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MILITARY STANDARD

MAINTAINABILITY PROGRAM

FOR

SYSTEMS AND EQUIPMENT

AMSC NO. F4720 AREA MNTY

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FOREWORD

1. This military standard is approved 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: RADC/RBE-2, Griffiss AFB NY 13441-5700 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

3. This military standard consists of basic application requirements, specific tailorable maintainability program tasks, and an appendix which includes an application matrix and guidance and rationale for task selection.

4. Maintainability and the means through which it is achieved affects combat culpability, survivability of the combat support structure, mobility requirements per unit, manpower requirements per units, and life cycle costs (LCC). Maintainability programs must take cognizance of such effects during the acquisition process and linkages between maintainability and its various "costs" (acquisition, overall manpower/ personnel, training, support equipment, etc.) and operational effects must be established. This is consistent with the Air Force "R&M 2000", the Navy "Best Practices Approach" and the Army "Reliability Initiatives" programs.

5. Effective maintainability programs must be tailored to fit program needs and constraints. Including readiness, mission success criteria, Life Cycle Costs (including manpower, personnel and training (MPT)), Logistics Support Analysis (LSA) and testability/diagnostics considerations. This document is intentionally structured to discourage indiscriminate blanket applications. Tailoring is forced by requiring that specific tasks be selected and identified with essential information relative to implementation provided by the Contracting Activity.

6. Many of the tasks solicit facts and recommendations from the contractors on the need for, or scope of, the work to be done rather than requiring that a specific task be done in a specific way. The selected tasks can be tailored to meet specific and peculiar program news.

7. Although not all encompassing, the guidance and rationale provided in Appendix A are intended to serve as an aid in selecting and scoping the tasks and requirements.

8. This revision contains the following fundamental changes from MIL-STD-470 and 470A.

a. Increased e mphasis has been placed on the need for including test - ability considerations as part of the Maintainability Program. Recogni - tion has been given the fact that Built-in-test (BIT), external test sys - tems and testers critically impact not only the attainment of maintaina - bility design characteristics but acquisition and life cycle costs as well.

b. Increased emphasis has been placed on considering maintainability program needs at all three levels of maintenance (Organizational, Inter- mediate, and Depot).

c. Increased emphasis has been placed in the Maintainability Program effort in obtaining Logistics Support Analysis (LSA) input data.

d. Increased emphasis has been placed on providing for the impact of scheduled and preventive maintenance .

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TABLES

1. SCOPE

1.1 Purpose . This standard provides task descriptions for maintainability program. The Tasks, as tailored, will be applied to systems and equipment development, acquisitions and modifications. Software maintainability is not covered by this standard.

1.2 Applicability .

1.2.1 Applicability of standard . Tasks described in this standard are to be selectively applied in Department of Defense (DoD) contract-definitized procurements, request for proposals (RFP). statements of work (SOW), and Government in-house developments requiring maintainability programs for the development and production of systems and equipment. The word "Contractor" herein also includes Government activities developing military systems and equipment. For NATO collaborative projects, this standard is to be used in complying with the contractual Maintainability Program implementation requirements of STANAG 4174, "Allied Reliability and Maintainability Publications".

1.2.2 Application guidance . In determining the applicability of the tasks herein and tailoring them to a program, the following principles shall be followed:

a. Every program is different.

b. Every design involves compromises among different desirable characteristics.

c. Programs must achieve a balance between operational need, equipment performance (including Reliability, Maintainability and Supportability as well as other performance needs), costs and schedule.

d. Maintainability tasks vary in their nature from one acquisition phase to another.

Application guidance and rationale for selecting tasks to fit the needs of a particular maintainability program are included in Appendix A. Appendix A does not impose contractual requirements.

1.2.3 Tailorinq of task descriptions . Task descriptions are intended to be tailored as required by their users as appropriate to particular systems or equipment program type, magnitude, and need.. When preparing a proposal, the contractor is encouraged to include additional tasks, alternative tasks, or task modifications with supporting rationale. The "Details to be Specified" paragraph under each task description is intended for listing the specific details, additions, modifications, deletions, or options to the requirements of the task that should be considered by the Contracting Activity (CA) when tailoring the task description to fit program needs. "Details" annotated by an

"(R)" (required) shall be provided to the contractor for proper implementation of the task.

1.3 Method of reference . When specifying the task descriptions of this standard as requirements, both the standard and the specific task description number(s) are to be cited. Applicable "Details to be Specified" shall be included in the SOW .

2. REFERENCED DOCUMENTS

2.1 Government documents .

2.1.1 Standards and handbooks . The following 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 issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

STANDARDS

MILITARY

MIL-STD-280	Definitions of Item Levels, Item Exchangeability, M odels, and Related Terms
MIL-STD-471	Maintainability,Verification/Demonstration/Evaluation
MIL-STD-721	Definitions of Terms for Reliability and Maintainability
MIL-STD-785	Reliability Program for Systems and Equipment Development and Production
MIL-STD-1388-1	Logistics Support Analysis
MIL-STD-1388-2	DOD Requirements for Logistics Support Analysis Record
MIL-STD-1629	Procedures for Performing a Failure Model Effects and C riticality Analysis
MIL-STD-2165	Testability Program for Electronic systems and Equipment

HANDBOOKS

MILITARY

MIL-HDBK-472 Maintainability Prediction

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Naval Publications and Forms Center (Attn: NPODS), 5801 Tabor Avenue, Philadelphia PA 19120-5099.)

(Copies of the DODISS's are available on a yearly subscription basis either from the Superintendent of Documents, US Government Printing Office, Washing - ton DC 20402-0001 for hard copy, or microfiche copies are available from the Director , Navy, Publications and Printing Service. Office, 700 Robbins Avenue, Philadelphia PA 19111-5093.)

2.2 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. TERMS, DEFINITIONS, AND ACRONYMS

3.1 Terms. The terms used herein are defined in MIL-STD-280 and MIL-STD-721.

3.2 Definitions. Definitions applicable to this standard are as follows :

a. Tailoring. The process of evaluating individual potential requirements to determine their pertinence and cost effectiveness for a specific system or equipment acquisition, and modifying these requirements to ensure that each contributes to an optimal balance between need and cost. The tailoring of data requirements shall consist of determining the essentiality of potential CDRL items and shall be limited to the exclusion of information requirement provisions .

b. Acquisition Phases:

(1) Conceptual (CONCEPT) Phase : The identification and exploration of alternative solutions or solution concepts to satisfy a validated need.

(2) Demonstration and Validation (DEMVAL) Phase : The period when selected candidate solutions are refined through extensive study and analysis; hardware development, if appropriate ; test; and evaluation.

(3) Full-Scale Development (FSD) Phase : The period when the system and the principle items necessary for its support are designed, fabricated, tested and evaluated.

(4) Production (PROD) Phase : The period from production approval until the last system is delivered and accepted.

c. Modification : Major engineering changes to an existing equipment or system to effect improvements in designed capabilities or characteristics.

d. System/Subsystem/Equipment : A general term referring to the end item or items to be obtained from the acquisition. The term is synonymous with the term "item" as defined in MIL-STD-280 and MIL-STD-721. System/Subsystem/Equipment includes the following levels:

(1) System
(2) Subsystem
(3) Set
(4) Group
(5) Unit
(6) Assembly
(7) Subassembly

any of which may be the objective of the acquisition.

3.3 Acronyms

ADM	-	Activity-Acquisition Decision Memorandum
AMSDL	-	Acquisition Management Systems and Data Requirements Control List
BIT(E)	-	Built-in-Test (Equipment)
CA	-	Contracting Activity
CDR	-	Critical Design Review
CDRL	-	Contract Data Requirements List
CI	-	Configuration Item
CONCEPT	-	Conceptual
DCP	-	Decision Coordinating Paper
DEMVAL	-	Demonstration and Validation
DID	-	Data Item Description
DMH/MA	-	Direct Manhours per Maintenance Action
DOD	-	Department of Defense
DOD-ADL	-	Department of Defense Authorized Data List
FMEA	-	Failure Mode and Effects Analysis
FMECA	-	Failure Mode, Effects and Criticality Analysis
FSD	-	full Scale Development
GFAE	-	Government Furnished Aeronautical Equipment
GFE	-	Government Furnished Equipment
ILS	-	Integrated Logistics Support
LSA	-	Logistics Support Analysis

LSAR - Logistics Support Analysis Records
MD - Maintainability/Testability Demonstration
MNS - Mission Need Statement
MPMT - Mean Preventive Maintenance Time
MPT - Manpower, Personnel, and Training
MR - Maintenance Ratio
MTBM - Mean Time Between M aintenance
MTBPM - Mean Time Between Preventive Maintenance
MTTR - Mean Time to Repair
MTTRF - Mean Time to Restore Functions
MTTRS - Mean Time to Restore System
MTTS - Mean Time to Service
MTUT - Mean Equipment Corrective Maintenance Time Required to Support a Unit Hour of Operating Time
NATO - North Atlantic Treaty Organization
OTS - Off the Shelf
PCB - Printed Circuit Board
PDR - Preliminary Design Review
PMD - Program Management Directive
PMP - Program Management Plan
PROD - Production
RFP - Request for Proposal
SOW - Statement of Work
STANAG - Standardization Agreement (NATO)

4. GENERAL REQUIREMENTS

4.1 Maintainability program . The purpose of the Maintainability Program is to improve operational readiness, reduce maintenance manpower needs, reduce life cycle cost and to provide data essential for management. The objective is to assure attainment of the maintainability requirements of the acquisition . The contractor will establish and maintain an effective maintainability program that is planned, integrated, and developed in conjunction with other design, development, and production functions to permit the most cost-effective achievement of overall program objectives. The maintainability pro gram will include the management/technical resources, plans, procedures, schedule, and controls for the work needed to assure achievement of maintaina - bility requirements. Procedures will be established which assure that main-tainability engineering is an integral part of the design process, including design changes. The procedures will identify the means by which maintainability engineering contributes to the design of the system or equipment acquisition including its fault detection and diagnostics subsystems at organi - zation , intermediate, and depot levels of application. In addition, the means through which maintainability engineering tasks interface with the logistics support analysis (LSA) process and other related disciplines (i.e., reliability, value engineering, safety engineering, etc.) will be identified. The program will be developed to suit the type of system/equipment, the phase of the procurement (CONCEPT, DEMVAL, FSD, or PROD). and its nature (development, production or modification). The program will be consistent with the criti-

cality of the missions, the severity of the requirements, the complexity of the design, commonality, and the manufacturing techniques required.

4.1.1 Maintainability program interfaces and coordination. The contractor may be tasked to utilize maintainability data and information resulting from applicable tasks in the maintainability program to satisfy the LSA and LSAR requirements called out in MIL-STD-1388-1 and -2. All maintainability data and information used for all logistics support and engineering activities involved throughout the life cycle of the system/subsystem/equipment will be based upon, and traceable to, the outputs of the maintainability program. Some of the same types of tasks, analyses, etc., called for in this standard (for example, failure modes and effects analysis) are also called out for the purposes of other program requirements. Reliability program requirements (MIL-STD-785), in particular, contain tasks and analyses related and similar in purpose and objectives to tasks 102, 103, 104, 204 and 207 of this standard. Testability Program Requirements for Electronic Systems and Equipments (MIL-STD-2165), in particular, has a significant interface with a majority of tasks identified in this standard. To avoid duplication of effort, performance of such tasks, or analyses will be coordinated, and where possible combined with similar tasks called for under other program elements.

4.2 Quantitative requirements: The system maintainability requirements essential to the mission and its support and the subsystem/equipment maintainability requirements essential to support at the various levels of maintenance activity (organization, intermediates depot), will be specified contractually. Quantitative requirements for the system, all major subsystems, and equipments, will be included in appropriate sections of the system and item specifications. The sub-tier values not established by the CA will be established by the system or equipment contractor not later than a contractually specified control point prior to detail design. Maintainability requirements may be structured as functions of time, man-hours or in terms of the attributes of fault detection and isolation subsystems. Examples of quantitative measures to be considered for contractually specified requirements are: Mean - Time-To-Repair (MTTR), Mean-Time-To-Restore-System (MTTRS), Mission-Time-To-Restore-Functions (MTTRF), Direct Manhours per Maintenance Action (DMH/MA), Mean Equipment Corrective Maintenance Time Required to Support a Unit Hour of Operating Time (MTUT), Maintenance Ratio (MR), Mean Time to Service (MTTS), Mean Time Between Preventive Maintenance (MTBPM), Mean Preventive Maintenance Time (MPMT), Probability of Fault Detection, Proportion of Faults Isolatable and Reconfiguration Times. Such requirements will be capable of certification through Maintainability/Testability Demonstration (MD). The quantitative maintainability requirements for systems/equipments will be stated in terms of a "Required" (worst case) value. It is desirable to associate with each "Required" value a "design goal" (desired) value. Measures selected should be consistent with any system readiness parameters, mission requirements, support cost objectives and maintenance manpower constraints; measures should be related to operational values and be traceable through all phases of the system life cycle and between program objectives and contract requirements.

