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Construction and Selection of Single Sampling Quick Switching Variables System for given Control Limits Involving Minimum Sum of Risks

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Abstract- A table and the construction procedure is given for finding the single sampling quick switching variables system involving minimum sum of risks for specified, Acceptable Quality Level and Limiting Quality Level.

Key Words: Quick Switching System, Variables Sampling, Acceptable Quality Level (AQL), Limiting Quality Level (LQL) and Minimum Sum of Risks.

I.Introduction

Acceptance sampling is a scrutiny procedure applied in statistical quality control for manufacturing the products and is used to measure random samples of population consideration. This contains lot of products that are against predetermined quality. In order to achieve uniqueness of manufacturing products with high quality level, many methodologies have been implemented. Among them, Quick Switching Sampling System is regarded as high efficient protocol for acceptance sampling. Previously, it was proposed by Dodge (1967) and it was further investigated by various authors, Romboski (1969) and Govindaraju(1991). It was also examined by Taylor (1996) to identify a method to evaluate and select Quick Switching Sampling System. As the base to the above arguments, in 1957 Golub Abraham described the designing of single sampling inspection plan for fixed sample size, which was noticed as the sampling plan involving minimum sum of risks. Govindaraju and Subramani (1990a) have constructed tables for selection of single sampling quick switching systems (QSS-1) for given Acceptable Quality Level and Limiting Quality Level. They also provided the table that is used to select an MDS-1 plan for given AQL (p_1) and LQL (p_2) with minimum sum of risks. Palanivel (1999) has constructed the table on Quick Switching Variables Single Sampling (QSVSS) Systems. Senthilkumar and Sivakumaran (2004) have constructed the table for selection of minimum risk single sampling quick switching system QSS-1(n; c_2, c_1) by attributes.

This paper provides a procedure for finding the single – sampling quick switching variables system for which the sum of producer's and consumer's risk are minimum for specified Acceptable Quality Level and Limiting Quality Level.

Quick Switching Variables Sampling System of type QSVSS (n;k_N,k_T)

The conditions and the assumptions under which the QSVSS can be applied are as follows:

Conditions for applications

- Production is steady so that results on current, preceding and succeeding lots are broadly indicative of a continuing process.
- Lots are submitted substantially in the order of production.
- Normally lots are expected to be essentially of the same quality.
- Inspection is by variables, with quality defined as the fraction of non-conforming.

Basic Assumptions

- The quality characteristic is represented by a random variable X measurable on a continuous scale.
- Distribution of X is normal with mean and standard deviation.
- An upper limit U, has been specified and a product is qualified as defective when X>U. [when the lower limit L is specified, the product is a defective one if X<L].
- The Purpose of inspection is to control the fraction defective, p in the lot inspected.

When the conditions listed above are satisfied the fraction defective in a lot will be defined by p = 1-F (v) = F (-v) with $v = (U-\mu)/\sigma$ and

$$F(y)=\int_{-\infty}^{y}\frac{1}{\sqrt{2\pi}}\exp\left(\frac{-z^2}{2}\right)dz \qquad (1)$$

provided that the quality characteristic of interest is normally distributed with mean μ and standard deviation σ, and the unit is classified as non-conforming if it exceeds the upper specification limit U. The operating procedure of QSVSS (n; k_N, k_T) is described below.

Operating Procedure

The steps involved are as follows

Step 1. Draw a random sample of size n_σ. Inspect and record the measurement of the quality characteristic for each unit of the sample. Compute the sample mean $\bar{x}$.

Step 2. i) If $\bar{x} + k_N\sigma \le U$ or $\bar{x} + k_N\sigma \ge L$, accept the lot and repeat step 1 for the next lot.

ii) If $\bar{x} + k_N\sigma > U$ or $\bar{x} + k_N\sigma < L$, reject the lot and go to step 3.

Step 3. Draw a random sample of size n_σ. Inspect and record the measurement of the quality characteristic for each unit of the sample. Compute the sample mean $\bar{x}$.

Step 4. i) If $\bar{x} + k_T\sigma \le U$ or $\bar{x} + k_T\sigma \ge L$, accept the lot and repeat step 1 for the next lot.

ii) If $\bar{x} + k_T\sigma > U$ or $\bar{x} + k_T\sigma < L$, reject the lot and repeat step 3.

Where k_N and k_T are the acceptable criterion for normal and tightened inspection, with $\bar{X}$ and σ as the average quality characteristic and standard deviation respectively.

