

Table of Contents

Preface	ix
Chapter 1. Elements of Analysis of Reliability and Quality Control	1
1.1. Introduction	1
1.1.1. The importance of true physical acceleration life models (accelerated tests = true acceleration or acceleration).	3
1.1.2. Expression for linear acceleration relationships	4
1.2. Fundamental expression of the calculation of reliability	5
1.3. Continuous uniform distribution	9
1.3.1. Distribution function of probabilities (density of probability)	10
1.3.2. Distribution function	10
1.4. Discrete uniform distribution (discrete U).	12
1.5. Triangular distribution.	13
1.5.1. Discrete triangular distribution version	13
1.5.2. Continuous triangular law version.	14
1.5.3. Links with uniform distribution	14
1.6. Beta distribution	15
1.6.1. Function of probability density	16
1.6.2. Distribution function of cumulative probability	18
1.6.3. Estimation of the parameters (p, q) of the beta distribution	19
1.6.4. Distribution associated with beta distribution	20
1.7. Normal distribution	20
1.7.1. Arithmetic mean	20
1.7.2. Reliability	22
1.7.3. Stabilization and normalization of variance error	23
1.8. Log-normal distribution (Galton).	28
1.9. The Gumbel distribution	28
1.9.1. Random variable according to the Gumbel distribution (CRV, E_1 Maximum).	29
1.9.2. Random variable according to the Gumbel distribution (CRV E_1 Minimum)	30

1.10. The Frechet distribution (E_2 Max)	31
1.11. The Weibull distribution (with three parameters)	32
1.12. The Weibull distribution (with two parameters).	35
1.12.1. Description and common formulae for the Weibull distribution and its derivatives	37
1.12.2. Areas where the extreme value distribution model can be used	39
1.12.3. Risk model	40
1.12.4. Products of damage	41
1.13. The Birnbaum–Saunders distribution.	42
1.13.1. Derivation and use of the Birnbaum–Saunders model	43
1.14. The Cauchy distribution	45
1.14.1. Probability density function	45
1.14.2. Risk function.	48
1.14.3. Cumulative risk function	48
1.14.4. Survival function (reliability).	49
1.14.5. Inverse survival function	49
1.15. Rayleigh distribution.	50
1.16. The Rice distribution (from the Rayleigh distribution)	52
1.17. The Tukey-lambda distribution	53
1.18. Student’s (t) distribution	55
1.18.1. t-Student’s inverse cumulative function law (T)	57
1.19. Chi-square distribution law (χ^2).	57
1.19.1. Probability distribution function of chi-square law (χ^2)	57
1.19.2. Probability distribution function of chi-square law (χ^2)	58
1.20. Exponential distribution	59
1.20.1. Example of applying mechanics to component lifespan	63
1.21. Double exponential distribution (Laplace).	66
1.21.1. Estimation of the parameters	66
1.21.2. Probability density function	66
1.21.3. Cumulated distribution probability function	67
1.22. Bernoulli distribution	68
1.23. Binomial distribution.	71
1.24. Polynomial distribution	75
1.25. Geometrical distribution	75
1.25.1. Hypergeometric distribution (the Pascal distribution) versus binomial distribution.	76
1.26. Hypergeometric distribution (the Pascal distribution).	78
1.27. Poisson distribution	80
1.28. Gamma distribution	81
1.29. Inverse gamma distribution	85
1.30. Distribution function (inverse gamma distribution probability density)	85
1.31. Erlang distribution (characteristic of gamma distribution, Γ)	85
1.32. Logistic distribution	89
1.33. Log-logistic distribution	91
1.33.1. Mathematical–statistical characteristics of log-logistic distribution.	91