5. DETAILED REQUIREMENTS

5.1 The following task descriptions are divided into three general sections: Section 100, Program Surveillance and Control; Section 200, Design and Analysis; and Section 300, Evaluation and Test.

6. NOTES

(This section contains Information of a general) or explanatory nature that may be helpful . but is not mandatory.

6.1 Intended use . This document is for use of Department of Defense contracting activities, Government In-house activities, and prime contractors or subcontractors involved in equipment/system acquisition where a maintainability program is required. It will guide the customer in imposing maintainability tasks upon contractors and guide the contractor in communications with its customers. This document should not be used to establish requirements .

6.2 Issue of DODISS . When this standard is used in acquisition, the applicable issue of the DODISS must be cited in the solicitation (see 2.1.1).

6.3 Data requirements . The following Data Item Descriptions (DIDs) must be listed, as applicable on the Contract Data Requirements List (DD Form 1423) when this standard is applied on a contract, in order to obtain the data, except where DOD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

Task	DID Number	DID Title
101	DI- MNTY -80822	Maintainability Program Plan
103	DI- MNTY -80823	Maintainability Status Report
104	DI-MNTY-80824	Data Collection, Analysis and Corrective Action System, Reports
201	DI-MNTY-80825	Maintainability Modeling Report
202	DI-MNTY-80826	Maintainability Allocations Report
203	DI-MNTY-8O827	Maintainability Predictions Report
204	DI-R-7085A	Failure Mode, Effects, and Criticality Analysis Report
205	DI-MNTY-80828	Maintainability Analysis Report
206	DI-MNTY-80829	Maintainability Design Cri teria Plan

Task	DID Number	DID Title
207	DI -MNTY-80830	Inputs to the Detailed Maintenance Plan and Logistics Support Analysis
301	DI-MNTY-80831	Maintainability/Testability Demonstration Test Plan
	D1-R-2129	Plans Maintainability Demonstration (DI-R-2129 Is to be used only when MIL-STD-471 is designated as the basis for NIL-STD-470B, Task 301)
	DI-MNTY-80832	Maintainability/Testability/Demonstration Test Report (to be used only when MIL-STD- 471-and its associated 01-R-1724 are not designated as a basis for NIL-STD-4708, Task 301)

The above DIDs were those cleared as of the date of this standard. The current issue of DOD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL)I, must be researched to ensure that only current, cleared DIDs are cited an the DO Form 1423.

6.4 Subject term (key word) listing. The following key words and phrases apply to this standard.

Maintainability
Maintenance
Program Management

6.5 Source of STANAG 4174 . Copies of STANAG 4174 are available from the Naval Publications and Forms Center (Attn: NPODS). 5801 Tabor Avenue, Philadelphia PA 19120-6099.

6.6 Changes from previous issue . The margins of this standard are marked with vertical lines to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies In these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:
Army - MI
Navy - AS
Air Force - 17

Preparing Activity:
Air Force - 17
(Project MNTY-0011)

Review Activities:
Army - AV, AR, TE, ER
Navy - EC OS, MC, TD, YD, CG
Air Force 10, 11 13, 24,, 15, 18, 19, 71, 82, 99
DLA DH

TASK SECTION 100

PROGRAM SURVEILLANCE AND CONTROL

TASK 101

MAINTAINABILITY PROGRAM PLAN

101.1 PURPOSE. The purpose of Task 101 is to develop a maintainability program plan which identifies and ties together all maintainability tasks required to accomplish program requirements.

101.2 TASK DESCRIPTION.

10l.2.1 A maintainability program plan shall be prepared and shall include the following:

a. A description of how the maintainability program will be conducted to meet the requirements of the Statement of Work (SOW).

b. An identification of each maintainability task to be accomplished under the maintainability program.

c. A detailed description of how each maintainability task will be performed or complied with.

d. The procedures (where existing procedures are applicable) to evaluate the status and control of each task.

e. The identification of the organizational unit with the authority and responsibility for executing each task.

f. The descriptions of the interrelationships of maintainability, testability, and diagnostic tasks and activities shall include: (1) how maintainability, testability, and diagnostic tasks will Interface and be integrated with other system oriented tasks i.e.. reliability, human factors personnel, system life cycle and design to cost, safety, Logistics Support Analysis (LSA), system engineering, value engineering. Integrated Logistics Support (ILS), etc.), and 12) how duplication of effort will be avoided. The description of interrelationships shall specifically include procedures to be employed which will assure that the maintainability, testability and diagnostics program will operate within the goals and constraints established by front-end LSA activity, and that applicable maintainability, testability and diagnostics data derived from, and traceable to, the maintainability, testability and diagnostics tasks specified are available for integration into the Logistic Support Analysis Records (LSAR) throughout the life cycle of the system.

g. A schedule with estimated start and completion points for each maintainability program activity or task and level of effort to be spent on each task.

h. The relationship of the Maintainability Program schedule to other schedules for system engineering tasks (such as Reliability, Testability and LSA) shall be established.

i. The procedures or methods for identification and resolution of problems and tracking status.

j. The method by which the maintainability requirements are disseminated to associated personnel, subcontractors, suppliers and the controls levied under such circumstances.

k. The identification of contractor organizational elements responsible for managing and Implementing the maintainability program and a description of related management structure. Including interrelationship between line, service, staff and policy organizations.

l. A statement identifying which sources of maintainability design guidelines will be utilized including all DoD, internal contractor and other non-DoD prepared material.

m. The procedures for recording maintainability data.

102.2.2 The contractor may propose additional tasks or modifications with supporting rationale for such additions or modifications.

101.3 DETAILS TO BE SPECIFIED BY THE CA (Reference 1.2.3)

101.3.1 Details to be specified in the SOW shall Include the following, as applicable:

(R) a. Identification of each maintainability task.

(R) b. Identification of contractual status of the program plan.

(R) c. Applicability of par 101.2.2.

d. Identification of additional tasks to be performed or additional information to be provided.

e. Identification of any specific indoctrination or training requirements.

f. Identification of data items required (see 6.3).

g. Identification of reporting requirements necessary for the tailored LSA and LSAR programs.

TASK 102

MONITOR/CONTROL OF SUBCONTRACTORS AND SUPPLIERS

102.1 PURPOSE The purpose of Task 102 is to provide the prime contractor and the CA with appropriate surveillance and management control of subcontractors'/suppliers' maintainability programs so that timely management action can be taken as the need arises and program progress is ascertained.

102.2 TASK DESCRIPTION

102.2.1 The contractor shell Insure that system elements obtained from sup pliers will most maintainability requirements. This effort shall apply to contractor furnished equipment, items obtained from any supplier whether in the first or any subsequent tier, or whether the item is obtained by in intra-company order from any element of the contractor's organization. All subcontracts shall include provisions for review and evaluation of the suppliers' maintainability efforts by the prime contractor, and by the CA at their discretion.

102.2.2 The contractor shall assure that his subcontractors' and suppliers' maintainability efforts are consistent with overall system requirements, and that provisions are made for surveillance of their maintainability activities. The contractor shall advise the CA of the maintainability requirements for subcontractors and suppliers and whether or not they are consistent with the overall system requirements. The contractor shall, as appropriate:

a. Incorporate in specifications for procurements from subcontractors and suppliers such information as:

(1) system/equipment maintainability concepts, constraints and re - quirements .

(2) Maintenance, diagnostic and support concepts/requirements.

(3) Standardization and interchangeability requirements.

(4) Maintainabilit y and fault detection and isolation demonstration requirements.

(5) Maintainability requirements to provide data to support Logistics Support Analysis (LSA).

b. Assure that subcontractors have a maintainability program that is their compatible with the overall program and include previsions to review and evalu ate supplier's(s') maintainability efforts.

c. Attend and participate in subcontractors' design reviews.

d. Review subcontractors' predictions and analysis techniques a nd results for accuracy, correctness of approach and consistency with end item requirements.

e. Assure that subcontractors/suppliers will provide the necessary technical and administrative support for the items they supply during production and deployment of the hardware. This support may include such Items as; failure modes and effects analysis, technical manuals and test software.

f. Assure that subcontractors provide maintainability data Inputs necessary to LSA. (See Task 201).

g. Describe th e LSA requirements specified to the contract relating to subcontractors and suppliers maintainability efforts.

102.3 DETAILS TO BE SPECIFIED BY THE CA (reference 1.2.3)

102.3.1 Details to be specified in the SDW shall include the following, as applicable:

a. Notification requirements for attendance at "Special Meetings." Program Reviews, Preliminary Design Reviews (PDR), Critical Design Reviews (CDR), etc.

b. Definition of the requirements for subcontractor / supplier Maintainability Program Tasks and Demonstrations.

c. Identification of data elements necessary for input to LSA and LSAR.

TASK 103

PROGRAM REVIEWS

103.1 PURPOSE. The purpose of Task 103 is to establish a requirement for the prime (or associate) contractor to conduct maintainability program review on scheduled dates in time to assure that the maintainability program is proceeding to accordance with the contractual milestones and that the systems subsystem, equipment, or component maintainabil ity performance requirements will be achieved. This task shall include consideration of how maintainability tasks and activities and their results will interface and integrate with other related system-oriented tasks (i.e., human factors, testability, LSA, personnel and systems life cycle cost).

103.2 TASK DESCRIPTION

103.2.1 The maintainability program shall be planned and scheduled to permit the contractor and the CA to review program status. Formal review and assessment of contract maintainability requirements shall be conducted at major program points, identified as system program reviews, as specified by the contract. As the program develops, maintainability progress shall also be assessed by the use of additional maintainability program reviews as necessary. The contractor shall schedule review as appropriate with his subcontractors and vendors and insure that the CA is informed in advance of each review.

103.2.2 The reviews shall identify and discuss all pertinent aspects of the maintainability program such as the following, when applicable:

a. At System Requirements Review:

(1) Results of trade studies leading to Preliminary System Design Concept.

b. At System Design Review:

(1) Diagnostic Content of Development Specification.

(2) Diagnostic Maturation and Data Collection Plan.

(3) System Optimization Tradeoffs.

(4) Risk Analysis.

(5) Diagnostic Allocation.

c. At the Preliminary Design Review (PDR):

(1) Updated maintainability status including:

(a) Maintainability modeling.

(b) Maintainability apportionment (Allocation).

(c) Maintainability predictions.

(d) FMEA (Maintainability Information).

(e) Maintainability content of specification.

(f) Design guideline criteria.

(g) Establishment of data collection, analysis and corrective action system.

(h) Results of the planned maintainability analysis which impacts either the maintenance plan/concept testability needs, the LSA (see Task 207) or repair levels.

(i) Subcontracto r maintainability.

(j) Other tasks as identified.

(2) Projected maintenance, manpower and personnel (skill) impacts based on assessed maintainability characteristics, and projected ability to meet maintainability requirements within manpower and personnel constraints.

(3) Other problems affecting maintainability.

(4) Maintainability design approach including the extent of modularity and, the fault detection and isolation approach at each level of maintenance.

d. At the Critical Design Review (CDR):

(1) Maintainability content of specifications.

(2) Maintainability predictions and analyses. (i.e., LSA (see Tasks 203 and 205)).

(3) Fault detection and isolation design Approach and general testability assessment (for each appropriate maintenance level).

(4) Quantity and types of maintenance tasks for each level of the hardware breakdown structure of the system configuration and for each maintenance level.

(5) Final content and descriptions of all pert inent inputs to the maintenance plan and LSA (See Task 207).

(6) FMEA as related to the fault detection and isolation system's design and characteristics.

(7) Projected manpower skill requirements based an assessed main - tainability characteristics.

(8) Other problems affecting maintainability.

(g) Other tasks as identified .

e. At the Test Readiness Review:

(1) Maintainability prediction.

(2) Test schedule.

(3) Review of adherence to appropriate portions of MIL-STD-471.

(4) Test repor t format.

(5) Review of Task 301 (Maintainability /Testability Demonstration).

(6) Availability of personnel (in number, skills and training as determined by the contract), technical manuals and support equipment .

f. At Production Readiness Review:

(1) Results of Evaluation of Entire Diagnostic Capability.

g. Other Maintainability Program Reviews:

(1) Discussion of those items reviewed at PDRs and CDRs.

(2) Results of Failure Modes and Effects Analysis (FMEA).

