



John F. Kennedy Space Center

A New NASA Preferred Standard - ANSI/NCSL Z540.3-2006 -

Requirements for the Calibration of Measuring and Test Equipment

Scott Mimbs

NASA Safety & Mission Assurance

John F. Kennedy Space Center

Page No. 1

2008 Measurement Science Conference, Anaheim, CA

March 13-14, 2008



NASA's view on Metrology...

John F. Kennedy Space Center



S121E97412

Page No. 2

2008 Measurement Science Conference, Anaheim, CA

March 13-14, 2008



Outgoing and Incoming Standards

- NASA policy requires the use of “domestic and international voluntary consensus standards,” in lieu of creating Government standards.
- The exception is when “they would demonstrably fail to serve NASA’s program needs.”
- **ANSI/NCSL Z540.1 (R2002)**, *Calibration Laboratories and Measuring and Test Equipment – General Requirements*.
 1. Adopted by NASA in 1995
 2. Currently NASA requirement per NPD 8730.1B
- **ANSI/NCSL Z540.3:2006**, *Requirements for the Calibration of Measuring and Test Equipment*.
 1. Reviewed by NASA Metrology and Calibration Working Group beginning September 2006
 2. Recommended as a NASA Preferred Standard August 2007



Differences in Scope

ANSI/NCSL Z540.1 (R2002)

Part I - establishes the competency requirements of a calibration provider.

- Based on ISO Guide 25 (cancelled)
- Some elements similar to ANS/ISO/IEC 17025

Part II - establishes the quality assurance requirements for a supplier of calibration services.

- Based on MIL-STD-45662
- Some elements similar to ISO 10012

ANSI/NCSL Z540.3:2006

Establishes the requirements for a calibration system to control the accuracy of measuring and test equipment.

- Address optional use of ANS/ISO/IEC 17025
- Some elements similar to ISO 10012



Significant Differences in Z540.3

John F. Kennedy Space Center

ANS/ISO/IEC 17025 and ISO 10012 address calibration and measurement systems. Their shortcomings were considered in the creation of Z540.3 to either address in better detail or by providing additional requirements in the following areas:

- Calibration intervals & measurement reliability;
- Calibration & measurement assurance procedures;
- Tolerance-type calibrations;
- Measurement risk and test uncertainty ratio (TUR) use;
- Measurement uncertainty procedure;
- Non-laboratory type calibration services.



Z540.3 Highlights – General Requirements

John F. Kennedy Space Center

Z540.3:

Levies requirements to the overall organization where the Calibration Lab may only be a component.

4.1 Calibration system objective

- *The organization shall establish, document, operate, and improve a system to manage the calibration of measuring and test equipment. ...*

4.2 Quality objectives

- *The organization shall define and establish measurable quality objectives for the calibration system and its components. ...*



Z540.3 Highlights– Calibration System implementation

John F. Kennedy Space Center

5.1 Calibration requirements

- The organization shall include all measuring and test equipment in the calibration system that have an influence on the quality of the organization's product.
- The organization shall document and use procedures for the determination of measuring and test equipment to be included in the calibration system. [...]

5.2.3.1 As-found calibration

- Establishes a requirement for the closed-loop reporting of equipment found out-of-tolerance during calibration.
 - The organization must set the criteria of how much out-of-tolerance can be tolerated before action is required.



Z540.3 Highlights– Calibration System implementation

John F. Kennedy Space Center

5.3 Calibration of measuring and test equipment

- Specifies that calibrations may be performed outside a laboratory
 - in situ,
 - on-site,
 - customers facility,
- Provides that levels of measurement decision risk be acceptable to both the customer and supplier.
 - Measurement uncertainty is to be used where calibrations only report measured values (e.g., Standard Labs),
 - Verification of specified tolerances will use a risk metric: the probability of incorrect acceptance decisions (false accept) shall not exceed 2%
 - Test uncertainty ratios (TUR) of 4:1 or better are allowed when determining the risk probability is not practicable.
- In conjunction with this sub-clause, demonstration of calibration competency is deferred to
 - ANS/ISO/IEC 17025, or
 - "otherwise found to be in conformance by an authority acceptable to the customer."



Z540.3 Highlights– Calibration System implementation

John F. Kennedy Space Center

5.3.3.1 Expression of measurement uncertainty

- A documented procedure shall be used to estimate and express the uncertainty of measurement for all calibrations. As a minimum, the procedure shall address:
 - a) sources of measurement uncertainty;
 - b) estimation and combining of uncertainties;
 - c) conditions and assumptions;
 - d) documentation and reporting criteria; and
 - e) bibliography.
- NOTE 1: Sources of measurement uncertainty that should be addressed include:
 - measuring and test equipment associated with the calibration;
 - measurement and calibration methods and procedures;
 - measurement traceability;
 - measurement repeatability and reproducibility;
 - calibration quality monitoring;
 - changes over time; and
 - influence quantities.
- NOTE 2: For guidance on the expression of measurement uncertainty, see [ANSI/NCSL Z540-2-1997 \(R2002\)](#)



