.6807	33.4008	9.7644	1.4415	33.4008	9.7644	1.2675	33.4008	9.7644
			(1.0000)			(1.0000)			(1.0000)
0	2.8366	370.3983	20.2987	2.0836	370.3983	20.2987	1.6020	370.3983	20.2987
			(0.8501)			(0.8065)			(0.7621)
-0.5	1.6807	33.4008	2.1776	1.4415	33.4008	2.1776	1.2675	33.4008	2.1776
			(0.5944)			(0.5848)			(0.5784)
-1	1.1049	4.4953	1.1888	1.0654	4.4953	1.1888	1.0386	4.4953	1.1888
			(0.6017)			(0.6119)			(0.6242)
-1.5	1.0077	1.5665	1.0420	1.0040	1.5665	1.0420	1.0020	1.5665	1.0420
			(0.7158)			(0.7310)			(0.7472)
-2	1.0002	1.0758	1.0107	1.0001	1.0758	1.0107	1.0000	1.0758	1.0107
			(0.8359)			(0.8476)			(0.8595)
-2.5	1.0000	1.0048	1.0029	1.0000	1.0048	1.0029	1.0000	1.0048	1.0029
			(0.9161)			(0.9227)			(0.9293)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table C21 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (1) $p_L = p_U$ = 0.00108, (2) $p_L = p_U$ = 0.00238, (3) $p_L = p_U$ = 0.00496

shift (δ)	P.C.(1)	S.C.	A.C. (1)	P.C.(2)	S.C.	A.C. (2)	P.C.(3)	S.C.	A.C. (3)
2.5	1.0059	1.0048	1.0039 (1.0000)	1.0028	1.0048	1.0039 (1.0000)	1.0013	1.0048	1.0039 (1.0000)
2	1.0871	1.0758	1.2816 (1.0000)	1.0522	1.0758	1.2816 (1.0000)	1.0300	1.0758	1.2816 (1.0000)
1.5	1.6324	1.5665	2.2166 (1.0000)	1.4239	1.5665	2.2166 (1.0000)	1.2806	1.5665	2.2166 (1.0000)
1	4.9332	4.4953	4.5269 (1.0000)	3.5895	4.4953	4.5269 (1.0000)	2.7333	4.4953	4.5269 (1.0000)
0.5	39.0606	33.4008	9.7644 (1.0000)	22.6598	33.4008	9.7644 (1.0000)	13.8630	33.4008	9.7644 (1.0000)
0	464.1226	370.3983	20.2987 (0.9989)	210.2577	370.3983	20.2987 (0.9976)	100.8940	370.3983	20.2987 (0.9951)
-0.5	39.0606	33.4008	2.1776 (0.6978)	22.6598	33.4008	2.1776 (0.6921)	13.8630	33.4008	2.1776 (0.6846)
-1	4.9332	4.4953	1.1888 (0.5756)	3.5895	4.4953	1.1888 (0.5757)	2.7333	4.4953	1.1888 (0.5761)
-1.5	1.6324	1.5665	1.0420 (0.6473)	1.4239	1.5665	1.0420 (0.6497)	1.2806	1.5665	1.0420 (0.6531)
-2	1.0871	1.0758	1.0107 (0.7736)	1.0522	1.0758	1.0107 (0.7762)	1.0300	1.0758	1.0107 (0.7797)
-2.5	1.0059	1.0048	1.0029 (0.8778)	1.0028	1.0048	1.0029 (0.8795)	1.0013	1.0048	1.0029 (0.8818)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table C22 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (4) $p_L = p_U$ = 0.00976, (5) $p_L = p_U$ = 0.01816, (6) $p_L = p_U$ = 0.03197

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0006	1.0048	1.0039 (1.0000)	1.0002	1.0048	1.0039 (1.0000)	1.0001	1.0048	1.0039 (1.0000)
2	1.0166	1.0758	1.2816 (1.0000)	1.0088	1.0758	1.2816 (1.0000)	1.0044	1.0758	1.2816 (1.0000)
1.5	1.1823	1.5665	2.2166 (1.0000)	1.1157	1.5665	2.2166 (1.0000)	1.0714	1.5665	2.2166 (1.0000)
1	2.1722	4.4953	4.5269 (1.0000)	1.7962	4.4953	4.5269 (1.0000)	1.5400	4.4953	4.5269 (1.0000)
0.5	8.9310	33.4008	9.7644 (1.0000)	6.0479	33.4008	9.7644 (1.0000)	4.2958	33.4008	9.7644 (1.0000)
0	51.2511	370.3983	20.2987 (0.9903)	27.5391	370.3983	20.2987 (0.9822)	15.6398	370.3983	20.2987 (0.9690)
-0.5	8.9310	33.4008	2.1776 (0.6751)	6.0479	33.4008	2.1776 (0.6636)	4.2958	33.4008	2.1776 (0.6502)
-1	2.1722	4.4953	1.1888 (0.5768)	1.7962	4.4953	1.1888 (0.5780)	1.5400	4.4953	1.1888 (0.5801)
-1.5	1.1823	1.5665	1.0420 (0.6576)	1.1157	1.5665	1.0420 (0.6634)	1.0714	1.5665	1.0420 (0.6708)
-2	1.0166	1.0758	1.0107 (0.7843)	1.0088	1.0758	1.0107 (0.7901)	1.0044	1.0758	1.0107 (0.7971)
-2.5	1.0006	1.0048	1.0029 (0.8848)	1.0002	1.0048	1.0029 (0.8885)	1.0001	1.0048	1.0029 (0.8929)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table C23 ARL of $\alpha_3 = 2.5$, $\alpha_4 = 12.38$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

for case (7) $p_L = p_U = 0.05332$, (8) $p_L = p_U = 0.08432$, (9) $p_L = p_U = 0.12662$

shift (δ)	P.C.(7)	S.C.	A.C. (7)	P.C.(8)	S.C.	A.C. (8)	P.C.(9)	S.C.	A.C. (9)
2.5	1.0000	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)
2	1.0021	1.0758	1.2816 (1.0000)	1.0010	1.0758	1.2816 (1.0000)	1.0004	1.0758	1.2816 (1.0000)
1.5	1.0426	1.5665	2.2166 (1.0000)	1.0246	1.5665	2.2166 (1.0000)	1.0137	1.5665	2.2166 (1.0000)
1	1.3638	4.4953	4.5269 (1.0000)	1.2421	4.4953	4.5269 (1.0000)	1.1584	4.4953	4.5269 (1.0000)
0.5	3.1920	33.4008	9.7644 (1.0000)	2.4735	33.4008	9.7644 (1.0000)	1.9916	33.4008	9.7644 (1.0000)
0	9.3780	370.3983	20.2987 (0.9494)	5.9301	370.3983	20.2987 (0.9222)	3.9489	370.3983	20.2987 (0.8876)
-0.5	3.1920	33.4008	2.1776 (0.6355)	2.4735	33.4008	2.1776 (0.6202)	1.9916	33.4008	2.1776 (0.6059)
-1	1.3638	4.4953	1.1888 (0.5832)	1.2421	4.4953	1.1888 (0.5878)	1.1584	4.4953	1.1888 (0.5941)
-1.5	1.0426	1.5665	1.0420 (0.6797)	1.0246	1.5665	1.0420 (0.6905)	1.0137	1.5665	1.0420 (0.7029)
-2	1.0021	1.0758	1.0107 (0.8054)	1.0010	1.0758	1.0107 (0.8150)	1.0004	1.0758	1.0107 (0.8255)
-2.5	1.0000	1.0048	1.0029 (0.8981)	1.0000	1.0048	1.0029 (0.9038)	1.0000	1.0048	1.0029 (0.9101)

(x) represents case x^{th} at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table C24 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (10) $p_L = p_U$ = 0.18086, (11) $p_L = p_U$ = 0.24623, (12) $p_L = p_U$ = 0.32026

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)
2	1.0002	1.0758	1.2816 (1.0000)	1.0001	1.0758	1.2816 (1.0000)	1.0000	1.0758	1.2816 (1.0000)
1.5	1.0073	1.5665	2.2166 (1.0000)	1.0038	1.5665	2.2166 (1.0000)	1.0019	1.5665	2.2166 (1.0000)
1	1.1012	4.4953	4.5269 (1.0000)	1.0626	4.4953	4.5269 (1.0000)	1.0363	4.4953	4.5269 (1.0000)
0.5	1.6590	33.4008	9.7644 (1.0000)	1.4233	33.4008	9.7644 (1.0000)	1.2516	33.4008	9.7644 (1.0000)
0	2.7645	370.3983	20.2987 (0.8468)	2.0306	370.3983	20.2987 (0.8024)	1.5612	370.3983	20.2987 (0.7574)
-0.5	1.6590	33.4008	2.1776 (0.5936)	1.4233	33.4008	2.1776 (0.5841)	1.2516	33.4008	2.1776 (0.5780)
-1	1.1012	4.4953	1.1888 (0.6025)	1.0626	4.4953	1.1888 (0.6130)	1.0363	4.4953	1.1888 (0.6257)
-1.5	1.0073	1.5665	1.0420 (0.7169)	1.0038	1.5665	1.0420 (0.7324)	1.0019	1.5665	1.0420 (0.7489)
-2	1.0002	1.0758	1.0107 (0.8368)	1.0001	1.0758	1.0107 (0.8487)	1.0000	1.0758	1.0107 (0.8608)
-2.5	1.0000	1.0048	1.0029 (0.9166)	1.0000	1.0048	1.0029 (0.9233)	1.0000	1.0048	1.0029 (0.9300)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix D

Comparisons of ARL of control charts for $C_L < C_U$, n = 4

Appendix Table D1 ARL of α_3 = 0.25, α_4 = 3.09, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (1) p_U = 0.00146, p_L = 0.00124, (2) p_U = 0.00322, p_L = 0.00274, (3) p_U = 0.00671, p_L = 0.00571

shift (δ)	P.C.[(1)]	S.C.	A.C. [(1)]	P.C.[(2)]	S.C.	A.C. [(2)]	P.C.[(3)]	S.C.	A.C. [(3)]
2.5	1.0220	1.0233	1.0000 (1.0000)	1.0116	1.0233	1.0000 (1.0000)	1.0058	1.0233	1.0000 (1.0000)
2	1.1806	1.1886	1.0000 (1.0000)	1.1124	1.1886	1.0000 (1.0000)	1.0676	1.1886	1.0000 (1.0000)
1.5	1.9628	2.0000	1.0000 (1.0000)	1.6432	2.0000	1.0000 (1.0000)	1.4262	2.0000	1.0000 (1.0000)
1	6.0799	6.3030	1.0003 (1.0000)	4.2661	6.3030	1.0003 (1.0000)	3.1412	6.3030	1.0003 (1.0000)
0.5	41.5055	43.8947	1.0108 (1.0000)	23.5870	43.8947	1.0108 (1.0000)	14.1491	43.8947	1.0108 (1.0000)
0	370.3983	370.3983	1.0704 (0.9988)	167.7986	370.3983	1.0704 (0.9943)	80.5196	370.3983	1.0704 (0..9889)
-0.5	46.6469	43.8947	1.2160 (0.9641)	26.4282	43.8947	1.2160 (0.9303)	15.7983	43.8947	1.2160 (0..9040)
-1	6.5557	6.3030	1.3355 (0.8295)	4.5783	6.3030	1.3355 (0.7658)	3.3540	6.3030	1.3355 (0.7287)
-1.5	2.0417	2.0000	1.2180 (0.6519)	1.7006	2.0000	1.2180 (0.6049)	1.4686	2.0000	1.2180 (0.5826)
-2	1.1975	1.1886	1.0572 (0.5450)	1.1246	1.1886	1.0572 (0.5268)	1.0761	1.1886	1.0572 (0.5195)
-2.5	1.0248	1.0233	1.0027 (0.5093)	1.0133	1.0233	1.0027 (0.5062)	1.0068	1.0233	1.0027 (0.5058)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table D2 ARL of α_3 = 0.25, α_4 = 3.09, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (4) p_U = 0.01321, p_L = 0.01124, (5) p_U = 0.02459, p_L = 0.02091, (6) p_U = 0.04330, p_L = 0.03682

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0027	1.0233	1.0000 (1.0000)	1.0012	1.0233	1.0000 (1.0000)	1.0005	1.0233	1.0000 (1.0000)
2	1.0390	1.1886	1.0000 (1.0000)	1.0215	1.1886	1.0000 (1.0000)	1.0112	1.1886	1.0000 (1.0000)
1.5	1.2782	2.0000	1.0000 (1.0000)	1.1776	2.0000	1.0000 (1.0000)	1.1101	2.0000	1.0000 (1.0000)
1	2.4214	6.3030	1.0003 (1.0000)	1.9486	6.3030	1.0003 (1.0000)	1.6319	6.3030	1.0003 (1.0000)
0.5	8.9469	43.8947	1.0108 (0..9997)	5.9535	43.8947	1.0108 (0.9988)	4.1601	43.8947	1.0108 (0.9962)
0	40.9016	370.3983	1.0704 (0..9795)	21.9779	370.3983	1.0704 (0.9645)	12.4815	370.3983	1.0704 (0.9422)
-0.5	9.9495	43.8947	1.2160 (0.8706)	6.5892	43.8947	1.2160 (0.8305)	4.5783	43.8947	1.2160 (0.7855)
-1	2.5716	6.3030	1.3355 (0.6902)	2.0578	6.3030	1.3355 (0.6527)	1.7132	6.3030	1.3355 (0.6182)
-1.5	1.3097	2.0000	1.2180 (0.5624)	1.2010	2.0000	1.2180 (0.5453)	1.1273	2.0000	1.2180 (0.5316)
-2	1.0449	1.1886	1.0572 (0.5074)	1.0254	1.1886	1.0572 (0.5095)	1.0137	1.1886	1.0572 (0.5070)
-2.5	1.0033	1.0233	1.0027 (0.5065)	1.0015	1.0233	1.0027 (0.5085)	1.0007	1.0233	1.0027 (0.5121)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table D3 ARL of $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4,

for case (7) $p_U = 0.07221$, $p_L = 0.06142$, (8) $p_U = 0.11420$, $p_L = 0.09710$, (9) $p_U = 0.17149$, $p_L = 0.14582$

shift (δ)	P.C.$^{(7)}$	S.C.	A.C. $^{(7)}$	P.C.$^{(8)}$	S.C.	A.C. $^{(8)}$	P.C.$^{(9)}$	S.C.	A.C. $^{(9)}$
2.5	1.0002	1.0233	1.0000 (1.0000)	1.0001	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)
2	1.0056	1.1886	1.0000 (1.0000)	1.0026	1.1886	1.0000 (1.0000)	1.0011	1.1886	1.0000 (1.0000)
1.5	1.0658	2.0000	1.0000 (1.0000)	1.0376	2.0000	1.0000 (1.0000)	1.0205	2.0000	1.0000 (1.0000)
1	1.4169	6.3030	1.0003 (1.0000)	1.2701	6.3030	1.0003 (1.0000)	1.1701	6.3030	1.0003 (0.9998)
0.5	3.0448	43.8947	1.0108 (0.9962)	2.3269	43.8947	1.0108 (0.9906)	1.8499	43.8947	1.0108 (0.9802)
0	7.4842	370.3983	1.0704 (0.9422)	4.7326	370.3983	1.0704 (0.9115)	3.1515	370.3983	1.0704 (0.8727)
-0.5	3.3280	43.8947	1.2160 (0.7855)	2.5220	43.8947	1.2160 (0.7385)	1.9843	43.8947	1.2160 (0.6925)
-1	1.4784	6.3030	1.3355 (0.6182)	1.3171	6.3030	1.3355 (0.5882)	1.2057	6.3030	1.3355 (0.5635)
-1.5	1.0782	2.0000	1.2180 (0.5316)	1.0464	2.0000	1.2180 (0.5212)	1.0265	2.0000	1.2180 (0.5140)
-2	1.0071	1.1886	1.0572 (0.5070)	1.0035	1.1886	1.0572 (0.5061)	1.0016	1.1886	1.0572 (0.5070)
-2.5	1.0003	1.0233	1.0027 (0.5121)	1.0001	1.0233	1.0027 (0.5177)	1.0000	1.0233	1.0027 (0.5257)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table D4 ARL of α_3 = 0.25, α_4 = 3.09, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

fore case (10) p_U = 0.24496, p_L = 0.20829, (11) p_U = 0.33350 p_L = 0.28357, (12) p_U = 0.43376, p_L = 0.36883

shift (δ)	P.C.(10)	S.C.	A.C. (10)	P.C.(11)	S.C.	A.C. (11)	P.C.(12)	S.C.	A.C. (12)
2.5	1.0000	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)
2	1.0005	1.1886	1.0000 (1.0000)	1.0002	1.1886	1.0000 (1.0000)	1.0001	1.1886	1.0000 (1.0000)
1.5	1.0105	2.0000	1.0000 (1.0000)	1.0049	2.0000	1.0000 (1.0000)	1.0019	2.0000	1.0000 (1.0000)
1	1.1022	6.3030	1.0003 (0.9987)	1.0562	6.3030	1.0003 (0.9957)	1.0242	6.3030	1.0003 (0.9892)
0.5	1.5232	43.8947	1.0108 (0.9632)	1.2928	43.8947	1.0108 (0.9384)	1.1254	43.8947	1.0108 (0.9055)
0	2.2063	370.3983	1.0704 (0.8276)	1.6205	370.3983	1.0704 (0.7791)	1.2460	370.3983	1.0704 (0.7306)
-0.5	1.6132	43.8947	1.2160 (0.6503)	1.3479	43.8947	1.2160 (0.6137)	1.1512	43.8947	1.2160 (0.5836)
-1	1.1286	6.3030	1.3355 (0.5443)	1.0743	6.3030	1.3355 (0.5300)	1.0339	6.3030	1.3355 (0.5199)
-1.5	1.0144	2.0000	1.2180 (0.5094)	1.0073	2.0000	1.2180 (0.5071)	1.0031	2.0000	1.2180 (0.5068)
-2	1.0007	1.1886	1.0572 (0.5096)	1.0003	1.1886	1.0572 (0.5142)	1.0001	1.1886	1.0572 (0.5213)
-2.5	1.0000	1.0233	1.0027 (0.5365)	1.0000	1.0233	1.0027 (0.5508)	1.0000	1.0233	1.0027 (0.5691)

(x) represents case x^{th} at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table D5 ARL of $\alpha_3 = 0.5$, $\alpha_4 = 3.38$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4

for case (1) $p_U = 0.00155$, $p_L = 0.00115$, (2) $p_U = 0.00342$ $p_L = 0.00254$, (3) $p_U = 0.00713$, $p_L = 0.00529$

shift (δ)	P.C.$^{(1)}$	S.C.	A.C. $^{(1)}$	P.C.$^{(2)}$	S.C.	A.C. $^{(2)}$	P.C.$^{(3)}$	S.C.	A.C. $^{(3)}$
2.5	1.0210	1.0233	1.0000 (1.0000)	1.0110	1.0233	1.0000 (1.0000)	1.0054	1.0233	1.0000 (1.0000)
2	1.1746	1.1886	1.0000 (1.0000)	1.1081	1.1886	1.0000 (1.0000)	1.0646	1.1886	1.0000 (1.0000)
1.5	1.9348	2.0000	1.0024 (1.0000)	1.6228	2.0000	1.0024 (1.0000)	1.4113	2.0000	1.0024 (1.0000)
1	5.9136	6.3030	1.0337 (1.0000)	4.1568	6.3030	1.0337 (1.0000)	3.0666	6.3030	1.0337 (1.0000)
0.5	39.7506	43.8947	1.1395 (1.0000)	22.6156	43.8947	1.1395 (1.0000)	13.5842	43.8947	1.1395 (1.0000)
0	370.3983	370.3983	1.3874 (0.9989)	167.7986	370.3983	1.3874 (0.9975)	80.5196	370.3983	1.3874 (0.9947)
-0.5	49.2687	43.8947	1.6079 (0.9098)	27.8747	43.8947	1.6079 (0.8937)	16.6363	43.8947	1.6079 (0.8731)
-1	6.7925	6.3030	1.3098 (0.6986)	4.7334	6.3030	1.3098 (0.6821)	3.4597	6.3030	1.3098 (0.6633)
-1.5	2.0804	2.0000	1.0329 (0.5609)	1.7287	2.0000	1.0329 (0.5544)	1.4894	2.0000	1.0329 (0.5477)
-2	1.2058	1.1886	0.9638 (0.5226)	1.1305	1.1886	0.9638 (0.5224)	1.0804	1.1886	0.9638 (0.5228)
-2.5	1.0262	1.0233	0.9715 (0.5378)	1.0142	1.0233	0.9715 (0.5411)	1.0073	1.0233	0.9715 (0.5455)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table D6 ARL of α_3 = 0.5, α_4 = 3.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (4) p_U = 0.01403, p_L = 0.01042, (5) p_U = 0.02612 p_L = 0.01938, (6) p_U = 0.04599, p_L = 0.03413

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0025	1.0233	1.0000 (1.0000)	1.0011	1.0233	1.0000 (1.0000)	1.0005	1.0233	1.0000 (1.0000)
2	1.0370	1.1886	1.0000 (1.0000)	1.0202	1.1886	1.0000 (1.0000)	1.0104	1.1886	1.0000 (1.0000)
1.5	1.2671	2.0000	1.0024 (1.0000)	1.1694	2.0000	1.0024 (1.0000)	1.1041	2.0000	1.0024 (1.0000)
1	2.3687	6.3030	1.0337 (1.0000)	1.9104	6.3030	1.0337 (1.0000)	1.6035	6.3030	1.0337 (1.0000)
0.5	8.6028	43.8947	1.1395 (1.0000)	5.7347	43.8947	1.1395 (1.0000)	4.0158	43.8947	1.1395 (1.0000)
0	40.9016	370.3983	1.3874 (0.9897)	21.9779	370.3983	1.3874 (0.9810)	12.4815	370.3983	1.3874 (0.9670)
-0.5	10.4578	43.8947	1.6079 (0.8476)	6.9106	43.8947	1.6079 (0.8172)	4.7890	43.8947	1.6079 (0.7827)
-1	2.6461	6.3030	1.3098 (0.6430)	2.1120	6.3030	1.3098 (0.6219)	1.7536	6.3030	1.3098 (0.6012)
-1.5	1.3252	2.0000	1.0329 (0.5410)	1.2126	2.0000	1.0329 (0.5350)	1.1359	2.0000	1.0329 (0.5300)
-2	1.0478	1.1886	0.9638 (0.5238)	1.0273	1.1886	0.9638 (0.5258)	1.0150	1.1886	0.9638 (0.5291)
-2.5	1.0036	1.0233	0.9715 (0.5512)	1.0017	1.0233	0.9715 (0.5584)	1.0007	1.0233	0.9715 (0.5673)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table D7 ARL of α_3 = 0.5, α_4 = 3.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (7) p_U = 0.07669, p_L = 0.05692, (8) p_U = 0.12128 p_L = 0.09002, (9) p_U = 0.18212, p_L = 0.13519

shift (δ)	P.C.$^{(7)}$	S.C.	A.C. $^{(7)}$	P.C.$^{(8)}$	S.C.	A.C. $^{(8)}$	P.C.$^{(9)}$	S.C.	A.C. $^{(9)}$
2.5	1.0002	1.0233	1.0000 (1.0000)	1.0001	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)
2	1.0051	1.1886	1.0000 (1.0000)	1.0023	1.1886	1.0000 (1.0000)	1.0010	1.1886	1.0000 (1.0000)
1.5	1.0615	2.0000	1.0024 (1.0000)	1.0347	2.0000	1.0024 (1.0000)	1.0185	2.0000	1.0024 (1.0000)
1	1.3955	6.3030	1.0337 (1.0000)	1.2539	6.3030	1.0337 (1.0000)	1.1578	6.3030	1.0337 (1.0000)
0.5	2.9467	43.8947	1.1395 (1.0000)	2.2590	43.8947	1.1395 (0.9993)	1.8028	43.8947	1.1395 (0.9959)
0	7.4842	370.3983	1.3874 (0.9461)	4.7326	370.3983	1.3874 (0.9174)	3.1515	370.3983	1.3874 (0.8809)
-0.5	3.4701	43.8947	1.6079 (0.7454)	2.6195	43.8947	1.6079 (0.7072)	2.0511	43.8947	1.6079 (0.6702)
-1	1.5091	6.3030	1.3098 (0.5819)	1.3406	6.3030	1.3098 (0.5649)	1.2237	6.3030	1.3098 (0.5508)
-1.5	1.0846	2.0000	1.0329 (0.5264)	1.0510	2.0000	1.0329 (0.5247)	1.0297	2.0000	1.0329 (0.5251)
-2	1.0078	1.1886	0.9638 (0.5339)	1.0039	1.1886	0.9638 (0.5405)	1.0019	1.1886	0.9638 (0.5491)
-2.5	1.0003	1.0233	0.9715 (0.5782)	1.0001	1.0233	0.9715 (0.5913)	1.0000	1.0233	0.9715 (0.6067)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table D8 ARL of $\alpha_3 = 0.5$, $\alpha_4 = 3.38$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4

for case (10) $p_U = 0.26015$, $p_L = 0.19310$, (11) $p_U = 0.35418$ $p_L = 0.26290$, (12) $p_U = 0.46066$, $p_L = 0.34193$

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)
2	1.0004	1.1886	1.0000 (1.0000)	1.0001	1.1886	1.0000 (1.0000)	1.0000	1.1886	1.0000 (1.0000)
1.5	1.0092	2.0000	1.0024 (1.0000)	1.0042	2.0000	1.0024 (1.0000)	1.0015	2.0000	1.0024 (1.0000)
1	1.0932	6.3030	1.0337 (1.0000)	1.0502	6.3030	1.0337 (1.0000)	1.0210	6.3030	1.0337 (1.0000)
0.5	1.4915	43.8947	1.1395 (0.9873)	1.2732	43.8947	1.1395 (0.9712)	1.1161	43.8947	1.1395 (0.9460)
0	2.2063	370.3983	1.3874 (0.8382)	1.6205	370.3983	1.3874 (0.7918)	1.2460	370.3983	1.3874 (0.7452)
-0.5	1.6576	43.8947	1.6079 (0.6362)	1.3748	43.8947	1.6079 (0.6067)	1.1638	43.8947	1.6079 (0.5825)
-1	1.1421	6.3030	1.3098 (0.5401)	1.0837	6.3030	1.3098 (0.5330)	1.0392	6.3030	1.3098 (0.5294)
-1.5	1.0166	2.0000	1.0329 (0.5277)	1.0087	2.0000	1.0329 (0.5328)	1.0038	2.0000	1.0329 (0.5407)
-2	1.0009	1.1886	0.9638 (0.5600)	1.0004	1.1886	0.9638 (0.5735)	1.0001	1.1886	0.9638 (0.5899)
-2.5	1.0000	1.0233	0.9715 (0.6247)	1.0000	1.0233	0.9715 (0.6454)	1.0000	1.0233	0.9715 (0.6690)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table D9 ARL of α_3 = 1, α_4 = 4.5, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (1) p_U = 0.00165, p_L = 0.00105, (2 p_U = 0.00364 p_L = 0.00232, (3) p_U = 0.00759, p_L = 0.00483

shift (δ)	P.C.(1)	S.C.	A.C. (1)	P.C.(2)	S.C.	A.C. (2)	P.C.(3)	S.C.	A.C. (3)
2.5	1.0200	1.0233	1.0000 (1.0000)	1.0104	1.0233	1.0000 (1.0000)	1.0051	1.0233	1.0000 (1.0000)
2	1.1685	1.1886	1.0068 (1.0000)	1.1038	1.1886	1.0068 (1.0000)	1.0616	1.1886	1.0068 (1.0000)
1.5	1.9063	2.0000	1.0766 (1.0000)	1.6022	2.0000	1.0766 (1.0000)	1.3960	2.0000	1.0766 (1.0000)
1	5.7460	6.3030	1.2344 (1.0000)	4.0466	6.3030	1.2344 (1.0000)	2.9913	6.3030	1.2344 (1.0000)
0.5	38.0028	43.8947	1.5118 (1.0000)	21.6473	43.8947	1.5118 (1.0000)	13.0205	43.8947	1.5118 (1.0000)
0	370.3983	370.3983	1.9611 (0.9990)	167.7986	370.3983	1.9611 (0.9977)	80.5196	370.3983	1.9611 (0.9952)
-0.5	52.6309	43.8947	1.5498 (0.7867)	29.7273	43.8947	1.5498 (0.7790)	17.7081	43.8947	1.5498 (0.7687)
-1	7.0910	6.3030	1.0681 (0.5982)	4.9288	6.3030	1.0681 (0.5951)	3.5927	6.3030	1.0681 (0.5912)
-1.5	2.1285	2.0000	0.9333 (0.5446)	1.7638	2.0000	0.9333 (0.5445)	1.5154	2.0000	0.9333 (0.5444)
-2	1.2161	1.1886	0.9211 (0.5563)	1.1380	1.1886	0.9211 (0.5575)	1.0857	1.1886	0.9211 (0.5592)
-2.5	1.0279	1.0233	0.9394 (0.5984)	1.0153	1.0233	0.9394 (0.6003)	1.0080	1.0233	0.9394 (0.6030)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table D10 ARL of $\alpha_3 = 1$, $\alpha_4 = 4.5$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4

for case (4) $p_U = 0.01494$, $p_L = 0.00951$, (5) $p_U = 0.02781$ $p_L = 0.01769$, (6) $p_U = 0.04896$, $p_L = 0.03116$

