BUREAU OF INDIAN STANDARDS

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भारतीय मानक *मसौदा*
खाद्य पदार्थों के संवेदी मूल्यांकन के लिए मार्गदर्शिका
भाग 3 डेटा सांख्यिकीय विश्लेषण अनुभाग 1अंतर / वरीयता परीक्षण (टेस्ट)
(आई एस 6273 भाग 3 अनुभाग 1 का *दूसरा पुनरीक्षण)*

Draft ***Indian Standard***
Sensory Evaluation of Foods — Guide
Part 3 Statistical Analysis of Data Section 1 Difference/Preference Tests
[*Second Revision* of IS 6273 (Part 3/Sec 1)]
ICS 67.240

Test Methods for Food Products Sectional Committee, FAD 28	Last Date of Comments **15 12 2024**

FOREWORD
(*Formal clause would be added later*)

The sensory evaluation of food is an essential aspect of quality control, product development, and consumer research. It encompasses a range of methods designed to assess the characteristics of food as perceived by the senses, including taste, smell, sight, touch, and sound. The growing complexity of the food industry, along with evolving consumer preferences, necessitates the development of standardized methods that ensure consistency, accuracy, and reliability in sensory analysis.

Sensory evaluation depends on proper panel selection; environmental conditions and equipment for the test; selection of representative sample, its preparation and presentation; terminology; methods employed and statistical techniques applied for the analysis of data. In order to facilitate easy application and to provide guidelines on the above aspects, this standard has been published in three parts. Whereas this part of the standard covers the statistical analysis of data, Part 1 covers the optimum requirements and Part 2 covers the methods and evaluation cards for sensory evaluation of foods.

This standard (Part3) was originally published in 1975. In the first revision of the standard published in 1983 the standard was split into two sections, Section 1 dealing with difference/preference tests and Section 2 dealing with ranking and scoring tests. The first revision brought together various tests of the same type having same field of application. The various statistical tests were presented in a more simplified form so that a common user may be able to understand them easily. Further, it also incorporated the preference matrix analysis, which was based on the extension of the paired comparison test to more than two samples. The sign test was deleted, as the same purpose is served by the paired comparison test.

While bringing out second revision, the standard has been brought out in the latest style and format of Indian Standard, and references to Indian Standards, wherever applicable, have been updated.

The descriptions given in this revision are designed to suit sensory evaluation personnel and more detailed procedures of some of the statistical tests are included in various parts of IS 6200‘Statistical tests of significance’.

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’.

Draft **Indian Standard**

Guide for Sensory Evaluation of Foods
Part 3 Statistical Analysis of Data Section 1 Difference/Preference Tests
(*Second Revision*)

1 SCOPE

1.1 This standard (Part 3/Sec 1) covers difference/preference tests. The various tests included in this standard are paired comparison test, duo-trio test, triangle test, normal test, preference matrix analysis and χ^2-test.

2 REFERENCES

The standards given below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of these standards:

IS No.	*Title*
IS 5126 : 2016/ ISO 5492 : 2008	Sensory analysis — Vocabulary (*second revision*)
Doc: FAD 28 (XXXXX) WC	Guide for sensory evaluation of foods: Part 2 Methods and evaluation Cards [*first revision of IS 6273 (Part 2) : 1971*]

3TERMINOLOGY

For the purpose of this standard, the following definitions in addition to the definitions given in IS 5126 shall apply.

3.1 Arithmetic Mean

Sum of the values of the observations divided by the number of observations.

3.2 Critical Difference

The magnitude of difference which will be significant at a chosen level of significance, calculated from the value of the standard error of the difference.

3.3 Degrees of Freedom

The number of independent component values, which are used to determine a statistic.

3.4 Error

The difference between observed value and its true or expected value. It is not synonymous with mistake.

3.5 Hypothesis, Alternate

The hypothesis of the difference or non-equivalence between effects of the method(s). The alternate hypothesis may be two-sided or one-sided.

3.6 Hypothesis, Null

The hypothesis of the equivalence & no difference between the effects of the method(s) so that the sample emanates from the same population.