NASA's Issues & Concerns

John F. Kennedy Space Center

1. The most significant issues and concerns within NASA, centers on the 2% rule of Section 5.3.
 - Currently no industry or government standards for estimating measurement risk based on the Z540.3 definition
 - NCSL's Recommended Practice for risk is still in draft
2. The Z540.3 Handbook being developed by NCSLI is not "Interpretive" by definition;
3. Therefore NASA must identify and make the interpretation for those sections of the Standard that could potentially have the most impacts to NASA operations.
 - Establish when 2% false accept risk "good enough."
 - Provide acceptable measurement decision risk analysis techniques.
 - Define "practicable." What level of effort/expense is required?
 - Establish guidance for when the using the 4:1 TUR is appropriate.
 - Define the appropriate calibration competence authority
 - ANSI/ISO/IEC 17025: Accreditation versus Compliance



John F. Kennedy Space Center

Resolving the Issues & Concerns

1. NASA is updating its metrology policy to add Z540.3 for calibration programs.
2. NASA is developing an interim guidance document for implementing the 2% rule of Section 5.3.
 - Use current "Body of knowledge" – do not create new material
 - ✓ Current version of RP 1342
 - ✓ Industry papers
 - Focus on implementation
 - Provide guidance if requirement can not be met
 - To be released in early summer 2008
3. NASA is drafting a procedural requirements document to provide acceptable boundaries for implementing Z540.3.



John F. Kennedy Space Center

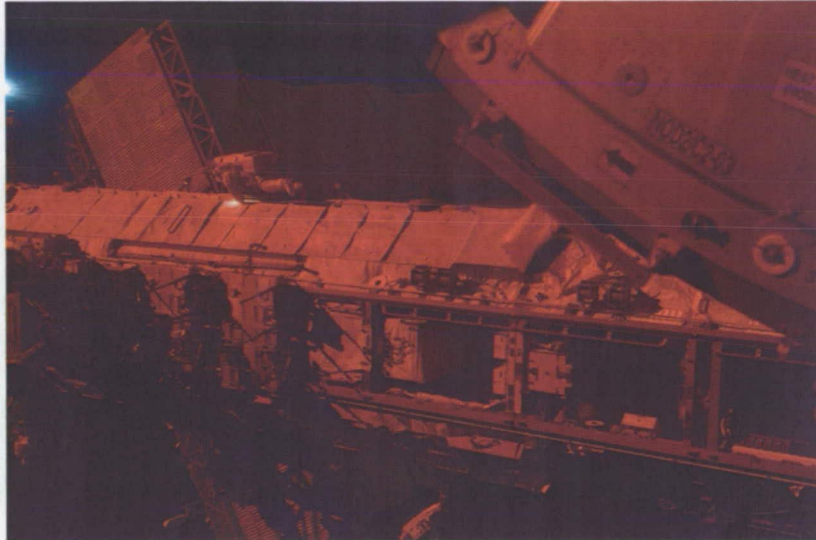
Summary

1. Z540.3 addresses the requirements and responsibilities of the Calibration System.
2. The overall organization is responsible for the M&TE calibration program (e.g., NASA, Program, Contractor, etc.).
3. Calibration providers have defined quality requirements.
4. Demonstration of calibration competency is deferred to ANS/ISO/IEC 17025.
5. NASA is addressing internal concerns for Z540.3 implementation.



For NASA, Metrology is not always easy...

John F. Kennedy Space Center



S122E000153

Page No. 13

2008 Measurement Science Conference, Anaheim, CA

March 13-14, 2008



Its going to get even more difficult...

John F. Kennedy Space Center



Page No. 14

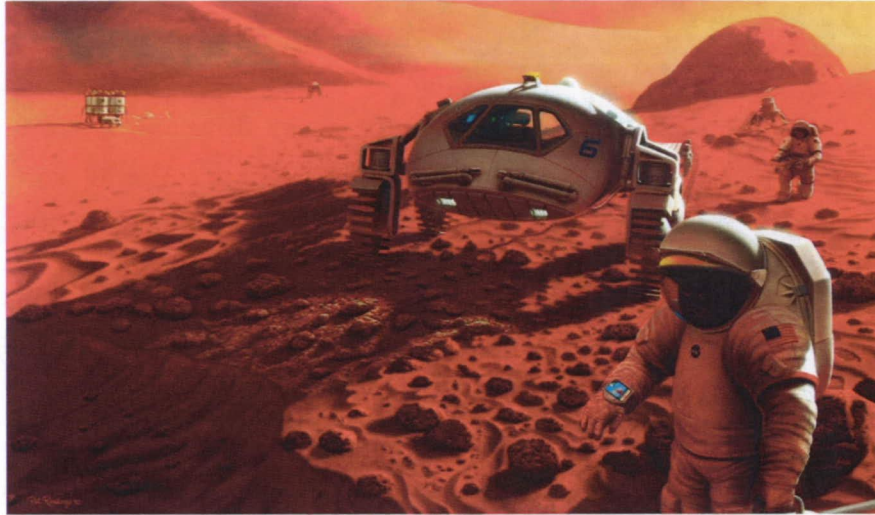
2008 Measurement Science Conference, Anaheim, CA

March 13-14, 2008



John F. Kennedy Space Center

And more difficult.



Page No. 15

2008 Measurement Science Conference, Anaheim, CA

March 13-14, 2008



John F. Kennedy Space Center

Looking to the Future of Metrology.



Page No. 16

2008 Measurement Science Conference, Anaheim, CA

March 13-14, 2008