
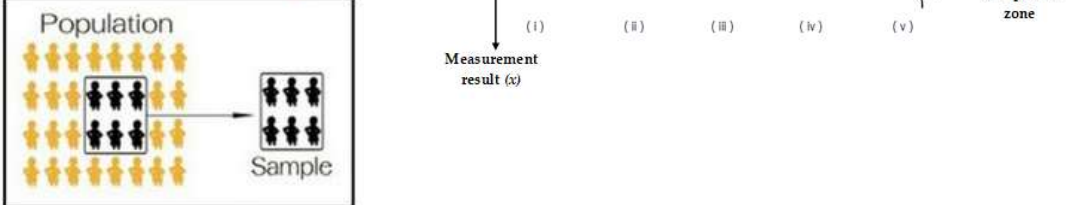


Lisbon, 11 and 12 May 2026

CONFORMITY ASSESSMENT IN THE OIL AND GAS INDUSTRY

Population

Sample

Guard band (GB)
 $1.64 \times u(x)$

Upper Specification limit (L)

Rejection zone

Acceptance zone

(i) (ii) (iii) (iv) (v)

Measurement result (x)

1




Lisbon, 11 and 12 May 2026

INTRODUCTION

- Where does the measurement process begin?
- In the oil and gas industry, even though some studies on the metrological evaluation of fuel analyses address measurement uncertainty, **sampling uncertainty** is rarely discussed.
- **ISO/IEC 17025** makes it clear that sampling is an essential contributor to the overall measurement uncertainty and, as such, is a mandatory item in accreditation audits.

2

2

Lisbon, 11 and 12 May 2026




INTRODUCTION

Thus, to deepen the understanding of **sampling-related uncertainty** and its impact on overall analytical uncertainty, this study seeks to:

- underscore sampling as an indispensable contributor to **measurement uncertainty**; and
- demonstrate just how decisive this component can be in **conformity assessment**.

3

3

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Case Study 1: Risk Assessment of Manganese Concentration in Formation Waters by ICP-MS




The formation water is assumed homogeneous at the sampling point. Sampling uncertainty reflects **temporal/process variability**, not material heterogeneity.

Considering an Upper Specification Limit (USL) of 0.1 mg L^{-1} , evaluate whether consumer risk should be accepted or rejected under two scenarios: (1) using analytical uncertainty only; and (2) using the analytical uncertainty + sampling uncertainty.

	S1A1	S1A2	S2A1	S2A2
A	0.0703	0.0834	0.0947	0.0805
B	0.0858	0.0789	0.0842	0.0880
C	0.0796	0.0963	0.0747	0.0878
D	0.0859	0.1048	0.0928	0.0899
E	0.0809	0.0666	0.1027	0.0937
F	0.0795	0.0745	0.0994	0.0982
G	0.0721	0.0739	0.0839	0.0968
H	0.0951	0.0776	0.0956	0.0932

4

4




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Case Study 1: Risk Assessment of Manganese Concentration in Formation Waters by ICP-MS

Considering an Upper Specification Limit (USL) of 0.1 mg L^{-1} , evaluate whether consumer risk should be accepted or rejected under two scenarios: (1) using analytical uncertainty only.

$$\bar{X} = 0.0863 \quad u_{\text{analytical}} = 0.0079942$$




$$g = u_{\text{analytical}} \times k = 0.0079942 \times 1.64 = 0.0131104$$

$$\text{UAL (Upper Acceptance Limit)} = \text{USL} - g = 0.1 - 0.0131104 = 0.0869 > 0.0863$$

ACCEPTED

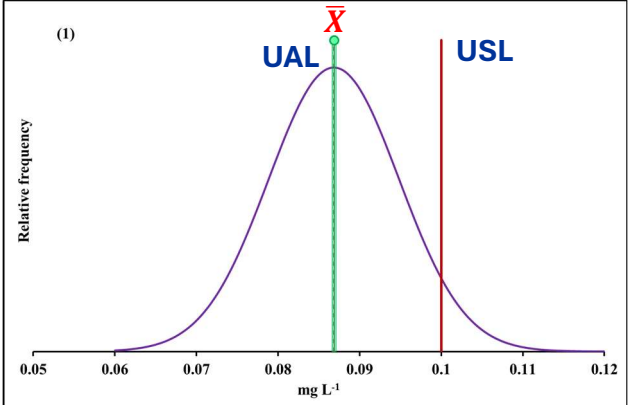
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5




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Case Study 1: Risk Assessment of Manganese Concentration in Formation Waters by ICP-MS




Considering an Upper Specification Limit (USL) of 0.1 mg L^{-1} , evaluate whether consumer risk should be accepted or rejected under two scenarios: (1) using analytical uncertainty only.