(3) Test schedule: start date s and completion dates.

(4) Design, maintainability, and schedule problems.

(5) Status of assigned action items.

(6) Contractor assessment of maintainability task effectiveness.

(7) Results of all analyses and modeling efforts (life cycle cost LSA (see Task 207), fault detection and isolation, test system

designs, identification of Engineering critical items).

(8) Results of reliability testing and use of the data in updating maintainability predictions.

(9) Other topics and issues as deemed appropriate by the contractor and the CA.

103.3 DETAILS TO BE SPECIFIED BY THE CA (reference 1.2.3)

103.3.1 Details to be specified in the SOW shall include the following, as applicable:

(R) a. Identification of reviews required.

(R) b. Advance notification to the CA of all scheduled reviews. The specific number of days advance notice should be contractual.

c. Recording procedures for the results of the reviews.

d. Identification of CA and contractor follow-up methods on review of open items.

e. Identification of reviews other than system program reviews (for examples reviews during the conceptual phase).

f. Identification of data items required (see 6.3).

TASK 104

DATA COLLECTION, ANALYSIS, AND CORRECTIVE ACTION SYSTEM

104.1 PURPOSE. The purpose of Task 104 is to establish a data collection and analysis system to aid design, identify corrective action tasks and evaluate test results .

104.2 TASK DESCRIPTION

104.2.1 The contractor shall est ablish a. maintainability and diagnostics effectiveness data collection system to augment predictions with preliminary trial results during design, and for measurement and evaluation of demonstration results at specified levels of maintenance. Data collection should be integrated as much as possible with similar data collection requirements, such as reliability, LSA (see Task 207), etc..

104.2.2 The data collection system used to aid design should be defined as early as possible, but not later than the demonstration and validation phase. The same data collection system should be used during testing and preliminary trials.

104.2.3 The data collection system used during demonstration should receive preliminary planning during the demonstration and validation phase and should become firm in the maintainability demonstration plan (ref. Task 301) prior to testing.

104.2.4 The data collection system shall be used as a means for identifying maintainability, testability and diagnostics design problems, errors, and for initiating corrective actions. Such corrective actions can take the form of modifications and changes to equipment fault detection and isolation subsystems (hardware and software), packaging, assembly. training, manuals, etc..

104.2.5 Procedures for providing inputs to the system; the analysis of problems; and feedback of corrective action into the design, manufacturing and test processes shall be identified .

104.3 DETAILS TO BE SPECIFIED BY THE CA (reference 1.2.3)

104.3.1 Details to be specified in the SOW 'shall include the following, as applicable:

(R) a. Identification of equipment levels of maintenance for corrective maintenance action reporting.

(R) b. Identification of diagnostics system attribute date to be reported (percent of faults detectable, proportion of faults isolatable, false alarm rates, etc.).

c. Identification of the extent to which the contractor's data collection system must be compatible with CA's data system.

d. Identification of data elements for inpu t to LSA (See Task 207).

e. Identification of data items required (see 6.3).

TASK SECTION 200

DESIGN AND ANALYSIS

TASK 201

MAINTAINABILITY MODELING

201.1 PURPOSE. The purpose of Task 201 is to develop a maintainability model for making numerical apportionments and estimates to evaluate item maintainability when system/equipment complexity or importance warrant such a model.

201.2 TASK DESCRIPTION

201.2.1 Appropriate maintainability mathematical models shall be developed based on:

a. The equipment (system) design characteristics which impact maintainability, (for example, fault detection probability, ambiguity, proportion of failures isolatable, mobility, frequency of failure, maintenance time and manhours required, maintenance manhours or time expended on maintenance per hour of operation, maintenance plan, etc.).

b. The appropriate level of maintenance to which the model pertains.

c. Relationship between the contract maintainability terms and the maintainability parameters related to each of the operational system parameters (operational readiness, mission success, logistics supportability, maintenance manpower and logistic support-costs, etc.).

201.2.2 The model shall be compatible with contractual maintainability requirements, logistic and personnel constraints and other maintainability terms as specified.

201.2.3 The complexity of the model will necessarily vary according to the complexity of the equipment being procured. The model shall be updated with information resulting from design changes as well as changes in item configuration, mission parameters, and operational constraints. Inputs and outputs of the maintainability mathematical model shall be compatible with the input and output requirements of the system and subsystem level analysis models.

201.3 DETAILS TO BE SPECIFIED BY THE CA (reference 1.2.3)

201.3.1 Details to be specified in the SOW shall include the following, as applicable:

(R) a. Identification of maintenance levels to which model(s) will pertain.

(R) b. Identification of maintenance and support concepts.

c. Imposition of Task 202 or 203 (or both) as requisite tasks (imposition of Task 201 normally should not occur without Imposition of Task 202,203 or both).

d. Coordinated reporting requirements for LSA (see Task 207).

e. Identification of additional maintainability terms.

f. Identification of any maintainability objectives, goals, or constraints derived from front-end LSA.

g. Identification of data items required (see 6.3).

h. Requirements for updating models.

i. Identification of the maintainability design characteristics used as quantitative requirements.

TASK 202

MAINTAINABILITY ALLOCATIONS

202 .1 PURPOSE . The purpose of Task 202 is to assure that once quantitative system requirements have been determined, they are allocated or apportioned to lower levels.

202.2 TASK DESCRIPTION

202.2.1 System/Subsystem/equipment numerical maintainability requirement(s) shall be broken down to the subsystem/ equipment/unit/subunit levels as necessary to establish requirements for designers. Requirements consistent with the allocations shall be imposed on the subcontractors and supplier. The apportioned values shall be included in appropriate sections of procurement specifications and contract end item specifications. All allocated maintainability values established by the contractor and included in contract end item specifications shall be consistent with the maintainability model (see Task 201) and any change thereto, and subject to CA review. Outputs from Task 201 of MIL-STD-2155, if called out shall form the basis for diagnostic allocation .

202.2.2 The method and rationale for the maintainability allocations shall be documented and forwarded for CA review.

202.3 DETAILS T0 BE SPECIFIED BY THE CA (reference 1.2.3)

202.3.1 Details to be specified in the SOW shall include th e following, as applicable:

(R) a. Identification of minimum item levels of allocation (Organizational Removable Unit, Printed Circuit Board (PCB), etc.).

b. Imposition of task 201 as requisite task in the demonstration and validation phase.

c. Coordinated reporting requirements for LSA (see Task 207).

d. Identification of data items required (see 6.3).

e. Requirements for updating allocations.

f. Whether or not Task 201 of MIL-STD-2165 is called out.

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TASK 203

MAINTAINABILITY PREDICTIONS

203.1 PURPOSE. The purpose of Task 203 is to estimate the maintainability of the system/subsystem/equipment and to make a determination of whether the maintainability required can be achieved with the proposed design within the prescribed support and personnel /skill requirements.

203.2 TASK DESCRIPTION

203.2.1 Maintainability predictions related to each associated level of maintenance shall be made for the system/subsystem/equipment. When required, predictions shall account for and differentiate between, each maintenance, operational. and support concept defined in the item specification. Predic - tions shall be made showing the capability of the system/subsystem/equipment to meet all maintainability. requirements at each level of maintenance specified by the CA. These predictions shall be made using the associated mathmatical model and maintainability prediction procedure approved by, or provided by, the CA. Items shall not be excluded from the maintainability predictions unless substantiating documentation verify that the item failure aid maintenance action cycle have no influence an the required measure of maintainability (or unless the item in question has associated with it an established maintainability history in which case the actual maintainability values attained for the item may be substituted for the prediction). Item to be excluded from the maintainability predictions require CA approval.

203.2.2 Predictions for items shall be made usin g one of the methods contained in NIL-HDBK-472, or alternatives approved or provided by the CA. In either case, the specific techniques for predicting quantitative requirements at lower item level of the system (group, unit, assembly, subassembly, etc.) shall be defined and sources of data shall be identified. Predictions for types of equipment not covered by MIL-HDBK-472 shall be made using either contractor data or alternatives, both of which shall require CA approval. Where appropriate, predictions of scheduled and preventive maintenance workload shall also be considered. Predictions shall be made corresponding to the quantitative maintainability requirements. Predictions shall be updated as required.

203.3 DETAILS TO BE SPECIFIED BY THE CA [reference 1.2.3)

203.3.1 Details to be specified in the SOW shall include the following, as applicable:

(R) a. Identification of maintenance levels for which predictions are to be performed.

(R) b. Identification of hardware levels (system/subsystem/equipment/replaceable item) for which predictions are to be performed.

(R) c. Identification of equipment maintenance and support concepts or alternatives.

(R) d. Pertinent maintainability information on any specified Government Furnished Equipment (GFE).

(R) e. Identification of the maintainability parameter related to the applicable system parameters (operational readiness, mission success. logistics supportability maintenance manpower, personnel and skill requirements, logistics support costs, etc.) which are to be predicted.

f. Imposition of Tasks 201 (contingent on the complexity of the equipment) and 202 as requisite tasks In the FSD phase.

g. Identification of requirements to update predictions using actual experience and test data.

h. Sources of the prediction techniques to be used (i.e., MIL-HDBK-472, or other sources).

1. Establishment of CA approval requirements for use of actual data.

j. Identification of alternative methods to be used for predictions.

k. Requirements for providing data for LSA and LSAR (see Task 207).

1. Identification of additional maintainability parameters for which predictions are required.

m. Identification of data items required (see 6.3).

n. Conditions/requirements for updating predictions.

TASK 204

FAILURE MODES AND EFFECTS ANALYSIS (FMEA) - MAINTAINABILITY INFORMATION

204.1 PURPOSE. The purpose of Task 204 is to define the Potential failure modes and their effects an systems, equipments, and item operation in order to establish necessary maintainability design characteristics including those that must be ascribed to fault detection and isolation subsystems.

204.2 TASK DESCRIPTION

204.2.1 Maintainability information, in accordance with Task 103 of MIL-STD-16Z9, "Failure Modes, Effects and Criticality Analysis (FMECA)", will be developed in conjunction with any Failure Modes and Effects Analysis (FMEA) performed.

204.2.2 Information developed in the performance of this task shall be integrated with FMEA/FMECA efforts for related areas, such as reliability, LSA, safety. human factors, and technical manual preparation.

204.2.3 Specific uses of the results of this task for designing Built-in-Test (BIT). internal and external test subsystems, testers. etc., shall be identified.

204.3 DETAILS TO BE SPECIFIED BY THE CA (reference 1.2.3)

204.3.1 Details to be specified In the SOW shall include the following, as applicable:

(R) a. NIL-STD-1629, Task 101, Is a requisite for this task. If not contractually invoked elsewhere in the SOW, MIL-STD-1629, Task 101, must be invoked in conjunction with this task.

(R) b. Identification of required details as indicated in MIL-STD-1629 to be necessary when invoking that document.

(R) c. Identification of maintenance levels for which the FMEA is to be performed.

d. Related tasks of NIL-STD-1629 (such as Task 105, FMECA Plan) and deliverable data required in the performance of this task.

e. Coordinated reporting requirements for LSA (see Task 2 07).

TASK 205

MAINTAINABILITY ANALYSIS

205.1 PURPOSE The Purpose of Task 205 is to translate data from contractor's studies, engineering reports (both unique to maintainability design and developed as a consequence of other requirements) and information which is available from the CA into a detailed design approach and to provide inputs to the detailed maintenance and support plan, which is part of the LSA (see Tasks 201, 203 and 207).

205.2 TASK DESCRIPTION

205.2.1 The maintainabil ity analysis which shall be performed integrates data from contractor's studies with engineering reports and information which is available from the CA into a detailed design approach. Outputs from Tasks 201 and 202 of MIL-STD-2165. If called out shall form the basis for testability and diagnostic analysis.

205.2.2 A listing of the elements of which the analysis will be comprised shall be presented for CA approval at the PDR. Studies and analyses necessary as an input, and common to this and. other standards, shall be combined such that a comprehensive single study or analysis, will be capable of meeting required needs. Elements to be considered include:

205.2.2. 1 Mean and Maximum time(.s) to repair (all levels of maintenance, organizational, intermediate, depot).

205.2.2.2 Maintenance manhours and maintenance time expended/maintenance task/flight hour/operating hour (for all appropriate levels of maintenance).

205.2.2.3 False alarm rates, cannot duplicate rates, retest ok rates associa ted with all levels of maintenance.

205.2.2.4 Proportion of faults detectable (all levels of maintenance including system/equipment/unit built-in detection, and external fault detec - tion subsystems)

205.2.2.5 Level(s) of isolation or ambiguity (for example, does the built-in-test or external test system or tester identify N possible units or assemblies etc., only one of which is failed?) for the system, equipment, unit. assembly, subassembly, etc., for each level of maintenance.

