IASSC Exam Packet

Version: 1.2.0M

Publish Date: 12.12.2010

Table of Contents

Formulas

Statistical Tables

Descriptive Statistics

Calculation	Formula	Notes
Population Mean	$\mu = \frac{\sum X}{N}$	Where μ = Population Average X = Individual Values of Population N = Count of Individual Values
Sample Mean	$\overline{X} = \frac{\sum X}{n}$	Where $\overline{X}$ = Sample Average X = Individual Values of Population n = Count of Individual Values in Sample
Weighted Mean	$\overline{X}_w = \frac{w_1x_1 + w_2x_2 + w_3x_3 + \ldots + w_nx_n}{w_1 + w_2 + w_3 + \ldots + w_n}$	Where $\overline{X}_W$ = Weighted Sample Average W_J = Weight of Value J XJ = Individual value to be weighted
Sample Mean of grouped data	$\overline{X} = \frac{\sum f_i X_i}{n}$	Where f_i = Number of observations In the i'th group X_i = Midpoint of the i'th class n = Count of all observations of i'th classes
Range	*Range = highest - lowest*	Where highest = Sample Max Value lowest = Sample Min Value
Mean Deviation	$MD = \frac{\sum \lvert X - \overline{X} \rvert}{n}$	Where X = Individual value in the sample $\overline{X}$ = Sample average n = Count of samples
Population Variance	$\sigma^2 = \frac{\sum (X - \mu)^2}{N}$	Where μ = Population average X = Individual value in population N = Count of population

Calculation	Formula	Notes
Population Standard Deviation	$\sigma = \sqrt{\frac{\sum (X - \mu)^2}{N}}$	Where μ = Population average X = Individual value in population N = Count of population
Sample Variance	$s^2 = \frac{\sum (X - \overline{X})^2}{n-1}$	Where $\overline{X}$ = Sample average X = Individual value from sample n = Count of sample
Sample Standard Deviation	$S = \left[\sqrt{\frac{n}{n-1}}\right]\sigma$	*None*

Hypothesis Testing

Calculation	Formula	Notes
2 Sample T (Unequal Variance)	$A=\sqrt{\frac{S_1^2}{n_1}}\quad B=\sqrt{\frac{S_2^2}{n_2}}\quad S_{\overline{X}_1-\overline{X}_2}=\sqrt{A+B}$ $df=\frac{(A+B)^2}{\frac{A^2}{(n_1-1)}+\frac{B^2}{(n_2-1)}}\quad t=\frac{\overline{X}_1-\overline{X}_2}{S_{\overline{X}_1-\overline{X}_2}}$	Where S^2_1 = Standard Deviation of the Sample One n_1 = Sample One size S^2_2 = Standard Deviation of the Sample Two n_2 = Sample Two size $\overline{X}_1$ The average of the Sample One $\overline{X}_2$ The average of the Sample Two $S_{\overline{X}1-\overline{X}2}$ =Sigma of the Averaged Difference
2t Test of Means (separate s)	$t_{n-1,1-\alpha/2}=\frac{\overline{X}_1-\overline{X}_2}{\sqrt{\left(\frac{S_1^2}{n_1}+\frac{S_2^2}{n_2}\right)}}$	Where s_1 = Sample 1 variance (S^2) s_2 = Sample 2 variance (S^2) n_1 = Sample size of group 1 n_2 = Sample size of group 2 X_1 =Sample 1 Average X_2 =Sample 2 Average $t_{n-1,1-\alpha/2}$ =T statistic from table – or Critical t
2t Test of Means (pooled s)	$t_{n-1,1-\alpha/2}=\frac{\overline{X}_1-\overline{X}_2}{S_p\sqrt{\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$	Where s_1 = Sample 1 variance (S^2) s_2 = Sample 2 variance (S^2) n_1 = Sample size of group 1 n_2 = Sample size of group 2 X_1 =Sample 1 Average X_2 =Sample 2 Average $t_{n-1,1-\alpha/2}$ =T statistic from table – or Critical t
2Z Test of Means (Equal Variance)	$z_{1-\alpha/2}=\frac{\overline{X}_1-\overline{X}_2}{\sqrt{\frac{\sigma^2_1}{n_1}+\frac{\sigma^2_2}{n_2}}}$	Where σ_1 = Sigma of group 1 σ_2 = Sigma of group 2 n_1 = Sample size of group 1 n_2 = Sample size of group 2 $\overline{X}_1$ Average of Group 1 $\overline{X}_2$ Average of Group 1 $Z_{(1-\alpha/2)}$ = Z table @ (1-α/2) Two tailed
AOV Sum of Squares Correction Factor	$C=\frac{T^2}{N}$	Where T = Grand total (sum of all samples) N = Total samples (balanced = rows*columns)

