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Systems Department

Test and Evaluation Report

Aviation Diagnostics and Maintenance (ADAM) System Preliminary Concept of Operation and Functional Description

by

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DTRC-91/017 Aviation Diagnostics and Maintenance (ADAM) System Preliminary Concept of Operation and Functional Description

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The Aviation Diagnostics and Maintenance (ADAM) System is an initiative to acquire, store, distribute, and use technical maintenance information for aircraft in a digitized, integrated, and task–oriented format. The initiative is consistent with DoD Computer–aided Acquisition and Logistics Support (CALS) direction and provides tools for Statistical Process Control (SPC) under Total Quality Management (TQM) concepts. While oriented toward new technology aircraft, segments of the concept have applicability to the existing Naval Aviation inventory.

ADAM consists of a maintenance system equipped with state–of–the–art hardware/software through which complete, current and consistent data will be made automatically available in electronic format to all maintenance technicians and production managers, thereby improving maintenance performance and unit readiness with reduced Life Cycle Costs (LCC). The ADAM system incorporates expert system diagnostic techniques, which interface with the aircraft's Built–In–Test (BIT) data, to generate subsets of optimized maintenance task information for fault isolation and repair processes. This maintenance task information will be available to the technician on both workcenter display devices and on portable display devices which can be used at the work site.

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ABSTRACT

The Aviation Diagnostics and Maintenance (ADAM) System is an initiative to acquire, store, distribute, and use technical maintenance information for aircraft in a digitized, integrated, and task-oriented format. The initiative is consistent with DoD Computer-aided Acquisition and Logistics Support (CALS) direction and provides tools for Statistical Process Control (SPC) under Total Quality Management (TQM) concepts. While oriented toward new technology aircraft, segments of the concept have applicability to the existing Naval Aviation inventory.

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This document has been developed to present the objectives of ADAM, and to describe the concept of operation as well as the functional requirements and physical characteristics of the proposed system.

ADMINISTRATIVE INFORMATION

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1. SCOPE

This document contains the concept of operation for the Aviation Diagnostics And Maintenance (ADAM) system. It describes the functional requirements, and the operational and support environments in which the system will function.

1.1 CONCEPT OF OPERATION

1.1.1 Problem Statement

Numerous problems have long existed in the way the Services have specified, procured, maintained and controlled their Technical Information (TI). Complaints dealing with incomprehensibility, errors, the lack of configuration management, the difficulty of dealing logistically with massive quantities of paper, and the inability to make timely corrections once errors are detected have been rife for decades. In addition, paper-based Technical Manuals (TM) are growing increasingly bulky, continue to lack the organization and referencing that a technician requires to find quickly the data he needs, and present complex maintenance procedures in terms which are poorly understood by technicians. The sheer weight and bulk of required paper TM have become significant problems for shipboard use. Existing nonstandard acquisition, update, and configuration management procedures which attempt to print, transport, stock, and issue large quantities of paper manuals have resulted in decreased maintenance effectiveness, with attendant deterioration of the level of readiness of fleet weapon systems. Moreover, paper TMs cannot be made part of a truly integrated logistic-support system available to a variety of users in real time, each of whom must contribute some critical function to an individual case of system maintenance. Recognition of these deficiencies in the TM system has resulted in a Department of Defense commitment to transition from a paper-intensive TM system to a highly automated and integrated mode of operation.

1.1.2 ADAM Functional Entities

The Aviation Diagnostics and Maintenance (ADAM) System is an integrated system, which combines aircraft maintenance functions into a single entity with information available to all participants simultaneously. It involves the acquisition, storage, distribution, and use of technical maintenance information for aircraft in a digitized, integrated, and task-oriented format. The initiative is consistent with DoD Computer-aided Acquisition and Logistics Support (CALS) direction and provides tools for Statistical Process Control (SPC) under Total Quality Management (TQM) concepts. While oriented toward new technology aircraft, segments of the concept have applicability to the existing Naval Aviation inventory. ADAM consists of a maintenance system equipped with state-of-the-art hardware/software through which complete, current and consistent data will be made automatically available in electronic format to all maintenance technicians and production managers, thereby improving maintenance performance and unit readiness with reduced Life Cycle Costs (LCC). The ADAM system incorporates expert system diagnostic techniques, which interfaces with the aircraft's Built-In-Test (BIT) data, to generate subsets of optimized maintenance task information for fault isolation and repair processes. This maintenance task information will be available to the technician on both work center display devices and on portable display devices which can be used at the work site. ADAM involves the following linked automated stations.

1.1.2.1 Debrief. The Debrief station is an essential part of post-flight debrief for both the pilot and maintenance technician. The processing of the BIT data, collected during flight, will be an integral function in the debrief station. Once the aircraft has completed its flight, the BIT data will be downloaded to the debrief station. The data will be analyzed and in-flight discrepancies generated. The pilot will also be queried to input any discrepancies he noticed during flight. Maintenance personnel will have the ability to generate discrepancies from information they receive after the aircraft has landed. From these observations and analysis, an automated version of the Visual Information Display System/Maintenance Action Form (VIDS/MAF) will be generated for use as input to NALCOMIS and to Maintenance Control.

1.1.2.2 Maintenance Control. Maintenance Control is empowered with complete control of maintenance and thus has the responsibility of monitoring flight schedules, aircraft mission configuration, Daily Time Sheets, updating the Aircraft Discrepancy Book, and assigning jobs to the various work centers, and monitoring the status of the maintenance actions. The ADAM system supports Maintenance Control with the information needed to monitor and control the status and availability of all of the squadron's aircraft at Organizational level (O-Level) maintenance.

1.1.2.3 Work Center. Work Centers are designated functional areas to which maintenance personnel are assigned. Typical work centers are airframe shops, jet engine shops, maintenance/material control, etc.

1.1.2.3.1 The primary job of the Work Center is to be responsive to the hour-by-hour maintenance situation. This requires constant communications between the Work Center and Maintenance Control. The ADAM system can relieve the Work Center supervisor of the majority of the communication burden. The ADAM system facilitates all of the needed communication tasks between the Work Centers and Maintenance Control. The following Work Center supervisor information exchanges with Maintenance Control are made much easier by ADAM:

- availability of skills (personnel) to perform maintenance tasks
- change in status of assigned maintenance (e.g., change from in-work to AWM and from in-work to AWP)
- anything which may affect the ability of the Work Center to maintain the systems assigned

1.1.2.3.2 In addition, the following work center tasks will be simplified by ADAM through facilitation or automation of the function:

- monitor and update the master Individual Material Readiness List (IMRL) of all Support Equipment assigned to the work center
- report availability of Support Equipment
- provide test equipment status
- initiate change requests
- assist in wall to wall inventory
- initiate surveys on IMRL items that are lost or unserviceable
- ensure functionality, completeness, and personnel familiarity with the application and use of all IMRL items
- ensure that all equipment requiring calibration (i.e., SE, PME, and TAMS) is identified under the MEASURE system and is submitted in a timely manner to the calibration coordinator
- ensure that the work center has up-to-date SE licensing in sufficient quantity to permit performance of its required functions
- support maintenance of Technical Manuals
- interact with the Planned Maintenance System (PMS) for controlling degradation of aeronautical equipment due to time, operational cycles, use, or climatic exposure

1.1.2.3.3 The Work Center supervisor is responsible for many other tasks. Each of the following tasks should be considered individually to determine whether or not it is advantageous to automate them:

- maintain a current list of QAR, CDQAR, and CDI that are assigned to the Work Center for the monthly maintenance plan
- assist QA/A in implementing the Maintenance Department/ Division Safety Program within the Work Center

- ensure that all aeronautical material is preserved, packaged, and handled by supply and maintenance personnel in such a manner as to prevent damage and deterioration

- assure the utilization of personnel training to the maximum benefit and to provide on-going training to personnel

- assign collateral duties to reduce the supervisor's workload

- supervise and coordinate the Corrosion Control Program, and ensure use and availability of the proper materials, equipment, current technical data and proper documentation

- administer an effective Foreign Object Damage (FOD) Prevention Program

- ensure required parts are stocked in the Pre-Expended Bin (PEB) by providing necessary documentation (the Supply Support Center (SSC), maintains the actual stock)

- prevent SE misuse/abuse

- administer the Hydraulic Fluid Contamination Control Program

- administer the Nitrogen Servicing Equipment Surveillance Program

1.1.2.4 Quality Assurance. Quality Assurance has two major areas of responsibility, inspection and collection of information. Inspections normally fall into one of the following categories: (a) receiving or screening inspections which apply to material, components, parts, equipment, logs/records, and documents; (b) in-process inspections which are QA functions that are required during the performance of maintenance actions where satisfactory task performance cannot be determined after the task has been completed; (c) final inspections which are QA functions performed following completion of a task or series of tasks.

1.1.2.4.1 Information collection is required to provide qualitative and quantitative analytical information to the Maintenance Officer (MO) to enable him to continually review management practices within the activity. The information collected will be used to make qualitative decisions with regard to aircraft/equipment material condition, readiness, and utilization. The information collected could be used to formulate recommendations relative to optimum utilization of human and material resources.

1.1.2.5 Logs and Records. Logs and Records provides administrative services for the maintenance department by:

a) Preparing maintenance-related correspondence which requires an executive action or attention by the Maintenance Officer or a higher authority.

b) Establishing and controlling a central maintenance reporting and record-keeping system for all correspondence and administrative reports.

c) Distributing messages and other data and implementing directives concerning administrative records and reports.

d) Properly distributing nontechnical information and publications, and the maintaining personnel assignment records for the department.

1.1.3 Related Maintenance Programs

Several recent Naval Air Systems Command acquisition programs have incorporated some elements of the ADAM system in their maintenance concept. Inasmuch as the ADAM system needs to interface with these efforts, a short description of some of these programs follows.

1.1.3.1 Naval Aviation Logistics Data Analysis (NALDA). Data relating to parts-life tracking is consolidated at the Intermediate Maintenance Activity (IMA) and up-lined to NALDA as the central repository.

1.1.3.2 Naval Aviation Logistics Command Management Information System (NALCOMIS). NALCOMIS is a series of software application programs developed and implemented in three phases under the concept of increasing aircraft readiness by providing local maintenance and supply managers with timely and accurate information. Phases I and II (Intermediate Level and Supply Support Center) implementation have been developed and deployed. Phase III (Organizational Level) implementation is imminent. The entire system will implement standardized local Aviation 3M source-data collection as a key component of centralized Naval Aviation maintenance management and accounting.

1.1.3.3 Enhanced Computer Assisted Maintenance System (ECAMS). ECAMS accepts data from the F/A-18 hosted Data Storage Unit (DSU) pertaining to engine, structure, and flight event data for batch processing and analysis.

1.1.3.4 V-22 Maintenance Analysis and Reporting System (VMARS). VMARS records maintenance data after each flight, which, when correlated with the aircrew debrief and aircraft maintenance history, will automate the identification of appropriate maintenance activity.

