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MILITARY STANDARD

TEST REQUIREMENTS FOR GROUND EQUIPMENT AND ASSOCIATED COMPUTER SOFTWARE SUPPORTING SPACE VEHICLES

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DEPARTMENT OF THE AIR FORCE
Washington, D.C. 20360

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Test Requirements for Ground Equipment and Associated Computer
Software Supporting Space Vehicles

1. This military standard is approved for use within the
Department of the Air Force, and is available for use by all
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2. Beneficial comments (recommendations, additions, deletions)
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Proposal (DD Form 1426) appearing at the end of this document or
by letter.

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FOREWORD

1.   The elements of a ground support system for space vehicles involves various launch systems, complex ground equipment, and associated computer software at installations all over the world.   These installations are interconnected by a global control and communications network.   The high cost of schedule delays or of operational failures make it important that modifications or upgrades to the ground equipment and computer resources be carefully tested prior to operational use.

2.   This document contains the baseline test requirements for the design, development, and network integration of new or modified ground equipment and associated computer software. More detailed technical test requirements for a particular acquisition would be addressed in the applicable specifications, or in other applicable documents, as an expansion of the baseline herein.

3.   This baseline is also an approach to the test and evaluation of limited procurement quantity programs in implementing the policies of Development Tests and Evaluations (DT&E) and Operational Tests and Evaluations (OT&E) as outlined in AFR 80-14, "Test and Evaluation."   Software specific development tests and evaluations established by DOD-STD-2167, "Defense System Software Development", are applied and augmented to include in DT&E those tests needed for the integration into the network of new or modified ground equipment software.

4.   Test documentation established by DOD-STD-2167 differ in nomenclature, content, and scope from test documentation that may currently be in use following military standards published prior to DOD-STD-2167.   These differences are recognized and addressed herein so as to be of no particular consequence to the test program.

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SECTION 1

SCOPE

1.1 <u>PURPOSE</u>

   This document establishes the test and evaluation requirements
baseline for new or modified ground equipment supporting space
vehicles and the associated new or modified computer software.

1.2 <u>APPLICATION</u>

   This standard is intended for reference in applicable program
specifications, or in other documents, to establish general test
requirements for ground equipment supporting space vehicles and
for the associated computer software. It is applicable to the
design, development, and integration of new or modified equipment
and software into the operational ground elements of space support
systems.

1.3 <u>TAILORING</u>

   Tests should be tailored considering the test item design
complexity, state of the art, mission criticality, cost, and
acceptable risk. For some projects, tailoring may relax the
requirements in this standard. For other projects the requirements
may be made more stringent to demonstrate with greater confidence
that the system being acquired performs adequately when all
parameters, environments, and related uncertainties are considered.

1.4 <u>TEST CATEGORIES</u>

   The test requirements herein are categorized as:

        a.   Part, material, and software unit development tests
              and evaluations   (DT&E)

        b.   Step 1 :   Component tests and evaluations   (DT&E)

        c.   Step 2 :   Configuration item (CI) compliance tests
                         (qualification and acceptance)   (DT&E)

        d.   Step 3 :   Integrated system testing   (DT&E)

        e.   Step 4 :   Initial operational tests and evaluations
                         (IOT&E)

        f.   Step 5 :   Follow-on operational tests and evaluations
                         (FOT&E)

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SECTION 2

REFERENCED DOCUMENTS

NONE

SECTION 3

DEFINITIONS AND ACRONYMS

3.1 DEFINITIONS

Terms are in accordance with the following definitions:

3.1.1 Acceptance Tests.   Acceptance tests are the required formal tests conducted to demonstrate acceptability of an item for delivery. The tests are designed to demonstrate performance to specified requirements and to act as quality control screens to detect deficiencies of workmanship, material, and quality.

3.1.2 Commercial Off the Shelf. Commercial off the shelf (COTS) is an item (hardware, software, or both) produced and made commercially available or in stock by a vendor prior to the vendor receiving orders or contracts for sale of the item. The vendor may produce the item to either commercial, military, or federal specifications or descriptions. COTS includes items stocked by distributors for which government contracts may be received. Nondevelopmental software is considered as COTS in this document.

3.1.3 Component. A component is a functional unit that is viewed as an entity for purposes of analysis, manufacturing, maintenance, or record keeping. Hardware examples are hydraulic actuators, valves, batteries, electrical harnesses, and individual electronic boxes such as transmitters, receivers, or multiplexer. (See definition of computer software component.)

3.1.4 Computer Software Component.   A computer software component (CSC) is a functionally or logically distinct part of a computer software configuration item (CSCI) that is distinguished for purposes of convenience in designing and specifying a complex CSCI as an assembly of subordinate elements.

3.1.5 Computer Software Configuration Item.   A computer software configuration item (CSCI) is a configuration item (CI) for computer software.   (See definition of configuration item.)

3.1.6 Computer Software Unit. A computer software unit (CSU) is an computer specified in the design of a computer software component (CSC) that is separately testable.

3.1.7 Configuration Item. A configuration item (CI) is hardware or software, or an aggregation of both, that satisfies an end use function and is designated by the Procuring Activity as a CI for configuration management purposes. A CI may be a hardware configuration item (HWCI), a computer software configuration item (CSCIL or a configuration item that is an aggregation of both hardware and software.