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0023	1.0233	1.0000 (1.0000)	1.0010	1.0233	1.0000 (1.0000)	1.0004	1.0233	1.0000 (1.0000)
2	1.0349	1.1886	1.0068 (1.0000)	1.0188	1.1886	1.0068 (1.0000)	1.0096	1.1886	1.0068 (1.0000)
1.5	1.2559	2.0000	1.0766 (1.0000)	1.1611	2.0000	1.0766 (1.0000)	1.0981	2.0000	1.0766 (1.0000)
1	2.3155	6.3030	1.2344 (1.0000)	1.8717	6.3030	1.2344 (1.0000)	1.5748	6.3030	1.2344 (1.0000)
0.5	8.2590	43.8947	1.5118 (1.0000)	5.5159	43.8947	1.5118 (1.0000)	3.8711	43.8947	1.5118 (1.0000)
0	40.9016	370.3983	1.9611 (0.9906)	21.9779	370.3983	1.9611 (0.9826)	12.4815	370.3983	1.9611 (0.9698)
-0.5	11.1068	43.8947	1.5498 (0.7555)	7.3203	43.8947	1.5498 (0.7392)	5.0570	43.8947	1.5498 (0.7199)
-1	2.7399	6.3030	1.0681 (0.5863)	2.1802	6.3030	1.0681 (0.5807)	1.8044	6.3030	1.0681 (0.5746)
-1.5	1.3446	2.0000	0.9333 (0.5444)	1.2271	2.0000	0.9333 (0.5448)	1.1468	2.0000	0.9333 (0.5456)
-2	1.0515	1.1886	0.9211 (0.5615)	1.0298	1.1886	0.9211 (0.5647)	1.0166	1.1886	0.9211 (0.5688)
-2.5	1.0040	1.0233	0.9394 (0.6066)	1.0019	1.0233	0.9394 (0.6113)	1.0009	1.0233	0.9394 (0.6172)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table D11 ARL of $\alpha_3 = 1$, $\alpha_4 = 4.5$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4

for case (7) $p_U = 0.08165$, $p_L = 0.05196$, (8) $p_U = 0.12913$ $p_L = 0.08217$, (9) $p_U = 0.19391$, $p_L = 0.12340$

shift (δ)	P.C.$^{(7)}$	S.C.	A.C. $^{(7)}$	P.C.$^{(8)}$	S.C.	A.C. $^{(8)}$	P.C.$^{(9)}$	S.C.	A.C. $^{(9)}$
2.5	1.0002	1.0233	1.0000 (1.0000)	1.0001	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)
2	1.0046	1.1886	1.0068 (1.0000)	1.0021	1.1886	1.0068 (1.0000)	1.0009	1.1886	1.0068 (1.0000)
1.5	1.0572	2.0000	1.0766 (1.0000)	1.0317	2.0000	1.0766 (1.0000)	1.0166	2.0000	1.0766 (1.0000)
1	1.3739	6.3030	1.2344 (1.0000)	1.2375	6.3030	1.2344 (1.0000)	1.1456	6.3030	1.2344 (1.0000)
0.5	2.8482	43.8947	1.5118 (1.0000)	2.1906	43.8947	1.5118 (1.0000)	1.7553	43.8947	1.5118 (1.0000)
0	7.4842	370.3983	1.9611 (0.9506)	4.7326	370.3983	1.9611 (0.9241)	3.1515	370.3983	1.9611 (0.8902)
-0.5	3.6503	43.8947	1.5498 (0.6982)	2.7427	43.8947	1.5498 (0.6749	2.1351	43.8947	1.5498 (0.6512)
-1	1.5478	6.3030	1.0681 (0.5684)	1.3704	6.3030	1.0681 (0.5627)	1.2466	6.3030	1.0681 (0.5581)
-1.5	1.0926	2.0000	0.9333 (0.5472)	1.0568	2.0000	0.9333 (0.5498)	1.0338	2.0000	0.9333 (0.5537)
-2	1.0089	1.1886	0.9211 (0.5741)	1.0046	1.1886	0.9211 (0.5807)	1.0022	1.1886	0.9211 (0.5890)
-2.5	1.0004	1.0233	0.9394 (0.6246)	1.0002	1.0233	0.9394 (0.6335)	1.0001	1.0233	0.9394 (0.6443)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table D12 ARL of $\alpha_3 = 1$, $\alpha_4 = 4.5$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4,

for case (10) $p_U = 0.27699$, $p_L = 0.17627$, (11) $p_U = 0.37710$ $p_L = 0.23997$, (12) $p_U = 0.49047$, $p_L = 0.31212$

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)
2	1.0003	1.1886	1.0068 (1.0000)	1.0001	1.1886	1.0068 (1.0000)	1.0000	1.1886	1.0068 (1.0000)
1.5	1.0080	2.0000	1.0766 (1.0000)	1.0035	2.0000	1.0766 (1.0000)	1.0012	2.0000	1.0766 (1.0000)
1	1.0844	6.3030	1.2344 (1.0000)	1.0443	6.3030	1.2344 (1.0000)	1.0180	6.3030	1.2344 (1.0000)
0.5	1.4593	43.8947	1.5118 (1.0000)	1.2533	43.8947	1.5118 (1.0000)	1.1067	43.8947	1.5118 (0.9931)
0	2.2063	370.3983	1.9611 (0.8501)	1.6205	370.3983	1.9611 (0.8065)	1.2460	370.3983	1.9611 (0.7621)
-0.5	1.7131	43.8947	1.5498 (0.6291)	1.4084	43.8947	1.5498 (0.6099)	1.1793	43.8947	1.5498 (0.5946)
-1	1.1594	6.3030	1.0681 (0.5550)	1.0959	6.3030	1.0681 (0.5542)	1.0460	6.3030	1.0681 (0.5563)
-1.5	1.0194	2.0000	0.9333 (0.5594)	1.0106	2.0000	0.9333 (0.5672)	1.0048	2.0000	0.9333 (0.5777)
-2	1.0011	1.1886	0.9211 (0.5992)	1.0005	1.1886	0.9211 (0.6116)	1.0002	1.1886	0.9211 (0.6267)
-2.5	1.0000	1.0233	0.9394 (0.6569)	1.0000	1.0233	0.9394 (0.6718)	1.0000	1.0233	0.9394 (0.6891)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table D13 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (1) p_U = 0.00167, p_L = 0.00103, (2) p_U = 0.00368 p_L = 0.00228, (3) p_U = 0.00767, p_L = 0.00475

shift (δ)	P.C.$^{(1)}$	S.C.	A.C. $^{(1)}$	P.C.$^{(2)}$	S.C.	A.C. $^{(2)}$	P.C.$^{(3)}$	S.C.	A.C. $^{(3)}$
2.5	1.0199	1.0233	1.0018 (1.0000)	1.0103	1.0233	1.0018 (1.0000)	1.0050	1.0233	1.0018 (1.0000)
2	1.1675	1.1886	1.1212 (1.0000)	1.1031	1.1886	1.1212 (1.0000)	1.0611	1.1886	1.1212 (1.0000)
1.5	1.9016	2.0000	1.4752 (1.0000)	1.5987	2.0000	1.4752 (1.0000)	1.3935	2.0000	1.4752 (1.0000)
1	5.7185	6.3030	2.2129 (1.0000)	4.0285	6.3030	2.2129 (1.0000)	2.9790	6.3030	2.2129 (1.0000)
0.5	37.7184	43.8947	3.6453 (1.0000)	21.4896	43.8947	3.6453 (1.0000)	12.9287	43.8947	3.6453 (1.0000)
0	370.3983	370.3983	6.3110 (0.9990)	167.7986	370.3983	6.3110 (0.9977)	80.5196	370.3983	6.3110 (0.9953)
-0.5	53.2719	43.8947	2.4161 (0.7559)	30.0802	43.8947	2.4161 (0.7489)	17.9121	43.8947	2.4161 (0.7397)
-1	7.1473	6.3030	1.2789 (0.5836)	4.9656	6.3030	1.2789 (0.5819)	3.6177	6.3030	1.2789 (0.5799)
-1.5	2.1375	2.0000	1.0593 (0.5718)	1.7703	2.0000	1.0593 (0.5731)	1.5202	2.0000	1.0593 (0.5751)
-2	1.2180	1.1886	1.0098 (0.6328)	1.1394	1.1886	1.0098 (0.6356)	1.0867	1.1886	1.0098 (0.6394)
-2.5	1.0283	1.0233	0.9993 (0.7234)	1.0155	1.0233	0.9993 (0.7265)	1.0081	1.0233	0.9993 (0.7308)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table D14 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (4) p_U = 0.01510, p_L = 0.00935, (5) p_U = 0.02810 p_L = 0.01740, (6) p_U = 0.04948, p_L = 0.03064

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0023	1.0233	1.0018 (1.0000)	1.0010	1.0233	1.0018 (1.0000)	1.0004	1.0233	1.0018 (1.0000)
2	1.0346	1.1886	1.1212 (1.0000)	1.0186	1.1886	1.1212 (1.0000)	1.0095	1.1886	1.1212 (1.0000)
1.5	1.2540	2.0000	1.4752 (1.0000)	1.1598	2.0000	1.4752 (1.0000)	1.0971	2.0000	1.4752 (1.0000)
1	2.3068	6.3030	2.2129 (1.0000)	1.8654	6.3030	2.2129 (1.0000)	1.5701	6.3030	2.2129 (1.0000)
0.5	8.2030	43.8947	3.6453 (1.0000)	5.4801	43.8947	3.6453 (1.0000)	3.8475	43.8947	3.6453 (1.0000)
0	40.9016	370.3983	6.3110 (0.9907)	21.9779	370.3983	6.3110 (0.9829)	12.4815	370.3983	6.3110 (0.9703)
-0.5	11.2302	43.8947	2.4161 (0.7278)	7.3981	43.8947	2.4161 (0.7134)	5.1078	43.8947	2.4161 (0.6964)
-1	2.7575	6.3030	1.2789 (0.5776)	2.1930	6.3030	1.2789 (0.5753)	1.8140	6.3030	1.2789 (0.5731)
-1.5	1.3483	2.0000	1.0593 (0.5779)	1.2299	2.0000	1.0593 (0.5817)	1.1488	2.0000	1.0593 (0.5868)
-2	1.0522	1.1886	1.0098 (0.6445)	1.0303	1.1886	1.0098 (0.6511)	1.0169	1.1886	1.0098 (0.6594)
-2.5	1.0041	1.0233	0.9993 (0.7364)	1.0019	1.0233	0.9993 (0.7435)	1.0009	1.0233	0.9993 (0.7523)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table D15 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (7) p_U = 0.08251, p_L = 0.05110, (8) p_U = 0.13049 p_L = 0.08081,(9) p_U = 0.19596, p_L = 0.12135

shift (δ)	P.C.(7)	S.C.	A.C. (7)	P.C.(8)	S.C.	A.C. (8)	P.C.(9)	S.C.	A.C. (9)
2.5	1.0002	1.0233	1.0018 (1.0000)	1.0001	1.0233	1.0018 (1.0000)	1.0000	1.0233	1.0018 (1.0000)
2	1.0045	1.1886	1.1212 (1.0000)	1.0020	1.1886	1.1212 (1.0000)	1.0008	1.1886	1.1212 (1.0000)
1.5	1.0565	2.0000	1.4752 (1.0000)	1.0313	2.0000	1.4752 (1.0000)	1.0163	2.0000	1.4752 (1.0000)
1	1.3703	6.3030	2.2129 (1.0000)	1.2349	6.3030	2.2129 (1.0000)	1.1436	6.3030	2.2129 (1.0000)
0.5	2.8321	43.8947	3.6453 (1.0000)	2.1795	43.8947	3.6453 (1.0000)	1.7475	43.8947	3.6453 (1.0000)
0	7.4842	370.3983	6.3110 (0.9514)	4.7326	370.3983	6.3110 (0.9252)	3.1515	370.3983	6.3110 (0.8918)
-0.5	3.6844	43.8947	2.4161 (0.6775)	2.7659	43.8947	2.4161 (0.6572)	2.1509	43.8947	2.4161 (0.6376)
-1	1.5551	6.3030	1.2789 (0.5717)	1.3760	6.3030	1.2789 (0.5716)	1.2510	6.3030	1.2789 (0.5735)
-1.5	1.0941	2.0000	1.0593 (0.5936)	1.0579	2.0000	1.0593 (0.6024)	1.0346	2.0000	1.0593 (0.6137)
-2	1.0091	1.1886	1.0098 (0.6698)	1.0047	1.1886	1.0098 (0.6824)	1.0023	1.1886	1.0098 (0.6973)
-2.5	1.0004	1.0233	0.9993 (0.7629)	1.0002	1.0233	0.9993 (0.7753)	1.0001	1.0233	0.9993 (0.7894)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table D16 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (10) p_U = 0.27991, p_L = 0.17335, (11) p_U = 0.38108, p_L = 0.2360, (12) p_U = 0.49564, p_L = 0.30695

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0233	1.0018 (1.0000)	1.0000	1.0233	1.0018 (1.0000)	1.0000	1.0233	1.0018 (1.0000)
2	1.0003	1.1886	1.1212 (1.0000)	1.0001	1.1886	1.1212 (1.0000)	1.0000	1.1886	1.1212 (1.0000)
1.5	1.0078	2.0000	1.4752 (1.0000)	1.0034	2.0000	1.4752 (1.0000)	1.0012	2.0000	1.4752 (1.0000)
1	1.0830	6.3030	2.2129 (1.0000)	1.0433	6.3030	2.2129 (1.0000)	1.0175	6.3030	2.2129 (1.0000)
0.5	1.4540	43.8947	3.6453 (1.0000)	1.2500	43.8947	3.6453 (1.0000)	1.1051	43.8947	3.6453 (0.9999)
0	2.2063	370.3983	6.3110 (0.8523)	1.6205	370.3983	6.3110 (0.8091)	1.2460	370.3983	6.3110 (0.7651)
-0.5	1.7235	43.8947	2.4161 (0.6206)	1.4146	43.8947	2.4161 (0.6077)	1.1822	43.8947	2.4161 (0.6003)
-1	1.1627	6.3030	1.2789 (0.5781)	1.0983	6.3030	1.2789 (0.5863)	1.0474	6.3030	1.2789 (0.5993)
-1.5	1.0200	2.0000	1.0593 (0.6279)	1.0109	2.0000	1.0593 (0.6455)	1.0050	2.0000	1.0593 (0.6675)
-2	1.0011	1.1886	1.0098 (0.7148)	1.0005	1.1886	1.0098 (0.7350)	1.0002	1.1886	1.0098 (0.7583)
-2.5	1.0000	1.0233	0.9993 (0.8053)	1.0000	1.0233	0.9993 (0.8229)	1.0000	1.0233	0.9993 (0.8421)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table D17 ARL of α_3 = 2, α_4 = 9, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (1) p_U = 0.00165, p_L = 0.00105, (2) p_U = 0.00364, p_L = 0.00232, (3) p_U = 0.00759, p_L = 0.00438

shift (δ)	P.C.(1)	S.C.	A.C. (1)	P.C.(2)	S.C.	A.C. (2)	P.C.(3)	S.C.	A.C. (3)
2.5	1.0200	1.0233	1.0914 (1.0000)	1.0104	1.0233	1.0914 (1.0000)	1.0051	1.0233	1.0914 (1.0000)
2	1.1685	1.1886	1.5687 (1.0000)	1.1038	1.1886	1.5687 (1.0000)	1.0616	1.1886	1.5687 (1.0000)
1.5	1.9063	2.0000	2.7468 (1.0000)	1.6022	2.0000	2.7468 (1.0000)	1.3960	2.0000	2.7468 (1.0000)
1	5.7460	6.3030	5.3154 (1.0000)	4.0466	6.3030	5.3154 (1.0000)	2.9913	6.3030	5.3154 (1.0000)
0.5	38.0028	43.8947	10.5919 (1.0000)	21.6473	43.8947	10.5919 (1.0000)	13.0205	43.8947	10.5919 (1.0000)
0	370.3983	370.3983	20.2987 (0.9990)	167.7986	370.3983	20.2987 (0.9977)	80.5196	370.3983	20.2987 (0.9952)
-0.5	52.6309	43.8947	2.4948 (0.7286)	29.7273	43.8947	2.4948 (0.7223)	17.7081	43.8947	2.4948 (0.7139)
-1	7.0910	6.3030	1.2670 (0.5792)	4.9288	6.3030	1.2670 (0.5788)	3.5927	6.3030	1.2670 (0.5786)
-1.5	2.1285	2.0000	1.0663 (0.6151)	1.7638	2.0000	1.0663 (0.6177)	1.5154	2.0000	1.0663 (0.6215)
-2	1.2161	1.1886	1.0188 (0.7212)	1.1380	1.1886	1.0188 (0.7247)	1.0857	1.1886	1.0188 (0.7294)
-2.5	1.0279	1.0233	1.0057 (0.8292)	1.0153	1.0233	1.0057 (0.8320)	1.0080	1.0233	1.0057 (0.8357)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table D18 ARL of $\alpha_3 = 2$, $\alpha_4 = 9$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4

for case (4) $p_U = 0.01494$, $p_L = 0.00951$, (5) $p_U = 0.02781$, $p_L = 0.01769$, (6) $p_U = 0.04896$, $p_L = 0.03116$

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0040	1.0233	1.0914 (1.0000)	1.0010	1.0233	1.0914 (1.0000)	1.0004	1.0233	1.0914 (1.0000)
2	1.0515	1.1886	1.5687 (1.0000)	1.0188	1.1886	1.5687 (1.0000)	1.0096	1.1886	1.5687 (1.0000)
1.5	1.3446	2.0000	2.7468 (1.0000)	1.1611	2.0000	2.7468 (1.0000)	1.0981	2.0000	2.7468 (1.0000)
1	2.7399	6.3030	5.3154 (1.0000)	1.8717	6.3030	5.3154 (1.0000)	1.5748	6.3030	5.3154 (1.0000)
0.5	11.1497	43.8947	10.5919 (1.0000)	5.5159	43.8947	10.5919 (1.0000)	3.8711	43.8947	10.5919 (1.0000)
0	52.5877	370.3983	20.2987 (0.9906)	21.9779	370.3983	20.2987 (0.9826)	12.4815	370.3983	20.2987 (0.9698)
-0.5	11.1497	43.8947	2.4948 (0.7033)	7.3203	43.8947	2.4948 (0.6904)	5.0570	43.8947	2.4948 (0.6753)
-1	2.7399	6.3030	1.2670 (0.5785)	2.1802	6.3030	1.2670 (0.5791)	1.8044	6.3030	1.2670 (0.5805)
-1.5	1.3446	2.0000	1.0663 (0.6265)	1.2271	2.0000	1.0663 (0.6332)	1.1468	2.0000	1.0663 (0.6418)
-2	1.0515	1.1886	1.0188 (0.7356)	1.0298	1.1886	1.0188 (0.7434)	1.0166	1.1886	1.0188 (0.7532)
-2.5	1.0040	1.0233	1.0057 (0.8406)	1.0019	1.0233	1.0057 (0.8466)	1.0009	1.0233	1.0057 (0.8539)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table D19 ARL of α_3 = 2, α_4 = 9, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (7) p_U = 0.08165, p_L = 0.05196, (8) p_U = 0.12913, p_L = 0.08217, (9) p_U = 0.19391, p_L = 0.12340

shift (δ)	P.C.(7)	S.C.	A.C. (7)	P.C.(8)	S.C.	A.C. (8)	P.C.(9)	S.C.	A.C. (9)
2.5	1.0002	1.0233	1.0914 (1.0000)	1.0001	1.0233	1.0914 (1.0000)	1.0000	1.0233	1.0914 (1.0000)
2	1.0046	1.1886	1.5687 (1.0000)	1.0021	1.1886	1.5687 (1.0000)	1.0009	1.1886	1.5687 (1.0000)
1.5	1.0572	2.0000	2.7468 (1.0000)	1.0317	2.0000	2.7468 (1.0000)	1.0166	2.0000	2.7468 (1.0000)
1	1.3739	6.3030	5.3154 (1.0000)	1.2375	6.3030	5.3154 (1.0000)	1.1456	6.3030	5.3154 (1.0000)
0.5	2.8482	43.8947	10.5919 (1.0000)	2.1906	43.8947	10.5919 (1.0000)	1.7553	43.8947	10.5919 (1.0000)
0	7.4842	370.3983	20.2987 (0.9506)	4.7326	370.3983	20.2987 (0.9241)	3.1515	370.3983	20.2987 (0.8902)
-0.5	3.6503	43.8947	2.4948 (0.6586)	2.7427	43.8947	2.4948 (0.6410)	2.1351	43.8947	2.4948 (0.6251)
-1	1.5478	6.3030	1.2670 (0.5835)	1.3704	6.3030	1.2670 (0.5885)	1.2466	6.3030	1.2670 (0.5964)
-1.5	1.0926	2.0000	1.0663 (0.6526)	1.0568	2.0000	1.0663 (0.6660)	1.0338	2.0000	1.0663 (0.6823)
-2	1.0089	1.1886	1.0188 (0.7648)	1.0046	1.1886	1.0188 (0.7785)	1.0022	1.1886	1.0188 (0.7941)
-2.5	1.0004	1.0233	1.0057 (0.8623)	1.0002	1.0233	1.0057 (0.8720)	1.0001	1.0233	1.0057 (0.8826)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table D20 ARL of $\alpha_3 = 2$, $\alpha_4 = 9$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4

for case (10) $p_U = 0.27699$, $p_L = 0.17627$, (11) $p_U = 0.37710$, $p_L = 0.23997$, (12) $p_U = 0.49047$, $p_L = 0.31212$

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0233	1.0914 (1.0000)	1.0000	1.0233	1.0914 (1.0000)	1.0000	1.0233	1.0914 (1.0000)
2	1.0003	1.1886	1.5687 (1.0000)	1.0001	1.1886	1.5687 (1.0000)	1.0000	1.1886	1.5687 (1.0000)
1.5	1.0080	2.0000	2.7468 (1.0000)	1.0035	2.0000	2.7468 (1.0000)	1.0012	2.0000	2.7468 (1.0000)
1	1.0844	6.3030	5.3154 (1.0000)	1.0443	6.3030	5.3154 (1.0000)	1.0180	6.3030	5.3154 (1.0000)
0.5	1.4593	43.8947	10.5919 (1.0000)	1.2533	43.8947	10.5919 (1.0000)	1.1067	43.8947	10.5919 (1.0000)
0	2.2063	370.3983	20.2987 (0.8501)	1.6205	370.3983	20.2987 (0.8065)	1.2460	370.3983	20.2987 (0.7621)
-0.5	1.7131	43.8947	2.4948 (0.6127)	1.4084	43.8947	2.4948 (0.6055)	1.1793	43.8947	2.4948 (0.6055)
-1	1.1594	6.3030	1.2670 (0.6079)	1.0959	6.3030	1.2670 (0.6241)	1.0460	6.3030	1.2670 (0.6462)
-1.5	1.0194	2.0000	1.0663 (0.7017)	1.0106	2.0000	1.0663 (0.7247)	1.0048	2.0000	1.0663 (0.7514)
-2	1.0011	1.1886	1.0188 (0.8114)	1.0005	1.1886	1.0188 (0.8306)	1.0002	1.1886	1.0188 (0.8513)
-2.5	1.0000	1.0233	1.0057 (0.8940)	1.0000	1.0233	1.0057 (0.9061)	1.0000	1.0233	1.0057 (0.9186)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table D21 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (1) p_U = 0.00162, p_L = 0.00108, (2) p_U = 0.00358, p_L = 0.00238, (3) p_U = 0.00746, p_L = 0.00496

shift (δ)	P.C.$^{(1)}$	S.C.	A.C. $^{(1)}$	P.C.$^{(2)}$	S.C.	A.C. $^{(2)}$	P.C.$^{(3)}$	S.C.	A.C. $^{(3)}$
2.5	1.0203	1.0233	1.0914 (1.0000)	1.0105	1.0233	1.0914 (1.0000)	1.0052	1.0233	1.0914 (1.0000)
2	1.1701	1.1886	1.5687 (1.0000)	1.1049	1.1886	1.5687 (1.0000)	1.0623	1.1886	1.5687 (1.0000)
1.5	1.9138	2.0000	2.7468 (1.0000)	1.6076	2.0000	2.7468 (1.0000)	1.4001	2.0000	2.7468 (1.0000)
1	5.7902	6.3030	5.3154 (1.0000)	4.0757	6.3030	5.3154 (1.0000)	3.0112	6.3030	5.3154 (1.0000)
0.5	38.4613	43.8947	10.5919 (1.0000)	21.9014	43.8947	10.5919 (1.0000)	13.1685	43.8947	10.5919 (1.0000)
0	370.3983	370.3983	20.2987 (0.9989)	167.7986	370.3983	20.2987 (0.9976)	80.5196	370.3983	20.2987 (0.9951)
-0.5	51.6588	43.8947	2.4948 (0.7285)	29.1919	43.8947	2.4948 (0.7221)	17.3985	43.8947	2.4948 (0.7136)
-1	7.0053	6.3030	1.2670 (0.5791)	4.8727	6.3030	1.2670 (0.5787)	3.5545	6.3030	1.2670 (0.5784)
-1.5	2.1147	2.0000	1.0663 (0.6150)	1.7538	2.0000	1.0663 (0.6176)	1.5079	2.0000	1.0663 (0.6213)
-2	1.2131	1.1886	1.0188 (0.7211)	1.1359	1.1886	1.0188 (0.7246)	1.0842	1.1886	1.0188 (0.7292)
-2.5	1.0274	1.0233	1.0057 (0.8292)	1.0150	1.0233	1.0057 (0.8319)	1.0078	1.0233	1.0057 (0.8356)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table D22 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (4) p_U = 0.01469, p_L = 0.00976, (5) p_U = 0.02734, p_L = 0.01816, (6) p_U = 0.04815, p_L = 0.03197

shift (δ)	P.C.(4)	S.C.	A.C. (4)	P.C.(5)	S.C.	A.C. (5)	P.C.(6)	S.C.	A.C. (6)
2.5	1.0024	1.0233	1.0914 (1.0000)	1.0010	1.0233	1.0914 (1.0000)	1.0004	1.0233	1.0914 (1.0000)
2	1.0355	1.1886	1.5687 (1.0000)	1.0192	1.1886	1.5687 (1.0000)	1.0098	1.1886	1.5687 (1.0000)
1.5	1.2588	2.0000	2.7468 (1.0000)	1.1633	2.0000	2.7468 (1.0000)	1.0997	2.0000	2.7468 (1.0000)
1	2.3296	6.3030	5.3154 (1.0000)	1.8819	6.3030	5.3154 (1.0000)	1.5823	6.3030	5.3154 (1.0000)
0.5	8.3493	43.8947	10.5919 (1.0000)	5.5734	43.8947	10.5919 (1.0000)	3.9092	43.8947	10.5919 (1.0000)
0	40.9016	370.3983	20.2987 (0.9903)	21.9779	370.3983	20.2987 (0.9822)	12.4815	370.3983	20.2987 (0.9690)
-0.5	10.9194	43.8947	2.4948 (0.7028)	7.2021	43.8947	2.4948 (0.6897)	4.9798	43.8947	2.4948 (0.6745)
-1	2.7130	6.3030	1.2670 (0.5783)	2.1606	6.3030	1.2670 (0.5797)	1.7898	6.3030	1.2670 (0.5801)
-1.5	1.3391	2.0000	1.0663 (0.6263)	1.2230	2.0000	1.0663 (0.6329)	1.1437	2.0000	1.0663 (0.6413)
-2	1.0504	1.1886	1.0188 (0.7353)	1.0291	1.1886	1.0188 (0.7431)	1.0161	1.1886	1.0188 (0.7528)
-2.5	1.0039	1.0233	1.0057 (0.8404)	1.0018	1.0233	1.0057 (0.8464)	1.0008	1.0233	1.0057 (0.8536)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table D23 ARL of $\alpha_3 = 2.5$, $\alpha_4 = 12.38$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4

for case (7) $p_U = 0.08030$, $p_L = 0.05332$, (8) $p_U = 0.12698$, $p_L = 0.08432$, (9) $p_U = 0.19069$, $p_L = 0.12662$

shift (δ)	P.C.$^{(7)}$	S.C.	A.C. $^{(7)}$	P.C.$^{(8)}$	S.C.	A.C. $^{(8)}$	P.C.$^{(9)}$	S.C.	A.C. $^{(9)}$
2.5	1.0002	1.0233	1.0914 (1.0000)	1.0001	1.0233	1.0914 (1.0000)	1.0000	1.0233	1.0914 (1.0000)
2	1.0047	1.1886	1.5687 (1.0000)	1.0021	1.1886	1.5687 (1.0000)	1.0009	1.1886	1.5687 (1.0000)
1.5	1.0584	2.0000	2.7468 (1.0000)	1.0325	2.0000	2.7468 (1.0000)	1.0171	2.0000	2.7468 (1.0000)
1	1.3795	6.3030	5.3154 (1.0000)	1.2418	6.3030	5.3154 (1.0000)	1.1488	6.3030	5.3154 (1.0000)
0.5	2.8741	43.8947	10.5919 (1.0000)	2.2087	43.8947	10.5919 (1.0000)	1.7678	43.8947	10.5919 (1.0000)
0	7.4842	370.3983	20.2987 (0.9494)	4.7326	370.3983	20.2987 (0.9222)	3.1515	370.3983	20.2987 (0.8876)
-0.5	3.5985	43.8947	2.4948 (0.6577)	2.7073	43.8947	2.4948 (0.6399)	2.1110	43.8947	2.4948 (0.6237)
-1	1.5367	6.3030	1.2670 (0.5829)	1.3618	6.3030	1.2670 (0.5877)	1.2400	6.3030	1.2670 (0.5953)
-1.5	1.0903	2.0000	1.0663 (0.6520)	1.0551	2.0000	1.0663 (0.6653)	1.0326	2.0000	1.0663 (0.6813)
-2	1.0086	1.1886	1.0188 (0.7643)	1.0044	1.1886	1.0188 (0.7778)	1.0021	1.1886	1.0188 (0.7932)
-2.5	1.0004	1.0233	1.0057 (0.8620)	1.0001	1.0233	1.0057 (0.8715)	1.0001	1.0233	1.0057 (0.8820)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table D24 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (10) p_U = 0.27239, p_L = 0.18086, (11) p_U = 0.37084, p_L = 0.24623, (12) p_U = 0.48233, p_L = 0.32026

