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DOD-STD-170(NS) HARDWARE DIAGNOSTIC TEST SYSTEM REQUIREMENTS

MILITARY STANDARD

HARDWARE DIAGNOSTIC

TEST SYSTEM

REQUIREMENTS

DEPARTMENT OF DEFENSE

Washington, DC 20362

Hardware Diagnostic Test System Requirements

DOD-STD-1701(NS)

1. This Military Standard is approved for use by the National Security Agency and is available for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to Director, National Security Agency/Central Security Service, ATTN: T-2137, Fort George G. Meade, MD 20755-6000, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at end of this document or by letter.

FOREWARD

This standard was written expressly for the designer of diagnostic testing systems.

1. SCOPE

1.1 Scope.
This establishes the general procedures, terms and conditions governing the preparation and completion of a hardware diagnostic test system (HDTS).

1.2 Purpose.
The purpose of this Standard is to establish the development criteria for the preparation

and completion of the hardware diagnostic test system for systems, subsystems, and equipments.

2. REFERENCES DOCUMENTS

2.1 Government documents.

2.1.1 Standards. Unless otherwise specified, the following standards of the issue listed in that edition of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this Standard to the extent specified herein.

STANDARD MILITARY

MIL-STD-470 Maintainability Program for Systems and Equipment

(Copies of standards required by manufacturers in connection with standard acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.1.2 Order of precedence. In the event of a conflict between the text of this Standard and the reference cited herein, the text of this Standard shall take precedence.

3. DEFINITIONS

3.1 Hardware diagnostic test system. Any combination of built-in test equipment (BITE)/built-in test diagnostics (BITD) or software routine such that upon operation or execution, identification of a failure or potential failure of the hardware element, determination of its failure location, or potential location shall be identified.

4. GENERAL REQUIREMENTS

4.1 Introduction. The HDTS shall be capable of verifying the operational capabilities of the system, which consists of the unique complex of equipments interconnected to perform the stated mission. The HDTS shall incorporate fault detection techniques to identify hardware malfunctions during normal system operations and report all malfunctions to the system operator.

4.1.1. Functional requirements. All systems/subsystems/ equipments that are developed or commercially purchased shall include a hardware diagnostic test system. The HDTS shall be capable of detecting hardware malfunctions and isolating these malfunctions to the Lowest Replaceable Unit (LRU)/Single Replaceable Unit (SRU) as defined by the Maintenance Concept. Fault isolation and module/LRU replacement shall be accomplished within the allocated Mean Time to Restore (MTR). MTR is determined and defined by the system design and specific user requirements. Procedural use of the hardware diagnostic test system shall be documented and tested to insure operational

compliance and product quality. All developed hardware diagnostic software (HDS) shall be documented to support software maintenance.

4.1.2 Hardware diagnostic test system requirement. The system designer shall develop the hardware diagnostic test system for the applicable system, subsystem, or equipment as specified in the procurement document. If the level of diagnostics is not specified in the procurement document, the system designer shall use the Diagnostic Decision Tree (Figure 1) as a guide in developing a diagnostic test system that will most effectively and economically identify any failure or potential failure of the appropriate system, subsystem or equipment.

4.2 The hardware diagnostic test system shall be comprised of diagnostic/fault isolation programs, built-in-test, automatic test equipment (ATE), or special purpose electronic test equipment (SPETE).

4.3 Diagnostic/fault isolation programs.

4.3.1 There are four types of diagnostic programs: power-up, in-line, on-line, and off-line. Each type has a special function, defined by the time of execution and/or the operating system to which they interface.

4.3.2 System fault detection and confidence testing. Initial testing and fault detection of the system shall be performed by implementing the power-up and in-line diagnostic programs.

4.3.2.1 Power-up diagnostics. These programs provide initial power-up sequence checks of the electronics as the system first receives power. They provide initial fault identification of hardware errors which cause the computer to fail while attempting an initial program load (IPL) of an operating system (OS). They also provide a visual indication of GO/NOGO status to the operator. Status response is provided to the operator in clear non-encoded text.

Figure 1. Diagnostic Decision Tree

4.3.2.2 In-line diagnostics. These tests often part of the operating system shall perform a status monitoring function of input/output routines during normal system operations. They report I/O error conditions during normal system operations to the operator at a system/subsystem level. These tests check word initiation processes, and data or status time dependent transfers. They provide error messages of bad data, bad status, or timeouts.

4.3.3 Subsystem fault identification and equipment fault isolation. At the subsystem level fault identification and equipment fault isolation shall be comprised of on-line and off-line diagnostic programs.