Calculation	Formula	Notes
AOV Sum of Squares Total	$SS_{Total} = \sum X^2 - \frac{(\sum X)^2}{n}$	Where n = Sample size of total X =Individual samples (all)
AOV Sum of Squares Total (Calculator)	$SS_{Total} = (n-1)s^2_{Total}$	Where n = Sample size of total S_{TOTAL} =Std Deviation of ALL items in the test
Chi Squared (Variance, not Proportions)	$\chi^2 = \frac{(n-1)s^2}{\sigma_o^2}$	Where S^2 = Sample variance σ_o^2 = Population variance
F Statistic (Variances)	$\frac{1}{F_{\alpha/2;\nu Y;\nu X}(s_x^2/s_y^2)} \le \frac{\sigma_Y^2}{\sigma_x^2} \le \frac{F_{\alpha/2;\nu X;\nu Y}}{(s_x^2/s_y^2)}$	Where $F_{\alpha/2,\nu Y,\nu X}$ =F statistic from table df Y then df X $F_{\alpha/2,\nu X,\nu Y}$ =F statistic from table df X then df Y σ_Y^2 =Population variance for Y σ_X^2 =Population variance for X s_X^2 =Sample variance for X s_Y^2 =Sample variance for Y
Interval for Proportions	$p_1 - p_2 \pm z_{1-\alpha/2}\sqrt{\frac{p_1(1-p_1)}{n_1} + \frac{p_2(1-p_2)}{n_2}}$	Where P_1 =sample proportion defective group 1 P_2 =sample proportion defective group 2 P_c = Pooled Proportion X_x Successes in sample n_x n_x = Sample size of group x
Paired t Test	$t_{n-1,1-\alpha/2} = \frac{\bar{d}}{s_d/\sqrt{n}}$	Where s_d = Standard Deviation of the paired differences n = Sample size $\bar{d}$ The average of the paired differences $t_{n-1,1-\alpha/2}$ =T statistic from table – or Critical t
Pooled Variance	$s_p = \sqrt{\frac{(n_1-1)s^2_1 + (n_2-1)s^2_2}{n_1+n_2-2}}$	Where s_1 = Sample 1 variance (S^2) s_2 = Sample 2 variance (S^2) n_1 = Sample size of group 1 n_2 = Sample size of group 2

Calculation	Formula	Notes
Single Sample Test of Proportions	$z_{1-\alpha/2} = \frac{p-\pi}{\sqrt{\frac{\pi(1-\pi)}{n}}}$	Where π =population proportion defective p =sample proportion defective $Z_{(1-\alpha/2)}$ = Z table @ (1-α/2) Two tailed
Single Sample (Compare to Standard)	$t_{n-1,1-\alpha/2} = \frac{\overline{X}-\mu}{\frac{S}{\sqrt{n}}}$	Where $t_{n-1,1-\alpha/2}$ =T statistic from table – or Critical t $\overline{X}$ =sample average μ = Population average or target value n = Sample size S = Sample Standard Deviation
Sum of Squares (Equal n)	$SS_{Treatment} = n(k-1)s_{\bar{x}}^2$	Where n = Samples inside a treatment (k) (within) k = Number of treatments (between) $s_{\bar{x}}$ = Standard error of the treatment mean
Sum of Squares (Unequal n)	$SS_{Treatment} = \sum_{i=1}^{k} n_i \bar{x}_i^2 - N\bar{\bar{x}}^2$	Where $\bar{x}_i^2$ = Square of the i'th average n_i = Sample size of group I $\bar{\bar{x}}^2$ Grand average squared N Total sample size k Treatments
Sum of Squares Treatments	$SS_{Treatments} = \sum_{i-1}^{k} \frac{T_i^2}{n_i} - C$	Where n = Samples inside a treatment (k) (within) k = Number of treatments (between) $s_{\bar{x}}$ = Standard error of the treatment mean
Two Sample Test of Proportions	$z_{1-\alpha/2} = \frac{p_1 - p_2}{\sqrt{\frac{p_1(1-p_1)}{n_1} + \frac{p_2(1-p_2)}{n_2}}}$	Where π =Population proportion defective p_1 =Sample proportion defective group 1 p_2 =Sample proportion defective group 2 n_1 = Sample size of group 1 n_2 = Sample size of group 2 $Z_{(1-\alpha/2)}$ = Z table @ (1-α/2) Two tailed d Err Is the sqrt function in the denominator
Variance	$F_{n_1-1,n_2-1,1-\alpha} = \frac{s^2{}_1}{s^2{}_2}$	Where $F_{n1-1,n2-1,1-\alpha/2}$ =F statistic from table – or Critical F s^2_1 =sample variance group 1 s^2_2 =sample variance group 2

Regression

Calculation	Formula	Notes
Correlation Coefficient	$r = \frac{\sum (X_m - \overline{X})(Y_m - \overline{Y})}{\sqrt{\sum (X_m - \overline{X})^2 \sum (Y_m - \overline{Y})^2}}$	Where n = Sample size of the pairs of data Y =Individual sample for Independent Variable X =Individual sample for Dependent Variable $\overline{X}$ Average Value for X $\overline{y}$ Average Value for Y
Linear Regression	$\hat{Y} = a + bX$	Where a = Intercept of line b = Slope of the line
Multiple Regression	$\hat{Y} = a + b_1X_1 + b_2X_2 + b_3X_3 \ldots + b_kX_k$	*None, model only*
Multiple Standard Error	$SE = \sqrt{\frac{\sum \left(Y - \hat{Y}\right)^2}{n - (k+1)}}$	*None*