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0233	1.0914 (1.0000)	1.0000	1.0233	1.0914 (1.0000)	1.0000	1.0233	1.0914 (1.0000)
2	1.0003	1.1886	1.5687 (1.0000)	1.0001	1.1886	1.5687 (1.0000)	1.0000	1.1886	1.5687 (1.0000)
1.5	1.0083	2.0000	2.7468 (1.0000)	1.0037	2.0000	2.7468 (1.0000)	1.0013	2.0000	2.7468 (1.0000)
1	1.0867	6.3030	5.3154 (1.0000)	1.0458	6.3030	5.3154 (1.0000)	1.0188	6.3030	5.3154 (1.0000)
0.5	1.4678	43.8947	10.5919 (1.0000)	1.2586	43.8947	10.5919 (1.0000)	1.1092	43.8947	10.5919 (1.0000)
0	2.2063	370.3983	20.2987 (0.8468)	1.6205	370.3983	20.2987 (0.8024)	1.2460	370.3983	20.2987 (0.7574)
-0.5	1.6972	43.8947	2.4948 (0.6110)	1.3988	43.8947	2.4948 (0.6033)	1.1749	43.8947	2.4948 (0.6025)
-1	1.1544	6.3030	1.2670 (0.6065)	1.0924	6.3030	1.2670 (0.6221)	1.0440	6.3030	1.2670 (0.6435)
-1.5	1.0186	2.0000	1.0663 (0.7004)	1.0100	2.0000	1.0663 (0.7229)	1.0045	2.0000	1.0663 (0.7490)
-2	1.0010	1.1886	1.0188 (0.8104)	1.0005	1.1886	1.0188 (0.8292)	1.0002	1.1886	1.0188 (0.8497)
-2.5	1.0000	1.0233	1.0057 (0.8933)	1.0000	1.0233	1.0057 (0.9053)	1.0000	1.0233	1.0057 (0.9177)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix E

Comparisons of ARL of control charts for $C_L < C_U$, n = 5

Appendix Table E1 ARL of $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

for case (1) $p_U = 0.00146$, $p_L = 0.00124$, (2) $p_U = 0.00322$, $p_L = 0.00274$, (3) $p_U = 0.00671$, $p_L = 0.00571$

shift (δ)	P.C.$^{(1)}$	S.C.	A.C. $^{(1)}$	P.C.$^{(2)}$	S.C.	A.C. $^{(2)}$	P.C.$^{(3)}$	S.C.	A.C. $^{(3)}$
2.5	1.0052	1.0048	1.0000 (1.0000)	1.0025	1.0048	1.0000 (1.0000)	1.0011	1.0048	1.0000 (1.0000)
2	1.0799	1.0758	1.0000 (1.0000)	1.0472	1.0758	1.0000 (1.0000)	1.0267	1.0758	1.0000 (1.0000)
1.5	1.5905	1.5665	1.0000 (1.0000)	1.3930	1.5665	1.0000 (1.0000)	1.2577	1.5665	1.0000 (1.0000)
1	4.6533	4.4953	1.0001 (1.0000)	3.4003	4.4953	1.0001 (1.0000)	2.6008	4.4953	1.0001 (1.0000)
0.5	35.4102	33.4008	1.0081 (1.0000)	20.5944	33.4008	1.0081 (1.0000)	12.6343	33.4008	1.0081 (1.0000)
0	403.0038	370.3983	1.0704 (0.9988)	182.5696	370.3983	1.0704 (0.9973)	87.6076	370.3983	1.0704 (0.9943)
-0.5	35.4102	33.4008	1.2365 (0.9541)	20.5944	33.4008	1.2365 (0.9376)	12.6343	33.4008	1.2365 (0.9154)
-1	4.6533	4.4953	1.3294 (0.7860)	3.4003	4.4953	1.3294 (0.7557)	2.6008	4.4953	1.3294 (0.7223)
-1.5	1.5905	1.5665	1.1507 (0.6037)	1.3930	1.5665	1.1507 (0.5855)	1.2577	1.5665	1.1507 (0.5680)
-2	1.0799	1.0758	1.0205 (0.5219)	1.0472	1.0758	1.0205 (0.5168)	1.0267	1.0758	1.0205 (0.5125)
-2.5	1.0052	1.0048	0.9977 (0.5057)	1.0025	1.0048	0.9977 (0.5062)	1.0011	1.0048	0.9977 (0.5076)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table E2 ARL of α_3 = 0.25, α_4 = 3.09, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (4) p_U = 0.01321, p_L = 0.01124, (5) p_U = 0.02459, p_L = 0.02091, (6) p_U = 0.04330, p_L = 0.03682

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0004	1.0048	1.0000 (1.0000)	1.0001	1.0048	1.0000 (1.0000)	1.0001	1.0048	1.0000 (1.0000)
2	1.0123	1.0758	1.0000 (1.0000)	1.0062	1.0758	1.0000 (1.0000)	1.0029	1.0758	1.0000 (1.0000)
1.5	1.1473	1.5665	1.0000 (1.0000)	1.0902	1.5665	1.0000 (1.0000)	1.0531	1.5665	1.0000 (1.0000)
1	1.9745	4.4953	1.0001 (1.0000)	1.6500	4.4953	1.0001 (1.0000)	1.4299	4.4953	1.0001 (1.0000)
0.5	7.3746	33.4008	1.0081 (1.0000)	5.0314	33.4008	1.0081 0.9999)	3.6029	33.4008	1.0081 (0.9994)
0	40.9016	370.3983	1.0704 (0.9889)	21.9779	370.3983	1.0704 (0.9795)	12.4815	370.3983	1.0704 (0.9645)
-0.5	8.1581	33.4008	1.2365 (0.8865)	5.5397	33.4008	1.2365 (0.8507)	3.9451	33.4008	1.2365 (0.8090)
-1	2.0766	4.4953	1.3294 (0.6871)	1.7254	4.4953	1.3294 (0.6521)	1.4866	4.4953	1.3294 (0.6192)
-1.5	1.1654	1.5665	1.1507 (0.5519)	1.1033	1.5665	1.1507 (0.5379)	1.0624	1.5665	1.1507 (0.5266)
-2	1.0145	1.0758	1.0205 (0.5091)	1.0075	1.0758	1.0205 (0.5069)	1.0037	1.0758	1.0205 (0.5060)
-2.5	1.0005	1.0048	0.9977 (0.5100)	1.0002	1.0048	0.9977 (0.5138)	1.0001	1.0048	0.9977 (0.5195)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table E3 ARL of α_3 = 0.25, α_4 = 3.09, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (7) p_U = 0.07221, p_L = 0.06142, (8) p_U = 0.11420, p_L = 0.09710, (9) p_U = 0.17149, p_L = 0.14582

shift (δ)	P.C.$^{(7)}$	S.C.	A.C. $^{(7)}$	P.C.$^{(8)}$	S.C.	A.C. $^{(8)}$	P.C.$^{(9)}$	S.C.	A.C. $^{(9)}$
2.5	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0013	1.0758	1.0000 (1.0000)	1.0005	1.0758	1.0000 (1.0000)	1.0002	1.0758	1.0000 (1.0000)
1.5	1.0299	1.5665	1.0000 (1.0000)	1.0160	1.5665	1.0000 (1.0000)	1.0081	1.5665	1.0000 (1.0000)
1	1.2798	4.4953	1.0001 (1.0000)	1.1778	4.4953	1.0001 (1.0000)	1.1092	4.4953	1.0001 (1.0000)
0.5	2.7008	33.4008	1.0081 (0.9977)	2.1124	33.4008	1.0081 (0.9937)	1.7173	33.4008	1.0081 (0.9857)
0	7.4842	370.3983	1.0704 (0.9422)	4.7326	370.3983	1.0704 (0.9115)	3.1515	370.3983	1.0704 (0.8727)
-0.5	2.9380	33.4008	1.2365 (0.7634)	2.2800	33.4008	1.2365 (0.7170)	1.8358	33.4008	1.2365 (0.6728)
-1	1.3229	4.4953	1.3294 (0.5899)	1.2105	4.4953	1.3294 (0.5654)	1.1337	4.4953	1.3294 (0.5459)
-1.5	1.0363	1.5665	1.1507 (0.5180)	1.0203	1.5665	1.1507 (0.5120)	1.0108	1.5665	1.1507 (0.5082)
-2	1.0017	1.0758	1.0205 (0.5065)	1.0008	1.0758	1.0205 (0.5085)	1.0003	1.0758	1.0205 (0.5124)
-2.5	1.0000	1.0048	0.9977 (0.5274)	1.0000	1.0048	0.9977 (0.5381)	1.0000	1.0048	0.9977 (0.5522)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table E4 ARL of α_3 = 0.25, α_4 = 3.09, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

fore case (10) p_U = 0.24496, p_L = 0.20829, (11) p_U = 0.33350, p_L = 0.28357, (12) p_U = 0.43376, p_L = 0.36883

shift (δ)	P.C.(10)	S.C.	A.C. (10)	P.C.(11)	S.C.	A.C. (11)	P.C.(12)	S.C.	A.C. (12)
2.5	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0001	1.0758	1.0000 (1.0000)	1.0000	1.0758	1.0000 (1.0000)	1.0000	1.0758	1.0000 (1.0000)
1.5	1.0039	1.5665	1.0000 (1.0000)	1.0017	1.5665	1.0000 (1.0000)	1.0006	1.5665	1.0000 (1.0000)
1	1.0638	4.4953	1.0001 (0.9997)	1.0341	4.4953	1.0001 (0.9985)	1.0144	4.4953	1.0001 (0.9952)
0.5	1.4444	33.4008	1.0081 (0.9718)	1.2505	33.4008	1.0081 (0.9506)	1.1082	33.4008	1.0081 (0.9214)
0	2.2063	370.3983	1.0704 (0.8276)	1.6205	370.3983	1.0704 (0.7791)	1.2460	370.3983	1.0704 (0.7306)
-0.5	1.5259	33.4008	1.2365 (0.6331)	1.3018	33.4008	1.2365 (0.5993)	1.1330	33.4008	1.2365 (0.5721)
-1	1.0817	4.4953	1.3294 (0.5312)	1.0463	4.4953	1.3294 (0.5207)	1.0209	4.4953	1.3294 (0.5136)
-1.5	1.0055	1.5665	1.1507 (0.5066)	1.0026	1.5665	1.1507 (0.5068)	1.0011	1.5665	1.1507 (0.5089)
-2	1.0001	1.0758	1.0205 (0.5184)	1.0000	1.0758	1.0205 (0.5270)	1.0000	1.0758	1.0205 (0.5387)
-2.5	1.0000	1.0048	0.9977 (0.5701)	1.0000	1.0048	0.9977 (0.5923)	1.0000	1.0048	0.9977 (0.6193)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table E5 ARL of α_3 = 0.5, α_4 = 3.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (1) p_U = 0.00155, p_L = 0.00115, (2) p_U = 0.00342, p_L = 0.00254, (3) p_U = 0.00713, p_L = 0.00529

shift (δ)	P.C.$^{(1)}$	S.C.	A.C.$^{(1)}$	P.C.$^{(2)}$	S.C.	A.C.$^{(2)}$	P.C.$^{(3)}$	S.C.	A.C.$^{(3)}$
2.5	1.0043	1.0048	1.0000 (1.0000)	1.0020	1.0048	1.0000 (1.0000)	1.0008	1.0048	1.0000 (1.0000)
2	1.0695	1.0758	1.0000 (1.0000)	1.0401	1.0758	1.0000 (1.0000)	1.0221	1.0758	1.0000 (1.0000)
1.5	1.5289	1.5665	1.0003 (1.0000)	1.3477	1.5665	1.0003 (1.0000)	1.2242	1.5665	1.0003 (1.0000)
1	4.2508	4.4953	1.0215 (1.0000)	3.1275	4.4953	1.0215 (1.0000)	2.4096	4.4953	1.0215 (1.0000)
0.5	30.3746	33.4008	1.1212 (1.0000)	17.7421	33.4008	1.1212 (1.0000)	10.9368	33.4008	1.1212 (1.0000)
0	370.3983	370.3983	1.3874 (0.9989)	167.7986	370.3983	1.3874 (0.9975)	80.5196	370.3983	1.3874 (0.9947)
-0.5	37.3107	33.4008	1.5977 (0.8875)	21.6659	33.4008	1.5977 (0.8701)	13.2674	33.4008	1.5977 (0.8482)
-1	4.8009	4.4953	1.2223 (0.6553)	3.5001	4.4953	1.2223 (0.6411)	2.6707	4.4953	1.2223 (0.6253)
-1.5	1.6127	1.5665	0.9916 (0.5386)	1.4094	1.5665	0.9916 (0.5349)	1.2698	1.5665	0.9916 (0.5313)
-2	1.0837	1.0758	0.9640 (0.5249)	1.0498	1.0758	0.9640 (0.5266)	1.0285	1.0758	0.9640 (0.5290)
-2.5	1.0055	1.0048	0.9809 (0.5630)	1.0027	1.0048	0.9809 (0.5681)	1.0012	1.0048	0.9809 (0.5746)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table E6 ARL of $\alpha_3 = 0.5$, $\alpha_4 = 3.38$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

for case (4) $p_U = 0.01403$, $p_L = 0.01042$, (5) $p_U = 0.02612$, $p_L = 0.01938$, (6) $p_U = 0.04599$, $p_L = 0.03413$

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0003	1.0048	1.0000 (1.0000)	1.0001	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0116	1.0758	1.0000 (1.0000)	1.0057	1.0758	1.0000 (1.0000)	1.0027	1.0758	1.0000 (1.0000)
1.5	1.1409	1.5665	1.0003 (1.0000)	1.0856	1.5665	1.0003 (1.0000)	1.0499	1.5665	1.0003 (1.0000)
1	1.9386	4.4953	1.0215 (1.0000)	1.6235	4.4953	1.0215 (1.0000)	1.4100	4.4953	1.0215 (1.0000)
0.5	7.1050	33.4008	1.1212 (1.0000)	4.8561	33.4008	1.1212 (1.0000)	3.4847	33.4008	1.1212 (1.0000)
0	40.9016	370.3983	1.3874 (0.9897)	21.9779	370.3983	1.3874 (0.9810)	12.4815	370.3983	1.3874 (0.9670)
-0.5	8.5544	33.4008	1.5977 (0.8217)	5.7963	33.4008	1.5977 (0.7909)	4.1174	33.4008	1.5977 (0.7566)
-1	2.1271	4.4953	1.2223 (0.6085)	1.7628	4.4953	1.2223 (0.5915)	1.5147	4.4953	1.2223 (0.5752)
-1.5	1.1743	1.5665	0.9916 (0.5280)	1.1098	1.5665	0.9916 (0.5254)	1.0671	1.5665	0.9916 (0.5240)
-2	1.0156	1.0758	0.9640 (0.5324)	1.0081	1.0758	0.9640 (0.5370)	1.0041	1.0758	0.9640 (0.5430)
-2.5	1.0005	1.0048	0.9809 (0.5827)	1.0002	1.0048	0.9809 (0.5926)	1.0001	1.0048	0.9809 (0.6064)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table E7 ARL of $\alpha_3 = 0.5$, $\alpha_4 = 3.38$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

for case (7) $p_U = 0.07669$, $p_L = 0.05692$, (8) $p_U = 0.12128$, $p_L = 0.09002$, (9) $p_U = 0.18212$, $p_L = 0.13519$

shift (δ)	P.C.$^{(7)}$	S.C.	A.C. $^{(7)}$	P.C.$^{(8)}$	S.C.	A.C. $^{(8)}$	P.C.$^{(9)}$	S.C.	A.C. $^{(9)}$
2.5	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0012	1.0758	1.0000 (1.0000)	1.0005	1.0758	1.0000 (1.0000)	1.0002	1.0758	1.0000 (1.0000)
1.5	1.0278	1.5665	1.0003 (1.0000)	1.0146	1.5665	1.0003 (1.0000)	1.0073	1.5665	1.0003 (1.0000)
1	1.2648	4.4953	1.0215 (1.0000)	1.1665	4.4953	1.0215 (1.0000)	1.1008	4.4953	1.0215 (1.0000)
0.5	2.6186	33.4008	1.1212 (0.9461)	2.0542	33.4008	1.1212 (0.9999)	1.6760	33.4008	1.1212 (0.9984)
0	7.4842	370.3983	1.3874 (0.7204)	4.7326	370.3983	1.3874 (0.9174)	3.1515	370.3983	1.3874 (0.8809)
-0.5	3.0572	33.4008	1.5977 (0.7204)	2.3639	33.4008	1.5977 (0.6842)	1.8949	33.4008	1.5977 (0.6498)
-1	1.3443	4.4953	1.2223 (0.5605)	1.2269	4.4953	1.2223 (0.5480)	1.1463	4.4953	1.2223 (0.5383)
-1.5	1.0396	1.5665	0.9916 (0.5239)	1.0225	1.5665	0.9916 (0.5256)	1.0123	1.5665	0.9916 (0.5293)
-2	1.0019	1.0758	0.9640 (0.5508)	1.0009	1.0758	0.9640 (0.5606)	1.0004	1.0758	0.9640 (0.5725)
-2.5	1.0000	1.0048	0.9809 (0.6188)	1.0000	1.0048	0.9809 (0.6353)	1.0000	1.0048	0.9809 (0.6542)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table E8 ARL of $\alpha_3 = 0.5$, $\alpha_4 = 3.38$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

for case (10) $p_U = 0.26015$, $p_L = 0.19310$, (11) $p_U = 0.35418$, $p_L = 0.26290$, (12) $p_U = 0.46066$, $p_L = 0.34193$

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0001	1.0758	1.0000 (1.0000)	1.0000	1.0758	1.0000 (1.0000)	1.0000	1.0758	1.0000 (1.0000)
1.5	1.0034	1.5665	1.0003 (1.0000)	1.0014	1.5665	1.0003 (1.0000)	1.0005	1.5665	1.0003 (1.0000)
1	1.0578	4.4953	1.0215 (1.0000)	1.0301	4.4953	1.0215 (1.0000)	1.0123	4.4953	1.0215 (1.0000)
0.5	1.4159	33.4008	1.1212 (0.9931)	1.2324	33.4008	1.1212 (0.9813)	1.0994	33.4008	1.1212 (0.9611)
0	2.2063	370.3983	1.3874 (0.8382)	1.6205	370.3983	1.3874 (0.7918)	1.2460	370.3983	1.3874 (0.7452)
-0.5	1.5664	33.4008	1.5977 (0.6188)	1.3271	33.4008	1.5977 (0.5924)	1.1452	33.4008	1.5977 (0.5713)
-1	1.0910	4.4953	1.2223 (0.5316)	1.0527	4.4953	1.2223 (0.5281)	1.0245	4.4953	1.2223 (0.5277)
-1.5	1.0064	1.5665	0.9916 (0.5351)	1.0032	1.5665	0.9916 (0.5433)	1.0013	1.5665	0.9916 (0.5543)
-2	1.0002	1.0758	0.9640 (0.5868)	1.0001	1.0758	0.9640 (0.6039)	1.0000	1.0758	0.9640 (0.6240)
-2.5	1.0000	1.0048	0.9809 (0.6756)	1.0000	1.0048	0.9809 (0.6993)	1.0000	1.0048	0.9809 (0.7254)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table E9 ARL of α_3 = 1, α_4 = 4.5, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (1) p_U = 0.00165, p_L = 0.00105, (2) p_U = 0.00364, p_L = 0.00232, (3) p_U = 0.00759, p_L = 0.00483

shift (δ)	P.C.(1)	S.C.	A.C. (1)	P.C.(2)	S.C.	A.C. (2)	P.C.(3)	S.C.	A.C. (3)
2.5	1.0040	1.0048	1.0000 (1.0000)	1.0018	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0667	1.0758	1.0000 (1.0000)	1.0383	1.0758	1.0000 (1.0000)	1.0000	1.0758	1.0000 (1.0000)
1.5	1.5124	1.5665	1.0428 (1.0000)	1.3356	1.5665	1.0428 (1.0000)	1.0005	1.5665	1.0428 (1.0000)
1	4.1450	4.4953	1.1879 (1.0000)	3.0557	4.4953	1.1879 (1.0000)	1.0123	4.4953	1.1879 (1.0000)
0.5	29.0952	33.4008	1.4712 (1.0000)	17.0164	33.4008	1.4712 (1.0000)	1.0994	33.4008	1.4712 (1.0000)
0	370.3983	370.3983	1.9611 (0.9990)	167.7986	370.3983	1.9611 (0.9977)	1.2460	370.3983	1.9611 (0.9952)
-0.5	39.7497	33.4008	1.4675 (0.7564)	23.0420	33.4008	1.4675 (0.7492)	1.1452	33.4008	1.4675 (0.7395)
-1	4.9863	4.4953	1.0159 (0.5763)	3.6255	4.4953	1.0159 (0.5741)	1.0245	4.4953	1.0159 (0.5714)
-1.5	1.6403	1.5665	0.9218 (0.5438)	1.4297	1.5665	0.9218 (0.5442)	1.0013	1.5665	0.9218 (0.5449)
-2	1.0885	1.0758	0.9285 (0.5735)	1.0531	1.0758	0.9285 (0.5751)	1.0000	1.0758	0.9285 (0.5773)
-2.5	1.0060	1.0048	0.9515 (0.6315)	1.0029	1.0048	0.9515 (0.6337)	1.0000	1.0048	0.9515 (0.6367)

(x) represents case x[th] at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table E10 ARL of $\alpha_3 = 1$, $\alpha_4 = 4.5$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

for case (4) $p_U = 0.01494$, $p_L = 0.00951$, (5) $p_U = 0.02781$, $p_L = 0.01769$, (6) $p_U = 0.04896$, $p_L = 0.03116$

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0003	1.0048	1.0000 (1.0000)	1.0001	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0108	1.0758	1.0000 (1.0000)	1.0053	1.0758	1.0000 (1.0000)	1.0024	1.0758	1.0000 (1.0000)
1.5	1.1344	1.5665	1.0428 (1.0000)	1.0810	1.5665	1.0428 (1.0000)	1.0467	1.5665	1.0428 (1.0000)
1	1.9023	4.4953	1.1879 (1.0000)	1.5967	4.4953	1.1879 (1.0000)	1.3900	4.4953	1.1879 (1.0000)
0.5	6.8355	33.4008	1.4712 (1.0000)	4.6807	33.4008	1.4712 (1.0000)	3.3662	33.4008	1.4712 (1.0000)
0	40.9016	370.3983	1.9611 (0.9906)	21.9779	370.3983	1.9611 (0.9826)	12.4815	370.3983	1.9611 (0.9698)
-0.5	9.0598	33.4008	1.4675 (0.7272)	6.1230	33.4008	1.4675 (0.7120)	4.3364	33.4008	1.4675 (0.6943)
-1	2.1904	4.4953	1.0159 (0.5681)	1.8096	4.4953	1.0159 (0.5644)	1.5501	4.4953	1.0159 (0.5605)
-1.5	1.1856	1.5665	0.9218 (0.5460)	1.1181	1.5665	0.9218 (0.5475)	1.0731	1.5665	0.9218 (0.5498)
-2	1.0170	1.0758	0.9285 (0.5803)	1.0090	1.0758	0.9285 (0.5843)	1.0046	1.0758	0.9285 (0.5894)
-2.5	1.0006	1.0048	0.9515 (0.6408)	1.0002	1.0048	0.9515 (0.6460)	1.0001	1.0048	0.9515 (0.6526)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table E11 ARL of $\alpha_3 = 1$, $\alpha_4 = 4.5$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

for case (7) $p_U = 0.08165$, $p_L = 0.05196$, (8) $p_U = 0.12913$, $p_L = 0.08217$, (9) $p_U = 0.19391$, $p_L = 0.12340$

shift (δ)	P.C.(7)	S.C.	A.C. (7)	P.C.(8)	S.C.	A.C. (8)	P.C.(9)	S.C.	A.C. (9)
2.5	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0010	1.0758	1.0000 (1.0000)	1.0004	1.0758	1.0000 (1.0000)	1.0002	1.0758	1.0000 (1.0000)
1.5	1.0256	1.5665	1.0428 (1.0000)	1.0133	1.5665	1.0428 (1.0000)	1.0064	1.5665	1.0428 (1.0000)
1	1.2497	4.4953	1.1879 (1.0000)	1.1552	4.4953	1.1879 (1.0000)	1.0924	4.4953	1.1879 (1.0000)
0.5	2.5361	33.4008	1.4712 (1.0000)	1.9957	33.4008	1.4712 (1.0000)	1.6344	33.4008	1.4712 (1.0000)
0	7.4842	370.3983	1.9611 (0.9506)	4.7326	370.3983	1.9611 (0.9241)	3.1515	370.3983	1.9611 (0.8902)
-0.5	3.2083	33.4008	1.4675 (0.6745)	2.4700	33.4008	1.4675 (0.6535)	1.9694	33.4008	1.4675 (0.6328)
-1	1.3714	4.4953	1.0159 (0.5567)	1.2477	4.4953	1.0159 (0.5536)	1.1622	4.4953	1.0159 (0.5516)
-1.5	1.0438	1.5665	0.9218 (0.5529)	1.0254	1.5665	0.9218 (0.5573)	1.0142	1.5665	0.9218 (0.5631)
-2	1.0022	1.0758	0.9285 (0.5958)	1.0010	1.0758	0.9285 (0.6037)	1.0005	1.0758	0.9285 (0.6134)
-2.5	1.0000	1.0048	0.9515 (0.6607)	1.0000	1.0048	0.9515 (0.6705)	1.0000	1.0048	0.9515 (0.6820)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table E12 ARL of $\alpha_3 = 1$, $\alpha_4 = 4.5$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

for case (10) $p_U = 0.27699$, $p_L = 0.17627$, (11) $p_U = 0.37710$, $p_L = 0.23997$, (12) $p_U = 0.49047$, $p_L = 0.31212$