4.3.3.1 On-line diagnostics. These tests interface to the operating system and are initiated by the operator. They have the ability to diagnose malfunctions providing fault isolation to the equipment level. The subsystem under test continues to function in a degraded mode. Operational impact to the user will depend on system design and level of degradation.

4.3.3.2 Off-line diagnostics. These tests interface to the diagnostic operating system for equipment level fault isolation. The system/subsystem becomes totally dedicated to the equipment under test and is unavailable to the user. Off-line tests shall include the dedicated vendor supplied CPU/peripheral diagnostics and all diagnostics generated/ acquired for related unique/special purpose equipment designs.

4.4 Test equipment. Analysis at the system/subsystem level shall be made to determine the total maintenance test and support equipment (MT&SE) requirements. In determining actual MT&SE requirements consideration shall be given to the following: diagnostic integration, cost effectiveness, availability of similar equipment on-site, duplication requirements, and any unique logistic support requirements.

5. DETAILED REQUIREMENTS

5.1 Hardware diagnostic test system development plan. The system designer shall develop a plan (see 6.2) describing the technical approach to achieve functional goals for the design of the hardware diagnostic test system (HDTS). The HDTS shall be developed at the system/subsystem/equipment level. The development requirements for the HDTS when approved by the Government shall become the HDTS baseline.

5.2 Unit Development Folders. The systems designer shall establish and maintain Computed Software Unit Development Folders for each software unit under development. The folder(s) shall provide a central file of requirements, design data, code, test data for each software unit developed and a record of unit level schedules and status information (see 6.2).

5.3 Maintainability analysis. The system designer shall perform a maintainability analysis in accordance with Task 205 of MIL-STD-470 at the system/subsystem/equipment level. A detailed analysis of each-generic equipment used in the specified architecture shall determine if that equipment when operationally excluded from the system can be maintained to the lowest replaceable unit (LRU)/single replaceable unit (SRU). Each LRU/SRU shall be identified by: type, quantity, and uniqueness. Fault isolation analysis of each LRU/SRU shall be addressed in terms of diagnostic capability (in-line, on-line, off-line), and measured in terms of percentage probability of isolating the faulted LRU/SRU based on diagnostic capability (see Figure 2). Where applicable the fault isolation technique employed shall identify the reduced operational capability of the system (see 6.2).

5.4 Maintainability demonstration.

5.4.1 Maintainability demonstration test plan. The system designer shall prepare and submit a demonstration plan (see 6.2) in accordance with Task 301 of MIL-STD-470 which specifies how the hardware diagnostic test system shall be demonstrated and provide the scheduling for these demonstrations.

5.4.2 Maintainability demonstration. Maintainability demonstrations of the HDTS shall be performed in accordance with the Maintainability demonstration test plan, to verify that all requirements have been satisfied and demonstrate both applicability and quality of the HDTS in terms of fault isolation capability. Results of these demonstrations shall be provided the Government (see 6.2).

5.5 Program maintenance manual. The system designer shall prepare a program maintenance manual (see 6.2) for the software/firmware incorporated in the HDTS. The manual shall include step-by-step procedures to regenerate or support diagnostic software and the software component of firmware developed by the contractor for both end item equipments and system/subsystem diagnostic maintenance. Vendor and commercial software shall be included and defined to the extent allowed by proprietary rights. This manual shall also include information necessary to place this generated software into operation for each computer and firmware item in the developed system. These procedures shall be written for use by quality assurance personnel for future software maintenance

XYZ DIAGNOSTIC CAPABILITY SUBSYSTEM

LRU IN LINE ON LINE OFF LINE % PROB OF ISOLATING

A STATUS PERIODIC TEST SIGNAL BITD IN H/S 93

POLLING (SPP) GENERATOR (TSG) PROC PROM AND IN I/O

PROC PROM TSG

B SPP TSG BITD IN I/O 61

PROC PROM

TSG

C STATUS TSG AND MESSAGE BITD IN H/S 86

CONTINUOUSLY RECORDING PROC PROM

MONITORED AND IN I/O

PROC PROM

TSG

D SPP SUBSYSTEM- BITD IN I/O 91

TO-CTL TEST PROC PROM

MESSAGE

E STATUS CONTINUOUS NA 100

CONTINUOUSLY MONITORING

MONITORED

Figure 2. XYZ Diagnostic Capability

and may not assume familiarity with computer hardware or software. This manual(s) shall be completed and ready for use by the scheduled software test and evaluation.

5.6 Development specifications.

5.6.1 Diagnostic hardware. The system designer may use within the system/subsystem any diagnostic hardware device that satisfies the functional requirements of the system/ subsystem, and is approved by the Government. Diagnostic hardware shall include built-in test equipment (BITE), special purpose electronic test equipment (SPETE), automatic test equipment (ATE), programmable test devices, GO/NOGO testers, and any other device/circuits designed to perform fault detection and fault isolation functions within the system. The contractor is responsible for the definition, use and proper documentation of any diagnostic device used within the system.

