

CONTENTS

NOTE FROM THE SERIES EDITOR, <i>D. B. Owen</i>	v
FOREWORD, <i>Colin G. Drury</i>	vii
PREFACE	ix
ACKNOWLEDGMENTS	xi
Chapter 1 INTRODUCTION	1
Acceptance Quality Control	2
Acceptance Control and Process Control	5
Process Quality Control	5
Background of Acceptance Quality Control	8
Problems	11
References	11
Chapter 2 PROBABILITY AND THE OPERATING CHARACTERISTIC CURVE	14
Probability	14
Random Samples and Random Numbers	16
Counting Possibilities	18
Probability Calculus	22
The Operating Characteristic Curve	26
Problems	31
References	32
Chapter 3 PROBABILITY FUNCTIONS	33
Probability Distributions	34
Measures of Distribution Functions	37
Hypergeometric Distribution	40
Binomial Distribution	42
Poisson Distribution	46
Negative Binomial Distribution	47
Exponential and Continuous Distributions	51
Weibull Distribution	53
Normal Distribution	56
Summary of Distributions	59
Tables of Distributions	59
Useful Approximations	64

Tests of Fit	68
Problems	71
References	72
Chapter 4 CONCEPTS AND TERMINOLOGY	76
Sample Size and Lot Size	80
Effect of Inspection Error	84
Rectification	86
Curtailment	91
Tolerance and Confidence Intervals	92
Levels and Risks	95
Classification of Defects	97
Choosing Quality Levels	98
Measures of Sampling Plans: Terminology	98
Graphs of Measures	101
Specifying a Plan	104
Problems	107
References	108
Chapter 5 SINGLE SAMPLING BY ATTRIBUTES	110
Operation	110
Selection	111
Measures	121
Problems	124
References	125
Chapter 6 DOUBLE AND MULTIPLE SAMPLING BY ATTRIBUTES	127
Operation	128
Selection	131
Measures	137
Further Considerations	151
Problems	151
References	152
Chapter 7 SEQUENTIAL SAMPLING BY ATTRIBUTES	154
Operation	155
Selection	156
Measures	159
Sequential Sampling for Defects per Unit	160
Further Considerations	161
Problems	164
References	165
Chapter 8 VARIABLES SAMPLING FOR PROCESS PARAMETER	166
Single Sampling for Process Parameter	167
Acceptance Control Charts	169
Sequential Plans for Process Parameter (σ Known)	173
Sequential Plans for Process Parameter (σ Unknown)	184
Cumulative Sum Charts	186
Problems	190
References	191

Chapter 9	BULK SAMPLING	192
	Construction of the Sample	193
	Estimation	197
	Sampling Plans	208
	Simple Random Sampling of Unique Lot (Components of Variance Unknown)	210
	Sampling from a Stream of Lots	213
	Problems	218
	References	219
Chapter 10	SAMPLING BY VARIABLES FOR PROPORTION NONCONFORMING	222
	Specification Limits	224
	Assumptions and Theory	224
	Areas of Application	228
	Operation	229
	Selection	235
	Measures	241
	M Method	250
	Plans Based on Sample Range	256
	Double Sampling by Variables	260
	Tolerance Intervals and Variables Plans for Percent Nonconforming	263
	Sequential Plans for Proportion Nonconforming	269
	Further Considerations	270
	Problems	272
	References	273
Chapter 11	ATTRIBUTES SAMPLING SCHEMES : MIL-STD-105D	277
	Operation	280
	Selection	286
	Measures	290
	Implementation of MIL-STD-105D	294
	Matching Individual Sampling Plans to MIL-STD-105D System Performance	299
	Further Considerations	302
	Problems	304
	References	305
Chapter 12	VARIABLES SAMPLING SCHEMES : MIL-STD-414	307
	Operation	309
	Selection	312
	Measures	317
	Implementation of Form 2	317
	Implementation of Form 1	320
	Implementation of Plans for Range and Variability Known	321
	Match Between MIL-STD-414 and MIL-STD-105D	322
	Further Considerations	323
	Problems	324
	References	324
Chapter 13	SPECIAL PLANS AND PROCEDURES	326
	No-Calc Plans	326
	Lot Plot Plans	329
	Narrow Limit Gauging	333