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0001	1.0758	1.0000 (1.0000)	1.0000	1.0758	1.0000 (1.0000)	1.0000	1.0758	1.0000 (1.0000)
1.5	1.0029	1.5665	1.0428 (1.0000)	1.0012	1.5665	1.0428 (1.0000)	1.0004	1.5665	1.0428 (1.0000)
1	1.0518	4.4953	1.1879 (1.0000)	1.0263	4.4953	1.1879 (1.0000)	1.0104	4.4953	1.1879 (1.0000)
0.5	1.3871	33.4008	1.4712 (1.0000)	1.2142	33.4008	1.4712 (1.0000)	1.0905	33.4008	1.4712 (0.9996)
0	2.2063	370.3983	1.9611 (0.8501)	1.6205	370.3983	1.9611 (0.8065)	1.2460	370.3983	1.9611 (0.7621)
-0.5	1.6172	33.4008	1.4675 (0.6138)	1.3589	33.4008	1.4675 (0.5967)	1.1604	33.4008	1.4675 (0.5851)
-1	1.1030	4.4953	1.0159 (0.5512)	1.0612	4.4953	1.0159 (0.5531)	1.0293	4.4953	1.0159 (0.5577)
-1.5	1.0077	1.5665	0.9218 (0.5706)	1.0039	1.5665	0.9218 (0.5804)	1.0017	1.5665	0.9218 (0.5928)
-2	1.0002	1.0758	0.9285 (0.6249)	1.0001	1.0758	0.9285 (0.6387)	1.0000	1.0758	0.9285 (0.6551)
-2.5	1.0000	1.0048	0.9515 (0.6953)	1.0000	1.0048	0.9515 (0.7107)	1.0000	1.0048	0.9515 (0.7284)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table E13 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (1) p_U = 0.00167, p_L = 0.00103, (2) p_U = 0.00368, p_L = 0.00228, (3) p_U = 0.00767, p_L = 0.00475

shift (δ)	P.C.(1)	S.C.	A.C. (1)	P.C.(2)	S.C.	A.C. (2)	P.C.(3)	S.C.	A.C. (3)
2.5	1.0040	1.0048	1.0000 (1.0000)	1.0018	1.0048	1.0000 (1.0000)	1.0008	1.0048	1.0000 (1.0000)
2	1.0663	1.0758	1.0405 (1.0000)	1.0379	1.0758	1.0405 (1.0000)	1.0207	1.0758	1.0405 (1.0000)
1.5	1.5097	1.5665	1.3162 (1.0000)	1.3336	1.5665	1.3162 (1.0000)	1.2139	1.5665	1.3162 (1.0000)
1	4.1276	4.4953	1.9911 (1.0000)	3.0439	4.4953	1.9911 (1.0000)	2.3509	4.4953	1.9911 (1.0000)
0.5	28.8868	33.4008	3.4241 (1.0000)	16.8982	33.4008	3.4241 (1.0000)	10.4341	33.4008	3.4241 (1.0000)
0	370.3983	370.3983	6.3110 (0.9990)	167.7986	370.3983	6.3110 (0.9977)	80.5196	370.3983	6.3110 (0.9953)
-0.5	40.2140	33.4008	2.1534 (0.7250)	23.3038	33.4008	2.1534 (0.7186)	14.2375	33.4008	2.1534 (0.7102)
-1	5.0212	4.4953	1.1942 (0.5705)	3.6490	4.4953	1.1942 (0.5699)	2.7749	4.4953	1.1942 (0.5691)
-1.5	1.6455	1.5665	1.0331 (0.5878)	1.4336	1.5665	1.0331 (0.5898)	1.2878	1.5665	1.0331 (0.5926)
-2	1.0894	1.0758	1.0027 (0.6739)	1.0537	1.0758	1.0027 (0.6770)	1.0311	1.0758	1.0027 (0.6812)
-2.5	1.0061	1.0048	0.9979 (0.7782)	1.0030	1.0048	0.9979 (0.7811)	1.0014	1.0048	0.9979 (0.7851)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table E14 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (4) p_U = 0.01510, p_L = 0.00935, (5) p_U = 0.02810, p_L = 0.01740, (6) p_U = 0.04948, p_L = 0.03064

shift (δ)	P.C.$^{(4)}$	S.C.	A.C.$^{(4)}$	P.C.$^{(5)}$	S.C.	A.C.$^{(5)}$	P.C.$^{(6)}$	S.C.	A.C.$^{(6)}$
2.5	1.0003	1.0048	1.0000 (1.0000)	1.0001	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0107	1.0758	1.0405 (1.0000)	1.0052	1.0758	1.0405 (1.0000)	1.0024	1.0758	1.0405 (1.0000)
1.5	1.1334	1.5665	1.3162 (1.0000)	1.0802	1.5665	1.3162 (1.0000)	1.0462	1.5665	1.3162 (1.0000)
1	1.8963	4.4953	1.9911 (1.0000)	1.5923	4.4953	1.9911 (1.0000)	1.3867	4.4953	1.9911 (1.0000)
0.5	6.7915	33.4008	3.4241 (1.0000)	4.6521	33.4008	3.4241 (1.0000)	3.3468	33.4008	3.4241 (1.0000)
0	40.9016	370.3983	6.3110 (0.9907)	21.9779	370.3983	6.3110 (0.9829)	12.4815	370.3983	6.3110 (0.9703)
-0.5	9.1558	33.4008	2.1534 (0.6994)	6.1850	33.4008	2.1534 (0.6863)	4.3779	33.4008	2.1534 (0.6711)
-1	2.2023	4.4953	1.1942 (0.5684)	1.8184	4.4953	1.1942 (0.5679)	1.5568	4.4953	1.1942 (0.5681)
-1.5	1.1877	1.5665	1.0331 (0.5964)	1.1196	1.5665	1.0331 (0.6015)	1.0742	1.5665	1.0331 (0.6081)
-2	1.0173	1.0758	1.0027 (0.6867)	1.0092	1.0758	1.0027 (0.6938)	1.0047	1.0758	1.0027 (0.7027)
-2.5	1.0006	1.0048	0.9979 (0.7903)	1.0003	1.0048	0.9979 (0.7969)	1.0001	1.0048	0.9979 (0.8049)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table E15 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (7) p_U = 0.08251, p_L = 0.05110, (8) p_U = 0.13049, p_L = 0.08081,(9) p_U = 0.19596, p_L = 0.12135

shift (δ)	P.C.(7)	S.C.	A.C. (7)	P.C.(8)	S.C.	A.C. (8)	P.C.(9)	S.C.	A.C. (9)
2.5	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0010	1.0758	1.0405 (1.0000)	1.0004	1.0758	1.0405 (1.0000)	1.0001	1.0758	1.0405 (1.0000)
1.5	1.0253	1.5665	1.3162 (1.0000)	1.0130	1.5665	1.3162 (1.0000)	1.0063	1.5665	1.3162 (1.0000)
1	1.2473	4.4953	1.9911 (1.0000)	1.1533	4.4953	1.9911 (1.0000)	1.0911	4.4953	1.9911 (1.0000)
0.5	2.5226	33.4008	3.4241 (1.0000)	1.9861	33.4008	3.4241 (1.0000)	1.6276	33.4008	3.4241 (1.0000)
0	7.4842	370.3983	6.3110 (0.9514)	4.7326	370.3983	6.3110 (0.9252)	3.1515	370.3983	6.3110 (0.8918)
-0.5	3.2369	33.4008	2.1534 (0.6543)	2.4900	33.4008	2.1534 (0.6369)	1.9835	33.4008	2.1534 (0.6210)
-1	1.3765	4.4953	1.1942 (0.5692)	1.2517	4.4953	1.1942 (0.5719)	1.1652	4.4953	1.1942 (0.5766)
-1.5	1.0446	1.5665	1.0331 (0.6166)	1.0260	1.5665	1.0331 (0.6272)	1.0146	1.5665	1.0331 (0.6404)
-2	1.0023	1.0758	1.0027 (0.7135)	1.0011	1.0758	1.0027 (0.7264)	1.0005	1.0758	1.0027 (0.7415)
-2.5	1.0000	1.0048	0.9979 (0.8145)	1.0000	1.0048	0.9979 (0.8255)	1.0000	1.0048	0.9979 (0.8378)

(x) represents case x^{th} at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table E16 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (10) p_U = 0.27991, p_L = 0.17335, (11) p_U = 0.38108, p_L = 0.23600, (12) p_U = 0.49564, p_L = 0.30695

shift (δ)	P.C.(10)	S.C.	A.C. (10)	P.C.(11)	S.C.	A.C. (11)	P.C.(12)	S.C.	A.C. (12)
2.5	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0001	1.0758	1.0405 (1.0000)	1.0000	1.0758	1.0405 (1.0000)	1.0000	1.0758	1.0405 (1.0000)
1.5	1.0028	1.5665	1.3162 (1.0000)	1.0011	1.5665	1.3162 (1.0000)	1.0004	1.5665	1.3162 (1.0000)
1	1.0509	4.4953	1.9911 (1.0000)	1.0257	4.4953	1.9911 (1.0000)	1.0101	4.4953	1.9911 (1.0000)
0.5	1.3824	33.4008	3.4241 (1.0000)	1.2112	33.4008	3.4241 (1.0000)	1.0891	33.4008	3.4241 (1.0000)
0	2.2063	370.3983	6.3110 (0.8523)	1.6205	370.3983	6.3110 (0.8091)	1.2460	370.3983	6.3110 (0.7651)
-0.5	1.6268	33.4008	2.1534 (0.6076)	1.3648	33.4008	2.1534 (0.5982)	1.1632	33.4008	2.1534 (0.5942)
-1	1.1053	4.4953	1.1942 (0.5842)	1.0628	4.4953	1.1942 (0.5954)	1.0302	4.4953	1.1942 (0.6113)
-1.5	1.0079	1.5665	1.0331 (0.6563)	1.0041	1.5665	1.0331 (0.6756)	1.0018	1.5665	1.0331 (0.6988)
-2	1.0002	1.0758	1.0027 (0.7587)	1.0001	1.0758	1.0027 (0.7782)	1.0000	1.0758	1.0027 (0.8000)
-2.5	1.0000	1.0048	0.9979 (0.8514)	1.0000	1.0048	0.9979 (0.8661)	1.0000	1.0048	0.9979 (0.8819)

(x) represents case x^{th} at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table E17 ARL of $\alpha_3 = 2$, $\alpha_4 = 9$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

for case (1) $p_U = 0.00165$, $p_L = 0.00105$, (2) $p_U = 0.00364$, $p_L = 0.00232$, (3) $p_U = 0.00759$, $p_L = 0.00438$

shift (δ)	P.C.(1)	S.C.	A.C. (1)	P.C.(2)	S.C.	A.C. (2)	P.C.(3)	S.C.	A.C. (3)
2.5	1.0040	1.0048	1.0039 (1.0000)	1.0018	1.0048	1.0039 (1.0000)	1.0008	1.0048	1.0039 (1.0000)
2	1.0667	1.0758	1.2816 (1.0000)	1.0383	1.0758	1.2816 (1.0000)	1.0209	1.0758	1.2816 (1.0000)
1.5	1.5124	1.5665	2.2166 (1.0000)	1.3356	1.5665	2.2166 (1.0000)	1.2154	1.5665	2.2166 (1.0000)
1	4.1450	4.4953	4.5269 (1.0000)	3.0557	4.4953	4.5269 (1.0000)	2.3592	4.4953	4.5269 (1.0000)
0.5	29.0952	33.4008	9.7644 (1.0000)	17.0164	33.4008	9.7644 (1.0000)	10.5046	33.4008	9.7644 (1.0000)
0	370.3983	370.3983	20.2987 (0.9990)	167.7986	370.3983	20.2987 (0.9977)	80.5196	370.3983	20.2987 (0.9952)
-0.5	39.7497	33.4008	2.1776 (0.6980)	23.0420	33.4008	2.1776 (0.6923)	14.0826	33.4008	2.1776 (0.6849)
-1	4.9863	4.4953	1.1888 (0.5764)	3.6255	4.4953	1.1888 (0.5771)	2.7584	4.4953	1.1888 (0.5781)
-1.5	1.6403	1.5665	1.0420 (0.6487)	1.4297	1.5665	1.0420 (0.6519)	1.2849	1.5665	1.0420 (0.6563)
-2	1.0885	1.0758	1.0107 (0.7750)	1.0531	1.0758	1.0107 (0.7782)	1.0307	1.0758	1.0107 (0.7826)
-2.5	1.0060	1.0048	1.0029 (0.8786)	1.0029	1.0048	1.0029 (0.8808)	1.0013	1.0048	1.0029 (0.8836)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table E18 ARL of $\alpha_3 = 2$, $\alpha_4 = 9$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

for case (4) $p_U = 0.01494$, $p_L = 0.00951$, (5) $p_U = 0.02781$, $p_L = 0.01769$, (6) $p_U = 0.04896$, $p_L = 0.03116$

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0003	1.0048	1.0039 (1.0000)	1.0001	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)
2	1.0108	1.0758	1.2816 (1.0000)	1.0053	1.0758	1.2816 (1.0000)	1.0024	1.0758	1.2816 (1.0000)
1.5	1.1344	1.5665	2.2166 (1.0000)	1.0810	1.5665	2.2166 (1.0000)	1.0467	1.5665	2.2166 (1.0000)
1	1.9023	4.4953	4.5269 (1.0000)	1.5967	4.4953	4.5269 (1.0000)	1.3900	4.4953	4.5269 (1.0000)
0.5	6.8355	33.4008	9.7644 (1.0000)	4.6807	33.4008	9.7644 (1.0000)	3.3662	33.4008	9.7644 (1.0000)
0	40.9016	370.3983	20.2987 (0.9906)	21.9779	370.3983	20.2987 (0.9826)	12.4815	370.3983	20.2987 (0.9698)
-0.5	9.0598	33.4008	2.1776 (0.6755)	6.1230	33.4008	2.1776 (0.6641)	4.3364	33.4008	2.1776 (0.6509)
-1	2.1904	4.4953	1.1888 (0.5798)	1.8096	4.4953	1.1888 (0.5823)	1.5501	4.4953	1.1888 (0.5861)
-1.5	1.1856	1.5665	1.0420 (0.6621)	1.1181	1.5665	1.0420 (0.6697)	1.0731	1.5665	1.0420 (0.6793)
-2	1.0170	1.0758	1.0107 (0.7884)	1.0090	1.0758	1.0107 (0.7956)	1.0046	1.0758	1.0107 (0.8044)
-2.5	1.0006	1.0048	1.0029 (0.8873)	1.0002	1.0048	1.0029 (0.8919)	1.0001	1.0048	1.0029 (0.8973)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table E19 ARL of $\alpha_3 = 2$, $\alpha_4 = 9$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5

for case (7) $p_U = 0.08165$, $p_L = 0.05196$, (8) $p_U = 0.12913$, $p_L = 0.08217$, (9) $p_U = 0.19391$, $p_L = 0.12340$

shift (δ)	P.C.(7)	S.C.	A.C. (7)	P.C.(8)	S.C.	A.C. (8)	P.C.(9)	S.C.	A.C. (9)
2.5	1.0000	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)
2	1.0010	1.0758	1.2816 (1.0000)	1.0004	1.0758	1.2816 (1.0000)	1.0002	1.0758	1.2816 (1.0000)
1.5	1.0256	1.5665	2.2166 (1.0000)	1.0133	1.5665	2.2166 (1.0000)	1.0064	1.5665	2.2166 (1.0000)
1	1.2497	4.4953	4.5269 (1.0000)	1.1552	4.4953	4.5269 (1.0000)	1.0924	4.4953	4.5269 (1.0000)
0.5	2.5361	33.4008	9.7644 (1.0000)	1.9957	33.4008	9.7644 (1.0000)	1.6344	33.4008	9.7644 (1.0000)
0	7.4842	370.3983	20.2987 (0.9506)	4.7326	370.3983	20.2987 (0.9241)	3.1515	370.3983	20.2987 (0.8902)
-0.5	3.2083	33.4008	2.1776 (0.6365)	2.4700	33.4008	2.1776 (0.6227)	1.9694	33.4008	2.1776 (0.6110)
-1	1.3714	4.4953	1.1888 (0.5917)	1.2477	4.4953	1.1888 (0.5996)	1.1622	4.4953	1.1888 (0.6104)
-1.5	1.0438	1.5665	1.0420 (0.6911)	1.0254	1.5665	1.0420 (0.7054)	1.0142	1.5665	1.0420 (0.7223)
-2	1.0022	1.0758	1.0107 (0.8148)	1.0010	1.0758	1.0107 (0.8268)	1.0005	1.0758	1.0107 (0.8402)
-2.5	1.0000	1.0048	1.0029 (0.9036)	1.0000	1.0048	1.0029 (0.9107)	1.0000	1.0048	1.0029 (0.9184)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table E20 ARL of α_3 = 2, α_4 = 9, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (10) p_U = 0.27699, p_L = 0.17627, (11) p_U = 0.37710, p_L = 0.23997, (12) p_U = 0.49047, p_L = 0.31212

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)
2	1.0001	1.0758	1.2816 (1.0000)	1.0000	1.0758	1.2816 (1.0000)	1.0000	1.0758	1.2816 (1.0000)
1.5	1.0029	1.5665	2.2166 (1.0000)	1.0012	1.5665	2.2166 (1.0000)	1.0004	1.5665	2.2166 (1.0000)
1	1.0518	4.4953	4.5269 (1.0000)	1.0263	4.4953	4.5269 (1.0000)	1.0104	4.4953	4.5269 (1.0000)
0.5	1.3871	33.4008	9.7644 (1.0000)	1.2142	33.4008	9.7644 (1.0000)	1.0905	33.4008	9.7644 (1.0000)
0	2.2063	370.3983	20.2987 (0.8501)	1.6205	370.3983	20.2987 (0.8065)	1.2460	370.3983	20.2987 (0.7621)
-0.5	1.6172	33.4008	2.1776 (0.6028)	1.3589	33.4008	2.1776 (0.5997)	1.1604	33.4008	2.1776 (0.6035)
-1	1.1030	4.4953	1.1888 (0.6249)	1.0612	4.4953	1.1888 (0.6439)	1.0293	4.4953	1.1888 (0.6685)
-1.5	1.0077	1.5665	1.0420 (0.7419)	1.0039	1.5665	1.0420 (0.7643)	1.0017	1.5665	1.0420 (0.7897)
-2	1.0002	1.0758	1.0107 (0.8549)	1.0001	1.0758	1.0107 (0.8706)	1.0000	1.0758	1.0107 (0.8874)
-2.5	1.0000	1.0048	1.0029 (0.9266)	1.0000	1.0048	1.0029 (0.9351)	1.0000	1.0048	1.0029 (0.9439)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table E21 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (1) p_U = 0.00162, p_L = 0.00108, (2) p_U = 0.00358, p_L = 0.00238, (3) p_U = 0.00746, p_L = 0.00496

shift (δ)	P.C.(1)	S.C.	A.C. (1)	P.C.(2)	S.C.	A.C. (2)	P.C.(3)	S.C.	A.C. (3)
2.5	1.0041	1.0048	1.0039 (1.0000)	1.0019	1.0048	1.0039 (1.0000)	1.0008	1.0048	1.0039 (1.0000)
2	1.0674	1.0758	1.2816 (1.0000)	1.0387	1.0758	1.2816 (1.0000)	1.0212	1.0758	1.2816 (1.0000)
1.5	1.5167	1.5665	2.2166 (1.0000)	1.3388	1.5665	2.2166 (1.0000)	1.2177	1.5665	2.2166 (1.0000)
1	4.1729	4.4953	4.5269 (1.0000)	3.0747	4.4953	4.5269 (1.0000)	2.3725	4.4953	4.5269 (1.0000)
0.5	29.4310	33.4008	9.7644 (1.0000)	17.2070	33.4008	9.7644 (1.0000)	10.6181	33.4008	9.7644 (1.0000)
0	370.3983	370.3983	20.2987 (0.9989)	167.7986	370.3983	20.2987 (0.9976)	80.5196	370.3983	20.2987 (0.9951)
-0.5	39.0450	33.4008	2.1776 (0.6978)	22.6446	33.4008	2.1776 (0.6921)	13.8473	33.4008	2.1776 (0.6846)
-1	4.9332	4.4953	1.1888 (0.5764)	3.5895	4.4953	1.1888 (0.5770)	2.7333	4.4953	1.1888 (0.5779)
-1.5	1.6324	1.5665	1.0420 (0.6487)	1.4239	1.5665	1.0420 (0.6518)	1.2806	1.5665	1.0420 (0.6561)
-2	1.0871	1.0758	1.0107 (0.7749)	1.0522	1.0758	1.0107 (0.7781)	1.0300	1.0758	1.0107 (0.7825)
-2.5	1.0059	1.0048	1.0029 (0.8786)	1.0028	1.0048	1.0029 (0.8807)	1.0013	1.0048	1.0029 (0.8835)

(x) represents case x[th] at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table E22 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (4) p_U = 0.01469, p_L = 0.00976, (5) p_U = 0.02734, p_L = 0.01816, (6) p_U = 0.04815, p_L = 0.03197

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0003	1.0048	1.0039 (1.0000)	1.0001	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)
2	1.0110	1.0758	1.2816 (1.0000)	1.0054	1.0758	1.2816 (1.0000)	1.0025	1.0758	1.2816 (1.0000)
1.5	1.1361	1.5665	2.2166 (1.0000)	1.0822	1.5665	2.2166 (1.0000)	1.0476	1.5665	2.2166 (1.0000)
1	1.9119	4.4953	4.5269 (1.0000)	1.6038	4.4953	4.5269 (1.0000)	1.3953	4.4953	4.5269 (1.0000)
0.5	6.9063	33.4008	9.7644 (1.0000)	4.7268	33.4008	9.7644 (1.0000)	3.3973	33.4008	9.7644 (1.0000)
0	40.9016	370.3983	20.2987 (0.9903)	21.9779	370.3983	20.2987 (0.9822)	12.4815	370.3983	20.2987 (0.9690)
-0.5	8.9140	33.4008	2.1776 (0.6751)	6.0288	33.4008	2.1776 (0.6636)	4.2733	33.4008	2.1776 (0.6502)
-1	2.1722	4.4953	1.1888 (0.5795)	1.7962	4.4953	1.1888 (0.5820)	1.5400	4.4953	1.1888 (0.5857)
-1.5	1.1823	1.5665	1.0420 (0.6619)	1.1157	1.5665	1.0420 (0.6694)	1.0714	1.5665	1.0420 (0.6789)
-2	1.0166	1.0758	1.0107 (0.7882)	1.0088	1.0758	1.0107 (0.7953)	1.0044	1.0758	1.0107 (0.8041)
-2.5	1.0006	1.0048	1.0029 (0.8872)	1.0002	1.0048	1.0029 (0.8917)	1.0001	1.0048	1.0029 (0.8971)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table E23 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (7) p_U = 0.08030, p_L = 0.05332, (8) p_U = 0.12698, p_L = 0.08432, (9) p_U = 0.19069, p_L = 0.12662

shift (δ)	P.C.$^{(7)}$	S.C.	A.C. $^{(7)}$	P.C.$^{(8)}$	S.C.	A.C. $^{(8)}$	P.C.$^{(9)}$	S.C.	A.C. $^{(9)}$
2.5	1.0000	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)
2	1.0011	1.0758	1.2816 (1.0000)	1.0004	1.0758	1.2816 (1.0000)	1.0002	1.0758	1.2816 (1.0000)
1.5	1.0262	1.5665	2.2166 (1.0000)	1.0136	1.5665	2.2166 (1.0000)	1.0066	1.5665	2.2166 (1.0000)
1	1.2537	4.4953	4.5269 (1.0000)	1.1581	4.4953	4.5269 (1.0000)	1.0946	4.4953	4.5269 (1.0000)
0.5	2.5578	33.4008	9.7644 (1.0000)	2.0111	33.4008	9.7644 (1.0000)	1.6454	33.4008	9.7644 (1.0000)
0	7.4842	370.3983	20.2987 (0.9494)	4.7326	370.3983	20.2987 (0.9222)	3.1515	370.3983	20.2987 (0.8876)
-0.5	3.1648	33.4008	2.1776 (0.6357)	2.4395	33.4008	2.1776 (0.6216)	1.9480	33.4008	2.1776 (0.6097)
-1	1.3636	4.4953	1.1888 (0.5911)	1.2417	4.4953	1.1888 (0.5988)	1.1576	4.4953	1.1888 (0.6064)
-1.5	1.0426	1.5665	1.0420 (0.6906)	1.0246	1.5665	1.0420 (0.7047)	1.0137	1.5665	1.0420 (0.7213)
-2	1.0021	1.0758	1.0107 (0.8144)	1.0010	1.0758	1.0107 (0.8262)	1.0004	1.0758	1.0107 (0.8395)
-2.5	1.0000	1.0048	1.0029 (0.9034)	1.0000	1.0048	1.0029 (0.9104)	1.0000	1.0048	1.0029 (0.9180)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table E24 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (10) p_U = 0.27239, p_L = 0.18086, (11) p_U = 0.37084, p_L = 0.24623, (12) p_U = 0.48233, p_L = 0.32026

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)
2	1.0001	1.0758	1.2816 (1.0000)	1.0000	1.0758	1.2816 (1.0000)	1.0000	1.0758	1.2816 (1.0000)
1.5	1.0030	1.5665	2.2166 (1.0000)	1.0012	1.5665	2.2166 (1.0000)	1.0004	1.5665	2.2166 (1.0000)
1	1.0534	4.4953	4.5269 (1.0000)	1.0273	4.4953	4.5269 (1.0000)	1.0109	4.4953	4.5269 (1.0000)
0.5	1.3947	33.4008	9.7644 (1.0000)	1.2190	33.4008	9.7644 (1.0000)	1.0929	33.4008	9.7644 (1.0000)
0	2.2063	370.3983	20.2987 (0.8468)	1.6205	370.3983	20.2987 (0.8024)	1.2460	370.3983	20.2987 (0.7574)
-0.5	1.6026	33.4008	2.1776 (0.6012)	1.3498	33.4008	2.1776 (0.5976)	1.1560	33.4008	2.1776 (0.6006)
-1	1.0995	4.4953	1.1888 (0.6235)	1.0587	4.4953	1.1888 (0.6420)	1.0279	4.4953	1.1888 (0.6658)
-1.5	1.0073	1.5665	1.0420 (0.7406)	1.0037	1.5665	1.0420 (0.7627)	1.0016	1.5665	1.0420 (0.7876)
-2	1.0002	1.0758	1.0107 (0.8540)	1.0001	1.0758	1.0107 (0.8696)	1.0000	1.0758	1.0107 (0.8861)
-2.5	1.0000	1.0048	1.0029 (0.9261)	1.0000	1.0048	1.0029 (0.9346)	1.0000	1.0048	1.0029 (0.9433)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix F

