NOT MEASUREMENT SENSITIVE

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DEPARTMENT OF DEFENSE

HANDBOOK

CALIBRATION AND MEASUREMENT REQUIREMENTS

This handbook is for guidance only. Do not cite this document as a requirement.

AMSC N/A **AREA QCIC**

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FOREWORD

1. This military handbook is approved for use by all Departments and Agencies of the Department of Defense.

2. This handbook is for guidance only. This handbook cannot be cited as a requirement. If it is, the contractor does not have to comply.

3. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to AFMETCAL/MLSR, 813 Irving-Wick Dr W, Suite 4M, Heath OH 43056-6116, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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CONTENTS

1. SCOPE

1.1 Scope. The information and interpretive guidance provided by this handbook are intended to clarify the requirements invoked by MIL-STD-1839. This handbook is for guidance only. This handbook cannot be cited as a requirement. If it is, the contractor does not have to comply.

1.2 Purpose. This handbook is an informational guide intended to provide design activities (government representatives and contractor personnel) with an expanded understanding of MIL-STD-1839 requirements, and to assist in providing for the uniform evaluation of the contractor's compliance to the individual requirements as they apply to the contract. Accordingly, this handbook quotes (" ") the requirements from the respective sections of MIL-STD-1839, for easy reference, followed by interpretive guidance for the requirements of the standard. This handbook cannot modify or add to any of the MIL-STD-1839 requirements.

1.3 Applicability. The requirements of MIL-STD-1839 apply to all systems, subsystems, and equipment that require measurements of any type to ensure proper operation while this handbook provides supplemental information to the standard.

1.3.1 Application guidance.

a. When Logistics Support Analysis (LSA) is required on an acquisition program, the requirements of MIL-STD-1839 should be an integral part of the LSA effort. Data developed as a result of these requirements should be documented in and become part of the LSA documentation.

b. When LSA is exempted or the LSA is tailored to exempt development of the data requirements, MIL-STD-1839 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 below are not necessarily all of the documents referenced herein, but are the ones that are needed in order to fully understand the information provided by this handbook.

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. Unless otherwise specified, the issues of these documents are those listed in the latest issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto.

HANDBOOK

DEPARTMENT OF DEFENSE

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

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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

3. DEFINITIONS

"3.1 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."

Interpretive guidance: Calibration does not imply that the item being calibrated can be adjusted. There are some items (such as a fixed resistor, or an attenuator) which can be calibrated but not adjusted, and upon failing calibration a new calibration factor is assigned or the item is simply taken out of service or no longer used for making quantitative measurements.

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

Interpretive guidance: Calibration standards are by definition SE as they are support equipment for support equipment.

"3.3 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; and technical orders). TMDE is SE that provides for measurement traceability."

Interpretive guidance: TMDE is a sub-set of SE, i.e. all TMDE is SE, but not all SE is TMDE. Calibration standards are a sub-set of TMDE as they are used to test, measure, evaluate, and inspect TMDE and they are essential to establishing traceability.

"3.4 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."

Interpretive guidance: It is the intent of the Calibration and Measurement Requirements Summary (CMRS), (see APPENDIX A for FREQUENTLY ASKED QUESTIONS and APPENDIX B for an example of a CMRS) to document the traceability of the measurement from the prime system, (e.g., F/A-18, B-2, V-22, M1A2, CASS, etc) through an unbroken chain of calibrated TMDE and calibration laboratories to either a national standard or a physical constant. In effect, the CMRS outlines traceability for each measurement from the prime system level through the SE, and through the calibration standard(s) to the National Institute of Standards and Technology (NIST) the United States Naval Observatory (USNO) or other recognized reference standards.

"3.5 Test Uncertainty Ratio (TUR). The total uncertainty of the unit to be measured or calibrated divided by the total uncertainty of the measuring or generating device used to perform the measurement. For example, if it is required that a system or equipment output parameter's uncertainty is 8% and the uncertainty of the measuring device used to measure the output parameter is 2%, then the TUR is 8 to 2 or 4 to 1."

Interpretive guidance: The desired TUR is 4 to 1. TUR is the calculated result of dividing the uncertainty or tolerance of a measurement/input requirement by the uncertainty/tolerance of the equipment satisfying the requirement. TURs are generally calculated for each operational system test requirement that is supported by SE and for SE supported (calibrated) by SE. The maximum permitted uncertainty should reflect the actual use requirement of the unit being measured/calibrated for the intended use. Tolerances used in TUR calculations will be in the same measurement units. Uncertainties expressed in logarithmic units such as decibels should be considered. Decibels should first be converted to linear units before computing TUR. For example, suppose the system uncertainty and the measurement uncertainty is 4db and 1db respectively. The db ratio may be 4 to 1 but the linear ratio may be only 2 to 1 or a 3db gain is generally double in value when dealing with power measurements. Caution should be used when uncertainties are stated as percentages because they often are not related (i.e. percentage of full scale versus percentage of reading). Tolerances expressed as "minimum", "maximum", "less than", "more than", "greater than" and "less than", do not allow TURs to be calculated, thus using them is not desired. However, when no other option exists, the design activity should specify the recommended uncertainty of the supporting equipment (see 5.4.3).

"3.6 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."

Interpretive guidance: Upon contract award, some program offices provide a Logistics Guidance Conference. As part of this conference, it is highly recommended to set aside time to discuss the development and expectations of a CMRS. If a Logistics Guidance Conference is not held, it is highly recommended that a CMRS guidance conference be coordinated between the Program Office, the Service specific CMRS reviewing activity, and the design activity as early in the acquisition life cycle as possible.

"3.7 Design activity. A design activity is an activity that has responsibility for the design or modification of an item. The activity may be a U.S. Government, commercial, or nonprofit organization."

Interpretive guidance: The design activity is the activity that is normally responsible for the development of a CMRS. This ensures that the U.S. Government obtains maximum benefit from the development of the CMRS, taking advantage of the benefits via concurrent engineering concepts thereby minimizing redundant/conflicting engineering decisions.

"3.8 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 department's metrology and calibration program."

Interpretive guidance: The report format is identified in the associated Data Item Description (DID). The report media needs to be agreed to during the logistics guidance conference, or the CMRS guidance conference, unless otherwise specified by contract.

"3.9 Automatic Test Equipment (ATE) Unit Under Test (UUT) interface. The point located on the ATE where all input and output signals are accessible for connection to an external UUT or calibration standard."

