620.0042 ASTM

Contents

Preface xv

PART 1
PRESENTATION OF DATA

Summary 1
Recommendations for Presentation of Data 1
Glossary of Symbols Used in Part 1 1

INTRODUCTION

SECTION
1. Purpose 2
2. Type of Data Considered 3
3. Homogeneous Data 3
4. Typical Examples of Physical Data 4

UNGROUPED FREQUENCY DISTRIBUTIONS

5. Ungrouped Frequency Distributions 4
6. Remarks 5

GROUPED FREQUENCY DISTRIBUTIONS

7. Introduction 5
8. Definitions 5
9. Choice of Cell Boundaries 11
10. Number of Cells 11
11. Methods of Classifying Observations 11
12. Cumulative Frequency Distribution 12
13. Tabular Presentation 12
14. Graphical Presentation 13
15. Remarks 14

FUNCTIONS OF A FREQUENCY DISTRIBUTION

16. Introduction 15
17. Relative Frequency 17
18. Average (Arithmetic Mean) 17

19. Other Measures of Central Tendency 17
20. Standard Deviation 18
21. Other Measures of Dispersion 19
22. Skewness—g_1 19
22a. Kurtosis—g_2 20
23. Remarks 20

METHODS OF COMPUTING $\bar{X}$, s, g_1, AND g_2

24. Computation of Average and Standard Deviation 20
25. Short Method of Computation When n is Large 24
26. Remarks 24

AMOUNT OF INFORMATION CONTAINED IN p, $\bar{X}$, s, g_1, AND g_2

27. Introduction 25
28. The Problem 28
29. Several Values of Relative Frequency, p 28
30. Single Value of Relative Frequency, p 28
31. Average, $\bar{X}$, Only 29
32. Average, $\bar{X}$, and Standard Deviation, s 30
33. Average, $\bar{X}$, Standard Deviation, s, Skewness, g_1, and Kurtosis, g_2 33
34. Use of Coefficient of Variation Instead of Standard Deviation 35
35. General Comment on Observed Frequency Distributions of a Series of ASTM Observations 38
36. Summary: Amount of Information Contained in Simple Functions of the Data 38

ESSENTIAL INFORMATION

37. Introduction 39
38. What Functions of the Data Contain the Essential Information 40
39. Presenting $\bar{X}$ Only Versus Presenting $\bar{X}$ and s 41
40. Observed Relationships 41
41. Summary: Essential Information 43

PRESENTATION OF RELEVANT INFORMATION

42. Introduction 44
43. Relevant Information 45
44. Evidence of Control 45

RECOMMENDATIONS

45. Recommendations for Presentation of Data 46

SUPPLEMENTS

Supplement 46
References for Part 1 49

PART 2
PRESENTING PLUS OR MINUS LIMITS OF UNCERTAINTY OF AN OBSERVED AVERAGE

Glossary of Symbols Used in Part 2 53
1. Purpose 53
2. The Problem 53
3. Theoretical Background 54
4. Computation of Limits 55
5. Experimental Illustration 59
6. Presentation of Data 59
6a. One-Sided Limits 60
7. Number of Places to be Retained in Computation and Presentation 61
8. General Comments on the Use of Confidence Limits 63

SUPPLEMENTS

A. Presenting Plus or Minus Limits of Uncertainty for σ', Normal Universe 64 66
B. Presenting Plus or Minus Limits of Uncertainty for p' 68
References for Part 2

PART 3
CONTROL CHART METHOD OF ANALYSIS AND PRESENTATION OF DATA

Glossary of Terms and Symbols Used in Part 3 71

GENERAL PRINCIPLES

1. Purpose 73
2. Terminology and Technical Background 75
3. Two Uses 75
4. Breaking up Data into Rational Subgroups 76
5. General Technique in Using Control Chart Method 76
6. Control Limits 77

CONTROL—NO STANDARD GIVEN

7. Introduction 78

8. Control Charts for Averages, $\bar{X}$, and for Standard Deviations, s—Large Samples 78
(*a*) Large Samples of Equal Size 78
(*b*) Large Samples of Unequal Size 79
9. Control Charts for Averages, $\bar{X}$, and for Standard Deviations, s—Small Samples 80
(*a*) Small Samples of Equal Size 80
(*b*) Small Samples of Unequal Size 80
10. Control Charts for Averages, $\bar{X}$, and for Ranges, R—Small Samples 81
(*a*) Small Samples of Equal Size 81
(*b*) Small Samples of Unequal Size 82
11. Summary, Control Charts for $\bar{X}$, s, and R—No Standard Given 82
12. Control Charts for Attributes Data 82
13. Control Chart for Fraction Defective, p 84
(*a*) Samples of Equal Size 84
(*b*) Samples of Unequal Size 85
14. Control Chart for Number of Defectives, pn 85
15. Control Chart for Defects per Unit, u 86
(*a*) Samples of Equal Size 87
(*b*) Samples of Unequal Size 88
16. Control Chart for Number of Defects, c 88
(*a*) Samples of Equal Size 88
(*b*) Samples of Unequal Size 89
17. Summary, Control Charts for p, pn, u, and c—No Standard Given 89