IV. Operating Characteristic Function

According to Romboski (1969), the OC function of QSS-1 is given by

$$P_a(p) = \frac{P_T}{1 - P_T + P_N} \qquad (2)$$

Based on the OC function of the QSS Romboski (1969) the OC function of QSVSS $(n;k_N,k_T)$ can be written as

$$P_a(p) = \frac{\phi(w_T)}{1 - \phi(w_N) + \phi(w_T)} \qquad (3)$$

with

$$w_T = \sqrt{n_\sigma}(U - k_{T\sigma} - \mu)/\sigma = (v - k_{T\sigma})\sqrt{n_\sigma}$$
$$w_N = \sqrt{n_\sigma}(U - k_{N\sigma} - \mu)/\sigma = (v - k_{N\sigma})\sqrt{n_\sigma}$$
$$v = (U - \mu)/\sigma$$

Under the assumption of normal approximation to the non-central t distribution (Abramowitz and Stegun, 1964), the values of P_N and P_T are respectively given by

$$P_N = F(w_N) = pr[(U - \bar{x})/\sigma > k_{N\sigma}] \qquad (4)$$
$$P_T = F(w_T) = pr[(U - \bar{x})/\sigma > k_{T\sigma}] \qquad (5)$$

Where, P_N and P_T are the proportion of lots expected to be accepted using normal (n_σ, k_N) and tightened (n_σ, k_T) variable single sampling plans respectively. These two equations are applied in the OC function of QSVSS $(n;k_N,k_T)$. We get the following

$$P_a(p) = \frac{Pr[(U - \bar{x})/\sigma > k_{T\sigma}]}{1 - Pr[(U - \bar{x})/\sigma > k_{N\sigma}] + Pr[(U - \bar{x})/\sigma > k_{T\sigma}]} \qquad (6)$$

If $P_a(p_1)$ and $P_a(p_2)$ are

$$P_a(p_1) = \frac{Pr[(U - \bar{x})/\sigma > k_{T\sigma}]}{1 - Pr[(U - \bar{x})/\sigma > k_{N\sigma}] + Pr[(U - \bar{x})/\sigma > k_{T\sigma}]} = 1 - \alpha \qquad (7)$$

$$P_a(p_2) = \frac{Pr[(U - \bar{x})/\sigma > k_{T\sigma}]}{1 - Pr[(U - \bar{x})/\sigma > k_{N\sigma}] + Pr[(U - \bar{x})/\sigma > k_{T\sigma}]} = \beta \qquad (8)$$

The expression for the sum of producer's and consumer's risks is given by

$$\alpha + \beta = 1 - P_a(p_1) + P_a(p_2) \qquad (9)$$

For given AQL and LQL, the parametric values of QSVSS namely k_N, k_T, the sample size n_σ, α and β are determined by using a computer search.

A procedure for QSVSS $(n_\sigma;k_N,k_T)$ System involving Minimum sum of risks

From table1, a procedure and the designing of Quick Switching Variables Sampling Systems involving minimum sum of risks for the given values of AQL and LQL is indicated below.

Table1 is used to select the QSVSS for given values of (AQL, 1-α), (LQL, β). The plans given here have the minimum sum of risks. Fix the values of p_1 and p_2 from which a Quick Switching Variables Sampling System can be selected under known σ-method. Entering the row giving p_1 and p_2, one gets the acceptance criteria k_T, k_N, α, β and the sample size n_σ of QSVSS $(n_\sigma;k_{N\sigma},k_{T\sigma})$. For example, for given p_1=0.005, p_2=0.009, n_σ=139, $k_{T\sigma}$ =2.79, $k_{N\sigma}$=2.29, α=6% and β=0%.

Plotting the OC Curve

The OC curve for the quick switching sampling system by variables with n=244, k_T =3.02, k_N = 2.99, α=8% and β=1% and Figure 1 shows the OC curve of quick switching sampling system by variables involving minimum sum of risks.