1.1.3.5 Parts Life Tracking System (PLTS). PLTS consists of a system which tracks those serialized components which need to be identified for life-cycle, warranty, inventory or configuration purposes. The PLTS, in addition to tracking components, must generate appropriate maintenance activity as a function of a variety of parameters, which among others includes time in operation for components such as Cartridge Activated Devices (CAD), cycles for components such as launch bars, and life used indices for components such as engines.

1.2 FUNCTION REQUIREMENTS

1.2.1 Problem Statement

The complexity of current and future Navy weapon systems such as aircraft makes the maintenance of these systems more difficult due to both component technology and interaction between components. Build-In-Test (BIT) can greatly improve the capability to identify system problems, but this has also created difficulties resulting from ambiguities in its results and tendencies of technicians to ignore BIT and trust their own experience. The expansion of BIT to mechanical and hydraulic subsystems increases the potential for both rapid solution and more confusion. To improve diagnostics, a better maintenance-data collection procedure is needed including both BIT and related environmental conditions. One problem is the lack of sufficient configuration management, which is due to the difficulty of collecting, maintaining and verifying large amounts of manually entered data. Current VIDS/MAF procedures require improved means of data collection. In addition, the organization that collects this data should be able to sort and analyze it as well as transmit it to others for integration with data gathered from other sources. The local data- analysis capability, coupled with easier data-gathering methods, will improve the quality of the data and will allow the maintenance organization to better gauge problems such structural fatigue. Other functional problems affecting maintenance also exist. Technicians are reluctant to report problems with technical manuals due to a perception that the system ignores their input. The tendency of technicians is to rely on memory rather than carry large and often out-of-date TMs to the worksite. Personnel need to be detached to schools to learn material and techniques for maintaining weapon systems rather than learn on the job. On-the-job learning requires simple and up-to-date maintenance and training information within each maintenance organization. The ADAM system will solve these problems.

1.2.2 Functional Solution

The ADAM solution to the above problems is to provide a unified system containing the required capabilities needed by the maintenance organization without altering in any significant manner the procedures that work today. BIT and other flight information needed for maintenance and stored electronically on an aircraft will be transmitted to the maintenance ground station (or central data server). Problems requiring maintenance will be turned into electronically displayed VIDS/MAFs and presented to the aircrew and plane captain during debrief for comments, changes or additions. This collected data can be used to update NAVFLIRS, aircraft logs, and 3M reports, as well as other higher echelon data. Much of the process, as well as others described below, will be transparent to those involved because computers will perform the tedious and often error-prone processes of collecting, transmitting, organizing and storing information. ADAM signals new gripes as well as existing gripes to Maintenance Control thru a computer-updated status board. Maintenance Control then assigns tasks to the various Work Centers. When a Work Center receives an assignment, ADAM will also provide both the VIDS/MAF and any background information available. This package of information would include pertinent TMs, maintenance history of the aircraft involved, configuration data on the aircraft, especially of components that may be the problem, and any testing procedures that would resolve ambiguities. This information would be integrated into the Interactive Electronic Technical Manuals (IETM) that present the information in guided instructions with pertinent graphics. Navy and Air Force tests performed with IETMs have shown that inexperienced technicians perform maintenance, including diagnostics, nearly as well as experienced technicians. ADAM must provide the capability to store, access, update and integrate the various data bases necessary using standard commercially available micro- and super micro-computers in a network environment. The ADAM equipment must be capable of operating in the shipboard aviation-maintenance environment. The Work Center must be capable of providing the technician all the information required on a small, lightweight, portable, battery-powered computer called a Portable Maintenance Aid (PMA) that he can carry with his tools to the work site. At the work site, the technician will record on the PMA, by reading electronic tags, all parts removed from and inserted into the aircraft as well as any diagnostic procedure performed. After completing his task, the technician will upload the PMA data at the Work Center; and this information will be available for review by Quality Assurance and for report preparation by Logs and Records. The former station will evaluate both the technician and procedures which could lead to recommendations for training or modification of specific maintenance processes. The Logs and Records station can keep accurate and current records and track components sent to other maintenance levels for repair.

1.3 OPERATIONAL AND SUPPORT ENVIRONMENT

1.3.1 Operational Environment

ADAM will be designed and fielded to operate on-board ship and in shore based units. ADAM must be modular and redundant in nature, simple to operate, reliable and accurate, capable of operating in a degraded mode, and provide the technician with a means of taking the maintenance information to the work site.

1.3.1.1 Modularity. Space and weight are two primary concerns aboard ship. ADAM will be designed to operate on equipment that is powerful yet compact, capable of being networked in a distributed environment and flexible enough to provide backup redundancy for other parts of the configuration.

1.3.1.2 Simplicity of Operation. The design of ADAM will be such that operation will not require extensive training. It will be menu driven and allow the novice maintenance technician to easily navigate through the displays presented.

1.3.1.3 Reliability and Accuracy. One of the problems facing today's technician is that the systems supporting him do not provide timely and accurate information. Data is collected by the technician and reported to higher echelons for processing, but the results are not returned in a timely enough manner to effectively be used for preventive maintenance. The obtaining of accurate configuration data is also a major problem facing the squadrons. In many cases the only way to determine accurately the configuration of an aircraft is to perform a physical inventory to determine the model, lot, and type of equipment installed. To resolve this problem, ADAM will provide the technician an automated means of collecting and inputing required data, along with immediate access and use of the data he collects. Because of the improved method and ease of data collection, it is expected that he will see a useful purpose for the data and be more cautious in ensuring the accuracy and timeliness of his reporting to both ADAM and higher echelons.

1.3.1.4 Operation in Degraded Mode. The standard mode of operation for ADAM will be in a networked environment, with all users sharing information with other work stations on the network. However, due to unforseen situations which may occur aboard ship, each segment of ADAM must be capable of operating in a degraded mode to individually carry out its primary functions. For example, a Work Center must be capable of continued operation during periods of interruption in the network or during a partial/complete power failure. ADAM must also be flexible enough to operate in a "stand-alone" manner to support aircraft or squadrons that are deployed from the parent unit.

1.3.1.5 Portability of Information. The ADAM system's primary function is to support the technician in his work site. To accomplish this goal, the technician must be capable of taking information, such as IETM's, to the location where the work will be performed.

1.3.2 Support Environment.

ADAM will be designed to provide information to the technician at the work site. ADAM will perform the up-line reporting of locally collected information to higher echelon systems in a manner which should be transparent to the technician. ADAM will be designed to input information to and receive information from such systems as NALCOMIS, ECAMS, and SAFE.

2. SYSTEM FUNCTIONAL REQUIREMENTS

2.1 GENERAL

The ADAM system will become the technician's primary information source for the accomplishment of all aircraft maintenance. The system concept is oriented primarily at the Organizational Level, but will be integrated with Intermediate and Depot Level maintenance activities. It will process, integrate, and display in a task-oriented format every piece of information required to operate, inspect, and maintain an aircraft and its associated support equipment. In addition, ADAM will provide the resources to automatically collect maintenance information as work is performed so required maintenance reports can be generated requiring little additional keying of data by technicians. Some of the areas that have to be specifically addressed include:

1. Aircraft Built In Test,

2. Maintenance Action Functions, and

3. Naval Aviation Maintenance Program.

2.1.1 Aircraft Built In Test (BIT)

The ADAM maintenance concept will rely extensively on WRA/SRA Built In Test (BIT) collected during flight. BIT information will be downloaded into the ADAM System. Appropriate maintenance activity will be based on this BIT data correlated with aircrew observations. To reduce system false removal rates, the expert system knowledge base will be routinely updated by the CFA based on the analysis of the subsequent maintenance history of WRA removals, the recorded BIT data, and the diagnostic expert system trace which formulated the maintenance removal action.

2.1.2 Maintenance Action Functions

To process, integrate, and display in a task-oriented format every piece of information required to operate, inspect, and maintain an aircraft and its associated support equipment, the basic functional requirements of the ADAM Ground Station consist of the following:

1. Provide the interface with the aircraft's maintenance data storage device.

2. Separate the engine data; process the engine's Life Used Indices (LUIs); generate appropriate maintenance activity based on the recorded flight data; compute the remaining engine life from LUI data and project engine removal requirements; transfer this data through appropriate collection

activities in magnetic media or through networking to the Central Tracking Facility (CTF) and Navy life tracking data base facility (NALDA).

3. Separate the structural life monitoring data; process the data and generate appropriate maintenance activity based on the recorded flight data; transfer this data on magnetic media in a format compatible with the Structural Analysis and Fatigue Effects (SAFE) system at NADC.

4. Process BIT data; correlate this data with aircrew debrief information and the aircraft's maintenance history; and through expert system techniques generate appropriate maintenance activity with the associated Visual Information Display System/ Maintenance Action Form (VIDS/MAF) for each fault identified.

5. Store the historical flight and VIDS/MAF data for each aircraft and reformat as appropriate for transfer via magnetic media or through local networking to the Naval Aviation Logistics Command Management Information System (NALCOMIS).

6. Host and display all IETMs in workpackage format, with the ability to download appropriate workpackages to a PMA, or to a local printer for hardcopy, either of which could be used by O-Level technicians in the conduct of flight line, flight deck or hangar deck maintenance.

7. Host an expanded expert system and associated diagnostics data base.

8. Integrate the expanded diagnostics data base with the IETM's to resolve fault detection/isolation ambiguities, and identify appropriate workpackages properly sequenced for any additional fault isolation with all related corrective maintenance procedures.

9. Perform on-aircraft expanded diagnostics procedures based on the expanded diagnostics fault isolation techniques to resolve fault isolation ambiguities which could not be resolved from the post flight BIT data.

10. Interface with the I-Level Consolidated Automatic Support System (CASS).

11. Interface with the local Supply Support Center.

12. Provide for the display of all appropriate technical information, production control and maintenance coordination in each work center; provide interfaces for work center PMAs.

2.1.3 NAMP Related Functions

Additionally, the system will provide basic process control and maintenance management functions which essentially automate the existing paper-based Naval Aviation Maintenance Program (NAMP). These processes include the following:

1. Configuration management; automated Serial Number Tracking (SNT) of appropriate components and installed software by aircraft Bureau Number.

2. Life-cycle component management; automated tracking of appropriate components for expenditure of warranty or service/repair cycle life indices.

3. Weight and Balance; automated tracking of aircraft stores/component configuration and calculation of the corresponding aircraft weight and balance.

4. Maintenance Data Collection and Reporting; automated collection, processing and validation of Aviation Maintenance and Material Management (3M) data, all associated aircraft and component logbooks, and additional related maintenance data from other appropriate sources.