Capability Indices

Calculation	Formula	Notes
Confidence Interval for C_{pk}	$C_{pk} \pm Z_{\alpha/2}\sqrt{\frac{1}{9n}+\frac{C_{pk}^{2}}{2n-2}}$	*None*
C_{pk} Attribute Data	$C_{pk} = \frac{1.5 + Z_{P(Good)}}{3}$	*None*
Process Capability	$C_p = \frac{(SpecLimit_{Upper})-(SpecLimit_{Lower})}{6s}$	*None*
Process Centering (Short Term 1)	$C_{pk} = Minimum \left\{\frac{Z_{Upper}}{3}, \frac{Z_{Lower}}{3}\right\}$	*None*
Process Centering (Short Term 2)	$Z_{Upper} = \frac{(SpecLimit_{Upper} - \overline{X})}{s}$ $Z_{Lower} = \frac{(\overline{X} - SpecLimit_{Lower})}{s}$	*None*
Sigma of C_{pk}	$\sigma_{Cpk} = \sqrt{\frac{1}{9n}+\frac{C_{pk}^{2}}{2n-2}}$	*None*

Control Charts

Calculation	Formula	Notes
c Chart (Fixed n_1)	$c = \#\ Defects$ $\bar{c} = \frac{\sum c_i}{\sum n_i}$ $UCL = \bar{c} + 3\sqrt{\bar{c}}$ $LCL = \bar{c} - 3\sqrt{\bar{c}}$	*None*
Control Limits for np	$UCL = n\bar{p} + 3\sqrt{n\bar{p}(1-\bar{p})}$ $LCL = n\bar{p} - 3\sqrt{n\bar{p}(1-\bar{p})}$	*None*
np Chart (Fixed n)	$n\bar{p} = \frac{\sum np}{\#\ Subgroups}$	*None*
p Chart (Average Sample Size)	$\bar{n} = \frac{\sum n_i}{k}$	*None*
p Chart (n can vary, Control Limits for Proportions)	$UCL = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{\bar{n}}}$ $LCL = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{\bar{n}}}$	*None*
p Chart (n can vary, Mean Percent Defects)	$Subgroup\ p = \frac{np}{p}$ $\bar{p} = \frac{\sum np}{\sum n}$	*None*

Calculation	Formula	Notes
u Chart (n can vary, Mean Percentage Defectives)	$Subgroup = u = \frac{c}{n}$ $\bar{u} = \frac{\sum c}{\sum n}$	*None*
u Chart (Average Sample Size)	$\bar{n} = \frac{\sum n_i}{k}$	*None*
u Chart (n can vary, Control Limits for Proportions)	$UCL = \bar{u} + 3\sqrt{\frac{\bar{u}}{n}}$ $LCL = \bar{u} - 3\sqrt{\frac{\bar{u}}{n}}$	*None*
X and R Charts (Grand Mean)	$\bar{\bar{X}} = \frac{\sum \bar{X}}{k}$	*None*
X and R Charts (Control Limits for the Mean)	$UCL = \bar{\bar{X}} + A_2\bar{R}$ $LCL = \bar{X} - A_2\bar{R}$	*None*
X and R Charts (Control Limits for the Range)	$UCL = D_4\bar{R}$ $LCL = D_3\bar{R}$	*None*
X and R Charts (Range Target)	$\bar{R} = \frac{(R_1 + R_2 \ldots R_n)}{k}$	*None*

Calculation	Formula	Notes
X and S Charts (Control Limits for the Mean)	$UCL = \overline{\overline{X}} + A_3\overline{S}$ $LCL = \overline{\overline{X}} - A_3\overline{S}$	*None*
X and S Charts (Grand Mean)	$\overline{\overline{X}} = \frac{\sum \overline{X}}{k}$	*None*
X and S Charts (Grand Mean)	$\overline{S} = \frac{(S_1 + S_2 \ldots S_n)}{k}$	*None*
X and S Charts (Control Limits for the Range)	$UCL = B_4\overline{S}$ $LCL = B_4\overline{S}$	*None*