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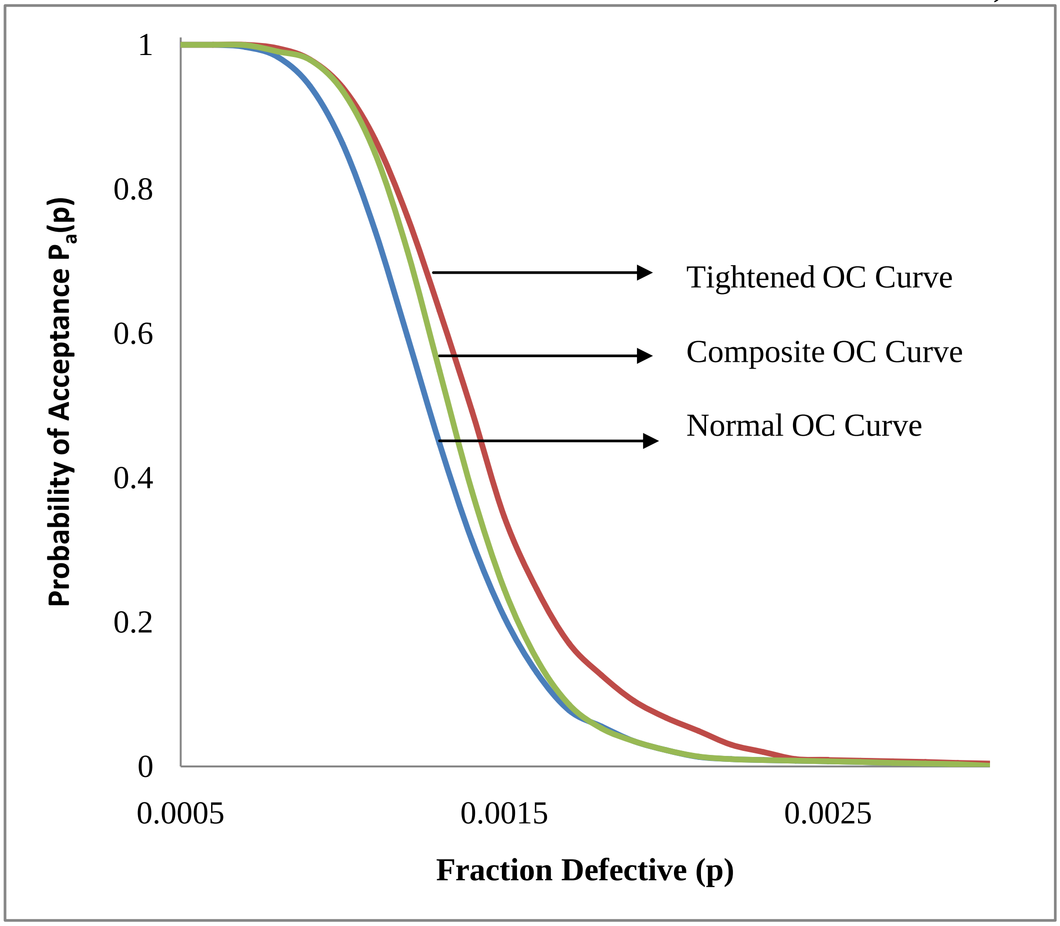

Figure 1. Normal, Composite and Tightened OC Curves with minimum sum of risks for QSVSS, (n=244, k_T =3.02, k_N =2.99, α=8% and β=1%)

QSVSS with unknown σ variables plan as the reference plan

If the population standard deviation σ is unknown, then it is estimated from the sample standard deviation S (n-1 as the divisor). If the sample size of the unknown sigma variables system (s method) is n_s and the acceptance parameters are k_N and k_T, then the operating procedure is as follows:

Step 1. Draw a random sample of size n_{σ}. Inspect and record the measurement of the quality characteristic for each unit of the sample. Compute the sample mean $\bar{x}$ and $S=\sqrt{\frac{\Sigma(x-\bar{x})^2}{n-1}}$.

Step 2. i) If $\bar{x}+k_N S \le U$ or $\bar{x}+k_N S \ge L$, accept the lot and repeat Step 1 for the next lot.

ii) If $\bar{x}+k_N S > U$ or $\bar{x}+k_N S < L$, reject the lot and go to step 3.

Step 3. Draw a random sample of size n_{σ}. Inspect and record the measurement of the quality characteristic for each unit of the sample. Compute the sample mean $\bar{x}$ and

$$S=\sqrt{\frac{\Sigma(x-\bar{x})^2}{n-1}}$$

Step 4. i) If $\bar{x}+k_T S \le U$ or $\bar{x}+k_T S \ge L$ accept the lot and repeat Step 1 for the next lot.

ii) If $\bar{x}+k_T S > U$ or $\bar{x}+k_T S < L$ reject the lot and repeat step 3.

Here $\bar{X}$ and S are the average and the standard deviation of quality characteristic respectively from the sample. Under the assumptions for Quick Switching System stated, the probability of acceptance $P_a(p)$ of a lot is given in the equation (2) and P_T and P_N respectively are

$$P_T = \int_{-\infty}^{w_T} \frac{1}{\sqrt{2\pi}} e^{-z^2/2} dz \text{ and}$$

$$P_N = \int_{-\infty}^{w_N} \frac{1}{\sqrt{2\pi}} e^{-z^2/2} dz \text{ with}$$

$$w_N = \frac{U - k_S - \mu}{S} \cdot \frac{1}{\sqrt{\left(\frac{1}{n_s} + \frac{k_N^2}{2n_s}\right)}}$$

$$w_T = \frac{U - k_S - \mu}{S} \cdot \frac{1}{\sqrt{\left(\frac{1}{n_s} + \frac{k_T^2}{2n_s}\right)}}$$

Designing QSVSS ($n_S;k_N,k_T$) System with unknown σ involving minimum sum of risks

Table1 can be used to determine QSVSS ($n_s;k_T,k_N$) for specified values of p_1 and p_2. For example, if it is desired to have a QSVSS ($n_s;k_{Ts},k_{Ns}$) for given $p_1=0.005$, $p_2=0.006$,Table1 gives $n_s=795$, $k_{Ts}=2.8$, $k_{Ns}=2.3$ $\alpha=7\%$ and $\beta=2\%$ as desired plan parameters.