5. Performance data; automated collection and processing of appropriate aircraft Built-In-Test (BIT) data with associated diagnostic expert system traces for use by the Cognizant Field Activity (CFA) in the validation and update of aircraft and ADAM System diagnostic expert system knowledge-bases.

6. Maintenance and Material Management; provisions for production/process control and appropriate statistical data analysis.

7. Security considerations; provisions for processing and storage of classified data through the use of TEMPEST certified hardware, data partitioning, removable media, encryption and other appropriate procedures.

8. Naval Flight Record Subsystem (NAVFLIRS); automated collection, processing and validation of NAVFLIRS data.

9. Maintenance training management; automated self-paced training and tracking of maintenance qualifications and training records.

10. Maintenance administration; automation of the various required paper products (messages, letters and reports).

11. Appropriate connectivity for data transfer in both directions between central (up-line) Navy data bases and all individual unit/reporting activity data bases.

2.2 SPECIFIC FUNCTIONS O-LEVEL

2.2.1 Debrief

The ADAM maintenance concept is based, in part, upon correlating aircrew debrief data with the aircraft BIT data, which will be down loaded from the aircraft via a 1553 bus. During pilot/aircrew mission debriefings, ADAM will function as a data collection unit and technical analysis expert system for fault reporting and fault isolation. It will accept, correlate, and analyze manually input aircrew-observed symptoms, as well as read and analyze in-flight failure information from the downloaded BIT data. It will use this information to identify probable failures, resolving failure ambiguities, insofar as possible, based on the diagnostic knowledge base and aircraft maintenance history. The output of this process is the production of a digital Visual Information Display System / Maintenance Action Form (VIDS/MAF) that will identify appropriate maintenance activity to be performed on the aircraft. For the purposes of serving as an electronic Aircraft Discrepancy Book (ADB), the system will display the last ten flights of historical data for each aircraft. The VIDS/MAF will be displayed on the PC monitor, or optionally printed out to form a hard copy. This functional module would, of course, be used by all maintenance personnel to generate appropriate maintenance activity and produce the associated VIDS/MAF. ADAM will also access the aircraft historical data base and compare debriefing information with historical data to identify unusual parts usage, repeat discrepancies, and other similar trends. Appropriate portions of the debriefing information will then be compiled, reformatted, and added to the stored historical data base.

2.2.1.1 Aircraft. The interface with 1553 bus and subsequent processing of the BIT data in conjunction with the aircrew debrief is a basic requirement upon which the entire ADAM system concept is based, however, the system must have the capability for manual generation of maintenance actions in instances of unavailability and/or loss of BIT data or operational requirements (the system must be flexible enough to be fully functional with or without either aircrew debrief data or BIT data, and neutral to the sequence in which such data is input).

An important consideration, which is particularly critical during time sensitive carrier operations, is the definitization of exactly how and by whom the data is downloaded from the aircraft to the ADAM system. For the purposes of this document, it is assumed that the aircraft BIT data will be downloaded to a PMA via the 1553 interface by the aircrew. The PMA would be taken to the aircrew debrief station or to a flight deck or flight line interface to be downloaded into the ADAM system. The PMA might additionally be used to upload on-aircraft expanded diagnostic procedures to resolve fault isolation ambiguities which could not be resolved form the post flight BIT data. Subsequently, the BIT data resulting from these expanded procedures would be downloaded to the PMA and taken to the debrief station for upload to ADAM and subsequent analysis for appropriate maintenance action.

2.2.1.2 Aircrew. Typically, from 1 to 6 aircrews may require debriefing, which will, in general, take place in the squadron maintenance control area.

2.2.1.3 NAVFLIRS. This requirement is derived from the concept of automating the aircrew input, and subsequently providing for the processing, validation and upload to NALCOMIS of all NAVFLIRS data. Accumulated flight time data is also central to the maintenance history and component life tracking data bases. The requirement consists of the collection of standard NAVFLIRS data elements selected largely from standardized menu options with provisions to accommodate the input of flight schedule/air plan data from ready room personnel in advance of the postflight aircrew debriefing. Provisions to output hard-copy for aircrew logbooks would also be required. Connectivity required to upload this data to NALCOMIS and/or the CFA is also included in this requirement.

2.2.2 Maintenance Control

Through its information system and its ability to interface with other information systems, ADAM will provide all production control tools required by the maintenance community in assessing needs, planning maintenance schedules, assigning tasks, recording maintenance actions, analyzing maintenance performance, tracking maintenance resources (personnel, parts, equipment), performing various administrative functions, and generally improving communication and coordination throughout the maintenance structure.

2.2.2.1 Task-Oriented Maintenance. Based on the debriefing activity, the ADAM system generates a complete, accurate, and consistent set of technical data in work package format to accomplish every task required for each identified maintenance action. The devices used to access/display this information will vary according to the action being performed and the level of maintenance required. The ADAM system will aid in the assignment of personnel, predict the repair time and, as part of the automatically generated task package, specify the parts, tools, and test equipment the technician(s) will need to complete the task. At the organizational level, it is envisioned that technicians would primarily use the Portable Display Device, while supervisors and schedulers would use standard micro-computer workstations. At the intermediate or depot levels standard micro-computers would likely be the primary display device, although there may be a requirement for some amount of paper products, particularly large scale graphic material at the depot.

2.2.2.2 Periodic Maintenance. ADAM will also provide Task Packages for the performance of routine, periodic maintenance on the aircraft and its support equipment. These packages will enable the technician to operate, inspect, test, checkout, service, adjust, align, calibrate, remove, replace, rebuild, overhaul, recover, jack, refurbish, lubricate, disassemble, install, clean, paint, prime, coat, handle, ship, fabricate, manufacture, make safe, purge, tow, and perform other tasks as required.

2.2.2.3 Maintenance Analysis. ADAM will have the capability to receive, sort, file, and analyze raw data generated by daily maintenance activities. From this data it will be able to generate one-time or recurring studies, summaries, briefings, and reports tailored for the desired application and formatted so as to be readily understood by the intended users.

2.2.2.4 Quality Assurance. ADAM will also enhance the performance of quality maintenance. It will act as a self-inspection and quality assurance (QA) tool to assess and record aircraft/equipment condition and personnel proficiency. It will review the data collected from maintenance actions and QA inspections, and analyze the information to identify instances of poor maintenance as well as pinpoint the underlying causes. It will also aid QA personnel in identifying, analyzing, and correcting faulty technical procedures or diagnostic routines.

2.2.3 Configuration Management

The requirement for an effective and automated process of both local and centralized configuration management is fundamental to the concept of automating the current fleet aviation maintenance process. Included in this requirement is tracking by Bureau Number those serialized components which will be identified for life-cycle, warranty, inventory or configuration purposes. In addition to the more obvious aircraft components and installed software such as the Operational Flight Program (OFP) and all imbedded avionics Test Program Sets (TPS), are component structural Non-Destructive Inspection (NDI) data and Radar Cross Section (RCS) data which are newer and non-traditional configuration management requirements. The requirement also includes the identification of an effective means of readily and accurately identifying each component, to the extent of examining alternative and newer technologies to today's ubiquitous Code 39 bar-code, as well as identifying the additional hardware requirements to support this process, i.e., bar-code or microchip printers and readers. An optimum solution would be for the aircraft to keep track of its own configuration with an imbedded electronic inventory management process. From a fleet maintenance perspective, it is also a basic requirement that the configuration management process must be such that routine wall-to-wall inventories of the entire aircraft through the use of Aircraft Inventory Records (AIRs) upon each transfer and acceptance must be eliminated. This Fleet requirement dictates a process with high validity to establish a continuous chain of accountability for specific equipment and material installed on or designated for use on the aircraft. Implicit in this requirement is that of the development of appropriate interfaces and protocols to establish connectivity (batch processing) for the transfer of data to and from a central Navy repository for Serial Number Tracking (SNT), i.e., NALDA and/or the CFA.

2.2.3.1 Configuration Support. ADAM will assist the activity in managing aircraft system configuration to insure the weapon system is mission capable and correctly configured for the assigned mission. Following each mission, ADAM will update aircraft current configuration and health. This capability information will be available to mission planners, allowing time to adjust mission parameters or plans to best accomplish the next mission. This information will also aid technicians in assessing what maintenance, if any, is necessary to return the aircraft to fully mission capable status.

2.2.3.2 Weight and Balance Data. The requirement is to automate the calculation of each aircraft's Weight and Balance as a function of stores/fuel/configuration, thereby ensuring that no flight is attempted in which a combination of stores/fuel/configuration generates a gross weight and/or center of gravity relationship in excess of that allowed for safe flight.

2.2.4 Life Tracking

Life tracking is, to some extent, a subset of configuration management. The fundamental requirement is to provide automated tracking of all components which have life limits, warranty provisions, installed service intervals or conditional inspection intervals expressed in some cumulative measure of operating time. Within this functional category is a specific requirement to provide data for the Navy Structural Analysis and Fatigue Effects (SAFE) program at the Navy Air Development Center (NADC), therefore, life tracking consists of the following four functions:

1. Local Structural Life Monitoring,
2. Parts Life Tracking,
3. Engine Life Tracking, and
4. RCS/NDI Tracking.

2.2.4.1 Local Structural Life Monitoring. In view of the requirement to track RCS and NDI on a real time basis, the entire concept of monitoring structural life only through the NADC SAFE program must be reevaluated. Inasmuch as SLM data exists in digital format in the aircraft, there are benefits to be derived at all levels of fleet maintenance by processing such data at the organizational activity with the ADAM system, thereby providing Fleet and Type Commanders with the analytical tools to manage the expenditure of community airframe life on a real time basis, and providing the CFA with actual analytical age determination data. Furthermore, it would be extremely beneficial if SLM data were to capture hard landing and other events which require conditional maintenance inspections. By processing SLM data in the ADAM system, organizational activities would be provided with automated tools to ensure that all airframe over-stress events are subjected to appropriate maintenance activity. A requirement also exists to develop appropriate interfaces and protocols to establish connectivity (batch processing) for the transfer of data to and from central Navy repositories for fatigue life, i.e., NADC, and/or the CFA.

2.2.4.2 Parts Life Tracking. This requirement consists of tracking those serialized components which will be identified for life-cycle, warranty, inventory or configuration purposes. The Parts Life Tracking System (PLTS) in addition to tracking components, must generate appropriate maintenance activity as a function of a variety of parameters, which among others includes time for components such as CADS, cycles for components such as launch bars, and life used indices for components such as engines. To meet Fleet objections regarding limitations in existing systems such as the F/A-18 Enhanced Comprehensive Asset Management System (ECAMS), a fundamental requirement is that the data be available for immediate on-line review and analysis at the appropriate Work Center, rather than be produced periodically in a paper-based batch process.

