Kennedy NASA Procedural Requirements

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Responsible Office: Engineering

KSC Metrology and Calibration Procedural Requirements

National Aeronautics and Space Administration

John F. Kennedy Space Center

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Change Log

Date	Revision	Description
7/1/2009	A	Revised.
6/13/2014	A-1	Administratively changed to extend expiration date three months.
9/29/2014	A-2	Administratively changed to extend expiration date. Safety and Mission Assurance internal review and rewrite took longer than expected.
12/22/2014	A-3	Administratively changed to extend expiration date. A longer review cycle is required due to the significance of the revision and to allow adequate time for all stakeholders to review the significant changes. The significant changes include making revisions to support the new KSC environment and to accommodate changes recently made to Agency documentation.
4/13/2015	B	This directive went through a significant revision. Updates include clarifying Agency and Center requirements and modifying the document to comply with NASA formatting/content standards for Center directives.
6/22/2017	C	Revised to align the document with the latest revision of the Agency document, NPD 8730.1, Metrology and Calibration pertaining to acceptable consensus standards, capture document organization of primary responsibility change from Safety and Mission Assurance directorate to the Engineering directorate, and to comply with content and structure requirements of NPR 1400.1, Directives and Charters Procedural Requirements.
3/9/2018	C-1	Administratively changed to align document with new Agency MetCal document - NASA-STD-8739.12, Metrology & Calibration due to NPD 8730.1, Metrology and Calibration being cancelled January 25, 2018.
3/1/2021	D	Updated labeling direction and changed ‘Cal Before Use’ label to ‘Standardized MTE’. Added Electrostatic Discharge requirements from NASA-STD-8739.12, Metrology & Calibration.
3/26/2021	D-1	Added NPR 4200.1, NASA Equipment Management Procedural Requirements, to the Section P.4, Applicable Documents and Forms.

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Date	Revision	Description
7/14/2023	E	This KNPR was updated due to the cancellation of NPD 8730.5, NASA Quality Assurance Program Policy. Cancellation of this document removed the requirement for the NASA Center Director to designate a qualified representative to the Metrology and Calibration Working Group. Reorganization of the calibration program responsibilities were moved to Engineering after the Safety and Mission Assurance (S&MA) Calibration Office was dissolved. • Updated the Responsibilities section to clarify Calibration POC responsibilities. • Removed reference to S&MA as HQ OSMA dissolved this office of responsibility. • Clarified labeling requirement note to assist users and auditors. • Updated shall statements throughout document to align with NPR 1400.1H, NASA Directives and Charters Procedural Requirements.

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PREFACE

P.1 PURPOSE

This Kennedy NASA Procedural Requirements (KNPR) document provides Metrology and Calibration (Met/Cal) requirements for the John F. Kennedy Space Center (KSC), including requirements for measurement applications (i.e., metrology) and the calibration of the measuring and test equipment (MTE) used in those measurement applications.

P.2 APPLICABILITY

a. The provisions of this KNPR apply to KSC organizations and to their contractors (to the extent specified in their respective contracts) that use calibrated test equipment to accomplish program/project/institutional operational and safety objectives.

b. This KNPR is only applicable to other organizations (e.g., commercial partners, other Federal agencies, international parties, and tenants) as specified and described in written agreements.

c. In the event of a conflict between the requirements set forth in this document and:

(1) Program or Agency requirements, the Program or Agency requirements take precedence.

(2) Existing contract provisions, the contract provisions take precedence.

(3) Sub-tier documents, the provisions of this document take precedence.

(4) Other documents at an equivalent level (e.g., other KNPR documents), the respective document organization of primary responsibility will resolve the conflict on a case-by-case basis and provide appropriate guidance.

d. If disagreement exists over which of the aforementioned documents takes precedence, the NASA KSC Director and KSC Engineering Director will make the final determination.

e. In this directive, all mandatory actions (i.e., requirements) are denoted by statements containing the term “shall.” The terms “may” or “can” denote discretionary privilege or permission; “should” denotes a good practice and is recommended, but not required; “will” denotes expected outcome, and “are/is” denotes descriptive material.

f. In this directive, all document citations are assumed to be the latest version unless otherwise noted.

