Use of uncertainty information in compliance assessment

EURACHEM/CITAC Guidance note

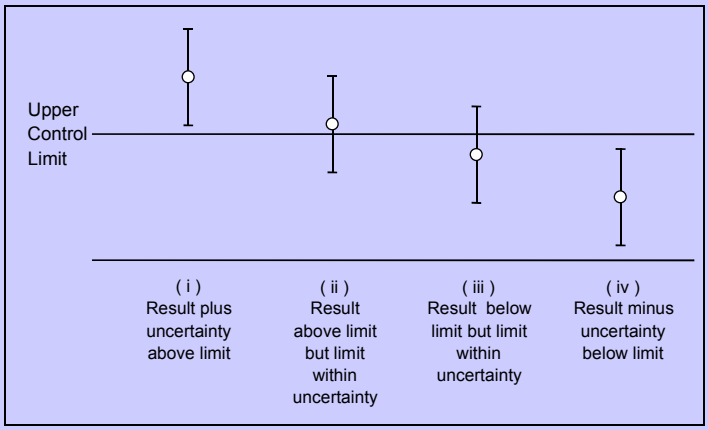
Alex Williams

Chairman EURACHEM/CITAC WG

Measurement Uncertainty &Traceability

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?



Guidance should cover cases (ii) & (iii)

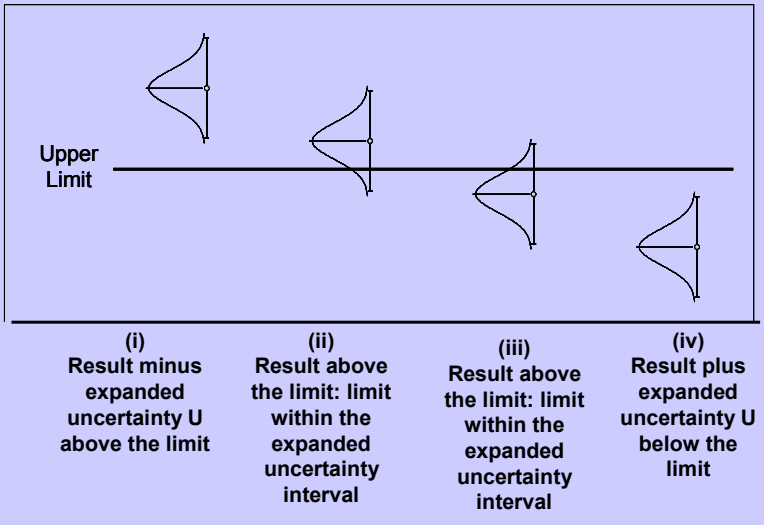
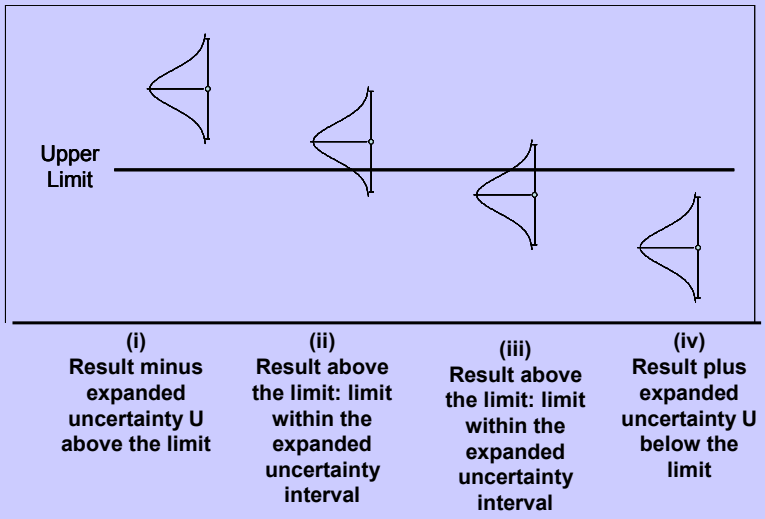


Figure 1 Assessment of Compliance with an Upper Limit



Need additional information to deal with cases (ii) & (iii)

What additional information is required ?