Comparisons of ARL of control charts for $C_L > C_U$, n = 4

Appendix Table F1 ARL of α_3 = 0.25, α_4 = 3.09, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (1) p_U = 0.00124, p_L = 0.00146, (2) p_U = 0.00274, p_L = 0.00322, (3) p_U = 0.00571, p_L = 0.00671

shift (δ)	P.C.$^{(1)}$	S.C.	A.C. $^{(1)}$	P.C.$^{(2)}$	S.C.	A.C. $^{(2)}$	P.C.$^{(3)}$	S.C.	A.C. $^{(3)}$
2.5	1.0248	1.0233	1.0000 (1.0000)	1.0133	1.0233	1.0000 (1.0000)	1.0068	1.0233	1.0000 (1.0000)
2	1.1975	1.1886	1.0000 (1.0000)	1.1246	1.1886	1.0000 (1.0000)	1.0761	1.1886	1.0000 (1.0000)
1.5	2.0417	2.0000	1.0000 (1.0000)	1.7006	2.0000	1.0000 (1.0000)	1.4686	2.0000	1.0000 (1.0000)
1	6.5557	6.3030	1.0003 (1.0000)	4.5783	6.3030	1.0003 (1.0000)	3.3540	6.3030	1.0003 (1.0000)
0.5	46.6469	43.8947	1.0108 (1.0000)	26.4282	43.8947	1.0108 (1.0000)	15.7983	43.8947	1.0108 (1.0000)
0	370.3983	370.3983	1.0704 (0.9968	167.7986	370.3983	1.0704 (0.9933)	80.5196	370.3983	1.0704 (0.9933)
-0.5	41.5055	43.8947	1.2160 (0.9462)	23.5870	43.8947	1.2160 (0.9248)	14.1491	43.8947	1.2160 (0.9248)
-1	6.0799	6.3030	1.3355 (0.7929)	4.2661	6.3030	1.3355 (0.7574)	3.1412	6.3030	1.3355 (0.7574)
-1.5	1.9628	2.0000	1.2180 (0.6234)	1.6432	2.0000	1.2180 (0.5996)	1.4262	2.0000	1.2180 (0.5996)
-2	1.1806	1.1886	1.0572 (0.5335)	1.1124	1.1886	1.0572 (0.5250)	1.0676	1.1886	1.0572 (0.5250)
-2.5	1.0220	1.0233	1.0027 (0.5069)	1.0116	1.0233	1.0027 (0.5056)	1.0058	1.0233	1.0027 (0.5056)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table F2 ARL of α_3 = 0.25, α_4 = 3.09, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (4) p_U = 0.01124, p_L = 0.01321, (5) p_U = 0.02091, p_L = 0.02459, (6) p_U = 0.03682, p_L = 0.04330

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0033	1.0233	1.0000 (1.0000)	1.0015	1.0233	1.0000 (1.0000)	1.0007	1.0233	1.0000 (1.0000)
2	1.0449	1.1886	1.0000 (1.0000)	1.0254	1.1886	1.0000 (1.0000)	1.0137	1.1886	1.0000 (1.0000)
1.5	1.3097	2.0000	1.0000 (1.0000)	1.2010	2.0000	1.0000 (1.0000)	1.1273	2.0000	1.0000 (1.0000)
1	2.5716	6.3030	1.0003 (1.0000)	2.0578	6.3030	1.0003 (1.0000)	1.7132	6.3030	1.0003 (1.0000)
0.5	9.9495	43.8947	1.0108 (0.9999)	6.5892	43.8947	1.0108 (0.9996)	4.5783	43.8947	1.0108 (0.9982)
0	40.9016	370.3983	1.0704 (0.9870)	21.9779	370.3983	1.0704 (0.9760)	12.4815	370.3983	1.0704 (0.9947)
-0.5	8.9469	43.8947	1.2160 (0.8962)	5.9535	43.8947	1.2160 (0.8601)	4.1601	43.8947	1.2160 (0.9327)
-1	2.4214	6.3030	1.3355 (0.8962)	1.9486	6.3030	1.3355 (0.6796)	1.6319	6.3030	1.3355 (0.7696)
-1.5	1.2782	2.0000	1.2180 (0.7190)	1.1776	2.0000	1.2180 (0.5574)	1.1101	2.0000	1.2180 (0.6074)
-2	1.0390	1.1886	1.0572 (0.5772)	1.0215	1.1886	1.0572 (0.5122)	1.0112	1.1886	1.0572 (0.5277)
-2.5	1.0027	1.0233	1.0027 (0.5178)	1.0012	1.0233	1.0027 (0.5057)	1.0005	1.0233	1.0027 (0.5058)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table F3 ARL of α_3 = 0.25, α_4 = 3.09, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4,

for case (7) p_U = 0.06142, p_L = 0.07221, (8) p_U = 0.09710, p_L = 0.11420, (9) p_U = 0.14582, p_L = 0.17149

shift (δ)	P.C.$^{(7)}$	S.C.	A.C. $^{(7)}$	P.C.$^{(8)}$	S.C.	A.C. $^{(8)}$	P.C.$^{(9)}$	S.C.	A.C. $^{(9)}$
2.5	1.0003	1.0233	1.0000 (1.0000)	1.0001	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)
2	1.0071	1.1886	1.0000 (1.0000)	1.0035	1.1886	1.0000 (1.0000)	1.0016	1.1886	1.0000 (1.0000)
1.5	1.0782	2.0000	1.0000 (1.0000)	1.0464	2.0000	1.0000 (1.0000)	1.0265	2.0000	1.0000 (1.0000)
1	1.4784	6.3030	1.0003 (1.0000)	1.3171	6.3030	1.0003 (1.0000)	1.2057	6.3030	1.0003 (0.9995)
0.5	3.3280	43.8947	1.0108 (0.9947)	2.5220	43.8947	1.0108 (0.9947)	1.9843	43.8947	1.0108 (0.9737)
0	7.4842	370.3983	1.0704 (0.9327)	4.7326	370.3983	1.0704 (0.9327)	3.1515	370.3983	1.0704 (0.8536)
-0.5	3.0448	43.8947	1.2160 (0.6074)	2.3269	43.8947	1.2160 (0.7696)	1.8499	43.8947	1.2160 (0.6734)
-1	1.4169	6.3030	1.3355 (0.5545)	1.2701	6.3030	1.3355 (0.6074)	1.1701	6.3030	1.3355 (0.5545)
-1.5	1.0658	2.0000	1.2180 (0.5277)	1.0376	2.0000	1.2180 (0.5277)	1.0205	2.0000	1.2180 (0.5114)
-2	1.0056	1.1886	1.0572 (0.5058)	1.0026	1.1886	1.0572 (0.5058)	1.0011	1.1886	1.0572 (0.5055)
-2.5	1.0002	1.0233	1.0027 (0.5105)	1.0001	1.0233	1.0027 (0.5105)	1.0000	1.0233	1.0027 (0.5219)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table F4 ARL of $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4

fore case (10) $p_U = 0.20829$, $p_L = 0.24496$, (11) $p_U = 0.28357$, $p_L = 0.33350$, (12) $p_U = 0.36883$, $p_L = 0.43376$

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)
2	1.0007	1.1886	1.0000 (1.0000)	1.0003	1.1886	1.0000 (1.0000)	1.0001	1.1886	1.0000 (1.0000)
1.5	1.0144	2.0000	1.0000 (1.0000)	1.0073	2.0000	1.0000 (1.0000)	1.0031	2.0000	1.0000 (0.9998)
1	1.1286	6.3030	1.0003 (0.9975)	1.0743	6.3030	1.0003 (0.9923)	1.0339	6.3030	1.0003 (0.9817)
0.5	1.6132	43.8947	1.0108 (0.9517)	1.3479	43.8947	1.0108 (0.9197)	1.1512	43.8947	1.0108 (0.8774)
0	2.2063	370.3983	1.0704 (0.8032)	1.6205	370.3983	1.0704 (0.7499)	1.2460	370.3983	1.0704 (0.6975)
-0.5	1.5232	43.8947	1.2160 (0.6310)	1.2928	43.8947	1.2160 (0.5950)	1.1254	43.8947	1.2160 (0.5660)
-1	1.1022	6.3030	1.3355 (0.5364)	1.0562	6.3030	1.3355 (0.5234)	1.0242	6.3030	1.3355 (0.5145)
-1.5	1.0105	2.0000	1.2180 (0.5072)	1.0049	2.0000	1.2180 (0.5050)	1.0019	2.0000	1.2180 (0.5045)
-2	1.0005	1.1886	1.0572 (0.5074)	1.0002	1.1886	1.0572 (0.5110)	1.0001	1.1886	1.0572 (0.5162)
-2.5	1.0000	1.0233	1.0027 (0.5309)	1.0000	1.0233	1.0027 (0.5425)	1.0000	1.0233	1.0027 (0.5569)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table F5 ARL of α_3 = 0.5, α_4 = 3.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4
for case (1) p_U = 0.00115, p_L = 0.00155, (2) p_U = 0.00254, p_L = 0.00342, (3) p_U = 0.00529, p_L = 0.00713

shift (δ)	P.C.$^{(1)}$	S.C.	A.C. $^{(1)}$	P.C.$^{(2)}$	S.C.	A.C. $^{(2)}$	P.C.$^{(3)}$	S.C.	A.C. $^{(3)}$
2.5	1.0262	1.0233	1.0000 (1.0000)	1.0142	1.0233	1.0000 (1.0000)	1.0073	1.0233	1.0000 (1.0000)
2	1.2058	1.1886	1.0000 (1.0000)	1.1305	1.1886	1.0000 (1.0000)	1.0804	1.1886	1.0000 (1.0000)
1.5	2.0804	2.0000	1.0024 (1.0000)	1.7287	2.0000	1.0024 (1.0000)	1.4894	2.0000	1.0024 (1.0000)
1	6.7925	6.3030	1.0337 (1.0000)	4.7334	6.3030	1.0337 (1.0000)	3.4597	6.3030	1.0337 (1.0000)
0.5	49.2687	43.8947	1.1395 (1.0000)	27.8747	43.8947	1.1395 (1.0000)	16.6363	43.8947	1.1395 (1.0000)
0	370.3983	370.3983	1.3874 0.9985	167.7986	370.3983	1.3874 0.9966	80.5196	370.3983	1.3874 0.9929
-0.5	39.7506	43.8947	1.6079 0.9044	22.6156	43.8947	1.6079 0.8861	13.5842	43.8947	1.6079 0.8628
-1	5.9136	6.3030	1.3098 0.6928	4.1568	6.3030	1.3098 0.6749	3.0666	6.3030	1.3098 0.6548
-1.5	1.9348	2.0000	1.0329 0.5583	1.6228	2.0000	1.0329 0.5514	1.4113	2.0000	1.0329 0.5442
-2	1.1746	1.1886	0.9638 0.5215	1.1081	1.1886	0.9638 0.5210	1.0646	1.1886	0.9638 0.5210
-2.5	1.0210	1.0233	0.9715 0.5365	1.0110	1.0233	0.9715 0.5394	1.0054	1.0233	0.9715 0.5432

(x) represents case xth at specified p_L and p_U.
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table F6 ARL of α_3 = 0.5, α_4 = 3.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4 for case (4) p_U = 0.01042, p_L = 0.01403, (5) p_U = 0.01938, p_L = 0.02612, (6) p_U = 0.03413, p_L = 0.04599

shift (δ)	P.C.(4)	S.C.	A.C. (4)	P.C.(5)	S.C.	A.C. (5)	P.C.(6)	S.C.	A.C. (6)
2.5	1.0036	1.0233	1.0000	1.0017	1.0233	1.0000	1.0007	1.0233	1.0000
			(1.0000)			(1.0000)			(1.0000)
2	1.0478	1.1886	1.0000	1.0273	1.1886	1.0000	1.0150	1.1886	1.0000
			(1.0000)			(1.0000)			(1.0000)
1.5	1.3252	2.0000	1.0024	1.2126	2.0000	1.0024	1.1359	2.0000	1.0024
			(1.0000)			(1.0000)			(1.0000)
1	2.6461	6.3030	1.0337	2.1120	6.3030	1.0337	1.7536	6.3030	1.0337
			(1.0000)			(1.0000)			(1.0000)
0.5	10.4578	43.8947	1.1395	6.9106	43.8947	1.1395	4.7890	43.8947	1.1395
			(1.0000)			(1.0000)			(1.0000)
0	40.9016	370.3983	1.3874	21.9779	370.3983	1.3874	12.4815	370.3983	1.3874
			(0.9862)			(0.9745)			(0.9560)
-0.5	8.6028	43.8947	1.6079	5.7347	43.8947	1.6079	4.0158	43.8947	1.6079
			(0.8340)			(0.7999)			(0.7616)
-1	2.3687	6.3030	1.3098	1.9104	6.3030	1.3098	1.6035	6.3030	1.3098
			(0.6331)			(0.6111)			(0.5897)
-1.5	1.2671	2.0000	1.0329	1.1694	2.0000	1.0329	1.1041	2.0000	1.0329
			(0.5371)			(0.5307)			(0.5254)
-2	1.0370	1.1886	0.9638	1.0202	1.1886	0.9638	1.0104	1.1886	0.9638
			(0.5216)			(0.5231)			(0.5256)
-2.5	1.0025	1.0233	0.9715	1.0011	1.0233	0.9715	1.0005	1.0233	0.9715
			(0.5481)			(0.5543)			(0.5620)

(x) represents case x^{th} at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table F7 ARL of α_3 = 0.5, α_4 = 3.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4
for case (7) p_U = 0.05692, p_L = 0.07669, (8) p_U = 0.09002, p_L = 0.12128, (9) p_U = 0.13519, p_L = 0.18212

shift (δ)	P.C.$^{(7)}$	S.C.	A.C. $^{(7)}$	P.C.$^{(8)}$	S.C.	A.C. $^{(8)}$	P.C.$^{(9)}$	S.C.	A.C. $^{(9)}$
2.5	1.0003	1.0233	1.0000 (1.0000)	1.0001	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)
2	1.0078	1.1886	1.0000 (1.0000)	1.0039	1.1886	1.0000 (1.0000)	1.0019	1.1886	1.0000 (1.0000)
1.5	1.0846	2.0000	1.0024 (1.0000)	1.0510	2.0000	1.0024 (1.0000)	1.0297	2.0000	1.0024 (1.0000)
1	1.5091	6.3030	1.0337 (1.0000)	1.3406	6.3030	1.0337 (1.0000)	1.2237	6.3030	1.0337 (1.0000)
0.5	3.4701	43.8947	1.1395 (0.9997)	2.6195	43.8947	1.1395 (0.9973)	2.0511	43.8947	1.1395 (0.9893)
0	7.4842	370.3983	1.3874 (0.9288)	4.7326	370.3983	1.3874 (0.8918)	3.1515	370.3983	1.3874 (0.8459)
-0.5	2.9467	43.8947	1.6079 (0.7210)	2.2590	43.8947	1.6079 (0.6803)	1.8028	43.8947	1.6079 (0.6418)
-1	1.3955	6.3030	1.3098 (0.5700)	1.2539	6.3030	1.3098 (0.5530)	1.1578	6.3030	1.3098 (0.5392)
-1.5	1.0615	2.0000	1.0329 (0.5216)	1.0347	2.0000	1.0329 (0.5195)	1.0185	2.0000	1.0329 (0.5191)
-2	1.0051	1.1886	0.9638 (0.5294)	1.0023	1.1886	0.9638 (0.5347)	1.0010	1.1886	0.9638 (0.5414)
-2.5	1.0002	1.0233	0.9715 (0.5712)	1.0001	1.0233	0.9715 (0.5821)	1.0000	1.0233	0.9715 (0.5948)

(x) represents case xth at specified p_L and p_U.
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table F8 ARL of α_3 = 0.5, α_4 = 3.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4
for case (10) p_U = 0.19310, p_L = 0.26015, (11) p_U = 0.26290, p_L = 0.35418, (12) p_U = 0.34193, p_L = 0.46066

shift (δ)	P.C.$^{(10)}$	S.C.	A.C.$^{(10)}$	P.C.$^{(11)}$	S.C.	A.C.$^{(11)}$	P.C.$^{(12)}$	S.C.	A.C.$^{(12)}$
2.5	1.0000	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)
2	1.0009	1.1886	1.0000 (1.0000)	1.0004	1.1886	1.0000 (1.0000)	1.0001	1.1886	1.0000 (1.0000)
1.5	1.0166	2.0000	1.0024 (1.0000)	1.0087	2.0000	1.0024 (1.0000)	1.0038	2.0000	1.0024 (1.0000)
1	1.1421	6.3030	1.0337 (1.0000)	1.0837	6.3030	1.0337 (1.0000)	1.0392	6.3030	1.0337 (1.0000)
0.5	1.6576	43.8947	1.1395 (0.9893)	1.3748	43.8947	1.1395 (0.9719)	1.1638	43.8947	1.1395 (0.9977)
0	2.2063	370.3983	1.3874 (0.8459)	1.6205	370.3983	1.3874 (0.7936)	1.2460	370.3983	1.3874 (0.8963)
-0.5	1.4915	43.8947	1.6079 (0.6418)	1.2732	43.8947	1.6079 (0.6073)	1.1161	43.8947	1.6079 (0.6846)
-1	1.0932	6.3030	1.3098 (0.5392)	1.0502	6.3030	1.3098 (0.5288)	1.0210	6.3030	1.3098 (0.5544)
-1.5	1.0092	2.0000	1.0329 (0.5191)	1.0042	2.0000	1.0329 (0.5206)	1.0015	2.0000	1.0329 (0.5174)
-2	1.0004	1.1886	0.9638 (0.5414)	1.0001	1.1886	0.9638 (0.5498)	1.0000	1.1886	0.9638 (0.5286)
-2.5	1.0000	1.0233	0.9715 (0.5948)	1.0000	1.0233	0.9715 (0.6092)	1.0000	1.0233	0.9715 (0.6426)

(x) represents case xth at specified p_L and p_U.
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table F9 ARL of $\alpha_3 = 1$, $\alpha_4 = 4.5$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4
for case (1) $p_U = 0.00951$, $p_L = 0.01494$, (2) $p_U = 0.00232$, $p_L = 0.00364$, (3) $p_U = 0.03116$, $p_L = 0.04896$

shift (δ)	P.C.(1)	S.C.	A.C. (1)	P.C.(2)	S.C.	A.C. (2)	P.C.(3)	S.C.	A.C. (3)
2.5	1.0000	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)	1.0080	1.0233	1.0000 (1.0000)
2	1.0009	1.1886	1.0000 (1.0000)	1.0004	1.1886	1.0000 (1.0000)	1.0857	1.1886	1.0000 (1.0000)
1.5	1.0166	2.0000	1.0024 (1.0000)	1.0087	2.0000	1.0024 (1.0000)	1.5154	2.0000	1.0024 (1.0000)
1	1.1421	6.3030	1.0337 (1.0000)	1.0837	6.3030	1.0337 (1.0000)	3.5927	6.3030	1.0337 (1.0000)
0.5	1.6576	43.8947	1.1395 (1.0000)	1.3748	43.8947	1.1395 (1.0000)	17.7081	43.8947	1.1395 (1.0000)
0	2.2063	370.3983	1.3874 (0.9853)	1.6205	370.3983	1.3874 0.9729	80.5196	370.3983	1.9611 (0.9533)
-0.5	1.4915	43.8947	1.6079 (0.7441)	1.2732	43.8947	1.6079 0.7242	13.0205	43.8947	1.5498 (0.7010)
-1	1.0932	6.3030	1.3098 (0.5811)	1.0502	6.3030	1.3098 0.5739	2.9913	6.3030	1.0681 (0.5661)
-1.5	1.0092	2.0000	1.0329 (0.5416)	1.0042	2.0000	1.0329 0.5410	1.3960	2.0000	0.9333 (0.5406)
-2	1.0004	1.1886	0.9638 (0.5591)	1.0001	1.1886	0.9638 0.5612	1.0616	1.1886	0.9211 (0.5641)
-2.5	1.0000	1.0233	0.9715 (0.6038)	1.0000	1.0233	0.9715 0.6074	1.0051	1.0233	0.9394 (0.6120)

(x) represents case x[th] at specified p_L and p_U.
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table F10 ARL of α_3 = 1, α_4 = 4.5, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4
for case (4) p_U = 0.05196, p_L = 0.08165, (5) p_U = 0.08217, p_L = 0.12913, (6) p_U = 0.12340, p_L = 0.19391

shift (δ)	P.C.(4)	S.C.	A.C. (4)	P.C.(5)	S.C.	A.C. (5)	P.C.(6)	S.C.	A.C. (6)
2.5	1.0279	1.0233	1.0000 (1.0000)	1.0153	1.0233	1.0000 (1.0000)	1.0080	1.0233	1.0000 (1.0000)
2	1.2161	1.1886	1.0068 (1.0000)	1.1380	1.1886	1.0068 (1.0000)	1.0857	1.1886	1.0068 (1.0000)
1.5	2.1285	2.0000	1.0766 (1.0000)	1.7638	2.0000	1.0766 (1.0000)	1.5154	2.0000	1.0766 (1.0000)
1	7.0910	6.3030	1.2344 (1.0000)	4.9288	6.3030	1.2344 (1.0000)	3.5927	6.3030	1.2344 (1.0000)
0.5	52.6309	43.8947	1.5118 (1.0000)	29.7273	43.8947	1.5118 (1.0000)	17.7081	43.8947	1.5118 (1.0000)
0	370.3983	370.3983	1.9611 (0.9245)	167.7986	370.3983	1.9611 (0.8856)	80.5196	370.3983	1.9611 (0.8376)
-0.5	38.0028	43.8947	1.5498 (0.6752)	21.6473	43.8947	1.5498 (0.6481)	13.0205	43.8947	1.5498 (0.6210)
-1	5.7460	6.3030	1.0681 (0.5581)	4.0466	6.3030	1.0681 (0.5504)	2.9913	6.3030	1.0681 (0.5436)
-1.5	1.9063	2.0000	0.9333 (0.5408)	1.6022	2.0000	0.9333 (0.5416)	1.3960	2.0000	0.9333 (0.5434)
-2	1.1685	1.1886	0.9211 (0.5678)	1.1038	1.1886	0.9211 (0.5725)	1.0616	1.1886	0.9211 (0.5782)
-2.5	1.0200	1.0233	0.9394 (0.6175)	1.0104	1.0233	0.9394 (0.6242)	1.0051	1.0233	0.9394 (0.6320)

(x) represents case xth at specified p_L and p_U.
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table F11 ARL of α_3 = 1, α_4 = 4.5, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4
for case (7) p_U = 0.17627, p_L = 0.27699, (8) p_U = 0.23997, p_L = 0.37710 , (9) p_U = 0.31212, p_L = 0.49047

shift (δ)	P.C.(7)	S.C.	A.C. (7)	P.C.(8)	S.C.	A.C. (8)	P.C.(9)	S.C.	A.C. (9)
2.5	1.0004	1.0233	1.0000 (1.0000)	1.0002	1.0233	1.0000 (1.0000)	1.0001	1.0233	1.0000 (1.0000)
2	1.0089	1.1886	1.0068 (1.0000)	1.0046	1.1886	1.0068 (1.0000)	1.0022	1.1886	1.0068 (1.0000)
1.5	1.0926	2.0000	1.0766 (1.0000)	1.0568	2.0000	1.0766 (1.0000)	1.0338	2.0000	1.0766 (1.0000)
1	1.5478	6.3030	1.2344 (1.0000)	1.3704	6.3030	1.2344 (1.0000)	1.2466	6.3030	1.2344 (1.0000)
0.5	3.6503	43.8947	1.5118 (0.9984	2.7427	43.8947	1.5118 (0.9744)	2.1351	43.8947	1.5118 (0.9189)
0	7.4842	370.3983	1.9611 (0.7831)	4.7326	370.3983	1.9611 (0.7262)	3.1515	370.3983	1.9611 (0.6709)
-0.5	2.8482	43.8947	1.5498 (0.5953)	2.1906	43.8947	1.5498 (0.5724)	1.7553	43.8947	1.5498 (0.5532)
-1	1.3739	6.3030	1.0681 (0.5381)	1.2375	6.3030	1.0681 (0.5343)	1.1456	6.3030	1.0681 (0.5323)
-1.5	1.0572	2.0000	0.9333 (0.5462)	1.0317	2.0000	0.9333 (0.5503)	1.0166	2.0000	0.9333 (0.5554)
-2	1.0046	1.1886	0.9211 (0.5850)	1.0021	1.1886	0.9211 (0.5928)	1.0009	1.1886	0.9211 (0.6016)
-2.5	1.0002	1.0233	0.9394 (0.6409)	1.0001	1.0233	0.9394 (0.6509)	1.0000	1.0233	0.9394 (0.6616)

(x) represents case xth at specified p_L and p_U .
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table F12 ARL of $\alpha_3 = 1$, $\alpha_4 = 4.5$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4,

for case (10) $p_U = 0.17627$, $p_L = 0.27699$, (11) $p_U = 0.23997$, $p_L = 0.37710$, (12) $p_U = 0.31212$, $p_L = 0.49047$

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)	1.0000	1.0233	1.0000 (1.0000)
2	1.0011	1.1886	1.0068 (1.0000)	1.0005	1.1886	1.0068 (1.0000)	1.0002	1.1886	1.0068 (1.0000)
1.5	1.0194	2.0000	1.0766 (1.0000)	1.0106	2.0000	1.0766 (1.0000)	1.0048	2.0000	1.0766 (1.0000)
1	1.1594	6.3030	1.2344 (1.0000)	1.0959	6.3030	1.2344 (1.0000)	1.0460	6.3030	1.2344 (1.0000)
0.5	1.7131	43.8947	1.5118 (1.0000)	1.4084	43.8947	1.5118 (1.0000)	1.1793	43.8947	1.5118 (1.0000)
0	2.2063	370.3983	1.9611 (0.9983)	1.6205	370.3983	1.9611 (0.9963)	1.2460	370.3983	1.9611 (0.9924)
-0.5	1.4593	43.8947	1.5498 (0.7520)	1.2533	43.8947	1.5498 (0.7433)	1.1067	43.8947	1.5498 (0.7317)
-1	1.0844	6.3030	1.0681 (0.5818)	1.0443	6.3030	1.0681 (0.5793)	1.0180	6.3030	1.0681 (0.5762)
-1.5	1.0080	2.0000	0.9333 (0.7520)	1.0035	2.0000	0.9333 (0.5710)	1.0012	2.0000	0.9333 (0.5720)
-2	1.0003	1.1886	0.9211 (0.6313)	1.0001	1.1886	0.9211 (0.6334)	1.0000	1.1886	0.9211 (0.6362)
-2.5	1.0000	1.0233	0.9394 (0.7219)	1.0000	1.0233	0.9394 (0.7243)	1.0000	1.0233	0.9394 (0.7276)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table F13 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4
for case (1) p_U = 0.00103, p_L = 0.00167, (2) p_U = 0.00228, p_L = 0.00368, (3) p_U = 0.00475, p_L = 0.00767

shift (δ)	P.C.(1)	S.C.	A.C. (1)	P.C.(2)	S.C.	A.C. (2)	P.C.(3)	S.C.	A.C. (3)
2.5	1.0283	1.0233	1.0018 (1.0000)	1.0155	1.0233	1.0018 (1.0000)	1.0081	1.0233	1.0018 (1.0000)
2	1.2180	1.1886	1.1212 (1.0000)	1.1394	1.1886	1.1212 (1.0000)	1.0867	1.1886	1.1212 (1.0000)
1.5	2.1375	2.0000	1.4752 (1.0000)	1.7703	2.0000	1.4752 (1.0000)	1.5202	2.0000	1.4752 (1.0000)
1	7.1473	6.3030	2.2129 (1.0000)	4.9656	6.3030	2.2129 (1.0000)	3.6177	6.3030	2.2129 (1.0000)
0.5	53.2719	43.8947	3.6453 (1.0000)	30.0802	43.8947	3.6453 (1.0000)	17.9121	43.8947	3.6453 (1.0000)
0	370.3983	370.3983	6.3110 (0.9983)	167.7986	370.3983	6.3110 (0.9963)	80.5196	370.3983	6.3110 (0.9924)
-0.5	37.7184	43.8947	2.4161 (0.7520)	21.4896	43.8947	2.4161 (0.7433)	12.9287	43.8947	2.4161 (0.7317)
-1	5.7185	6.3030	1.2789 (0.5818)	4.0285	6.3030	1.2789 (0.5793)	2.9790	6.3030	1.2789 (0.5762)
-1.5	1.9016	2.0000	1.0593 (0.7520)	1.5987	2.0000	1.0593 (0.5710)	1.3935	2.0000	1.0593 (0.5720)
-2	1.1675	1.1886	1.0098 (0.6313)	1.1031	1.1886	1.0098 (0.6334)	1.0611	1.1886	1.0098 (0.6362)
-2.5	1.0199	1.0233	0.9993 (0.7219)	1.0103	1.0233	0.9993 (0.7243)	1.0050	1.0233	0.9993 (0.7276)

