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CODE OF PRACTICE FOR

TARGET QUANTITY SETTING AND CONTROLLING NET CONTENTS OF PACKAGED GOODS

SRI LANKA STANDARDS INSTITUTION

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SLS 925 : 1991

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CODE OF PRACTICE FOR TARGET QUANTITY SETTING AND CONTROLLING NET CONTENTS OF PACKAGED GOODS

FOREWORD

This Sri Lanka Standard was authorized for adoption and publication by the council of the Sri Lanka Standards Institution on 1991-05-30, after the draft was finalized and approved by the Drafting Committee on Net contents of prepackaged goods.

This standard provides guidelines for the control of the filling process to ensure that the packages produced conform to the requirements of SLS 816, Method for checking net contents of prepackaged goods. These guidelines cover two phases of the control process. In the first phase it gives detailed procedure for fixing a value which is known as the target quantity. The target quantity means an average contents which a packing or filling operations is intended to produce. The second phase gives detailed guidelines for maintaining the process to achieve conformance to the required filling quantity.

Target quantity for a given nominal quantity (mass or volume indicated on the package) is determined on the basis of average quantity concept adopted by the European Economic Community (EEC) and recommended by the International Organization for Legal Metrology (OIML). When calculating the target quantity it is necessary to study the variation of the filling process. This involves the use of statistical techniques to study process variation, and such variations are considered when calculating the target quantity. This standard provides for adjusting the target quantity to compensate the variations due to other factors such as sampling, storage, tare variability and wandering average.

When reporting the results of a test done according to this standard, the observed value shall be rounded off in accordance with SLS 102. The number of significant places retained in the rounded off value shall be the same as that given as in Table 1 of SLS 816.

In the preparation of this standard the valuable assistance gained from the publications of the International Organization for Standardization (ISO), the International Organization for Legal Metrology (OIML), the European Economic Community (EEC) and the Manual of guidance for Inspectors and Code of practical guidance for packers and importers (weights and measures Act 1979) Department of Trade, United Kingdom is gratefully acknowledged.

1 SCOPE

This code provides guidelines on setting and monitoring the filling process in order to achieve the required net contents, as specified in SLS 816.

2 REFERENCE

SLS 102 Presentation of numerical values.
SLS 428 Random sampling methods.
SLS 816 Method for checking net contents of prepackaged goods.

3 OUTLINE OF THE PROCEDURE

The guidelines described consists of two parts as follows:

(a) fixing a target quantity at each filling point of the process.
(b) maintaining the filling process using control charts to achieve required net contents.

3.1 Fixing target quantity for a filling process

This involves four steps as follows:

Step 1 - Determine production period (rate of production) as given in clause 6 and Select a sample of packages according to the relevant production period.

Step 2 - Determine the net contents or gross contents of each of the packages in the sample drawn as in Step 1.

Step 3 - Statistical analysis of data to study the performance of the process. For this purpose two tests (see clause 8) are given in this code.

(a) **normality test**
This is a graphical method to check the validity of assumption that the data conform to normal distribution.

(b) **Process capability test**
This is to examine, the variability of the process with respect to specification limits.

NOTE

If the normality test and performance test fail then corrective actions given in 8 shall be taken.

If it is confirmed that the data satisfy the normality test and performance test then these data can be used to calculate target quantity as given in Step 4.

Step 4 - **Calculation of target quantity**
Calculate the target quantity at each filling point of the process separately. Each filling point shall be adjusted to the target quantities calculated.

3.2 **Maintaining the filling process to achieve required net contents**

This is done by maintaining control charts. There are two control charts to be maintained at each filling point. These are

(a) target quantity control chart
(b) range control chart
(see 10)

Both control charts shall be maintained simultaneously. These charts display whether the target quantity is within desired limits or not. If the target quantity is not within desired limits in any one of the control charts, then corrective actions shall be taken as given in 8. Same applies to range control chart.