Interpretive guidance: The ATE parameters are to be documented to the ATE/UUT interface and the calibration is to be performed at the UUT interface (see 5.4.4.3).

"3.10 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."

Interpretive guidance: BIT needs to be addressed in the CMRS. If the BIT makes a measurement, and that measurement is acted upon (i.e. go/no-go decision) the embedded measuring devices utilized by BIT need to be assessed for traceability and the results documented in the CMRS.

"3.11 Built-in-Test Equipment (BITE). Any device that 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."

Interpretive guidance: BITE needs to be addressed in the CMRS. If the BITE makes measurements resulting in test decisions then the BITE needs to be assessed for traceability and the results documented in the CMRS.

"3.12 Calibration interval. The maximum time an item, requiring calibration, may go between calibrations and still achieve its target measurement reliability."

Interpretive guidance: The period of time a calibration is valid. The length of time between a calibration and the next calibration due date. Measurement reliability is the probability of equipment remaining in tolerance throughout the calibration interval.

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 and equipment are identified and documented."

Interpretive guidance: Special attention should be paid to ensure that all parameters are addressed. Tools available to help are; maintenance plans, maintenance manuals, fault tree analysis, test requirements documents, test plans, LSA documentation, etc.

"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."

Interpretive guidance: Calibration and measurement actions conducted will be thorough so that system and subsystem performance can be adequately assessed.

"c. All parameters are readily accessible and measurable in a manner that minimizes the number and duration of the tests required."

Interpretive guidance: Both physical access and/or access via software needs to be considered.

"d. Measurement traceability of all system and subsystem parameters is documented."

Interpretive guidance: The traceability chain should be documented to the extent necessary to determine that it is unbroken from the end item through to the national or international standard or other DOD approved sources for all parameters including BIT and BITE (see 3.4).

5. DETAILED REQUIREMENTS

5.1 System, subsystem, and equipment measurement parameters.

"5.1.1 Assessment of parameters. The design activity shall assess all system, subsystem, and equipment parameters that require measuring or testing to ensure proper system or equipment operation and accuracy, and to ensure intended mission goals are met."

Interpretive guidance: The measurements and tests are made and/or performed to ensure that the system performs in accordance with its intended use.

"5.1.1.1 Sequence of relationship. This assessment of parameters shall portray the logical sequence of relationship within and between the system, subsystem, and equipment, and identify the parameters requiring measurement and verification.

a. System parameters require measurement and verification to ensure proper operation of the system so the mission requirements of the system can be accomplished.

b. Subsystem parameters require test and measurement to ensure interchangeability and proper operation of the subsystem when integrated into the complete system.

c. Equipment parameters require test and measurement to ensure interchangeability and proper operation of the equipment when used as part of or connected with the system or subsystem."

Interpretive guidance: Occasionally it is beneficial to the developer and/or the reviewer of the CMRS to develop a pictorial view of the parametric flow. A flow chart, with the subsystem parameters mapped to the system parameters, mapped to the SE parameters, mapped to either the appropriate service's approved calibration procedure or the calibration standards, mapped to the national standards or a physical constant. Generally, the parametric mapping (i.e. traceability) will be satisfied with either an appropriate service's approved calibration procedure or to a first tier calibration standard which has an approved procedure. Rarely does the parametric map have to document a flow to the national standards or a physical constant. The parameters required for interchangeability necessary to be documented will be driven down to the lowest level of repair documented in the LSA where measurements are required.

"5.1.1.2 Selecting TMDE. This assessment of parameters shall be used by the design activity during the evaluation process for recommending or selecting TMDE and developing support documentation."

Interpretive guidance: MIL-HDBK-300 is available to assist in selection of TMDE thereby aiding in the nonproliferation of SE. Experience has shown that the effective interrelationship of concurrent engineering and logistics planning support the awareness of traceability requirements and the implementation of cost effective and technically adequate measurement traceability. To realize maximum benefit, CMRS development should be an integral part of this concurrent engineering effort.

"5.1.1.3 Description of items. The system, subsystem, or equipment that 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 to determine or maintain the item's operational condition.

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."

Interpretive guidance: The system requirements should be based on operational tolerances instead of design tolerances since any differences in tolerance can have an impact on calibration intervals and the required accuracies in the traceability chain.

"d. Interval: The design activity shall recommend a maximum time lapse between tests or other method of scheduling tests."

"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."

Interpretive guidance. Weapon System SE that make quantitative measurements or provides known stimuli requires calibration. Advances in technology have resulted in reduction in the use of conventional SE in favor of BIT and BITE. It should be recognized that this does not alter the calibration requirement and that BIT and BITE, which makes quantitative measurements or provides known stimuli, require calibration just as does any other SE. Without calibration, traceability can not be maintained and out of tolerance conditions may not be detected. The result of not calibrating

BIT and BITE could be a high level of false rejects resulting in unnecessary rework of good systems or worse yet, false acceptances of out of tolerance conditions, resulting in systems erroneously identified as mission ready when they are not.

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

Interpretive guidance: Ready access to calibration test points provides the following: minimal disruption to the integrity of the system for calibration purposes, reduced safety risk to calibration personnel, reduction in the likelihood of equipment failures induced during calibration, and increased efficiency of the calibration.

5.4 Test, Measurement, and Diagnostic Equipment (TMDE).

"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. The design activity shall assess TMDE specifications in support of measurement requirements identified in accordance with sections 5.1 and 5.2 of this standard. Where several items of TMDE are used in combination, the overall test configuration specification and uncertainty shall be documented."

Interpretive guidance: MIL-HDBK-300 provides guidance on the selection of TMDE. BITE is considered to be TMDE for calibration and CMRS purposes.

"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. 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 33K-1-101, Army TB 43-180 or Navy NAVAIR 17-35NCE-1 and MIL-HDBK-300 to identify existing military department calibration equipment and standards. 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.

b. The contractor 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 paragraph 5.4.3 of this standard.

c. Where several items of calibration equipment and standards are used in combination to support other TMDE, the overall test configuration specification and uncertainty shall be documented."

Interpretive guidance: Subparagraph a. addresses the selection of calibration standards including standards in support of standards (if necessary). The selection of optimum calibration equipment/standards should consider the operational requirements, which will be met, but need not be exceeded, and the availability of existing support (i.e. procedures, standards, and intervals in place). Documenting traceability from the prime system to the national standard, may require more than one level of calibration standards in which case the CMRS may have four or more categories of equipment. These categories include system/subsystem, TMDE (test equipment), TMDE (standards), and TMDE (standards to support standards), etc.