205.2.2.6 Identification of the requir ed mix of automatic, semiautomatic, built-in and manual test capability, plus the maintenance aids and manual diagnostic procedures required at all levels of repair and their associated software and technical costs, skill levels required and manpower requirements, as well as acquisition costs if available.

205.2.2.7 Levels of repair associated moth each equipment design and each test system alternative as derived from the LSA.

205.2.2.8 Develop ant of unique external test systems and teste rs versus use of existing units (sto ck listed or commercial).

205.2.2.9 Producibility considerations relating to the realization of each test system alternative.

205.2.2.10 Determination of system/subsystem/equipment parameters that are monitored and not monitored by BIT or other diagnostic/test systems.

205.2.2.11 Impact of scheduled and preventive maintenance workload.

205.2.2.11.1 Mean time between scheduled and preventive maintenance at each required level of maintenance.

205.2.2.11.2 Mean preventive maintenance time.

205.2.3 Maintainability mathematical models, life cycle cost models, and acquisition cost estimates shall be developed from the inputs and considerations described above to:

205.2.3.1 Show the impacts on cost, maintainability and on system readiness parameters of the germane maintainability elements.

205.2.3.2 Allocate quantitative maintainability requirements to all significant item levels of the system/subsystem/equipment (see Task 202).

205.2.3.3 Develop the most cost effe ctive maintainability design and test system configuration which meets support and personnel constraints as well as system readiness and mission performance objectives.

205.2.3.4 Prepare inputs to support system analysis (see para 205.3).

206.2.4 Performance Design Trade-offs. NOTE: This task has significant possibilities for overlap with LSA efforts. and shall therefore be coordinated closely with the LSA community and LSA Statement of Work, to ensure consistency and prevent duplication.

205.2.4.1 Trade-offs between maintainability design alternatives and equip - ment design parameters shall be made to provide an economical design which best satisfies systems or equipment requirements.

205.2.4.2 Whenever design trade-offs are performed, in other areas which impact maintainability, the effects of any compromise of maintainability shall be evaluated, documented and reflected in the maintainability analysis. Trade-offs involving Impacts on maintainability attributed to changes in areas such as packaging, fault detection and isolation portions of the design or to external test equipment or testers shall be incorporated in status reports submitted.

205.3 DETAILS TO BE SPECIFIED BY THE CA (reference 1.2.3)

205.3.1 Details to be specified in the SOW shall include the following, as applicable:

(R) a. Specification of elements to be considered in the analysis (inclusion of additional elements, deletion of certain elements).

(R) b. Information available from CA relative to:

(1) Operation al and support concepts (and their alternatives) and requirements, Including environmental conditions, operational profile, life expectancy and functional performance definitions (failure definitions).

(2) Overall quantitative maintainability requirements.

(3) Personnel subsystem constraints.

(4) Projected facility, training program, skills, equipment. and tool availability.

(5) Cost constraints.

(6) Studies and engineering reports for the system/equipment con - cerned.

(7) Lists of standard tools and equipment.

c. Coordinated reporting requirements with LSA (see Task 207).

d. Identification of data items required (see 6.3).

e. Imposition of Tasks 201 and 203, as pre requisite tasks during FSD.

f. Whether or not Tasks 201 and 202 of MIL-STD-2165 are called out .

TASK 206

MAINTAINABILITY DESIGN CRITERIA

206.1 PURPOSE The purpose of Task 206 is to Identify the design criteria that will be employed in translating the quantitative and qualitative maintainability requirements and anticipated operational constraints into detailed hardware designs.

206.2 TASK DESCRIPTION

206.2.1 The maintainability design criteria is composed of those technical policies and procedures which shall be used to guide the design process. The contractor shall identify and document such criteria to be applied during the course of the appropriate acquisition phase.

206.2.2 A listing of design criteria (and their sources) to be applied shall be presented for CA approval at the PDR. The criteria shall be continually refined and updated as design progresses and final content and description presented at the CDR. Criteria to be considered for inclusion for all levels of maintenance are:

206.2.2.1 Appropriate design handbooks.

206.2.2.2 Checklists and lessons learned.

206.2.2.3 Guidelines and policies regarding:

a. General accessibility, work space, and work clearance.

b. Interchangeability.

c. Use of Mil-Standard parts and items within Government inventories (with respect to maintainability characteristics).

d. Circuit design techniques for fault detection and isolation.

e. Limitation of numbers and varieties of necessary tools. accessories and support equipments.

f. Number of personnel and skill levels.

g. Accessibility considerations of parts, test points, adjustments, and connections.

h. Testability of parts, adjustments, and connections.

i. Use of access panels for inspections.

j. Training requirements and needs.

k. Handling, mobility, and transportability.

1. Use of commercially available parts and Items, and off-the-shelf (OTS) equipment.

m. Inherent maintenance and maintainability characteristics of components to be used.

n. Inherent supportability considerations as mandated in the logistics support analysis (LSA) process (see Task 207).

o. Interface with computer-aided engineering and computer-aided design techniques.

p. Implications of fault tolerant designs (if applicable) on maintainability and general maintenance workload.

206.3 DETAILS TO BE SPECIFIED BY THE CA (reference 1.2.3)

206.3.1 Details to be specified in the SOW shall include the following, as applicable:

(R) a. Specification of particular design handbooks to be utilized .

(R) b. Specification of policies or guidance to be considered (inclusion of additions specific guidance or policies, deletion of certain guidance and policies in para 206.2.2.3).

(R) c. Information available from CA relative to constraints on system or equipment due to personnel, physical location, use environment, maintenance concept, etc..

d. Coordinated reporting requirements with LSA (see Task 207).

a. Identification of data items required (see 6.3).

TASK 207

PREPARATION OF INPUTS TO THE DETAILED MAINTENANCE PLAN AND LOGISTICS SUPPORT ANALYSIS (LSA)

207.1 PURPOSE . The purpose of Task 207 is to identify and prepare inputs for the detailed system or equipment maintenance plan and LSA. Those inputs will be based on the results of the tasks which make up the maintainability program. This is the task which effects coordination of the outputs of the maintainability program with the LSA.

207.2 TASK DESCRIPTION .

207.2.1 The inputs provided for the maintenance plan and LSA shall be based upon the broad operational And support concepts and requirements established by the CA and the results of Tasks 201, 205, 206. and other portions of the maintainability program.

207.2.2 A listing of the outputs and results of the maintainability analysis which impacts the maintenance plan and LSA shall be provided to the CA for approval. The listing shall be updated as the maintainability analysis proceeds and design criteria are established. Content and description of inputs to the maintenance plan and LSA shall be provided. Factors to be considered include:

207.2.2.1 Preliminary skill level and manpower needs (or constraints) related to; build-in, manual , semiautmatic test features; external test systems; and the levels of repair associated with the design.

207.2.2.2 Depth, Scope and frequency of maintenance requirements at each level of maintenance.

207-.2.2.3 Preliminary technical data required at each maintenance level.

207.2.2.4 Preliminary training and training equipment necessary for each maintenance level.

207.2.2.5 Preliminary facilities required at each maintenance level .

207.2.2.6 Preliminary special and general purpose support equipment and tools required at each maintenance level.

207.3 DETAILS TO BE SPECIFIED BY THE CA (REFERENCE 1.2.3)

207.3.1 Details to be specified in the SOW shall include the following, as applicable:

(R) a. Specification of particular maintainability program factors which will be considered as Inputs to the maintenance plan and LSA.

b. Coordinated reporting requirements with LSA.

c. Identification of data items required (see 6.3).

d Imposition of Task 205 as requisite tasks in the FSD phase.

TASK SECTION 300

EVALUATION AND TEST

TASK 301

MAINTAINABILITY/TESTABILITY DEMONSTRATION (MD)

301.1 PURPOSE The purpose of Task 301 is to determine compliance with specified maintainability requirements.

301.2 TASK DESCRIPTION

301.2.1 Maintainability tests shall be conducted on equipments which shall be identified by the CA and which shall be representative of the approved production configuration. A MIL-STD-471 or alternative test plan approved by the CA shall be used as a basis for MD. The maintainability demonstration tests may be integrated with other system/equipment tests, if approved by the CA. The MD tests shall Include evaluation of diagnostic capability fault detection and isolation as well as maintenance time and manhours characteristics.

301.2.2 An MD plan shall be prepared which shall include the following, subject to CA approval prior to initiation of testing:

a. Test objectives and selection rationale.

b. Justification, rationale and means for integrating MD with other system/equipment testing.

c. Identification of the equipment to be tested (with identification of the computer programs to be used for the test, if applicable) and the number of maintenance tasks to be applied.

d. Test duration and the appropriate test plan.

e. Test schedule. A testing start date and duration shall be selected that is reasonable and feasible, permits testing of equipments Which are representative of the approved production configuration, and allows sufficient time, as specified in the contract, for CA review and approval of each test procedure and test setup.

f. Scenario to be followed for the test. Include here the skill levels of maintenance personnel to be used in the test, the makeup of the test team and the internal team organization and test decision making authority of team members.

g. Ground rules with respect to such factors as: instrumentation failures; maintenance due to secondary failures; technical manual or support equipment usage or adequacy; personnel numbers and skill; cannibalization, maintenance Inspection; government furnished equipment usage; maintenance time limits.

h. The substance and nature of the data to be collected and its integration into the Data Collection, Analysis, and Corrective Action System, Talk 104.

i. Degree of CA participation.

j. Detailed test procedures shall be prepared for the tests that are Included in the PO plan. The test procedures should account for all the necessary resources, such as, prime equipment, support equipment, technical orders, and appropriate number of skilled personnel which are required for demonstrating operational maintainability.

301.2.3 The results of the test shall be prepared as a MD report.

301.2.4 Data collected as a result of the MD shall be used to update LSA date.

301.3 DETAILS TO BE SPECIFIED BY THE CA (reference 1.2.3)

301.3.1 Details to be specified in the SOW shall include the following, as applicable:

(R) a. Identification of contractual status of the MD plan and test procedures.

(R) b. Identification of equipment to be used for MD testing.

(R) c. Identification of MIL-STD-471, or alternative procedures to be used for conducting the MD (i.e., test plan, task selections, makeup of test team. skill levels, administration, etc.).

(R) d. Specific maintainability values acceptable (and, if desired, design goal values may be specified).

e. Coordinated reporting requirements for LSA (see Task 207).

f. Identification of data items required (see 6.3).

APPENDIX A

APPLICATION GUIDANCE FOR IMPLEMENTATION OF MAINTAINABILITY PROGRAM REQUIREMENTS

10. GENERAL

10.1 Scope. This appendix provides rationale and guidance for the selection and tailoring of tasks, and the specifying of details for the CA to fit the needs of any maintainability program, and identifies applicable data items for implementation of required tasks. No requirements are contained in this appendix.

10.2 Purpose. This appendix is to be used to tailor maintainability requirements in the most cost effective manner that meets established program objectives. HOWEVER, IT IS NOT TO BE REFERENCED, OR IMPLEMENTED, IN CONTRACTUAL DOCUMENTS.

10.3 USER. The user of this appendix any include the Department of Defense contracting activity, Government in-house activity, and prime contractor, or subcontractor, who wishes to impose maintainability talks upon supplier(s).

20. RELATED DOCUMENTS

DoDD 50O0.1	Major System Acquisitions
DoDD 5000.37	Acquisition and Distribution of Commerc ial Products (ADCOP) (P&L)
DoDD 5000.39	Acquisition and Management of Integrated Logistics Support of Systems and Equipment (P&L)
DoDD 5000.40	Reliability and Maintainability (P&L)
DoDD 5000.43	Acquisition Streamlining
DoDD 5010.12	Management of Technical Data (P&L)
DoD-HDBK-248	Acquisition Streamlining

30. TASK SELECTION

30.1 Selection Criteria.

30.1.1. A major problem which confronts all government and industry organizations responsible for a maintainability program is the selection of tasks which can materially aid in attaining program maintainability requirements. Today's schedule and funding constraints mandate a cost-effective selection, one that is based on identified program needs. The considerations presented herein are Intended to provide guidance and rationale for this selection. They are also intended to jog the memory for "lessons learned" to provoke questions which must be answered and to encourage dialogue with other engineers, operations and support personnel so that answers to questions and solutions to problems can be found.