2.2.4.3 Engine Life Tracking. One of the more complex requirements is that of engine life tracking which must contain provisions for tracking individual engine components, all with potentially different accumulated Life Used Indices (LUIs). In other military aircraft, software has been developed to track engine component life usage and perform diagnostic analysis on engines based on data collected during flight. In-flight Engine Condition Monitoring (IECM) software normally gathers engine data and computes LUIs based upon algorithms supplied by engine subcontractors. Engine LUIs and various engine parameters are stored in non-volatile memory, downloaded to the maintenance Data Storage Device, and finally uploaded into the ADAM system for processing. The ADAM system will host and execute the PLTS based on LUI data and perform any appropriate trend analysis based on engine sensor data. Additionally, the Ground Station must reformat such segments of this data as appropriate and provide the connectivity with the NALDA and/or CFA data base. This connectivity is achieved through the generation and shipment of magnetic media or through on-line data transfer. Conversely, ADAM must be able to accept baseline data from NALDA and/or the CFA and reformat such data as appropriate for use in locally tracking installed engine associated life limited components.

2.2.4.4 RCS/NDI Tracking. Aircraft with low observable characteristics may present new requirements to track non-traditional structural life parameters related to Radar Cross Section (RCS) and composite structure Non-Destructive Inspection (NDI) results. The requirement to track RCS would consist of developing software which will generate normalized RCS indices for each aircraft from the actual RCS measurement baseline. These indices would be continuously updated through algorithms based on time and/or environmental related factors, the cumulative effect of all structural maintenance repair activity, and each aircraft's physical configuration as appropriate. A requirement would also exist to convert between these normalized indices and the actual RCS in an appropriate environment for processing classified information. The requirement to track NDI data stems from depot structural repair and age exploration analysis programs, and might consist of little more than adding those composite structural components which have NDI anomalies to the aircraft configuration management data base. The requirement also consists of the development of appropriate interfaces and protocols to establish connectivity (batch processing) for the transfer of data to and from a central Navy repository for RCS and NDI data, i.e., NALDA and/or the CFA.

2.2.5 Aviation 3M Data Collection and Reporting

This functional requirement is basic to the aviation maintenance process, ensuring that data generated by maintenance and material personnel is collected, processed and made available to efficiently and effectively manage maintenance organizations. Fundamentally, the requirement is to automate most, if not all, of the existing paper-based NAMP processes of Maintenance Data Reporting, Material Reporting, Subsystem Capability Impact Reporting, and Utilization Reporting. Provisions to produce hard-copy of some of the source documents will have to be accommodated, particularly where full electronic connectivity does not exist, i.e., the VIDS/MAF documents accompanying a component turned into a supply support facility. Similarly, some documents which deal with acceptance or certification, i.e., the Aircraft Inspection and Acceptance Record, will, in all probability, continue to be paper. The requirement consists of a number of elements:

1. The requirement for the automated processing and validation of all Aviation 3M data, with provision for producing a hard-copy Aircraft Discrepancy Book (ADB).

2. The requirement for the automated update, processing and validation of aircraft logbooks (aircraft, engines and APU), and all associated records and cards (acceptance, service, inventory, history, configuration, inspection, removal, repair, rework, assembly, etc.), with provision for the production of the hard-copy thereof.

3. The requirement to automate the management of scheduled and unscheduled maintenance activities, e.g., automated maintenance control and Work Center VIDS management displays with provisions for producing hard-copy monthly maintenance plans.

4. The requirement to automate the process for management of aircraft status and mission capability reporting.

5. The requirement to automate the process of ordering parts and material, and the tracking, accounting and reporting of Budget OPTAR.

6. The requirement for access to appropriate segments of the Aviation 3M data base for ad hoc query (by trained personnel) to accommodate a full spectrum of local validation and analysis, with options to export the results

thereof to hard-copy or appropriate graphics, word processing and spreadsheet software.

2.2.5.1 Maintenance Data Collection. The interactive computer capabilities of ADAM will aid the technician in recording maintenance information for the Maintenance Data System (MDS) under the Naval Aviation Maintenance and Material Management System (3M). The technician and the computer will combine to collect all information required. During task performance, ADAM will select and store selective pieces of information; i.e., serial numbers, work unit codes, system/subsystem operating times, part numbers, malfunction codes, and repair codes. ADAM will also collect either automatically, or through prompts to the technician, additional information such as user identification code, skill level, job control number, crew size, and work center number. ADAM will automatically prompt technicians for QA verification which will be collected as conducted. ADAM will have an internal clock which will allow it to keep a record of the time required to complete a maintenance task. ADAM will prompt the technician for the review and validation of recorded information upon completion of a task. The system will be capable of performing validity checks of the information as it is collected. At the ADAM workstation, the information will be automatically formatted for storage in the activity's master ADAM data base.

2.2.5.2 Maintenance History. In addition to the storage and display of 10 flights of historical data per aircraft for an electronic Aircraft Discrepancy Book (ADB), the ADAM system must provide for the storage, retrieval and display of 6 months of Aviation 3M data as each aircraft's maintenance history. Networking or other appropriate connectivity related to the upload of this data to NALCOMIS and/or the CFA, is also included in this requirement. An additional requirement is to provide an adequate validation process of each user's "Personal Identification Number (PIN)".

2.2.5.3 Other Maintenance Related Data. While the bulk of the relevant maintenance data will be collected through the automation of the Aviation 3M process, provisions to capture and store additional data elements, as appropriate, which will enhance the utility of the system must be identified and accommodated. Including data elements such as component Logistics Control Numbers (LCNs) and BIT Function Failure Codes will assist in relating various data bases and thereby expand the ADAM System capability. The requirement is to identify those additional data elements which will optimize the analytical and relational potential of the ADAM System and incorporate a seamless process to automate the collection, validation and storage of this data.

2.2.6 Central Aviation Maintenance Data Bases

A critical interface requirement exists between the ADAM system and appropriate Navy central aviation maintenance data collection facilities, i.e., NALDA and NALCOMIS.

2.2.6.1 NALCOMIS Interface. Aviation 3M source data collection is a key component of centralized Naval Aviation maintenance management and accounting. The Naval Aviation Logistics Command Management Information System (NALCOMIS) was instituted to overcome a lack of timely, reliable management information resulting from a complex data collection process and poor quality of data reported upline. NALCOMIS will standardize local Aviation 3M source data collection and upline into the NALDA data base. Phase I and II (Intermediate Level and Supply Support Center) have been implemented. Phase III (Organizational Level) implementation is imminent. ADAM development will require coordination with the NALCOMIS Program Office to acquire appropriate technical interface documentation and schedules for NALCOMIS implementation. Interfacing ADAM and the NALCOMIS system presents a number of technical problems, and additionally, since the NALCOMIS program is not fully funded, ADAM development must be flexible enough to accommodate a variety of potential NALCOMIS hardware and software implementations and not become dependent on any specific configuration. The NALCOMIS plan is to provide a system meeting Government Open Systems Interconnect Profile (GOSIP) and Portable Operating System Interface (POSIX) standards with Navy standard systems (SNAP III) hardware in every Navy maintenance activity. The NALCOMIS Phase III implementation contains features and functions which to some extent parallel those envisioned for ADAM, and ideally (but not necessarily) to simplify supportabilty considerations, ADAM should be interfaced with and hosted on "NALCOMIS-like" hardware, expanded as appropriate to accommodate the additional ADAM unique features. ADAM should be viewed as a data collector for NALCOMIS. If co-hosted, ADAM and NALCOMIS software should operate seamlessly together. Alternatively, connectivity between ADAM and NALCOMIS would be achieved through electronic networking and on-line data transfer. Transfer of data through compatible magnetic media should also be available. In addition to providing the necessary interfaces, the ADAM system must reformat ADAM data into an appropriate NALCOMIS format prior to transfer and conversely, be able to process NALCOMIS data to populate the ADAM maintenance history data base.

2.2.6.2 NALDA Interface. The NALCOMIS data collection system uplines Aviation 3M data through the Naval Sea Logistics Center to the NALDA data base. Additionally, NALDA provides integrated O-Level, I-Level and Depot serial number tracking (SNT) through its Composition Tracking (COMTRAK) system. Flight Information and Recording Systems (FIRMS) that collect, process and analyze maintenance data generated during flight (i.e., ground stations such as ECAMS, MOMS, VMARS, ADAM, etc.) transfer component usage data to the COMTRAK data base in accordance with the technical requirements and standards of the Interface Control Document for Fleet and Depot FIRMS with NALDA (NA411-ICD-SNT1). The ADAM system will be required to transfer data related to component transactions and usage data to update the COMTRAK data base via the local Intermediate Maintenance Activity (IMA) either electronically or by magnetic media.

2.2.7 Maintenance Training

The requirement is to automate the management of the maintenance training and qualifications of all personnel assigned. Given the potential training capability inherent in the ADAM System with electronic technical manuals, the organizational activity requires a suite of software which will structure, evaluate and track individualized self-paced training. In concept, technicians would be able to download segments of the IETM data base into PMAs and through self-paced study achieve appropriate system maintenance qualifications.

2.2.7.1 Technician Proficiency Training. With the ability to access the entire system technical information data base including the diagnostic expert system rule base, ADAM will be an invaluable maintenance training aid. Additionally, it will serve as the technician's presentation device for computer-aided instruction within the activity's maintenance overall training structure. Intelligent training software packages with dynamic equipment simulations would allow the technician to learn new systems and try new techniques to maintain or increase proficiency in an environment where mistakes will not endanger themselves or the aircraft systems. The system would track and record training progress and thereby assist supervisors in planning/scheduling required training.

2.2.7.2 ADAM System Training. All personnel using ADAM will be required to complete some minimal formal training before being allowed to access the system either by some maintenance training school or unit training program, as appropriate. ADAM shall provide the capability for a user to learn how to use the system by practice on the system itself. It shall be able to accept training software, provide training management, and contain embedded help capabilities for hands-on training covering all aspects of the system. The user shall be able to use ADAM unassisted to accomplish his/her job after minimal system training.

2.2.8 Interactive Electronic Technical Manuals (IETMs)

Technical Manuals that document all maintenance procedures for each aircraft consist of text and figures that have fairly elaborate drawings to indicate details of the aircraft and provide guidance to maintenance technicians. There are various efforts in progress associated with validating the concept of placing these manuals into a computer based system and eliminating paper manuals in the field. The graphic features of present day computer systems makes this a viable option and costs associated with hosting this type of data are being reduced as better products become available.

2.2.8.1 Work Packages. It would be expected that the IETM data base and/or work packages would be distributed to individual activities in high density media, such as optical disks. The requirement will be to host an IETM data base and/or the electronic work packages assembled from this IETM data base and in conjunction with an expert system display these work packages at the work station or download them to a PMA thereby replacing standard paper technical manuals. Maintenance personnel would use the work center display device and/or PMA to obtain all relevant procedures, drawings or pictures to perform all fault isolation and corrective maintenance. These tailored work packages for any possible system fault would additionally serve as work center self-paced training aids.