"5.4.3 Test Uncertainty Ratio. 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."

Interpretive guidance: TUR is a recognized mechanism for establishing the criteria between equipment listed in proximity categories in the CMRS. Actually, use of the TUR is an alternative to performing a more difficult uncertainty analysis as described in ANSI/NCSL Z540-2-1997. The TUR does not relate directly to uncertainty analysis. However, it can be linked to the probability of making erroneous test decisions. Another important point, design activities often select SE that is more accurate than required for the application due to availability, future planning, cost considerations, etc. That is perfectly acceptable but in the application, as defined by the CMRS, the specifications should be derated to the 4 to 1 TUR so as not to create unnecessarily accurate and costly support requirements for the SE. Creation of unnecessarily over/under specified problems are minimized when the design activity emphasizes concurrent engineering processes where the logistics support planning and design engineering are time related and maintain a close liaison. The importance of not over specifying a piece of support equipment cannot be over emphasized as substantial unnecessary costs can be incurred by designs using overly stringent specifications.

"a. If a TUR of 4 to 1, or the specified TUR, cannot be achieved, the design activity shall analyze the measurement requirements and provide documented justification for the lesser TUR."

Interpretive guidance: It is highly recommended that if the CMRS preparing activity contact their designated service CMRS review agent to discuss any shortcomings in meeting specified TUR prior to submittal.

"b. 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."

Interpretive guidance: A TUR of 1 to 1 is acceptable between the system and an item of support equipment only when the system requires an input, stimulus, or applied value for establishing test conditions and the system itself does not measure the applied parameters or characterize its own performance. Examples of acceptable 1 to 1 TURs are input/supplied torque applications, electrical stimuli signals, and pressure inputs. A minimum TUR of 1 to 1 only applies between the system and the SE. It does not apply between SE and calibration equipment. A 4 to 1 TUR is desired when the system measures an applied/input parameter and the results determine pass/fail status or the systems performance is characterized.

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)."

Interpretive guidance: Consider the requiring system specifications and establish ATE specification based on the actual requirements.

"5.4.4.2 ATE technical description.

a. The design activity shall assess the complete measurement and stimuli capabilities that can be made available at the ATE UUT interface."

Interpretative guidance: Navy document NAVAIR 17-35TR-2 "Technical Requirements for Automatic Test Equipment Calibration Requirements Analysis (CRA)" provides guidance on conducting a calibration requirements analysis on ATE. This reference provides insight into various aspects of calibration requirements involving ATE. It also discusses the approach to CMRS development when the ATE is built with no specific weapon system identified.

"b. The design activity shall determine the subset of ATE capabilities actually used for UUT testing."

Interpretive guidance: The design activity should consider other applications of this ATE prior to tailoring of the calibration requirements of the ATE to fit the UUT requirements under consideration. In other words, consider the entire requirement and do not unnecessarily limit the ATE performance (specification) that is required for other, more capable systems. Alternatively, it is also necessary to consider the opposite scenario where the ATE is developed for a peculiar application and (appropriately) derated to support the use requirement. If a new UUT requirement arises which is more capable (but within the true capability of the ATE), the new requirement will provide for upgrading the calibration of the new bench.

"c. 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."

Interpretive guidance: A TPS normally consists of three elements; software, hardware (interface device), and documentation.

"a. The ATE/UUT parameters shall be documented to the ATE/UUT interface."

Interpretive guidance: Traceability chains often include active interconnect devices which will be addressed for calibration requirements.

"b. The ATE calibration TPS shall be structured to provide traceability of every calibrated function and parameter to approved national or international standards. To this end, external standards and calibrated ATE components, used as working or secondary standards, 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, self-test, and the calibration TPS itself."

Interpretive guidance: The term "self-test" is interpreted to encompass BIT. For TURs of less than 4 to 1 (see 5.4.3).

"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)."

Interpretive guidance: Calibration of the built-in calibration standards needs to be addressed for traceability purposes. The DoD does not recognize self-calibrating, due to the fact that self-calibration can not provide traceability.

"e. Calibration standards or calibration procedures used to support built-in standards shall be recommended."

6. NOTES

6.1 Intended use. This handbook is an informational guide to be used in conjunction with MIL-STD-1839 which provides a means for calibration and measurement traceability to ensure system and equipment operational integrity and accuracy.

6.2 Subject term (keyword) listing.

Metrology
Parameters
Specifications
Standards
Test uncertainty ratio
Tests
Traceability
Uncertainty

6.3 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.

FREQUENTLY ASKED QUESTIONS

A.1 SCOPE

A.1.1 Scope. This Appendix is not a mandatory part of this handbook. The information contained herein is intended for guidance only.

A.2 Frequently Asked Questions.

1. Who are the government points of contact that will be reviewing the CMRS?

Response: The CMRS reviewing activities are as follows:

Naval Warfare Assessment Station, Code MS 40
P. O. Box 5000
Corona, CA 92878-5000
Phone (909) 273-4456

AFMETCAL Det 1/MLSR, Code 84
813 Irving-Wick Drive West, Suite 4M
Heath Ohio 43056-6116
Phone (740) 788-5060
DSN 366-5060 DSN 923-4456
FAX (DSN)366-5021 FAX (DSN) 933-4237

United States Army TMDE Activity
5435 Fowler Road
Redstone Arsenal, AL 35898-5000
Phone (256) 876-1134
DSN 746-1134
FAX (DSN) 746-7664

2. What is the purpose of the CMRS?

Response: The CMRS is a technical summary of calibration and measurement requirements for weapons systems, subsystems, support equipment (including test equipment) and calibration standards. It provides an outline of relevant parameters, range accuracy and intervals. The CMRS document identifies calibration support requirements for a weapons system/platform or major subsystem. The CMRS is the recognized vehicle for documenting measurement traceability from the prime system through the measurement chain to national or international standards. More specifically, the CMRS does the following: it documents traceability of measurements from the initial system/subsystem to the national or international standard; identifies all system and subsystem parameters which require testing; provides data to verify the SE and calibration standards are capable of a minimum 4 to 1 TUR; identifies SE, calibration standards, and calibration procedure requirements; and recommends the calibration laboratory level where calibrations should be performed.

3. Where do I find calibration standards?

Response: Calibration standards are unique to each service and should be selected from the contracting service's document of standards. Specifically these are: Air Force TO 33K-1-101; Army Drawing 7917000/1 and 8205511; or Navy NAVAIR 17-35-NCE-1.