1.33.2. Moment properties	92
1.34. Fisher distribution (F-distribution or Fisher–Snedecor).	92
1.35. Analysis of component lifespan (or survival)	95
1.36. Partial conclusion of Chapter 1	96
1.37. Bibliography	97
Chapter 2. Estimates, Testing Adjustments and Testing the Adequacy of Statistical Distributions	99
2.1. Introduction to assessment and statistical tests	99
2.1.1. Estimation of parameters of a distribution	100
2.1.2. Estimation by confidence interval	102
2.1.3. Properties of an estimator with and without bias.	103
2.2. Method of moments	106
2.3. Method of maximum likelihood	106
2.3.1. Estimation of maximum likelihood	107
2.3.2. Probability equation of reliability-censored data.	108
2.3.3. Punctual estimation of exponential law	109
2.3.4. Estimation of the Weibull distribution	110
2.3.5. Punctual estimation of normal distribution	111
2.4. Moving least-squares method.	113
2.4.1. General criterion: the LSC	114
2.4.2. Examples of nonlinear models.	118
2.4.3. Example of a more complex process	122
2.5. Conformity tests: adjustment and adequacy tests	123
2.5.1. Model of the hypothesis test for adequacy and adjustment	125
2.5.2. Kolmogorov–Smirnov Test (KS 1930 and 1936)	126
2.5.3. Simulated test (1st application)	131
2.5.4. Simulated test (2nd application)	131
2.5.5. Example 1	132
2.5.6. Example 2 (Weibull or not?).	135
2.5.7. Cramer–Von Mises (CVM) test	139
2.5.8. The Anderson–Darling test.	140
2.5.9. Shapiro–Wilk test of normality	145
2.5.10. Adequacy test of chi-square (χ^2)	145
2.6. Accelerated testing method	151
2.6.1. Multi-censored tests	152
2.6.2. Example of the exponential model	152
2.6.3. Example of the Weibull model	152
2.6.4. Example for the log–normal model	153
2.6.5. Example of the extreme value distribution model (E-MIN).	153
2.6.6. Example of the study on the Weibull distribution	154
2.6.7. Example of the BOX–COX model	156
2.7. Trend tests	157
2.7.1. A unilateral test	158
2.7.2. The military handbook test (from the US Army).	160
2.7.3. The Laplace test.	160

2.7.4. Homogenous Poisson Process (HPP)	160
2.8. Duane model power law	164
2.9. Chi-Square test for the correlation quantity	166
2.9.1. Estimations and χ^2 test to determine the confidence interval	167
2.9.2. t test of normal mean.	170
2.9.3. Standard error of the estimated difference, s	171
2.10. Chebyshev's inequality	171
2.11. Estimation of parameters	173
2.12. Gaussian distribution: estimation and confidence interval	174
2.12.1. Confidence interval estimation for a Gauss distribution	175
2.12.2. Reading to help the statistical values tabulated	175
2.12.3. Calculations to help the statistical formulae appropriate to normal distribution	175
2.12.4. Estimation of the Gaussian mean of unknown variance	175
2.13. Kaplan–Meier estimator	178
2.13.1. Empirical model using the Kaplan–Meier approach	179
2.13.2. General expression of the KM estimator	180
2.13.3. Application of the ordinary and modified Kaplan–Meier estimator	181
2.14. Case study of an interpolation using the bi-dimensional <i>spline</i> function	181
2.15. Conclusion	183
2.16. Bibliography	184
Chapter 3. Modeling Uncertainty	187
3.1. Introduction to errors and uncertainty	187
3.2. Definition of uncertainties and errors as in the ISO norm	189
3.3. Definition of errors and uncertainty in metrology	191
3.3.1. Difference between error and uncertainty.	192
3.4. Global error and its uncertainty.	202
3.5. Definitions of simplified equations of measurement uncertainty	204
3.5.1. Expansion factor k and range of relative uncertainty	206
3.5.2. Determination of type A and B uncertainties according to GUM	208
3.6. Principal of uncertainty calculations of <i>type A</i> and <i>type B</i>	229
3.6.1. Standard and expanded uncertainties	231
3.6.2. Components of type A and type B uncertainties	232
3.6.3. Error on repeated measurements: composed uncertainty	232
3.7. Study of the basics with the help of the GUMic software package: quasi-linear model	239
3.8. Conclusion	245
3.9. Bibliography	245
Glossary	249
Index	257