2.2.8.2 Specifications. Draft DoD specifications and handbooks regarding the transfer, storage and presentation of electronic technical manuals have been prepared for the acquisition of IETMs.

2.2.9 Fault Isolation and Troubleshooting

The ADAM system will provide tecnnicians with comprehensive on-aircraft diagnostic procedures that will normally resolve any failure ambiguity remaining after completion of the aircrew debrief and analysis of the in-flight component failure information. ADAM will interactively guide the technician through the entire fault isolation and troubleshooting sequence from identification to restoration to checkout and documentation. Based on the results of the troubleshooting effort, the system's expert system will diagnose the failure, assemble and display all applicable information for repair of the problem. The diagnostics scenario includes explanation of diagnostic decisions, capability for the technician to override the computer's suggested actions, selection and presentation of the appropriate technical data, and the automatic recording of the technician's actions. ADAM will provide diagnostic tools to help in the detection and isolation of failed components. These tools, integrated within the supporting technical information, include historical maintenance data analysis and trending algorithms, diagnostic expert system software programs, and intelligent explanation facilities. Using all available information, ADAM will analyze the symptoms and related data and recommend a test or tests to isolate the failure. The isolation procedures may be troubleshooting instructions, test generation and monitoring, or remove and replace instructions, as appropriate. The technician has the option to request an explanation of system logic for suggesting one test over another, or overriding the recommended test and initiating another. The system will accept the manual input and present the necessary technical information to support the technician's option. The system will provide the capability to maintain and display a dynamic functional graphic presentation of a subsystem, its test points, and its components, as well as maintain a log of progress, actions, results, etc. taken in diagnosing/isolating the fault. When the fault has been isolated, ADAM will identify the probable causes, and provide complete instructions for repair. When there is insufficient data for a positive isolation of a fault, ADAM will provide data to best support repair based on the information available.

2.2.9.1 Enhanced Diagnostics. This feature expands the capability of the ADAM system through optimization of corrective maintenance actions based on an advanced diagnostics knowledge base. As detailed above, ADAM will generate the required maintenance action based on the BIT data taken during flight. The Enhanced Diagnostic concept would optimize maintenance activity based on modeling matured through historical data provided by the ADAM maintenance history data base. Data will be kept on each maintenance action and tracked to determine if the action correctly fixed the problem. In the event the problem was finally corrected through a different action, a record will be kept to serve as the basis for improving the diagnostic call-out of ADAM. The output of the Enhanced Diagnostics will be to mature the ADAM diagnostic process and the on-board expert system rules. Should the normal fault isolation process be unsuccessful in correcting the observed failure, ADAM will, if appropriate, after an analysis of all the results of all prior diagnostic efforts, generate an expanded aircraft systems diagnostic procedure which would be uploaded to the aircraft's on-board expert system using the PMA via the 1553 bus. This expanded diagnostic routine would be executed on-aircraft with the assistance of an additional set of procedures loaded into the technician's PMA. Results of this expanded on-aircraft process would yield a failure diagnosis and generate a set of complete instructions for repair. This expanded on-aircraft process is loaded only for the duration of existing test. It does not modify or become of the existing on-aircraft BIT.

2.2.9.2 Aircraft Damage Assessment/Repair. The ADAM system will have capability to function as the technician's aircraft damage assessment and repair aid. The technician would only have to input the location of the damage, and the damage assessment aid program will present a series of graphic displays of the structural members, wire bundles, hydraulic lines, mechanisms, and electronic components that reside in the damaged area. The system would then present functional test options to aid the technician in determining the extent of the damage, the degradation in mission capability, and an indication of the repairs required. These options would include quick checks to determine integrity or operability, system serviceability criteria, and data which would allow accurate assessments of the time, procedures, and resources required for repairs.

2.2.10 External Interfaces

2.2.10.1 I-Level. It seems clear that the efficiency of the I-Level fault isolation process would be improved with connectivity to the O-Level ADAM System, whereby the in-flight WRA/SRA BIT data which precipitated the WRA replacement at the O-Level would be passed to the I-Level in conjunction with the electronic VIDS/MAF. Furthermore, it is clear that the results of the I-Level fault isolation and repair process for each WRA removed at the O-Level must be analyzed to mature the diagnostic expert systems resident on both ADAM System and aircraft, as well as to identify "bad actor" WRAs (those whose in-flight failures are seldom duplicated during I-Level fault isolation).

2.2.10.2 Supply Interface. Among the potential benefits of connectivity are those related to the process of aircraft configuration management through the involvement of the supply support center in component serial number tracking, which might be nothing more than serving as an independent source of component serial numbers to be validated against those recorded by the O-Level work center technician.

Providing an interface between the O-Level Material Control and the local Supply Support Center is similar to the issue of providing an interface between the O-Level and I-Level maintenance activities. The connectivity benefits also seem clear, but the obstacles and potential costs associated with integrating these two systems requires further study as to feasibility and cost/benefit. Complicating this issue is the difference between ashore and afloat supply processes with an existing NAMP requirement to utilize the Shipboard Uniform Automated Data Processing System (SUADPS) aboard all CVs. SUADPS is separate and distinct from the NALCOMIS Phase II I-Level Aviation 3M System utilized both ashore and afloat, although it does utilize the Ethernet LAN installed on all CVs under the NALCOMIS Phase II SHIPALT.

Therefore, the requirement with respect to the interface between Material Control and site Supply Support Centers is as follows:

1. Determine the appropriate functional interface between the ADAM System and site Supply Support Centers, both ashore and afloat.

2. Determine the appropriate mix of additional hardware, software and connectivity interfaces both ashore and afloat to accommodate the introduction of the ADAM System (and associated maintenance concept) in the existing NALCOMIS/NALDA/SUADPS environment.

2.2.10.3 ADAM/CTF Concept. Recent integrated logistic support concepts include the implementation of a Central Tracking Facility (CTF) which networks contractor engineering and logistic data bases with program management and appropriate NAVAIR field activities for the purposes of digital data review and delivery. This same network is envisioned as a mechanism to collect and analyze appropriate ADAM digital data at the CFA for the purpose of improving the character of ongoing organic Navy engineering analysis and fleet support.

2.2.11 Operating Environment

Organizational Level maintenance must be performed in a broad range of environmental and operational circumstances, and therefore either the ADAM system must be sufficiently flexible to meet all functional requirements regardless of the operating mode or environment, or these maintenance functions must not be totally dependent on the reliability or availability of the system. For example:

1. Provisions for embarked environmental constraints.
2. Provisions for differences between embarked and ashore operating environments, detachment operations, etc., with respect system portability and connectivity.
3. Provisions for redundancy, data backup and graceful degradation of operation without loss of data or functionality.

4. Compatibility with current and projected systems.

2.2.11.1 Environmental. The carrier environment is, to be generous, harsh for a computer system. Environmental conditions unique to carrier operations must be addressed. By requiring that any potential system hardware be ruggedized, potential hard disk drive motion problems inherent in embarked operations will be overcome as well as providing for a wider temperature and humidity envelope. This requirement of ruggedized hardware is even more critical for the PMA where the environmental conditions are even more extreme, including the additional problem of complete material failure as a result of an accidental fall of a PMA from an aircraft work area onto a steel hangar deck or concrete ramp.

2.2.11.2 Power Requirements. The power problems that exist on all carriers are well documented. This limitation may require that both a power conditioning/isolation transformer and an uninterruptable power supply be incorporated as part of the ADAM system. While the initial cost of these units seem extreme, the problems and frustrations that can be avoided may be well worth the cost.

2.2.11.3 Portability. The entire issue of portability is a function of the fact that the ADAM system is fundamentally an O-Level support system, which must move from ashore to afloat and back with every squadron deployment. Given that the preliminary design concept envisions data base servers linked to a perhaps 20 workstations and perhaps as many portable maintenance devices on a local area network, an analysis must be conducted to determine if it is more effective to permanently position a central core of these systems aboard carriers and home operating bases, thereby eliminating much of the back and forth transportation of the system components between home operating base and carrier and reducing the inevitable damage. An additional constraint in the movement of ADAM system components is the extremely limited afloat storage for any component packaging and handling containers. Central to such a concept would be a determination of ownership and responsibility for the maintenance of the entire system. In general, units prefer to own and maintain their own support equipment and not rely on other activities who may not be similarly motivated. Alternatively, advances in micro-computer technology may be such as to reduce the size and cost of the total system and make it feasible to outfit each squadron with a complete ADAM, which would be the preferred option. Implementation of NALCOMIS Phase III and its integration with ADAM will also be a major factor in the overall system configuration.

Additionally, such an analysis must consider some provision for additional sets or subsets of the system which would be used for unit detachment operations from sites which are not configured to support an ADAM supported aircraft; for example, weapons training, carrier qualifications and beach operations while deployed. Provision for data consolidation from these detachment operations would also have to be incorporated.

2.2.12 System Site Architecture

A requirement exists to define the SHIPALT associated with the ADAM installation While the location of workstations is determined by the work centers involved, th optimum location for the central server system with associated peripherals would be one which is adequately secured such that only a major catastrophe would completely disable the system, yet the location must be reasonably accessible to squadron personnel. Details of the NALCOMIS SHIPALT, which has already been incorporated, must be examined to minimize duplication and achieve commonality where feasible. The SHIPALT must also include provisions for the accommodating each gateway interface into the existing NALCOMIS local area network.

2.3 INTERMEDIATE AND DEPOT LEVEL MAINTENANCE

While the basic focus of the ADAM System functional requirement was the support of Organizational Level maintenance, many ADAM System functions are required to support the advanced maintenance concept at both I-Level and Depot maintenance activities, with access to a ADAM System a requirement to attain the full benefits of the concept. Certainly all configuration management, life-cycle tracking, maintenance data collection and reporting functions addressed as organizational requirements for the ADAM System are also Intermediate and Depot maintenance requirements. Similarly, the basic ADAM system interface which provides the means to download, process and analyze WRA BIT data, aircraft fatigue life and engine data is a fundamental requirement for Depot aircraft acceptance, transfer and test flight purposes.

2.3.1 Technical Information

The benefits which would be derived from Intermediate and Depot Level electronic technical manuals produced from the same neutral IETM data base from which the Organizational Level technical manuals are produced is also clear.

2.3.2 Intermediate Level Maintenance

For I-Level maintenance, ADAM has some of the same functions as O-Level ADAM, plus its own unique functional requirements. Functions that are similar to O-Level ADAM include quality assurance, maintenance control, configuration control, and technical information usage and management. The unique requirements include interfaces to unique I-Level test equipment. Currently, t he standard I-Level test station is CASS, Consolidated Automatic Support System.

2.3.2.1 Consolidated Automatic Support System (CASS). If external ATE is required, modern Navy aircraft will be supported by the Navy's CASS test stations. CASS is similar to other Automatic Test Equipment (ATE), in that, there are instruments to provide stimulus and measurement functions and the tester is programmed using the ATLAS test language. The CASS testers will support the avionics in the form of Test Program Sets (TPS). The TPS will normally consist of a cable set, an Interface Device (ID), a Test Program Medium (TPM), and a Test Program Instruction (TPI).