Construction of the Table

The expression for the probability of acceptance $P_a(p)$ and minimum sum of risks of QSVSS (n, k_T, k_N) under normal distribution are given by equation (2) and (9), respectively with the following expressions:

$$P_a(p) = \frac{P_T}{1 - P_T + P_N} \text{ and}$$

$$\alpha + \beta = 1 - P_a(p_1) + P_a(p_2)$$

Where

$$P_T = \int_{-\infty}^{w_T} \frac{1}{\sqrt{2\pi}} e^{-z^2/2} dz \text{ and}$$

$$P_N = \int_{-\infty}^{w_N} \frac{1}{\sqrt{2\pi}} e^{-z^2/2} dz$$

Now, for given p_1, p_2, α and β, i.e. the two points (p_1, 1-α) and (p_2, β) on the operating characteristic curve, one may write the following expressions:

$$P_a(p_1) = \frac{\Pr[(U - \bar{x})/\sigma > k_{T\sigma}]}{1 - \Pr[(U - \bar{x})/\sigma > k_{N\sigma}] + \Pr[(U - \bar{x})/\sigma > k_{T\sigma}]} = 1 - \alpha \quad \text{and}$$

$$P_a(p_2) = \frac{\Pr[(U - \bar{x})/\sigma > k_{T\sigma}]}{1 - \Pr[(U - \bar{x})/\sigma > k_{N\sigma}] + \Pr[(U - \bar{x})/\sigma > k_{T\sigma}]} = \beta$$

Here, the values of n, k_T, k_N, α and β are obtained by using computer search routine. The values of n, k_T, k_N for the QSVSS satisfies the equation (2) as well as given α and β for minimizing the sum of risks in equation (9).

By using Hamaker (1979) approximation, for finding parameters of s- method scheme from σ – method scheme with parameters ($n_s;k_T$, k_N) were as follows:

$$n_S = n_\sigma(1 + k_\sigma^2/2), \text{ where } \qquad k_\sigma = (k_{T\sigma} + k_{N\sigma})/2$$

$$k_{Ts} = k_{T\sigma}(4n_s - 4)/(4n_s - 5) \qquad \text{and}$$

$$k_{Ns} = k_{N\sigma}(4n_s - 4)/(4n_s - 5)$$

Table1 provides the values of n_σ, $k_{T\sigma}$, $k_{N\sigma}$, n_s, k_{Ts} and k_{Ns} which satisfies the equations (2) and (9).

Conclusion

The Quick Switching Variables Sampling plan presented in this paper is particularly useful for testing the quality of finished products at shop floor situations. Such that the Producer and the consumer represents the same party. So, the sum of these two risks should be minimized whereas at that situation this plan is commendable.

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Table 1

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The values of n_σ, $k_{T\sigma}$, $k_{N\sigma}$, n_s, k_{Ts}, k_{Ns}, α, β for given AQL and LQL Involving Minimum Sum of Risks.

p_1	p_2	n_σ	$k_{T\sigma}$	$k_{N\sigma}$	α	β	n_s	k_{Ts}	k_{Ns}
0.001	0.002	244	3.02	2.99	8	1	1346	3.02	2.99
	0.003	169	3.42	2.72	8	0	965	3.42	2.72
	0.004	164	3.31	2.81	7	0	932	3.31	2.81
	0.005	158	3.47	2.67	6	0	903	3.47	2.67
	0.006	157	3.36	2.76	5	0	892	3.36	2.76
	0.007	152	3.41	2.71	4	0	864	3.41	2.71
	0.008	151	3.41	2.71	3	0	858	3.41	2.71
	0.009	150	3.46	2.66	2	0	852	3.46	2.66
	0.01	145	3.40	2.70	1	0	819	3.40	2.70
	0.02	096	3.26	2.76	1	0	531	3.26	2.76
	0.03	076	3.24	2.74	1	0	416	3.24	2.74
	0.04	065	3.23	2.73	1	0	354	3.23	2.73
	0.05	064	3.22	2.72	1	0	346	3.22	2.72
	0.06	063	3.22	2.72	1	0	341	3.22	2.72
	0.07	062	3.22	2.72	1	0	335	3.22	2.72
	0.08	060	3.22	2.72	1	0	325	3.22	2.72
	0.09	057	3.21	2.71	1	0	307	3.21	2.71
	0.1	054	3.21	2.71	1	0	291	3.21	2.71
	0.11	051	3.20	2.70	1	0	273	3.20	2.70
	0.12	049	3.19	2.69	1	0	261	3.19	2.69
	0.13	047	3.19	2.69	1	0	250	3.19	2.69
	0.14	045	3.18	2.68	1	0	238	3.18	2.68
	0.15	043	3.18	2.68	1	0	228	3.18	2.68
0.002	0.003	243	3.11	2.61	9	0	1237	3.11	2.61
	0.004	215	3.16	2.56	8	0	1094	3.16	2.56
	0.005	209	3.05	2.65	7	0	1058	3.05	2.65
	0.006	182	3.10	2.60	6	0	921	3.10	2.60
	0.007	165	3.15	2.55	5	0	835	3.15	2.55
	0.008	154	3.09	2.59	4	0	775	3.09	2.59
	0.009	142	3.14	2.54	3	0	715	3.14	2.54
	0.01	125	3.13	2.53	2	0	626	3.13	2.53
	0.02	091	3.04	2.54	1	0	445	3.04	2.54
	0.03	072	3.02	2.52	1	0	348	3.02	2.52
	0.04	065	3.01	2.51	1	0	313	3.01	2.51
	0.05	061	3.07	2.47	1	0	295	3.07	2.47
	0.06	059	3.00	2.50	1	0	282	3.00	2.50
	0.07	056	3.06	2.46	1	0	269	3.06	2.46
	0.08	055	3.06	2.46	1	0	265	3.06	2.46
	0.09	054	2.99	2.49	1	0	256	2.99	2.49
	0.1	051	3.05	2.45	1	0	244	3.05	2.45