3.7 Level of Significance

The probability (or risk) of rejecting the null hypothesis when it is true.

3.7.1 Comparison of products is performed with a limited number of panelists and a decision has to be projected to the population. As such the risk of taking a decision arises which is called level of significance or error of the first kind. This is usually fixed at 5 or 1 percent. It follows that a decision which is correct at 5 percent level may not be so at 1 percent level.

3.7.2 Level of significance also represents the chance of not taking a correct decision if the experiment were to be repeated a large number of times. Significance at 5 percent and 1 percent level means that the chance of making a wrong decision is one in 20 and one in 100 respectively.

3.8 Population

The totality of items under consideration.

3.9 Probability

If a trial results in n possible outcomes which are equally likely such that any one of them can occur at a time and out of which m cases are favourable to the happening of an event E, the probability of event E is given by $P(E) = m/n$.

3.10 Probability Distribution

The distribution which determines the probability that a random variable takes any given value or belongs to a given set of values. The probability over the whole interval of variation of the variable equals one.

3.11 Random Variable

A variable which may take any of the values of a specified set of values and to which is associated a probability distribution.

3.12 Range

The difference between the largest and the smallest observed values of a measurable characteristic.

3.13 Replication

The execution of experiment more than once, essentially under the same experimental conditions.

3.14 Statistical Errors

3.14.1 *Error of the first kind*

The error, in concluding that there is a difference when in fact there is no difference, resulting in rejection of the null hypothesis when it is true.

3.14.2 *Error of the second kind*

The error, in concluding that there is no difference when in fact there is difference, accepting the null hypothesis, when it is false.

3.15 Critical Region

The region of possible values of the statistic used such that if the value of the statistic which results from the observed values belongs to the region, the null hypothesis will be rejected.

3.16 Test, One-Sided

A test in which the statistic used is uni-dimensional and the critical region is the set of values lower (or greater) than a given number. In the case of directional difference tests where the direction of difference is known or assumed in advance, a one-sided test has to be used.

3.17 Test Two-Sided

A test in which a statistic used is uni-dimensional and in which a set of values lower than a first given number and the set of values greater than a second given number form the critical region,

3.17.1 In preference tests, where the decision can be for any of the tested samples and no prior information regarding the direction of the preference is available, a two-sided test is used.

3.18 Variance

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.

3.19 Standard Deviation

It is the positive square root of variance.

3.20 Standard Error (SE)

Standard deviation of an estimator, the standard error provides an estimate of the random part of the error involved in estimating a population parameter from a sample.

3.21 Statistic

A function of observed values derived from the sample.

4 SYMBOLS

4.1 Following symbols have been used for expression of sensory evaluation results:

N: number of items in the population,
n: number of samples/sample pairs,
m: number of panelists,
k: number of preferences into which the sample is classified,
$\sum$: summation,
$| \ |$: absolute value,
x_i : measurement on ith item,
p: proportion of observations possessing a given attribute, and

$$\bar{x} = \frac{x_1 + x_2 + \ldots + x_m}{m}$$

5 DIFFERENCE/PREFERENCE TESTS

5.1 These tests involve separately or jointly detection of differences or preferences or both regarding organoleptic attributes of two products. It is necessary to know from the static, whether a particular test is one-sided (one direction is of particular interest) or a two-sided (both directions are of equal interest). For example, in two samples of orange squash one with 14 percent sugar and another with 16 percent sugar, if the test is required to be done to identify the sweeter sample, a one-sided test has to be used. On the other hand, for testing of two market brands of a cola beverage, if the test is required to be conducted to decide which of the two is sweeter, a two-sided test has to be used.

5.2 The various statistical tests used for analysing the data arising from sensory evaluation experiments are covered in **5.7** to **5.12.** The selection of the appropriate test shall depend upon the objective of an experiment, the strength of the measurement, the type of panel used and number of samples to be evaluated.

