# Metrological Traceability Discussion

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## Discussion Objective

- Provide the NASA perception of the international paradigm for metrological traceability
- Gain insight into the NACLA thoughts on metrological traceability, with respect to international policy and agreements

# International Policy & Agreements

- *Joint BIPM, OIML, ILAC, ISO Declaration on Metrological Traceability*, dated 9th November 2011
  - *The BIPM, OIML, ILAC, and ISO endorse the following recommendations:*
  - *in order to be able to rely on their international acceptability, calibrations should be performed*
    - *in National Metrology Institutes who should normally be signatories to the CIPM MRA and have CMCs published in the relevant areas of the KCDB or*
    - *in laboratories accredited by accreditation bodies which are signatories to the ILAC Arrangement;*
- ILAC-P10:2002, *ILAC Policy on Traceability of Measurement Results*
  - *1.4 (b)* ***uncertainty of measurement****; the uncertainty of measurement for each step in the traceability chain must be calculated or estimated according to agreed methods and* ***must be stated*** *so that an overall uncertainty for the whole chain may be calculated or estimated;*
- ILAC-P14:12/2010, *Policy for Uncertainty in Calibration*
  - 6.1 […] Accredited calibration laboratories shall report the uncertainty of measurement, in compliance with the requirements in 6.2 – 6.5 of this section.

## NASA Concern

- Recent international agreements combined with changes in international metrology documents have, by current definitions, made a large portion of measurements in the U.S. non-traceable to the International System of Units (SI).
- This could include measurements made by U.S. Government agencies, such as NASA, DOD, and DOE.

# Metrological Traceability Discussion



- Evolving over the past decade, the current paradigm expressed by international definitions and policy documents is that metrological traceability, as well as the acceptability of calibrations and/or measurements, requires the inclusion of a quantified statement of measurement uncertainty for all measurement processes.
- A recent international document, known as the Quadripartite Agreement, reinforces this paradigm by emphasizing the link between metrological traceability, accredited calibration, and measurement uncertainty.
  - *Joint BIPM, OIML, ILAC, ISO Declaration on Metrological Traceability*, dated 9th November 2011
  - The stated rationale for explicitly linking accredited calibration and measurement uncertainty to traceability is to "reduce technical barriers to trade (TBTs) which might result in a lack of [measurement] equivalence."
- These changes and this agreement may have introduced unintended consequences, the most prevalent being increased costs for lower echelon conformance-test calibrations.

# Metrological Traceability Discussion



- Historically, within U.S. calibration programs, conformance-test calibrations have used quantified uncertainty limits that are developed to ensure a measurement process parameter's uncertainty is negligible relative to the required accuracy of the conformance-test.
- U.S. military and national calibration standards have provided requirements for developing and using calibration measurement procedures that limit uncertainty, coupled with stated acceptance criteria, to ensure acceptability and traceability of measurement processes without explicitly quantifying and stating overall calibration process uncertainty.
- Accreditation for U.S. Government calibration programs has traditionally been based on each agency's internal policy.

# Metrological Traceability Discussion



- Although the approach of bounding uncertainty used by most U.S. National calibration programs does not conflict with the GUM, it does conflict with the international paradigm of providing quantified statements of uncertainty.
- Within U.S calibration programs, quantifying and documenting the measurement uncertainty for established legacy measurement processes would be cost-prohibitive.
- In addition, analysis of empirical reliability data within NASA's calibration program indicates that quantifying the measurement uncertainty of adequately performing legacy calibration processes would not lead to changes in those processes, thus adding no value.

# Metrological Traceability Discussion



- While there may be no technical issues with affected U.S. measurements, the changes in international definitions and policy have the potential for far reaching economic implications.
- Depending on international reaction to the Quadripartite Agreement, an unintended consequence may be the exclusion of many U.S. companies, which operate under U.S. national calibration standards, from international competition.
- This may also impact U.S. Government acquisition/sustainment by creating a direct or indirect cost-driver, especially for complex systems such as space or weapon systems, where international suppliers are intrinsically integrated into the supply chain.

## Summary

- Over the last sixty years, U.S. calibration programs have successfully supported the largest period of technology development in human history.
  - This has essentially been accomplished by limiting the influence of measurement uncertainty, without quantifying the value.
- Going forward, in addition to limiting its influence, quantifying the uncertainty of the measurement process might be cost-effective for new measurement processes developed to support new technology.
- However, some legacy measurement systems may take decades to be replaced; even today there are half-century-old instruments in use.

## Questions

- What is the NACLA stance on metrological traceability for calibrations, specifically conformance-test calibrations?
  - Are statements of uncertainty a requirement?
  - Is accreditation a requirement?
- Are legacy U.S. Government calibrations systems that are built on military or American National Standards (e.g., MIL-STD 45662A, ANSI/NCSL Z540.1) traceable?
  - If not, when did they lose their traceability?