- It is provided by the use of "Decision rules"
- Introduced in ASME B89.7.3.1-2001
- Decision rules, enable an "Acceptance Zone" and a "Rejection Zone" to be clearly defined

Required Information

- 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 decision rule

Simple example of a Decision Rule

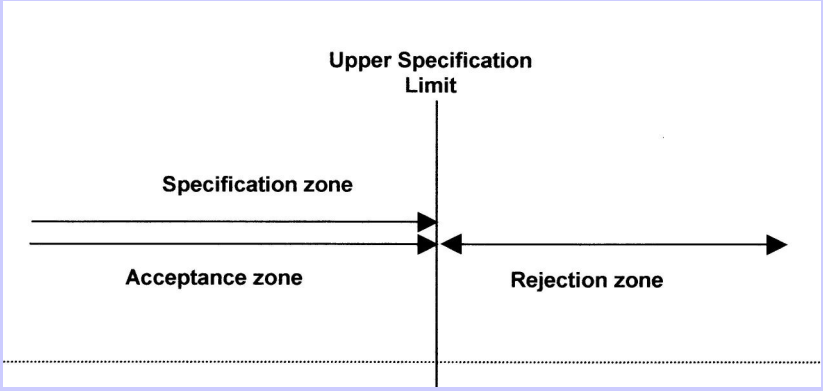
•A result equal to or above the upper limit implies non-compliance result below the limit implies compliance,

•provided that uncertainty is below a specified value.

•e.g. uncertainty is small compared with the limit

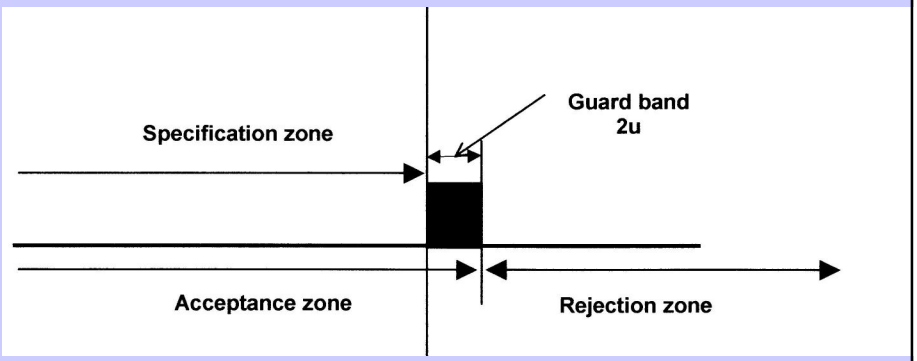
•the risk of making a wrong decision is acceptable.

Examples of Decision Rules



Examples of Decision Rules

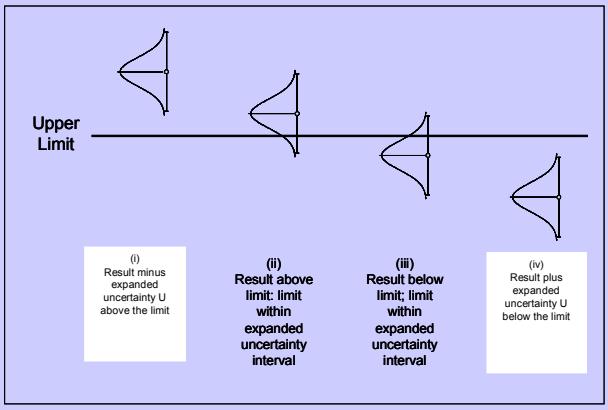
Non compliant with an upper limit if the measured value exceeds the limit by more than 2u