5.3 In addition to statistical considerations mentioned with respective methods of analysis, psychological errors which may be committed by a panelist have also to be kept in view. These errors may be committed due to the panelist’s previous knowledge of the test samples or their method of presentation, tendency to repeat previous impressions, reluctance to use extreme values on a scale specially for unfamiliar foods, tendency to rate the adjacent quality factors similar as in the case of simultaneous scoring of colour texture, odour, taste and general acceptability on the same set of samples, and tendency to continue to give the same response when a series of slowly increasing or decreasing stimuli are presented.

5.4 The minimum number of panelists for these tests shall be seven. However, depending upon the purpose of the experiment and type of panel, this number shall be sufficiently larger. For general guidance regarding the number of panelists, IS 6273 (Part 2) may be referred.

5.5 In the presentation of test samples, the following precautions shall be taken:

a) Provision shall be made for sufficient quantity of bulk sample which can be divided into the necessary number of individual samples;

b) It shall not be possible for the panelists to draw conclusions as to the nature of samples from the way in which they are presented. The various pairs of the series shall be prepared in an identical fashion (same apparatus, vessel and quantities of products);

c) The temperature of the samples in any given pair shall be the same and if possible, shall be same as that of all other samples in a given test series; and

d) The vessels containing the test samples shall be suitably coded and coding shall be different for each test.

5.6 If ‘no difference’ or ‘no preference’ replies have been permitted, ignore them, that is subtract them from the total number of replies received.

5.6.1 A large proportion of ‘no difference’ or ‘no preference’ replies could indicate, in particular, that the difference between the samples is below the detection threshold of the panelists. This may equally reveal an imperfect experimentation technique, reflect the existence of an important physiological variation in the panelists or even the lack of motivation of certain panelists for the tests in which they are participating.

5.7 Paired Comparison Test

It may be used for the following purposes:

a) *Directional Differences*— In order to determine the direction of differences between two test samples for a specified attribute, for example, more or less sweet; and

b) *Preference* — In order to establish whether there is a preference between two test samples, for example, in consumer tests.

5.7.1 Paired samples shall be presented simultaneously or successively for evaluation. The order of presentation shall be balanced so that the combinations *AB* and *BA* appear an equal number of times and are distributed at random among the panelists. Several pairs may be offered in succession (series of pairs), provided that sensory fatigue is minimized or avoided.

5.7.2 The manner in which the questions are asked is very important as it may lead to bias in the replies of the panelists. Depending on the aim of the test, the following questions may be asked:

a) *Test for directional difference*— Of these two samples, which is the more......? (sweet, salty, etc.); and

b) *Test for preference*— Of these two samples, which do you prefer?

5.7.3 The total number of correct responses for a one-sided test and the total number of predominant responses (that is, the larger of the two figures) for a two-sided test shall be compared with the corresponding values given in Table 1 for determining whether there is a significant difference between samples or a significant preference for one of them.

Example 1— A paired comparison test was conducted with two samples of orange squash, one of them being known to have better aroma; the panelists were asked to make a judgement, as to which of the samples had a stronger aroma. Twenty panelists participated in the evaluation, out of which 17 concurring judgements of detection of difference were recorded. It is clearly a one-sided test and referring to Table 1, 16 concurring judgements are the minimum required for significance at one percent level. The null hypothesis that there is no difference is thus rejected.

Example 2— A preference test was run with 35 nursery school children on two *Balahar* samples; formulation *A* contained corn, soya and skim milk; and formulation *B* contained wheat, groundnut, and Bengal gram flours. 26 children preferred formulation *A* and the remaining preferred the formulation *B*. It is required to test whether any significant preference is there for one of the formulations. It is clearly a two-sided test as either sample can be preferred with equal chance. Referring to Table 1 for two sided test, 26 concurring judgements are required for significance at 1 percent level. Hence formulation *A* is preferred to *B* at 1 percent level.

5.8 Duo-Trio-Test

The samples are presented in groups of three, one of them labelled as *R* (reference) and the other two coded. One of the coded samples is identical with *R* and the other is different. The panelists will be given the reference sample first and then other two coded samples. They will be asked to pick out the sample in the coded pair matching with the reference sample. For testing the significance, Table 1 shall be referred.