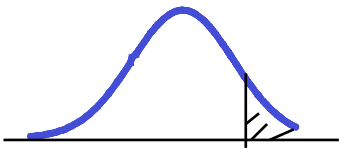
Normal Distribution - Right Tail Area

Z	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.50000	0.49601	0.49202	0.48803	0.48405	0.48006	0.47608	0.47210	0.46812	0.46414
0.1	0.46017	0.45620	0.45224	0.44828	0.44433	0.44038	0.43644	0.43251	0.42858	0.42465
0.2	0.42074	0.41683	0.41294	0.40905	0.40517	0.40129	0.39743	0.39358	0.38974	0.38591
0.3	0.38209	0.37828	0.37448	0.37070	0.36693	0.36317	0.35942	0.35569	0.35197	0.34827
0.4	0.34458	0.34090	0.33724	0.33360	0.32997	0.32636	0.32276	0.31918	0.31561	0.31207
0.5	0.30854	0.30503	0.30153	0.29806	0.29460	0.29116	0.28774	0.28434	0.28096	0.27760
0.6	0.27425	0.27093	0.26763	0.26435	0.26109	0.25785	0.25463	0.25143	0.24825	0.24510
0.7	0.24196	0.23885	0.23576	0.23270	0.22965	0.22663	0.22363	0.22065	0.21770	0.21476
0.8	0.21186	0.20897	0.20611	0.20327	0.20045	0.19766	0.19489	0.19215	0.18943	0.18673
0.9	0.18406	0.18141	0.17879	0.17619	0.17361	0.17106	0.16853	0.16602	0.16354	0.16109
1.0	0.15866	0.15625	0.15386	0.15151	0.14917	0.14686	0.14457	0.14231	0.14007	0.13786
1.1	0.13567	0.13350	0.13136	0.12924	0.12714	0.12507	0.12302	0.12100	0.11900	0.11702
1.2	0.11507	0.11314	0.11123	0.10935	0.10749	0.10565	0.10383	0.10204	0.10027	0.09853
1.3	0.09680	0.09510	0.09342	0.09176	0.09012	0.08851	0.08692	0.08534	0.08379	0.08226
1.4	0.08076	0.07927	0.07780	0.07636	0.07493	0.07353	0.07215	0.07078	0.06944	0.06811
1.5	0.06681	0.06552	0.06426	0.06301	0.06178	0.06057	0.05938	0.05821	0.05705	0.05592
1.6	0.05480	0.05370	0.05262	0.05155	0.05050	0.04947	0.04846	0.04746	0.04648	0.04551
1.7	0.04457	0.04363	0.04272	0.04182	0.04093	0.04006	0.03920	0.03836	0.03754	0.03673
1.8	0.03593	0.03515	0.03438	0.03362	0.03288	0.03216	0.03144	0.03074	0.03005	0.02938
1.9	0.02872	0.02807	0.02743	0.02680	0.02619	0.02559	0.02500	0.02442	0.02385	0.02330
2.0	0.02275	0.02222	0.02169	0.02118	0.02068	0.02018	0.01970	0.01923	0.01876	0.01831
2.1	0.01786	0.01743	0.01700	0.01659	0.01618	0.01578	0.01539	0.01500	0.01463	0.01426
2.2	0.01390	0.01355	0.01321	0.01287	0.01255	0.01222	0.01191	0.01160	0.01130	0.01101
2.3	0.01072	0.01044	0.01017	0.00990	0.00964	0.00939	0.00914	0.00889	0.00866	0.00842
2.4	0.00820	0.00798	0.00776	0.00755	0.00734	0.00714	0.00695	0.00676	0.00657	0.00639
2.5	0.00621	0.00604	0.00587	0.00570	0.00554	0.00539	0.00523	0.00508	0.00494	0.00480
2.6	0.00466	0.00453	0.00440	0.00427	0.00415	0.00402	0.00391	0.00379	0.00368	0.00357
2.7	0.00347	0.00336	0.00326	0.00317	0.00307	0.00298	0.00289	0.00280	0.00272	0.00264
2.8	0.00256	0.00248	0.00240	0.00233	0.00226	0.00219	0.00212	0.00205	0.00199	0.00193
2.9	0.00187	0.00181	0.00175	0.00169	0.00164	0.00159	0.00154	0.00149	0.00144	0.00139
3.0	0.00135	0.00131	0.00126	0.00122	0.00118	0.00114	0.00111	0.00107	0.00104	0.00100
3.1	0.00097	0.00094	0.00090	0.00087	0.00084	0.00082	0.00079	0.00076	0.00074	0.00071
3.2	0.00069	0.00066	0.00064	0.00062	0.00060	0.00058	0.00056	0.00054	0.00052	0.00050
3.3	0.00048	0.00047	0.00045	0.00043	0.00042	0.00040	0.00039	0.00038	0.00036	0.00035
3.4	0.00034	0.00032	0.00031	0.00030	0.00029	0.00028	0.00027	0.00026	0.00025	0.00024
3.5	0.00023	0.00022	0.00022	0.00021	0.00020	0.00019	0.00019	0.00018	0.00017	0.00017
3.6	0.00016	0.00015	0.00015	0.00014	0.00014	0.00013	0.00013	0.00012	0.00012	0.00011
3.7	0.00011	0.00010	0.00010	0.00010	0.00009	0.00009	0.00008	0.00008	0.00008	0.00008
3.8	0.00007	0.00007	0.00007	0.00006	0.00006	0.00006	0.00006	0.00005	0.00005	0.00005
3.9	0.00005	0.00005	0.00004	0.00004	0.00004	0.00004	0.00004	0.00004	0.00003	0.00003
4.0	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003	0.00002	0.00002	0.00002
4.1	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00001
4.2	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
4.3	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
4.4	0.00001	0.00001	0.00001	0.00001	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000
4.5	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
4.6	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
4.7	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
4.8	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
4.9	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

