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**DEPARTMENT OF DEFENSE
STANDARD PRACTICE
CALIBRATION AND
MEASUREMENT REQUIREMENTS**



AMSC 9117

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FOREWORD

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2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to 588th CBSS/GBNA, 813 Irving-Wick Dr W, Heath OH 43056-1199, or by letter emailed to MIL-PRF@AFMETCAL.AF.MIL since contact information can change; you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.daps.dla.mil>.

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1. SCOPE

1.1 Purpose. This standard describes the requirement to provide a means for calibration and measurement traceability of all system, subsystem, and equipment. From this point on in this document, the word system will refer to system, subsystem, and equipment. This ensures system operational integrity and accuracy. It defines the requirement for establishing measurement traceability from actual system level measurements to the National Institute of Standards and Technology (NIST) or other approved measurement sources.

1.2 Applicability. The requirements of this standard apply to all systems that require measurements of any type to ensure proper operation.

1.2.1 Application guidance.

When Logistics Support Analysis (LSA) is required on an acquisition program, the requirements of this standard should be an integral part of the LSA effort. Data developed as a result of this standard should be documented in and become part of the LSA documentation.

When LSA is exempted or the LSA is tailored to exempt development of the data requirements, this standard can become an independent compliance document of the acquisition program and tailored in accordance with the contract.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3, 4, and 5 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein.

HANDBOOK**DEPARTMENT OF DEFENSE**

MIL-HDBK-300 Military Handbook, Technical Information File of Support Equipment.

MIL-HDBK-1839 Military Handbook, Calibration and Measurement Requirements

(Unless otherwise indicated, copies of the above military handbooks are available through the Acquisition Streamlining and Standardization Information System. Located on the internet at <https://assist.daps.dla.mil/online/start/> .)

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2.2.2 Other government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

NAVAIR 17-35MTL-1	Metrology Requirements List (METRL)
NAVAIR 17-35NCE-1	Navy Calibration Equipment List (NCE)
TB 43-180	Calibration and Repair Requirements for the Maintenance of Army Material
TM-10510-14/1	U.S. Marine Corps Electronics Test Equipment Listing
TO 33K-1-100-1	Calibration Procedure for Maintenance Data Collection Codes, and Calibration Measurement Summaries.
TO 33K-1-100-2	TMDE Calibration Notes , Calibration Interval, Technical Order, And Work Unit Code Reference Guide

(Copies of Air Force TO 33K-1-100-1, 33K-1-100-2, Army TB 43-180, NAVAIR 17-35MTL-1, or NAVAIR 17-35NCE-1 should be obtained as directed by the contracting officer. The Marine Corps Technical Manual is available from HQMC, Technical Manual Sec, Washington, DC 20380-0001.)

2.3 Order of Precedence. In the event of a conflict between the text of this standard and the references cited herein, the text of this standard will take precedence. Nothing in this standard, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

3.1 Definitions

3.1.1 Accuracy. Closeness of agreement between a measured quantity value and a true quantity value of the measured.

3.1.2 Built-in-Test (BIT). A test approach using built-in test equipment or self-test hardware and software that is internally designed into the supported system, subsystem, or equipment to test all or a part of that system, subsystem, or equipment.

3.1.3 Built-in-Test Equipment (BITE). Any device which is a part of a system, subsystem, or equipment and is used for the express purpose of testing the system, subsystem or equipment. BITE is an identifiable unit of the system, subsystem, or equipment.

3.1.4 Calibration. The set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards.

3.1.5 Calibration Interval. The maximum time an item of TMDE, may go between calibrations and still achieve its target measurement reliability.

3.1.6 Calibration and Measurement Requirements Summary (CMRS). A report which details the measurement requirements of a system, subsystem, or equipment; the TMDE, and the calibration standards and equipment required to assure traceability of all measurements through the applicable individual military service's metrology and calibration program.

3.1.7 Design Activity. A design activity is an activity that has responsibility for the design or

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modification of an item. The activity may be a U.S. Government, commercial, or nonprofit organization.

3.1.8 Interface Test Adapter. The point located on the ATE where all input and output signals are accessible for connection to an external UUT or calibration standard.

3.1.9 Logistics Support Analysis (LSA). The selective application of scientific and engineering efforts undertaken during the acquisition process, as part of the system engineering and design process, to assist in complying with supportability and other Integrated Logistics Support (ILS) objectives. The LSA process is a planned series of tasks performed to examine all elements of a proposed system to determine the logistics support required to keep that system useable for its intended purpose; and to influence the design so both the system and support can be provided at an affordable cost.

3.1.10 Measurement Traceability. The property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties. Traceability, as used in this standard, applies to measurements/calibrations made from the prime system or subsystem through an unbroken chain of comparisons to the national reference standards.