(x) represents case xth at specified p_L and p_U.
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table F14 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4 for case (4) p_U = 0.00935, p_L = 0.01510, (5) p_U = 0.01740, p_L = 0.02810, (6) p_U = 0.03064, p_L = 0.04948

shift (δ)	P.C.[(4)]	S.C.	A.C. [(4)]	P.C.[(5)]	S.C.	A.C. [(5)]	P.C.[(6)]	S.C.	A.C. [(6)]
2.5	1.0041	1.0233	1.0018 (1.0000)	1.0019	1.0233	1.0018 (1.0000)	1.0009	1.0233	1.0018 (1.0000)
2	1.0522	1.1886	1.1212 (1.0000)	1.0303	1.1886	1.1212 (1.0000)	1.0169	1.1886	1.1212 (1.0000)
1.5	1.3483	2.0000	1.4752 (1.0000)	1.2299	2.0000	1.4752 (1.0000)	1.1488	2.0000	1.4752 (1.0000)
1	2.7575	6.3030	2.2129 (1.0000)	2.1930	6.3030	2.2129 (1.0000)	1.8140	6.3030	2.2129 (1.0000)
0.5	11.2302	43.8947	3.6453 (1.0000)	7.3981	43.8947	3.6453 (1.0000)	5.1078	43.8947	3.6453 (1.0000)
0	40.9016	370.3983	6.3110 (0.9851)	21.9779	370.3983	6.3110 (0.9727)	12.4815	370.3983	6.3110 (0.9529)
-0.5	8.2030	43.8947	2.4161 (0.7170)	5.4801	43.8947	2.4161 (0.6993)	3.8475	43.8947	2.4161 (0.6788)
-1	2.3068	6.3030	1.2789 (0.5725)	1.8654	6.3030	1.2789 (0.5683)	1.5701	6.3030	1.2789 (0.5641)
-1.5	1.2540	2.0000	1.0593 (0.5735)	1.1598	2.0000	1.0593 (0.5757)	1.0971	2.0000	1.0593 (0.5787)
-2	1.0346	1.1886	1.0098 (0.6399)	1.0186	1.1886	1.0098 (0.6447)	1.0095	1.1886	1.0098 (0.6509)
-2.5	1.0023	1.0233	0.9993 (0.7319)	1.0010	1.0233	0.9993 (0.7374)	1.0004	1.0233	0.9993 (0.7442)

(x) represents case x^{th} at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table F15 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4
for case (7) p_U = 0.05110, p_L = 0.08251, (8) p_U = 0.08081, p_L= 0.13049, (9) p_U = 0.12135, p_L = 0.19596

shift (δ)	P.C.$^{(7)}$	S.C.	A.C. $^{(7)}$	P.C.$^{(8)}$	S.C.	A.C. $^{(8)}$	P.C.$^{(9)}$	S.C.	A.C. $^{(9)}$
2.5	1.0004	1.0233	1.0018 (1.0000)	1.0002	1.0233	1.0018 (1.0000)	1.0001	1.0233	1.0018 (1.0000)
2	1.0091	1.1886	1.1212 (1.0000)	1.0047	1.1886	1.1212 (1.0000)	1.0023	1.1886	1.1212 (1.0000)
1.5	1.0941	2.0000	1.4752 (1.0000)	1.0579	2.0000	1.4752 (1.0000)	1.0346	2.0000	1.4752 (1.0000)
1	1.5551	6.3030	2.2129 (1.0000)	1.3760	6.3030	2.2129 (1.0000)	1.2510	6.3030	2.2129 (1.0000)
0.5	3.6844	43.8947	3.6453 (1.0000)	2.7659	43.8947	3.6453 (1.0000)	2.1509	43.8947	3.6453 (1.0000)
0	7.4842	370.3983	6.3110 (0.9238)	4.7326	370.3983	6.3110 (0.8846)	3.1515	370.3983	1.0704 (0.8362)
-0.5	2.8321	43.8947	2.4161 (0.6562)	2.1795	43.8947	2.4161 (0.6327)	1.7475	43.8947	1.2160 (0.6092)
-1	1.3703	6.3030	1.2789 (0.5601)	1.2349	6.3030	1.2789 (0.5568)	1.1436	6.3030	1.3355 (0.5548)
-1.5	1.0565	2.0000	1.0593 (0.5828)	1.0313	2.0000	1.0593 (0.5881)	1.0163	2.0000	1.2180 (0.5950)
-2	1.0045	1.1886	1.0098 (0.6584)	1.0020	1.1886	1.0098 (0.6674)	1.0008	1.1886	1.0572 (0.6780)
-2.5	1.0002	1.0233	0.9993 (0.7522)	1.0001	1.0233	0.9993 (0.7616)	1.0000	1.0233	1.0027 (0.7722)

(x) represents case xth at specified p_L and p_U.
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table F16 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (10) p_U = 0.17335, p_L = 0.27991, (11) p_U = 235997, p_L = 0.381078 (12) p_U = 0.30695, p_L = 0.49564

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0233	1.0018 (1.0000)	1.0000	1.0233	1.0018 (1.0000)	1.0000	1.0233	1.0018 (1.0000)
2	1.0011	1.1886	1.1212 (1.0000)	1.0005	1.1886	1.1212 (1.0000)	1.0002	1.1886	1.1212 (1.0000)
1.5	1.0200	2.0000	1.4752 (1.0000)	1.0109	2.0000	1.4752 (1.0000)	1.0050	2.0000	1.4752 (1.0000)
1	1.1627	6.3030	2.2129 (1.0000)	1.0983	6.3030	2.2129 (1.0000)	1.0474	6.3030	2.2129 (1.0000)
0.5	1.7235	43.8947	3.6453 (1.0000)	1.4146	43.8947	3.6453 (0.9889)	1.1822	43.8947	3.6453 (0.9407)
0	2.2063	370.3983	6.3110 (0.7813)	1.6205	370.3983	6.3110 (0.7241)	1.2460	370.3983	6.3110 (0.9407)
-0.5	1.4540	43.8947	2.4161 (0.5872)	1.2500	43.8947	2.4161 (0.5683)	1.1051	43.8947	2.4161 (0.6686)
-1	1.0830	6.3030	1.2789 (0.55430	1.0433	6.3030	1.2789 (0.5683)	1.0175	6.3030	1.2789 (0.55290
-1.5	1.0078	2.0000	1.0593 (0.6034)	1.0034	2.0000	1.0593 (0.5557)	1.0012	2.0000	1.0593 (0.5590)
-2	1.0003	1.1886	1.0098 (0.6899)	1.0001	1.1886	1.0098 (0.6134)	1.0000	1.1886	1.0098 (0.6250)
-2.5	1.0000	1.0233	0.9993 (0.7838)	1.0000	1.0233	0.9993 (0.7031)	1.0000	1.0233	0.9993 (0.8090)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table F17 ARL of $\alpha_3 = 2$, $\alpha_4 = 9$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4

for case (1) $p_U = 0.00105$, $p_L = 0.00165$, (2) $p_U = 0.00232$, $p_L = 0.00364$, (3) $p_U = 0.00438$, $p_L = 0.00759$

shift (δ)	P.C.(1)	S.C.	A.C. (1)	P.C.(2)	S.C.	A.C. (2)	P.C.(3)	S.C.	A.C. (3)
2.5	1.0279	1.0233	1.0914 (1.0000)	1.0153	1.0233	1.0914 (1.0000)	1.0080	1.0233	1.0914 (1.0000)
2	1.2161	1.1886	1.5687 (1.0000)	1.1380	1.1886	1.5687 (1.0000)	1.0857	1.1886	1.5687 (1.0000)
1.5	2.1285	2.0000	2.7468 (1.0000)	1.7638	2.0000	2.7468 (1.0000)	1.5154	2.0000	2.7468 (1.0000)
1	7.0910	6.3030	5.3154 (1.0000)	4.9288	6.3030	5.3154 (1.0000)	3.5927	6.3030	5.3154 (1.0000)
0.5	52.6309	43.8947	10.5919 (1.0000)	29.7273	43.8947	10.5919 (1.0000)	17.7081	43.8947	10.5919 (1.0000)
0	370.3983	370.3983	20.2987 (0.9984)	167.7986	370.3983	20.2987 (0.9964)	80.5196	370.3983	20.2987 (0.9925)
-0.5	38.0028	43.8947	2.4948 (0.7253)	21.6473	43.8947	2.4948 (0.7175)	13.0205	43.8947	2.4948 (0.7072)
-1	5.7460	6.3030	1.2670 (0.5774)	4.0466	6.3030	1.2670 (0.5763)	2.9913	6.3030	1.2670 (0.5749)
-1.5	1.9063	2.0000	1.0663 (0.6133)	1.6022	2.0000	1.0663 (0.6151)	1.3960	2.0000	1.0663 (0.6176)
-2	1.1685	1.1886	1.0188 (0.7195)	1.1038	1.1886	1.0188 (0.7221)	1.0616	1.1886	1.0188 (0.7257)
-2.5	1.0200	1.0233	1.0057 (0.8280)	1.0104	1.0233	1.0057 (0.8301)	1.0051	1.0233	1.0057 (0.8330)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table F18 ARL of α_3 = 2, α_4 = 9, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4
for case (4) p_U = 0.00951, p_L = 0.01494, (5) p_U = 0.01769, p_L = 0.02781, (6) p_U = 0.03116, p_L = 0.04896

shift (δ)	P.C.(4)	S.C.	A.C. (4)	P.C.(5)	S.C.	A.C. (5)	P.C.(6)	S.C.	A.C. (6)
2.5	1.0040	1.0233	1.0914 (1.0000)	1.0019	1.0233	1.0914 (1.0000)	1.0009	1.0233	1.0914 (1.0000)
2	1.0515	1.1886	1.5687 (1.0000)	1.0298	1.1886	1.5687 (1.0000)	1.0166	1.1886	1.5687 (1.0000)
1.5	1.3446	2.0000	2.7468 (1.0000)	1.2271	2.0000	2.7468 (1.0000)	1.1468	2.0000	2.7468 (1.0000)
1	2.7399	6.3030	5.3154 (1.0000)	2.1802	6.3030	5.3154 (1.0000)	1.8044	6.3030	5.3154 (1.0000)
0.5	11.1068	43.8947	10.5919 (1.0000)	7.3203	43.8947	10.5919 (1.0000)	5.0570	43.8947	10.5919 (1.0000)
0	40.9016	370.3983	20.2987 (0.9853)	21.9779	370.3983	20.2987 (0.9729)	12.4815	370.3983	20.2987 (0.9533)
-0.5	8.2590	43.8947	2.4948 (0.6942)	5.5159	43.8947	2.4948 (0.6786)	3.8711	43.8947	2.4948 (0.6607)
-1	2.3155	6.3030	1.2670 (0.5734)	1.8717	6.3030	1.2670 (0.5720)	1.5748	6.3030	1.2670 (0.5710)
-1.5	1.2559	2.0000	1.0663 (0.6211)	1.1611	2.0000	1.0663 (0.6257)	1.0981	2.0000	1.0663 (0.6316)
-2	1.0349	1.1886	1.0188 (0.7304)	1.0188	1.1886	1.0188 (0.7364)	1.0096	1.1886	1.0188 (0.7439)
-2.5	1.0023	1.0233	1.0057 (0.8368)	1.0010	1.0233	1.0057 (0.8416)	1.0004	1.0233	1.0057 (0.8473)

(x) represents case x^{th} at specified p_L and p_U.
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table F19 ARL of $\alpha_3 = 2$, $\alpha_4 = 9$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4

for case (7) $p_U = 0.05196$, $p_L = 0.08165$, (8) $p_U = 0.08217$, $p_L = 0.12913$, (9) $p_U = 0.12340$, $p_L = 0.19391$

shift (δ)	P.C.$^{(7)}$	S.C.	A.C. $^{(7)}$	P.C.$^{(8)}$	S.C.	A.C. $^{(8)}$	P.C.$^{(9)}$	S.C.	A.C. $^{(9)}$
2.5	1.0004	1.0233	1.0914 (1.0000)	1.0002	1.0233	1.0914 (1.0000)	1.0001	1.0233	1.0914 (1.0000)
2	1.0089	1.1886	1.5687 (1.0000)	1.0046	1.1886	1.5687 (1.0000)	1.0022	1.1886	1.5687 (1.0000)
1.5	1.0926	2.0000	2.7468 (1.0000)	1.0568	2.0000	2.7468 (1.0000)	1.0338	2.0000	2.7468 (1.0000)
1	1.5478	6.3030	5.3154 (1.0000)	1.3704	6.3030	5.3154 (1.0000)	1.2466	6.3030	5.3154 (1.0000)
0.5	3.6503	43.8947	10.5919 (1.0000)	2.7427	43.8947	10.5919 (1.0000)	2.1351	43.8947	10.5919 (1.0000)
0	7.4842	370.3983	20.2987 (0.9245)	4.7326	370.3983	20.2987 (0.8856)	3.1515	370.3983	20.2987 (0.8376)
-0.5	2.8482	43.8947	2.4948 (0.9245)	2.1906	43.8947	2.4948 (0.6207)	1.7553	43.8947	2.4948 (0.6004)
-1	1.3739	6.3030	1.2670 (0.5708)	1.2375	6.3030	1.2670 (0.5718)	1.1456	6.3030	1.2670 (0.5744)
-1.5	1.0572	2.0000	1.0663 (0.6391)	1.0317	2.0000	1.0663 (0.6483)	1.0166	2.0000	1.0663 (0.6593)
-2	1.0046	1.1886	1.0188 (0.7528)	1.0021	1.1886	1.0188 (0.7631)	1.0009	1.1886	1.0188 (0.7747)
-2.5	1.0002	1.0233	1.0057 (0.8540)	1.0001	1.0233	1.0057 (0.8616)	1.0000	1.0233	1.0057 (0.8699)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table F20 ARL of $\alpha_3 = 2$, $\alpha_4 = 9$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 4

for case (10) $p_U = 0.17627$, $p_L = 0.27699$ (11) $p_U = 0.23997$, $p_L = 0.37710$, (12) $p_U = 0.31212$, $p_L = 0.49047$

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0233	1.0914	1.0000	1.0233	1.0914	1.0000	1.0233	1.0914
			(1.0000)			(1.0000)			(1.0000)
2	1.0011	1.1886	1.5687	1.0005	1.1886	1.5687	1.0002	1.1886	1.5687
			(1.0000)			(1.0000)			(1.0000)
1.5	1.0194	2.0000	2.7468	1.0106	2.0000	2.7468	1.0048	2.0000	2.7468
			(1.0000)			(1.0000)			(1.0000)
1	1.1594	6.3030	5.3154	1.0959	6.3030	5.3154	1.0460	6.3030	5.3154
			(1.0000)			(1.0000)			(1.0000)
0.5	1.7131	43.8947	10.5919	1.4084	43.8947	10.5919	1.1793	43.8947	10.5919
			(1.0000)			0.9985			0.9653
0	2.2063	370.3983	20.2987	1.6205	370.3983	20.2987	1.2460	370.3983	20.2987
			0.7831			0.7262			0.6709
-0.5	1.4593	43.8947	2.4948	1.2533	43.8947	2.4948	1.1067	43.8947	2.4948
			0.5821			0.5671			0.5557
-1	1.0844	6.3030	1.2670	1.0443	6.3030	1.2670	1.0180	6.3030	1.2670
			0.5790			0.5857			0.5947
-1.5	1.0080	2.0000	1.0663	1.0035	2.0000	1.0663	1.0012	2.0000	1.0663
			0.6720			0.6864			0.7021
-2	1.0003	1.1886	1.0188	1.0001	1.1886	1.0188	1.0000	1.1886	1.0188
			0.7874			0.8010			0.8150
-2.5	1.0000	1.0233	1.0057	1.0000	1.0233	1.0057	1.0000	1.0233	1.0057
			0.8787			0.8878			0.8969

(x) represents case x^{th} at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table F21 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (1) p_U = 0.00108, p_L = 0.00162, (2) p_U = 0.00238, p_L = 0.00358, (3) p_U = 0.00496, p_L = 0.00746

shift (δ)	P.C.$^{(1)}$	S.C.	A.C. $^{(1)}$	P.C.$^{(2)}$	S.C.	A.C. $^{(2)}$	P.C.$^{(3)}$	S.C.	A.C. $^{(3)}$
2.5	1.0274	1.0233	1.0914 (1.0000)	1.0150	1.0233	1.0914 (1.0000)	1.0078	1.0233	1.0914 (1.0000)
2	1.2131	1.1886	1.5687 (1.0000)	1.1359	1.1886	1.5687 (1.0000)	1.0842	1.1886	1.5687 (1.0000)
1.5	2.1147	2.0000	2.7468 (1.0000)	1.7538	2.0000	2.7468 (1.0000)	1.5079	2.0000	2.7468 (1.0000)
1	7.0053	6.3030	5.3154 (1.0000)	4.8727	6.3030	5.3154 (1.0000)	3.5545	6.3030	5.3154 (1.0000)
0.5	51.6588	43.8947	10.5919 (1.0000)	29.1919	43.8947	10.5919 (1.0000)	17.3985	43.8947	10.5919 (1.0000)
0	370.3983	370.3983	20.2987 (0.9989)	167.7986	370.3983	20.2987 (0.9976)	80.5196	370.3983	20.2987 (0.9951)
-0.5	38.4613	43.8947	2.4948 (0.7285)	21.9014	43.8947	2.4948 (0.7221)	13.1685	43.8947	2.4948 (0.7136)
-1	5.7902	6.3030	1.2670 (0.5791)	4.0757	6.3030	1.2670 (0.5787)	3.0112	6.3030	1.2670 (0.5784)
-1.5	1.9138	2.0000	1.0663 (0.6150)	1.6076	2.0000	1.0663 (0.6176)	1.4001	2.0000	1.0663 (0.6213)
-2	1.1701	1.1886	1.0188 (0.7211)	1.1049	1.1886	1.0188 (0.7246)	1.0623	1.1886	1.0188 (0.7292)
-2.5	1.0203	1.0233	1.0057 (0.8292)	1.0105	1.0233	1.0057 (0.8319)	1.0052	1.0233	1.0057 (0.8356)

(x) represents case x$^{\text{th}}$ at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table F22 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (4) p_U = 0.00976, p_L = 0.01469, (5) p_U = 0.01816, p_L = 0.02734, (6) p_U = 0.03197, p_L = 0.04815

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0039	1.0233	1.0914 (1.0000)	1.0018	1.0233	1.0914 (1.0000)	1.0008	1.0233	1.0914 (1.0000)
2	1.0504	1.1886	1.5687 (1.0000)	1.0291	1.1886	1.5687 (1.0000)	1.0161	1.1886	1.5687 (1.0000)
1.5	1.3391	2.0000	2.7468 (1.0000)	1.2230	2.0000	2.7468 (1.0000)	1.1437	2.0000	2.7468 (1.0000)
1	2.7130	6.3030	5.3154 (1.0000)	2.1606	6.3030	5.3154 (1.0000)	1.7898	6.3030	5.3154 (1.0000)
0.5	10.9572	43.8947	10.5919 (1.0000)	7.2021	43.8947	10.5919 (1.0000)	4.9798	43.8947	10.5919 (1.0000)
0	51.2511	370.3983	20.2987 (0.9903)	21.9779	370.3983	20.2987 (0.9822)	12.4815	370.3983	20.2987 (0.9690)
-0.5	10.9572	43.8947	2.4948 (0.7028)	5.5734	43.8947	2.4948 (0.6897)	3.9092	43.8947	2.4948 (0.6745)
-1	2.7130	6.3030	1.2670 (0.5783)	1.8819	6.3030	1.2670 (0.5787)	1.5823	6.3030	1.2670 (0.5801)
-1.5	1.3391	2.0000	1.0663 (0.6263)	1.1633	2.0000	1.0663 (0.6329)	1.0997	2.0000	1.0663 (0.6413)
-2	1.0504	1.1886	1.0188 (0.7353)	1.0192	1.1886	1.0188 (0.7431)	1.0098	1.1886	1.0188 (0.7528)
-2.5	1.0039	1.0233	1.0057 (0.8404)	1.0010	1.0233	1.0057 (0.8464)	1.0004	1.0233	1.0057 (0.8536)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table F23 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (7) p_U = 0.05332, p_L = 0.08030, (8) p_U = 0.08432, p_L = 0.12698, (9) p_U = 0.12662, p_L = 0.19069

shift (δ)	P.C.$^{(7)}$	S.C.	A.C. $^{(7)}$	P.C.$^{(8)}$	S.C.	A.C. $^{(8)}$	P.C.$^{(9)}$	S.C.	A.C. $^{(9)}$
2.5	1.0004	1.0233	1.0914 (1.0000)	1.0001	1.0233	1.0914 (1.0000)	1.0001	1.0233	1.0914 (1.0000)
2	1.0086	1.1886	1.5687 (1.0000)	1.0044	1.1886	1.5687 (1.0000)	1.0021	1.1886	1.5687 (1.0000)
1.5	1.0903	2.0000	2.7468 (1.0000)	1.0551	2.0000	2.7468 (1.0000)	1.0326	2.0000	2.7468 (1.0000)
1	1.5367	6.3030	5.3154 (1.0000)	1.3618	6.3030	5.3154 (1.0000)	1.2400	6.3030	5.3154 (1.0000)
0.5	3.5985	43.8947	10.5919 (1.0000)	2.7073	43.8947	10.5919 (1.0000)	2.1110	43.8947	10.5919 (1.0000)
0	7.4842	370.3983	20.2987 (0.9494)	4.7326	370.3983	20.2987 (0.9222)	3.1515	370.3983	20.2987 (0.8715)
-0.5	2.8741	43.8947	2.4948 (0.6577)	2.2087	43.8947	2.4948 (0.6399)	1.7678	43.8947	2.4948 (0.6237)
-1	1.3795	6.3030	1.2670 (0.5829)	1.2418	6.3030	1.2670 (0.5877)	1.1488	6.3030	1.2670 (0.5953)
-1.5	1.0584	2.0000	1.0663 (0.6520)	1.0325	2.0000	1.0663 (0.6653)	1.0171	2.0000	1.0663 (0.6813)
-2	1.0047	1.1886	1.0188 (0.7643)	1.0021	1.1886	1.0188 (0.7778)	1.0009	1.1886	1.0188 (0.7932)
-2.5	1.0002	1.0233	1.0057 (0.8620)	1.0001	1.0233	1.0057 (0.8715)	1.0000	1.0233	1.0057 (0.8820)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table F24 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 4

for case (10) p_U = 0.18086, p_L = 0.27239, (11) p_U = 0.24623, p_L = 0.37084, (12) p_U = 0.32026, p_L = 0.48233

shift (δ)	P.C.(10)	S.C.	A.C. (10)	P.C.(11)	S.C.	A.C. (11)	P.C.(12)	S.C.	A.C. (12)
2.5	1.0000	1.0233	1.0914 (1.0000)	1.0000	1.0233	1.0914 (1.0000)	1.0000	1.0233	1.0914 (1.0000)
2	1.0010	1.1886	1.5687 (1.0000)	1.0005	1.1886	1.5687 (1.0000)	1.0002	1.1886	1.5687 (1.0000)
1.5	1.0186	2.0000	2.7468 (1.0000)	1.0100	2.0000	2.7468 (1.0000)	1.0045	2.0000	2.7468 (1.0000)
1	1.1544	6.3030	5.3154 (1.0000)	1.0924	6.3030	5.3154 (1.0000)	1.0440	6.3030	5.3154 (1.0000)
0.5	1.6972	43.8947	10.5919 (1.0000)	1.3988	43.8947	10.5919 (1.0000)	1.1749	43.8947	10.5919 (1.0000)
0	2.2063	370.3983	20.2987 (0.8468)	1.6205	370.3983	20.2987 (0.8024)	1.2460	370.3983	20.2987 (0.7574)
-0.5	1.4678	43.8947	2.4948 (0.6110)	1.2586	43.8947	2.4948 (0.6033)	1.1092	43.8947	2.4948 (0.6025)
-1	1.0867	6.3030	1.2670 (0.6065)	1.0458	6.3030	1.2670 (0.6221)	1.0188	6.3030	1.2670 (0.6435)
-1.5	1.0083	2.0000	1.0663 (0.7004)	1.0037	2.0000	1.0663 (0.7229)	1.0013	2.0000	1.0663 (0.7490)
-2	1.0003	1.1886	1.0188 (0.8104)	1.0001	1.1886	1.0188 (0.8292)	1.0000	1.1886	1.0188 (0.8497)
-2.5	1.0000	1.0233	1.0057 (0.8933)	1.0000	1.0233	1.0057 (0.9053)	1.0000	1.0233	1.0057 (0.9177)

(x) represents case x^{th} at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix G

Comparisons of ARL of control charts for $C_L > C_U$, $n = 5$

Appendix Table G1 ARL of α_3 = 0.25, α_4 = 3.09, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (1) p_U = 0.00124, p_L = 0.00146, (2) p_U = 0.00274, p_L = 0.00322, (3) p_U = 0.00571, p_L = 0.00671

shift (δ)	P.C.(1)	S.C.	A.C. (1)	P.C.(2)	S.C.	A.C. (2)	P.C.(3)	S.C.	A.C. (3)
2.5	1.0052	1.0048	1.0000 (1.0000)	1.0025	1.0048	1.0000 (1.0000)	1.0011	1.0048	1.0000 (1.0000)
2	1.0799	1.0758	1.0000 (1.0000)	1.0472	1.0758	1.0000 (1.0000)	1.0267	1.0758	1.0000 (1.0000)
1.5	1.5905	1.5665	1.0000 (1.0000)	1.3930	1.5665	1.0000 (1.0000)	1.2577	1.5665	1.0000 (1.0000)
1	4.6533	4.4953	1.0001 (1.0000)	3.4003	4.4953	1.0001 (1.0000)	2.6008	4.4953	1.0001 (1.0000)
0.5	35.4051	33.4008	1.0081 (1.0000)	20.5894	33.4008	1.0081 (1.0000)	12.6290	33.4008	1.0081 (1.0000)
0	370.3983	370.3983	1.0704 (0.9985)	167.7986	370.3983	1.0704 (0.9968)	80.5196	370.3983	1.0704 (0.9933)
-0.5	31.6574	33.4008	1.2365 (0.9512)	18.4690	33.4008	1.2365 (0.93334)	11.3694	33.4008	1.2365 (0.9093)
-1	4.3553	4.4953	1.3294 (0.7803)	3.1984	4.4953	1.3294 (0.7488)	2.4593	4.4953	1.3294 (0.7142)
-1.5	1.5450	1.5665	1.1507 (0.6001)	1.3595	1.5665	1.1507 (0.5817)	1.2330	1.5665	1.1507 (0.5641)
-2	1.0722	1.0758	1.0205 (0.5208)	1.0419	1.0758	1.0205 (0.5158)	1.0233	1.0758	1.0205 (0.5115)
-2.5	1.0045	1.0048	0.9977 (0.5053)	1.0021	1.0048	0.9977 (0.5058)	1.0009	1.0048	0.9977 (0.5069)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table G2 ARL of $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5
for case (4) $p_U = 0.01124$, $p_L = 0.01321$, (5) $p_U = 0.02091$, $p_L = 0.02459$, (6) $p_U = 0.03682$, $p_L = 0.04330$