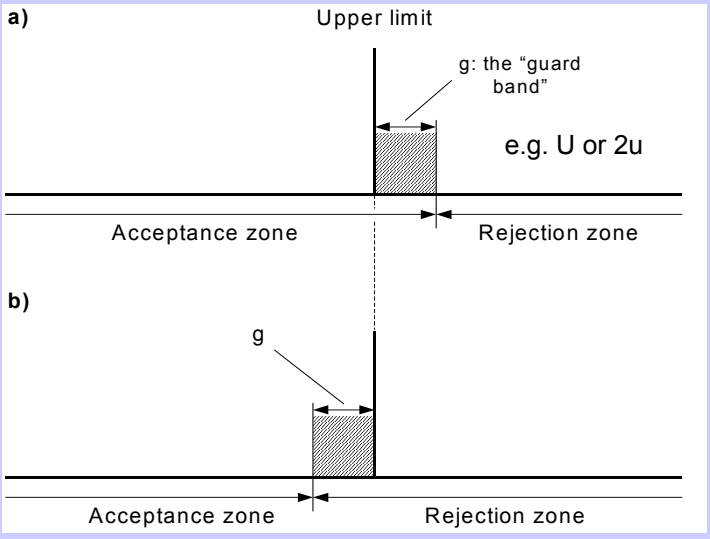
Examples of Decision Rules

Non compliant with an upper limit if the measured value exceeds the limit by

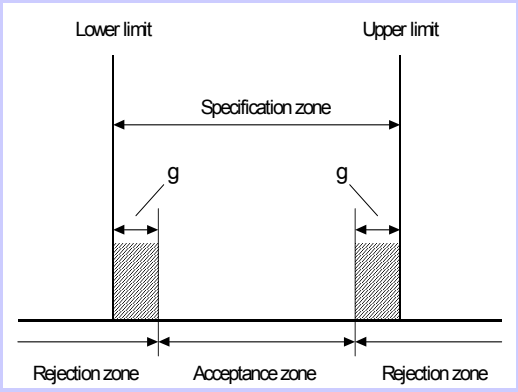
more than the expanded uncertainty U



Decision Rules & Guard Bands



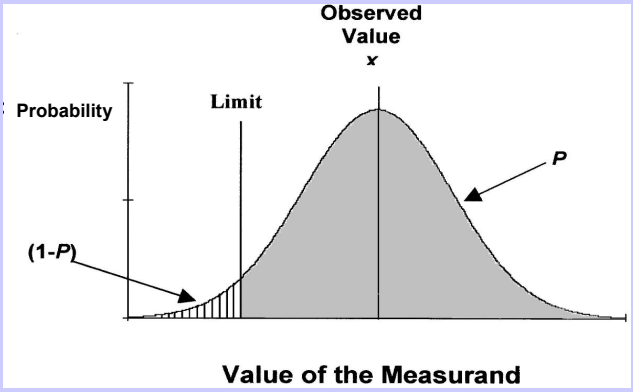
Decision Rules & Guard Bands



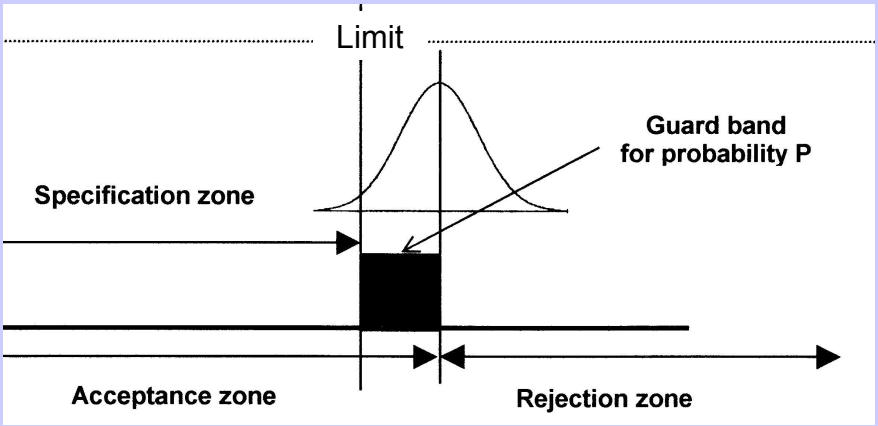
Decision Rules & Guard Bands

- 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

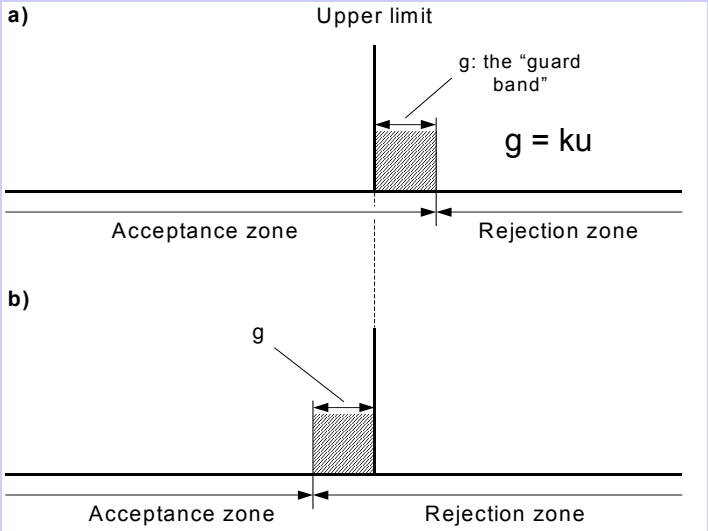
Probability Distribution of Value of Measurand



Decision Rules & Guard Bands



Decision Rules & Guard Bands



Decision Rules- Value of k