3.1.11 Support Equipment (SE). All equipment used in calibration and maintenance support of mission and operational equipment.

3.1.12 Support Equipment Recommendation Data (SERD). The document, usually prepared by an equipment manufacturer, which describes the support requirement for an item of equipment and recommends an item of support equipment to satisfy the requirement.

3.1.13 Test Accuracy Ratio (TAR). A simple comparison between the accuracy of the Unit Under Test (UUT) and the accuracy of the calibration standard. However, this ratio does not consider other potential sources of error in the calibration process. For example, if it is required that an equipment output parameter's accuracy is $\pm 8\%$ and the accuracy of the single measuring device used to measure the output parameter is $\pm 2\%$, then the TAR is 8 to 2 or 4 to 1.

3.1.14 Test, Measurement, and Diagnostic Equipment (TMDE). Any system or device used to test, measure, evaluate, inspect, or otherwise examine materials, supplies, equipment, or a system to identify and/or isolate any actual or potential malfunction, or to determine compliance with specifications established in technical documents (e.g. research, development, test, and evaluation documents; specifications; engineering drawings; technical orders). TMDE is SE that provides for measurement traceability.

3.1.15 Test Program Set (TPS). The ensemble of input-desired response data used to verify the performance of the system under test.

3.1.16 Test Uncertainty Ratio (TUR). The comparison between the accuracy of the Unit Under Test and the estimated calibration uncertainty is known as a Test Uncertainty Ratio (TUR). This ratio is more reliable because it accounts for possible sources of error in the calibration process that the TAR does not. This value also takes into account issues such as temperature, humidity, Type A (statistical analysis including actual and random measurement results), and Type B (anything not a Type A) uncertainties.

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3.1.17 Uncertainty. The word “uncertainty” means doubt, and thus in its broadest sense “uncertainty of measurement” means doubt about the validity of the result of a measurement. Because of the lack of different words for this general concept of uncertainty and the specific quantities that provide quantitative measures of the concept, for example, the standard deviation, it is necessary to use the word “uncertainty” in these two different senses.

4. GENERAL REQUIREMENTS

4.1 General Measurement Requirements. The design activity shall ensure the following actions are accomplished for the affected systems and equipment throughout their life cycle.

- a. All parameters that require measurement to ensure proper and accurate operation of the system are identified and documented.
- b. Calibration and measurement actions are conducted as required to maintain accurate operation. Such actions are to be accomplished at all applicable system and subsystem levels and are appropriately integrated into the total system requirements.
- c. All parameters are readily accessible and measurable in a manner that minimizes the number and duration of the tests required.
- d. Measurement traceability of all system and subsystem parameters is documented.

5. DETAILED REQUIREMENTS

5.1 System Measurement Parameters.

5.1.1 Description of Items. The system, subsystem, or equipment, which has parameters that require measurement, shall be identified by nomenclature, manufacturer and manufacturer's code, part or model number, and type designation. If an item does not have an approved part number, but does have an approved or proposed end item specification number or system number, that number shall be referenced. Each requirement shall identify:

- a. Function: The function (specific input, output, or other characteristic which has units of measurement such as volts, frequency, power, current, length, force, etc.) which will be measured, tested, checked, or adjusted.
- b. Operational range or specific value: The range of values or actual value that shall be measured to satisfy operational requirements.
- c. Operational Tolerance: The tolerance of the range or specific value within which the equipment is required to perform to meet operational specifications.
- d. Calibration Interval: The design activity shall recommend a maximum time lapse between tests.

5.1.2 Identification of Parameters. The design activity shall identify all system, subsystem, and equipment parameters that require measurement or testing to ensure proper system or equipment accuracy, and to ensure intended mission goals are met.

5.1.3 Sequence of Relationship. This assessment of parameters shall portray the logical sequence of relationship between the systems, and identify the parameters requiring measurement and verification.

5.1.4 Selecting TMDE. This assessment of parameters shall be used by the design activity during the

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evaluation process for recommending or selecting TMDE and developing support documentation.

5.1.5 Firmware of System. The design activity shall ensure that all firmware equipment that is required for measurement or testing is annotated by version, revision number and revision date. Any changes to the firmware that affects measurement or testing is documented as to the extent the change affect the measurement accuracy of the equipment should be noted.

5.2 Built-In Test and Built-In Test Equipment. For parameters of BIT and BITE, or other internal measurements which are part of the operational equipment requiring test or measurement, the nomenclature, manufacturer or code, part number or model number, range and accuracy of the operational equipment shall be identified, as well as the parameters being monitored or generated. When built-in references are employed, a method of test or measurement shall be identified or, if not required, a narrative justification shall be documented.

5.3 System Test Points. The design activity shall ensure measurements can be accomplished; test points are identified in technical data, and are accessible with minimum disturbance to configuration of the system and/or equipment.