T-Distribution

$\alpha = .05$ 1-sided

1 - .05 =.95



$\alpha = .05$ 2-sided

$1 - \frac{.05}{2} = .975$

					1-sided	2-sided		
Alpha Risk	**0.600**	**0.700**	**0.800**	**0.900**	**0.950**	**0.975**	**0.990**	**0.995**
DF = n-1								
1	0.325	0.727	1.376	3.078	6.314	12.706	31.821	63.657
2	0.289	0.617	1.061	1.886	2.920	4.303	6.965	9.925
3	0.277	0.584	0.978	1.638	2.353	3.182	4.541	5.841
4	0.271	0.569	0.941	1.533	2.132	2.776	3.747	4.604
5	0.267	0.559	0.920	1.476	2.015	2.571	3.365	4.032
6	0.265	0.553	0.906	1.440	1.943	2.447	3.143	3.707
7	0.263	0.549	0.896	1.415	1.895	2.365	2.998	3.499
8	0.262	0.546	0.889	1.397	1.860	2.306	2.896	3.355
9	0.261	0.543	0.883	1.383	1.833	2.262	2.821	3.250
10	0.260	0.542	0.879	1.372	1.812	2.228	2.764	3.169
11	0.260	0.540	0.876	1.363	1.796	2.201	2.718	3.106
12	0.259	0.539	0.873	1.356	1.782	2.179	2.681	3.055
13	0.259	0.538	0.870	1.350	1.771	2.160	2.650	3.012
14	0.258	0.537	0.868	1.345	1.761	2.145	2.624	2.977
15	0.258	0.536	0.866	1.341	1.753	2.131	2.602	2.947
16	0.258	0.535	0.865	1.337	1.746	2.120	2.583	2.921
17	0.257	0.534	0.863	1.333	1.740	2.110	2.567	2.898
18	0.257	0.534	0.862	1.330	1.734	2.101	2.552	2.878
19	0.257	0.533	0.861	1.328	1.729	2.093	2.539	2.861
20	0.257	0.533	0.860	1.325	1.725	2.086	2.528	2.845
21	0.257	0.532	0.859	1.323	1.721	2.080	2.518	2.831
22	0.256	0.532	0.858	1.321	1.717	2.074	2.508	2.819
23	0.256	0.532	0.858	1.319	1.714	2.069	2.500	2.807
24	0.256	0.531	0.857	1.318	1.711	2.064	2.492	2.797
25	0.256	0.531	0.856	1.316	1.708	2.060	2.485	2.787
26	0.256	0.531	0.856	1.315	1.706	2.056	2.479	2.779
27	0.256	0.531	0.855	1.314	1.703	2.052	2.473	2.771
28	0.256	0.530	0.855	1.313	1.701	2.048	2.467	2.763
29	0.256	0.530	0.854	1.311	1.699	2.045	2.462	2.756
30	0.256	0.530	0.854	1.310	1.697	2.042	2.457	2.750
40	0.255	0.529	0.851	1.303	1.684	2.021	2.423	2.704
60	0.254	0.527	0.848	1.296	1.671	2.000	2.390	2.660
120	0.254	0.526	0.845	1.289	1.658	1.980	2.358	2.617
✕	0.253	0.524	0.842	1.282	1.645	1.960	2.326	2.576

F- Distribution (Table 1)

Tabulated values for a = .05

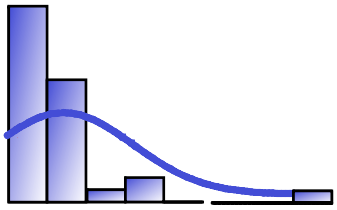
D/N	1	2	3	4	5	6	7	8	9	10
1	161.40	199.50	215.70	224.60	230.20	234.00	236.80	238.90	240.50	241.90
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38	19.40
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24
26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25	2.20
28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24	2.19
29	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22	2.18
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99
120	3.92	3.07	2.68	2.45	2.29	2.17	2.09	2.02	1.96	1.91
	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83

F-Distribution (Table 2)

Tabulated values for a = .05

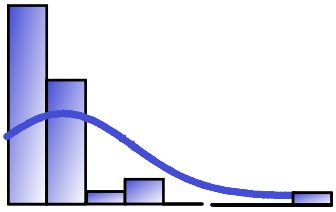
D/N	12	15	20	24	30	40	60	120	
1	243.90	245.90	248.00	249.10	250.10	251.10	252.20	253.30	254.30
2	19.41	19.43	19.45	19.45	19.46	19.47	19.48	19.49	19.50
3	8.74	8.70	8.66	8.64	8.62	8.59	8.57	8.55	8.53
4	5.91	5.86	5.80	5.77	5.75	5.72	5.69	5.66	5.63
5	4.68	4.62	4.56	4.53	4.50	4.46	4.43	4.40	4.36
6	4.00	3.94	3.87	3.84	3.81	3.77	3.74	3.70	3.67
7	3.57	3.51	3.44	3.41	3.38	3.34	3.30	3.27	3.23
8	3.28	3.22	3.15	3.12	3.08	3.04	3.01	2.97	2.93
9	3.07	3.01	2.94	2.90	2.86	2.83	2.79	2.75	2.71
10	2.91	2.85	2.77	2.74	2.70	2.66	2.62	2.58	2.54
11	2.79	2.72	2.65	2.61	2.57	2.53	2.49	2.45	2.40
12	2.69	2.62	2.54	2.51	2.47	2.43	2.38	2.34	2.30
13	2.60	2.53	2.46	2.42	2.38	2.34	2.30	2.25	2.21
14	2.53	2.46	2.39	2.35	2.31	2.27	2.22	2.18	2.13
15	2.48	2.40	2.33	2.29	2.25	2.20	2.16	2.11	2.07
16	2.42	2.35	2.28	2.24	2.19	2.15	2.11	2.06	2.01
17	2.38	2.31	2.23	2.19	2.15	2.10	2.06	2.01	1.96
18	2.34	2.27	2.19	2.15	2.11	2.06	2.02	1.97	1.92
19	2.31	2.23	2.16	2.11	2.07	2.03	1.98	1.93	1.88
20	2.28	2.20	2.12	2.08	2.04	1.99	1.95	1.90	1.84
21	2.25	2.18	2.10	2.05	2.01	1.96	1.92	1.87	1.81
22	2.23	2.15	2.07	2.03	1.98	1.94	1.89	1.84	1.78
23	2.20	2.13	2.05	2.01	1.96	1.91	1.86	1.81	1.76
24	2.18	2.11	2.03	1.98	1.94	1.89	1.84	1.79	1.73
25	2.16	2.09	2.01	1.96	1.92	1.87	1.82	1.77	1.71
26	2.15	2.07	1.99	1.95	1.90	1.85	1.80	1.75	1.69
27	2.13	2.06	1.97	1.93	1.88	1.84	1.79	1.73	1.67
28	2.12	2.04	1.96	1.91	1.87	1.82	1.77	1.71	1.65
29	2.10	2.03	1.94	1.90	1.85	1.81	1.75	1.70	1.64
30	2.09	2.01	1.93	1.89	1.84	1.79	1.74	1.68	1.62
40	2.00	1.92	1.84	1.79	1.74	1.69	1.64	1.58	1.51
60	1.92	1.84	1.75	1.70	1.65	1.59	1.53	1.47	1.39
120	1.83	1.75	1.66	1.61	1.55	1.50	1.43	1.35	1.25
	1.75	1.67	1.57	1.52	1.46	1.39	1.32	1.22	1.00