3.1.8 Development Contractor. A development contractor is a contractor responsible for the development engineering and modification of configuration items (hardware, software, or both) .

3.1.9 Development Tests. Development tests include all tests conducted to obtain information to aid in the design and manufacturing processes. Development tests are conducted to generate design parameters, validate design concepts, verify design criteria, determine design margins, identify failure modes, and to determine manufacturing processes. Development testing may be informal in that controlled design and test documentation, formal certification, formal retest requirements, and flight type hardware are normally not required.

3.1.10 Development Tests and Evaluations. Development tests and evaluations (DT&E) are the formal tests conducted to assist the engineering design and development process and to verify attainment of the specified performance requirements and objectives . This may include tests and evaluations of components, subsystems, computer software, prototype models, full-scale engineering development models of the system, integration of related hardware and software, and tests of compatibility and interoperability with existing or planned equipment and systems.

3.1.11 Firmware. Firmware is a combination of a hardware device and computer instructions or computer data that reside as read-only software on the hardware device. The software cannot be readily modified under program control.

3.1.12 Engineering Charge Proposal. A proposed engineering change and the documentation; by which the change is described, justified, and submitted to the Procuring Activity for approval or disapproval.

3.1.13 Forma Qualification Test A formal qualification test (FQT) is a test process performed to determine whether a configuration item complies with the allocated requirements for that item.

3.1.14 Hardware Configuration Item. A hardware configuration item (HWCI) is a configuration item (CI) for hardware. (See definition of configuration item.)

3.1.15 Item Levels. The item levels used in this document, from the simplest to the most complex, are:

> a.   Part (for hardware only)
>
> b.   Subassembly (for hardware only)
>
> c.   Unit (for software only)
>
> d.   Component
>
> e.   Subsystem
>
> f.   Configuration item
>
> g.   System segment
>
> h.   System

3.1.16 Launch System. A launch system is the composite of equipment, skills, and-techniques capable of launching and boosting a space vehicle into orbit. The launch system includes the space vehicle(s), the upper stage(s), the launch vehicle and related facilities, equipment, material, software, procedures, services, and personnel required for their operation.

3.1.17 Nondevelopmental software. Nondevelopmental software (NDS) is deliverable software that is not developed under the contract but is provided by the contractor, the government, or a third party. NDS may be referred to as reusable software, government furnished software, or commercially available software, depending on its source.

3.1.18 (In-orbit System. An on-orbit system is the composite of equipment, skills, and techniques permitting on-orbit operation of the space vehicle. The on-orbit system includes the space vehicle(s), the command and control network, and related facilities, equipment, material, software, procedures, services, and personnel required for their operation.

3.1.19 Operating Agency The operating agency is a generic term which is used to describe any agency primarily responsible for the operational employment of a system or items of equipment.

3.1.20 Operational Modes. The operational modes for an item include all combinations of operational configurations or conditions that can occur during each operational state. Some examples are: power on or power off, command modes, readout modes, standby, calibration, and antennas stowed or tracking.

3.1.21 Operational States The operational states for a system or system segment include the major operational configurations or conditions that can occur during their service life. Some examples are: maintenance state, standby state, launch support, on-orbit support, and training.

3.1.22 Operational Test and Evaluation. Operational test and evaluation (OT&E) is the process that appraises a system's operational effectiveness and suitability of new items, modifications, or installations (hardware, software, or both) and provides information on tactics, doctrine, organization, and personnel requirements in a realistic operational environment.

      a. Initial operational tests and evaluations (IOT&E) are conducted with the equipment in its operational configuration, in an operational environment, by the operating personnel in order to test and evaluate the effectiveness and suitability of the hardware and software in meeting operational requirements. These tests emphasize reliability, maintainability, supportability, and logistics.

      b. Follow-on operational tests and evaluations (FOT&E) are conducted with the equipment in its operational configuration, in an operational environment, by the operating personnel assigned to refine estimates made during initial operational tests and evaluations (IOT&E) and to identify operational system deficiencies.

3.1.23 Part. A part is a single piece, or two or more pieces joined together, which are not normally subject to disassembly without destruction or impairment of the design use. Some examples are resistors, transistors, integrated circuits, relays, capacitors, gears, screws, and mounting brackets.

3.1.24 Procuring Activity. The Procuring Activity is the Government office or agency with primary responsibility for developing and acquiring the system, subsystem, equipment, computer software, or engineering services addressed in this document.

3.1.25 **Reusable Software.** Reusable software is software developed in response to the requirements for one application that can be used, in whole or in part, to satisfy the requirements of another application.

3.1.26 **Site.** A site is a generic term used to refer to any operating location, operating complex, operations area, or support area.

3.1.27 **Software Developmental File.** The software development file (SDF) is a collection of documentation material pertinent to the development or support of software. Contents typically include (either directly or by reference) design considerations and constraints, design documentation and data, schedule and status information, test requirements, test cases, test procedures, and test results.

3.1.28 **Software Maintenance.** In general, software maintenance refers to a variety of support activities required during the operational life of the computer software configuration items, including the implementation of changes or modifications to meet continuing changes in operational requirements, or to correct inherent design defects or errors. This term also includes the reissuing of software specifications as well as operator and user manuals to reflect implemented changes or modifications.