5.6.2 Firmware. The system designer may use microcomputer devices to meet functional diagnostic requirements as approved by the Government. The contractor is responsible for the definition, use and effective documentation for the physical firmware component, as in diagnostic hardware. The contractor is also responsible for the use and effective documentation of the software component, as in hardware diagnostic software (HDS) (see 6.2).

5.6.3 Software. The system designer may use in-line, on- line, and/or off-line HDS in any mix to meet the functional diagnostic requirements of the system, as approved by the Government. The contractor is responsible for the definition, use, documentation, and delivery of the software product (see 6.2).

5.7 Diagnostic development specifications.

5.7.1 System in-line diagnostics. An application level software capability that will provide hardware fault identification to the subsystem level. In-line diagnostics shall be a

part of normal system operations and shall be distributed between the applications software and the operating system. Errors detected by the in-line diagnostics shall not prevent any application in progress from being completed. The in-line diagnostics test shall note and inform the operator of errors detected on all input/output lines and peripherals. Operator notification shall be in clear non- encoded text with the date and time of day of the first occurrence of a unit error and the resumption of correct operation.

5.7.2 System GO/NOGO diagnostics. The GO/NOGO diagnostic test shall enable the system operator to make initial determination of the overall system operability. The GO/NOGO diagnostic test shall consist of built-in test equipment (BITE) and/or software that shall function under an executive that responds to specific hardware tests. Each test shall communicate with the hardware under test, and provide hardware status reports concerning the system's availability. The GO/NOGO test shall operate within 15 minutes.

5.7.3 System/subsystem on-line diagnostics. The on-line HDS shall provide fault identification using built-in or resident software test functions to the equipment level. The on-line HDS shall be capable of concurrent system/subsystem operation with other active resident applications software. The on-line diagnostic test shall enable hardware maintenance personnel to diagnose and/or correct malfunctions while the system continues to function in a mode degraded only by unavailability of the equipment being tested. The on-line diagnostic test shall function under an executive that responds to operator directives to invoke specific hardware tests. Each test shall communicate to the applications software that the hardware/firmware under test is unavailable for normal operations. A part of the on-line diagnostic test function shall provide hardware status reports when directed to do so by the operator. The on-line diagnostic shall lead to fault isolation at the LRU/SRU level. This isolation shall be accomplished either by direct identification of the LRU/SRU or identification of the off-line diagnostic to be subsequently executed on the isolated subsystem/equipment.

The system designer shall be responsible for proper documentation of the on-line hardware diagnostic software (HDS) as contained in the following: applications software requirements, user manual(s), positional handbook(s), program maintenance manuals, and the diagnostic software/firmware maintenance manual.

5.7.4 Off-line hardware diagnostics. The off-line diagnostic tests shall consist of BITE/BITD and/or software that may be called in for maintenance purposes, but requires that normal operation of the system/subsystem/equipment be discontinued. For OEM type equipments, off-line diagnostics shall be provided by the vendor. However, they shall be evaluated by the contractor for compliance to system/subsystem/equipment availability, and maintainability requirements. Any upgrades of the vendor-supplied diagnostics to satisfy the stated RAM requirements shall become the responsibility of the contractor. Upgrades shall be submitted to the Government for review and agreed upon prior to PDR. Off-line diagnostics shall perform fault isolation to the LRU/SRU level. They shall be supported with all material, Procedures, and instructions necessary for maintenance personnel to isolate hardware malfunctions in a non-operating system.

5.8 Documentation standards. The system designer shall produce system/subsystem/equipment/manuals which contain instructions necessary to operate, use and maintain the HDTS.

5.8.1. Diagnostic hardware. The system designer shall be responsible for the documentation of all diagnostic hardware devices including firmware used within the system/subsystem/ equipments. Diagnostic firmware shall be documented, (see 6.2). Diagnostic hardware devices (i.e., built-in test equipment) shall be supported by the system/subsystem/ equipment technical manuals (see 6.2) as appropriate. Each hardware operation/maintenance (O/M) manual shall contain all the information necessary to provide life cycle support of the diagnostic hardware devices.

5.8.2. Diagnostic software. The system designer shall be responsible for documenting all diagnostic software and the software component of firmware within the program maintenance manual (see 6.2). This manual shall contain all information and procedures necessary for the life cycle support and configuration control of diagnostic software. The contractor shall include all information pertinent to the operation of in-line, on-line, and GO/NOGO diagnostic software within the user's manual and the positional handbook. Defining procedural use of the off-line diagnostic software in corrective maintenance actions shall be documented in the program maintenance manual. Their detailed operating instructions shall be documented in the system/equipment technical manual(s) and the positional handbook (see 6.2).