Example 3— A duo-trio test was conducted with two samples of grape juice, one prepared with 0.3 percent lactic acid and the other with 0.4 percent lactic acid, the former being the reference sample. 25 panelists participated in the evaluation, out of which 11 could identify the sample matching with reference sample correctly. The test is clearly one-sided test as the panelists are required to identify the sample matching with the reference sample. Referring to Table 1, 18 concurring judgements are necessary to establish significance at 5 percent level. Hence, it can be concluded that the difference between the two levels of lactic acid is not perceptible.

5.9 Triangle Test

The coded samples are presented to each panelist in groups of three. The panelists are given the information that two of the samples are identical. The identification of the odd sample is required. For testing significance, Table 2 may be referred.

Example 4— A triangle test with two meat sausages, one with normal salt and the other with extra salt was conducted, the latter being given as the odd sample. Out of 20 panelists, 15 correctly identified the odd sample. It is a one-sided test. Referring to Table 2, it may be noted that 14 correct judgements are required for significance at 0.1 percent level. Hence, it is concluded that the two sausages are significantly different from one another.

5.10 Normal Test for Proportions

This test is used to test the significance of difference between observed and expected proportions. Any preference data with more than 30 panelists obtained by paired comparisons can be analysed by this method.

5.10.1 The *u* statistic to be computed for this test is obtained as:

$$u \frac{|p - po|}{SE(p)}$$

Where,

p=observed proportion,

p_o=expected proportion, and

SE(p)=$\frac{\sqrt{p_o(1-p_o)}}{m}$, *m* being the total number of panelists.

5.10.2 For a two-sided test, the computed value of u is compared with the critical value of 1.96 at 5 percent, 2.58 at 1 percent and 3.29 at 0.1 percent levels of significance. For a one-sided test, the critical values at 5 percent, 1 percent and 0.1 percent levels of significance are 1.64, 2.33 and 3.09 respectively. The null hypothesis of the equivalence of observed and expected proportion is rejected, if the computed value of *u* exceeds the corresponding critical value at the chosen level of significance.

Example 5 — A preference test was run between samples *A* and *B* with 121 panelists. The sample A was preferred by 72 panelists and sample *B* by 49. It is required to test whether the preferences for samples A and B are significantly different.

In this example, the null hypothesis is that the preferences for samples *A* and *B* are same against the alternate hypothesis that they are different. Thus, it is clearly a case of a two-sided test. The *u* statistic is computed as below:

Observed proportion (p) = $\frac{72}{121}$ = 0.595

Expected proportion (p_o) = $\frac{1}{2}$ 0.500

$SE(p) = \frac{\sqrt{0.5 \times 0.5}}{121} = 0.045$

Hence $u = \frac{0.595 - 0.500}{0.045} = 2.11$

As the computed value of u is greater than 1.96, the preferences for two samples A and B are found to be different at 5 percent level of significance.

5.11 Preference Matrix Analysis

This method is essentially an extension of paired preference test to more than two samples and the selection of a subset of samples just large enough to ensure with a pre-assigned probability that the most preferred sample is included in the subset.

5.11.1 The paired preference test is conducted on all possible pairs and results are tabulated in a matrix as shown below:

Preferred Sample	Not Preferred Sample					Total
	$A1$	A_2	A_3	...	An	
A	...	$f(A_1, A_2)$	$f(A_1,A_3)$	...	$f(A_1,A_n)$	$f(A_1)$
A_2	$f(A_2,A_1)$	...	$f(A2,A3)$	...	$f(A_2 A_n)$	$f(A_2)$
A_3	$f(A_3,A_1)$	$f(A_3,A_2)$	...	...	$f(A_3,A_n)$	$f(A_3)$
...	...	...	...	...	...	...
...	...	...	...	...	...	...
...	...	...	...	...	...	...
A_n	$f(A_n,A_1)$	$f(A_n,A_2)$	$f(An,A_3)$	...	...	$f(A_n)$

In the matrix, $f(A\text{i}, A\text{j})$ indicates the frequency of preference of Ai over Aj in the pair (Ai, Aj) where $i \neq j$. The number of panellists participating in the test is given by f (Ai, Aj) + f (Aj, Ai), where $i \neq j$.