4 DEFINITIONS

For the purpose of this standard the following definitions shall apply:

4.1 **nominal quantity (D):** The mass or volume indicated or declared on the package.

4.2 **net quantity or net contents:** The mass or volume of product contained in the package.

4.3 **package:** A container, together with the predetermined quantity of its contents made up in the absence of the purchaser in such a way that none of the contents can be removed without opening the container.

4.4 **prepackage :** Commodities put up in a package in advance of bein g offered for sale.

4.5 **gross mass :** The mass of the package including the contents (product), packaging materials, labels etc.

4.6 **tare mass :**The mass of all packaging materials (including labels, ties, gifts, coupons etc.) that can be separated from the packaged product.

4.7 **package error:**The difference between the net contents of an individualpackages as measured and the nominal quantity (declared net contents) on the package label.

ie. package error = measured net quantity of an individual package- -nominal quantity on the packaging label.

4.8 **tolerable negative error (T)** : Limiting value beyond which it is considered to be an unreasonable package error. T is determined according to SLS 816.

4.9 **target quantity (Q_t)** : The average contents which a packing or filling operations is intended to produce.

4.10 **tolerance limit (T_1)** : The nominal quantity minus the tolerable negative error.

ie. $T_1 = D - T$

4.11 **absolute tolerance limit (T_2)** : The nominal quantity minus twice the tolerable negative error.

ie. $T_2 = D - 2T$

4.12 **average (or Arithmatic Mean)** : Sum of the observed values divided by their number.

4.13 **standard deviation** : The square root of the quotient obtained by dividing the sum of squares of deviations of the observations from their mean by one less than the number of observations in the sample.

5 REQUIREMENTS FOR THE QUANTITIES IN PREPACKAGES

5.1 The target quantity (Q_t) shall not be less than nominal quantity (D).

5.2 Not more than 1 in 40 prepackages shall contain less than the tolerance limit (T_1), appropriate to the nominal quantity (D).

5.3 The packer shall not pack quantities below the absolute tolerance limit (T_2) appropriate to the nominal quantity (D) and system design shall ensure that not more than 1 in 10 000 prepackages violate the absolute tolerance limit (T_2) by chance.

6 PRODUCTION PERIOD

6.1 If the production is at the rate of 10 000 or more per hour then the production period shall be one hour.

6.2 If the production rate is less than 1 250 per hour, then the production period shall be one day or shift agreeable to packer.

6.3 For intermediate cases the production rate shall be the time taken to produce 10 000 packages.

NOTE

If P is the hourly production rate, then production period $= \frac{10\,000}{P}$ *hours*

7 DATA COLLECTION

Data shall be collected during smooth production period and no unusual occurance of operations takes place. Data collection shall be done at each individual filling point before any form of checkweighing effected.

7.1 Determination of sample size and frequency of sampling

7.1.2 *Production period one hour*

At least 200 packages shall be collected such that h=25 sets of packages shall be drawn at the rate of one set per 15 minutes from each filling point and each set shall contain n=8 packages.

7.1.3 *Production period one shift or more or one day (agreable to packer)*

At least 200 packages shall be collected such that h=20 sets of packages shall be drawn from one production shift (or day) from each filling point and each set shall contain n= 10 consecutive packages.

7.1.4 *Production period = 10 000/P hours (P = production rate per hour)*

At least 200 packages shall be collected such that h=20 sets of packages shall be drawn at the rate of one set per 30 minutes from each filling point and each set shall contain n=10 consecutive packages.

7.2 Determination of net contents

Net contents or gross contents shall be measured and recorded of each of the packages drawn as given in 7.1. Net contents shall be obtained from gross contents as given in SLS 816.

8 PERFORMANCE CHECK OF THE PRODUCTION PROCESS

The two tests given as in 8.1 and 8.2 shall be performed as preliminary tests before target setting commences. The test 8.2 shall be performed only if the test 8.1 passes. If test 8.1 or 8.2 fails then target setting shall be suspended and corrective measures shall be taken as given in Appendix E to characteristise the process, until the data sets freshly drawn conform to the two tests.