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30.1.2 Once appropriate tasks have been selected. the tasks themselves can be tailored as outlined in the "Details To Be Specified By The CA". It is also essential to coordinate task requirements with other engineering support tasks, such as Integrated Logistics Supports, System Safety, Reliability, Test - ability, etc., to eliminate duplication of tasks, assure compatible schedules of integrated tasks, and to be aware of any potential effects, impacts , etc. on maintainability resulting from the activities of these other groups. For example, front end LSA analyses help frame the boundaries and goals for the maintainability program. Maintainability modeling and analysis (Tasks 201 & 204) have particular need to be consistent with and not overlap the LSA effort. Conversely, many of the 470 tasks (such as 203 and 206) provide data which must be fed into the LSAR to serve as a basis for support and personnel resource planning. Finally, the timing and depth required for each task, as well as action to be taken based an task outcome, are largely dependent on individual experience and program requirements. For these reasons, hard and fast rules are not stated.

30.1.3. Selection and tailoring of tasks, specifying maintainability requirements , addition of supporting details, and establishing CDRL requirements requires a balanced approach. The tendency to overtask and to acquire exten - sive delivered data results in unnecessary contractor efforts, increased contract costs and possible delays in the schedule. An extensive maintainability program requirement will not result in equipment meeting repair time quantitative requirements if the quantitative requirements were unrealistic in the first place. For this reason, it's important to insure that analysis and data are not duplicated among the LSA/LSAR, testability and maintainability programs. The emphasis on acquiring off-the-shelf commercial products and existing equipment meeting minimum form, fit and function requirements (DOD directive 5000.37) means that extensive maintainability requirements at all item levels are inappropriate. There is a common tendency to over control the contractor's efforts and to over require CA approvals of the maintainability program and effort. The contractor has the right to manage his own organiza - tion, to develop his own designs, and to manufacture equipment as he sees fit to do. The Government's approval and control requirements should be only that required to insure that acceptable maintainability is designed into the pro - duct.

30.2 Application Matrix Program Phases . Table A-1 herein provides general guidance, in summary form, of "when and what" to include in a Request for Proposal (RFP) to establish an acceptable and cost effective maintainability program. This table can be used to initially identify those tasks which typically are included in an effective maintainability program for the particular acquisition phase involved. The user of the document can then refer to the particular task referenced by the matrix and determine from the detailed purpose at the beginning of the task if it is appropriate to identify as a

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program task. The use of this matrix for developing a maintainability program is to be considered as optional guidance only and is not to be construed as covering all procurement situations.

30.3 Task Prioritization . The problem of prioritizing or establishing a baseline group from all the tasks in this document cannot be solved unless variables like system complexity, program phase, availability of funds, schedule , etc., are known. The maintainability program plan (Task 101) should always be considered for selection, however, total program complexity should be considered for determining the need for this task. Individual tasks may be cited without requiring a maintainability program plan.

30.4 Data Items

30.4.1 Contractor Originated Data . Each task may involve some form of contractor prepared plan, document, statement, list, form or data. If any of these are to be received by the CA they are deliverable items. Each separate identifiable data item must be included on a DD Form 1423 which must be included as part of the RFP and Contract.

30.4.2 DD Form 1423 Requirements . Each DD Form 1423 must refer to an authorized Data Item Description (DID) which can be found, listed by title in DOD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL). Tailoring of the DID to meet the specific data requirement is authorized (via block 16 on DD Form 1423). The CA should review all DIDs and assure, through tailoring, that the preparation instructions in the DID are compatible with task requirements as specified in the SOW. Each DD Form 1423 must also include a specific contract reference (e.g., SOW, para 5.2.1.3) that specifies and authorizes the work to be done for each data item. Also to be filled out are blocks establishing delivery dates, delivery destinations , approval authority, and approval procedures. Refer to governing directives for specific information.

TASK NO.	TASK TITLE	TASK TYPE	PROGRAM PHASE				OPERAT SYSTEM DEV (MODS)*
			CON-CEPT	DEMVAL	FSD	PROD	
101	Maintainability Program Plan	MGT	N/A	G(3)	G	G(3)(1)	G(1)
102	Monitor/Control of Sub-contractors and Suppliers	MGT	N/A	S	G	G	S
103	Program Reviews	MGT	S	G(3)	G	G	S
104	Data Collection, Analysis and Corrective Action System	ENG	N/A	S	G	G	S
201	Maintainability Modeling	ENG	S	S(4)	G	C	N/A
202	Maintainability Allocations	ACC	S	G	G	C	S(4)
203	Maintainability Predictions	ACC	N/A	S(2)	G(2)	C	S(2)
204	Failure Modes and Effects Analysis (FMEA) Maintainability Information	ENG	N/A	S(2) (3)(4)	G(1) (2)	C(1) (2)	S(2)
205	Maintainability Analysis	ENG	S(3)	G(3)	G(1)	C(1)	S
206	Maintainability Design Criteria	ENG	N/A	S(3)	G	C	S
207	Preparation of Inputs to Detailed Maintenance Plan and Logistics Support Analysis (LSA)	ACC	N/A	S(2) (3)	G(2)	C(2)	S
301	Maintainability Demonstration (MD)	ACC	N/A	S(2)	G(2)	C(2)	S(2)

TABLE A-1. Application Matrix

*Operational System Developments (Modifications)

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CODE DEFINITIONS FOR TABLE A-l:

S - Selectively applicable

G - Generally Applicable

C - Generally Applicable to design changes only

N/A - Not applicable

ACC - Maintainability Accounting

ENG - Maintainability Engineering

MGT - Management

(1) Requires considerable interpretation of intent to be cost effective.

(2) MIL-STD-470 is not the primary implementation document. Other MIL-STDS or Statement of Work requirements must be included to define or rescind the requirements. For example MIL-STD-471 must be imposed to describe maintainability demonstration details and methods.

(3) Appropriate for those task elements suitable to definition during phase.

(4) Depends on physical complexity of the system or unit being procured, its packaging and its overall maintenance policy.

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40. RATIONALE AND GUIDANCE FOR TASK SECTIONS

40.1 TASK SECTION 100 - Program Surveillance and Control

40.1.1 Structuring the Program Requirements (Identifying and Quantifying Maintainability Needs)

40.1.1.1 The elements of a maintainability program must be selected to meet needs identified by higher authority through documentation such as the Mission Needs Statement (MNS), the Decision Coordination Paper (DCP), the Program Management Directive (PMD), Program Management Plan (PMP). Activity Acquisition Decision Memorandum (ACM) and the results of early front end LSA efforts. Identifying and quantifying these needs rust be accomplished prior to release of in RFP for the appropriate acquisition phase so that task and requirements commensurate with the needs may be included in the RFP . The tasks and requirements which are included establish the framework for the continuing maintainability dialogue between the CA and the proposing contractors, one or more of whom will ultimately be selected to develop the hardware. It is essential to make appropriate analyses in determining maintainability needs.

40.1 .1.2 The MNS, DCP , PMD, PNP and ADM as amplified in the following postulated operational and deployment constraints and concepts represent the most fundamental statements of user needs:

a. Operating hours per unit calendar time.

b. System readiness and mission success objectives.

c. Downtime or availability constraints.

d. Mobility requirements.

e. Self-sufficiency constraints.

f. Manpower, skill a nd support constraints.

g. Reaction time requirements.

h. Operational environment.

I. Number and locations of operational sites.

J. Number of operational systems per site.

k. Deployment schedule.

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A proper understanding and assessment of these needs is critical to all subsequent program events, including those 'related to maintainability and maintenance planning. Basic maintainability requirements are derived through analysis of such stated user needs. These requirements address such subjects as diagnostic concepts, maintenance concepts, allowable downtime. skill level limitations, diagnostic and test time to restore system, direct manhours, per maintenance action, maintenance manhours per hour of operation, probability of fault detection, proportion of faults isolatable at a given level of maintenance, false alarm rate, and Impact of scheduled and preventive maintenance requirements.

40.1.1.2.1 Such requirements should be levied at the equipment level or at the system level , whichever is most appropriate. Furthermore, in consonance with the needs defined, appropriate requirements at organization, inter-mediate. and depot levels of maintenance should be included.

40.1.1.3 The system contractor generally is given system level requirements for contracted performance. As long as the requirement is given at the highest level of the system, flexibility Insofar as allocations to lower indenture levels are afforded, provided they balance out to achieve the system requirement. The allocation task Is discussed in Task 202.

40.1.1.4 The primary guideline for the development of specifications is as follows: If a qualitative or quantitative criterion is required and if it can be tested or verified, then state the criterion in the specification. In the evolution of specifications from needs, the wording must reflect definitively the nature of the requirements). Effort must be expended to eliminate the use of such vague wording as minimize, maximize. etc. The specification should contain the following:

a. Definitive statements with no ambiguity in wording. The statement, "The (equipment name) shall be packaged with plug-in modules (except for lapsed time indicators)" is more definitive than "The (equipment name) shall be packaged with plug-in modules to the maximum extent possible."

b. Realistic quantitative and qualitative requirements consistent with the state of the art and cost constraints.

c. Requirements which can be verified or demonstrated.

40.1.1.5 It Is the respons ibility of the CA. to ensure that the maintainability Inputs and requirements are submitted for incorporation into the legal contract documents. These inputs are as follows:

a. Quantitative and qualitative requirements.

b. Demonstration-and verification-requirements .

c. Specific maintainability tasks to be conducted (trade-offs, etc.) during performance of the contract.

d. Maintainability documentation requirements.

e. Maintainability task schedule.

40.1.1.6.1 The quantitative, qualitative, verification and demonstration requirements are stated in the CI specifications. The task schedule and documentation requirements should be stipulated as part of the SOW.

40.1.2 Maintainability Program Plan (Task 101).

40.1.2.1 The requirements for a maintainability program plan will normally apply to the development of all systems and equipment subject to validation or FSD.

40.1.2.1.1 As a rule, a scaled down program plan for concept, production and modification phases is In order. Tasks should be identified by necessity and the scope of each task structured to its need.

40.1.2.2 If a program plan is requested in a Request for Proposal (RFP), the contractor may be asked to describe, in as much detail as appropriate, how he plans to conduct the maintainability program. He should be asked to discuss how he intends to accomplish all of the applicable and essential tasks of the program defined in the tailored version of the standard. When there is a contractor's proposal for the Validation Phase, normally a preliminary maintainability program plan will be submitted to the CA. The contractor will then be expected to expand and modify the preliminary plan as necessary during the Validation Phase to produce the proposed maintainability program plan that will guide the maintainability program during the FSD. Since the maintainability program plan describes how the contractor intends to satisfy mission maintainability requirements, the plan is a factor in source selection.

40.1.2.3 The maintainability program to be called out must be consistent with the type and complexity of the system or equipment. Insofar as the interfaces between the maintainability program and other closely related programs or efforts listed in the standard, there must be sufficient coordination such that duplication of effort will be avoided. Further, the tasks to be called out must be tailored both with respect to type and scope to be appropriate to the needs of the particular procurement.

40.1.2.4 A maintainability program centers around the maintainability tasks and management procedures that will be utilized to control maintainability throughout a system's life cycle. Every program phase has different needs with respect to the composition and scope of its maintainability program. The primary objectives of a maintainability program are to ensure design adherence

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to Specified maintainability parameters in an environment of maintenance and support response requirements (constraints) and of lowest life cycle cost.

40.1.2.6 The CA should specify in its RFP the requirements for the conduct of a maintainability program. It is the responsibility of the CA to identify the requirement for a maintainability program and to monitor the contractor's maintainability program; it is the responsibility of the contractor to establish and maintain an effective maintainability program.

40.1.2.6 The contractor's response to the RFP should be evaluated by the CA to assure that the contractor understands and is responsive to the requirements, and to assure that the contractor has an effective, realistic set of resources and management tools to assure timely attainment of the requirements and demonstration of the attainment.

40.1.2.7 The tasks making up contractors plans should be consistent with MIL-STD-470. The plan submitted for review should reflect the contractor's understanding of the particular maintainability program and the system requirements and will describe his maintainability organization and techniques for maintainability analysis. The tasks, in other words, are defined by a tailored version of MIL-STD-470; the "how" reflects the contractor's understanding of the requirements and his capability.

40.1.2.8 The effectiveness of the maintainability effort is defeated unless the efforts within the program are completed In a timely manner in consonance with the overall design engineering milestones. All tasks should be scheduled to be completed time to be effective in the design-making process. To be effective, the maintainabililty organization should be in a position to recognize foreseeable problem areas, identify efforts required to investigate and correct these problems, and he timely with changes within the design phase. There must be an effective working relationship with design engineering established at the onset of the program and continued through Its conclusion.

40.1.3 Monitor/control of Subcontractors and Suppliers (Task 102). The RFPs for the validation, FSD, production and major modification phases contains system/subsystem/equipment requirements and some of the equipment will undoubtedly be designed and developed by subcontractors. Maintainability tasks, previously determined as necessary. will also be included in the RFP, and in turn must be normally levied by the prime (or associate) or intergrating contractor on the subcontractors. The CA must know that these necessary tasks and requirements are correctly understood and carried out by the subcontractors. This understanding is fundamental to meeting program needs.