The last column (total) represents the total preference for each sample. A subset containing the most preferred sample can be identified in the following manner.

The sample with maximum total preference is selected first. The tabulated value corresponding to a given number of panellists participating and number of samples is read from Table 3A at 5 percent level of significance or from Table 3B at 1 percent level of significance. If f denotes the maximum total preference and t' denotes the tabulated value, all the samples which have frequencies in the range of (f - t') to f are taken as forming the required subset.

Example 6—Paired comparison tests are conducted for 4 formulations of cola beverages and the data so collected is analysed by using a preference matrix. 100 panellists familiar with cola beverages participated in the test. The following preference matrix is obtained:

Preferred Formulations	Not Preferred Formulations				Total
	A	*B*	*C*	*D*	
A	-	90	80	50	220
B	10	-	50	20	80
C	20	50	-	40	110
D	50	80	60	-	190

It is required to select a subset of samples just large enough to ensure with a 99 percent probability that the most preferred formulation is included in the subset.

The formulation ***A*** with 220 as maximum total preference is first selected. In order to identify the required subset, the tabulated value at 1 percent level of significance from Table 3B corresponding to 100 panellists and 4 samples is 38. All the formulations which have the total frequencies in the range of 182 (= 220 - 38) to 220 are taken as forming the required subset. In this case only formulations *A* and *D* can be included in the subset.

5.12 χ^2-Test

This is a useful test for testing goodness of fit and independence of attributes with respect to some characteristic. As it holds good for large sample size, the total number of panellists participating in an experiment should be sufficiently large (say not less than 50) and each expected cell frequency shall not be less than 5. If any expected cell frequency is less than 5, appropriate classes may be combined.

5.12.1 *Goodness of Fit*

The problem that frequently arises in sensory evaluation of foods is the testing of the compatibility of a set of observed and expected number of panellists having preference for various samples included in a particular experiment. In such cases the null hypothesis is that the preferences for various samples are same against the alternate hypothesis that they are different.

5.12.1.1 Data arising from paired comparison test can also be analysed by using this test. As ready tables are available for paired comparison test, this test may be used for the situations where the number of panellists included in an experiment exceeds the number of panellists covered in Table 1. It is particularly useful whenever more than two samples are to be compared. It may be noted that even by normal test given in **5.10** only two samples can be compared.

5.12.1.2 If there are *n* samples (1,2, 3, ... *n*) to be compared and 0_1, 0_2,. . . .0_n are the observed number of panellists preferring the samples 1,2, . .., *n* respectively so that $\sum_{i=1}^{n} o_t$ is the total number of panelists participatingin the experiment, it may be of interest to know whether these

observedfrequencies differ significantly from those which could be expectedfor these samples on the basis of the null hypothesis that preferences for various samples are same. In this case if we denote the expected number of panellists preferring the samples 1, 2, . . .*n* by e_1, e_2, ...,e_n respectively so
that$\sum_{i=1}^{n} o_i = \sum_{i=1}^{n} e_i$, the test statistic to be used is:

$\chi^2 = \sum_{i=1}^{n} \frac{(o_i - e_i)^2}{ei}$, with (*n* - 1) degrees of freedom or less, depending on whether the expected cell frequencies computed from the data are required to be combined.

5.12.1.3 A small value χ^2 is associated with good agreement between observed and expected frequencies, whereas a large value tends to indicate the discrepancy. Whether the discrepancy is likely to arise by, chance, is decided by reference to Table 4.

5.12.1.4 If the calculated value of χ^2 is greater than or equal to the tabulated value given in Table 4, the null hypothesis that observed and expected number of panellists preferring various samples is same, is rejected at a specified level of significance. In other words preferences for various samples are found to be different at that level of significance.