3.1.29 **Software Requirements Specification** A software requirements specification (SRS) is a document that specifies the detailed requirements (functional, interface, performance, qualification, etc.) allocated to a particular computer software configuration item.

3.1.30 **Software Test Description.** A software test description (STD) is a document that identifies the input data, expected output data, and evaluation criteria that comprise the test cases. The STD also contains the necessary procedures to perform the formal testing of a computer software configuration item.

3.1.31 **Software Test Plan.** A software test plan is a document that describes the formal qualification test plans for one or more computer software configuration items, identifies the software test environment resources required, and provides schedules for the activities. In addition, the software test plan identifies the individual tests that are to be performed.

3.1.32 **Subassembly.** The term subassembly denotes two or more parts joined together to form a stockable unit which is capable of disassembly or part replacement. Examples are a printed circuit board with parts mounted, or a gear train.

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3.1.33 Subsystem.   A subsystem is an assembly of two or more components, including the supporting structure to which they are mounted, and any interconnecting cables or tubing. A subsystem is composed of functionally related components that perform one or more prescribed functions.

3.1.34 Syvstem.   A system is the composite of equipment, skills, and techniques capable of performing or supporting an operational role. A system includes all operational equipment, related facilities, material, software, services, and personnel required for its operation. Examples of systems that include space vehicles and ground equipment as major subtier elements are launch systems and on-orbit systems.

3.1.35 System Segment.   A system segment is a major subtier element of a system that is so identified by the responsible program office, either for management expediency or to facilitate separate procurements.

3.1.36 Target Site   The target site is the operational location slated for a hardware or software modification or installation.

3.1.37 Test Discrepancy   A test discrepancy is a functional or structural anomaly that occurs during testing and which indicates a possible deviation from specification requirements for the test item. A test discrepancy may be a momentary, nonrepeatable, or permanent failure to respond in the predicted manner to a specified combination of test environment and functional test stimuli. Test discrepancies may be due to a failure of the test unit or to some other cause, such as the test setup, test instrumentation, supplied power, test procedures, or computer software used.

3.1.38 Version Description Document   The Version Description Document (VDD) describes the exact release and version of an individual computer software configuration item or a major software development. The VDD identifies the software units and components involved, all Engineering Change Proposals (ECPs) incorporated, problems, and known errors that are corrected by the ECPs. The VDD also provides installation instructions and other data needed to load, operate, or regenerate the delivered software.

3.2 ACRONYMS

AFR	Air Force Regulation
CDRL	Contract Data Requirements List
CI	Configuration Item
COTS	Commercial Off the Shelf

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List of Acronyms (continued)

CSC	Computer Software Component
CSCI	Computer Software Configuration Item
CSU	Computer Software Unit
DoD	Department of Defense
DT&E	Development Tests and Evaluations
ECP	Engineering Change Proposal
FOT&E	Follow-on Operational Tests and Evaluations
FQT	Formal Qualification Test
GFE	Government Furnished Equipment
HWCI	Hardware Configuration Item
IOT&E	Initial Operational Tests and Evaluations
NDS	Nondevelopmental Software
OT&E	Operational Tests and Evaluations
SDF	Software Development File
SRS	Software Requirements Specification
SSD	Space Systems Division (Air Force Systems Command)
STD	Software Test Description
VDD	Version Description Document

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SECTION 4

GENERAL REQUIREMENTS

4.1 TESTING PHILOSOPHY

The test program for ground equipment and associated computer software encompasses the testing of progressively more complex assemblies of hardware and computer software. The test program requires the completion of specific test objectives prior to the accomplishment of others. Design suitability shall be demonstrated in the earlier development tests prior to testing the next more complex assemblies or combinations in the progression.

4.2 TEST PLANS AND PROCEDURES

Test plans and procedures shall be tailored to the specific needs of the equipment or associated computer software and the tests shall be combined when practical. Depending upon the characteristics and complexity of the development or modification, individual procedure steps may have additional substeps defined. For simpler developments, the test plans, the test procedures, or both may be consolidated to conserve resources. If two or more development tests are to be conducted in the same test facility or operational area, the advantages of combining the tests into one test plan should be considered. A single test plan is generally best, provided test quality and thoroughness are not compromised.

4.2.1 Test Plans. The test plans shall be based upon a function by function mission analysis and the testing requirements. Test objectives shall be planned to verify compliance with the design and specified requirements of the items involved, including interfaces. To the degree possible, tests shall be planned and executed with the idea of fulfilling test objectives that are both developmental and operational in nature. The test plans shall indicate the test requirements, testing approach for each item, related special test equipment, facilities, system interfaces, and downtime requirements. The test plans shall identify the allocation of requirements to appropriate testable levels of assembly. A brief background of the project and test item descriptions shall be included in the test plans. For software test plans, where test item descriptions may not be in order, a brief background, which includes the requirements to be fulfilled and a brief description of new capabilities or deficiencies to be corrected, may suffice.