P.3 AUTHORITY

NASA-STD-8739.12, Metrology & Calibration

P.4 APPLICABLE DOCUMENTS AND FORMS

a. NPD 1280.1, NASA Integrated Management System Policy

b. NASA Procedural Requirements (NPR) 1441.1, NASA Records Management Program Requirements

c. NPR 4200.1, NASA Equipment Management Procedural Requirements

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d. NPR 7120.8, NASA Research and Technology Program and Project Management Requirements

e. ANSI/NCSL Z540.3-2006 (R2013), Requirements for the Calibration of Measuring and Test Equipment

f. ANSI/NCSL Z540.1-1994 (R2002), Calibration Laboratories and Measuring and Test Equipment – General Requirements

g. ISO/IEC 17025:2017, General Requirements for the Competence of Testing and Calibration Laboratories

h. SAE AS9100, Quality Management Systems – Requirements for Aviation, Space and Defense Organizations

i. SAE AS9003, Inspection and Test Quality System

j. ISO 9001, Quality Management Systems-Requirements

k. ANSI/ESD S20.20 Standard for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment (Excluding Electrically Initiated Explosive Devices)

l. KSC Form 50-147, Label, Calibration with Short Note

m. KSC Form 50-147A, Label, Calibration with Long Note

n. KSC Form 50-149A, Label Limited Use Calibration (OM)

o. KSC Form 50-204, Label Limited Use Calibration (OM)

p. KSC Form 50-205, Label, Limited Use Calibration (OM)

q. KSC Form 50-206, Label, Standards Calibration (OM)

r. KSC Form 50-246, Label, Calibration Operational Check Small (OM)

s. KSC Form 50-247, Label, Calibration Operational Check (OM)

t. KSC Form 50-415, Standardized MTE OM

u. KSC Form 22-408, Card, Spares Calibration Recall Update

v. KSC Form 22-418, Label, Calibration Not Required

w. KSC Form 22-419, Label, Calibration-Operational Check

x. KSC Form 22-420, Label, Calibration-Operational Check

y. KSC Form 22-495, Tag, Reject NASA/KSC

z. KSC Form 22-496, Calibration Request

aa. KSC Form 22-658, Label, Calibration

bb. KSC Form 22-659, Label, Limited Use Calibration

cc. KSC Form 22-660, Label, Limited Use Calibration

dd. KSC Form 22-661, Label, Calibration Not Required

ee. KSC Form 28-411, Label, Reject NASA KSC

ff. KSC Form 28-412, Label, Not In Use NASA KSC

gg. KSC Form 28-483, Label, Calibration, Void if Broken

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hh. KSC Form 28-519, Label, Limited Use Calibration

P.5 MEASUREMENT/VERIFICATION

Compliance with the requirements contained in this KNPR will be verified through surveillance, audit, and assessment activities performed by the NASA S&MA organization or the KSC Met/Cal point-of-contact. NASA personnel or their designees have the right to enter any NASA KSC-controlled facility to monitor operations to accomplish this verification. These personnel are subject to safety practices and reasonable security requirements.

P.6 CANCELLATION

This document cancels KNPR 8730.1, Revision D-1, KSC Metrology and Calibration Procedural Requirements.

/original digitally signed by/

Scott T. Colloredo
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Distribution: TechDoc Library

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CHAPTER 1: GENERAL REQUIREMENTS

1.1 GOAL

MTE is a general term that includes the measuring instruments, measurement standards, reference materials, or auxiliary apparatuses necessary to realize a measurement process. MTE is integral to all measurement processes and must be selected, calibrated, and used in a controlled manner to ensure correct and adequate measurement results. The goal of this document is to provide Center-specific metrology and calibration requirements to ensure MTE is used and calibrated appropriately at KSC.

1.2 OBJECTIVE

The objective of this KNPR is to implement the policy established in NASA Technical Standard, NASA-STD-8739.12, and to establish Center metrology and calibration requirements.

1.3 RESPONSIBILITY

1.3.1 The Director of NASA KSC Engineering is responsible for:

a. Establishing the KSC Calibration Program through the publication of this KNPR.

b. Identifying a Metrology and Calibration Principal Center Point-of-Contact (POC).

1.3.2 The KSC Metrology and Calibration POC is responsible for:

a. Serving as the KSC representative to the Agency's Metrology and Calibration Working Group (MCWG).

b. Assessing and recommending changes to this document.