Example 7 —In a preference test on three samples of candy *A*,*B* and *C* with 150 panellists, 60 chose *A*, 50 chose Band 40 chose *C*. It is required to determine whether the preferences for candies *A*, *B* and C are significantly different.

Here the null hypothesis is that the preferences for samples A, Band Care same. Thus, the expected number of panellists preferring each of the three samples A, Band C is 50. The value of χ^2in this case is

$$\chi^2 = \sum_{i=1}^{3} \frac{(oi - ei)^2}{ei} = \frac{(60 - 50)^2}{50} + \frac{(50 - 50)^2}{50} + \frac{(40 - 50)^2}{50} = 4.00$$

with 2 (=3-1) degrees of freedom.

The tabulated value of $\chi^2$from Table 4 for 2 degrees of freedom is 5.9 at 5 percent level of significance. As the computed value of $\chi^2$is less than the tabulated value, there is not enough evidence to reject the null hypothesis meaning thereby that the preferences for candies *A*, *B* and *C* are not different at 5 percent level of significance.

5.12.2*Independence in Contingency Tables*

When a set of observations are tabulated according to two variables in *n* rows and k columns, a two way table is obtained with $n \times k$ cells. Such two way tables are also called contingency tables. It is required to test whether the two classifications are independent, that is the probability that an observation falls in a particular row (column) is not affected by the particular column (row) to which it belongs.

5.12.2.1 If there are *n* types of a product (number of samples), each of which is classified into *k* preferences, the number of panellists indicating a particular preference shall constitute the observed frequency for that cell. Here the null hypothesis is that the number of panellists showing a certain preference is independent of types of samples and preferences into which each of the samples is classified. Hence the expected frequency for a cell is obtained by dividing the product of corresponding row and column totals by overall total.

5.12.2.2 If o_{ij} and e_{ij} represent the observed and expected frequencies respectively in the *nk* cells of the contingency table, e_{ij} under the null hypothesis can be obtained with the help of marginal totals and the overall totals Thus e_{ij}, that is, the expected number of panellists classifying the *i*th sample into *j*th preference is obtained by dividing the product of marginal totals of *i*th row and *j*th column by the overall total. The test statistic is then calculated as:

$$x^2 = \sum_{i=1}^{n}\sum_{j=1}^{k}\frac{\left(o_{ij} - e_{ij}\right)^2}{e_{ij}}$$

with (*n* - 1) x (*k* - 1) degrees of freedom.

Example 8— Three groups of 50, 100 and 150 school children respectively, each selected at random from a school were given protein chewy candies flavoured with rose, vanilla-cocoa and almond for classifying into three categories as excellent, good and just acceptable. Each group was given protein chew candies flavoured differently. The data obtained in the following two-way table:

Type	Number of School Children Preferences Observed (Expected)			Total
	Excellent	Good	Just Acceptable	
Rose	28 (23.8)	18 (18.0)	4 (8.2)	50
Vanilla-cocoa	45 (47.7)	40 (36.0)	15 (16.3)	100
Almond	70 ((71.5)	50 (54.0)	30 (24.5)	150
Total	143	108	49	300

It is intended to test whether the relative preferences of the children for the three types of candies are same, which then forms the null hypothesis.

If the number of school children showing a certain preference is independent of types and preferences, the expected frequency for rose type with excellent preference is calculated as 50 × 143/300 = 23.8. The expected frequencies for various combinations of types and preferences are given in brackets. The χ^2- statistic is then calculated as:

$$\frac{(28 - 23.8)^2}{23.8} + \ldots\ldots\ldots\ldots\ldots + \frac{(30 - 24.5)^2}{24.5} = 5.14$$

Since this value is less than the tabulated value of 9.49 [5 percent value of χ^2-distribution given in Table 4 corresponding to (3- 1)(3 – 1) = 4degrees of freedom], we do not have enough evidence to doubt the null hypothesis that the preferences of children for three types of candies are not significantly different.