Mixed Variables - Attributes Plan	347
Philips Standard Sampling System	365
Problems	368
References	369
Chapter 14 SERIES OF LOTS : RECTIFICATION SCHEMES	372
Single-Sampling AOQL Plan	373
Dodge-Romig Sampling Scheme	374
Anscombe Rectifying Inspection Procedure	393
Problems	398
References	399
Chapter 15 CONTINUOUS SAMPLING PLANS	400
Dodge Continuous Plans	401
Multi-Level Plans	415
Tightened Multi-Level Plans	420
Block Continuous Plans	421
MIL-STD-1235A	426
Problems	435
References	439
Chapter 16 CUMULATIVE RESULTS PLANS	442
Skip-Lot Sampling Plans	443
Chain Sampling Plans	451
Deferred Sentencing Schemes	459
Demerit Rating Plan	463
Cumulative Results Criterion Plan (CRC)	468
Problems	471
References	472
Chapter 17 COMPLIANCE SAMPLING	474
Lot Sensitive Sampling Plan (LSP)	475
Tightened-Normal-Tightened Scheme (TNT)	482
Quick Switching System (QSS)	487
Simplified Grand Lot Procedure	488
Procedure for Determining Validity of Inspection : H-109	510
Problems	520
References	520
Chapter 18 RELIABILITY SAMPLING	524
Censored Sampling	526
Variables Plans for Life Testing and Reliability	528
Handbook H-108	531
Technical Report TR 7	543
Problems	560
References	562
Chapter 19 ADMINISTRATION OF ACCEPTANCE SAMPLING	564
Selection and Implementation of a Sampling Procedure	568
Determining Quality Levels	571
Economic Considerations	583
Mandatory Standards	585
Computer Programs	586

A Basic Principle of Administration	586
Problems	588
References	589

APPENDIX TABLES

	593
T1-1 Control Chart Limits for Samples of n	594
T2-1 Random Numbers	595
T3-1 Values of e^{-x}	597
T3-2 Cumulative Normal Probability, $F(z)$	598
T3-3 Lieberman-Owen Table of Hypergeometric Distribution, $F(x)$, $f(x)$	600
T3-4 Harvard Table of Binomial Distribution, $1 - F(r - 1)$	603
T3-5 Molina Table of Poisson Distribution, $1 - F(c - 1)$	608
T5-1 Cameron Table of Unity Values for Constructing Single-Sampling Plans	619
T5-2 Cameron Table of Unity Values to Determine Probability of Acceptance	620
T6-1 Unity Values for Construction and Evaluation of Single-, Double-, and Multiple-Sampling Plans	621
T7-1 Statistical Research Group: Table of Sequential Sampling Plans	626
T7-2 Statistical Research Group: Table of Values of a and b for Sequential Sampling	630
T7-3 g_1 and g_2 in Terms of p_1 and p_2 Using Common Logarithms for Sequential Sampling	631
T8-1 Operating Characteristics of the One-Sided Normal Test for a Level of Significance Equal to 0.05	632
T8-2 Operating Characteristics of the Two-Sided Normal Test for a Level of Significance Equal to 0.05	632
T8-3 Operating Characteristics of the One-Sided t-Test for a Level of Significance Equal to 0.05	633
T8-4 Operating Characteristics of the Two-Sided t-Test for a Level of Significance Equal to 0.05	633
T8-5 Operating Characteristics of the One-Sided (Upper Tail) Chi-Square Test for a Level of Significance Equal to 0.05	634
T8-6 Factors for Acceptance Control Limits	635
T8-7 Correction Terms for Acceptance Control Factors	636
T8-8 Boundary Values for Barnard's Sequential t-Test	637
T10-1 d_2^* Factors and Degrees of Freedom v for Estimating the Standard Deviation for the Average Range of k Samples of n	638
T10-2 Matched Single and Double, Known (σ) and Unknown (s) Standard Deviation, Variables Sampling Plans for Values of p_1 and p_2 with $\alpha = .05$, $\beta = .10$	639
T10-3 Comparison of Approximate and Exact Values of N and k for Variables Sampling Plans	642
T10-4 Odeh-Owen Table 5: Two-Sided Sampling Plan Factors to Control Equal Tails	643
T10-5 Odeh-Owen Table 6: Two-Sided Sampling Plan Factors to Control Tails Separately	644
T11-1 MIL-STD-105D Table VIII. Limit Numbers for Reduced Inspection	645
T11-2 MIL-STD-105D Table I. Sample Size Code Letters	646