4. What does a CMRS look like?

Response: An example of a CMRS is provided in appendix B of this handbook. Additionally, there are illustrations in DID DI-QCIC-80278.

5. What is full traceability?

Response: Full traceability applies to measurements/calibrations made from the weapons system or subsystem through an unbroken chain of comparisons to national or international reference standards. The International Vocabulary of Basic and General Terms in Metrology (VIM) defines traceability as "Traceability is 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."

6. When does the requirement for CMRS category IV, and higher, go into effect?

Response: When category III lists a calibration standard that is not a DoD approved standard (See 5.4.2a).

7. What is the relationship of the CMRS to the rest of the LSA?

Response: The CMRS is an integral part of the LSA process for the development of a new weapons system. The MIL-STD-1388 LSA process had the CMRS as a part of the LSAR. With the advent of the Logistics Management Information (LMI) process for new development systems, the process allows for incorporation of the CMRS into the LMI. If the Program Office opts to not develop a CMRS within the LMI process, the Program Office can use MIL-STD-1839 and develop a stand alone CMRS. In any case, the CMRS is a vital element in the LSA process which, if done properly, will likely influence design and help to optimize the support of the weapons system, minimize the Life Cycle Costs associated with calibration of the new system, and optimally enhance the reliability of the weapons system.

8. What are the roles and responsibilities of those involved in CMRS development.

Response: The Logistics Manager (LM) in the program office manages the CMRS effort and is responsible for calling a Logistics Guidance Conference or a CMRS Guidance Conference at which time the CMRS purpose, format, data required, report media, etc. are discussed and agreement reached. The design activity (typically a contractor) is responsible for developing the CMRS based on specifications, and information received at the guidance conference. The third activity involved is the military department's CMRS reviewing agent which will be specified.

9. What is the approval process for the CMRS?

Response: Approval will be via use of DD Form 1423 unless otherwise specified. To facilitate development of an effective and complete CMRS, which will be readily accepted, interaction between the design activity and the government CMRS reviewing activity is vital.

Note: Normally weapon system parameters are displayed as CAT I in the Summary Data Section with the supporting TMDE displayed as CAT II. Appendix B describes an exception and a partial example of a test station being displayed as CAT I using CORE PATEC as CAT II.

B.1 SCOPE

B.1.1 Scope. This Appendix is not a mandatory part of this handbook. This information herein is intended for guidance only.

B2 Example CMRS. The following is an example CMRS:

Document Number 100
Revision 1
30 FEB 2002

CALIBRATION and MEASUREMENT

REQUIREMENTS SUMMARY

(CMRS)

for the

Big Automatic Tester (BAT)

____
Prepared by

____
Title

____
Approved by

____
Title

TABLE OF CONTENTS

INTRODUCTION
for the
Big Automatic Tester (BAT)
CALIBRATION & MEASUREMENT REQUIREMENTS
SUMMARY
(CMRS)

This CMRS identifies the Big Automatic Testers for the following configurations:

PN: ABC with options 01/02/03, NSN 6625-01-234-0099
PN: CDE with options 02/03/04/05, NSN 6625-01-456-0099
PN: FGH with options 02/03/04/05/06, NSN 6625-01-789-0099

However, this CMRS does not include the calibration capability to support the Phase Noise Measurement Module (PN 9500004-10) contained in the BAT model number 303C. This module was omitted, as the technical data is proprietary and not available from the OEM. The phase noise measurement required by this module can be calibrated through the local PMEL with the 3048MS, phase noise measurement system. The optimum solution regarding phase noise measurement would be to supplement the PATEC with a spectrum analyzer and low noise synthesizer for the BAT model 303C, 305 and 405 systems. The addition of a microwave counter to the CORE PATEC would improve the calibration capability and accuracies of instruments in the RF Station.

The following instrument limitations have been incurred in the development of this CMRS.

1. Elgar AC Power supply Model SW5250 - no technical data available from OEM.

2. Power Meter sensors, 8481D and 8481A - recommend sensors should be calibrated by PMEL (33K4-4-184-1 and 33K4-4-35-1), not in the field. A field calibration using PATEC can be achieved with a reduction in uncertainty to 0.5 dB.

3. Test Uncertainty Ratio (TUR) of 1:1 can only be achieved for the DDCC37001 and the 5410C-89-1. The current technology can improve this ratio to the recommended 4:1. It would require the purchase of additional standards. The estimated cost would be roughly $18,000.

The CMRS relies on the following BAT instruments to be utilized as working standards during the calibration process.

1. Spectrum Analyzer, HP 71209A/C

2. Digital Multimeter, HP E1410A

3. Synchro/Resolver, 5410C-89-1

4. Power Meter, HP 70100A

NOTE: When the spectrum analyzer, part number 71209A/C is calibrated with the PATEC, the following modules in the 71000A mainframe are also calibrated.

1. Local Oscillator, 70900B

2. RF Section, 71908B

3. IF Amplifier, 70902A

4. IF Amplifier, 70903A

5. Digitizer, 70700A

The format used to assemble the CMRS for the BAT system follows the guidelines outlined in appropriate AFMETCAL documents.

The increased emphasis to calibrate an instrument to its full specifications has been adopted in this CMRS. Normally, a CMRS would only address the most stringent specification of the weapons system requiring calibration. Had this posture not been utilized, a new CMRS would be required each time a new weapons system was supported by the BAT. It is believed that each instrument that requires traceability should be calibrated as close to 100% as can be achieved using the PATEC. This methodology should ensure that an instrument has traceability to the National Institute of Standards and Technology (NIST).

Phase Noise has been a common measurement requirement of many instruments installed in BAT. The PATEC does not have the capability to make phase noise measurements, but the BAT does. The Spectrum Analyzer, model 71209A/C, has the ability to make direct phase noise measurement. This method has adequate measurement range to satisfy most of the requirements for BAT unless very demanding phase noise measurements are required for specific mission requirement.