Test tools and test beds shall be identified in the test plan. The test plan shall also state the qualification testing planned for the test tools and test beds to demonstrate that the tools, test beds, or both represent an operational system environment and verify that simulated interfaces are correct.

When appropriate, the test plan may be drafted using an existing test plan properly modified for the purpose. The use of template test plans for modifications to an existing configuration baseline is encouraged.

4.2.2 Test Procedures Tests shall be conducted using documented test procedures prepared for performing all of the required tests in accordance with the test objectives in the approved test plans. The test objectives, testing criteria, and pass-fail criteria shall be stated clearly in the test procedures. The test procedures shall cover all operations in enough detail so that there is no doubt as to the execution of any step. Test objectives and criteria shall be stated clearly to relate to design or operations specifications. Where appropriate, pass-fail criteria shall be provided at the procedure step level. Traceability shall be provided from the specifications or requirements to the test procedures. Where possible, the individual procedure step which satisfies the requirement shall be identified. The test procedure for each configuration item (CI) shall include, as a minimum, descriptions of the following:

      a.   Initialization requirements

      b.   Input data

      c.   Expected intermediate test results

      d.   Expected output data

      e.   Pass-fail criteria for evaluating results

      f.   Assumptions and constraints

4.2.3 Software Test Plans and Software Test Description Documents. Some acquisition contracts may have requirements for the delivery of a Software Test Plan and a Software Test Description (STD) document for the software development involved. In those cases, the requirements stated in this document for test plans and test procedures that are applicable to the software should be satisfied in the applicable Software Test Plan and STD documents. The STD document shall provide traceability of the requirements in the software requirement specification and interface requirement specification to the test

cases that fully or partially satisfy each requirement or set of requirements. For software maintenance, traceability to the deficiency which identified a problem shall be provided in the test procedures or software test description.

4.2.4 Test Condition Tolerances. Meeting particular design and testing environmental requirements may be necessary during some compliance testing. Design and testing parameters normally include allowable test condition tolerances. Unless stated otherwise, the design and test environmental parameters specified can be assumed to include the following maximum allowable test tolerances:

Design and Test Parameters	Test Tolerance
Temperature	± 3 deg C
Relative Humidity	± 5 percent
Acceleration	± 10 percent
Pressure	
Above 1.3×10^2 Pascals (1 Torr)	± 10 percent
1.3×10^{-1} to 1.3×10^2 Pascals (0.001 Torr to 1 Torr)	± 25 percent
Less than 1.3×10^{-1} Pascals (0.001 Torr)	± 80 percent
Vibration Frequency	± 2 percent
Sinusoidal Vibration Amplitude	± 10 percent
Random Vibration Acceleration	
Power Spectral Density	
20 to 500 Hz (25 Hz or narrower)	± 1.5 dB
500 to 2000 Hz (50 Hz or narrower)	± 3.0 dB
Random Overall g rms	± 1.5 dB
Sound Pressure Level	
1/3 Octave Band	± 3.0 dB
Overall	± 1.5 dB
Shock Response Spectrum (Q = 10) 1/6 Octave Band Center Frequency Amplitude	± 6 dB with 30 percent of the response spectrum center frequency amplitudes greater than nominal test specification
Static Load	± 5 percent

4.3 RETEST

Whenever the design of hardware or the coding of computer software is changed, the hardware and computer software involved shall be retested, as necessary, and all documentation pertinent to the changes shall be revised. When retesting a configuration item (CI), limited retesting of the CI may be adequate to verify that the new design is satisfactory and no new problems have been introduced. However, care must be exercised with this limited retesting concept since even small changes can potentially affect the CI in unexpected ways. The degree of retesting requires approval by the Procuring Activity.

Retesting may also be necessary if a discrepancy occurs while performing any of the required testing steps. In that case, conducting a proper failure analysis plays an important part in determining the type and degree of retesting. The failure analysis should include the determination of whether a failure occurred, the cause of the failure, the symptoms of the failure, and isolation of the failure to the smallest replaceable item.

4.3.1 During Compliance Testing. If a test discrepancy occurs during compliance testing, the test may be continued without corrective action if the discrepant item or software coding area does not affect the validity of test data obtained by the continuation of testing. Otherwise the test shall be interrupted and the discrepancy verified. If the discrepancy is caused by the test setup, test software, or a failure in the test equipment, the test being conducted at the time of the failure may be continued after the cause is removed and repairs are completed, as long as the failure did not overstress the item under test. If the discrepancy is caused by a failure of the item under test, the preliminary failure analysis and appropriate corrective action shall normally be completed and properly documented before testing is resumed. Retesting may be required to establish a basis for determining compliance of a test item to a specification or requirement, and may be required to assess the readiness of test items for integrated system testing.

4.3.2 During Integrated System Testing. If a discrepancy occurs during integrated system testing, it shall be properly documented for later evaluation. The test director is responsible for assessing the effect of the discrepancy to determine whether the discrepancy has jeopardized the probable success of the remainder of the test. The test director may decide to continue or halt the test. If continued, the test starts at the test procedure step designated by the test director. The integrated system testing should be continued, where practicable, to conserve time-critical operational resources. When the discrepancy has been corrected or explained, retesting may be required. Depending upon contract provisions, test location, and operational factors,

the degree of retesting may require approval by the Procuring
Activity or other government agencies.