1.3.3 NASA heads of primary organizations are responsible for:

a. Establishing procedures which assign responsibility for the calibration and control of test and measuring equipment in accordance with the provisions of this KNPR.

b. Ensuring that the Statement of Work in Requests for Proposals and resulting contracts contain requirements for calibration programs which are appropriate for the contract and consistent with the provisions of this KNPR.

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CHAPTER 2: REQUIREMENTS FOR THE SELECTION, CALIBRATION, AND USE OF MEASURING AND TEST EQUIPMENT

2.1 APPLICATIONS REQUIRING CALIBRATED MEASURING AND TEST EQUIPMENT

2.1.1 Calibrated MTE will be used for measurements associated with the following functions and conditions (in accordance with NASA-STD-8739.12):

a. Testing, qualification, certification, and acceptance measurements of flight hardware, ground support equipment (GSE), test systems, or other flight-related products.

b. Measurements essential to the safety of personnel and the public or for the protection of Government or private property, including hazardous and critical applications.

c. Operation of telecommunications and transmission systems where exact signal interfaces and circuit confirmations are essential to mission success.

d. Research and technology development (reference NPR 7120.8), manufacturing, inspection, testing, operations, maintenance, support, or other applications where the accuracy of measurements is essential to achieve mission success.

e. NASA publications or other documents released for external review containing conclusions/ recommendations that depend on the accuracy of measurement results and that impact the safety or success of NASA missions.

Note: Preliminary research papers and research instruments under development that have not had traceable units of measurement established are excluded.

f. Physical measurements used to apportion, levy, or otherwise assign cost(s), or ensure local, State, or Federal regulatory compliance.

2.2 CONTROL OF CALIBRATION

2.2.1 Metrology and calibration requirements associated with contractor quality management systems shall be invoked in accordance with NPD 1280.1.

2.2.2 This document was written for the scenario in which all MTE that requires calibration is submitted to the KSC Calibration Laboratory. For contracts that levy this KNPR but permit in-house calibrations or direct outsourcing (i.e., contracts that are not required to submit MTE to the KSC Calibration Laboratory), the contract/contractor shall ensure that all requirements levied on the KSC Calibration Laboratory in this document are performed by the contractor or by the selected calibration vendor.

2.2.3 Unless otherwise specified in a contract, all MTE that requires calibration (as defined in section 2.1) shall be sent to the KSC Calibration Laboratory.

2.2.4 The KSC Calibration Laboratory shall implement a calibration system within the context of a quality management system: SAE AS9100, SAE AS9003, or ISO 9001 (ref: NASA-STD-8739.12, Section 4.2.1).

2.2.5 The KSC Calibration Laboratory shall provide a calibration system compliant with this KNPR and a calibration standard listed below (ref: NASA-STD-8739.12, Section 4.2.2):

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a. American National Standards Institute (ANSI)/National Conference of Standards Laboratories (NCSL) ANSI/NCSL Z540.1-1994 (R2002), Calibration Laboratories and Measuring and Test Equipment - General Requirements.

b. ANSI/NCSL Z540.3-2006 (R2013), Requirements for the Calibration of Measuring and Test Equipment.

c. ISO/IEC 17025:2017, General Requirements for the Competence of Testing and Calibration Laboratories.

2.2.6. Calibrations outside the scope of capability of the KSC Calibration Laboratory will be outsourced to outside calibration suppliers by the KSC Calibration Laboratory. The KSC Calibration Laboratory shall ensure that outsourced calibrations are compliant to an accepted compliance standard listed in 2.2.5.

Note: OEM or their approved vendor's may provide proprietary calibrations, operational verifications, or standardizations for their MTE. In such cases the OEM should provide evidence of traceability and documented test data (reference NASA-STD-8739.12, Section 4.2.3).

2.2.7 For calibrations that are outsourced to outside calibration suppliers, the KSC Calibration Laboratory shall:

a. Maintain a list of approved suppliers of outside calibration services.

b. Ensure all outside calibration services are performed by approved suppliers.

2.2.8. The KSC Calibration Laboratory may be able to accept the calibration data supplied with newly purchased MTE that is submitted for initial calibration. In those cases, the lab shall:

a. Ensure the calibration meets the requirements of this KNPR.

b. Ensure the calibration was performed by an approved supplier or assess the supplier and add them to the approved suppliers list.