T11-3	MIL-STD-105D Table II-A. Single-Sampling Plans for Normal Inspection (Master Table)	647
T11-4	MIL-STD-105D Table II-B. Single-Sampling Plans for Tightened Inspection (Master Table)	648
T11-5	MIL-STD-105D Table II-C. Single-Sampling Plans for Reduced Inspection (Master Table)	649
T11-6	MIL-STD-105D Table III-A. Double-Sampling Plans for Normal Inspection (Master Table)	650
T11-7	MIL-STD-105D Table III-B. Double-Sampling Plans for Tightened Inspection (Master Table)	651
T11-8	MIL-STD-105D Table III-C. Double-Sampling Plans for Reduced Inspection (Master Table)	652
T11-9	MIL-STD-105D Table IV-A. Multiple-Sampling Plans for Normal Inspection (Master Table)	653
T11-10	MIL-STD-105D Table IV-B. Multiple-Sampling Plans for Tightened Inspection (Master Table)	655
T11-11	MIL-STD-105D Table IV-C. Multiple-Sampling Plans for Reduced Inspection (Master Table)	657
T11-12	MIL-STD-105D Table V-A. Average Outgoing Quality Limit Factors for Normal Inspection (Single Sampling)	659
T11-13	MIL-STD-105D Table V-B. Average Outgoing Quality Limit Factors for Tightened Inspection (Single Sampling)	660
T11-14	MIL-STD-105D Table VI-A. Limiting Quality (in percent defective) for Which $P = 10$ Percent	661
T11-15	MIL-STD-105D Table VI-B. Limiting Quality (in defects per hundred units) for Which $P_a = 10$ Percent	662
T11-16	MIL-STD-105D Table VII-A. Limiting Quality (in percent defective) for Which $P = 5$ Percent	663
T11-17	MIL-STD-105D Table VII-B. Limiting Quality (in defects per hundred units) for Which $P_a = 5$ Percent	664
T11-18	MIL-STD-105D Table IX. Average Sample Size Curves for Double and Multiple Sampling	665
T11-19	MIL-STD-105D Table X-F. Tables for Sample Size Code Letter: F	666
T11-20	MIL-STD-105D Scheme Average Outgoing Quality Limit Factors (in defects per hundred units)	668
T11-21	MIL-STD-105D Scheme Limiting Quality (in defects per hundred units) for Which $P_a = 10$ Percent	669
T11-22	MIL-STD-105D Scheme Limiting Quality (in defects per hundred units) for Which $P_a = 5$ Percent	670
T11-23	Scheme Measures of Performance for MIL-STD-105D, Code F	671
T11-24	Operating Ratios for the MIL-STD-105D Scheme ($R = p_{.10}/p_{.95}$, calculated using Poisson distribution)	672
T12-1	MIL-STD-414 Table B-6. Values of T for Tightened Inspection: Standard Deviation Method	673
T12-2	MIL-STD-414 Table B-7. Limits of Estimated Lot Percent Defective for Reduced Inspection: Standard Deviation Method	675
T12-3	MIL-STD-414 Table A-1. AQL Conversion Table	677
T12-4	MIL-STD-414 Table A-2. Sample Size Code Letters	678
T12-5	MIL-STD-414 Table B-3. Master Table for Normal and Tightened Inspection for Plans Based on Variability Unknown: Standard Deviation Method, Form 2	679
T12-6	MIL-STD-414 Table B-4. Master Table for Reduced Inspection for Plans Based on Variability Unknown: Standard Deviation Method, Form 2	680