8.1 Normality test

The data relating to the net contents of the production process collected as in 7 shall be tested for normality according to the test given as in Appendix A.

8.2 Test for process capability

8.2.1 *Determination of tolerance*

Tolerance shall be calculated by taking the positive difference of the upper specification limit and lower specification limit. Lower specification limit shall not be less than $T_1 = D - T$.

8.2.2 *Determination of standard deviation*

Data collected as in 7 shall be used to determine the standard deviation. Overall data shall be used for this calculation.

8.2.3 *Calculation of process capability*

Process capability (C_p) shall be calculated by dividing the tolerance determined in 8.2.1 by six times the standard deviation determined in 8.2.2 .

8.2.4 *Check for conformity*

If $C_p \geq 1.33$ the data set shall be considered passing the test. Otherwise corrective measures shall be taken as given in Appendix E.

9 PROCEDURE OF TARGET SETTING

9.1 Selection of filling line

Each filling line may consist of one or more filling points. Each filling point shall be dealt with separately and target quantity calculated and fixed for each filling point separately.

NOTE

Target quantity fixed may not be exactly the calculated target quantity but may deviate depending on the minimum controlable filling quantity of the filling point. However the fixing value shall be greater than or equal to the calculated value.

9.2 Tare variability

If the net contents data obtained by subtracting tare quantity from gross quantity, then allownace shall be made to the target quantity depending on the tare variation. Method of determining this factor is given in Appendix C.

9.3 Wandering average

Significant fluctuation in the average quantity among sets of samples (packages) occur and if this fluctuation cannot be controlled then an allownace shall be made to the target quantity. This shall be calculated as given in Appendix C.

9.4 Variation due to dessication

When desiccating goods are being packed an allowance shall be made to compensate material loss through desiccation. Method of determining this allowance (allowance for storage) is given in **Appendix C.**

9.5 Determination of target quantity (Q_t)

The three expressions indicated below shall be calculated and the highest value from them shall be selected as the target quantity (Q_t).

ie. (i) $D + Y$

(ii) $T_1 + 2\sigma + Y$

(iii) $T_2 + 3.72\sigma + Y$

where,

D is the nominal quantity

T_1 is the tolerance limit

T_2 is the absolute tolerance limit

σ is the standard deviation calculated as given in Appendix B and modified by Appendix C.

Y is the allowance indicated below

If the production rate is less than 10 000 packages per hour take y to be zero. Otherwise take y to be $2S_1/\sqrt{h}$ where h is the number of sets of samples (packages) taken per hour, S_1 is the standard deviation calculated as given in **Appendix** B.

9.6 Trial run

The trial run shall be performed on the filling point after fixing target quantity to operate within new specification limits. Samples of packages shall be drawn and net quantity measured in order to ascertain whether the filling point operated under statistical control. If the filling point does not operate under statistical control appropriate actions shall be taken according as given in **Appendix E.**

10 CONTROL PROCEDURE

After fixing target quantity (Q_t) as described in 9, fresh data shall be collected from the filling point to determine the limits of the control charts to be maintained. Two types of control charts, target quantity (Q_t) and range (R) shall be maintained at each filling point separately. For this purpose following procedures shall be followed.

10.1 Construction of control charts

10.1.1 *Collection of data for the determination of control limits*

10.1.1.1 Determination of sample size and frequency of sampling

At least 200 data shall be collected in accordance with 7.

10.1.2 *Determination of net contents*

Same as given in 7.2 shall be followed.

10.1.3 *Q_t control chart*

10.1.3.1 Control line or the central line

The target quantity calculated as given in 9.5 shall be the control line for Q_t control chart.

10.1.3.2 Action limits

Lower and upper action limit shall be taken as $Q_t - 3\sigma_e$ and $Q_t + 3\sigma_e$ respectively. σ_e shall be calculated as given in Appendix D.

