

ISO Guide 98-3:2010-11 (E)

Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)

Contents

Page

Preliminary	v
Foreword	vi
0 Introduction.....	viii
1 Scope	1
2 Definitions	1
2.1 General metrological terms.....	2
2.2 The term “uncertainty”	2
2.3 Terms specific to this <i>Guide</i>	3
3 Basic concepts	4
3.1 Measurement	4
3.2 Errors, effects, and corrections	5
3.3 Uncertainty	5
3.4 Practical considerations	7
4 Evaluating standard uncertainty.....	8
4.1 Modelling the measurement	8
4.2 Type A evaluation of standard uncertainty.....	10
4.3 Type B evaluation of standard uncertainty.....	11
4.4 Graphical illustration of evaluating standard uncertainty	15
5 Determining combined standard uncertainty.....	18
5.1 Uncorrelated input quantities	18
5.2 Correlated input quantities.....	21
6 Determining expanded uncertainty	23
6.1 Introduction.....	23
6.2 Expanded uncertainty	23
6.3 Choosing a coverage factor	24
7 Reporting uncertainty	24
7.1 General guidance	24
7.2 Specific guidance	25
8 Summary of procedure for evaluating and expressing uncertainty	27
Annex A Recommendations of Working Group and CIPM	28
A.1 Recommendation INC-1 (1980)	28
A.2 Recommendation 1 (CI-1981)	29
A.3 Recommendation 1 (CI-1986)	29
Annex B General metrological terms	31
B.1 Source of definitions	31
B.2 Definitions	31
Annex C Basic statistical terms and concepts.....	39
C.1 Source of definitions	39
C.2 Definitions	39
C.3 Elaboration of terms and concepts	45
Annex D “True” value, error, and uncertainty	49
D.1 The measurand	49
D.2 The realized quantity	49
D.3 The “true” value and the corrected value	49
D.4 Error	50

D.5	Uncertainty	51
D.6	Graphical representation	51
Annex E	Motivation and basis for Recommendation INC-1 (1980).....	54
E.1	“Safe”, “random”, and “systematic”	54
E.2	Justification for realistic uncertainty evaluations.....	54
E.3	Justification for treating all uncertainty components identically.....	55
E.4	Standard deviations as measures of uncertainty.....	58
E.5	A comparison of two views of uncertainty	59
Annex F	Practical guidance on evaluating uncertainty components	61
F.1	Components evaluated from repeated observations: Type A evaluation of standard uncertainty.....	61
F.2	Components evaluated by other means: Type B evaluation of standard uncertainty.....	64
Annex G	Degrees of freedom and levels of confidence	70
G.1	Introduction	70
G.2	Central Limit Theorem.....	71
G.3	The <i>t</i> -distribution and degrees of freedom	72
G.4	Effective degrees of freedom	73
G.5	Other considerations.....	75
G.6	Summary and conclusions	76
Annex H	Examples.....	79
H.1	End-gauge calibration	79
H.2	Simultaneous resistance and reactance measurement.....	85
H.3	Calibration of a thermometer.....	89
H.4	Measurement of activity	93
H.5	Analysis of variance	98
H.6	Measurements on a reference scale: hardness.....	104
Annex J	Glossary of principal symbols	109
Bibliography	114
Alphabetical index	116