    4.3.3 During Operational Tests and Evaluations. If a
discrepancy occurs during operational tests and evaluations, it is
documented for later evaluation. The operating agency is
responsible for assessing the effect of the discrepancy to
determine whether the discrepancy has jeopardized the probable
success of the remainder of the test. The operating agency is
also responsible for determining the degree of retesting required.

4.4 DOCUMENTATION

    4.4.1 Test Documentation Files. The test procedures, list
of test equipment used, computer software used, test data, test
results, problems or deficiencies encountered all pertinent
analyses, and resolutions shall be documented and maintained. The
test documentation files shall be maintained by the applicable
contractors for the duration of their contracts and shall be made
available for Procuring Activity review upon request.

    4.4.2 Test Data. Pertinent test data shall be maintained
to permit the evaluation of performance under the various
specified test conditions. Transient responses and mode switching
tests shall be examined for proper response. The test data shall
also be compared across major test sequences for trends or
evidence of anomalous behavior. All relevant test measurements
and the environmental conditions imposed on the units shall be
recorded on electronic media, such as magnetic tape, or by other
suitable means to facilitate automated accumulation and sorting of
data for the critical test parameters. These records are intended
to be an accumulation of trend data and critical test parameters
which shall be examined for out of tolerance values and for
characteristic signatures. A summary of the test results shall be
documented in a test report. The test report shall detail the
degree of success in meeting the test objectives of the approved
test plans and shall document the test results, deficiencies,
problems encountered, and problem resolutions.

    4.4.3 Test Log Formal test conduct shall be documented
in a test log. The test log shall be time-tagged to permit a
reconstruction of test events such as start time, stop time, and
any periods of interruption. The test log shall be made available
for Procuring Activity review upon request.

4.5 FIRMWARE TEST.

    Firmware that falls under the intent and purpose of a
Commercial Off the Shelf item (COTS, see 3.1.2) shall be tested as
COTS (see 5.4.3). Firmware that is not COTS shall be tested as a

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development item subject to the test requirements of this
document. The software element of firmware shall be tested as
software, and the hardware element of firmware shall be tested as
hardware.

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SECTION 5

DETAILED REQUIREMENTS

5.1 CATEGORIES OF INSPECTIONS AND TESTS.

As outlined in Table I, the primary tests for ground equipment and associated computer software start at the component level of assembly and progress at each higher level of assembly until the entire system can be tested in its operational environment. These primary tests are identified as Step 1, Step 2, Step 3, Step 4, and Step 5 tests. In addition, there may be development tests and evaluations at lower levels of assembly, and in-process inspections and tests required for hardware to avoid assembling a defective system. The categories specified herein are intended to encompass all ground equipment and associated computer software tests and inspections required during the system life cycle. The tests and inspections are categorized as follows:

a. Part, material, and software unit development tests and evaluations (DT&E)

    1. Part and material development tests and evaluations, qualification tests, and acceptance tests (DT&E)

    2. Subassembly level development tests and in-process tests and inspections (DT&E)

    3. Computer software unit (CSU) level tests (DT&E)

b. Step 1 : Component tests and evaluations (DT&E)

c. Step 2 : Configuration item (CI) compliance tests (qualification and acceptance) (DT&E)

    Step 2.1: Single CI compliance tests (DT&E)

    Step 2.2: Combined CI compliance tests (DT&E)

d. Step 3 : Integrated system tests (DT&E)

e. Step 4 : Initial operational tests and evaluations (IOT&E)

f. Step 5 : Follow-on operational tests and evaluations (FOT&E)

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TABLE I. OVERVIEW MATRIX OF GROUND SYSTEM AND ASSOCIATED COMPUTER SOFTWARE TESTS AND EVALUATIONS

TEST ELEMENTS		TEST STEPS					
	PART, MATERIAL, AND SOFTWARE UNIT TESTS	DEVELOPMENT TESTS AND EVALUATIONS				OPERATIONAL TESTS AND EVALUATIONS	
ELEMENTS		STEP 1 TESTS	STEP 2.1 TESTS	STEP 2.2 TESTS	STEP 3 TESTS	STEP 4 TESTS	STEP 5 TESTS
TEST TITLE	SUBTIER TESTS	COMPONENT TESTS & EVALUATIONS	SINGLE CI COMPLIANCE TESTS	COMBINED CI COMPLIANCE TESTS	INTEGRATED SYSTEM TESTS	INITIAL OPERATIONAL TESTS & EVALUATIONS (IOT&E)	FOLLOW-ON OPERATIONAL TESTS & EVALUATIONS (FOT&E)
TEST PURPOSE	SUPPORT DESIGN AND DEVELOPMENT	SUPPORT DESIGN AND DEVELOPMENT	DEMONSTRATE HWCI & CSCI CONFORMANCE TO DEVELOPMENT SPECIFICATIONS	DEMONSTRATE PERFORMANCE REQUIREMENTS OF A SYSTEM OR A SYSTEM SEGMENT SPECIFICATION	DEMONSTRATE PERFORMANCE REQUIREMENTS OF THE INTEGRATED SYSTEM	EVALUATE HOW WELL THE OPERATIONAL REQUIREMENTS HAVE BEEN MET	VERIFY THE SYSTEMS CONTINUED ABILITY TO SUPPORT OPERATIONS
ITEM LEVEL	PART, MATERIAL, SUBASSEMBLY, OR SOFTWARE UNIT	COMPONENT	HWCI OR CSCI	INTEGRATED CIs	INTEGRATED SYSTEM	INTEGRATED SYSTEM	INTEGRATED SYSTEM
HWCI & CSCI CONFIGURATION	IN TEST CONFIGURATION	IN TEST CONFIGURATION	IN TEST CONFIGURATION	IN SIMULATED SYSTEM CONFIG.	IN SIMULATED OR OPERATIONAL SYS.	OPERATIONAL CONFIGURATION	OPERATIONAL CONFIGURATION
TEST LOCATION	CONTRACTOR FACILITY OR TEST BED	CONTRACTOR FACILITY OR TEST BED	CONTRACTOR FACILITY OR TEST BED	TEST BED OR OPERATIONAL SITE	OPERATIONAL SITE OR TEST BED	OPERATIONAL SITE	OPERATIONAL SITE