NOTE

Upper limit of action may be selected any where below $Q_t + 3\sigma_e$ and above Q_t. Lower limit of action may be selected any where above $Q_t - 3\sigma_e$ and below Q_t.

10.1.3.3 Warning limits

Lower and upper warning limits shall be taken as $Q_t-2\sigma_e$ and $Q_t+2\sigma_e$ respectively.

NOTE

Upper warning limit may be selected any where below $Q_t+2\sigma_e$ and above Q_t. Lower warning limit may be selected anywhere above $Q_t-2\sigma_e$ and below Q_t.

10.1.4 *R_t control chart*

10.1.4.1 Control line or the central line

The data collected as given in 7 or fresh data shall be used to calculate the control value (average) for R_t control chart. The range for each set shall be determined and the average $\bar{R}$ of these ranges shall be the central value.

NOTE

Range for each sample is determined by subtracting the minimum value by the maximum value recorded in that sample.

10.1.4.2 Action limits

Action limit shall be calculated by multiplying the average range determined as given in 10.1.4.1 by the factor corresponding to the sample size given in Table 2.

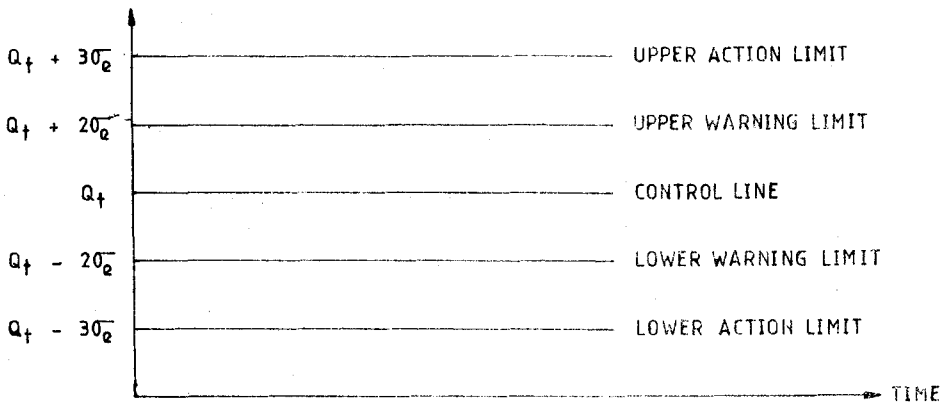
10.1.4.3 Warning limits

Warning limits shall be calculated by multiplying the average range by the factor corresponding to the sample size given in Table 2.

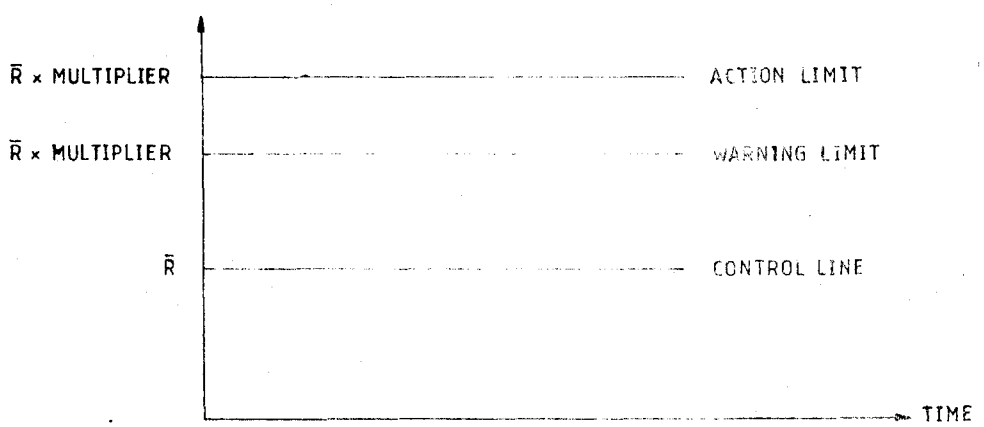
10.2 Drawing of control charts

Suitable paper shall be used, preferably graph papers.