LIST OF ABBREVIATIONS, SYMBOLS AND ACRONYMS

AFMETCAL	Air Force Metrology and Calibration
AFPSL	Air Force Primary Standards Laboratory
ATE	Automatic Test Equipment
BW	Bandwidth
CMRS	Calibration and Measurement Requirements Summary
CW	Continuous Wave
dB	Decibels
dBc/Hz	Decibels below the carrier at specified frequency offset
dBm	decibels milliwatt
DMM	Digital Multimeter
GHz	gigahertz
IF	Intermediate Frequency
KHz	kilohertz
MHz	megahertz
NCR	No Calibration Required
ns	nanoseconds
PATEC	Portable Automatic Test Equipment Calibrator
PMEL	Precision Measurement Equipment Laboratory
ppm	parts per million
psec	picoseconds
RFIU	RF Interface Unit
SICL	see individual component listing
SRU	Shop Replacement Unit
TUR	Test Uncertainty Ratio
TMDE	Test, Measurement, and Diagnostic Equipment
TPS	Test Program Sets
VME	Versa Modula Europa
VRMS	Volts AC
VXI	VME Extensions for Instruments
µs	microseconds
%	Percent
°	Degrees

TABLE OF CATEGORY II TMDE

This summary data represents the common and peculiar calibration equipment, standards and TMDE used for calibration, testing, troubleshooting or maintenance of Category II TMDE, as specified in MIL-STD-1839. This summary lists the DoD approved equipment and procedures traceable to the National Institute of Standards and Technology (NIST). Any peculiar calibration equipment shall be listed in Category III column adjacent to the equipment it was designed to support, and also listed in Category II column so a method of support and traceability can be established in its Category III column.

Model, Type or Part No.	Nomenclature	CAGE	National Stock Number	Cal Int	Calibration Procedure[1]	SERD No.	Maintenance Document[2]
PATEC Core	PATEC Core	30653	6625-01-154-5040	SICL	SICL		N/A
8810	Angle Position Indicator	07342	7035-01-106-4131	12	33K8-4-81-1		33AA45-8-11
PG506	Pulse Generator	80009	6625-00-520-5158	06	33K3-4-2138-1		33A1-8-780-1
SG503	Sine Wave Generator	80009	6625-00-520-5143	06	33K3-4-2138-1		33A1-8-780-1
TM5006	Main Frame	80009	NSL	NCR	NCR		33D7-33-182
11683A	Range Calibrator	28480	6625-01-037-0429	24	33K1-4-228-1		33D7-45-76-1
436A	Power Meter	28480	7050-01-113-3143	10	33K4-4-16-1		33A1-7-261-1
5700ANAF	Meter Calibrator	89536	6625-01-391-2969	12	33K8-4-567-1		Commercial Data
8481A	Power Sensor	28480	6625-00-354-9762	05	33K4-4-35-1		33A1-7-270-1

[1]Applicable Military Department calibration procedure number.
[2]Applicable Military Department maintenance T.O., manual, etc.

TABLE OF CATEGORY II TMDE (Continued)

Model, Type or Part No.	Nomenclature	CAGE	National Stock Number	Cal Int	Calibration Procedure[1]	SERD No.	Maintenance Document [2]
8484A	Power Sensor	28480	6625-01-028-2882	12	33K4-4-184-1		33A1-7-262-1
8491B	Attenuator	28480	5985-01-035-7688	NCR	NCR		33AA-36-10-1
8496B	Step Attenuator	28480	5985-01-013-8502	24	33K4-4-64-1		33AA-36-33-1
SG504	Sine Wave Generator	80009	6625-00-531-5143	12	33K3-4-41-1		33AA-22-15
8482A	Power Sensor	28480	6625-01-015-4412	05	33K4-4-35-1		33A1-7-270-21
8902A	Measuring Receiver	28480	NSL	12	33K4-4-283-1		Commercial Data
11793A	Down Convertor	28480	6625-01-296-4789	NCR	NCR		Commercial Data
8673D	Synthesizer	28480		6	33K4-4-344-1		33A1-8-943-1
5335A	Universal Counter	28480	6625-01-242-8373	6	33K3-4-480-1		33A1-10-254-1
11683A	Range Calibrator	28480	6625-01-037-0429	24	33K1-4-228-1		33D7-45-76-1
5065B	Rubidium Freq Std	28480	6625-01-024-7377	6	33K3-4-2133-1		Commercial Data
527E	Frequency Meter	19397	6625-01-085-7707	12	33K3-4-3207-1		Commercial Data

[1]Applicable Military Department calibration procedure number.
[2]Applicable Military Department maintenance T.O., manual, etc.

TABLE OF CATEGORY II TMDE (Continued)

Model, Type or Part No.	Nomenclature	CAGE	National Stock Number	Cal Int	Calibration Procedure[1]	SERD No.	Maintenance Document[2]
8481D	Power Sensor	28480	6625-01-312-8743	12	33K4-4-184-1		33A1-7-270
8482A	Power Sensor	28480	6625-01-015-4415	12	33K4-4-35-1		33A1-7-270
8485A	Power Sensor	28480	6625-01-178-7627	12	33K4-4-35-1		Commercial Data

[1]Applicable Military Department calibration procedure number.
[2]Applicable Military Department maintenance T.O., manual, etc.

LIST OF MANUFACTURERS' CAGE CODE TO NAME

Code	Name
28480	Hewlett-Packard
89536	Fluke
30653	AFPSL
80009	Tektroxix
19397	Tracor
07342	North Atlantic Instrument

SUMMARY DATA TABLE OF CONTENTS

CALIBRATION & MEASUREMENT

REQUIREMENTS SUMMARY DATA

This summary data table presents system, subsystem and equipment; TMDE; and calibration equipment and standards parameters which require measurement or calibration support for the Big Automatic Tester (BAT).

CATEGORY I OPERATIONAL/SYSTEM EQUIPMENT					CATEGORY II TEST/MEASUREMENT & DIAGNOSTIC EQUIPMENT			CATEGORY III CALIBRATION EQUIPMENT/STANDARDS		
TOC No.	Description of Item	Operation Range Spec Value	Operating Tolerance	Interval	Description of Item	Specific Range/ Value	Specific Tolerance	Description of Item	Specific Range/ Value	Specific Tolerance
1.0	BIG ABC									
1.1	Digital Multimeter* E1410A			12	Meter Calibrator PN 5700A NAF (Part of PATEC)			33K8-4-567-1 (Air Force Procedure)		
	DC Voltage (Vdc)	.03	± 0.02%			200 mV	± 0.002 %			
		0.3	± 0.05 %			2 V	± 0.002 %			
		3.0	± 0.03 %			20 V	± 0.002 %			
		- 3.0	± 0.03 %			2 V	± 0.002 %			
		30	± 0.05 %			200 V	± 0.008 %			
		300	± 0.06 %			1100 V	± 0.008 %			