40.1.3.1 The prime contractor' s maintainability program, hence, must provide controls for assuring adequate maintainability of purchased hardware. Such assurance is achieved through the following:

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a. Selection of subcontractors from the standpoint of demonstrated capability to produce a maintainable product.

d. Development of adequate design specifications and test requirements for the subcontractor produced product.

c. Developme nt of proper maintainability requirements to impose on each subcontractor.

d. Close technical liaison with the subcontractor (both in design and maintainability areas) to minimize communication problems and to facilitate early identification and correction of interface or Interrelation design problems.

e. Continuous review and assessment to assure that each subcontractor is implementing his maintainability program effectively.

40.1.3.2 Maintainability assurance requirements should be imposed an subc on-tractors and suppliers on the basis of the criticality of the hardware item being supplied. Similarly, the depth of these requirements should determine the mount of effort expended by the contractor to verify that the subcontractor is performing his assurance function adequately.

40.1.3.3 For suppliers of major components and subsystems, the prime contractor should evaluate each subcontracted item independently to determine the type of maintainability program needed. He should then impose appropriate requirements on-each contractor. Each major subcontractor should submit a maintainability program plan, and the contractor should monitor program implementation to assure compliance with the plan and to assess the timeliness and adequacy of individual tasks. The subcontract should contain surveillance provisions to permit such monitoring. This procedure places the prime contractor in a situation very similar to that of the CA in monitoring and evaluating maintainability program performances.

40.1.3.4 It is prudent to include contractual provisions which permit the CA to participate, at its discretion, in appropriate formal prime/subcontractor maintainability related meetings. Information gained at these meetings can provido a basis for follow-up action necessary to maintain adequate visibility of subcontractors' progress.

40.1.4 Program Reviews (Task 103)

40.1.4.1 Maintainability program reviews should be conducted throughout the product design cycle, in accordance with contract requirements, as an integral part of the system engineering review and evaluation program. The reviews are conducted so that particular aspects of the work or the entire system can be reviewed. These reviews should be specified in the SOW to ensure adequate

staffing and funding. Typically, reviews are held to evaluate the progress, consistency, and technical adequacy of a selected design and test approach, (PDR); and to determine the acceptability of the detail design approach, (CDR) before commitment to production. Review may. also be called for during the conceptual phase to determine general adequacy. Both the CA and contractor maintainability personnel should consider design reviews as major milestones. The result of the contractor's internal, and subcontractors design reviews should be documented and made available to the CA on request.

40.1.4.2 Reviews should be conducted from time to time. Early in the program the reviews should be held frequently, as the program progresses, time between reviews may be extended. In addition to more detailed coverage of those items discussed at PDRs and CDRS, the reviews should address progress on all maintainabillty related tasks specified in the SOW including logistic and support analysis assessments as they relate to the maintainability effort. Maintainability reviews should be specified and scheduled In the SOW.

40.1.4.3 Design Review (Conceptual Phase). The primary purpose of the design review during the conceptual phase is to make a choice from among alternative system design approaches that may have evolved during the design process.

40.1.4.3.1 The results of this first design review should include an understanding of the weak areas in the chosen design concept. A maintainability block diagram of the chosen design concept, showing major system elements should also result from the review.

40.1.4.3.2 There should be an overall system maintainability concept provided to ascertain that the elements of the system are assigned the necessary and proper General Design attributes which will satisfy the required characteristics.

40.1.4.3.3 The design review should also reveal information relative to the following:

a. Preventive and scheduled maintenance requirements and constraints.

b. Hardware, its configuration, and accessibility as it impacts on maintainability.

c. Necessary diagnostic and testing schemes.

d. Special facilities that may be required.

40.1.4.4 Preliminary Design Review . At this point, the preliminary system design is nearly complete and many component parts and assemblies will have undergone some development testing. Some of the maintainability influencing factors to be considered at this review are adherence to specifications, from,

fit, function, human engineering factors, packaging and compatibility with other specifications .

40.1.4.4.1 To estimate if the design will meet the maintainability requirement, a maintainability prediction must be Provided. Estimates of fault detection, diagnosis and support needs must be provided for the equipment. Such estimates should be made for all levels of maintenance activity as are required by the RFP. If improvement is needed, areas that require more attention should be identified. This is the point at which design decisions my be required as to redundancy versus rapid fault isolation techniques, or redesign of inaccessible areas versus a search for high-reliability parts. The latter is a typical example of the extensive interface between maintainability and reliability.

40.1.4.4.2 In analyzing the results of this design review, management should determine whether decisions made in the previous design review were valid, and how to plan the continuation of the design phase.

40.1.4.5 Critical Design Review . After changes as indicated in the previous design review are incorporated, the product has matured into the final stage. The purpose of the CDR is to assure that all the requirements have been met.

40.1.4.5.1 Nesting design requirements is the prime considera tion in the CDR. The results of the final maintainability prediction should be presented as should the final packaging design, the details relating to the design characteristics of fault isolation and detection, interfaces with support equipment needs, and impact on logistics.

40.1.4.5.2 Following the successful conclusion of the CDR, the design of the system or equipment is essentially complete and considered ready for prototype assembly and testing or production assembly and testing.

40.1.5 Data Collection, Analysis and Corrective Action System (Task 104). Data becomes useful only when assembled into manageable aggregates for purposeful evaluation, The underlying objective of a data system is to provide information by which to establish assessment of a system's maintainability performance. There is an inseparable relationship between reliability and maintainability with regard to frequency of failure (MTBF) and frequency of maintenance MTBN) as well as mean time to repair (HTBR) and the criticality of certain failure modes with the impact an various maintainability parameters. It is thus paramount that the maintainability data system interact with the reliability program and its data system.

40.1.5.1 Maintainability, testability and diagnostics data is collected throughout the acquisition cycle of the equipment. The data is derived from the following:

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a. Maintainability analysis.

b. Engineering test.

c. Maintainability demonstration test.

d. Mockups.

e. Users test.

40.1.5.1.1 The data collected from these sources is used as follows:

a. To provide logistics and support information.

b. To assess the adequacy of support resources:

(1) Technical manuals.

(2) Test equipment (including special and general support equipment, BITE, etc.);

(3) Training (including training equipment).

c. To determine personnel requirements.

d. To detect deficiencies in the system's or equipment's maintainability and provide a basis for corrective action.

a. To establish repair time histories for comparison and for use in prediction.

f. To determine compliance with specified maintainability, testability and diagnostic requirements.

g. To detect excessive amounts of or determine frequency of preventive maintenance time.

40.1.5.2 The data generated and reported should be adaptable to usage by both the contractor and the CA to aid in evaluation of equipment objectives or requirements. The data system should provide for the rapid retrieval of all maintainability data in the format required to provide valid comparisons of quantitative or qualitative results. At the same time the scope of the data system and its content should be commensurate to the needs of the acquisition program.

40.1.5.2.1 Examples of additional information which may be appropriate includes identification of:

a. failure symptoms.

b. corrective actions.

c. failed parts.

d. time to restore function.

e. maintenance manhours.

f. skill level of te st personnel and maintenance personnel.

40.1.5.2.1.1 Data Reports from tests should contain sufficient information to corroborate findings and assessments. Example as of information on which may be appropriate include:

a. Time and dote maintenance commenced.

b. Identification of system, equipment or assembly by use of appropriate designation.

c. Maintenance actions team to affect correction.

d. Methods of Fault Detection and Isolation utilized and the results of the diagnostic effort.

e. Circumstances surrounding the maintenance, with particular reference to any abnormalities noticed.

f. Entries to reflect the time expanded by the individual or crew (reported in actual clock hours).

40.1.5.2.2 Entries from the last item listed will be used to establish or verify the maintainability of the equipment reported. Further, they can be used to verify the distribution of maintenance times assumed in predicting the maintainability parameters.

40.1.6.8 A primary purpose of date analysis during the development and test - ing phases is to assist in design. The emphasis in such analysis is not so much on determining if the numerical maintainability requirements will be not by the time design is completed but rather on providing assessment and insight into areas of the design that may be deficient in maintainability. Early analyses also provide information inputs for planning the logistic support and person - nel requirements of a system.

40.1.6.4 Both engineering and qualitative analysis of the system or sub-elements should be initiated on each item which fails to comply with the

specified requirements. This consists of the determination of the causes leading to noncompliance and the determination of changes required in order to effect compliance with specified requirements .

40.1.5.4.1 Qualitative analysis consists of review of specifications, design drawings. and examination of prototype or production hardware. and other efforts required to adequately determine cause of noncompliance and to make corrective action recommendations, if necessary.

40.1.5.6 After the system enters its maintainability' demonstration, data analysis is required for verification purposes. Any unforeseen problems in maintainability can be detected. personnel and spares requirements can be reaffirmed, and necessary adjustments can be made. Fully operational systems may also require the imposition of a detailed data collection plan for a short period to meet the needs of technical development or to locate specific problems in a troublesome system.

40.1.5.6 The data collection system" should be integrated as much as possible with similar data collection requirements. The data system should be compatible with and capable of accepting data from other existing data systems called for in other program areas (i.e. Reliability, Safety. etc.).

40.1.5.7 Data collection systems to be used In maintainability prediction or assessment should be defined as early as possible, but not later than Valida - tion Phase and used during the FSD and operational testing.

40.1.5.8 Data collection for demonstration should receive preliminary plan - ning during the Validation Phase and should become firm in the MD plan prior to testing.

40.2 TASK SECTION 200 - Design and Analysis

40.2.1 Maintainability Modeling (Task 201). The systems engineering process is defined as the process by which input requirements from the user or CA are converted into output information which describes an optimum combination of system elements to satisfy requirements. The optimum decision is derived based on an iterative process which includes functional analysis, synthesis of alternative candidates. and evaluation. Selection of an optimum configuration for design or support in mot cases is based on life cycle cost (acquisition and support costs), performance characteristics relative to total cost effectiveness, personnel and support constraints. and system readiness objectives.

40.2-1.1 The utility of models to the design process is almost in direct proportion to equipment complexity. For example, a model is almost mandatory for design purposes for a radar system, but Is of, at best, marginal utility

for a small equipment such as hand held transceivers. Hence, contemplated complexity should be an important consideration in determining the need for and scope of this task.

40.2.1.2 Models are used in the deterministic process for the cost and perfomance parameters. A model is defined as a systematic, analytical process used to predict system parameters . The complexity, of the model may range from a simple functional flow or block diagram of few elements to a complex flow diagram depicting a total system operational flow to a mathematical form of relationship which relates system parameters to system performance. Models may be implemented either manually or through computer programming, and may specifically be used as a maintainability tool to perform allocations. predictions, design,, or support concept alternative trade-offs.

40.2.1.3 Maintainability Models are used to determine the effect a change in one variable has on acquisition or total system cost or maintainability or maintenance performance characteristics. The models should, when possible relate to or be consistent with cost and system readiness models and other appropriate LSA high level models. They may be utilized to determine the impacts of changes in fault detection probability, proportion of failures isolatable frequency of failure, mean time to repairs critical percentile to repair, maintenance hours per flying (or operating) hour etc.. The models may also be expanded and used to determine and evaluate the level of repair. The level of repair identifies not only the repair location, but the extent of maintenance permitted and the resources necessary to support the repair process. Care should be taken not to duplicate repair level- analysis done under the LSA effort. Instead, models should work in conjunction with the repair level analysis to determine the most maintainable, testable,, supportable and cost effective system available. Repair level analysts is normally a requirement called out as NIL-STD-1388-1. It is evident that such decisions must be made as an integral part of system design. The investments made during the development and production phases preclude or seriously inhibit subsequent reversal of repair-level decisions during tie operational phase. Design features incorporated to achieve logistics support objectives can be made at minimal cost to preliminary drawings specifications . They are much more costly when made to prototype and production hardware.

40.2.1.4 The model should be developed as soon as hardware definition permits, even though usable numerical Input data am not available, Careful review of even the early models can reveal conditions where management action may be required.

40.2.1.6 During the conceptual phase and validation phase of procurement, various design and support alternatives way be postulated and evaluated through use of models. The selected alternative establishes the baseline for eventual hardware fabrication and for operation and support policies. During FSD the models previously developed will be updated and used to provide

visibility as to progress toward attainment of specified requirements and design goals as well as to evaluate the consequence of engineering changes.