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Depending upon the characteristics and complexity of the development or modification, each step may have additional substeps defined, or for simpler developments, some of the test steps may be omitted.

5.2 PART, MATERIAL AND SOFTWARE UNIT DEVELOPMENT TESTS AND EVALUATIONS

Part, material, and software unit development tests and evaluations are conducted to demonstrate the feasibility of using certain items in the implementation of a design. These subtier development tests and evaluations may be conducted to assess design alternatives, manufacturing alternatives, and to evaluate tradeoffs to best achieve the development objectives. Development tests may be required to validate hardware and computer program design concepts or to assist in the evolution of designs from the conceptual phase to the operational phase. An objective of these tests shall be to identify hardware and computer program problems early in their design evolution so that any required corrective actions can be taken prior to starting formal step testing. Development tests may be used to confirm performance margins, manufacturability, testability, maintainability, reliability, life expectancy, and compatibility with system safety. Where practicable, development tests should be conducted over a range of operating conditions that exceed the design limits to identify marginal design features.

These tests may be conducted at in-plant test facilities which may include subcontractor's facilities, at a government approved test bed, or at any other appropriate test facility. However, when performed at an operational government facility, that government facility may require approval of the test plans and procedures. Internal contractor documentation of development test plans, test procedures, and test results are normally used unless stated otherwise by contract.

5.2.1 Part and Material Level Development Tests and Evaluations. Part and material development tests and evaluations shall be conducted as required to qualify parts, materials, and processes to assure proper application in the design, to assure adequate performance margins, and to develop acceptance criteria for the items to avoid assembling defective hardware components. The minimum required development tests and evaluations include qualification of new types of parts, materials, and processes to assure proper application in the design, and to develop acceptance criteria for the items to avoid assembling defective hardware components.

5.2.2 Subassembly Level Development Tests and In-process Tests and Inspection. Subassemblies shall be subjected to development tests and evaluations as may be required to

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demonstrate feasibility, to minimize design risk, and to assess
the design and manufacturing alternatives and trade-offs
required to best achieve the development objectives. Tests
shall be conducted as required to develop in-process
manufacturing tests, inspections, and acceptance criteria for
the items to avoid assembling defective hardware items.

5.2.3 <u>Computer Software Unit Tests</u>. The earliest
development tests and evaluations of software are performed on
computer software units (CSUS) which are the smallest software
element of a computer software component that is separately
testable. As a minimum, each CSU shall be tested to ensure that
the algorithms and logic employed are correct and that the CSU
satisfies its specified requirements. For each CSU or logically
related group of CSUS, the test procedures, design code, test
results, deficiencies or problems encountered, and resolutions
shall be documented in a software development file (SDF)
maintained by the development contractor. Whenever the design
or coding are changed, the CSU shall be retested, as necessary,
and all documentation pertinent to the changes shall be revised
and updated.

5.3 <u>STEP 1: COMPONENT TESTS AND EVALUATIONS</u>.

Component tests and evaluations are in-process inspections
which are used to develop system design and performance margins
and to provide criteria used to avoid assembling defective
hardware items. These tests may be conducted at in-plant test
facilities which may include subcontractor's facilities, at a
government approved test bed, or at any other appropriate test
facility. Internal contractor documentation of component test
plans and test procedures is normally used, unless stated
otherwise in the contract. However, when a component test is
performed at an operational government facility, that government
facility may require approval of the test plans and procedures.

5.3.1 <u>Step 1 : Hardware Components.</u> Hardware components
shall be subjected to tests and evaluations as may be required
to qualify the components to assure proper application in the
design, to assure adequate performance margins, and to develop
acceptance criteria for the components to avoid assembling
defective hardware. Component tests and evaluations may also be
required to demonstrate manufacturing feasibility, and to assess
the design and manufacturing alternatives and trade-offs
required to best achieve the development objectives.

5.3.2 <u>Step 1 : Computer Software Components</u>. The
computer software units (CSUS) forming a software component with
specific functions constitute a computer software component
(CSC). CSC tests shall be conducted to assure that all

algorithms and logic used in each CSC are correct and satisfy
their allocated requirements. The tests shall also evaluate any
design alternatives or trade-offs, demonstrate the feasibility
of the CSC design, and assure that design risks are minimized.