CATEGORY I OPERATIONAL/SYSTEM EQUIPMENT					CATEGORY II TEST/MEASUREMENT & DIAGNOSTIC EQUIPMENT			CATEGORY III CALIBRATION EQUIPMENT/STANDARDS		
TOC No.	Description of Item	Operation Range Spec Value	Operating Tolerance	Interval	Description of Item	Specific Range/ Value	Specific Tolerance	Description of Item	Specific Range/ Value	Specific Tolerance
1.1	Continued									
	AC Voltage Gain Freq. @ 1 kHz (Vac)				Meter Calibrator PN 5700A NAF (Part of PATEC)			33K8-4-567-1 (Air Force Procedure)		
		.03	± 0.4 %			200 mV	± 0.1 %			
		0.3	± 0.4 %			2 V	± 0.1 %			
		1.0	± 0.4 %			2 V	± 0.1 %			
		2.0	± 0.4 %			2 V	± 0.1 %			
		3.0	± 0.4 %			20 V	± 0.1 %			
		30.0	± 0.4 %			200 V	± 0.1 %			
		300.0	± 0.4 %			200 V	± 0.1 %			
		30.0	± 0.4 %			20 V	± 0.1 %			
		3.0	± 1.0 %			2 V	± 0.25 %			
		0.3	± 1.0 %			2 V	± 0.25 %			
		0.03	± 1.0 %			200 mV	± 0.25 %			
	AC Voltage Frequency Response Test (Vac)				Meter Calibrator PN: 5700A NAF (Part of PATEC)			33K8-4-567-1 (Air Force Procedure)		

CATEGORY I OPERATIONAL/SYSTEM EQUIPMENT					CATEGORY II TEST/MEASUREMENT & DIAGNOSTIC EQUIPMENT			CATEGORY III CALIBRATION EQUIPMENT/STANDARDS		
TOC No.	Description of Item	Operation Range Spec Value	Operating Tolerance	Interval	Description of Item	Specific Range/ Value	Specific Tolerance	Description of Item	Specific Range/ Value	Specific Tolerance
1.2	UNIVERSAL COUNTER E1420B									
	TBO Uncertainty	10 MHz	$< 1x10^{-7}$/day**	12	Rubidium 5065B Freq. Std (Part of PATEC)	10 MHz	$< 1 \times 10^{-11}$ /month	33K3-4-2133-1 (Air Force Procedure)		
	INPUT RANGE & SENSITIVITY				FUNCTION GENERATOR E1440A			PATEC		
	Ch 1 50 ohm (dc coupled)	35 mVrms	± 2 mVrms				± 0.05 mVrms			
		10 Hz	± 0.5 Hz				± 0.1 Hz			
	Ch 2 50 ohm (dc coupled)	35 mVrms	+ 2 mVrms				± 0.05 mVrms			
		10 Hz	± 0.5 Hz				± 0.1 Hz			
	Ch 1 (ac coupled) With +100 mVdc	35 mVrms	+ 2 mVrms				± 0.05 mVrms			
	50 ohm input	100 Hz	± 0.05 Hz				± 0.01 Hz			
	Ch 2 (ac coupled) With +100 mVdc	35 mVrms	± 2 mVrms				± 0.05 mVrms			
	50 ohm input	100 Hz	± 0.1 Hz				± 0.025 Hz			
	RANGE & UNCERTAINTY DC Coupled in Hz				Signal Generator 8673D (Part of PATEC)		5×10^{-9}/day	33K4-4139-1 (Air Force Procedure)		
	Ch 1 (DC coupled) 50 ohm input	200 MHz	± 14 Hz				± 0.1 Hz			

CATEGORY I OPERATIONAL/SYSTEM EQUIPMENT					CATEGORY II TEST/MEASUREMENT & DIAGNOSTIC EQUIPMENT			CATEGORY III CALIBRATION EQUIPMENT/STANDARDS		
TOC No.	Description of Item	Operation Range Spec Value	Operating Tolerance	Interval	Description of Item	Specific Range/ Value	Specific Tolerance	Description of Item	Specific Range/ Value	Specific Tolerance
1.3	Digitizing O'Scope 250 MHz E1428A Ch 2									
	Channel 2 DC coupled	50 ohms	± 0.5 ohms			30 ohms	± 0.125 ohms			
	VOLTAGE MEASUREMENT UNCERTAINTY				Meter Calibrator 5700A NAF (Part of PATEC)			33K8-4-567-1 (Air Force Procedure)		
	Ch 1 & Ch 2 Range					DCV				
	Channel 1 with 15V offset	40 Vdc	± 0.4 %			30 Vdc	± 0.1%			
	Input Impedance 50 ohms	15 Vdc	± 0.4 %			15 Vdc	± 0.1%			
		5 Vdc	± 0.4 %			5 Vdc	± 0.1%			
	Offset 600 mV	1.2 Vdc	± 0.4 %			1.2 Vdc	± 0.1%			
		600 mVdc	± 0.4 %			600 mVdc	± 0.1%			
		200 mVdc	± 0.4 %			200 mVdc	± 0.1%			
		60 mVdc	± 0.4 %			60 mVdc	± 0.1%			
	Offset 30 mV	30 mVdc	± 0.4 %			30 mVdc	± 0.1%			
		10 mVdc	± 0.4 %			10 mVdc	± 0.1%			
	Offset 21 mV	42 mVdc	± 0.4 %			42 mVdc	± 0.1%			

CATEGORY I OPERATIONAL/SYSTEM EQUIPMENT					CATEGORY II TEST/MEASUREMENT & DIAGNOSTIC EQUIPMENT			CATEGORY III CALIBRATION EQUIPMENT/STANDARDS		
TOC No.	Description of Item	Operation Range Spec Value	Operating Tolerance	Interval	Description of Item	Specific Range/ Value	Specific Tolerance	Description of Item	Specific Range/ Value	Specific Tolerance
1.4	Function/Sweep Generator E1440A									
	Phase Increment Uncertainty				FREQUENCY COUNTER 5335A (Part of PATEC)			33K3-4-480-1 (Air Force Procedure)		
		- 100°								
		2777.78 ηs*	± 13.89 ηs*				± 3 ηs*			
	Amplitude Uncertainty				DMM E-1410A (Part of BAT)			PATEC		
	Sine, 100 Hz	3.536 Vrms	± 0.8%			3.536 Vrms	± 0.2%			
	Sine, 1 kHz	3.536 Vrms	± 0.8%			3.536 Vrms	± 0.2%			
	Sine, 100 kHz	3.536 Vrms	± 2.8%			3.536 Vrms	± 0.7%			
	Sine, 100 Hz	1.061 Vrms	± 0.8%			1.061 Vrms	± 0.2%			
	Sine, 1 kHz	1.061 Vrms	± 0.8%			1.061 Vrms	± 0.2%			
	Sine, 100 kHz	1.061 Vrms	± 2.8%			1.061 Vrms	± 0.7%			
	Sine, 100 Hz	0.3536 Vrms	± 0.8%			0.3536 Vrms	± 0.2%			
	Sine, 1 kHz	0.3536 Vrms	± 0.8%			0.3536 Vrms	± 0.2%			
	Sine, 100 kHz	0.3536 Vrms	± 2.8%			0.3536 Vrms	± 0.7%			