(1)

6

6




Lisbon, 11 and 12 May 2026

Case Study 1: Risk Assessment of Manganese Concentration in Formation Waters by ICP-MS

Considering an Upper Specification Limit (USL) of 0.1 mg L^{-1} , evaluate whether consumer risk should be accepted or rejected under two scenarios: (2) using the analytical uncertainty + sampling uncertainty.

$\bar{X} = 0.0863$

$u_{\text{analytical}} = 0.0079942$ and $u_{\text{sampling}} = 0.00836$




$g = u_{\text{measurement}} \times k = 0.011567 \times 1.64 = 0.018969$

UAL (Upper Acceptance Limit) = $USL - g = 0.1 - 0.018969 = 0.08103 < 0.0863$

REJECTED

7

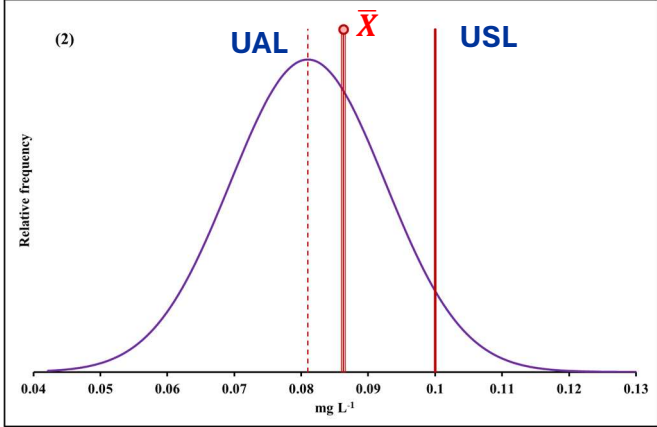
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Case Study 1: Risk Assessment of Manganese Concentration in Formation Waters by ICP-MS

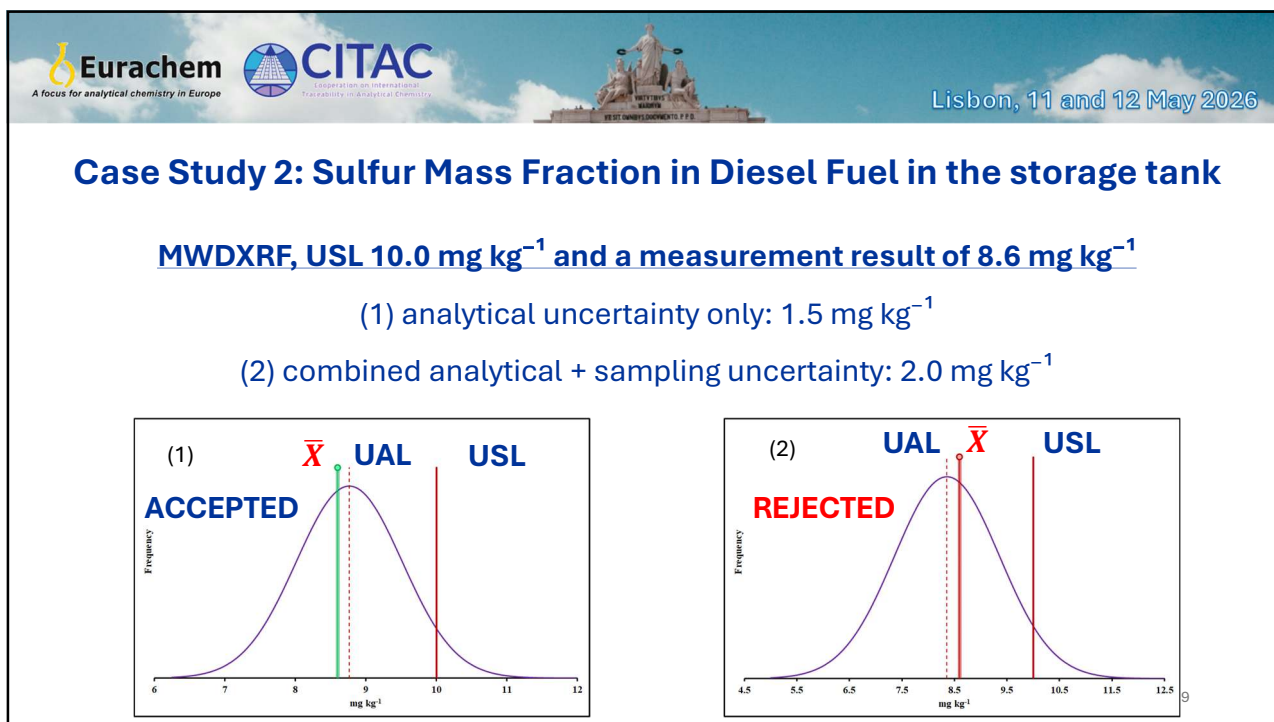
Considering an Upper Specification Limit (USL) of 0.1 mg L^{-1} , evaluate whether consumer risk should be accepted or rejected under two scenarios: (2) using the analytical uncertainty + sampling uncertainty.