Chi=Square Distribution (Table 1)



df	0.250	0.100	0.050	0.025	0.010	0.005	0.001
1	1.323	2.706	3.841	5.024	6.635	7.879	10.828
2	2.773	4.605	5.991	7.378	9.210	10.597	13.816
3	4.108	6.251	7.815	9.348	11.345	12.838	16.266
4	5.385	7.779	9.488	11.143	13.277	14.860	18.467
5	6.626	9.236	11.070	12.832	15.086	16.750	20.515
6	7.841	10.645	12.592	14.449	16.812	18.548	22.458
7	9.037	12.017	14.067	16.013	18.475	20.278	24.322
8	10.219	13.362	15.507	17.535	20.090	21.955	26.125
9	11.389	14.684	16.919	19.023	21.666	23.589	27.877
10	12.549	15.987	18.307	20.483	23.209	25.188	29.588
11	13.701	17.275	19.675	21.920	24.725	26.757	31.264
12	14.845	18.549	21.026	23.337	26.217	28.300	32.909
13	15.984	19.812	22.362	24.736	27.688	29.819	34.528
14	17.117	21.064	23.685	26.119	29.141	31.319	36.123
15	18.245	22.307	24.996	27.488	30.578	32.801	37.697
16	19.369	23.542	26.296	28.845	32.000	34.267	39.252
17	20.489	24.769	27.587	30.191	33.409	35.718	40.790
18	21.605	25.989	28.869	31.526	34.805	37.156	43.312
19	22.718	27.204	30.144	32.852	36.191	38.582	43.820
20	23.828	28.412	31.410	34.170	37.566	39.997	45.315
21	24.935	29.615	32.671	35.479	38.932	41.401	46.797
22	26.039	30.813	33.924	36.781	40.289	42.796	48.268
23	27.141	32.007	35.172	38.076	41.638	44.181	49.728
24	28.241	33.196	36.415	39.364	42.980	45.558	51.179
25	29.339	34.382	37.652	40.646	44.314	46.928	52.620
26	30.434	35.563	38.885	41.923	45.642	48.290	54.052
27	31.528	36.741	40.113	43.194	46.963	49.645	55.476
28	32.620	37.916	41.337	44.461	48.278	50.993	56.892
29	33.711	39.087	42.557	45.722	49.588	52.336	58.302
30	34.800	40.256	43.773	46.979	50.892	53.672	59.703
40	45.616	51.805	55.758	59.342	63.691	66.766	73.402
50	56.334	63.167	67.505	71.420	76.154	79.490	86.661
60	66.981	74.397	79.082	83.298	88.379	91.952	99.607
70	77.577	85.527	90.531	95.023	100.425	104.215	112.317
80	88.130	96.578	101.879	106.629	112.329	116.321	124.839
90	98.650	107.565	113.145	118.136	124.116	128.299	137.208
100	109.141	118.498	123.342	129.561	135.807	140.169	149.449

Chi-Square Distribution (Table 2)



df	0.995	0.990	0.975	0.950	0.900	0.750	0.500
1	0.000	0.000	0.001	0.004	0.158	0.102	0.455
2	0.010	0.020	0.051	0.103	0.211	0.575	1.386
3	0.072	0.115	0.216	0.352	0.584	1.213	2.366
4	0.207	0.297	0.484	0.711	1.064	1.923	3.357
5	0.412	0.554	0.831	1.145	1.610	2.675	4.351
6	0.676	0.872	1.237	1.635	2.204	3.455	5.348
7	0.989	1.239	1.690	2.167	2.833	4.255	6.346
8	1.344	1.646	2.180	2.733	3.490	5.071	7.344
9	1.735	2.088	2.700	3.325	4.168	5.899	8.343
10	2.156	2.558	3.247	3.940	4.865	6.737	9.342
11	2.603	3.053	3.816	4.575	5.578	7.584	10.341
12	3.074	3.571	4.404	5.226	6.304	8.438	11.340
13	3.565	4.107	5.009	5.892	7.042	9.299	12.340
14	4.075	4.660	5.629	6.571	7.790	10.165	13.339
15	4.601	5.229	6.262	7.261	8.547	11.036	14.339
16	5.142	5.812	6.908	7.962	9.312	11.912	15.338
17	5.697	6.408	7.564	8.672	10.085	12.792	16.338
18	6.265	7.015	8.231	9.390	10.865	13.675	17.338
19	6.844	7.633	8.907	10.117	11.651	14.562	18.338
20	7.434	8.260	9.591	10.851	12.443	15.452	19.337
21	8.034	8.897	10.283	11.591	13.240	16.344	20.337
22	8.643	9.542	10.982	12.338	14.041	17.240	21.337
23	9.260	10.196	11.688	13.091	14.848	18.137	22.337
24	9.886	10.856	12.401	13.848	15.659	19.037	23.337
25	10.520	11.524	13.120	14.611	16.473	19.939	24.337
26	11.160	12.198	13.844	15.379	17.292	20.843	25.336
27	11.808	12.879	14.573	16.151	18.114	21.749	26.336
28	12.461	13.565	15.308	16.928	18.939	22.657	27.336
29	13.121	14.256	16.047	17.708	19.768	23.567	28.336
30	13.787	14.953	16.791	18.493	20.599	24.478	29.336
40	20.707	22.164	24.433	26.509	29.051	33.660	39.335
50	27.991	29.707	32.357	34.764	37.689	42.942	49.335
60	35.535	37.485	40.482	43.188	46.459	52.294	59.335
70	43.275	45.442	48.758	51.739	55.329	61.698	69.334
80	51.172	53.540	57.153	60.391	64.278	71.145	79.334
90	59.196	61.754	65.647	69.126	73.291	80.625	89.334
100	67.328	70.065	74.222	77.929	82.358	90.133	99.334