2.3 SELECTION OF MEASURING AND TEST EQUIPMENT

2.3.1 Selection of MTE is based on the requirements of the measurement application in which the MTE will be used.

Note: MTE characteristics that can affect the accuracy of the measurement application include functionality, stability, unique or specialized ability/capability; MTE accuracy specification, range, and accuracy degradation due to environmental conditions (e.g., temperature, humidity, vibration); and MTE required conditions of use (e.g., environment, installation requirements, signal conditioning).

Note: The accuracy of MTE should be better than the measurement application requirements so that the probability of an incorrect conformance decision is controlled.

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2.3.2 MTE users shall assess and document degradation in MTE accuracy and performance due to the environmental conditions where the MTE is used in order to ensure the requirements of the measurement application can still be achieved.

Note: Causes of degradation in MTE accuracy include ambient temperature, humidity, grounding, AC power, radio frequency interference, vibration, dust, and noise.

2.4 USE OF MEASURING AND TEST EQUIPMENT

2.4.1 MTE user organizations shall ensure MTE is calibrated prior to performing applications requiring the use of calibrated MTE (as defined in 2.1).

Note: The calibration status of MTE is indicated on its calibration label. The calibration due date listed on the calibration label is the last day on which MTE may be used.

2.4.2 MTE owner shall submit new MTE requiring initial calibration to the KSC Calibration Laboratory along with a completed Calibration Request (KSC Form 22-496) or equivalent.

Note: Subsequent re-calibrations of MTE do not require a Calibration Request unless it is necessary to communicate special requirements or information to the laboratory.

2.4.3 MTE without a calibration label or with an altered calibration label or broken integrity seal is considered “not calibrated” and therefore not acceptable for use in measurement applications that require calibrated MTE.

Note: MTE without calibration labels may only be used in applications that do not require calibrated MTE.

2.4.4 Prior to using MTE with an illegible calibration label, the MTE user shall verify the calibration status is current using calibration records (e.g., calibration data sheet, test report).

Note: After verifying the calibration status, the MTE user organization may contact the KSC Calibration Laboratory for a replacement calibration label and may continue to use the MTE in the interim.

2.4.5 MTE user organizations shall document the use of calibrated MTE to ensure the MTE is traceable to the measurement processes in which it was used.

Note: This traceability allows for the determination of all potential impacts when MTE is found to be out-of-tolerance (OOT) during calibration.

2.4.6 MTE becoming due for calibration during a test may be used beyond its calibration due date. In this situation, the MTE user organization shall:

a. Obtain documented approval from stakeholders (e.g., project management, engineering).

b. Get the MTE calibrated after the test (delayed calibration) but prior to final closure of the test documentation.

Note: If the MTE receiving delayed calibration is found to be within tolerance as-received for calibration, the test measurements may be accepted as valid. If the MTE is found to be OOT as-received for calibration, an impact analysis will be performed to determine if the test measurements are acceptable (reference 2.7.3).

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2.4.7 MTE user organizations shall control the processes for shipping, handling, storing, and using its MTE, to include documentation of responsibilities and training of personnel, to maintain instrument accuracy during the calibration interval.

2.4.8 Computer software used in conjunction with MTE to produce measurement data shall be assessed prior to initial use and reconfirmed with subsequent revisions to ensure the measurement data is correct and the requirements of the measurement application are met.

2.4.9 Intermediate checks (e.g., pre-test, post-test verifications) of MTE may be used to provide additional confidence in measurement results. However, these checks are intended only to provide assurance and do not constitute or preclude calibration.

2.4.10 For MTE that requires calibration by the user or approved OEM vendor, verification using a Certified Reference Material (CRM), or standardization prior to use, the MTE users shall:

a. Ensure CRM used to standardize or calibrate MTE is certified and traceable, within shelf-life, and documented by the user.

Note: CRM is a general term that includes reference gases and solutions, physical artifacts, or any other measurable quantity required to standardize (set to a known value) MTE prior to use. In these cases, the CRM is integral to the accuracy and proper operation of the MTE and must also be within calibration. The manufacturer's operation or maintenance manual for the MTE normally defines the standardization process and recommends frequency of standardization. Dependent upon the MTE or the criticality of the measurement being made, the standardization process may be performed prior to each measurement or at a prescribed interval (e.g., hourly, daily).