Table 1 (Continued...)

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p_1	p_2	n_σ	$k_{T\sigma}$	$k_{N\sigma}$	α	β	n_s	k_{Ts}	k_{Ns}
0.002	0.11	050	2.98	2.48	1	0	236	2.98	2.48
	0.12	046	3.04	2.44	1	0	219	3.04	2.44
	0.13	043	3.03	2.43	1	0	203	3.03	2.43
	0.14	040	3.02	2.42	1	0	188	3.02	2.42
	0.15	037	3.01	2.41	1	0	173	3.01	2.41
0.003	0.004	243	2.98	2.48	9	0	1149	2.98	2.48
	0.005	217	3.03	2.43	8	0	1026	3.03	2.43
	0.006	171	2.97	2.47	7	0	804	2.97	2.47
	0.007	154	3.02	2.42	6	0	724	3.02	2.42
	0.008	141	2.96	2.46	5	0	659	2.96	2.46
	0.009	119	2.93	2.43	4	0	546	2.93	2.43
	0.01	107	2.94	2.44	3	0	494	2.94	2.44
	0.02	087	2.92	2.42	2	0	397	2.92	2.42
	0.03	072	2.89	2.39	1	0	323	2.89	2.39
	0.04	071	2.89	2.39	1	0	318	2.89	2.39
	0.05	069	2.95	2.35	1	0	311	2.95	2.35
	0.06	068	2.95	2.35	1	0	307	2.95	2.35
	0.07	065	2.88	2.38	1	0	290	2.88	2.38
	0.08	061	2.94	2.34	1	0	274	2.94	2.34
	0.09	059	2.87	2.37	1	0	262	2.87	2.37
	0.1	056	2.93	2.33	1	0	250	2.93	2.33
	0.11	054	2.86	2.36	1	0	238	2.86	2.36
	0.12	051	2.92	2.32	1	0	226	2.92	2.32
	0.13	050	2.85	2.35	1	0	219	2.85	2.35
	0.14	046	2.84	2.34	1	0	200	2.84	2.34
	0.15	043	2.90	2.30	1	0	188	2.90	2.30
0.004	0.005	200	2.88	2.38	9	0	892	2.88	2.38
	0.006	175	2.93	2.33	8	0	780	2.93	2.33
	0.007	148	2.87	2.37	7	0	656	2.87	2.37
	0.008	134	2.92	2.32	6	0	594	2.92	2.32
	0.009	127	2.86	2.36	5	0	560	2.86	2.36
	0.01	117	2.91	2.31	4	0	516	2.91	2.31
	0.02	084	2.83	2.33	3	0	364	2.83	2.33
	0.03	072	2.81	2.31	2	0	308	2.81	2.31
	0.04	065	2.85	2.25	1	0	276	2.85	2.25
	0.05	063	2.78	2.28	1	0	265	2.78	2.28
	0.06	062	2.78	2.28	1	0	260	2.78	2.28
	0.07	059	2.84	2.24	1	0	249	2.84	2.24
	0.08	057	2.77	2.27	1	0	238	2.77	2.27
	0.09	054	2.83	2.23	1	0	227	2.83	2.23
	0.1	053	2.83	2.23	1	0	223	2.83	2.23
	0.11	052	2.76	2.26	1	0	216	2.76	2.26
	0.12	049	2.82	2.22	1	0	205	2.82	2.22

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Table 1 (Continued...)