2.3.2.2 Intermediate Maintenance Concept. For the Intermediate level Maintenance concept, BIT codes captured during flight, the VIDS/MAF, and diagnostic data collected during fault isolation and troubleshooting will be transmitted along with any replace WRA sent to the I-Level. The ADAM system would reformat the data to be compatible with the CASS tester and transmit the data to CASS for use by the TPS. The functional requirement would be to network with the CASS stations or place the BIT data on a media compatible with CASS. Either capability would have the potential of impacting the CASS tester to the extent that a system software change may be required in order for the TPS to access the data. The TPS would also have to be designed around the concept of processing the BIT data and applying it to the appropriate WRA. Results of I-Level testing would be fed back to the ADAM system maintenance history data base to determine the accuracy of the existing rule base and help identify potential rule changes.

2.3.2.3 Interface Analysis. While the benefits of CASS/ADAM System connectivity seem clear, the obstacles and potential costs of integrating these two systems requires further study as to feasibility and cost/benefit. However, at a minimum, there is a requirement to provide a process for updating the diagnostic knowledge-base through an analysis of the O-Level fault isolation process which generates the removal of specific WRAs, and the subsequent I-Level/Depot repair activity on those specific WRAs.

2.3.2.4 Interface Options. At the present time, the nature of the interface into the I-level shop is uncertain. The simplest alternative would involve a workstation in AIMD networked to the ADAM system which would require no direct interface to CASS system software. The major drawback of this approach would be the required manual input into the ADAM system of I-Level test results necessary to correlate actual R&R with the BIT callout. The other end of the interface spectrum would be to modify CASS software to allow direct transfer of data between CASS and the ADAM system bidirectionally, which would require further definition and coordination with the CASS program office to accommodate.

2.3.2.5 ADAM/CASS Requirement. Therefore, the requirement with respect to I-Level and Depot maintenance is as follows:

1. Develop an appropriate functional interface between the ADAM System and CASS, and/or between the ADAM System and the I-Level/Depot production control system by which the repair of WRAs is optimized.

2. Determine the appropriate mix of additional hardware, software and connectivity interfaces at I-Level and Depot activities to accommodate the

introduction of the ADAM System (and associated advanced maintenance concept) in the existing CASS, NALCOMIS and NALDA environments.

3. Develop the process by which the ADAM System and on-aircraft expert system knowledge-bases are matured through correlation of O-Level, I-Level and Depot maintenance activity on each component removal.

2.3.4 Depot Concept

The ADAM concept has potentially wider applicability to Depot maintenance beyond providing for direct support for aircraft acceptance, transfer and flight test. Conceivably, an "ADAM-like" system might be implemented for the entire product support office, replacing existing inefficient production control systems and paper based processes.

2.4 HARDWARE/SOFTWARE

2.4.1 Standardization Requirements

To ensure compatibility, additional standardization requirements include, but are not limited to the following:

1. External communications shall be in accordance with FIPS PUB 146, Government Open Systems Interconnection Profile (GOSIP).

2. A standard Portable Operating System Interface (POSIX) compliant operating system shall be used as defined in FIPS PUB 151, POSIX Standard.

3. The approved high-order data base access language shall be Standard Structured Query Language (SQL) described in FIPS PUB 127, Data Base Language SQL.

2.4.2 End-User Environment

Requirements for the end-user environment are incorporated in the Draft DoD Specification MIL-M-GCSFUI. Lacking an approved government or industry standard for a user environment, section 3.3 of this specification describes an interface which can be implemented in either "Motif" or "Open Look", which represents leading "would-be" standards for "Windowing" user interfaces on "UNIX-like" workstations.

2.4.2.1 User Interface. User interface is the process of interaction between the user and the presentation device. The interface will be extremely "user friendly" such that the user will require a minimal understanding of computer concepts and little required formal training on operating the system, with only one set of hardware and software protocols to learn. The user interface will also facilitate the operation of the hardware under conditions and in environments that require the wearing of special protective clothing.

2.4.2.2 Data Presentation. ADAM components will have a high resolution, flat panel display which will show text and illustrations that can be clearly and easily read, under multiple lighting conditions, from a viewing distance of at least 5 feet.

2.4.2.3 Display Delay Tolerances. For any ADAM device, retrieval and appearance time for text-only frames and frames with moderate graphics, such as line drawings, will not exceed one second. For frames with more detailed text and graphics, including line drawings larger than screen size (for use with pan or scroll), retrieval and appearance time will not exceed two seconds. The system will also be capable of retrieving, generating, and displaying a 20,000 vector graphic from memory within five seconds.

2.4.3 Hardware Compatibility

In addition to meeting fundamental requirements in support of the advanced maintenance concept, another basic requirement is to field software having applicability across the aviation maintenance community. To that end, the software must be compatible with the Work Center Device (WCD) defined in the Draft Military Handbook (Navy) Electronic Display Systems for IETMs, MIL-HDBK-EDS (Navy).

2.4.4 Interfaces

Due to the existence of the NALCOMIS Ethernet LAN installation aboard all CVs, and the requirement to minimize the proliferation of hardware and software to be supported in a shipboard environment, network media and interface compatibility requirements seem to be defined, except for the fact that at present no comparable ashore network exists (NALCOMIS Phase II/III implementation does contain provision for comparable ashore networks). Therefore, the requirement is to determine appropriate network media/interfaces, both ashore and afloat, taking into consideration the following factors:

1. The general Navy requirement to minimize hardware and software to be supported, particularly on CVs,

2. The existence of the NALCOMIS Ethernet LAN (also utilized by SUADPS) aboard all CVs,

3. The requirement to determine appropriate interfaces between the ADAM System and CASS and/or the I-Level production control and between the ADAM System and the site supply support center, and

4. External communications shall be in accordance with FIPS PUB 146, Government Open Systems Interconnection Profile (GOSIP).

2.4.5 Non-Developmental Software (NDS)

For the purpose of this effort, NDS as described in DoD-STD-2167A paragraph 3.22 shall be further defined as "commercially available software", where this term means computer software which is used regularly for other than government purposes and is sold, licensed or leased in significant quantities to the general public at established market or catalog prices. NDS items shall be exempted from the detail documentation requirements of DoD-STD-2167A. NDS items, contractor pre-developed or developmental software items, and contractor developed augmentations and programs using NDS may be incorporated into the overall system in accordance with DoD-STD-2167A paragraph 4.2.4, within the following specific guidelines.

1. Each NDS item shall be designated as a separate Computer Software Configuration Item (CSCI).

2. Internal CSCI design documentation is not required for NDS items.

3. All documentation identifying interface requirements between CSCIs will be generated for each CSCI, including NDS CSCIs.

4. Functions implemented through the use of contractor developed augmentations to NDS items shall be fully documented and otherwise in compliance with all other applicable portions of this SOW and DoD-STD-2167A.

2.4.6 Graceful Degradation

No system can be designed that will withstand conflagration or direct combat damage. However, the system fielded should take all steps possible to provide 100% up time in a normal environment. To this end, features such as redundant processors and disk shadowing must be considered as requirements. Provisions must also be incorporated for periodic backup onto removal media. Should a catastrophic event occur in the area of the central server system, the majority of the software must be designed to take full advantage of local workstation processing and storage capabilities for a period of time. This degraded mode capability would not necessarily allow for networking and would require some data consolidation once the main system was again on-line. In the event of a complete system failure or shutdown there must be provision to manually input data which would otherwise have been input electronically. Return to full capability from a degraded mode of operation must be as automatic and seamless as possible.

2.5 SECURITY

It is anticipated that the supported aircraft will impose no unique security requirements and TI will be classified at no higher than the SECRET GENSER level at IOC. Therefore, a requirement to process some classified maintenance information will almost certainly exist, but as far as the ADAM System is concerned, classified data might be reasonably accommodated through data segregation and with removable magnetic media. The use of perhaps one or two off-network dedicated TEMPEST configured workstations to process classified material should be examined as an alternative. Tempest considerations as appropriate will be incorporated to ensure system functionality in an EMCON environment.

The ADAM will incorporate measures to ensure protection against unauthorized access to computer facilities, to shop or remote terminals, and to the data storage media.

2.6 ORGANIC SUPPORTABILITY

General Navy intent is to achieve organic support capability for all aircraft insofar as practicable. To achieve this capability, a ADAM system will be placed at the cognizant field activity given responsibility for system support. The fielded hardware of the ADAM system should be sufficient to allow software development and post deployment software support. If any additional software development tools are required to obtain full organic support capabilities, these tools must be identified separately from the SERD for the fielded system.

2.7 IETM DATA BASE MANAGEMENT

At the present time the Navy intends to interface with the Army, Air Force, and Defense Logistics Agency (DLA) in the design and acquisition of a common system for the maintenance and management of electronic technical manuals, the Joint Uniform Service Technical Information System (JUSTIS). Alternatively, the Navy would pursue an independent acquisition of the Navy Electronic Technical Manual System (NETMS) should participation in a joint program ultimately prove to be impracticable on the basis of unanticipated cost or schedule impacts.

The IETM data base would be procured utilizing draft DoD specifications. It is expected that upon acceptance of this data by the Navy, the Naval Air Technical Services Facility (NATSF) will assume responsibility for its management, the Navy Publishing and

Printing Service (NPPS) will assume responsibility for stocking, and the Naval Publications and Forms Center (NPFC) will serve as the single inventory control point for distribution to the unit level. The ADAM system will contain hardware/software elements to interface with the Technical Publications Deficiency Reporting (TPDR) system. Delivery of the IETM data base is expected to be in the form of CD-ROM optical disks. Provisions for delivery of timely updates are presently undefined but options exist for the use of magnetic media and/or on-line file transfer from one of the NPPS field activities or from the CFA.

3. SYSTEM DESCRIPTION

3.1 USER SYSTEM

The user element of ADAM will be an advanced, state-of-the-art maintenance-aiding system. It will provide digitized technical data upon demand and communicate/interact with both on-aircraft and ground-based maintenance and support computer systems. It will provide a single easy-to-use source of complete, current, consistent, and integrated technical information to meet the requirements of the maintenance community. The user system will be independent of specific hardware and will be designed to accept multiple power sources sufficient to insure continuous operation. The system will be deployable, operable in special purpose gear and survivable in all operating environments.

3.1.1 System Configuration

The ADAM system will consist of the computer resources necessary to accomplish the functional requirements specified herein. Although specific hardware and software configurations remain to be defined, a general system configuration meeting the functional requirements would consist of a micro- or super micro-computer CPU/Server providing rapid multi-user access through a local area network to the various aircraft data bases resident on conventional magnetic media and/or optical disk mass storage devices for perhaps 20 workstations and as many portable maintenance aids per squadron. In the interest of minimizing the movement of major hardware systems between ashore and afloat sites, alternative hardware configurations must be examined as alternatives to a basic concept of each squadron owning an ADAM system and moving it between ship and shore. Possible components of an ADAM system include the elements described below.