10.2.1 *Q_t control chart*



10.2.2 *R control chart*



NOTES

1 *Each filling point shall have both Q_t control chart and R_t control chart.*

2 *R_t control chart may be drawn below Q_t control chart so that positions of plotted points could be compared easily.*

10.3 Operation of control charts

10.3.1 *Data collection to plot the points on the control charts*

Collection of data shall be done at each filling point separately.

10.3.1.1 Production period one hour (production rate 10 000 or more) Two sets of samples or more an hour shall be drawn from the filling point. A sample shall consist of packages numbering between 2 to 10 both inclusive.

10.3.1.2 Production period one day or shift (production rate less than 1 250 per hour)

Two sets of samples each consisting of 5 to 10 consecutive packages shall be drawn per shift or day from the filling point. Samples drawn shall be equally spaced within the time interval.

10.3.1.3 Production period, time taken to produce 10 000 packages (10 000/P hrs, P = hourly production rate)

One set of sample consisting of 2 to 10 packages shall be drawn every quarter hour, half hour or hourly depending on p.

10.3.2 *Calculation of average quantity ($\bar{Q}_t$) and range (R_t)*

The net contents shall be measured as given in 7.2 in each package of the samples selected as in 10.3.1 and calculate the average net quantity ($\bar{Q}_t$) and range (R_t) of each sample.

NOTE

Range for each sample is determined by subtracting the minimum net contents by the maximum net contents recorded in that sample.

10.3.3 *Plotting of the points on Q_t and R_t control charts*

Average net quantity ($\bar{Q}_t$) of each sample calculated as given in 10.3.2 shall be plotted on the Q_t control chart drawn as given in 10.2.1
Range (R_t) of each sample calculated as given in 10.3.2 shall be plotted on the R_t control chart drawn as given in 10.2.2.

10.4 Actions to be taken from control charts

This shall be applicable to both control charts.

10.4.1 *Violation of action limits*

If a point on the control chart falls on or outside the action limit the filling point shall be stopped and investigation shall be made.

10.4.2 *Violation of warning limits*

If any two successive violation of warning limits occur in the control chart investigation shall be made on that filling point.

10.5 Maintenance of control charts

All the control charts drawn above shall be maintained and continued drawing along with filling operations. These charts shall be protected for future references.

APPENDIX A

NORMALITY TEST

A.1 Net contents data collected as in 7 shall be used for normality test.

A.2 Preparation of frequency distribution

The following steps shall be taken to prepare the cumulative frequency distribution table from the data collected in **A.1.**

Step 1 Calculate the range of set of data by subtracting the minimum value from the maximum value.

Step 2 Decide the number of cells from the table given below. Divide the range obtained in Step 1 by the corresponding recommended number of cells.

No. of observations	Recommended number of cells
50 to 100	7
101 to 200	8
201 to 500	9

Step 3 The cell boundaries should be to one or more significant digit that the actual data and should end in 5 . Thus the minimum cell boundary should be less than actual minimum observation and the maximum cell boundary should be greater than the actual maximum observation.

Step 4 The cell interval should be constant through out the entire frequency distribution. Tally each observation into the appropriate cell and then list the total frequency for each cell.

Step 5 Appropriate frequency distribution table shall be prepared according to the method given below.

Cell mid value	Frequency	Consecutive numbers (j)	Mean consecutive number ($\bar{J}$)
X_1	f_1	1 to f_1	$(1+f_1)/2$
X_2	f_2	f_1+1 to f_1+f_2	$(2f_1+f_2+1)/2$
X_3	f_3	f_1+f_2+1 to $f_1+f_2+f_3$	$(2f_1+2f_2+f_3+1)/2$
etc.	etc.	etc.	etc.