Table 1 Paired Comparison and Duo-Trio Tests

(*Clauses* 5.7.3, 5.8 and 5.12.1.1)

NUMBER OF JUDGEMENT	MINIMUM CONCURRING JUDGEMENTS FOR ONE-SIDED TEST FOR PROBABILITY LEVEL			MINIMUM CONCURRING JUDGEMENTS FOR TWO-SIDED TEST FOR PROBABILITY LEVEL		
	0.05	0.01	0.001	0.05	0.01	0.001
(1)	(2)	(3)	(4)	(5)	(6)	(7)
7	7	7	-	7	-	-
8	7	8	-	8	8	-
9	8	9	-	8	9	-
10	9	10	10	9	10	-
11	9	10	11	10	11	11
12	10	11	12	10	11	12
13	10	12	13	11	12	13
14	11	12	13	12	13	14
15	12	13	14	12	13	14
16	12	14	15	13	14	15
17	13	14	16	13	15	16
18	13	15	16	14	15	17
19	14	15	17	15	16	17
20	15	16	18	15	17	18
21	15	17	18	16	17	19
22	16	17	19	17	18	19
23	16	18	20	17	19	20
24	17	19	20	18	19	21
25	18	19	21	18	20	21
30	20	22	24	21	23	25
35	23	25	27	24	26	28
40	26	28	31	27	29	31
45	29	31	34	30	32	34
50	32	34	37	33	35	37
60	37	40	43	39	41	44
70	43	46	49	44	47	50
80	48	51	55	50	52	56
90	54	57	61	55	58	61
100	59	63	66	61	64	67

Table 2 Triangle Test
(*Clauses* 5.9)

NUMBER OF JUDGEMENT	MINIMUM CONCURRING JUDGEMENTS FOR ONE-SIDED TEST FOR PROBABILITY LEVEL			MINIMUM CONCURRING JUDGEMENTS FOR TWO-SIDED TEST FOR PROBABILITY LEVEL		
	0.05	0.01	0.001	0.05	0.01	0.001
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	3	-	-	-	-	-
4	4	-	-	-	-	-
5	4	5	-	-	-	-
6	5	6	-	-	-	-
7	5	6	7	5	6	7
8	6	7	8	6	7	8
9	6	7	8	6	7	8
10	7	8	9	7	8	9
11	7	8	10	7	8	9
12	8	9	10	8	9	10
13	8	9	11	8	9	10
14	9	10	11	9	10	11
15	9	10	12	9	10	12
16	9	11	12	10	11	12
17	10	11	13	10	11	13
18	10	12	13	10	12	13
19	11	13	14	11	12	14
20	11	13	14	11	13	14
21	12	13	15	12	13	15
22	12	14	15	12	14	15
23	12	14	16	13	14	16
24	13	15	16	13	14	16
25	13	15	17	13	15	17
30	15	17	19	16	17	19
35	17	19	22	18	19	21
40	19	21	24	20	22	24
45	21	24	26	22	24	26
50	23	26	26	24	26	28
60	27	30	33	28	30	33
70	31	34	37	32	34	37
80	35	38	41	35	38	41
90	30	45	45	39	42	45
100	42	46	49	43	46	49

Table 3A Critical Values for Preference Matrix Analysis at 5 Percent Level
(*Clause* 5.11.1)