Sample Size

Alpha Risk ->	20%				10%				5%				1%			
Beta Risk	20%	10%	5%	1%	20%	10%	5%	1%	20%	10%	5%	1%	20%	10%	5%	1%
δ / σ																
0.1	903	1315	1714	2605	1238	1714	2166	3156	1571	2103	2600	3676	2337	2977	3564	4808
0.2	227	330	430	652	311	430	543	790	394	527	651	920	585	745	892	1203
0.3	102	147	192	291	139	192	242	352	176	235	290	410	261	332	397	536
0.4	58	84	109	164	79	109	137	199	100	133	164	231	147	187	224	302
0.5	38	54	70	106	51	70	88	128	64	86	105	148	95	121	144	194
0.6	27	38	49	74	36	49	62	89	45	60	74	104	66	84	100	135
0.7	20	28	36	55	27	36	46	66	34	44	55	76	49	62	74	100
0.8	16	22	28	42	21	28	35	51	26	34	42	59	38	48	57	77
0.9	13	18	23	34	17	23	28	40	21	27	34	47	30	38	45	61
1.0	11	15	19	28	14	19	23	33	17	23	27	38	25	31	37	50
1.1	9	12	16	23	12	16	19	28	14	19	23	32	21	26	31	41
1.2	8	11	13	20	10	13	17	23	12	16	20	27	18	22	26	35
1.3	7	9	12	17	9	12	14	20	11	14	17	23	15	19	23	30
1.4	6	8	10	15	8	10	13	18	10	12	15	20	13	17	20	26
1.5	6	7	9	13	7	9	11	16	8	11	13	18	12	15	17	23
1.6	5	7	8	12	6	8	10	14	8	10	12	16	11	13	15	20
1.7	5	6	7	11	6	7	9	12	7	9	10	14	10	12	14	18
1.8	4	6	7	10	5	7	8	11	6	8	10	13	9	11	12	16
1.9	4	5	6	9	5	6	7	10	6	7	9	12	8	10	11	15
2.0	4	5	6	8	5	6	7	9	5	7	8	11	7	9	10	14
2.1	4	4	5	7	4	5	6	9	5	6	7	10	7	8	10	12
2.2	3	4	5	7	4	5	6	8	5	6	7	9	6	8	9	11
2.3	3	4	5	6	4	5	6	7	4	5	6	8	6	7	8	11
2.4	3	4	4	6	4	4	5	7	4	5	6	8	6	7	8	10
2.5	3	4	4	6	3	4	5	7	4	5	6	7	5	6	7	9
2.6	3	3	4	5	3	4	5	6	4	5	5	7	5	6	7	9
2.7	3	3	4	5	3	4	4	6	4	4	5	7	5	6	6	8
2.8	3	3	4	5	3	4	4	6	4	4	5	6	4	5	6	8
2.9	3	3	4	5	3	4	4	5	3	4	5	6	4	5	6	7
3.0	3	3	3	4	3	3	4	5	3	4	4	6	4	5	5	7
3.1	2	3	3	4	3	3	4	5	3	4	4	5	4	5	5	7
3.2	2	3	3	4	3	3	4	5	3	4	4	5	4	4	5	6
3.3	2	3	3	4	3	3	3	4	3	3	4	5	4	4	5	6
3.4	2	3	3	4	3	3	3	4	3	3	4	5	4	4	5	6
3.5	2	3	3	4	3	3	3	4	3	3	4	4	3	4	4	5
3.6	2	3	3	4	2	3	3	4	3	3	4	4	3	4	4	5
3.7	2	2	3	3	2	3	3	4	3	3	3	4	3	4	4	5
3.8	2	2	3	3	2	3	3	4	3	3	3	4	3	4	4	5
3.9	2	2	3	3	2	3	3	4	3	3	3	4	3	3	4	5
4.0	2	2	3	3	2	3	3	3	2	3	3	4	3	3	4	5