Note: When calibrations compliant to ANSI/NCSL Z540.1, ANSI/NCSL Z540.3, or ISO/IEC 17025 are not available; OEM may provide calibrations for their MTE. In such cases, evidence of traceability and documented test data shall be obtained from the OEM (reference NASA-STD-8739.12, Section 4.2.3)

b. Ensure the CRMs are uniquely identified, labeled to indicate date of calibration (or date of manufacture), the calibration due date (or expiration date), and controlled in the same manner as other MTE.

c. Document usage of CRMs when standardizing MTE for the purposes of traceability and impact assessment.

d. Control the processes in which CRMs are used to standardize MTE (e.g., documented procedures or other means for ensuring process control).

e. Maintain records of CRM certification and traceability and their usage.

2.4.11 MTE user organizations shall evaluate measurement applications prior to authorizing any limited calibrations of MTE. Limited calibrations should only be authorized when that measurement processes will not be adversely affected by limited calibration of the MTE.

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2.5 CALIBRATION INTERVALS

MTE is calibrated on a recurring basis to assess whether it is still performing to within the applicable accuracy specifications. If it is not within specifications, the MTE is adjusted or repaired to restore it to applicable specifications. MTE is affected by factors such as drift and wear that can cause its performance to degrade over time, and only a subset of the MTE population is expected to maintain acceptable accuracy throughout its assigned calibration interval. This is referred to as the target end-of-period reliability (EOPR), which is usually calculated and tracked for MTE of like make and model.

2.5.1 Establishing Calibration Intervals

2.5.1.1 Calibration intervals are established and adjusted by the KSC Calibration Laboratory to maximize MTE availability without adversely affecting the accuracy and quality of tests and measurements or the reliability of operating systems.

2.5.1.2 The KSC Calibration Laboratory shall establish, monitor, and adjust calibration intervals to achieve a target EOPR of 90% for all make/models of MTE.

Note: The goal of monitoring and adjusting calibration intervals is to achieve an EOPR close to but not below 90%.

2.5.1.3 The calibration intervals shall be established and adjusted based on the condition of MTE as it is received for scheduled periodic calibration (as-received condition).

Note: Calibration intervals for new make/models or MTE with insufficient reliability data may be established by other means (e.g., manufacturer's suggested like items).

2.5.1.4 Calibration intervals required by regulatory bodies (e.g., Department of Transportation, Nuclear Regulatory Commission, Environmental Protection Agency) take precedence over intervals established by this KNPR.

2.5.2 Requesting Calibration Interval Extensions

2.5.2.1 MTE user organizations may request a calibration interval that is longer than the established interval. Revisions to MTE calibration intervals are only applicable to the specific MTE included in the request.

Note: The MTE user organization may also request a calibration interval that is shorter than the calibration interval established by the KSC Calibration Laboratory. The primary purpose of shortened calibration intervals is avoidance of work-flow impact due to MTE coming due for calibration during a test (e.g., radiation survey meters at KSC use a shorter interval of six months due to Nuclear Regulatory Commission requirements).

a. Calibration intervals longer than the intervals established by the KSC Calibration Laboratory will result in degraded accuracy of the MTE in proportion to the interval change (e.g., a doubling of a calibration interval will result in limitation of the MTE accuracy by a factor of two).

b. Prior to requesting a longer calibration interval, the requesting organization shall ensure the resulting degraded (limited) accuracy specification is adequate for the measurement application (reference 2.4.11).

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2.5.2.2 Calibrations performed as part of maintenance of facility or GSE systems may initially be assigned intervals specified by the governing maintenance document.

Note: Examples of governing maintenance documents are: Job Plans, Operations and Maintenance Instructions, Intermediate and Depot Maintenance Manuals, and Preventative Maintenance Instructions.

a. MTE calibrated at the calibration intervals specified by governing maintenance documents shall meet the target EOPR of 90% (as described in section 2.5.1.2).

b. For MTE with EOPR less than 90%, the calibration interval shall be assessed and shortened as necessary to achieve a target EOPR of 90% (as described in section 2.5.1.2)

2.6 CALIBRATION RECALL

2.6.1 The KSC Calibration Laboratory shall:

a. Assign and affix a unique Metrology Number to MTE when initially received for calibration.