SAMPLES / PANELISTS	2	3	4	5	6	7	8	9	10
1	1	2	3	3	4	4	5	5	5
2	2	3	4	5	5	6	7	7	8
3	3	4	5	6	7	7	8	9	9
4	4	5	6	7	8	9	9	10	11
5	3	5	6	8	9	10	10	11	12
6	4	6	7	8	9	10	11	12	13
7	5	6	8	9	10	11	12	13	14
8	4	7	8	10	11	12	13	14	15
9	5	7	9	10	12	13	14	15	16
10	6	7	9	11	12	14	15	16	17
11	5	8	10	11	13	14	16	17	18
12	6	8	10	12	13	15	16	17	19
13	5	8	11	12	14	15	17	18	19
14	6	9	11	13	14	16	18	19	20
15	7	9	11	13	15	17	18	20	21
16	6	9	12	14	15	17	19	20	22
17	7	10	12	14	16	18	19	21	22
18	6	10	12	14	16	18	20	21	23
19	7	10	13	15	17	19	20	22	24
20	8	10	13	15	17	19	21	23	24
25	9	12	15	17	19	21	23	25	27
30	8	13	16	19	21	23	26	28	30
35	9	14	17	20	23	25	28	30	32
40	10	15	18	22	24	27	30	32	34
45	11	16	20	23	26	29	31	34	36
50	12	17	21	24	27	30	33	36	38
60	12	18	23	26	30	33	36	39	42
70	14	20	24	29	32	36	39	42	45
80	14	21	26	31	35	38	42	45	48
90	16	22	28	32	37	41	44	48	51
100	16	23	29	34	39	43	47	51	54

Table 3B Critical Values for Preference Matrix Analysis at 5 Percent Level
(*Clause* 5.11.1)

SAMPLES / PANELISTS	2	3	4	5	6	7	8	9	10
1	1	2	3	4	4	5	6	6	7
2	2	4	5	6	7	8	8	9	9
3	3	5	6	8	9	9	10	11	12
4	4	6	7	9	10	11	12	13	13
5	5	7	8	10	11	12	13	14	15
6	6	7	9	11	12	13	14	15	16
7	5	8	10	12	13	14	16	17	18
8	6	9	11	12	14	15	17	18	19
9	7	9	11	13	15	16	18	19	20
10	8	10	12	14	16	17	19	20	21
11	7	10	13	15	16	18	19	21	22
12	8	11	13	15	17	19	20	22	23
13	9	11	14	16	18	19	21	23	24
14	8	12	14	16	18	20	22	24	25
15	9	12	15	17	19	21	23	24	26
16	10	12	15	18	20	22	23	25	27
17	9	13	16	18	20	22	24	26	28
18	10	13	16	19	21	23	25	27	28
19	9	14	17	19	21	24	26	27	29
20	10	14	17	20	22	24	26	28	30
25	11	16	19	22	25	27	29	31	34
30	12	17	21	24	27	30	32	34	37
35	13	19	22	26	29	32	35	37	40
40	14	20	24	28	31	34	37	40	42
45	15	21	25	29	33	36	39	42	45
50	16	22	27	31	35	38	41	45	47
60	18	24	29	34	38	42	45	49	52
70	20	26	32	37	41	45	49	53	56
80	20	28	34	39	44	48	52	56	60
90	22	30	36	42	47	51	56	60	64
100	24	31	38	44	49	54	59	63	67

Table 4 Critical Values of χ^2 - Distribution
(*Clauses* 5.12.1.3 *and* 5.12.1.4)

DEGREES OF FREEDOM	SIGNIFICANCE LEVEL		
	0.05	0.01	0.001
1.	3.84	6.64	10.83
2.	5.99	9.21	13.82
3.	7.82	11.34	16.27
4.	9.49	13.28	18.46
5.	11.07	15.09	20.52
6.	12.59	16.81	22.46
7.	14.07	18.48	23.32
8.	15.51	20.09	26.12
9.	16.92	21.67	27.88
10.	18.31	23.21	29.59
11.	19.68	24.73	31.26
12.	21.03	26.22	32.91
13.	22.36	27.69	34.53
14.	23.69	29.14	36.12
15.	25.00	30.58	37.70
16.	26.30	32.00	39.25
17.	27.59	33.41	40.79
18.	28.87	34.81	42.31
19.	30.14	36.19	43.82
20.	31.41	37.57	45.32
21.	32.67	38.93	46.80
22.	33.92	40.29	48.27
23.	35.17	41.64	49.73
24.	36.42	42.98	51.18
25.	37.65	44.31	52.62
26.	38.89	45.64	54.05
27.	40.11	46.96	55.48
28.	41.34	48.28	56.89
29.	42.56	49.59	58.30
30.	43.77	50.89	59.70