CATEGORY I OPERATIONAL/SYSTEM EQUIPMENT					CATEGORY II TEST/MEASUREMENT & DIAGNOSTIC EQUIPMENT			CATEGORY III CALIBRATION EQUIPMENT/STANDARDS		
TOC No.	Description of Item	Operation Range Spec Value	Operating Tolerance	Interval	Description of Item	Specific Range/ Value	Specific Tolerance	Description of Item	Specific Range/ Value	Specific Tolerance
1.5	ARBITARY FUNCTION GENERATOR E1445A			12						
	DC ZERO TEST (No Filter)				DMM E-1410A (Part of BAT)			PATEC		
	100 mVdc	10.2375 V	± 0.2%			30	± 0.05 %			
		9.1347 V	± 0.2%			30	± 0.05 %			
		9.1241 V	± 0.2%			30	± 0.05 %			
		8.1319 V	± 0.2%			30	± 0.05 %			
		6.4594 V	± 0.2%			30	± 0.05 %			
		4.0756 V	± 0.2%			30	± 0.05 %			
		2.2918 V	± 0.12%			3	± 0.03 %			
		2.0426 V	± 0.12%			3	± 0.03 %			
		0.3238 V	± 0.12%			3	± 0.03 %			
	DC ZERO TEST (250 kHz Filter)				DMM E-1410A (Part of BAT)			PATEC		

CATEGORY I OPERATIONAL/SYSTEM EQUIPMENT					CATEGORY II TEST/MEASUREMENT & DIAGNOSTIC EQUIPMENT			CATEGORY III CALIBRATION EQUIPMENT/STANDARDS		
TOC No.	Description of Item	Operation Range Spec Value	Operating Tolerance	Interval	Description of Item	Specific Range/ Value	Specific Tolerance	Description of Item	Specific Range/ Value	Specific Tolerance
1.6	VXI Synchro/Resolver Simulate & Measure DDDC 37001			12	NA 8810 Angle Position Indicator (Part of PATEC)			33K8-4-81-1 (Air Force Procedure)		
	Synchro Simulate									
	Angle	000.000°	± 0.01°			0° to	± 0.005°			
		011.2445°	± 0.01°			359.999°	± 0.005°			
		011.2500°	± 0.01°				± 0.005°			
		029.9982°	± 0.01°				± 0.005°			
		045.0000°	± 0.01°				± 0.005°			
		059.9963°	± 0.01°				± 0.005°			
		089.9945°	± 0.01°				± 0.005°			
		090.000°	± 0.01°				± 0.005°			
		119.9982°	± 0.01°				± 0.005°			
		135.000°	± 0.01°				± 0.005°			
		149.9963°	± 0.01°				± 0.005°			

CATEGORY I OPERATIONAL/SYSTEM EQUIPMENT					CATEGORY II TEST/MEASUREMENT & DIAGNOSTIC EQUIPMENT			CATEGORY III CALIBRATION EQUIPMENT/STANDARDS		
TOC No.	Description of Item	Operation Range Spec Value	Operating Tolerance	Interval	Description of Item	Specific Range/ Value	Specific Tolerance	Description of Item	Specific Range/ Value	Specific Tolerance
2.1	Spectrum Analyzer 71209A			12						
	Calibrator				Measuring Receiver 8902A			33K4-4-283-1 (Air Force Procedure)		
	Output Power	- 10 dBm	± 0.3 dBm		With Sensor 8482A (Part of PATEC)		± 0.12 dB	33K4-4-35-1 (Air Force Procedure)		
	Frequency	300 MHz	± 3.0 kHz		Rubidium 5065B Freq. Std (Part of PATEC)	10 MHz	$< 1 \times 10^{-11}$ /month	33K3-4-2133-1 (Air Force Procedure)		
	Scale Fidelity				Synthesized Generator 8673D (Part of PATEC)			33K4-4139-1 (Air Force Procedure)		
	Span	0 Hz				50 MHz	± 1%			
	Ref. Level	-10 dB				+10 dBm	± 2%			
					Attenuator 8491B (Part of PATEC)	20 dB	± 0.1dB	33K4-4-25-1 (Air Force Procedure)		

CATEGORY I OPERATIONAL/SYSTEM EQUIPMENT					CATEGORY II TEST/MEASUREMENT & DIAGNOSTIC EQUIPMENT			CATEGORY III CALIBRATION EQUIPMENT/STANDARDS		
TOC No.	Description of Item	Operation Range Spec Value	Operating Tolerance	Interval	Description of Item	Specific Range/ Value	Specific Tolerance	Description of Item	Specific Range/ Value	Specific Tolerance
2.2	POWER METER 70100A			12						
	ZERO CARRYOVER TEST									
	Range 1	0 µW	1%		Range Calibrator Model 11683A with sensor cable HP11730A (Part of PATEC)		± 0.25 %	33K1-4-228-1 (Air Force Procedure)		
	Range 2	0 µ W	1%				± 0.25 %			
	Range 3	0 µ W	1%		Modular Measurement		± 0.25 %			
	Range 4	0 µ W	1%		System HP 70000 (Part of BAT)		± 0.25 %			
	Range 5	0 µ W	1%				± 0.25 %			
	INSTRUMENT UNCERTAINTY TEST				Range Calibrator Model 11683A (Part of PATEC)			33K1-4-228-1 (Air Force Procedure)		
		3 µ W	1%				± 0.25 %			
		10 µ W	1%				± 0.25%			
		30 µ W	1%				± 0.25 %			
		100 µ W	1%				± 0.25 %			