5.4 Test, Measurement, and Diagnostic Equipment.

5.4.1 Recommended TMDE. The design activity shall ensure that TMDE is recommended to satisfy all measurement requirements identified in accordance with sections 5.1 and 5.2 of this standard.

- a. The TMDE recommended shall be capable of functioning in the system operational measurement environment and satisfy all parameters of each measurement (see 5.4.3).
- b. Where several items of TMDE are used in combination, the overall test configuration specification and uncertainty shall be documented.

5.4.2 TMDE in support of TMDE.

- a. The design activity shall identify calibration equipment and standards required to support TMDE recommendations which are not currently supportable (i.e. not listed with calibration procedures and intervals) by the applicable military department metrology and calibration program.
- b. Refer to Air Force TO 33K-1-100-1, -2, Army TB 43-180, Navy NAVAIR 17-35MTL-1, or Marine Corps TM-10510-14/1 to determine TMDE supportability. Refer to Air Force TO AFCAV, Army TB 43-180 or Navy NAVAIR 17-35NCE-1 and MIL-HDBK-300 to identify existing military department calibration equipment and standards.
- c. If existing applicable military department calibration equipment and/or standards will not meet the requirements, the design activity shall recommend equipment and/or standards and a narrative justification shall be documented.
- d. The design activity shall assess specifications of the calibration equipment and standards used in support of other TMDE. The calibration equipment and standards identified shall satisfy all parameters of each measurement and comply with the requirements set forth in this standard (see 5.4.3).

5.4.3 Test Uncertainty Ratio (TUR). The recommended TMDE shall be capable of measuring or generating to a higher accuracy than the measurement parameters being supported. Unless otherwise specified, a minimum TUR of 4 to 1 is desired. The actual TUR shall be documented. If a TUR of 4 to 1, or the specified TUR, cannot be achieved, the design activity shall analyze the measurement

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requirements and provide documented justification for the lesser TUR. A TUR of 4 to 1 is not required when the TMDE only provides input stimuli which are not used to characterize performance of the operational equipment or other TMDE. In this case, a minimum TUR of 1 to 1 is acceptable.

5.4.4 Automatic Test Equipment.

5.4.4.1 ATE Design. The ATE performance specifications shall be more accurate than the system or equipment operational requirements (see 5.4.3).

5.4.4.2 ATE Technical Description.

- a. The design activity shall determine the ATE capabilities actually used for UUT testing.
- b. TMDE recommended for test, measurement, and calibration of ATE shall be selected to support ATE capabilities actually being used for UUT testing and ATE self testing.

5.4.4.3 ATE Calibration. The design activity shall assess all functions and parameters required for UUT testing, ATE self test, and calibration of the ATE. ATE calibration is implemented as a test program set (TPS) with the program running on the ATE host computer.

- a. The ATE/UUT parameters shall be documented to the ATE/UUT interface utilizing a CMRS.
- b. The ATE calibration TPS shall be structured to provide traceability of every calibrated function and parameter to approved national or international standards. External standards and calibrated ATE components shall be used.
- c. The ATE calibration TPS shall calibrate the ATE to a TUR of 4 to 1 when possible (see 5.4.3). This includes, but is not limited to, the most stringent support requirements of the UUT.
- d. In the case of ATE that uses built-in calibration standards, these standards shall be identified with their full measurement and stimuli capabilities (see 4.1c) in the CMRS.
- e. Calibration standards or calibration procedures used to support built-in standards shall be recommended in the CMRS.

6. NOTES

6.1 Intended Use. This document provides a means for calibration and measurement traceability to ensure system operational integrity and accuracy.

6.2 Associated Data Item Descriptions (DIDs). When it is necessary to obtain the data, the applicable DID must be listed on the Contract Data Requirements List (DD Form 1423), except where the DoD Federal Acquisition Regulation Supplement exempts the requirement for a DD Form 1423. DIDs can be obtained by going through the ASSIST database located at <https://assist.daps.dla.mil>.

DID Number DID Title

DI-QCIC-80278 Calibration and Measurement Requirements Summary (CMRS)

The ASSIST Online database at <https://assist.daps.dla.mil>, must be researched to ensure that only current and approved DIDs are cited on the DD Form 1423.

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6.3 Subject Term (keyword) Listing.

- Metrology
- Parameters
- Specifications
- Standards
- Test Accuracy Ratio
- Test uncertainty ratio
- Tests
- Traceability
- Uncertainty

6.4 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

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CONCLUDING MATERIAL

Custodians:

Army - MI

Navy - OS

Air Force – 84

Preparing Activity:

Air Force – 36

Agent:

Air Force – 99

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Review Activities:

Army - AR, AT, AV, CR, TM

Navy - AS, EC, MC, NM, SH, TD

Air Force - 11, 13, 19

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <https://assist.daps.dla.mil>.