5.4 **STEP 2 : CONFIGURATION ITEM COMPLIANCE TESTS (QUALIFICATION AND ACCEPTANCE).**

Step 2 tests are the qualification and acceptance tests of a
configuration item (CI), either a hardware configuration item
(HWCI), a computer software configuration item (CSCI), or a CI
consisting of both hardware and software. The Step 2 tests
includes qualification and acceptance tests of combined CIs.
The Step 2 tests shall be conducted at in-plant test facilities
which may include subcontractor's facilities, at a government
approved test bed, or at any other appropriate test facility.
All Step 2 tests shall be conducted using prequalified test
tools and test procedures designed to attain the test objectives
in the approved test plans. When included within the scope of
the contract, the completion of these tests may be made
contingent on the satisfactory completion of subsequent
integrated system tests. A Functional Configuration Audit and a
Physical Configuration Audit are normally conducted in
accordance with contract requirements following the completion
of Step 2.2 tests.

5.4.1 **Step 2.1 : Single CI Compliance Tests**

5.4.1.1 Step 2.1 Hardware CI Qualification. Each
hardware configuration item (CI) type shall be formally
qualified. The qualification tests shall verify that the CI
meets the specified system design requirements allocated to the
CI, including external interfaces. The qualification tests
shall verify the performance margins by evaluating the
functional performance of the CI in an environment that
simulates the operational environments associated with the CI.

5.4.1.2 Step 2.1 Hardware CI Acceptance The
qualification tests on the first production item of each type
serves as the acceptance test for that item. Subsequent
production items of each type shall be formally acceptance
tested as required. The acceptance tests of the subsequent
production items may be a subset of the qualification tests.

5.4.1.3 Step 2.1 Compter Software CI Qualification.
Functional or logically distinct computer software components
(CSCS) are organized or grouped into computer software
configuration items (CSCIS). Each CSCI performs or executes a
set of functions or tasks. Formal qualification tests shall be
conducted on each CSCI to verify CSCI compliance with design or

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specified requirements, i.e., stressing the CSCIs to the limits of their specified requirements. Step 2.1 tests associated with software maintenance shall be conducted on the CSCI as required to verify that the deficiency documented in the problem description has been corrected.

5.4.2 Step 2.2 : Combined CI Compliance Tests. A series of compliance test steps shall be conducted on expanding strings of configuration items (CIS). Typically, a hardware configuration item (HWCI) is combined with other HWCIS and the combination tested, a computer software configuration item (CSCI) is combined with other CSCIS and the combination tested, and then the various CIS are combined until the final end item equipment to be delivered is tested, including the interfaces. The actual combination of CIS to be tested, and the particular test sequence to follow, depend on the complexity of the development, criticality of the functions, and on the external interfaces involved. The tests shall be designed to confirm functional compatibility among the mechanical, electrical, and computer software interfaces. Step 2.2 tests shall demonstrate that the end item functions resulting at each test sequence of combined CIS meet the performance requirements and system specifications. To show the planned sequence for the Step 2.2 tests, the detailed tests should be further identified as Step 2.2.1 tests, Step 2.2.2 tests, Step 2.2.3 tests, Step 2.2.4 tests, etc. for the expanding strings of configuration items.

5.4.3 Commercial Off the Shelf or Government Furnished Equipment Testing. Commercial off the shelf (COTS) items that are not developed-specifically for the acquisition or modification are often included in the system design. Also, government furnished equipment (GFE) may be included in the system design. The COTS or GFE items may be either hardware, software, or a combination of the two. When incorporated in the system design, individual tests shall be conducted on the COTS and GFE items prior to incorporation in the configuration items or assemblies. The COTS and GFE shall be included in the testing baseline, that is, as incorporated in the configuration items being tested for compliance. The test shall be conducted at the level of detail necessary to determine whether the COTS and GFE perform satisfactorily, are documented adequately for the application, and satisfy the system requirements allocated to them. This test requirement shall apply to all nondevelopmental software.

5.5 STEP 3 : INTEGRATED SYSTEM TESTING.

Integrated system tests shall be designed to exercise, as near as practical and possible, the total system. The intent is to ensure that the products, which may be from multiple

contractors, are integrated, that interfaces are verified, and that all higher level operational requirements or specifications are met. Where practicable, integrated system tests shall be performed on integrated configuration items (CIS) installed in an operational system. Whenever possible, these tests shall be conducted at the target site with the support of the operational personnel. A development test bed approved by the Procuring Activity as sufficiently simulating the operational system capability for test purposes may be used for Step 3 integrated system tests if target sites, operational complexes, or other suitable operational support areas are not available. The Step 3 integrated system tests shall incorporate tests of the affected interfaces of the ground equipment and software with other elements of the operational system. The Step 3 tests shall be structured as appropriate to demonstrate design requirements of the system related to such items as performance, electromagnetic compatibility, reliability, maintainability, system safety (hazardous noise, radiation hazards, pressure vessels) , logistics supportability, operational procedures, and personnel performance.