PPM Conversion Table

Z	PPM
0.00	933,193
0.05	926,471
0.10	919,243
0.15	911,492
0.20	903,199
0.25	894,350
0.30	884,930
0.35	874,928
0.40	864,334
0.45	853,141
0.50	841,345
0.55	828,944
0.60	815,940
0.65	802,338
0.70	788,145
0.75	733,373
0.80	758,036
0.85	742,154
0.90	736,918
0.95	725,158
1.00	713,398
1.05	701,637
1.10	689,877
1.15	678,117
1.20	666,356
1.25	654,596
1.30	642,835
1.35	631,075
1.40	619,315
1.45	607,554
1.50	500,000
1.55	480,061
1.60	460,172
1.65	440,382
1.70	420,740
1.75	401,294
1.80	382,088
1.85	363,169
1.90	344,578
1.95	326,355
2.00	308,537
2.05	291,160
2.10	274,253
2.15	257,846

Z	PPM
2.20	241,964
2.25	266,627
2.30	211,856
2.35	197,663
2.40	184,060
2.45	171,056
2.50	158,655
2.55	146,859
2.60	135,666
2.65	125,072
2.70	115,070
2.75	105,650
2.80	96,800
2.85	88,508
2.90	80,757
2.95	73,529
3.00	66,807
3.05	60,571
3.10	54,799
3.15	49,471
3.20	44,565
3.25	40,059
3.30	35,930
3.35	32,157
3.40	28,717
3.45	25,588
3.50	22,750
3.55	20,182
3.60	17,865
3.65	15,778
3.70	13,904
3.75	12,225
3.80	10,724
3.85	9,387
3.90	8,198
3.95	7,143
4.00	6,210
4.05	5,386
4.10	4,661
4.15	4,024
4.20	3,467
4.25	2,980
4.30	2,555
4.35	2,186

Z	PPM
4.40	1,866
4.45	1,589
4.50	1,350
4.55	1,144
4.60	968
4.65	816
4.70	687
4.75	577
4.80	483
4.85	404
4.90	337
4.95	280
5.00	233
5.05	193
5.10	159
5.15	131
5.20	108
5.25	89
5.30	72
5.35	59
5.40	48
5.45	39
5.50	32
5.55	26
5.60	21
5.65	17
5.70	13
5.75	11
5.80	9
5.85	7
5.90	5
5.95	4
6.00	3

s to PPM

+/- Sigma Level at Spec Limit	Percent Within Spec Centered Distribution	Defective ppm: Centered Distribution (Short Term)	Percent within spec: 1.5 Sigma Shifted Distribution	Defective ppm: 1.5 Sigma Shifted Distribution (Long Term)
1.0	68.2689480	317310.520	30.232785	697672.15
1.1	72.8667797	271332.203	33.991708	660082.92
1.2	76.9860537	230139.463	37.862162	621378.38
1.3	80.6398901	193601.099	41.818512	581814.88
1.4	83.8486577	161513.423	45.830622	541693.78
1.5	86.6385542	133614.458	49.865003	501349.97
1.6	89.0401421	109598.597	53.886022	461139.78
1.7	91.0869136	89130.864	57.857249	421427.51
1.8	92.8139469	71860.531	61.742787	382572.13
1.9	94.2567014	57432.986	65.508472	344915.28
2.0	95.4499876	45500.124	69.122979	308770.21
2.1	96.4271285	34728.715	72.558779	274412.21
2.2	97.2193202	27806.798	75.792859	242071.41
2.3	97.8551838	21448.162	78.807229	211927.71
2.4	98.3604942	16395.058	81.589179	184108.21
2.5	98.7580640	12419.360	84.131305	158686.95
2.6	99.0677556	9322.444	86.431323	135686.77
2.7	99.3065954	6934.046	88.491691	115083.09
2.8	99.4889619	5110.381	90.319090	96809.10
2.9	99.6268240	3731.760	91.923787	80762.13
3.0	99.7300066	2699.934	93.318937	66810.63
3.1	99.8064658	1935.342	94.519860	54801.40
3.2	99.8625596	1374.404	95.543327	44566.73
3.3	99.9033035	966.965	96.406894	35931.06
3.4	99.9326038	673.962	97.128303	28716.97
3.5	99.9534653	465.347	97.724965	22750.35
3.6	99.9681709	318.291	98.213547	17864.53
3.7	99.9784340	215.660	98.609650	13903.50
3.8	99.9855255	144.745	98.927586	10724.14
3.9	99.9903769	96.231	99.180244	8197.56
4.0	99.9936628	63.372	99.379030	6209.70
4.1	99.9958663	41.337	99.533877	4661.23
4.2	99.9973292	26.708	99.653297	3467.03
4.3	99.9982908	17.092	99.744481	2555.19
4.4	99.9989166	10.834	99.813412	1865.88
4.5	99.9993198	6.802	99.865003	1349.97
4.6	99.9995771	4.229	99.903233	967.67
4.7	99.9997395	2.605	99.931280	687.20
4.8	99.9998411	1.589	99.951652	483.48
4.9	99.9999040	0.960	99.966302	336.98
5.0	99.9999426	0.574	99.976733	232.67
5.1	99.9999660	0.340	99.984085	159.15
5.2	99.9999800	0.200	99.989217	107.83
5.3	99.9999884	0.116	99.992763	72.37
5.4	99.9999933	0.067	99.995188	48.12
5.5	99.9999962	0.038	99.996831	31.69
5.6	99.9999979	0.210	99.997933	20.67
5.7	99.9999988	0.012	99.998665	13.35
5.8	99.9999993	0.007	99.999145	8.55
5.9	99.9999996	0.004	99.999458	5.42
6.0	99.9999998	0.002	99.999660	3.40