NOTE

Cell mid value = sum of lower and upper value of the cell divided by 2

Step 6 The percentage proportional frequency (P) for each cell is determined by the formula

$$P = \frac{\bar{J} - 0.5}{\text{total frequency}} \times 100$$

Step 7 Normal probability paper is provided in this code of practice to plot the points obtained in the frequency distribution table. The percentage proportional frequency is plotted against respective cell mid values.

A.3 Criteria for checking normality

If the points plotted in A.2 fall close to a straight line it shall be concluded that the data follow a normal distribution, at least approximately. If a closely linear pattern of points is not obtained and that a straight line cannot be drawn between them, then it shall be concluded that data do not follow normal distribution.

APPENDIX B

DETERMINATION OF STANDARD DEVIATION (σ) USING NET QUANTITY DATA

B.1 Collection of data

Use the data collected in Appendix A for the calculations in this Appendix . Otherwise use fresh set of data same as collected in Appendix A.

B.2 Determination of within sample variation

B.2.1 Number each set of h results obtained in B.1. Calculate the standard deviation for each of the set. Square each standard deviation thus obtained, add together and divide by h. Take the square root of the result and symbolies as S_1.

B.2.2 Calculate the standard deviation of all nxh observations taken together and symbolise the result as S_2.

B.2.3 Calculate the ratio S_2/S_1, if this ratio is greater than the critical values given in Table 1, then S_2 is used to determine the target quantity (Q_t). Otherwise use S_1 to determine Q_t.

APPENDIX C

OTHER POSSIBLE FACTORS TO BE TAKEN INTO ACCOUNT IN CALCULATING Q_t.

C.1 Allowance for variation of tare

In cases where directly measuring of net quantity is not practicable, then estimated tare quantity should be subtracted from gross quantity to obtain net quantity.

C.1.1 *Estimation of tare quantity*

C.1.1.1 Take one package from each sample of h sets and measure the tare quantity giving h readings. Use samples collected in Appendix A for this purpose or collect fresh data. Calculate average t and standard deviation S_t of h readings.

C.1.1.2 (a) If S_t is equal to or less than 0.1 T, use t as the estimate of tare quantity

C.1.1.2 (b) Net quantity of each package in the sample is determined by subtracting t by gross quantity of each package. These data on net quantity in the sample is used to calculate the standard deviation as given in Appendix B.

C.1.1.3 If S_t exceeds 0.1 T, an allowance should be made in setting Q_t. In this case take the overall standard deviation when setting Q_t given as in 9.5 to be the square root of sum of squares of S_t and S_2 calculated in Appendix B., That means instead of σ given in Appendix B, σ should be replaced by $(S_t^2 + S_2^2)^{1/2}$.

NOTE

Occassional checks must be made on S_t and if necessary adjustment on filling process should be done.

C.2 Allowance for wandering average

Where there is a significant fluctuations in the average quantity from one sample of packages to the next and this fluctuations cannot be controlled, then allowance must be made to S_2 determined in Appendix D. Method of test is given in following steps.

C.2.(a) Use the data collected in Appendix A for this purpose or collect fresh data. Calculate average $\bar{x}$ for each set and calculate the absolute successive difference between each adjacent value of $\bar{x}$ in chronological order. The difference between each pair is denoted as δ. Then take the average ($\bar{\delta}$) of (h-1) values. Then determine $A=\frac{8}{9}\bar{\delta}$

C.2.(b) Calculate the standard deviation of the h values of x and let the result be B.

C.2.(c) Calculate the ratio A/B
if $0.8<A/B<1.2$ then no adjustment is required for S_2.

C.2.(d) If A/B falls outside the above range then there is evidence of drifting or cyclical movements of the average or large alternation of betweeen high and low values. The source should if possible be traced and eleminated. New series of samples should be taken to check the effectiveness of the adjustments. If no improvement is possible, then S_2 already calculated in B.2.2 of Appendix B should be replaced by $(S_1^2 + A^2)^{1/2}$ when calculating target quantity Q_t.

C.3 Allowance for storage

An allowance for storage may be needed where desiccating goods are being packed and where the packages are liable to desiccate (i.e. lose mass or volume solely through evaparation) to a material extent when they are kept in normal conditions of storage.