(2)

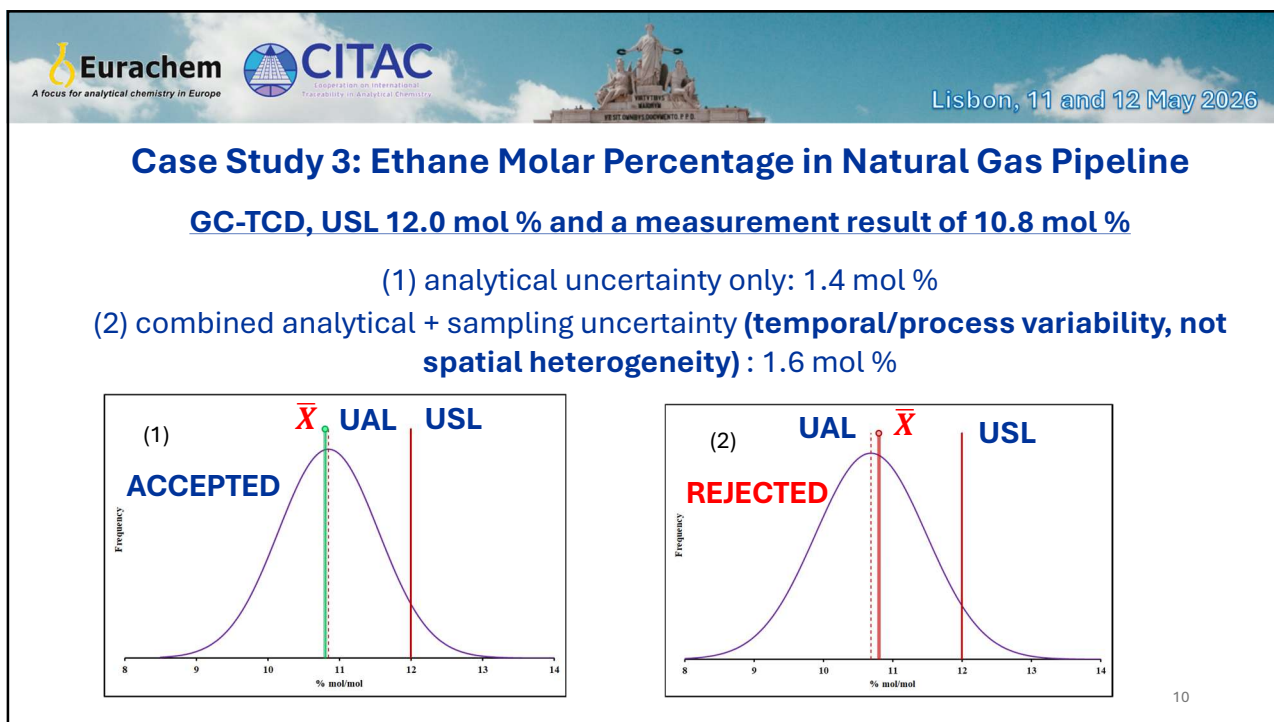


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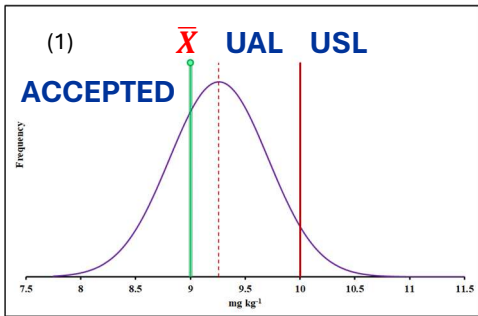



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Case Study 4: Phosphorus Mass Fraction in Biodiesel in a storage tank

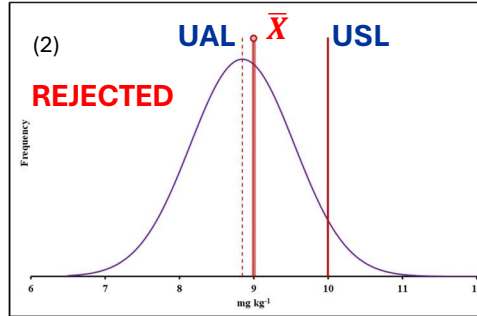
ICP-OES, USL 10.0 mg kg⁻¹, with a measurement result of 9.0 mg kg⁻¹

(1) analytical uncertainty only: 0.9 mg kg⁻¹

(2) combined analytical + sampling uncertainty: 1.4 mg kg⁻¹






(1) **ACCEPTED**



(2) **REJECTED**

11

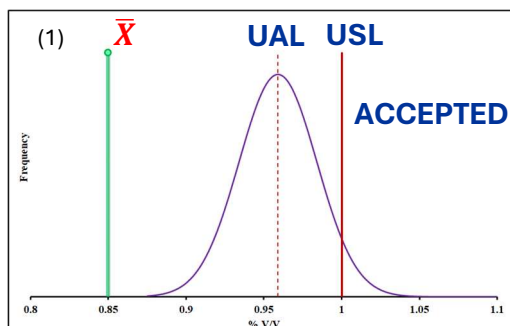



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Case Study 5: Water in Crude Oil in a storage tank

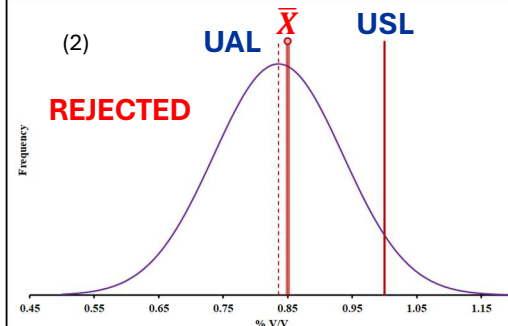
Karl Fischer Coulometric, USL 1.0 % v/v, with a measurement result of 0.85 % v/v

(1) analytical uncertainty only: 0.05 % v/v

(2) combined analytical + sampling uncertainty: 0.20 % v/v






(1) **ACCEPTED**



(2) **REJECTED**

12

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CONCLUSION

- The first stage of any analytical workflow is sampling, which depends first on how the measurand is defined: an instant in time or an average over material delivered. Even though it is usually performed outside the laboratory – and not always by an analytical chemist – it must still be tightly controlled.
- Based on a risk assessment relative to the specification limit, the uncertainty arising from sampling in chemical and physicochemical analyses cannot always be overlooked.