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0005	1.0048	1.0000 (1.0000)	1.0002	1.0048	1.0000 (1.0000)	1.0001	1.0048	1.0000 (1.0000)
2	1.0145	1.0758	1.0000 (1.0000)	1.0075	1.0758	1.0000 (1.0000)	1.0037	1.0758	1.0000 (1.0000)
1.5	1.1654	1.5665	1.0000 (1.0000)	1.1033	1.5665	1.0000 (1.0000)	1.0624	1.5665	1.0000 (1.0000)
1	2.0766	4.4953	1.0001 (1.0000)	1.7254	4.4953	1.0001 (1.0000)	1.4866	4.4953	1.0001 (1.0000)
0.5	8.1581	33.4008	1.0081 (1.0000)	5.5397	33.4008	1.0081 (0.9998)	3.9451	33.4008	1.0081 (0.9991)
0	40.9016	370.3983	1.0704 (0.9870)	21.9779	370.3983	1.0704 (0.9760)	12.4815	370.3983	1.0704 (0.9585)
-0.5	7.3746	33.4008	1.2365 (0.8781)	5.0314	33.4008	1.2365 (0.8397)	3.6029	33.4008	1.2365 (0.7953)
-1	1.9745	4.4953	1.3294 (0.6782)	1.6500	4.4953	1.3294 (0.6427)	1.4299	4.4953	1.3294 (0.6098)
-1.5	1.1473	1.5665	1.1507 (0.5481)	1.0902	1.5665	1.1507 (0.5345)	1.0531	1.5665	1.1507 (0.5237)
-2	1.0123	1.0758	1.0205 (0.5082)	1.0062	1.0758	1.0205 (0.5061)	1.0029	1.0758	1.0205 (0.5051)
-2.5	1.0004	1.0048	0.9977 (0.5091)	1.0001	1.0048	0.9977 (0.5125)	1.0001	1.0048	0.9977 (0.5175)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table G3 ARL of α_3 = 0.25, α_4 = 3.09, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (7) p_U = 0.06142, p_L = 0.07221, (8) p_U = 0.09710, p_L = 0.11420, (9) p_U = 0.14582, p_L = 0.17149

shift (δ)	P.C.$^{(7)}$	S.C.	A.C. $^{(7)}$	P.C.$^{(8)}$	S.C.	A.C. $^{(8)}$	P.C.$^{(9)}$	S.C.	A.C. $^{(9)}$
2.5	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0017	1.0758	1.0000 (1.0000)	1.0008	1.0758	1.0000 (1.0000)	1.0003	1.0758	1.0000 (1.0000)
1.5	1.0363	1.5665	1.0000 (1.0000)	1.0203	1.5665	1.0000 (1.0000)	1.0108	1.5665	1.0000 (1.0000)
1	1.3229	4.4953	1.0001 (1.0000)	1.2105	4.4953	1.0001 (1.0000)	1.1337	4.4953	1.0001 (0.9999)
0.5	2.9380	33.4008	1.0081 (0.9967)	2.2800	33.4008	1.0081 (0.9912)	1.8358	33.4008	1.0081 (0.9804)
0	7.4842	370.3983	1.0704 (0.9327)	4.7326	370.3983	1.0704 (0.8975)	3.1515	370.3983	1.0704 (0.8536)
-0.5	2.7008	33.4008	1.2365 (0.7476)	2.1124	33.4008	1.2365 (0.6996)	1.7173	33.4008	1.2365 (0.6547)
-1	1.2798	4.4953	1.3294 (0.5810)	1.1778	4.4953	1.3294 (0.5573)	1.1092	4.4953	1.3294 (0.5389)
-1.5	1.0299	1.5665	1.1507 (0.5156)	1.0160	1.5665	1.1507 (0.5100)	1.0081	1.5665	1.1507 (0.5065)
-2	1.0013	1.0758	1.0205 (0.5054)	1.0005	1.0758	1.0205 (0.5070)	1.0002	1.0758	1.0205 (0.5102)
-2.5	1.0000	1.0048	0.9977 (0.5244)	1.0000	1.0048	0.9977 (0.5338)	1.0000	1.0048	0.9977 (0.5459)

(x) represents case x^{th} at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table G4 ARL of α_3 = 0.25, α_4 = 3.09, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5
fore case (10) p_U = 0.20829, p_L = 0.24496, (11) p_U = 0.28357, p_L = 0.33350, (12) p_U = 0.36883, p_L = 0.43376

shift (δ)	P.C.(10)	S.C.	A.C. (10)	P.C.(11)	S.C.	A.C. (11)	P.C.(12)	S.C.	A.C. (12)
2.5	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0001	1.0758	1.0000 (1.0000)	1.0000	1.0758	1.0000 (1.0000)	1.0000	1.0758	1.0000 (1.0000)
1.5	1.0055	1.5665	1.0000 (1.0000)	1.0026	1.5665	1.0000 (1.0000)	1.0011	1.5665	1.0000 (1.0000)
1	1.0817	4.4953	1.0001 (0.9993)	1.0463	4.4953	1.0001 (0.9969)	1.0209	4.4953	1.0001 (0.9908)
0.5	1.5259	33.4008	1.0081 (0.9620)	1.3018	33.4008	1.0081 (0.9341)	1.1330	33.4008	1.0081 (0.8957)
0	2.2063	370.3983	1.0704 (0.8032)	1.6205	370.3983	1.0704 (0.7499)	1.2460	370.3983	1.0704 (0.6975)
-0.5	1.4444	33.4008	1.2365 (0.6152)	1.2505	33.4008	1.2365 (0.5823)	1.1082	33.4008	1.2365 (0.5564)
-1	1.0638	4.4953	1.3294 (0.5253)	1.0341	4.4953	1.3294 (0.5159)	1.0144	4.4953	1.3294 (0.5097)
-1.5	1.0039	1.5665	1.1507 (0.5049)	1.0017	1.5665	1.1507 (0.5048)	1.0006	1.5665	1.1507 (0.5062)
-2	1.0001	1.0758	1.0205 (0.5150)	1.0000	1.0758	1.0205 (0.5218)	1.0000	1.0758	1.0205 (0.5307)
-2.5	1.0000	1.0048	0.9977 (0.5611)	1.0000	1.0048	0.9977 (0.5796)	1.0000	1.0048	0.9977 (0.6015)

(x) represents case xth at specified p_L and p_U.
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table G5 ARL of $\alpha_3 = 0.5$, $\alpha_4 = 3.38$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5 for case (1) $p_U = 0.00115$, $p_L = 0.00155$, (2) $p_U = 0.00254$, $p_L = 0.00342$, (3) $p_U = 0.00529$, $p_L = 0.00713$

shift (δ)	P.C.[(1)]	S.C.	A.C. [(1)]	P.C.[(2)]	S.C.	A.C. [(2)]	P.C.[(3)]	S.C.	A.C. [(3)]
2.5	1.0055	1.0048	1.0000 (1.0000)	1.0027	1.0048	1.0000 (1.0000)	1.0012	1.0048	1.0000 (1.0000)
2	1.0837	1.0758	1.0000 (1.0000)	1.0498	1.0758	1.0000 (1.0000)	1.0285	1.0758	1.0000 (1.0000)
1.5	1.6127	1.5665	1.0003 (1.0000)	1.4094	1.5665	1.0003 (1.0000)	1.2698	1.5665	1.0003 (1.0000)
1	4.8009	4.4953	1.0215 (1.0000)	3.5001	4.4953	1.0215 (1.0000)	2.6707	4.4953	1.0215 (1.0000)
0.5	37.3107	33.4008	1.1212 (1.0000)	21.6659	33.4008	1.1212 (1.0000)	13.2674	33.4008	1.1212 (1.0000)
0	370.3983	370.3983	1.3874 (0.9985)	167.7986	370.3983	1.3874 (0.9966)	80.5196	370.3983	1.3874 (0.9929)
-0.5	30.3746	33.4008	1.5977 (0.8816)	17.7421	33.4008	1.5977 (0.8620)	10.9368	33.4008	1.5977 (0.8374)
-1	4.2508	4.4953	1.2223 (0.6503)	3.1275	4.4953	1.2223 (0.6350)	2.4096	4.4953	1.2223 (0.6181)
-1.5	1.5289	1.5665	0.9916 (0.5368)	1.3477	1.5665	0.9916 (0.5328)	1.2242	1.5665	0.9916 (0.5287)
-2	1.0695	1.0758	0.9640 (0.5239)	1.0401	1.0758	0.9640 (0.5252)	1.0221	1.0758	0.9640 (0.5272)
-2.5	1.0043	1.0048	0.9809 (0.5614)	1.0020	1.0048	0.9809 (0.5659)	1.0008	1.0048	0.9809 (0.5716)

(x) represents case x^{th} at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table G6 ARL of α_3 = 0.5, α_4 = 3.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (4) p_U = 0.01042, p_L = 0.01403, (5) p_U = 0.01938, p_L = 0.02612, (6) p_U = 0.03413, p_L = 0.04599

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0005	1.0048	1.0000 (1.0000)	1.0002	1.0048	1.0000 (1.0000)	1.0001	1.0048	1.0000 (1.0000)
2	1.0156	1.0758	1.0000 (1.0000)	1.0081	1.0758	1.0000 (1.0000)	1.0041	1.0758	1.0000 (1.0000)
1.5	1.1743	1.5665	1.0003 (1.0000)	1.1098	1.5665	1.0003 (1.0000)	1.0671	1.5665	1.0003 (1.0000)
1	2.1271	4.4953	1.0215 (1.0000)	1.7628	4.4953	1.0215 (1.0000)	1.5147	4.4953	1.0215 (1.0000)
0.5	8.5544	33.4008	1.1212 (1.0000)	5.7963	33.4008	1.1212 (1.0000)	4.1174	33.4008	1.1212 (1.0000)
0	40.9016	370.3983	1.3874 (0.9862)	21.9779	370.3983	1.3874 (0.9745)	12.4815	370.3983	1.3874 (0.9560)
-0.5	7.1050	33.4008	1.5977 (0.8078)	4.8561	33.4008	1.5977 (0.7736)	3.4847	33.4008	1.5977 (0.7361)
-1	1.9386	4.4953	1.2223 (0.6004)	1.6235	4.4953	1.2223 (0.5827)	1.4100	4.4953	1.2223 (0.5660)
-1.5	1.1409	1.5665	0.9916 (0.5251)	1.0856	1.5665	0.9916 (0.5222)	1.0499	1.5665	0.9916 (0.5203)
-2	1.0116	1.0758	0.9640 (0.5300)	1.0057	1.0758	0.9640 (0.5338)	1.0027	1.0758	0.9640 (0.5389)
-2.5	1.0003	1.0048	0.9809 (0.5787)	1.0001	1.0048	0.9809 (0.5874)	1.0000	1.0048	0.9809 (0.5978)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table G7 ARL of α_3 = 0.5, α_4 = 3.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (7) p_U = 0.05692, p_L = 0.07669, (8) p_U = 0.09002, p_L = 0.12128, (9) p_U = 0.13519, p_L = 0.18212

shift (δ)	P.C.$^{(7)}$	S.C.	A.C. $^{(7)}$	P.C.$^{(8)}$	S.C.	A.C. $^{(8)}$	P.C.$^{(9)}$	S.C.	A.C. $^{(9)}$
2.5	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0019	1.0758	1.0000 (1.0000)	1.0009	1.0758	1.0000 (1.0000)	1.0004	1.0758	1.0000 (1.0000)
1.5	1.0396	1.5665	1.0003 (1.0000)	1.0225	1.5665	1.0003 (1.0000)	1.0123	1.5665	1.0003 (1.0000)
1	1.3443	4.4953	1.0215 (1.0000)	1.2269	4.4953	1.0215 (1.0000)	1.1463	4.4953	1.0215 (1.0000)
0.5	3.0572	33.4008	1.1212 (1.0000)	2.3639	33.4008	1.1212 (0.9991)	1.8949	33.4008	1.1212 (0.9944)
0	7.4842	370.3983	1.3874 (0.9288)	4.7326	370.3983	1.3874 (0.8918)	3.1515	370.3983	1.3874 (0.8459)
-0.5	2.6186	33.4008	1.5977 (0.6972)	2.0542	33.4008	1.5977 (0.6591)	1.6760	33.4008	1.5977 (0.6237)
-1	1.2648	4.4953	1.2223 (0.5511)	1.1665	4.4953	1.2223 (0.5387)	1.1008	4.4953	1.2223 (0.5291)
-1.5	1.0278	1.5665	0.9916 (0.5198)	1.0146	1.5665	0.9916 (0.5207)	1.0073	1.5665	0.9916 (0.5232)
-2	1.0012	1.0758	0.9640 (0.5453)	1.0005	1.0758	0.9640 (0.5533)	1.0002	1.0758	0.9640 (0.5629)
-2.5	1.0000	1.0048	0.9809 (0.6100)	1.0000	1.0048	0.9809 (0.6240)	1.0000	1.0048	0.9809 (0.6398)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table G8 ARL of α_3 = 0.5, α_4 = 3.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5
for case (10) p_U = 0.19310, p_L = 0.26015, (11) p_U = 0.26290, p_L = 0.35418, (12) p_U = 0.34193, p_L = 0.46066

shift (δ)	P.C.(10)	S.C.	A.C. (10)	P.C.(11)	S.C.	A.C. (11)	P.C.(12)	S.C.	A.C. (12)
2.5	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0002	1.0758	1.0000 (1.0000)	1.0001	1.0758	1.0000 (1.0000)	1.0000	1.0758	1.0000 (1.0000)
1.5	1.0064	1.5665	1.0003 (1.0000)	1.0032	1.5665	1.0003 (1.0000)	1.0013	1.5665	1.0003 (1.0000)
1	1.0910	4.4953	1.0215 (1.0000)	1.0527	4.4953	1.0215 (1.0000)	1.0245	4.4953	1.0215 (0.9999)
0.5	1.5664	33.4008	1.1212 (0.9819)	1.3271	33.4008	1.1212 (0.9574)	1.1452	33.4008	1.1212 (0.9178)
0	2.2063	370.3983	1.3874 (0.7936)	1.6205	370.3983	1.3874 (0.7385)	1.2460	370.3983	1.3874 (0.6846)
-0.5	1.4159	33.4008	1.5977 (0.5926)	1.2324	33.4008	1.5977 (0.5667)	1.0994	33.4008	1.5977 (0.5462)
-1	1.0578	4.4953	1.2223 (0.5223)	1.0301	4.4953	1.2223 (0.5183)	1.0123	4.4953	1.2223 (0.5168)
-1.5	1.0034	1.5665	0.9916 (0.5273)	1.0014	1.5665	0.9916 (0.5330)	1.0005	1.5665	0.9916 (0.5403)
-2	1.0001	1.0758	0.9640 (0.5741)	1.0000	1.0758	0.9640 (0.5870)	1.0000	1.0758	0.9640 (0.6014)
-2.5	1.0000	1.0048	0.9809 (0.6573)	1.0000	1.0048	0.9809 (0.6763)	1.0000	1.0048	0.9809 (0.6962)

(x) represents case x^{th} at specified p_L and p_U.
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table G9 ARL of $\alpha_3 = 1$, $\alpha_4 = 4.5$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5
for case (1) $p_U = 0.00951$, $p_L = 0.01494$, (2) $p_U = 0.00232$, $p_L = 0.00364$,, (3) $p_U = 0.03116$, $p_L = 0.04896$

shift (δ)	P.C.$^{(1)}$	S.C.	A.C. $^{(1)}$	P.C.$^{(2)}$	S.C.	A.C. $^{(2)}$	P.C.$^{(3)}$	S.C.	A.C. $^{(3)}$
2.5	1.0060	1.0048	1.0000 (1.0000)	1.0029	1.0048	1.0000 (1.0000)	1.0013	1.0048	1.0000 (1.0000)
2	1.0885	1.0758	1.0000 (1.0000)	1.0531	1.0758	1.0000 (1.0000)	1.0307	1.0758	1.0000 (1.0000)
1.5	1.6403	1.5665	1.0428 (1.0000)	1.4297	1.5665	1.0428 (1.0000)	1.2849	1.5665	1.0428 (1.0000)
1	4.9863	4.4953	1.1879 (1.0000)	3.6255	4.4953	1.1879 (1.0000)	2.7584	4.4953	1.1879 (1.0000)
0.5	39.7497	33.4008	1.4712 (1.0000)	23.0420	33.4008	1.4712 (1.0000)	14.0826	33.4008	1.4712 (1.0000)
0	370.3983	370.3983	1.9611 (0.9984)	167.7986	370.3983	1.9611 (0.9964)	80.5196	370.3983	1.9611 (0.9925)
-0.5	29.0952	33.4008	1.4675 (0.7526)	17.0164	33.4008	1.4675 (0.7436)	10.5046	33.4008	1.4675 (0.7317)
-1	4.1450	4.4953	1.0159 (0.5747)	3.0557	4.4953	1.0159 (0.5718)	2.3592	4.4953	1.0159 (0.5682)
-1.5	1.5124	1.5665	0.9218 (0.5429)	1.3356	1.5665	0.9218 (0.5430)	1.2154	1.5665	0.9218 (0.5431)
-2	1.0667	1.0758	0.9285 (0.5726)	1.0383	1.0758	0.9285 (0.5738)	1.0209	1.0758	0.9285 (0.5755)
-2.5	1.0040	1.0048	0.9515 (0.6305)	1.0018	1.0048	0.9515 (0.6323)	1.0008	1.0048	0.9515 (0.6347)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table G10 ARL of $\alpha_3 = 1$, $\alpha_4 = 4.5$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5 for case (4) $p_U = 0.05196$, $p_L = 0.08165$, (5) $p_U = 0.08217$, $p_L = 0.12913$, (6) $p_U = 0.12340$, $p_L = 0.19391$

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0006	1.0048	1.0000 (1.0000)	1.0002	1.0048	1.0000 (1.0000)	1.0001	1.0048	1.0000 (1.0000)
2	1.0170	1.0758	1.0000 (1.0000)	1.0090	1.0758	1.0000 (1.0000)	1.0046	1.0758	1.0000 (1.0000)
1.5	1.1856	1.5665	1.0428 (1.0000)	1.1181	1.5665	1.0428 (1.0000)	1.0731	1.5665	1.0428 (1.0000)
1	2.1904	4.4953	1.1879 (1.0000)	1.8096	4.4953	1.1879 (1.0000)	1.5501	4.4953	1.1879 (1.0000)
0.5	9.0598	33.4008	1.4712 (1.0000)	6.1230	33.4008	1.4712 (1.0000)	4.3364	33.4008	1.4712 (1.0000)
0	40.9016	370.3983	1.9611 (0.9853)	21.9779	370.3983	1.9611 (0.9782)	12.4815	370.3983	1.9611 (0.9533)
-0.5	6.8355	33.4008	1.4675 (0.7166)	4.6807	33.4008	1.4675 (0.6982)	3.3662	33.4008	1.4675 (0.6770)
-1	1.9023	4.4953	1.0159 (0.5637)	1.5967	4.4953	1.0159 (0.5587)	1.3900	4.4953	1.0159 (0.5451)
-1.5	1.1344	1.5665	0.9218 (0.5434)	1.0810	1.5665	0.9218 (0.5440)	1.0467	1.5665	0.9218 (0.5851)
-2	1.0108	1.0758	0.9285 (0.5777)	1.0053	1.0758	0.9285 (0.5807)	1.0024	1.0758	0.9285 (0.5845)
-2.5	1.0003	1.0048	0.9515 (0.6378)	1.0001	1.0048	0.9515 (0.6419)	1.0000	1.0048	0.9515 (0.6470)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table G11 ARL of α_3 = 1, α_4 = 4.5, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5
for case (7) p_U = 0.17627, p_L = 0.27699, (8) p_U = 0.23997, p_L = 0.37710 , (9) p_U = 0.31212, p_L = 0.49047

shift (δ)	P.C.(7)	S.C.	A.C. (7)	P.C.(8)	S.C.	A.C. (8)	P.C.(9)	S.C.	A.C. (9)
2.5	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0022	1.0758	1.0000 (1.0000)	1.0010	1.0758	1.0000 (1.0000)	1.0005	1.0758	1.0000 (1.0000)
1.5	1.0438	1.5665	1.0428 (1.0000)	1.0254	1.5665	1.0428 (1.0000)	1.0142	1.5665	1.0428 (1.0000)
1	1.3714	4.4953	1.1879 (1.0000)	1.2477	4.4953	1.1879 (1.0000)	1.1622	4.4953	1.1879 (1.0000)
0.5	3.2083	33.4008	1.4712 (1.0000)	2.4700	33.4008	1.4712 (1.0000)	1.9694	33.4008	1.4712 (1.0000)
0	7.4842	370.3983	1.9611 (0.9245)	4.7326	370.3983	1.9611 (0.8856)	3.1515	370.3983	1.9611 (0.8376)
-0.5	2.5361	33.4008	1.4675 (0.6537)	1.9957	33.4008	1.4675 (0.6294)	1.6344	33.4008	1.4675 (0.6053)
-1	1.2497	4.4953	1.0159 (0.5479)	1.1552	4.4953	1.0159 (0.5429)	1.0924	4.4953	1.0159 (0.5388)
-1.5	1.0256	1.5665	0.9218 (0.5469)	1.0133	1.5665	0.9218 (0.5494)	1.0064	1.5665	0.9218 (0.5528)
-2	1.0010	1.0758	0.9285 (0.5892)	1.0004	1.0758	0.9285 (0.5950)	1.0002	1.0758	0.9285 (0.6018)
-2.5	1.0000	1.0048	0.9515 (0.6532)	1.0000	1.0048	0.9515 (0.6606)	1.0000	1.0048	0.9515 (0.6691)

(x) represents case x[th] at specified p_L and p_U .
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table G12 ARL of α_3 = 1, α_4 = 4.5, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5
for case (10) p_U = 0.17627, p_L = 0.27699, (11) p_U = 0.23997, p_L = 0.37710, (12) p_U = 0.31212, p_L = 0.49047

shift (δ)	P.C.(10)	S.C.	A.C. (10)	P.C.(11)	S.C.	A.C. (11)	P.C.(12)	S.C.	A.C. (12)
2.5	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0002	1.0758	1.0000 (1.0000)	1.0001	1.0758	1.0000 (1.0000)	1.0000	1.0758	1.0000 (1.0000)
1.5	1.0077	1.5665	1.0428 (1.0000)	1.0039	1.5665	1.0428 (1.0000)	1.0017	1.5665	1.0428 (1.0000)
1	1.1030	4.4953	1.1879 (1.0000)	1.0612	4.4953	1.1879 (1.0000)	1.0293	4.4953	1.1879 (1.0000)
0.5	1.6172	33.4008	1.4712 (1.0000)	1.3589	33.4008	1.4712 (0.9901)	1.1604	33.4008	1.4712 (0.9465)
0	2.2063	370.3983	1.9611 (0.7831)	1.6205	370.3983	1.9611 (0.7262)	1.2460	370.3983	1.9611 (0.6709)
-0.5	1.3871	33.4008	1.4675 (0.5829)	1.2142	33.4008	1.4675 (0.5633)	1.0905	33.4008	1.4675 (0.5471)
-1	1.0518	4.4953	1.0159 (0.5360)	1.0263	4.4953	1.0159 (0.5347)	1.0104	4.4953	1.0159 (0.5349)
-1.5	1.0029	1.5665	0.9218 (0.5574)	1.0012	1.5665	0.9218 (0.5630)	1.0004	1.5665	0.9218 (0.5697)
-2	1.0001	1.0758	0.9285 (0.6098)	1.0000	1.0758	0.9285 (0.6188)	1.0000	1.0758	0.9285 (0.6287)
-2.5	1.0000	1.0048	0.9515 (0.6787)	1.0000	1.0048	0.9515 (0.6892)	1.0000	1.0048	0.9515 (0.7005)

(x) represents case xth at specified p_L and p_U .
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table G13 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5
for case (1) p_U = 0.00103, p_L = 0.00167, (2) p_U = 0.00228, p_L = 0.00368, (3) p_U = 0.00475, p_L = 0.00767

shift (δ)	P.C.$^{(1)}$	S.C.	A.C. $^{(1)}$	P.C.$^{(2)}$	S.C.	A.C. $^{(2)}$	P.C.$^{(3)}$	S.C.	A.C. $^{(3)}$
2.5	1.0061	1.0048	1.0000 (1.0000)	1.0030	1.0048	1.0000 (1.0000)	1.0014	1.0048	1.0000 (1.0000)
2	1.0894	1.0758	1.0405 (1.0000)	1.0537	1.0758	1.0405 (1.0000)	1.0311	1.0758	1.0405 (1.0000)
1.5	1.6455	1.5665	1.3162 (1.0000)	1.4336	1.5665	1.3162 (1.0000)	1.2878	1.5665	1.3162 (1.0000)
1	5.0212	4.4953	1.9911 (1.0000)	3.6490	4.4953	1.9911 (1.0000)	2.7749	4.4953	1.9911 (1.0000)
0.5	40.2140	33.4008	3.4241 (1.0000)	23.3038	33.4008	3.4241 (1.0000)	14.2375	33.4008	3.4241 (1.0000)
0	370.3983	370.3983	6.3110 (0.9983)	167.7986	370.3983	6.3110 (0.9963)	80.5196	370.3983	6.3110 (0.9924)
-0.5	28.8868	33.4008	2.1534 (0.7214)	16.8982	33.4008	2.1534 (0.7134)	10.4341	33.4008	2.1534 (0.7029)
-1	4.1276	4.4953	1.1942 (0.5689)	3.0439	4.4953	1.1942 (0.5675)	2.3509	4.4953	1.1942 (0.5657)
-1.5	1.5097	1.5665	1.0331 (0.5864)	1.3336	1.5665	1.0331 (0.5877)	1.2139	1.5665	1.0331 (0.5895)
-2	1.0663	1.0758	1.0027 (0.6724)	1.0379	1.0758	1.0027 (0.6747)	1.0207	1.0758	1.0027 (0.6779)
-2.5	1.0040	1.0048	0.9979 (0.7768)	1.0018	1.0048	0.9979 (0.7791)	1.0008	1.0048	0.9979 (0.7822)

(x) represents case xth at specified p_L and p_U .