Note: The metrology number is the unique identification number used at KSC to identify, track, and recall MTE for calibration.

b. Operate and maintain a system to track the status of calibrated MTE, to document as-found condition, and to recall MTE for calibration when its calibration due date is set to expire.

c. Provide MTE user organizations with a weekly recall notice for MTE coming due for calibration, to include notifications for all MTE that is within 30-days of its calibration due date.

d. Provide MTE user organizations and their quality assurance organizations with a weekly overdue notice when the calibration due date for MTE has been reached.

e. Provide MTE user organization management and their quality assurance organizations with a weekly overdue notice when the calibration due date for MTE is overdue for 21-days or more.

2.6.2 MTE user organizations shall:

a. Remove overdue MTE from use by close of business on the MTE's calibration due date.

Note: Refer to 2.4.6 for requirements associated with using MTE beyond its calibration due date.

b. Submit to the KSC Calibration Laboratory all overdue MTE which was used during the previous calibration interval.

Note: This is necessary for impact assessment (reference 2.7.3) even when there is no further use planned in the near term.

Note: MTE that has been not-in-use for the entire calibration interval and will not be returned to service may be exempted from submission for calibration. The MTE user organization must request the KSC Calibration Laboratory to remove the MTE from recurring recall and to change its status in the recall system.

Note: If an instrument due for calibration is rack mounted, calibrated in-place, or part of a system that cannot be immediately removed for calibration, a broad red line may be drawn

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across its calibration label until such time as it can be removed or calibrated. This is intended to readily identify the expired condition and preclude use of the MTE.

c. Notify the KSC Calibration Laboratory whenever MTE is excessed or transferred and will no longer be submitted for calibration.

d. Ensure the KSC Calibration Laboratory has current contact information (name, title, phone, and Email) for points-of-contact for calibration recall and overdue notifications.

2.7 OUT-OF-TOLERANCE MEASURING AND TEST EQUIPMENT

2.7.1 MTE found to be OOT during calibration necessitates evaluation of all measurement data since its previous calibration to determine if the OOT condition was significant enough to adversely affect the data and possibly require rework or scrap of product.

2.7.2 MTE user organizations at KSC shall establish and document a process to assess the validity of previous measurements when MTE is found to be OOT.

a. The assessment process shall determine if the measurement data is still acceptable and, when measurement data is adversely impacted by OOT MTE, what mitigating actions are required.

b. Provide concurrence for limited use calibrations when necessary.

2.7.3 The KSC Calibration Laboratory shall:

a. Assess the impact on calibrated equipment when a measurement standard is found to be OOT during calibration or if a calibration process is determined to be suspect for any reason.

b. Notify MTE user organizations when calibrations of their MTE are determined to be suspect.

c. Notify MTE user organizations when any of the organization’s MTE is found to be OOT as-received for calibration.

d. Obtain and document concurrence for limited use calibrations.

2.7.4 MTE user organizations shall:

a. Perform an impact assessment when notified that any of its MTE was found to be OOT as-received for calibration or was affected by an OOT calibration standard.

b. Remove MTE from service and submit for calibration when the impact assessment determines it may no longer be fit for the intended application.

c. Take appropriate corrective actions to address any potential nonconformities identified by an impact analysis.

2.8 REPAIR AND ADJUSTMENT OF MEASUREMENT AND TEST EQUIPMENT

2.8.1 Calibration or repair of MTE requiring direct interaction with internal or external electrostatic discharge (ESD) sensitive components shall be performed using ESD controls that ensure preservation of the MTE. Recommended ESD control methods are provided in ANSI/ESD S20.20.

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2.9 MEASURING AND TEST EQUIPMENT LABELING

2.9.1 KSC utilizes a system of labels that are affixed to MTE to visually identify the calibration status. The form numbers are provided in this KNPR and descriptions and sample forms can be viewed in the NASA Electronic Forms .

a. MTE used at KSC shall be labeled per the requirements of this KNPR using the system of labels identified in this section.

Note: Ancillary labels used for identification of MTE (e.g., vendor labels) may be used for reference in conjunction with the labels controlled by this specification. However, the use of ancillary labels does not satisfy the labeling requirements stated herein. Vendor calibration labels do not satisfy the requirements of this document.

b. Calibration label (KSC Form 22-658, KSC Form 50-147, and KSC Form 50-147A) is used for all MTE that has been calibrated for conformance to the manufacturer's accuracy specifications.