40.2.1.6 It is important that an operational maintenance plan or its equivalent be provided to the contractor. The operational maintenance plan is a description of the planned general scheme for maintenance and support of an item in the operational environment. The maintenance plan provides a practical basis for developing models capable of influencing design, layout, and packaging of the system and its test equipment and establishes the scope of maintenance responsibility for each level of maintenance and the personnel resources required to maintain the system. Operational maintenance policy concept and plan should come from the up-front LSA effort.

40.2.1.6.1 Such maintenance plans for the system are established as part of the LSA using available information, prior feasibility studies and knowledge of the support elements. Timing of LSA Task Elements will influence the availability of this information. It's essential that coordination be effected with LSA personnel attached to the CA in order to scope and define the information to be provided. These plans provide guidance for the definition of support requirements. Operational maintenance plans should include:

a. Projected levels and locations of maintenance.

b. Facilities deemed to be required at each location.

c. Support equipment and tools anticipated at each location..

d. Skill, levels, types, and numbers of personnel available at each location.

e. Supply considerations at each location.

40.2.2 Maintainability Allocations (Task 202). The contractor will begin the maintainability design process with one or in specific maintainability objectives or requirements that may be expressed in any one of a variety of ways; i. e., mean time to repair, ratio of maintenance hours to operating hours, maintenance manhours per hour of operation, fault detection probability, probability of fault isolation to a given level(s) etc.. As an aid to achieving system maintainability objectives, these must be translated into maintainability requirements for system components. This process is known as maintainability allocation.

40.2.2.1 Maintainability allocations Are performed for the following purposes:

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a. To provide guidelines to designers of individual Items making up a system or equipment so that the system or equipment meets specified maintaina bility requirements if designed in accordance with these guidelines.

b. To provide a procedure for maintainability bookkeeping based on a logical distribution of the overall maintainability requirements.

c. To provide a maintainability management tool to system contractors when several suppliers are involved.

40.2.2.2 Allocations can be made by the CA, by its contractors, or by some combination of both. If the CA is to perform the system Integrating function, the responsible Government Agency performs the allocation and includes the results as requirements in the separate contracts to the various subsystem contractors. For systems being integrated by a contractor, the integrating contractor is responsible for overall system maintainability; he will perform the allocation and assure that his subcontractors collectively meet the system contractual maintainability requirement. Each equipment or component contrac- tor (or subcontractor) is responsible for the allocation of his provided re- quirements or objectives to the lower tier levels of design or packaging over which he has cognizance.

40.2.2.3 Allocations need only be made to the level of hardware and mainten- ance which has a direct bearing on the value of the maintainability indices being allocated. If, for example, the mean time to repair at organizational level was specified as a requirement and no requirements were levied on inter- mediate and-depot mean time to repair, the maintainability allocation is per- formed only to the removable units at the organizational level of maintenance.

40.2.2.4 In the allocation process initial estimates of maintainability must be made for each affected Item. The estimates must be made in the same units of measure as the maintainability objective. The estimates may be derived from any of the following sources:

a. Predictions .

b. Data on similar components.

c. Experience with similar components.

e. Engineering estimates based on personal experience and judgment.

40.2.2.5 The allocation process should be Initiated as soon as possible in the early acquisition phases, for It Is then that most flexibility in trade - offs and redefinition exists. Another reason for starting early is to allow time to establish lower level maintainability requirements (system requirement allocated to subsystems , subsystem requirement allocated to assemblies , etc.).

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Also, the requirements mist be frozen at some point to establish. baseline requirements for designers.

40.2.2.6 After Awe lower level maintainability requirements are defined, they should be levied an the responsible equipment engineers (contractor and subcontractor) for all hardware levels. Without specific maintainability requirements which must be designed to, or achieved, maintainability becomes a vague and undefined general objective for which nobody is responsible. From another perspective, program progress can be measured by evaluating defined maintainability requirements at a given milestone/time period with what has actually been accomplished.

40.2.2.7 Allocation objectives, results and problems are to be covered in both PDR and CDR.

40.2.3 Maintainability Predictions (Task 2031. To assure that established requirements (and allocations) for system maintainability have been met, it will be necessary to assess the system's maintainability characteristics periodically throughout the development process. Prediction methods are used for that purpose prior to demonstrations using production hardware.

40.2.3.1 During the validation phase, the predicted maintainability of the various systems proposed to meet an operational need are critical factors in selecting the optimum course of action. Since a limited quantity of specific data is available in this phase, maintainability predictions are based largely on experience with predecessor systems and on prediction techniques applicable during the validation phase.

40.2.3.2 During the early design phase of FSD, maintainability predictions can be used to determine the Inherent maintainability characteristics-of the proposed system, the effects of proposed changes on maintainability, and the optimum trade-off of equipment characteristics. Predictions made during this phase are generally more accurate than those made in the validation phase, since more specific system Information is available. Because they are more accurate, the predictions obtained during early FSD should be used to upgrade earlier predictions and the processes used to obtain them. The following information is required to implement the techniques:

a. Maintenance concept.

b. Functional block diagrams.

c. Equipment theory of operation.

d. List of major equipment replaceable units.

e. Reliability estimates at the replaceable unit level.

f. Diagnostic concept and capability.

40.2.3.3 The detailed design prediction technique (applied midway during FSD) is appropriate once detailed functional block diagrams and a complete packaging philosophy are established for an equipment. The method performing the detailed prediction is similar to that of the early prediction technique , and they provide a continuous median for establishing and updating ability predictions for a developing equipment. The following information is required to implement the technique:

a. Maintenance and diagnostic concepts, including status panels, operator control panel layouts, built-in test equipment operation and capability, interface data, removal and replacement task definitions, mounting hardware arrangements, and accessibility details.

b. Functional block diagrams.

c. Equipment theory of operation.

d. Detailed parts lists and schematics or circuit diagram for Removable Units.

e. Reliability estimates at each removable unit level.

f. Removable unit sketches and drawings.

40.2.3.3.1 The information in the first five of the above items is similar to that required the early prediction. However, at this point, engineering judgments and assumptions will have given way to program decisions. Some of the equipment will be past the sketch phase and into a formal drawing cycle (last item). Decisions will have been made on suppliers and subcontractors, and in many cases, individual removable items will have been breadboarded and tasted.

40.2.3.4 The prediction procedure to be chosen must correspond to the maintainability parameters specified. MIL-HDBK-472 establishes several preferred prediction techniques for end Items of equipment and systems, for several parameters. These include techniques capable of Incorporating such testability characteristics and philosophies as fraction of faults detectable/isolatable, levels of ambiguity and troubleshooting concepts pertinent to various levels of system indenture. Other techniques may be found desirable. The types of data required for prediction purposes are dependent upon the predic - tion parameters and system level of interest and the level of maintenance for which this prediction is to be made. Techniques are also available for predicting scheduled and preventive maintenance workload.

40.2.3.5 The prediction task, which is iterative throughout the program and interrelated with activities such as reliability allocation and configuration analysis, should be specified by the CA during the validation and FSD phases to determine maintainability, feasibility and attainability. Predictions provide engineers and management essential information for day-to-day activities; in addition, they are important supporting elements for program decision-makers.

40.2.3.6 Predictions should be made as early as possible and updated whenever changes occur.

40.2.3.7 Maintainability predictions at any maintenance level become inputs to availability, logistics support, and maintenance engineering analyses.

40.2.4 Failure Modes and Effects Analysis (FMEA) (Task 204). A FMEA is used to ascertain information necessary for general maintainability design factors which relate to fault detection and isolation. Specifically, it relates to such activities as the determination and design of Indices of failure, placement and nature of test points, development of troubleshooting schemes, and the establishment of design characteristics to be ascribed to fault detection and isolation subsystems. The effectiveness and efficiency of fault detection and isolation are critical drivers of maintainability at organizational. intermediate, and depot levels of maintenance. Through its use, potential design weaknesses which can also impact safety and reliability may also be identified.

40.2.4.1 Engineering schematics, reliability and test data are used in the Implementation of a FMEA. Modes of failure and their effects on symptoms are identified such that fault detection, diagnostic and isolation design can proceed effectively.

40.2.4.2 In a FEMA, system, subsystem, equipment. and replaceable unit (whichever is appropriate to the maintenance level of concern) failure modes are established first. All significant failure modes must be identified, although those which have no effect or system operation or at very small probability of occurrence may be disregarded (if the failure will rat create a hazardous condition). Next the failure effects are established for each failure mode. A failure effect is defined as a loss or degradation or change of a function or output of the item to below specified values (system, subsystem, equipment, replaceable unit) due to a failure. Effects are described in terms of the manner in which item signals or outputs are displayed operationally or are provided to another item. A systematic review of the functional block diagram or schematic can be used to generate a list of effects by examining the following:

a. External item outputs - signals provided to other items.

b. Item outputs - signals output to operators.

c. Status and monitor panels - these often display important internal

item signals.

d. Other performance monitoring information.

40.2.4.3 The depth and scope of a FMEA is dependent on the maintainability requirements levied in the RFP and the complexity packaging and nature of the item undergoing procurement. An uncomplex equipment which his a requirement levied only on maintainability at the organizational level, and is envisioned to have, say five or fewer replaceable units at the organizational level, will require only a all scope FMEA to the depth of the removable units. For a more complex equipment which has requirements levied on maintainability at both organizational and intermediate levels and is envisioned to contains say 10 or more replaceable units at the organizational level, and each replaceable unit contains at least 10 subunits which am in turn replaceable at the intermediate level, a larger scope FMEA to the depth of the removable subunit is called for.

40.2.4.3.1 Care must be taken when specifying maintainability requirements to indicate whether they relate to organizational, intermediate, depot or to some combination of these as such requirements impact interpretations of what is required for the FMEA task.

40.2.4.4 FMEAs or related analyses may be called out as part of both reliability and safety program and program plans. Effort should be made to coordinate and integrate such analyses.

40.2.4.6 Because of the many and varied skills required to determine failure modes, effects, corrective action, etc., the FMEA requires Inputs from many disciplines: it is relatively unimportant which engineering group is selected the contractor to make the analysis as long as cognizant design engineers play a major part. What is important is the critical examination of the results by all disciplines which could utilize the knowledge brought forth by the analysis. It is therefore effective to review the analysis findings and uses to which they are applied as part of required scheduled Program Reviews.

40.2.5 Maintainability Analysis (Task 2051 . The maintainability program is directed to the Development of the maintenance capability required by the operational needs of the system through design actions. The maintainability Analysis is a key task. It has four main purposes: (1) to establish design criteria that will provide the desired system features, (2) to allow for design decisions to be made through the evaluation of alternatives and through the use of trade-off studies, (3) to contribute toward determining maintenance, repair and servicing policies and critical support determined to be instrumental to maintainability performance achievement,, and (4) to verify that the design complies with the maintainability design requirements. This task has signifi cant possibilities for overlap with LSA efforts, and should therefore be coordinated closely to insure consistency and prevent duplication. These must be

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scheduled to match the overall design development and other Program milestones. In order to plan a meaningful program, the contractor should be provided with a clear understanding of system level requirements and operating plans so that he can select the essential elements to achieve necessary availability and downtime objectives.

40.2.5.1 The analysis task requires as inputs, the maintainability requirements at all levels of maintenance and all available information regarding the maintenance policy concept and plan. The maintenance policy consists of the rules established for maintenance conduct who, where, how); the maintenance concept is the approach, selected at various levels of maintenance, to implement the policy and achieve the maintenance performance goals; and the plan is the detailed methodology for implementing the concept.

40.2.5.2 The maintainability requirements in many instances depend on the adequacy and efficiency of test and diagnostic system design. Hence, any analysis of maintainability should include corresponding analysis of test and diagnostic system makeup and design. There are several test and diagnostic system categories which may be considered:

a. Automatic hardware,external.

b. Automatic software, external.

c. Automatic hardware, internal.

d. Automatic software, internal.

e. Manual software.

f. Manual.

g. Semiautomatic (combination of manual and automatic).

h. Maintenance aiding and other diagnostic procedures.

(All of varying degrees of complexity. The term automatic indicates that the testing is performed without human intervention.)

40.2.5.2.1 Hardware test usually means that the input(s) to a system, subsysten. unit or subunit may be provided a stimuli and the output(s) monitored. The level of isolation may, therefore, be just to that item. Hardware tests may also encompass performance monitoring, utilizing normal functional inputs.

40.2.6.2.2 Software testing still requires stimuli and monitoring, but a pre-

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determined logical analysis is applied to the results of the input/output relationship and isolation is to a lower level than that in hardware testing only (given-the same input(s) and output(s)).

40.2.5.2.3 Internal, embeded test equipment or functions are usually re ferred to as Built-In-Test-Equipment (SITE). It is special-purpose equipment, designed in to perform specific self-test functions for a particular systems subsystems equipment or equipments.