0.5 % of Q_t calculated as in 9.5 is added to Q_t as storage allowance.

APPENDIX D
DETERMINATION OF STANDARD DEVIATION (σ_e) FOR CONTROL PROCEDURES

From each sample collected in 7 (or use fresh data) standard deviation is calculated for at least 30 sets. Square each standard deviation thus calculated and add together and take the square root.

Symbolise the result as S_3.

Next pool the whole set of data and calculate overall standard deviation and symbolise as S_4.

Then σ_e is given by $(S_4^2+S_3^2/n)^{1/2}$
Where n is the number of packages in a set.

APPENDIX E

REMIDIAL ACTIONS FOR OUT OF CONTROL PROCESS

E.1 Failure of normality test

Variation of net quantity shall be closely studied. Assignable causes for non-normal behaviour of net quantity data shall be identified and eleminated from the process. For this purpose statistical process control techniques along with other technological techniques shall be applied to the process in order to make the process data, behave normally. After taking corrective measures described above the freshly drawn data set on net quantity shall be tested and the above procedure repeated until normality test is satisfied.

E.2 Failure of performance test

If $Cp < 1.33$ then the process variation is greater than the tolerance. Net quantity variation (process variation) shall be reduced so that it shall be within specification limits. That is the standard deviation calculated using net quantity data when multipluied by six must be less than or equal to tolerance. machine adjustments are necessary to reduce variation.

E.3 Failure of performance test even after variation reduction (or further reduction of variation not possible)

If further reduction of standard deviation is not possible, then review of specification limits may be done and arrived at a more realistic limits.

Upper specification limit may be taken to be average + four times standard deviation.

Lower specification limit may be taken to be average - four times standard deviation provided that it is greater than D-T.

TABLE 1
CRITICAL VALUES FOR S_2/S_1

No of samples h	No. of packages per sample,n									
	2	3	4	5	6	8	10	12	15	20
20	-	-	-	1.083	1.067	1.048	1.038	1.031	1.024	1.0181
25	-	-	1.098	1.075	1.061	1.044	1.035	1.028	1.022	1.0164
30	-	-	1.087	1.066	1.053	1.039	1.030	1.025	1.020	1.0145
35	-	1.115	1.079	1.060	1.048	1.035	1.028	1.023	1.0179	1.0133
40	-	1.107	1.073	1.056	1.045	1.033	1.026	1.021	1.0167	1.0124
50	1.172	1.093	1.065	1.049	1.040	1.029	1.023	1.0187	1.0147	1.0109
60	1.154	1.084	1.059	1.045	1.037	1.027	1.021	1.0174	1.0138	1.0102
70	1.140	1.077	1.053	1.041	1.033	1.024	1.0190	1.0156	1.0124	1.0092
80	1.129	1.071	1.050	1.038	1.031	1.023	1.0178	1.0147	1.0116	1.0086
100	1.114	1.064	1.044	1.034	1.028	1.020	1.0161	1.0133	1.0105	1.0078

Values to right of or below heavy lines are suggested minimum samples size/number of samples combinations. Other entries are for information.