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table G14 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5 for case (4) p_U = 0.00935, p_L = 0.01510, (5) p_U = 0.01740, p_L = 0.02810, (6) p_U = 0.03064, p_L = 0.04948

shift (δ)	P.C.[(4)]	S.C.	A.C. [(4)]	P.C.[(5)]	S.C.	A.C. [(5)]	P.C.[(6)]	S.C.	A.C. [(6)]
2.5	1.0006	1.0048	1.0000 (1.0000)	1.0003	1.0048	1.0000 (1.0000)	1.0001	1.0048	1.0000 (1.0000)
2	1.0173	1.0758	1.0405 (1.0000)	1.0092	1.0758	1.0405 (1.0000)	1.0047	1.0758	1.0405 (1.0000)
1.5	1.1877	1.5665	1.3162 (1.0000)	1.1196	1.5665	1.3162 (1.0000)	1.0742	1.5665	1.3162 (1.0000)
1	2.2023	4.4953	1.9911 (1.0000)	1.8184	4.4953	1.9911 (1.0000)	1.5568	4.4953	1.9911 (1.0000)
0.5	9.1558	33.4008	3.4241 (1.0000)	6.1850	33.4008	3.4241 (1.0000)	4.3779	33.4008	3.4241 (1.0000)
0	40.9016	370.3983	6.3110 (0.9851)	21.9779	370.3983	6.3110 (0.9727)	12.4815	370.3983	6.3110 (0.9529)
-0.5	6.7915	33.4008	2.1534 (0.6896)	4.6521	33.4008	2.1534 (0.6737)	3.3468	33.4008	2.1534 (0.6554)
-1	1.8963	4.4953	1.1942 (0.5637)	1.5923	4.4953	1.1942 (0.5615)	1.3867	4.4953	1.1942 (0.5596)
-1.5	1.1334	1.5665	1.0331 (0.5920)	1.0802	1.5665	1.0331 (0.5954)	1.0462	1.5665	1.0331 (0.5998)
-2	1.0107	1.0758	1.0027 (0.6821)	1.0052	1.0758	1.0027 (0.6874)	1.0024	1.0758	1.0027 (0.6941)
-2.5	1.0003	1.0048	0.9979 (0.7863)	1.0001	1.0048	0.9979 (0.7914)	1.0000	1.0048	0.9979 (0.7977)

(x) represents case x^{th} at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table G15 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5

for case (7) p_U = 0.05110, p_L = 0.08251, (8) p_U = 0.08081, p_L = 0.13049, (9) p_U = 0.12135, p_L = 0.19596

shift (δ)	P.C.$^{(7)}$	S.C.	A.C. $^{(7)}$	P.C.$^{(8)}$	S.C.	A.C. $^{(8)}$	P.C.$^{(9)}$	S.C.	A.C. $^{(9)}$
2.5	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0023	1.0758	1.0405 (1.0000)	1.0011	1.0758	1.0405 (1.0000)	1.0005	1.0758	1.0405 (1.0000)
1.5	1.0446	1.5665	1.3162 (1.0000)	1.0260	1.5665	1.3162 (1.0000)	1.0146	1.5665	1.3162 (1.0000)
1	1.3765	4.4953	1.9911 (1.0000)	1.2517	4.4953	1.9911 (1.0000)	1.1652	4.4953	1.9911 (1.0000)
0.5	3.2369	33.4008	3.4241 (1.0000)	2.4900	33.4008	3.4241 (1.0000)	1.9835	33.4008	3.4241 (1.0000)
0	7.4842	370.3983	6.3110 (0.9238)	4.7326	370.3983	6.3110 (0.8846)	3.1515	370.3983	6.3110 (0.8362)
-0.5	2.5226	33.4008	2.1534 (0.6355)	1.9861	33.4008	2.1534 (0.6148)	1.6276	33.4008	2.1534 (0.5946)
-1	1.2473	4.4953	1.1942 (0.5582)	1.1533	4.4953	1.1942 (0.5576)	1.0911	4.4953	1.1942 (0.5584)
-1.5	1.0253	1.5665	1.0331 (0.6055)	1.0130	1.5665	1.0331 (0.6126)	1.0063	1.5665	1.0331 (0.6212)
-2	1.0010	1.0758	1.0027 (0.7022)	1.0004	1.0758	1.0027 (0.7118)	1.0001	1.0758	1.0027 (0.7227)
-2.5	1.0000	1.0048	0.9979 (0.8051)	1.0000	1.0048	0.9979 (0.8136)	1.0000	1.0048	0.9979 (0.8230)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table G16 ARL of α_3 = 1.5, α_4 = 6.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5
for case (10) p_U = 0.17335, p_L = 0.27991, (11) p_U = 235997, p_L = 0.381078 (12) p_U = 0.30695, p_L = 0.49564

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)	1.0000	1.0048	1.0000 (1.0000)
2	1.0002	1.0758	1.0405 (1.0000)	1.0001	1.0758	1.0405 (1.0000)	1.0000	1.0758	1.0405 (1.0000)
1.5	1.0079	1.5665	1.3162 (1.0000)	1.0041	1.5665	1.3162 (1.0000)	1.0018	1.5665	1.3162 (1.0000)
1	1.1053	4.4953	1.9911 (1.0000)	1.0628	4.4953	1.9911 (1.0000)	1.0302	4.4953	1.9911 (1.0000)
0.5	1.6268	33.4008	3.4241 (1.0000)	1.3648	33.4008	3.4241 (0.9988)	1.1632	33.4008	3.4241 (0.9678)
0	2.2063	370.3983	6.3110 (0.7813)	1.6205	370.3983	6.3110 (0.7241)	1.2460	370.3983	6.3110 (0.6686)
-0.5	1.3824	33.4008	2.1534 (0.5764)	1.2112	33.4008	2.1534 (0.5610)	1.0891	33.4008	2.1534 (0.5489)
-1	1.0509	4.4953	1.1942 (0.5607)	1.0257	4.4953	1.1942 (0.5647)	1.0101	4.4953	1.1942 (0.5707)
-1.5	1.0028	1.5665	1.0331 (0.6314)	1.0011	1.5665	1.0331 (0.6431)	1.0004	1.5665	1.0331 (0.6561)
-2	1.0001	1.0758	1.0027 (0.7349)	1.0000	1.0758	1.0027 (0.7482)	1.0000	1.0758	1.0027 (0.7621)
-2.5	1.0000	1.0048	0.9979 (0.8332)	1.0000	1.0048	0.9979 (0.8439)	1.0000	1.0048	0.9979 (0.8548)

(x) represents case xth at specified p_L and p_U.

(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table G17 ARL of $\alpha_3 = 2$, $\alpha_4 = 9$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5
for case (1) $p_U = 0.00105$, $p_L = 0.00165$, (2) $p_U = 0.00232$, $p_L = 0.00364$, (3) $p_U = 0.00438$, $p_L = 0.00759$

shift (δ)	P.C.(1)	S.C.	A.C. (1)	P.C.(2)	S.C.	A.C. (2)	P.C.(3)	S.C.	A.C. (3)
2.5	1.0060	1.0048	1.0039 (1.0000)	1.0029	1.0048	1.0039 (1.0000)	1.0013	1.0048	1.0039 (1.0000)
2	1.0885	1.0758	1.2816 (1.0000)	1.0531	1.0758	1.2816 (1.0000)	1.0307	1.0758	1.2816 (1.0000)
1.5	1.6403	1.5665	2.2166 (1.0000)	1.4297	1.5665	2.2166 (1.0000)	1.2849	1.5665	2.2166 (1.0000)
1	4.9863	4.4953	4.5269 (1.0000)	3.6255	4.4953	4.5269 (1.0000)	2.7584	4.4953	4.5269 (1.0000)
0.5	39.7497	33.4008	9.7644 (1.0000)	23.0420	33.4008	9.7644 (1.0000)	14.0826	33.4008	9.7644 (1.0000)
0	370.3983	370.3983	20.2987 (0.9984)	167.7986	370.3983	20.2987 (0.9964)	80.5196	370.3983	20.2987 (0.9925)
-0.5	29.0952	33.4008	2.1776 (0.6950)	17.0164	33.4008	2.1776 (0.6881)	10.5046	33.4008	2.1776 (0.6789)
-1	4.1450	4.4953	1.1888 (0.5748)	3.0557	4.4953	1.1888 (0.5746)	2.3592	4.4953	1.1888 (0.5745)
-1.5	1.5124	1.5665	1.0420 (0.6469)	1.3356	1.5665	1.0420 (0.6492)	1.2154	1.5665	1.0420 (0.6524)
-2	1.0667	1.0758	1.0107 (0.7734)	1.0383	1.0758	1.0107 (0.7760)	1.0209	1.0758	1.0107 (0.7794)
-2.5	1.0040	1.0048	1.0029 (0.8777)	1.0018	1.0048	1.0029 (0.8794)	1.0008	1.0048	1.0029 (0.8816)

(x) represents case x^{th} at specified p_L and p_U.
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table G18 ARL of $\alpha_3 = 2$, $\alpha_4 = 9$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5
for case (4) $p_U = 0.00951$, $p_L = 0.01494$, (5) $p_U = 0.01769$, $p_L = 0.02781$, (6) $p_U = 0.03116$, $p_L = 0.04896$

shift (δ)	P.C.(4)	S.C.	A.C. (4)	P.C.(5)	S.C.	A.C. (5)	P.C.(6)	S.C.	A.C. (6)
2.5	1.0006	1.0048	1.0039 (1.0000)	1.0002	1.0048	1.0039 (1.0000)	1.0001	1.0048	1.0039 (1.0000)
2	1.0170	1.0758	1.2816 (1.0000)	1.0090	1.0758	1.2816 (1.0000)	1.0046	1.0758	1.2816 (1.0000)
1.5	1.1856	1.5665	2.2166 (1.0000)	1.1181	1.5665	2.2166 (1.0000)	1.0731	1.5665	2.2166 (1.0000)
1	2.1904	4.4953	4.5269 (1.0000)	1.8096	4.4953	4.5269 (1.0000)	1.5501	4.4953	4.5269 (1.0000)
0.5	9.0598	33.4008	9.7644 (1.0000)	6.1230	33.4008	9.7644 (1.0000)	4.3364	33.4008	9.7644 (1.0000)
0	40.9016	370.3983	20.2987 (0.9853)	21.9779	370.3983	20.2987 (0.9729)	12.4815	370.3983	20.2987 (0.9533)
-0.5	6.8355	33.4008	2.1776 (0.6675)	4.6807	33.4008	2.1776 (0.6538)	3.3662	33.4008	2.1776 (0.6382)
-1	1.9023	4.4953	1.1888 (0.5746)	1.5967	4.4953	1.1888 (0.5752)	1.3900	4.4953	1.1888 (0.5765)
-1.5	1.1344	1.5665	1.0420 (0.6567)	1.0810	1.5665	1.0420 (0.6622)	1.0467	1.5665	1.0420 (0.6692)
-2	1.0108	1.0758	1.0107 (0.7838)	1.0053	1.0758	1.0107 (0.7894)	1.0024	1.0758	1.0107 (0.7963)
-2.5	1.0003	1.0048	1.0029 (0.8845)	1.0001	1.0048	1.0029 (0.8881)	1.0000	1.0048	1.0029 (0.8925)

(x) represents case xth at specified p_L and p_U.
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table G19 ARL of $\alpha_3 = 2$, $\alpha_4 = 9$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5
for case (7) $p_U = 0.05196$, $p_L = 0.08165$, (8) $p_U = 0.08217$, $p_L = 0.12913$, (9) $p_U = 0.12340$, $p_L = 0.19391$

shift (δ)	P.C.(7)	S.C.	A.C. (7)	P.C.(8)	S.C.	A.C. (8)	P.C.(9)	S.C.	A.C. (9)
2.5	1.0000	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)
2	1.0022	1.0758	1.2816 (1.0000)	1.0010	1.0758	1.2816 (1.0000)	1.0005	1.0758	1.2816 (1.0000)
1.5	1.0438	1.5665	2.2166 (1.0000)	1.0254	1.5665	2.2166 (1.0000)	1.0142	1.5665	2.2166 (1.0000)
1	1.3714	4.4953	4.5269 (1.0000)	1.2477	4.4953	4.5269 (1.0000)	1.1622	4.4953	4.5269 (1.0000)
0.5	3.2083	33.4008	9.7644 (1.0000)	2.4700	33.4008	9.7644 (1.0000)	1.9694	33.4008	9.7644 (1.0000)
0	7.4842	370.3983	20.2987 (0.9245)	4.7326	370.3983	20.2987 (0.8856)	3.1515	370.3983	20.2987 (0.8376)
-0.5	2.5361	33.4008	2.1776 (0.6212)	1.9957	33.4008	2.1776 (0.6037)	1.6344	33.4008	2.1776 (0.5873)
-1	1.2497	4.4953	1.1888 (0.5788)	1.1552	4.4953	1.1888 (0.5826)	1.0924	4.4953	1.1888 (0.5880)
-1.5	1.0256	1.5665	1.0420 (0.6777)	1.0133	1.5665	1.0420 (0.6880)	1.0064	1.5665	1.0420 (0.6999)
-2	1.0010	1.0758	1.0107 (0.8044)	1.0004	1.0758	1.0107 (0.8137)	1.0002	1.0758	1.0107 (0.8239)
-2.5	1.0000	1.0048	1.0029 (0.8975)	1.0000	1.0048	1.0029 (0.9032)	1.0000	1.0048	1.0029 (0.9093)

(x) represents case x^{th} at specified p_L and p_U.
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table G20 ARL of $\alpha_3 = 2$, $\alpha_4 = 9$, $\gamma_2 = 1, 5, 10$, m = 10, 15, 20, 25, n = 5
for case (10) $p_U = 0.17627$, $p_L = 0.27699$ (11) $p_U = 0.23997$, $p_L = 0.37710$, (12) $p_U = 0.31212$, $p_L = 0.49047$

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)
2	1.0002	1.0758	1.2816 (1.0000)	1.0001	1.0758	1.2816 (1.0000)	1.0000	1.0758	1.2816 (1.0000)
1.5	1.0077	1.5665	2.2166 (1.0000)	1.0039	1.5665	2.2166 (1.0000)	1.0017	1.5665	2.2166 (1.0000)
1	1.1030	4.4953	4.5269 (1.0000)	1.0612	4.4953	4.5269 (1.0000)	1.0293	4.4953	4.5269 (1.0000)
0.5	1.6172	33.4008	9.7644 (1.0000)	1.3589	33.4008	9.7644 (1.0000)	1.1604	33.4008	9.7644 (0.9877)
0	2.2063	370.3983	20.2987 (0.7831)	1.6205	370.3983	20.2987 (0.7262)	1.2460	370.3983	20.2987 (0.6709)
-0.5	1.3871	33.4008	2.1776 (0.5732)	1.2142	33.4008	2.1776 (0.5620)	1.0905	33.4008	2.1776 (0.5542)
-1	1.0518	4.4953	1.1888 (0.5954)	1.0263	4.4953	1.1888 (0.6049)	1.0104	4.4953	1.1888 (0.6165)
-1.5	1.0029	1.5665	1.0420 (0.7134)	1.0012	1.5665	1.0420 (0.7283)	1.0004	1.5665	1.0420 (0.7441)
-2	1.0001	1.0758	1.0107 (0.8350)	1.0000	1.0758	1.0107 (0.8466)	1.0000	1.0758	1.0107 (0.8583)
-2.5	1.0000	1.0048	1.0029 (0.9157)	1.0000	1.0048	1.0029 (0.9223)	1.0000	1.0048	1.0029 (0.9288)

(x) represents case xth at specified p_L and p_U .
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. ($p_L = 0.00135$ and $p_U = 0.99865$).

Appendix Table G21 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5
for case (1) p_U = 0.00108, p_L = 0.00162, (2) p_U = 0.00238, p_L = 0.00358, (3) p_U = 0.00496, p_L = 0.00746

shift (δ)	P.C.(1)	S.C.	A.C. (1)	P.C.(2)	S.C.	A.C. (2)	P.C.(3)	S.C.	A.C. (3)
2.5	1.0059	1.0048	1.0039 (1.0000)	1.0028	1.0048	1.0039 (1.0000)	1.0013	1.0048	1.0039 (1.0000)
2	1.0871	1.0758	1.2816 (1.0000)	1.0522	1.0758	1.2816 (1.0000)	1.0300	1.0758	1.2816 (1.0000)
1.5	1.6324	1.5665	2.2166 (1.0000)	1.4239	1.5665	2.2166 (1.0000)	1.2806	1.5665	2.2166 (1.0000)
1	4.9332	4.4953	4.5269 (1.0000)	3.5895	4.4953	4.5269 (1.0000)	2.7333	4.4953	4.5269 (1.0000)
0.5	39.0450	33.4008	9.7644 (1.0000)	22.6446	33.4008	9.7644 (1.0000)	13.8473	33.4008	9.7644 (1.0000)
0	370.3983	370.3983	20.2987 (0.9984)	167.7986	370.3983	20.2987 (0.9964)	80.5196	370.3983	20.2987 (0.9926)
-0.5	29.4310	33.4008	2.1776 (0.6951)	17.2070	33.4008	2.1776 (0.6882)	10.6181	33.4008	2.1776 (0.6792)
-1	4.1729	4.4953	1.1888 (0.5748)	3.0747	4.4953	1.1888 (0.5747)	2.3725	4.4953	1.1888 (0.5746)
-1.5	1.5167	1.5665	1.0420 (0.6470)	1.3388	1.5665	1.0420 (0.6494)	1.2177	1.5665	1.0420 (0.6526)
-2	1.0674	1.0758	1.0107 (0.7735)	1.0387	1.0758	1.0107 (0.7761)	1.0212	1.0758	1.0107 (0.7795)
-2.5	1.0041	1.0048	1.0029 (0.8777)	1.0019	1.0048	1.0029 (0.8794)	1.0008	1.0048	1.0029 (0.8817)

(x) represents case xth at specified p_L and p_U.
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table G22 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5
for case (4) p_U = 0.00976, p_L = 0.01469, (5) p_U = 0.01816, p_L = 0.02734, (6) p_U = 0.03197, p_L = 0.04815

shift (δ)	P.C.$^{(4)}$	S.C.	A.C. $^{(4)}$	P.C.$^{(5)}$	S.C.	A.C. $^{(5)}$	P.C.$^{(6)}$	S.C.	A.C. $^{(6)}$
2.5	1.0006	1.0048	1.0039 (1.0000)	1.0002	1.0048	1.0039 (1.0000)	1.0001	1.0048	1.0039 (1.0000)
2	1.0166	1.0758	1.2816 (1.0000)	1.0088	1.0758	1.2816 (1.0000)	1.0044	1.0758	1.2816 (1.0000)
1.5	1.1823	1.5665	2.2166 (1.0000)	1.1157	1.5665	2.2166 (1.0000)	1.0714	1.5665	2.2166 (1.0000)
1	2.1722	4.4953	4.5269 (1.0000)	1.7962	4.4953	4.5269 (1.0000)	1.5400	4.4953	4.5269 (1.0000)
0.5	8.9140	33.4008	9.7644 (1.0000)	6.0288	33.4008	9.7644 (1.0000)	4.2733	33.4008	9.7644 (1.0000)
0	40.9016	370.3983	20.2987 (0.9855)	21.9779	370.3983	20.2987 (0.9734)	12.4815	370.3983	20.2987 (0.9541)
-0.5	6.9063	33.4008	2.1776 (0.6678)	4.7268	33.4008	2.1776 (0.6542)	3.3973	33.4008	2.1776 (0.6387)
-1	1.9119	4.4953	1.1888 (0.5749)	1.6038	4.4953	1.1888 (0.5755)	1.3953	4.4953	1.1888 (0.5769)
-1.5	1.1361	1.5665	1.0420 (0.6569)	1.0822	1.5665	1.0420 (0.6626)	1.0476	1.5665	1.0420 (0.6697)
-2	1.0110	1.0758	1.0107 (0.7840)	1.0054	1.0758	1.0107 (0.7897)	1.0025	1.0758	1.0107 (0.7967)
-2.5	1.0003	1.0048	1.0029 (0.8847)	1.0001	1.0048	1.0029 (0.8883)	1.0000	1.0048	1.0029 (0.8927)

(x) represents case xth at specified p_L and p_U.
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table G23 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5
for case (7) p_U = 0.05332, p_L = 0.08030, (8) p_U = 0.08432, p_L = 0.12698, (9) p_U = 0.12662, p_L = 0.19069

shift (δ)	P.C.(7)	S.C.	A.C. (7)	P.C.(8)	S.C.	A.C. (8)	P.C.(9)	S.C.	A.C. (9)
2.5	1.0000	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)
2	1.0021	1.0758	1.2816 (1.0000)	1.0010	1.0758	1.2816 (1.0000)	1.0004	1.0758	1.2816 (1.0000)
1.5	1.0426	1.5665	2.2166 (1.0000)	1.0246	1.5665	2.2166 (1.0000)	1.0137	1.5665	2.2166 (1.0000)
1	1.3636	4.4953	4.5269 (1.0000)	1.2417	4.4953	4.5269 (1.0000)	1.1576	4.4953	4.5269 (1.0000)
0.5	3.1648	33.4008	9.7644 (1.0000)	2.4395	33.4008	9.7644 (1.0000)	1.9480	33.4008	9.7644 (1.0000)
0	7.4842	370.3983	20.2987 (0.9257)	4.7326	370.3983	20.2987 (0.8873)	3.1515	370.3983	20.2987 (0.8398)
-0.5	2.5578	33.4008	2.1776 (0.6218)	2.0111	33.4008	2.1776 (0.6044)	1.6454	33.4008	2.1776 (0.5882)
-1	1.2537	4.4953	1.1888 (0.5794)	1.1581	4.4953	1.1888 (0.5833)	1.0946	4.4953	1.1888 (0.5890)
-1.5	1.0262	1.5665	1.0420 (0.6784)	1.0136	1.5665	1.0420 (0.6889)	1.0066	1.5665	1.0420 (0.7010)
-2	1.0011	1.0758	1.0107 (0.8049)	1.0004	1.0758	1.0107 (0.8143)	1.0002	1.0758	1.0107 (0.8248)
-2.5	1.0000	1.0048	1.0029 (0.8979)	1.0000	1.0048	1.0029 (0.9036)	1.0000	1.0048	1.0029 (0.9098)

(x) represents case xth at specified p_L and p_U.
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix Table G24 ARL of α_3 = 2.5, α_4 = 12.38, γ_2 = 1, 5, 10, m = 10, 15, 20, 25, n = 5
for case (10) p_U = 0.18086, p_L = 0.27239, (11) p_U = 0.24623, p_L = 0.37084, (12) p_U = 0.32026, p_L = 0.48233

shift (δ)	P.C.$^{(10)}$	S.C.	A.C. $^{(10)}$	P.C.$^{(11)}$	S.C.	A.C. $^{(11)}$	P.C.$^{(12)}$	S.C.	A.C. $^{(12)}$
2.5	1.0000	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)	1.0000	1.0048	1.0039 (1.0000)
2	1.0002	1.0758	1.2816 (1.0000)	1.0001	1.0758	1.2816 (1.0000)	1.0000	1.0758	1.2816 (1.0000)
1.5	1.0073	1.5665	2.2166 (1.0000)	1.0037	1.5665	2.2166 (1.0000)	1.0016	1.5665	2.2166 (1.0000)
1	1.0995	4.4953	4.5269 (1.0000)	1.0587	4.4953	4.5269 (1.0000)	1.0279	4.4953	4.5269 (1.0000)
0.5	1.6026	33.4008	9.7644 (1.0000)	1.3498	33.4008	9.7644 (1.0000)	1.1560	33.4008	9.7644 (0.9901)
0	2.2063	370.3983	20.2987 (0.7859)	1.6205	370.3983	20.2987 (0.7295)	1.2460	370.3983	20.2987 (0.6746)
-0.5	1.3947	33.4008	2.1776 (0.5743)	1.2190	33.4008	2.1776 (0.5634)	1.0929	33.4008	2.1776 (0.5559)
-1	1.0534	4.4953	1.1888 (0.5967)	1.0273	4.4953	1.1888 (0.6066)	1.0109	4.4953	1.1888 (0.6186)
-1.5	1.0030	1.5665	1.0420 (0.7148)	1.0012	1.5665	1.0420 (0.7300)	1.0004	1.5665	1.0420 (0.7462)
-2	1.0001	1.0758	1.0107 (0.8360)	1.0000	1.0758	1.0107 (0.8477)	1.0000	1.0758	1.0107 (0.8597)
-2.5	1.0000	1.0048	1.0029 (0.9163)	1.0000	1.0048	1.0029 (0.9229)	1.0000	1.0048	1.0029 (0.9295)

(x) represents case xth at specified p_L and p_U.
(xxxxx) is the ARL of A.C. at p_L and p_U held constant as S.C. (p_L = 0.00135 and p_U = 0.99865).

Appendix H

Example of ARL of control charts for m = 10, 15, 20, 25

Appendix Table H1 ARL of α_3 = 0.25, α_4 = 3.09, γ_2 = 1, m = 10, 15, 20, 25, n = 4, $C_L = C_U$

shift (δ)	P.C. $p_L = p_U = 0.00124$				S.C. $p_L = p_U = 0.00135$				A.C. $p_L = 0.00135$ $p_U = 0.00124$			
	m = 10	m = 15	m = 20	m =25	m = 10	m = 15	m = 20	m =25	m = 10	m = 15	m = 20	m =25
2.5	2	2	2	2	2	2	2	2	1	1	1	1
2	2	2	2	2	2	2	2	2	1	1	1	1
1.5	3	3	3	3	2	2	2	2	1	1	1	1
1	7	7	7	7	7	7	7	7	2	2	2	2
0.5	47	47	47	47	44	44	44	44	2	2	2	2
0	404	404	404	404	370	370	370	370	2	2	2	2
-0.5	47	47	47	47	44	44	44	44	2	2	2	2
-1	7	7	7	7	7	7	7	7	2	2	2	2
-1.5	3	3	3	3	2	2	2	2	2	2	2	2
-2	2	2	2	2	2	2	2	2	2	2	2	2
-2.5	2	2	2	2	2	2	2	2	2	2	2	2

Appendix Table H2 ARL of α_3 = 0.25, α_4 = 3.09, γ_2 = 1, m = 10, 15, 20, 25, n = 4, $C_L > C_U$

shift (δ)	P.C. p_L = 0.00146, p_U = 0.00124				S.C. p_L = p_U = 0.00135				A.C. p_L = 0.00135 p_U = 0.00124			
	m = 10	m = 15	m = 20	m =25	m = 10	m = 15	m = 20	m =25	m = 10	m = 15	m = 20	m =25
2.5	2	2	2	2	2	2	2	2	1	1	1	1
2	2	2	2	2	2	2	2	2	1	1	1	1
1.5	3	3	3	3	2	2	2	2	1	1	1	1
1	7	7	7	7	7	7	7	7	2	2	2	2
0.5	47	47	47	47	44	44	44	44	2	2	2	2
0	370	370	370	370	370	370	370	370	2	2	2	2
-0.5	42	42	42	42	44	44	44	44	2	2	2	2
-1	7	7	7	7	7	7	7	7	2	2	2	2
-1.5	2	2	2	2	2	2	2	2	2	2	2	2
-2	2	2	2	2	2	2	2	2	2	2	2	2
-2.5	2	2	2	2	2	2	2	2	2	2	2	2

Appendix Table H3 ARL of $\alpha_3 = 0.25$, $\alpha_4 = 3.09$, $\gamma_2 = 1$, m = 10, 15, 20, 25, n = 4 and $C_L < C_U$

shift (δ)	P.C. $p_L = 0.00124$, $p_U = 0.00146$				S.C. $p_L = p_U = 0.00135$				A.C. $p_L = 0.00135$ $p_U = 0.00124$			
	$m = 10$	$m = 15$	$m = 20$	$m = 25$	$m = 10$	$m = 15$	$m = 20$	$m = 25$	$m = 10$	$m = 15$	$m = 20$	$m = 25$
2.5	2	2	2	2	2	2	2	2	1	1	1	1
2	2	2	2	2	2	2	2	2	1	1	1	1
1.5	2	2	2	2	2	2	2	2	1	1	1	1
1	7	7	7	7	7	7	7	7	2	2	2	2
0.5	42	42	42	42	44	44	44	44	2	2	2	2
0	370	370	370	370	370	370	370	370	2	2	2	2
-0.5	47	47	47	47	44	44	44	44	2	2	2	2
-1	7	7	7	7	7	7	7	7	2	2	2	2
-1.5	3	3	3	3	2	2	2	2	2	2	2	2
-2	2	2	2	2	2	2	2	2	2	2	2	2
-2.5	2	2	2	2	2	2	2	2	2	2	2	2

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