Note: The manufacturer's specifications are those specifications that are directly applicable to a specific make/model of MTE. The manufacturer may identify a general specification (e.g., American Society of Mechanical Engineers, ANSI, NASA) for some MTE. In all cases, the specifications identified by the manufacturer are the applicable specifications for calibration.

c. Limited Use Calibration label (KSC Form 22-659, KSC Form 22-660, KSC Form 28-519; KSC Form 50-149A, KSC Form 50-204, and KSC Form 50-205) is used for all MTE that has been calibrated to less than the full manufacturer's specifications.

Note: Limited calibrations provide an opportunity to avoid repair costs for MTE which can no longer economically be brought in compliance with the OEM specifications but are still adequate for the user's application.

d. Standards Calibration label (KSC Form 50-206) is used for all MTE that are calibrated as measurement standards, or for MTE that requires direct comparison to KSC reference standards.

Note: Calibration labels will include at least the following information:

(1) MTE identification (typically the MTE's metrology number).
(2) Calibration date (date the calibration was performed).
(3) Calibration due date (date on which the calibration expires).
(4) Limitations of use (applicable for limited calibrations).

e. MTE calibrated as "Spares" is returned to the MTE user organization with the Calibration Due Date left blank and accompanied with a Spares Calibration Recall Update Card (KSC Form 22-408). The form shall be completed by the MTE user when the item is activated and returned to the KSC Calibration Laboratory.

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f. Calibration Integrity Seal (KSC Form 28-483) label is applied to MTE in a manner to prevent and detect unauthorized access to internal adjustments which would invalidate the calibration.

Note: For MTE where a Calibration Integrity Seal cannot be applied, other means (e.g., torque seal) may be used.

g. Standardized MTE label (KSC Form 50-415) is used to indicate MTE that requires periodic standardization by the MTE user, OEM, and/or OEM's certified vendor. This label may be used in conjunction with proprietary OEM calibrations referenced in the 2.2.6 Note. This label is also used with MTE that requires pre-test verification or standardization with CRM. CRM documentation requirements are included in 2.11.4.

h. Operational Check label (KSC Form 22-419, KSC Form 22-420; KSC Form 50-246, and KSC Form 50-247) may be used for MTE which has been functionally tested to determine that it operates and performs its intended function. This label is only be used for MTE that does not require calibration but has been functionally tested (i.e., conformance to an accuracy specification has not been confirmed).

i. Calibration Not Required label (KSC Form 22-418 and KSC Form 22-661) identifies MTE which does not require calibration. This label is used for non-calibrated MTE that is used in conjunction with, or in close proximity to, calibrated MTE.

j. Not-In-Use label (KSC Form 28-412) may be used to identify MTE which usually requires calibration but is temporarily not in use. This label should be applied directly over the calibration label.

k. Reject label (KSC Form 28-411) is used for MTE that cannot be calibrated and is returned to the MTE user organization not calibrated.

l. Reject Tag (KSC Form 22-495) is completed and attached to the MTE to provide details about the reason for the rejection.

Note: MTE will be rejected when it cannot be calibrated due to reasons such as MTE is unrepairable, missing hardware/accessories, or specification data unavailable.

m. Calibration status labels are affixed directly to the MTE whenever possible, but may alternatively be affixed to an accompanying tag or to the MTE's case or container when necessary (e.g., MTE is too small to facilitate the label).

n. When the calibration label is not affixed directly to the MTE, the MTE must be traceable to the tag, case, or container on which the calibration label is affixed.

2.10 CALIBRATION INTEGRITY

2.10.1 Calibrated MTE meeting any of the following conditions is considered suspect (calibration voided), removed from use, and submitted to the KSC Calibration Laboratory for calibration.

a. MTE has a broken/tampered integrity seal, torque seal, or other preventative measures (indicating possible unauthorized access to internal adjustments).

b. MTE has an altered or tampered calibration label.

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c. MTE has been damaged, overloaded, or mishandled.

d. MTE is malfunctioning in a manner that may invalidate the intended use.

e. MTE is known to be producing incorrect measurement results.

f. MTE has been exposed to influencing factors that can adversely affect its intended use (e.g., extreme temperature, condensation, mechanical shock).

2.11 CALIBRATION RECORDS

2.11.1 Records generated in the KSC Calibration Laboratory pertaining to calibration of MTE shall be maintained in accordance with this document and NPR 1441.1, NASA Records Management Program Requirements.