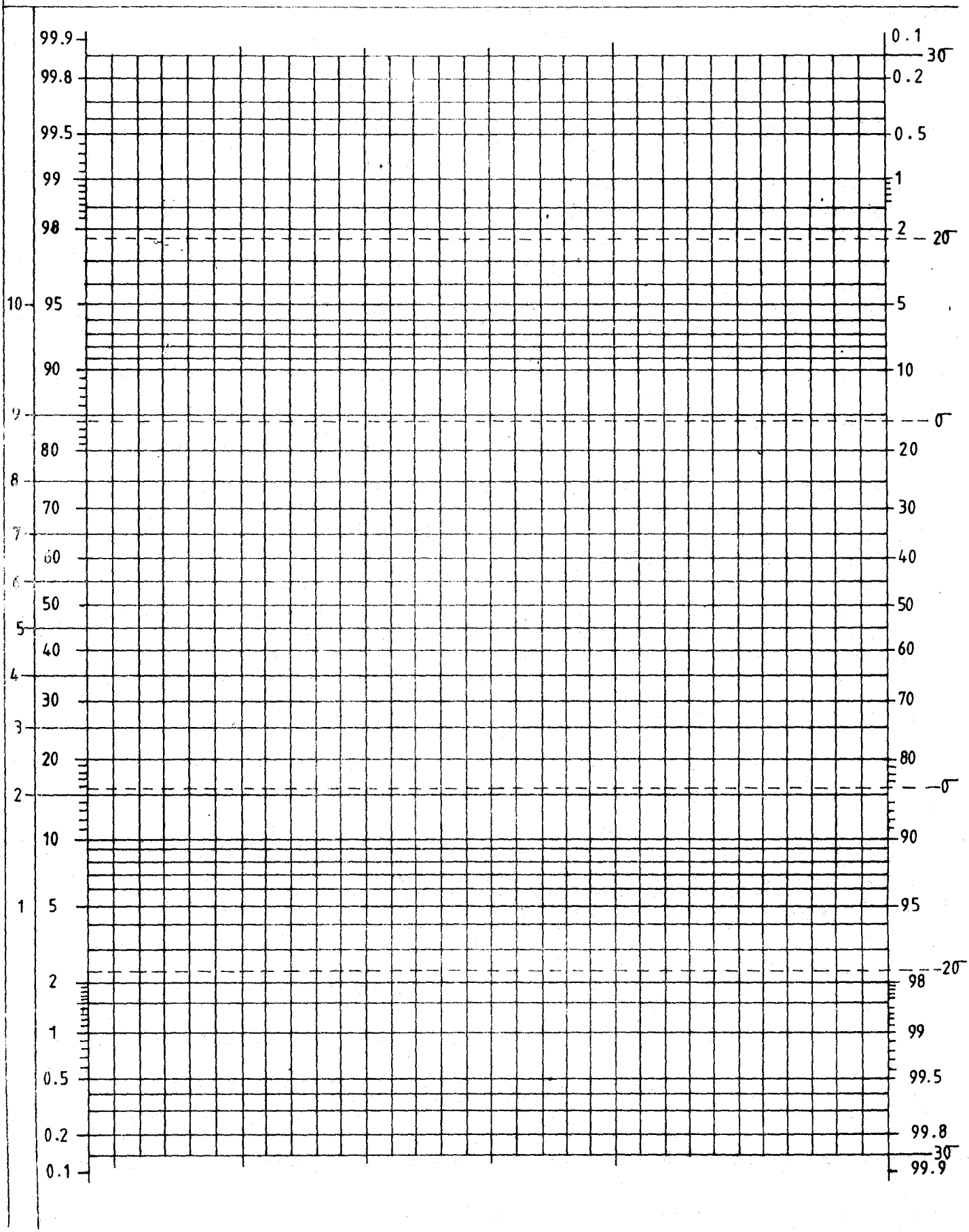
TABLE 2

CONTROL LIMITS FOR SAMPLING RANGE

Multipliers for	sample size,n						
	2	3	4	5	6	8	10
Upper Action limit	4.12	2.98	2.57	2.34	2.21	2.04	1.93
Upper Warning limit	2.81	2.17	1.93	1.81	1.72	1.62	1.56

NORMAL PROBABILITY PAPER

Article name	Article no.	Spec. index	Rev.
Intended for	Insp. group alt. op.	Date issued	Issued by
Remarks			



SRI LANKA STANDARDS INSTITUTION

The Sri Lanka Standards Institution (SLSI) is the National Standards Organization of Sri Lanka established under the Sri Lanka Standards Institution Act No. 6 of 1984 which repealed and replaced the Bureau of Ceylon Standards Act No. 38 of 1964. The Institution functions under the Ministry of Science & Technology.

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