p_1	p_2	n_σ	$k_{T\sigma}$	$k_{N\sigma}$	α	β	n_s	k_{Ts}	k_{Ns}
0.004	0.13	048	2.75	2.25	1	0	198	2.75	2.25
	0.14	045	2.81	2.21	1	0	187	2.81	2.21
	0.15	042	2.73	2.23	1	0	171	2.73	2.23
0.005	0.006	187	2.80	2.30	7	2	795	2.80	2.30
	0.007	174	2.80	2.30	8	0	740	2.80	2.30
	0.008	156	2.85	2.25	7	0	663	2.85	2.25
	0.009	139	2.79	2.29	6	0	587	2.79	2.29
	0.01	126	2.84	2.24	5	0	532	2.84	2.24
	0.02	084	2.76	2.26	4	0	349	2.76	2.26
	0.03	068	2.74	2.24	3	0	279	2.75	2.24
	0.04	061	2.72	2.22	2	0	247	2.72	2.22
	0.05	060	2.70	2.20	1	0	240	2.70	2.20
	0.06	057	2.76	2.16	1	0	230	2.76	2.16
	0.07	056	2.76	2.16	1	0	226	2.76	2.16
	0.08	055	2.69	2.19	1	0	219	2.69	2.19
	0.09	052	2.75	2.15	1	0	208	2.75	2.15
	0.1	051	2.68	2.18	1	0	202	2.68	2.18
	0.11	050	2.68	2.18	1	0	198	2.68	2.18
	0.12	047	2.74	2.14	1	0	187	2.74	2.14
	0.13	043	2.66	2.16	1	0	168	2.66	2.16
	0.14	040	2.72	2.12	1	0	157	2.72	2.12
	0.15	038	2.64	2.14	1	0	147	2.64	2.14
0.006	0.007	184	2.79	2.19	7	2	754	2.79	2.19
	0.008	164	2.89	2.09	8	0	672	2.89	2.09
	0.009	152	2.89	2.09	7	0	623	2.89	2.09
	0.01	145	2.89	2.09	6	0	595	2.89	2.09
	0.02	093	2.82	2.12	5	0	377	2.82	2.12
	0.03	076	2.75	2.15	4	0	304	2.75	2.15
	0.04	065	2.85	2.05	3	0	260	2.85	2.05
	0.05	064	2.66	2.16	2	0	250	2.66	2.16
	0.06	062	2.64	2.14	1	0	239	2.64	2.14
	0.07	060	2.64	2.14	1	0	231	2.64	2.14
	0.08	059	2.70	2.10	1	0	229	2.70	2.10
	0.09	057	2.63	2.13	1	0	218	2.63	2.13
	0.1	055	2.76	2.06	1	0	215	2.76	2.06
	0.11	054	2.69	2.09	1	0	208	2.69	2.09
	0.12	053	2.69	2.09	1	0	204	2.69	2.09
	0.13	052	2.62	2.12	1	0	198	2.62	2.12
	0.14	051	2.81	2.01	1	0	199	2.81	2.01
	0.15	050	2.62	2.12	1	0	190	2.62	2.12
0.007	0.008	158	2.84	2.04	8	1	628	2.84	2.04
	0.009	143	2.73	2.13	7.7	0.3	565	2.73	2.13
	0.01	138	2.78	2.08	6	0	545	2.78	2.08

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Table 1 (Continued...)