CATEGORY I OPERATIONAL/SYSTEM EQUIPMENT					CATEGORY II TEST/MEASUREMENT & DIAGNOSTIC EQUIPMENT			CATEGORY III CALIBRATION EQUIPMENT/STANDARDS		
TOC No.	Description of Item	Operation Range Spec Value	Operating Tolerance	Interval	Description of Item	Specific Range/ Value	Specific Tolerance	Description of Item	Specific Range/ Value	Specific Tolerance
2.4	DIGITIZER 70700A			12						
	Gain	2.5 Vac	± 1 %		Calibration Generator PG 506 (Part of PATEC)	10 Vac	± 0.25 %	33K3-4-2063-1 (Air Force Procedure)		
		2.0 Vac	± 1 %			10 Vac				
		1.0 Vac	± 1 %			5 Vac	± 0.25 %			
		500 mVac	± 1 %			2 Vac	± 0.25 %			
		200 mVac	± 1 %			1 Vac	± 0.25 %			
		100 mVac	± 1 %			0.5 Vac	± 0.25 %			
		50 mVac	± 1 %			0.2 Vac	± 0.25 %			
		20 mVac	± 1 %			0.1 Vac	± 0.25 %			
		12.5 mVac	± 1 %			0.05 Vac	± 0.25 %			
	OFFSET	2.5 Vdc	± 1 %		Meter Calibrator 5700A NAF (Part of PATEC)	10 Vdc	± 0.1 %	33K8-4-567-1 (Air Force Procedure)		
		2.5 Vdc	± 1 %			10 Vdc	± 0.1 %			
		2.0 Vdc	± 1 %			10 Vdc	± 0.1 %			
		1.0 Vdc	± 1 %			5 Vdc	± 0.1 %			

CATEGORY I OPERATIONAL/SYSTEM EQUIPMENT					CATEGORY II TEST/MEASUREMENT & DIAGNOSTIC EQUIPMENT			CATEGORY III CALIBRATION EQUIPMENT/STANDARDS		
TOC No.	Description of Item	Operation Range Spec Value	Operating Tolerance	Interval	Description of Item	Specific Range/ Value	Specific Tolerance	Description of Item	Specific Range/ Value	Specific Tolerance
2.7	Synthesized Sweeper 83752B			12						
	INTERNAL TIMEBASE AGING RATE				Rubidium Frequency Std. HP 5065B (Part of PATEC)	10 Mhz	< 1×10^{-11} /month	33K3-4-2133-1 (Air Force Procedure)		
2.7	Continued									
	Calculated		1.0×10^{10}/day*				< 5×10^{-12}			
		10 MHz	± 1 Hz		Frequency Meter 527E		< 5×10^{-10}	33K3-4-3207-1 (Air Force Procedure)		
	CW Frequency Uncertainty	10 MHz	± 2 Hz		System Counter 5335A (Part of PATEC)		± 1 Hz	33K3-4-480-1 (Air Force Procedure)		
		20 GHz**	± 1850 Hz		Measuring Receiver 8902A		± 10 Hz	33K4-4-283-1 (Air Force Procedure)		
					Down Converter 11793A (Part of PATEC)			NCR***		
	Swept Freq. Uncertainty				Spectrum Analyzer 71209A			PATEC		
	Sweep				O'Scope E1426A (Part of BAT)			PATEC		
		100 ηs	± 1.999 MHz				10 ηs*			
	Power Uncertainty Freq. Output Power	> -5 dBm			Power Meter 70100A (Part of BAT)			11683A (Part of PATEC)		

CATEGORY I OPERATIONAL/SYSTEM EQUIPMENT					CATEGORY II TEST/MEASUREMENT & DIAGNOSTIC EQUIPMENT			CATEGORY III CALIBRATION EQUIPMENT/STANDARDS		
TOC No.	Description of Item	Operation Range Spec Value	Operating Tolerance	Interval	Description of Item	Specific Range/ Value	Specific Tolerance	Description of Item	Specific Range/ Value	Specific Tolerance
2.8	Radio Frequency Interface Unit (RFIU)			12						
	RF Convertor Module (AR1)				Signal Generator 8673D (Part of PATEC)			33K4-4139-1 (Air Force Procedure)		
	PN 9400060	-10 dB								
		0.03-2 GHz**	±10 MHz		Output Freq	0.01 to 2.1 GHz**	± 1 MHz			
		-9 dBM	± 3 dB		Power Out	-9 dBm	± 0.5 dB			
		-11 dBm	± 3 dB			-11 dBm	± 0.5 dB			
		-14 dBm	± 3 dB			-14 dBm	± 0.5 dB			
	Module Amplifier AR2	2-6 GHz**	± 10 MHz		Output Frequency	2-6 GHz**	± 1 MHz			
		-4 dBm	± 3 dB		Power Out	-4 dBm	± 0.5 dB			
		-6 dBm	± 3 dB			-6 dBm	± 0.5 dB			
	Module Amplifier AR3	6-18 GHz**	± 10 MHz		Output Frequency	6-18 GHz**	± 1 MHz			

CONCLUDING MATERIAL

Custodians:
Army - MI
Navy - OS
Air Force – 84

Review Activities:
Army - AR, AT, AV, CR, TM
Navy - AS, EC, MC, NM, SH, TD
Air Force - 11, 13, 16, 19

Preparing Activity:
Air Force – 84

Agent:
Air Force – 99

(Project QCIC 0152)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

2. The submitter of this form must complete blocks 4, 5, 6, and 7, and send to preparing activity.

3. The preparing activity must provide a reply within 30 days from receipt of the form.

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I RECOMMEND A CHANGE:	**1. DOCUMENT NUMBER** MIL-HDBK-1839A	**2. DOCUMENT DATE** *(YYYYMMDD)* 20001127

3. DOCUMENT TITLE

CALIBRATION AND MEASUREMENT REQUIREMENTS

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*	b. ORGANIZATION	
c. ADDRESS *(Include ZIP Code)*	d. TELEPHONE *(Include Area Code)* (1) Commercial (2) DSN *(If applicable)*	**7. DATE SUBMITTED** *(YYYYMMDD)*

8. PREPARING ACTIVITY

a. NAME WR-ALC/TILCC ATTN: R. YOHE	b. TELEPHONE *(Include Area Code)* (1) Commercial 912-926-1183 (2) DSN 468-1183
c. ADDRESS *(Include ZIP Code)* 420 Second Street. Suite 100 Robins AFB, GA 3i098-1640	**IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:** Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman Road, Suite 2533 Fort Belvoir, Virginia 22060-6221 Telephone (703) 767-6888 DSN 427-6888