40.2.5.2.4 External test equipment can be either general purpose or special purpose. General purpose equipment is built for general test functions on many equipments and include such items as signal generators, Meters. Scopes, etc.).

40.2.5.2.5 Manual testing is basically the utilization of standard commercial test equipment and some degree of 'trial and error" techniques and generally results in some unacceptable degree of indiscriminate substitution and making adjustments to attempt a quick fix. However, for a very staple or uncomplex equipment, it may be rest effective.

40.2.6.2.6 While the use of automatic test equipment my have associat ed with it some of the same resulting problems as mutual testing, it can perform more tests at much greater speed on more complex equipment.

40.2.5.2.7 It must be borne in mind that the normal operational indi-cations provided in a system also provide some degree of fault determination and isolation so that the starting point for fault location, particularly at the system level, is not zero.

40.2.6.2.8 The use of maintenance aids, including diagnostic routines, repair procedures, and maintenance historical data provide a powerful tool when combined with a test capability.

40.2.5.3 The following points must be kept in mind:

a. Test systems cannot be considered as an afterthought; they must be an integral part of the design.

b. Test systems often mean additional hardware and software above and beyond that required for the primary function.

c. Test systems are rarely perfect; there are faults which are not detected; there are faults which defy isolations there are identifications of units or subunits as faulty which are in fact operating properly. These quality characteristics impact the attainment of maintainability, and logis-tics support requirements and goals. In addition, the acquisition costs of such test systems are &-very significant portion of total system program cost.

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It is for these reasons that it is essential for the maintainability analysis to define both the composition and quality attributes of the design of the test system.

40.2.5.4 The trade-off studies which are-p erformed as part of the analysis are conducted at the system level to evaluate system options and at the design level as the basis for selecting from among candidate detail designs. It provides for the definition of resulting maintainability values as functions of acquisition, work support costs, design concepts, design details and maintenance policies.

40.2.5.5 The Maintainability Analysis should contribute towards determining the repair policy for the system. each subsystem and then for each assembly or component. This is essential as an input to LSA. It's essential that necessary coordination be effected with LSA personnel attached to the CA to both apprise them of such imputs and to avoid duplication of effort.

40.2.6.6 Valuable and necessary inputs to the maintainability analysis task are obtained from the following:

a. Reliability analysis and prediction.

b. Human factors studies which recommend skill levels and quantities of personnel required.

c. System safety analysis.

d. Cost analys is tasks.

e. Manufacturing process analysis.

40.2.6 Maintainability Design Criteria (Task 206). In order to translate maintainability requirements and anticipated operational constraints into practical and effective hardware designs a broad spectrum of design criteria, standards, and policies, both general and specific must be defined and employed. Suggested criteria may be suboptimal and must be set within personnel and support constraints, and system readiness objectives.

40.2.6.1 As a result of all ocations, trade-offs, special analysis, and modeling, a firm basis is established for the selection of quantitative and qualitative design targets necessary to meet specification requirements.

40.2.6.2 General design criteria relate to the achievement of various goals or targets, for example:

a. To minimize downtime due to maintenance by using:

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(1) Maintenance- free design.

(2) Standard and proven design and components.

(3) Simple, reliable, and durable design and components.

(4) Fall-safe features to reduce failure consequences.

(5) "Worst-case" design techniques and tolerances which allow for us and wear over item life.

(6) Modular Design.

(7) An efficient integrated set of diagnostics from organiza - tional to depot levels of maintenance.

b. To minimize maintenance downtime, by designing for rapid and positive:

(1) Prediction or detection of malfunction or degradation.

(2) Localization to the affected assembly, rack, or unit.

(3) Isolation to a replaceab le or repairable module or part.

(4) Correction by replacement, adjustment, or repair.

(5) Verification of correction and serviceability.

(6) Identification of parts, test points, and connections.

(7) Calibration, adjustments servicing, and testing.

c. To minimize maintenance costs by designs which minimize:

(1) Hazards to personnel and equipments.

(2) Special implements for maintenance.

(3) Requirements for depot or contractor maintenance (unless proven to be most effective).

(4) Corre ction rates and costs of spares and materials.

(5) Unnecessary maintenance.

(6) Personnel skills.

d. To minimize the complexity of maintenance by designing for:

(1) Compatibility among system equipment and facilities.

(2) Standardization of design, parts, and nomenclature.

(3) Interchangeability of like components, material, and spares.

(4) Minimum maintenance tools, accessories, and equipment.

(5) Adequate accessibility, work space and work clearances.

e. To minimize the maintenance personnel requirements by designing for:

(1) Logical and sequential function and task allocations.

(2) Easy handling, mobility, transportability, and storability.

(3) Minimum numbers of personnel and maintenance specialties.

(4) Simple and valid maintenance procedures and instructions.

f. To minimize maintenance error by designing to reduce:

(1) Likelihood of undetected failure or degradation.

(2) Maintenance waste, oversight, misuse, or abuse.

(3) Dangerous, dirty, awkward, or tedious job elements.

(4) Ambiguity in maintenance in labeling or coding.

g. To minimize the frequency of tool failure by:

(1) Provision for solid seating of tools and, for uniform application of rotational force by ensuring adequate accessibility, work space, and work clearance around fasteners.

(2) Ensuring torque loads required to install and remove fasteners do not exceed the capability of required tools.

40.2.6.3 The design criteria must be developed to assist the maintainability analyst in the selection of maintainability quantitative design features to enhance the incorporation of optimum maintainability into the design of sys - tems and equipment.

40.2.6.4 System and equipment design criteria should be so structured that features which enable cost effective maintenance support throughout a deployed hardware life are considered in the design process. Some examples of maintainability design criteria which may be appropriate for some equipment programs are as follows:

a. All repair part items having the same part numbers shall be functionally and physically interchangeable without modification or adjustment of the items or the system or equipment- in which they are used.

b. Maintenance adjustment or alignment shall not be required.

c. Preventive (scheduled) maintenance requirements, including calibration, shall be eliminated.

d. Physical and functional maintenance access shall be provided to any active component upon opening or removal of access entries, and shall not require the prior removal or movement of other components.

e. Devices securing access entrances and maintenance replaceable items shall be the captive, "quick-release" type with positive locking features.

f. Special (system or equipment peculiar) tools shall not be required in the performance of user or intermediate level maintenance tasks.

40.2.6.5 Compliance with the criteria can best be determined by examining functional diagrams systems schematics, equipment packaging, form, fit and function, examination of technical orders, content of preliminary and critical design reviews, This process of confirming compliance with criteria should be continued through FSD and iterated as dictated by proposed changes during production.

40.2.7 Preparation of Inputs to the Detailed Maintenance Plan and LSA (Task 2071. Many of the results and outputs franc the maintainability program impact the development of the detailed maintenance plan and LSA. It is the purpose of this task to identify that relevant information and data developed under the maintainability program which relate to these. This task is essential to avoid duplication of effort and to provide for traceability of maintainability inputs used for maintenance plan and LSA development.

40.2.7.1 Depending on the nature and scope of the maintainability requirements and program plan (i.e., the figures of merit used to express the maintainability requirement (s); mean-time-to-repair, maintenance manhours per failure, etc. ,the maintenance level (s) at which the requirements are levied, or the acquisition phase) the quantity and types of information and data available as inputs to the detailed maintenance plan and LSA will vary from program to program.

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40.2.7.2 The detailed maintenance plan and LSA require such inputs as information relevant to maintainability design and characteristics, item layout and packaging and test subsystem design (BIT and external testing items) characteristics.

40.2.7.3 The following represent examples o f types of maintainability data which relate to the formulation of the detailed maintenance plan or LSA.

a. Packaging configuration as it relates to item maintainability.

b. Fault detection/isolation approach and characteristics.

c. The different-types of repair actions/replacements required for an item and its components at the various maintenance levels.

d. Scheduled maintenance required.

e. Results of maintainability predictions.

f. Test equipment and tools required for corrective/scheduling maintenance at each maintenance level.

g. Skill levels, types of personnel required at each maintenance level.

40.2.7.4 Portions of such inputs should be available prior to the start of FSD to guide the definition of support and logistic requirement, 101 inputs should be available during the FSD phase prior to the CDR.

40.3 TASK SECTION 300 - Evaluation and Test

40.3.1 Maintainability/Testability Demonstration (NO) (Task 301).
Maintainability demonstration is the process in which a test is conducted to show whether or not an item possesses satisfactory maintainability characteristics. The specific approach used can range from limited controlled tests to an extensive controlled field test of the product.

40.3.1.1 The requirements for formal MD tests should be introduced in the RFP. The SOW should specify details concerning the required nature, conduct and substance of the test(s) to be performed.

40.3.1.2 The CA should. determine the need, type and scope of this formal MD. The decision should be based on mission requirements, cost of tests, and the type of equipment being developed. A MD test does not guarantee achieving the required maintainability requirements however , it focuses the contractor's

attention on incorporation of maintainability features in the design. In some cases additional emphasis may be provided by including incentives in the contract.

40.3.1.3 The CA is responsible for supplying Information based on operational and other constraints, that provide a basis for defining the test procedures. As a minimum this information must include the maintenance philosophy, descriptions of the maintenance environments. the modes of operation for the test, and the levels of maintenance to be demonstrated.

40.3.1.4 MIL-STD-471 establishes uniform procedure test methods and requirements for the MD tests. In the event that none of the test are methods are appropriate to the demonstration in question due to unique equipment characteristics etc., alternative test methods should either be provided by the CA or solicited from the contractor.

40.3.1.6 The development of this task should start no later than the beginning of the FAD program. At this point, the plan should include, as a minimum, all of the information that is known about each of the following elements. It should be flexible enough to allow changes and additions as required.

a. Test Team.

b. Support Material.

c. Preparation Stage.

d. Demonstration.

e. Ground Rules for Test.

40.3.1.6 Specific dates for review by the CA should be established at the time the contract is awarded. Before the test' is conducted, the MD plan and detailed procedures must receive final approval of the reviewing activity.

40.3.1.7 The following provides guidance and Information with respect to the test team, its makeup and needs .

40.3.1.7.1 Test Team Function, Organizations, Makeup. The test team performs the demonstration and makes decisions relative to the information and data resulting from the demonstration. It is normally composed of personnel from the contractor and the CA. The team is usually organized into two major sections. The demonstration review section. which is responsible for the conduct of the test and for observation and interpretation of test results (it is of primary importance that CA personnel have representation in this section), and the maintenance section, which is responsible for the actual performance of the required maintenance actions. Members of the maintenance

section should be hardware oriented technicians with qualifications and skill levels equivalent to those of the personnel who will perform the post-deployment maintenance. Each task to be performed by the maintenance section should be performed with the personnel quantities prescribed for post-deployment maintenance. Where possible, it is desirable to have the members of this section composed of military personnel with prescribed training or specialities as required to support the equipment in the field.

40.3.1.7.2 If contractor personnel are used, the degree of experience and skill levels of such personnel should be defined .

40.3.1.7.3 If Government technicians are used, the training and indoctrination program should include the use of all commercial test equipment that will be used during the test and training on the equipment to be demonstrated.

40.3.1.7.4 Responsibilities. The responsibilities of the team members should be explicitly stated in the plan.

40.3.1.8 The following provides guidance and information with respect to ground rules which should be established for the demonstration.

40.3.1.8 .1 Ground Rules (For the Demonstration) should be established applicable to such items as:

a. Instrumentation Failures. These pertain to any failures of test instrumentation used to instrument the demonstration item for test purposes or the failures induced by such test instrumentation, their Installation or operation (and all maintenance time resulting from such failures).

b. Maintenance Due to Secondary Failures. T hese pertain to any secondary failures resulting from a chargeable primary failure, and the disposition of the total resultant maintenance time necessary to correct (restore the primary and its associated secondary failure(s)).

c. Inadequate Support Equipment. These pertain to the steps or actions to be taken in the event that in the accomplishment of a maintenance task, a technician finds the applicable support equipment to be inadequate.

d. Inadequacy in the Technical Manuals. Determination of chargeability of maintenance time in the event that an item is damaged, or maintenance error is induced due to improper, inaccurate or inadequate information contained in technical manuals (e.g., interchangeability of connectors).

e. Personnel Number and Skill Accounting. If personnel having different skill levels are required on an intermittent or sequenced basis, for a given maintenance task, how the manhours will be assessed against the maintenance task.

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f. Cannibalization. Wh ether or not, or under what conditions can maintenance associated with the removal or reinstallation of the item or support equipment assemblies or components for cannibalization purposes be chargeable.

g. Maintenance Inspection. Whether or not visual Inspection or any maintenance during pro-flight, post-flight, or any phase of a phased inspection shall be considered a preventive maintenance task.