p_1	p_2	n_σ	$k_{T\sigma}$	$k_{N\sigma}$	α	β	n_s	k_{Ts}	k_{Ns}
0.007	0.02	095	2.71	2.11	5	0	371	2.71	2.11
	0.03	072	2.75	2.05	4	0	279	2.75	2.05
	0.04	060	2.61	2.11	3	0	227	2.62	2.11
	0.05	058	2.66	2.06	2	0	220	2.66	2.06
	0.06	056	2.64	2.04	1	0	209	2.64	2.04
	0.07	055	2.57	2.07	1	0	203	2.57	2.07
	0.08	054	2.57	2.07	1	0	199	2.57	2.07
	0.09	051	2.63	2.03	1	0	189	2.63	2.03
	0.1	050	2.56	2.06	1	0	183	2.56	2.06
	0.11	047	2.62	2.02	1	0	174	2.62	2.02
	0.12	046	2.55	2.05	1	0	168	2.55	2.05
	0.13	043	2.54	2.04	1	0	156	2.54	2.04
	0.14	040	2.60	2.00	1	0	146	2.60	2.00
	0.15	038	2.52	2.12	1	0	140	2.52	2.12
0.008	0.01	135	2.62	2.12	5	4	514	2.62	2.12
	0.02	095	2.67	2.07	8	0	362	2.67	2.07
	0.03	069	2.71	2.01	7	0	261	2.71	2.01
	0.04	058	2.58	2.08	6	0	215	2.58	2.08
	0.05	054	2.57	2.07	5	0	199	2.57	2.07
	0.06	053	2.56	2.06	4	0	194	2.56	2.06
	0.07	052	2.55	2.05	3	0	190	2.55	2.05
	0.08	051	2.60	2.01	2	0	187	2.60	2.01
	0.09	049	2.51	2.01	1	0	174	2.51	2.01
	0.1	046	2.50	2.00	1	0	162	2.5	2.00
	0.11	042	2.49	1.99	1	0	147	2.49	1.99
	0.12	040	2.48	1.98	1	0	140	2.48	1.98
	0.13	037	2.54	1.94	1	0	130	2.54	1.94
	0.14	035	2.46	1.96	1	0	121	2.46	1.96
	0.15	033	2.45	1.95	1	0	113	2.45	1.95
0.009	0.02	093	2.57	2.07	8	0	343	2.57	2.07
	0.03	068	2.61	2.01	7	0	249	2.61	2.01
	0.04	061	2.60	2.00	6	0	222	2.60	2.00
	0.05	057	2.65	1.95	5	0	208	2.65	1.95
	0.06	053	2.58	1.98	4	0	191	2.58	1.98
	0.07	049	2.50	2.09	3	0	178	2.50	2.09
	0.08	046	2.61	1.91	2	0	164	2.61	1.91
	0.09	043	2.45	1.95	1	0	147	2.45	1.95
	0.1	040	2.44	1.94	1	0	136	2.44	1.94
	0.11	038	2.43	1.93	1	0	128	2.44	1.94
	0.12	037	2.50	1.9	1	0	127	2.51	1.90
	0.13	035	2.49	1.89	1	0	119	2.50	1.89
	0.14	033	2.48	1.88	1	0	111	2.49	1.88
	0.15	031	2.47	1.87	1	0	104	2.48	1.88

Table 1 (Continued...)

p_1	p_2	n_σ	$k_{T\sigma}$	$k_{N\sigma}$	α	β	n_s	k_{Ts}	k_{Ns}
0.01	0.02	088	2.53	2.03	9	0	317	2.53	2.03
	0.03	075	2.52	2.02	8	0	268	2.52	2.02
	0.04	059	2.62	1.92	7	0	211	2.62	1.92
	0.05	053	2.61	1.91	6	0	188	2.61	1.91
	0.06	050	2.48	1.98	5	0	174	2.48	1.98
	0.07	047	2.53	1.93	4	0	164	2.53	1.93
	0.08	046	2.52	1.92	3	0	159	2.52	1.92
	0.09	043	2.50	1.90	2	0	147	2.50	1.90
	0.1	038	2.39	1.89	1	0	125	2.40	1.89
	0.11	035	2.45	1.85	1	0	116	2.46	1.85
	0.12	033	2.44	1.84	1	0	109	2.45	1.84
	0.13	030	2.35	1.85	1	0	96	2.36	1.86
	0.14	028	2.34	1.84	1	0	89	2.35	1.85
	0.15	023	2.33	1.83	1	0	73	2.34	1.84
0.02	0.03	066	2.24	1.74	8	1	197	2.24	1.74
	0.04	064	2.24	1.74	8	0	191	2.24	1.74
	0.05	058	2.23	1.73	7	0	172	2.23	1.73
	0.06	052	2.22	1.72	6	0	153	2.22	1.72
	0.07	045	2.20	1.70	5	0	131	2.20	1.70
	0.08	044	1.77	1.27	0	4	95	1.78	1.27
	0.09	041	2.17	1.67	3	0	117	2.17	1.67
	0.1	040	2.22	1.62	2	0	114	2.23	1.62
	0.11	038	2.12	1.62	1	0	104	2.13	1.62
	0.12	037	2.04	1.64	1	0	100	2.05	1.64
	0.13	036	2.11	1.61	1	0	98	2.12	1.61
	0.14	035	2.03	1.63	1	0	94	2.04	1.63
	0.15	034	2.10	1.60	1	0	92	2.11	1.60
0.03	0.04	061	2.17	1.47	5	4	162	2.17	1.47
	0.05	058	2.06	1.56	8	0	153	2.06	1.56
	0.06	052	2.11	1.51	7	0	137	2.11	1.51
	0.07	049	2.04	1.54	6	0	128	2.04	1.54
	0.08	045	1.76	1.26	0	5	96	1.77	1.26
	0.09	042	1.71	1.21	0	4	87	1.72	1.21
	0.1	041	1.70	1.10	0	3	81	1.71	1.10
	0.11	040	1.63	1.13	0	2	78	1.64	1.13
	0.12	038	1.64	1.04	0	1	72	1.65	1.04
	0.13	037	1.94	1.44	1	0	90	1.95	1.44
	0.14	035	1.53	1.03	0	1	64	1.54	1.03
	0.15	034	2.10	1.60	1	0	92	2.11	1.60
0.04	0.05	065	2.16	1.26	7	2	160	2.16	1.26
	0.06	061	1.93	1.43	7	1	147	1.93	1.43
	0.07	053	1.92	1.42	7	0	127	1.92	1.42
	0.08	049	1.91	1.41	6	0	117	1.91	1.41