3.1.1.1 System CPU/Server. The ADAM CPU/Server would consist of a standard commercially available micro- or super micro-computer, peripheral storage devices and software necessary to store, manage and provide multi-user access to all local aircraft data bases. In combination with an appropriate communications gateway device, data will be accessible by and transferred to various activities as appropriate. Similarly, data from various external repositories will be available for processing by the ADAM system.

3.1.1.2 System Connectivity. Connectivity between local workstations and the CPU/Server would be achieved through a Local Area Network (LAN) interface. Connectivity between the unit activity and various remote central data base facilities would be achieved through an appropriate communications gateway, modem or through transfer of magnetic media.

3.1.1.3 Workstations. ADAM workstations would consist of standard commercially available micro-computers. The workstations will be capable of functioning as stand-alone devices or as network devices on local area networks. Workstations will be capable of accomplishing comprehensive fault isolation and bench-top troubleshooting through the assembly of comprehensive IETM work packages. Although not a requirement, workstations might also be able to function as front-end processors for other work center automated test equipment. As a networked device it will have access to all on-line data and will be capable of receiving work orders, scheduling job assignments, reporting maintenance actions, establishing stores requirements, tracking maintenance resources, sending messages, and a performing a multitude of maintenance and management functions described herein.

3.1.1.4 Portable Maintenance Aid (PMA). A ruggedized, lightweight computer/ presentation device will provide the technician with a single, integrated and portable source of maintenance information. This device will be capable of storing specified portions of the master ADAM data base in work package format which display technical instructions with appropriate schematics and graphics, provide expert system diagnostic advice assembled in conjunction with aircraft historical data. Through its system interface capabilities it will provide the technician with an easy, efficient method to receive work orders, perform/report maintenance actions, and through potential interfaces to external support facilities to order parts from supply, request fuel/munitions support, and complete computer-aided training lessons. It will be capable of functioning as a stand-alone device and networked with the ADAM system.

There may also be a requirement for a small handheld maintenance aid to display checklist data for simple repetitive maintenance tasks such as pre- and postflight inspections, fuel servicing, munitions loading, transient alert, etc., to be used in lieu of the PMA.

3.1.1.5 Aircraft Interface Panel. The aircraft interface panel will provide the plug-in port for the portable maintenance aid to download BIT data and in certain situations to upload expanded on-aircraft diagnostic routines required to complete the fault isolation process.

3.1.1.6 Portable ADAM System. A portable ADAM system would consist of some subset of the ADAM system which would be used for unit detachment operations from sites which are not configured for ADAM supported aircraft operations; for example, weapons training, carrier qualifications and beach detachment operations while the unit is deployed. It will be a ruggedized, stand-alone repository of the activity's data base with some undefined number of workstations and/or portable maintenance aids. This system would be full featured to provide all the basic maintenance support, yet may not necessarily be as capable as the parent ADAM system because of the relatively short time span of these operations and level of maintenance support required. Provision for data consolidation to the activity's master data base from these detachment operations would have to be incorporated. This system may be nothing more than a suitably configured system workstation and a number of portable maintenance devices.

3.1.1.7 Printers. Although ADAM is designed to function largely as a paperless system, the user will have the capability to produce all technical information in a print on demand mode. There may be a requirement to produce some technical information, such as large schematics, wiring diagrams and other similar large scale graphic material in only a paper mode until such time that these can be accommodated in an acceptably clear format on the workstation and PMA video displays.

3.1.2 System Software

Software packages will provide the capability for the most effective and user-friendly utilization and presentation of the ADAM data bases. They will also enable the integration/combination of information from multiple, automated systems and facilitate the presentation of this data to the technician in a transparent, systematic, and coordinated maintenance aid package. Specific software requirements include, but are not limited to, the following:

1. User Interface and overall system integration: In addition to the basic operating system and local area network software, this includes the single standard hardware/software user interface protocol, basic architecture and integration of all system menu function modules, user access validation, multi-user protocols, user system assistance, provision for user technical training, and integration of peripheral input and output devices.

2. IETM data base: Includes the basic multi-user relational data base software, the "neutral" IETM data and its relational structure, various view packages (subsets of the IETM data base which have been specifically assembled for a particular task) supporting a specific presentation of technical information for a particular type of ADAM presentation device, and the general format and structural requirements for interchange of this data with each type of ADAM display device. Additionally, as a function of the specific storage media for the IETM data base, protocols for updating segments of the data base and alerting users to these changes.

3. Diagnostic expert system and knowledge base: Includes the diagnostic expert system software, its associated knowledge base and dependency models as appropriate, protocols for updating the knowledge base as derived from the aircraft history data base. As appropriate, protocols for the identification and assembly of expanded diagnostic routines from the IETM data base for upload to the aircraft via the PMA.

4. Aircraft history data base: Includes the basic multi-user relational data base software, all the aircraft history data required to meet the needs of the Naval Aviation 3M system and/or NALCOMIS, protocols to reformat 3M data sent to and received from central Navy data base facilities, the data

to update the diagnostic knowledge base, the data required by the debrief expert system, and aircraft configuration data for serialized life tracking and routine scheduled maintenance.

5. Aircrew debrief and BIT download: Provisions for download of BIT data and generation of VIDS/MAFs on the basis of postflight analysis of component BIT failure data correlated with the aircrew debrief. All other scheduled and unscheduled VIDS/MAFs would be generated with this software module through interactive menus. The software would provide all the production control tools for maintenance and material control. Additionally, this software would encompass all the other Maintenance Data System (MDS) functions, including Maintenance Data Reporting, Material Reporting, Subsystem Capability Impact Reporting, and Utilization Reporting. As appropriate, provisions to be included for the upload of expanded diagnostic routines to the PMA or data storage device for additional on-aircraft fault isolation. Protocols to reformat data sent to and received from other external data bases as appropriate would be included.

6. Parts Life Tracking: Provisions for data storage device download of LUIs and life tracking source data as appropriate. Generation of LUIs through algorithms for components as appropriate. Provision to reformat and export Parts Life Tracking and SLM data to external data bases would be incorporated. Data would be made available to work centers for appropriate analysis on a real time basis.

7. Data base integration and multi-user management: Includes all protocols for the seamless integration of data between the various data bases in a full multi-user environment.

8. PMA upload/download: Includes protocols for the download of all data required by technicians in conducting scheduled and unscheduled maintenance and the upload of the post maintenance performance data to the aircraft history data base. Additionally, provisions for downloading segments of the data bases for training would be included.

9. Interfaces to external data bases: Includes protocols for the upload and download of data to various external central data bases either through magnetic media (including 9-track tape) direct networking via an appropriate communications gateway or via modem.

3.2 IETM DATA BASE

A neutral, integrated and interactive data base of technical information authored in accordance with the suite of draft DoD and Navy specifications for IETMs would be procured in conjunction with the ADAM concept. Draft DoD specifications and handbooks are:

MIL-M-GCSFUI	General Content, Format, Style and User Interaction Requirements for IETMs
MIL-D-IETMDB	Revisable Data Base for Support of IETMs
MIL-M-IETMQA	Quality Assurance Program Requirements for IETMs and Associated Technical Information
MIL-HDBK-VP	Guidelines for Developing Specifications for IETM View Packages

Draft Navy handbooks are:

MIL-HDBK-EDS	Electronic Display Systems for IETMs

3.2.1 Neutral and Integrated Data Bases

The IETM data base will consist of neutral, integrated, electronic maintenance and product definition information. This data will be "neutral" in that it will not have display formatting information embedded in it, which will allow the information to be stored once and used in innumerable ways by appropriate application programs. It will be "integrated" in that it will explicitly identify the relationships between various kinds of information. Such a data base will effortlessly and transparently provide the technician with all related and applicable information required to accomplish a maintenance task.

3.2.2 IETM Specifications

Ongoing efforts by the Tri-Service IETM Working Group have yielded a suite of three draft DoD IETM specifications and two handbooks (one DoD and one Navy), representing a consensus of the various service efforts, principally from the Air Force Logistics Command, the Air Force Human Resources Laboratory, and the David Taylor Research Center. These specifications are, in general, sufficiently comprehensive to define the acquisition of IETMs for a weapon system exclusive of an authoring system and precise definitions for the various electronic work packages which may be required.

3.2.3 Sources of Data

The IETM data base will consist of data produced directly for the most part from the LSA process. Other TI, such as general maintenance procedures, etc., may become available for integration with the IETM data base. Digitization of this "other TI" would be accomplished under the Navy Technical Manual Automation Transition Concept under the direction of the Navy Publishing and Printing Service and cognizant Systems Commands.

3.3 SYSTEM SECURITY

The user system will incorporate security features sufficient both to prevent unauthorized users from accessing the system, and provide for seamless, periodic data backup.

3.4 SYSTEM DIAGRAMS

The following diagrams of various ADAM concepts are provided for illustrative purposes and are not necessarily complete in every detail. Functional diagrams are general representations of OPNAVINST 4790.2 maintenance requirements.

1. The overall ADAM networking concept between unit organizational maintenance activities, site supporting activities and remote support activities is illustrated in Fig. 1.

2. The ADAM networking concept at the unit organizational maintenance level is illustrated in Fig. 2.

3. Details relating to organizational level maintenance Production Work Center functions and corresponding ADAM data flow is illustrated in Fig. 3.

4. Details relating to organizational level Maintenance Control functions and corresponding ADAM data flow is illustrated in Fig. 4.

5. Details relating to organizational level Material Control functions and corresponding ADAM data flow is shown in Fig. 5.

6. Details relating to organizational level Quality Assurance/Analysis functions and corresponding ADAM data flow is shown in Fig. 6.

7. Details relating to organizational level Logs and Records functions and corresponding ADAM data flow is shown in Fig. 7.