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 metrology



 applied sciences



Communication

The Importance of Measurement Uncertainty Arising from the Sampling Process in Conformity Assessment: The Case of Fuel Quality

José Daniel Hernandez-Vásquez¹ and Elcio Cruz de Oliveira^{2,3,*}

¹ Mechanical Engineering Program and Industrial Engineering Program, GIPOURIER Research Group, Universidad Antonio Nariño Campus Barranquilla, Puerto Colombia 113511, Colombia; director.barranquilla@uan.edu.co
² Postgraduate Programme in Metrology, Pontifical Catholic University of Rio de Janeiro, Rio de Janeiro 22451-900, Brazil
³ Logistics, Operational Planning and Control, Measurement and Product Inventory Management, PETROBRAS S.A., Rio de Janeiro 20231-030, Brazil
 * Correspondence: elciooliveira@puc-rio.br or elciooliveira@petrobras.com.br

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EDITORIAL

Use of Measurement Uncertainty in Compliance Assessment with Regulatory Limits

Elcio Cruz de Oliveira

Professor of the Postgraduate Programme in Metrology  Metrology for Quality and Innovation, Pontifical Catholic University of Rio de Janeiro – Rio de Janeiro, RJ, Brazil
 Technical Consultant, Petrobras Transporte S.A. – TRANSPETRO  Rio de Janeiro, RJ, Brazil

Communication

Measurement Uncertainty and Compliance Evaluation Applied to Natural Gas Moisture

Rosana Medeiros Moreira^{1,2}, Cesar Luis Biazon³ and Elcio Cruz de Oliveira^{4,5,*}

¹ Product and Process Engineering, National Institute of Technology, Rio de Janeiro 20881-312, Brazil; rosana.moreira@inpi.gov.br
² Postgraduate Programme in Metrology, Brazilian Institute of Metrology, Quality and Technology (INMETRO), Duque de Caxias 25250-020, Brazil
³ Exploration and Production (UN-BC/SE/LPCEN), PETROBRAS S.A., Macaé 27913-350, Brazil; cbiazon@petrobras.com.br
⁴ Postgraduate Programme in Metrology, Pontifical Catholic University of Rio de Janeiro, Rio de Janeiro 22451-900, Brazil
⁵ Land Transportation and Storage, Measurement and Product Inventory Management, Logistics, PETROBRAS S.A., Rio de Janeiro 20231-030, Brazil
 * Correspondence: elciooliveira@puc-rio.br

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Robust approach connected to measurement uncertainty for establishing acceptance limits in custody transfer measurements within the oil and gas industry

Guilherme Lucarelli Orsay⁶, Elcio Cruz de Oliveira^{6,5,*}

⁶ Postgraduate Programme in Metrology, Pontifical Catholic University of Rio de Janeiro, R. Marquês de São Vicente 225, 22451-900 Rio de Janeiro, Brazil
⁵ Logistics, Operational Planning and Control, Measurement and Product Inventory Management, PETROBRAS S.A., Av. Horácio Valadres 26, 20231-030 Rio de Janeiro, Brazil

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Full Length Article

Data reconciliation applied to the conformity assessment of fuel products

Elcio Cruz de Oliveira^{a,b,*}, Felipe Rebello Lourenço^c

^a Postgraduate Metrology Programme, Rio de Janeiro Catholic University, Marquês de São Vicente Street, 225, Gávea, Rio de C, RJ, Brazil
^b Technology Management, PETROBRAS TRANSPORTE S.A., Rio de Janeiro, RJ, Brazil
^c Programa de Pós-Graduação em Farmácia e Medicamentos, Departamento de Farmácia, Faculdade de Ciências Farmacêuticas, Universidade de São Paulo, Brazil

molecules

MDPI

Article

Measurement Uncertainty and Risk of False Compliance Assessment Applied to Carbon Isotopic Analyses in Natural Gas Exploratory Evaluation

Fabiano Galdino Leal¹, Alexandre de Andrade Ferreira¹, Gabriel Moraes Silva², Tullio Alves Freire¹, Marcelo Ribeiro Costa¹, Erica Tavares de Moraes¹, Jarbas Vicente Poley Guzzo¹ and Elcio Cruz de Oliveira^{3,4,*}

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Elcio Cruz de Oliveira

elcioliveira@puc-rio.br

elcioliveira@petrobras.com.br

<https://www.linkedin.com/in/elcio-cruz-de-oliveira-6472bb178/>




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