T12-7	MIL-STD-414 Table B-5. Table for Estimating the Lot Percent Defective Using Standard Deviation Method	681
T12-8	MIL-STD-414 Table B-1. Master Table for Normal and Tightened Inspection for Plans Based on Variability Unknown: Standard Deviation Method, Form 1	690
T12-9	MIL-STD-414 Table B-2. Master Table for Reduced Inspection for Plans Based on Variability Unknown: Standard Deviation Method, Form 1	691
T12-10	MIL-STD-414 Table B-8. Values of F for Maximum Standard Deviation (MSD)	692
T13-1	Values of Plotting Positions (p_i) to be Used in Plotting on Normal Probability Paper for the No-Calc Procedure	693
T13-2	Values of Maximum Estimated Percentage Defective Allowing Acceptance of the Lot (p^*)	693
T13-3	Matched Attributes, Narrow Limit, Known (σ) and Unknown (s) Standard Deviation Variables Plans for Values of p_1 and p_2 with $\alpha = .05$, $\beta = .10$	694
T13-4	Tightened Inspection Optimal Narrow Limit Plans for MIL-STD-105D	698
T13-5	Normal Inspection Optimal Narrow Limit Plans for MIL-STD-105D	699
T13-6	Reduced Inspection Optimal Narrow Limit Plans for MIL-STD-105D	700
T13-7	MIL-STD-105D Scheme Probability of Acceptance (P_a) and Average Sample Number (ASN) at AQL Using Narrow Limit Plans	701
T13-8	Joint Probabilities for Mixed Plans	702
T14-1	Values of x and y for Determining AOQL	708
T16-1	Values of Y for Determining AOQL, for SkSP-2 Plans	709
T16-2	Unity Values for SkSP-2 and Matched Single Sampling Plans	710
T16-3	Poisson Unity Values for Constructing ChSP-1 Plans	711
T16-4	ChSP-1 Plans Indexed by AQL($p_{.95}$) and LTPD($p_{.10}$)	712
T16-5	ChSP-1 Plans Indexed by AQL($p_{.95}$) and AOQL	713
T17-1	Unity Values for the QSS System	715
T17-2	H_Q Values for Simplified Grand Lot Sampling	721
T17-3	H109 Table I. Lot Action Limit Numbers, $d_C(A)$	722
T17-4	H109 Table II. Check Ratings for Paired Attributes Sampling Inspections	723
T17-5	H109 Table III. Cumulative Check Rating Criteria	726
T17-6	H109 Table IV. Probability of Acceptance in k Trials	727
T17-7	H109 Table V. Probability of Acceptance of Inspection Verification Plans	728
T18-1	Hazard Values Corresponding to Probability Plotting Positions for Censored Data	729
T18-2	H108 Table 2A-1. Life Test Sampling Plan Code Designation	731
T18-3	H108 Table 2B-1. Master Table for Life Tests Terminated upon Occurrence of Preassigned Number of Failures	732
T18-4	H108 Table 2C-1(b). Master Table for Life Tests Terminated at Preassigned Time: Testing Without Replacement	733
T18-5	H108 Table 2C-2(b). Master Table for Life Tests Terminated at Preassigned Time: Testing With Replacement	734

T18-6	H108 Table 2D-1(b). Master Table for Sequential Life Tests	735
T18-7	H108 Table 2C-5. Master Table for Proportion Failing Before Specified Time. Life Test Sampling Plans for Specified α , β , and p_1/p_0	736
T18-8	TR3 Table 1. Table of Values for Percent Truncation, $(t/\mu) \times 100$	737
T18-9	TR7 Table 1A. $100t/\mu$ Ratios at the Acceptable Quality Level (normal inspection) for the MIL-STD-105D Plans	738
T18-10	TR7 Table 1B. $100t/\mu$ Ratios at the Limiting Quality Level for the MIL-STD-105D Plans: Consumer's Risk = 0.10	739
T18-11	TR7 Table 1C. $100t/\mu$ Ratios at the Limiting Quality Level for the MIL-STD-105D Plans: Consumer's Risk = 0.05	742
ANSWERS TO PROBLEMS		745
AUTHOR INDEX		761
SUBJECT INDEX		765