CONTROL WITH RESPECT TO A GIVEN STANDARD

18. Introduction 90
19. Control Charts for Averages, $\bar{X}$, and for Standard Deviations, s 91
20. Control Chart for Ranges, R 91
21. Summary, Control Charts for $\bar{X}$, s, and R—Standard Given 92
22. Control Charts for Attributes Data 92
23. Control Chart for Fraction Defective, p 92
24. Control Chart for Number of Defectives, pn 94
25. Control Chart for Defects per Unit, u 95
26. Control Chart for Number of Defects, c 95
27. Summary, Control Charts for p, pn, u, and c—Standard Given 96

CONTROL CHARTS FOR INDIVIDUALS

28. Introduction 96
29. Control Chart for Individuals, X—Using Rational Subgroups 97

30. Control Chart for Individuals—Using Moving Ranges 99
(*a*) No Standard Given 99
(*b*) Standard Given 99

EXAMPLES

31. Illustrative Examples—Control, No Standard Given 99
Example 1: Control Charts for $\bar{X}$ and s, Large Samples of Equal Size (Section 8(a)) 100
Example 2: Control Charts for $\bar{X}$ and s, Large Samples of Unequal Size (Section 8(b)) 101
Example 3: Control Charts for $\bar{X}$ and s, Small Samples of Equal Size (Section 9(*a*)) 102
Example 4: Control Charts for $\bar{X}$ and s, Small Samples of Unequal Size (Section 9(*b*)) 103
Example 5: Control Charts for $\bar{X}$ and R, Small Samples of Equal Size (Section 10(*a*)) 104
Example 6: Control Charts for $\bar{X}$ and R, Small Samples of Unequal Size (Section 10(*b*)) 105
Example 7: Control Charts for p, Samples of Equal Size (Section 13(*a*)), and pn, Samples of Equal Size (Section 14) 105
Example 8: Control Chart for p, Samples of Unequal Size (Section 13(*b*)) 107
Example 9: Control Charts for u, Samples of Equal Size (Section 15(*a*)), and c, Samples of Equal Size (Section 16(*a*)) 109
Example 10: Control Chart for u, Samples of Unequal Size (Section 15(*b*)) 109
Example 11: Control Charts for c, Samples of Equal Size (Section 16(*a*)) 111
32. Illustrative Examples—Control With Respect to a Given Standard 113
Example 12: Control Charts for $\bar{X}$ and s, Large Samples of Equal Size (Section 19) 113
Example 13: Control Charts for $\bar{X}$ and s, Large Samples of Unequal Size (Section 19) 114
Example 14: Control Charts for $\bar{X}$ and s, Small Samples of Equal Size (Section 19) 115
Example 15: Control Charts for $\bar{X}$ and s, Small Samples of Unequal Size (Section 19) 116
Example 16: Control Charts for $\bar{X}$ and R, Small Samples of Equal Size (Section 20) 117

Example 17: Control Charts for p, Samples of Equal Size (Section 23), and pn, Samples of Equal Size (Section 24) 118
Example 18: Control Chart for p (Fraction Defective), Samples of Unequal Size (Section 23) 120
Example 19: Control Chart for p (Fraction Rejected), Total and Components, Samples of Unequal Size (Section 23) 121
Example 20: Control Chart for u, Samples of Unequal Size (Section 25) 125
Example 21: Control Chart for c, Samples of Equal Size (Section 26) 126
33. Illustrative Examples—Control Chart for Individuals 127
Example 22: Control Chart for Individuals, X—Using Rational Subgroups, Samples of Equal Size, No Standard Given—Based on $\bar{X}$ and $\bar{R}$ (Section 29) 128
Example 23: Control Chart for Individuals, X—Using Rational Subgroups, Standard Given—Based on $\bar{X}_0'$ and σ_0' (Section 29) 129
Example 24: Control Charts for Individuals, X, and Moving Range, R, of Two Observations, No Standard Given—Based on $\bar{X}$ and $\bar{R}$, the Mean Moving Range (Section 30(a)) 130
Example 25: Control Charts for Individuals, X, and Moving Range, R, of Two Observations, Standard Given—Based on $\bar{X}_0'$ and σ_0' (Section 30(b)) 132

SUPPLEMENTS

A. Mathematical Relations and Tables of Factors for Computing Control Chart Lines 136
B. Explanatory Notes 142
References for Part 3 145

APPENDIXES

I. Tables of Squares and Square Roots 149
II. List of Some Related Publications on Quality Control 155
III. Recommended Practice for Choice of Sample Size to Estimate the Average Quality of a Lot or Process (ASTM Designation E 122) 157
Recommended Practices for Designating Significant Places in Specified Limiting Values (ASTM Designation E 29) ...[a]

[a] Available as a separate reprint from ASTM Headquarters.

Recommended Practice for Probability Sampling of Materials (ASTM Designation E 105) ...[a]
Recommended Practice for Acceptance of Evidence Based on the Results of Probability Sampling (ASTM Designation E 141) ...[a]