The batch will be considered to be non-compliant if the probability of the value of the measurand being greater than the limit exceeds 95%.

Distribution of value of measurand

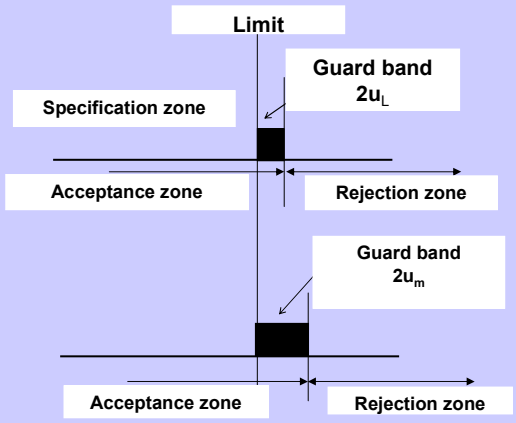
1. Normal k=1.65
2. *t* – then k = $\mathbf{t_{95}}$; for example if **v =** 10 then k= 1.8

Relative Uncertainty Constant

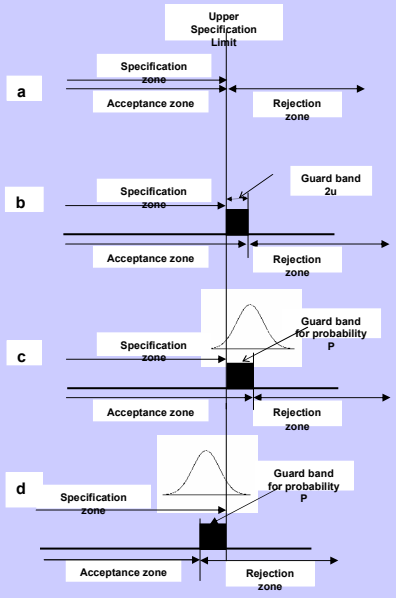
1. The result will be taken as indicating non-compliance if the measured value x is greater than the limit value L by more than $k_\alpha.u_L$ where u_L is the value of the uncertainty at the limit.
   This gives a guard band g_1 of $L.k_\alpha.u_{rel}$ where u_{rel} is the relative uncertainty.