Table 1 (Continued...)

p_1	p_2	n_σ	$k_{T\sigma}$	$k_{N\sigma}$	α	β	n_s	k_{Ts}	k_{Ns}
0.04	0.09	047	1.90	1.40	5	0	111	1.90	1.40
	0.1	046	1.89	1.30	5	0	105	1.90	1.30
	0.11	045	1.60	1.10	0	3	86	1.61	1.10
	0.12	044	1.86	1.36	2	0	101	1.87	1.36
	0.13	042	1.83	1.33	1	0	94	1.84	1.33
	0.14	039	1.82	1.32	1	0	87	1.83	1.32
	0.15	037	1.81	1.31	1	0	82	1.82	1.31
0.05	0.06	070	2.11	1.11	7	2	161	2.11	1.11
	0.07	063	1.81	1.31	4	4	140	1.81	1.31
	0.08	058	1.88	1.28	7	0	130	1.88	1.28
	0.09	054	1.93	1.23	6	0	121	1.93	1.23
	0.1	050	1.80	1.30	5	0	110	1.80	1.30
	0.11	049	1.79	1.29	4	0	107	1.79	1.29
	0.12	037	2.04	1.64	1	0	100	2.05	1.64
	0.13	036	2.11	1.61	1	0	98	2.12	1.61
	0.14	035	2.03	1.63	1	0	94	2.04	1.63
	0.15	034	2.10	1.60	1	0	92	2.11	1.60
0.06	0.07	083	1.97	1.07	6	3	179	1.97	1.07
	0.08	082	1.75	1.25	7	1	174	1.75	1.25
	0.09	069	1.74	1.24	7	0	146	1.74	1.24
	0.1	054	1.72	1.22	6	0	112	1.72	1.22
	0.11	052	1.57	1.07	0	5	97	1.57	1.07
	0.12	049	1.70	1.20	4	0	101	1.70	1.20
	0.13	045	1.50	1.00	0	3	80	1.51	1.00
	0.14	043	1.73	1.13	2	0	87	1.73	1.13
	0.15	042	1.73	1.07	1	0	83	1.74	1.07
0.07	0.08	104	1.84	1.04	4	5	212	1.84	1.04
	0.09	083	1.73	1.13	7	1	168	1.73	1.13
	0.1	081	1.67	1.17	7	0	163	1.67	1.17
	0.11	073	1.72	1.12	6	0	147	1.72	1.12
	0.12	067	1.50	1.00	0	5	119	1.50	1.00
	0.13	062	1.64	1.14	4	0	122	1.64	1.14
	0.14	060	1.63	1.13	3	0	117	1.63	1.13
	0.15	055	1.61	1.11	2	0	106	1.61	1.11
0.08	0.09	161	1.68	1.08	7	2	314	1.68	1.08
	0.1	153	1.68	1.08	8	0	299	1.68	1.08
	0.11	134	1.62	1.12	7	0	260	1.62	1.12
	0.12	121	1.67	1.07	6	0	235	1.67	1.07
	0.13	118	1.61	1.11	5	0	227	1.61	1.11
	0.14	108	1.66	1.06	4	0	208	1.66	1.06
	0.15	096	1.65	1.05	3	0	184	1.65	1.05
0.09	0.1	230	1.57	1.07	8	1	430	1.57	1.07
	0.11	229	1.57	1.07	8	0	429	1.57	1.07

Table 1 (Continued...)

p_1	p_2	n_σ	$k_{T\sigma}$	$k_{N\sigma}$	α	β	n_s	k_{Ts}	k_{Ns}
	0.12	206	1.62	1.02	7	0	386	1.62	1.02
	0.13	170	1.56	1.06	6	0	316	1.56	1.06
	0.14	154	1.61	1.01	5	0	286	1.61	1.01
	0.15	145	1.55	1.05	4	0	268	1.55	1.05
0.10	0.11	369	1.52	1.02	9	0	667	1.52	1.02
	0.12	208	1.51	1.01	8	0	373	1.51	1.01
	0.13	148	1.50	1.00	7	0	264	1.50	1.00
	0.14	144	1.44	1.04	6	0	255	1.44	1.04
	0.15	122	1.42	1.02	5	0	213	1.42	1.02
0.11	0.12	273	1.40	1.00	4	5	470	1.40	1.00
	0.13	195	1.40	1.00	9	0	335	1.40	1.00
	0.14	187	1.34	1.04	8	0	319	1.34	1.04