Step 3 tests shall be conducted to demonstrate the following, as applicable to the modification or upgrade:

a. That reliable operation is achieved at specified design limits

b. That specified system functional and performance requirements are met

c. That the system can recover from hardware or software malfunctions within a reasonable or specified time without loss of data or control

d. That performance requirements are met under all required logical or physical device assignment combinations

e. That the software and hardware modifications or upgrades have not degraded the capability of the system's baseline or of other operational systems

f. That security mechanisms are in place or incorporated to protect resources from unauthorized access or break-in from illicit users

Tests shall be focused on the external interfaces involved, the use of operational data bases and operational scenarios, and the system requirements from a mission operations perspective.

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The Step 3 tests shall also include other applicable tests, such as a reliability demonstration; a maintainability demonstration; system safety tests, inspections, and evaluations in such areas as hardware inspections for electrical and mechanical hazards, including caution labeling; evaluation of the fire suppression system; evaluation of emergency systems; use of any hazardous materials; possibility of personnel exposure to any equipment and ambient noise levels considered hazadous; RF radiation testing to determine actual levels of radiation to which personnel may be exposed and to evaluate the accuracy of the mathematical predictions of radiation levels; proper functioning of any radiation warning systems; and proper procedures for inspection, operation, and maintenance of pressure vessels.

Step 3 integrated system tests shall be conducted by an independent test organization approved by the Procuring Activity. This test organization shall be responsible for the development of test plans, test tools, and test procedures and the conduct of the test. Development contractors provide support for the Step 3 tests and the resolution of deficiencies only within the scope of the applicable contract provisions and as directed by the Procuring Activity.

5.6 STEP 4 : INITIAL OPERATIONAL TESTS AND EVALUATIONS.

Initial operational tests and evaluations (IOT&E) are conducted with the equipment in its operational configuration, in an operational environment, by the operating personnel. These Step 4 tests are conducted in an environment that is as operationally realistic as possible and practical in order to test and evaluate the effectiveness and suitability of the hardware and software in meeting operational requirements. Step 4 tests are conducted to demonstrate operational requirements on reliability, maintainability, logistics supportability, operational procedures, and personnel performance.

5.7 STEP 5 : FOLLOW-ON OPERATION TESTS AND EVALUATIONS.

Follow-on operational tests and evaluations (FOT&E) are conducted with the equipment in its operational configuration by the operating personnel assigned. The Step 5 tests demonstrate and verify the continued capability of the system, with the modification or upgrade incorporated, to support ongoing missions. Follow-on operational tests and evaluations (FOT&E) are conducted to refine estimates made during initial operational tests and evaluations (IOT&E) and to identify operational system deficiencies.

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SECTION 6

NOTES

This Notes section is not a mandatory part of this standard.
The contents of this section are intended for use by government
acquisition personnel for guidance and information only.

6.1 INTENDED USE

This standard is intended only for ground equipment and
associated computer software, where applicable. This standard is
not intended to be used in the acquisition of space equipment or
software to be used in space equipment. The test requirements
for the space elements of a space system are addressed in
MIL-STD-1540 , "Test Requirements for Space Vehicles", and not in
this document.

6.2 TAILORED APPLICATION

The technical requirements in each contract should be
tailored to the needs of that particular acquisition. Military
specifications and standards need not be applied in their
entirety. Only the minimum requirements needed to provide the
basis for achieving the program requirements should be imposed.
The cost of imposing each requirement of this standard should be
evaluated against the benefits that should be realized. However,
the risks and potential costs of not imposing requirements must
also be considered. The tailoring should be implemented by the
wording used to state the testing requirements in the
specifications or in other applicable contractual documents.

The extent of testing required and all tailored testing are
to comply with the intent and purpose of AFR 80-14. This is
especially crucial in software testing because of its rapidly
evolving technology. If adherence to this standard is by
selective application or tailoring, the fundamental purpose of
development tests and evaluations and operational tests and
evaluations must be properly observed.

6.3 DOCUMENTATION

Documents, forms, technical manuals, and data are prepared
and distributed in accordance with the Contract Data Requirements
List (CDRL) of the applicable contract. The data items discussed
in this standard are not deliverable unless invoked by the CDRL
or the applicable contract.

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL
(See Instructions – Reverse Side)

1. DOCUMENT NUMBER MIL-STD-1833 (USAF)	2. DOCUMENT TITLE TEST REQUIREMENTS FOR GROUND EQUIPMENT AND ASSOCIATED COMPUTER SOFTWARE SUPPORTING SPACE VEHICLES

3a. NAME OF SUBMITTING ORGANIZATION

4 TYPE OF ORGANIZATION (Mark one)

- [ ] VENDOR
- [ ] USER
- [ ] MANUFACTURER
- [ ] OTHER (Specify). _____

b. ADDRESS (Street, City, State, ZIP Code)

5 PROBLEM AREAS

a. Paragraph Number and Wording

b. Recommended Wording

c. Reason/Rationale for Recommendation

6. REMARKS

7a. NAME OF SUBMITTER (Last, First, MI) – Optional

b. WORK TELEPHONE NUMBER (Include Area Code) – Optional

c. MAILING ADDRESS (Street, City, State, ZIP Code) – Optional

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