2. The result will be taken as indicating non-compliance if the measured value x is greater than the limit value L by more than $k_\alpha.u_m$ where u_m is the value of the uncertainty at the measured value.
   This gives a guard band g_2 of $L.k_\alpha.u_{rel}/(1- k_\alpha.u_{rel})$

Relative Uncertainty Constant



Limit =2, k_α=2, u_{rel}=0.25, g_1=1, g_2=2



Conclusion
Assessment of compliance requires

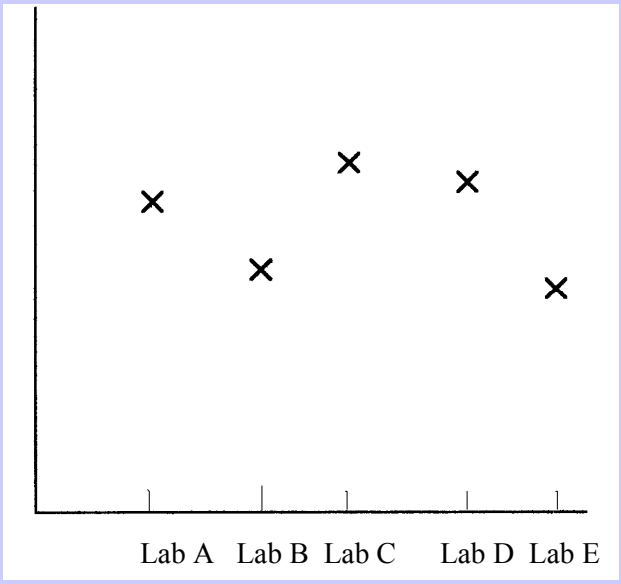
a) a measurement result and a stated uncertainty
b) a specification giving the upper and/or lower permitted limits of the characteristics (measurands) being controlled
c) a decision rule that describes how the measurement uncertainty will be taken into account with regard to accepting or rejecting a product according to its specification and the result of a measurement.
d) a reference to the decision rules used when reporting on compliance

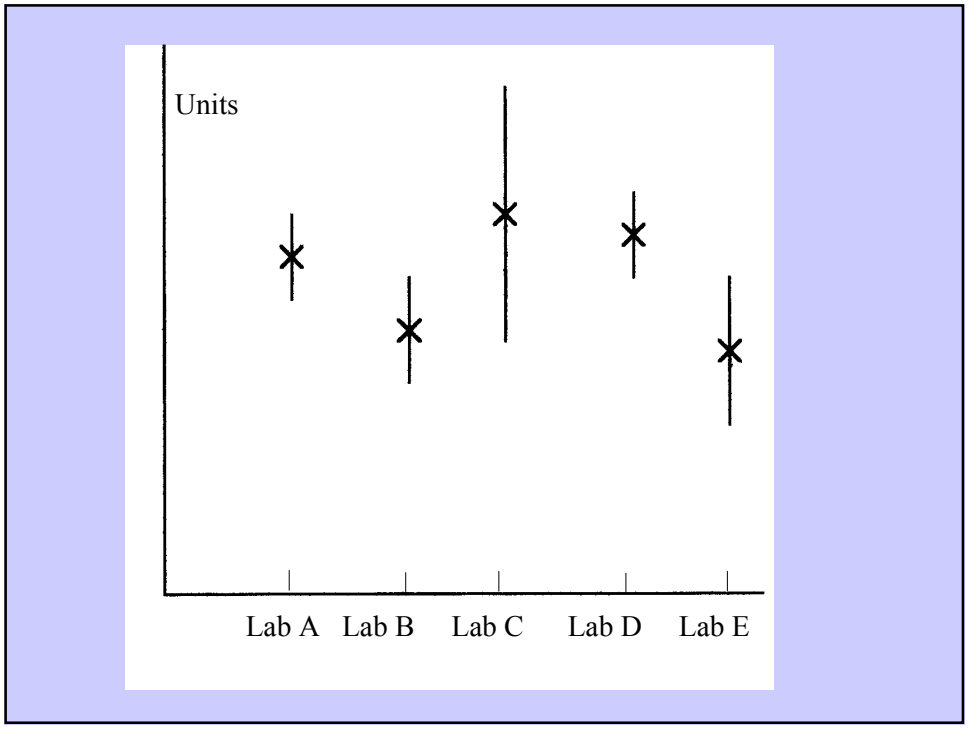
Use of uncertainty information in compliance assessment

EURACHEM/CITAC Guidance note

www. EURACHEM.org

www.lulu.com




Units
Lab A
Lab B
Lab C
Lab D
Lab E