Introduction

• Many analyses carried out to check compliance with a specification or regulation
• Necessary to take into account the measurement uncertainty when assessing compliance
• How can this be done?
• How does it help to control risk?
Basic use of limits

Upper control limit

Result above limit
Result above limit
Result at limit
Result below limit
Result below limit

Need additional information to deal with case (iii)

Basic guidance

Upper control limit

Result above limit
Result above limit but within uncertainty
Result at limit and within uncertainty
Result below limit but within uncertainty
Result below limit

Need additional information to deal with cases (ii) - (iv)
Consistent decisions need rules

Required information

ASME B89.7.3.1-2001 and similar guidance
- A specification giving upper and/or lower permitted limits
- A decision rule that describes how the uncertainty will be taken into account
- The limit(s) of the acceptance or rejection zone (i.e. the range of results), derived from the measurement result and a stated uncertainty
ISO/IEC 17025:2017

• Decision rule:
  “rule that describes how measurement uncertainty is accounted for when stating conformity with a specified requirement”

• §7.1.3: “When the customer requests a statement of conformity…the decision rule shall be clearly defined.”

Example of a decision rule

• A result equal to or above the upper limit implies non-compliance
  – result below the limit implies compliance

  “Simple acceptance”

  Also called “shared risk”
Probability of compliance

Compliance probability

Observed value

Small uncertainty

Small risk
Probability of compliance

For simple acceptance, small risk needs small uncertainty

Decision rules can control probabilities of false decisions
Probability of compliance

Decision rules & guard bands

a) Upper limit

Acceptance zone

Rejection zone

g: the “guard band”
e.g. U or 2u

b)

Acceptance zone

Rejection zone

“Relaxed acceptance”
(test for non-conformity)

“Stringent acceptance”
(test for conformity)

ILAC G-8 default
How does a Guard Band simplify interpretation?

Guard band based on expanded uncertainty at limit

Acceptance zone

Upper control limit

(i) Result above limit
(ii) Result above limit but within uncertainty
(iii) Result at limit and within uncertainty
(iv) Result below limit but within uncertainty
(v) Result below limit

Guard Band Stringent acceptance

Simple conclusions based on measured value

(i) Outside Acceptance zone
(ii) Outside Acceptance zone
(iii) Outside Acceptance zone
(iv) Outside Acceptance zone
(v) Inside Acceptance zone
Decision rules & guard bands

- Clear method of determining the location of acceptance and rejection zones
- Minimum acceptable level of the probability that the value of the measurand lies within the specification limits
- Procedure for dealing with repeated measurements and outliers
Additional technical problems

Other technical issues

• Relative uncertainty (uncertainty as % of value)
  – Affects guard band – set for limit, not for measurement result
• Asymmetry
  – May require special consideration
• Inconclusive results
  – Can be accommodated in the decision rule
• Setting coverage factor $k$
Choosing $k$: $k$ for 2-sided intervals

Note use of ONE-sided $t$ for TWO-sided interval

Summary

Assessment of compliance requires:

a) a measurement result and a stated uncertainty

b) a specification giving the upper and/or lower permitted limits of the characteristics (measurands) being controlled

c) a decision rule that describes how the measurement uncertainty will be taken into account

d) a reference to the decision rules used when reporting on compliance
Further reading

Use of uncertainty information in compliance assessment
Eurachem/CITAC Guide

www.eurachem.org