5.8.3 Support software. The system designer shall deliver all purchased or developed support software used in the design and development phases. All support software shall be executable on the deliverable hardware. Support software includes ancillary software, general purpose software, and test data generation software. Ancillary software is that software which is developed or acquired by the contractor for the purpose of supporting the design, development, integration or testing of the software/firmware required by the system design. General purpose software consists of utility programs, general purpose subroutines, etc., that are required to support operation or maintenance of software/firmware required by the system.

5.8.4. Vendor diagnostic software. Vendor/purchased software is defined as software which is commercially proven and available on the open market. Purchased/vendor software shall be the most recent version of the software available at the time of final system acceptance.

5.8.4.1 Standards for vendor diagnostic software. Contractor modification to purchased/vendor software is discouraged and shall not be allowed without prior written Government approval on a case-by-case basis (see 6.2).

5.8.4.2 Vendor documentation. The contractor shall provide complete documentation or operation, maintenance (as appropriate) and use of all purchased or licensed software in accordance with prevailing commercial practices. The contractor shall use the vendor's standard documentation to satisfy this requirement, except where modifications have

been made which Preclude such use. If modifications to purchased/ vendor software are authorized, all applicable documentation shall be annotated to reflect the impact of such modifications. The contractor shall detail, on a case-by-case basis, his specific approach to the documentation of modified purchased/vendor software when he requests Government approval for the use of such software.

5.9 Software system development test and evaluation plan. The contractor shall provide for the total test, verification, and Government acceptance of the hardware diagnostic test system (see 6.2). The HDTS capability shall be validated using simulated inputs and predetermined hardware malfunctions.

5.10 Hardware diagnostic software delivery. The contractor shall be responsible for the delivery of all diagnostic software in accordance with Computer Program End Item (see 6.2).

6. NOTES

6.1 Intended use. This standard contains requirements for the design and development of diagnostic testing systems.

6.2 Data requirements list and cross reference. When this standard is used in an acquisition which incorporates a DD Form 1423, Contract Data Requirements List (CDRL), the data requirements identified below shall be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved CDRL incorporated into the contract. When the provisions of the DOD FAR clause or data requirements (currently DOD FAR Supplement 52.227-7031) are invoked and the DD Form 1423 is not used, the data specified below shall be delivered by the contractor in accordance with the contract or purchase order requirements. Deliverable data required by this specification is cited in the following paragraphs.

Paragraph No. Data Requirement Title Applicable DID No.Option

5.1 Hardware Diagnostic Test System Development Plan DI-ATTS-80005

5.2 Computer Software Unit Development Folders DI-H-5587

5.3 Maintainability Analysis Report DI-R-7109

5.4 Maintainability Demonstration Test Plan DI-R-7112

5.4 Report, Maintainability Demonstration DI-R-7113

5.5, Program Maintenance Manual DI-R-5567

5.6.3 5.6.2, Firmware Documentation Standards DI-M-5552

5.8.1

5.8.1, System Technical Manual DI-M-5590

5.8.2

5.8.1 Subsystem Technical Manual DI-M-5591

5.8.1, Equipment Technical Manual DI-M-5592

5.8.2

5.8.3, Positional Handbook DI-M--5538

5.8.2

5.8.4.1, Software Change/Software Enhancement Proposal DI-E-2177

5.9 Software System Development Test & Evaluation Plan DI-T-5535

5.6.3,. Computer Program End Items DI-E-5541

5.10

(Data item descriptions related to this Standard, and identified in section 6 will be approved and listed as such in DOD 5000.19-L, Vol. II, AMSDL. Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the Naval Publications and Forms Center or as directed by the contracting officer.)

6.3 Subject team (keyword) listing.

Automatic Test Equipment (ATE)

Built-in Test Diagnostic (BITD)

Built-in Test Equipment (BITE)

Confidence Testing

Diagnostic Hardware

Diagnostic Software

Fault Isolation

Firmware

Hardware Diagnostic Test System Equipment

In-line Diagnostics

Maintainability Analysis

Maintainability Demonstration

Off-line Diagnostics

Off-line Hardware Diagnostics

On-line Diagnostics

Power-up Diagnostics

Software

Special Purpose Electronic Test Equipment (SPETE)

System Fault Detection

System CO/NOCO Diagnostics

System In-line Diagnostics

System/Subsystem On-line Diagnostics

Support Software

Vendor Diagnostic Software