2.11.2 The KSC Calibration Laboratory shall maintain the following calibration-related records, as a minimum:

a. Quantitative calibration results (calibration data sheets and test reports).

b. Calibration Requests (KSC Form 22-496).

c. Calibration interval analyses.

d. Impact assessments and MTE user notifications for OOT calibration standards.

e. Lab environment monitoring/control data (e.g., temperature/humidity charts, geodetic surveys, grounding surveys).

f. Evaluations of outside calibration service providers.

g. Internal audits or other quality control activities (e.g., sampling, document review, surveillance activity).

2.11.3 Records generated by MTE user organizations pertaining to the use of calibrated MTE shall be maintained in accordance with this document and NPR 1441.1, NASA Records Management Program Requirements.

2.11.4 The MTE user organization shall document and maintain the following calibration-related records, as a minimum:

a. Impact assessments for OOT MTE.

b. CRM usage and OEM, or OEM authorized vendor's, maintenance/standardization records for 'Standardized MTE' (*reference 2.9.1.g*).

2.12 MEASURING AND TEST EQUIPMENT PROCUREMENT

2.12.1 Organization purchasing MTE may coordinate with the KSC Calibration Laboratory manager or designee for recommendations or to identify any calibration support issues.

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Note: Coordination with the KSC Calibration Laboratory prior to MTE purchases may reduce future recurring calibration costs. The KSC Calibration Laboratory is familiar with available MTE and most MTE manufacturer's and can often provide information on make/models of MTE that are reliable and already supported at KSC, reducing support costs.

2.12.2 Organizations purchasing MTE should take into account life cycle cost, to include the cost of calibration and maintenance and the availability of Center support versus use of offsite suppliers. To this end, the procurement process should consider the availability of data necessary for the KSC Calibration Laboratory to perform the calibration.

Note: At times, the purchasing organization may be asked to purchase a calibration procedure, software, or associated accessories to facilitate calibration.

2.12.3 Newly purchased MTE that requires calibration shall be submitted to the KSC Calibration Laboratory for assignment of a Metrology Number (barcode label for unique identification), entry into the MTE recall system, and initial calibration.

2.12.4 Organizations purchasing MTE should obtain a compliant calibration (reference 2.2.4), if available, to avoid having to recalibrate the item immediately upon submission to the KSC Calibration Laboratory.

Note: If compliant calibration is not available but the OEM can provide evidence that the equipment meets the compliance standard requirements, the KSC Calibration Laboratory may be able to accept that calibration and not need to perform the initial calibration itself. In these cases, the KSC Calibration Laboratory will assign a metrology number to the new MTE, enter it into the recall system, and apply a KSC calibration label with the calibration date provided by the manufacturer and a calibration due date assigned from the KSC calibration interval analysis process.

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APPENDIX A: DEFINITIONS

Accuracy: The closeness of the agreement between the result of a measurement and a true value of the measured quantity.

Calibration: A set of operations which establish, under specified conditions, the relationship between values indicated by a measuring instrument or measuring system, and corresponding standard or known values derived from the standard.

Delayed Calibration: The post-application calibration of MTE that becomes due for calibration during an application.

End-of Period Reliability: The probability of MTE being in-tolerance at the end of its calibration interval.

Limited Calibration: The calibration of MTE to meet some (but not all) of the performance requirements stated by the manufacturer. This may include calibration over a limited range, calibration of only certain functions, or calibration to degraded accuracy specifications.

Metrology: The science of measurement.

MTE: General term that includes the measuring instruments, measurement standards, reference materials, or auxiliary apparatuses necessary to realize a measurement process.

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APPENDIX B: ACRONYMS

ANSI	American National Standards Institute
CRM	Certified Reference Material
EOPR	End-of-Period Reliability
ESD	Electrostatic Discharge
GSE	Ground Support Equipment
KNPR	Kennedy NASA Procedural Requirements
KSC	Kennedy Space Center
Met/Cal	Metrology and Calibration
MTE	Measuring and Test Equipment
NCSL	National Conference of Standards Laboratories
NPD	NASA Policy Directive
NPR	NASA Procedural Requirements
OEM	Original Equipment Manufacturers
OOT	Out-of-Tolerance
SAE	SAE International
S&MA	Safety and Mission Assurance

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