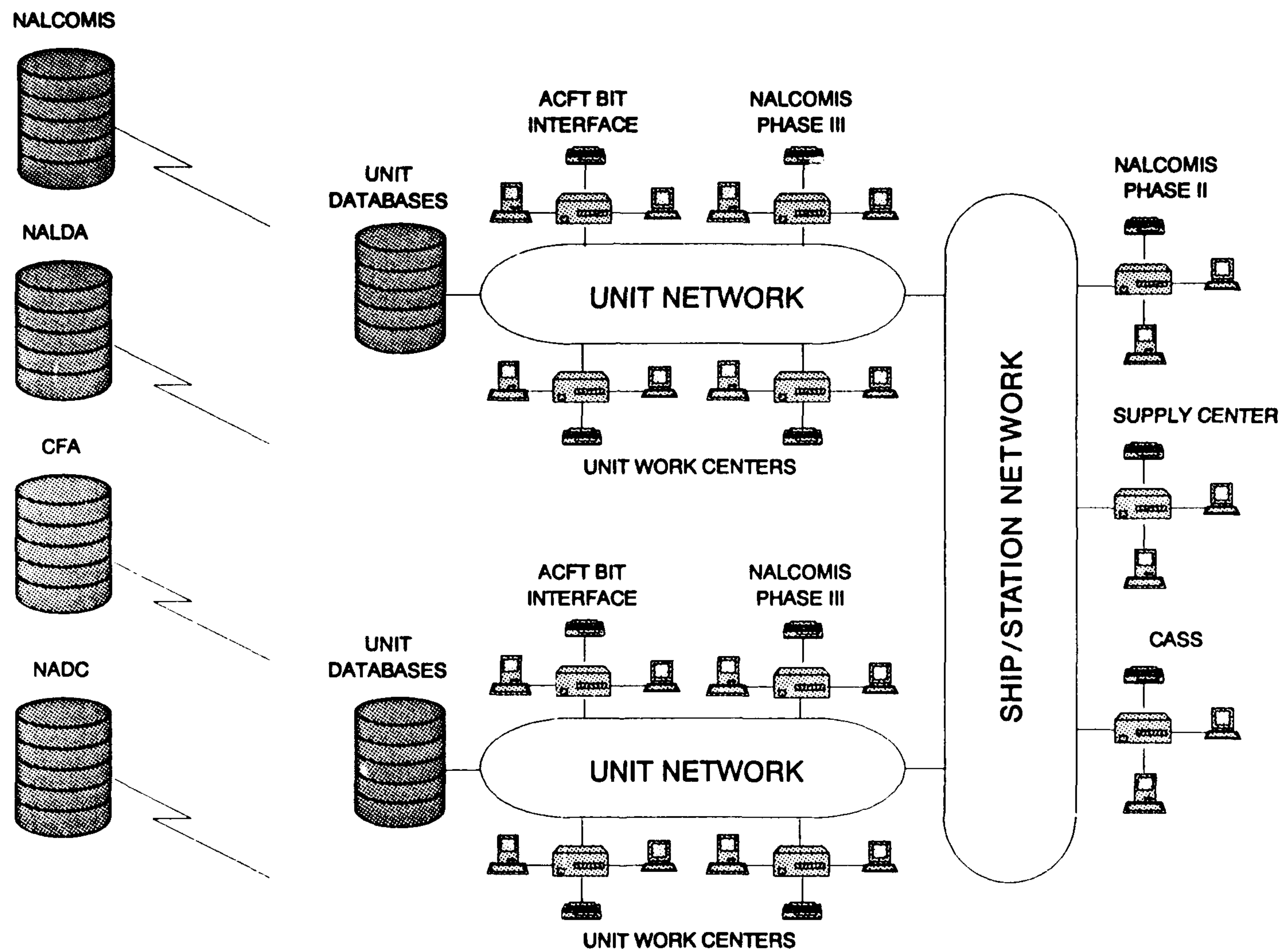

Fig. 1. Overall ADAM networking concept.

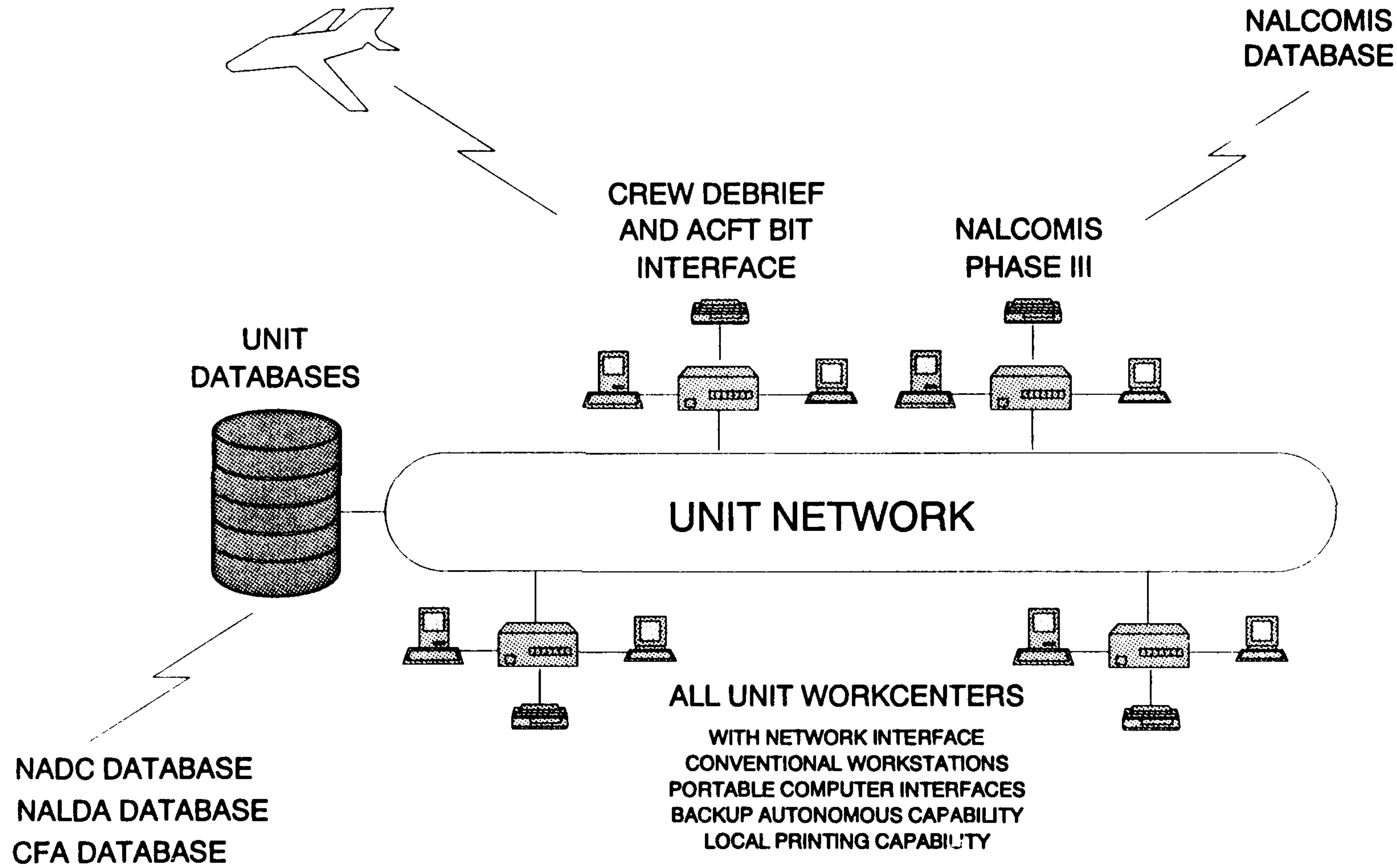

Fig. 2. Unit networking concept.

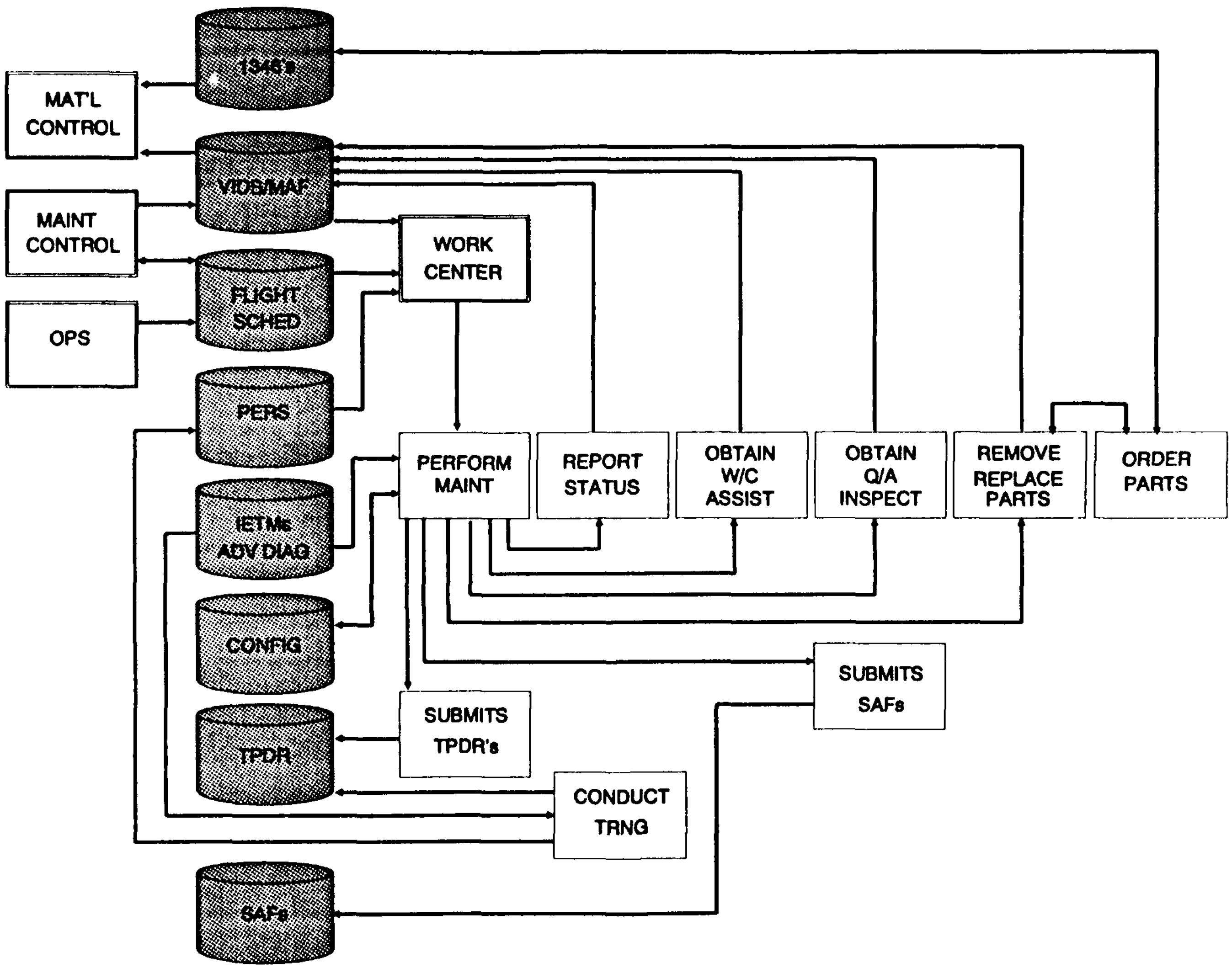

Fig. 3. Production work center functions.

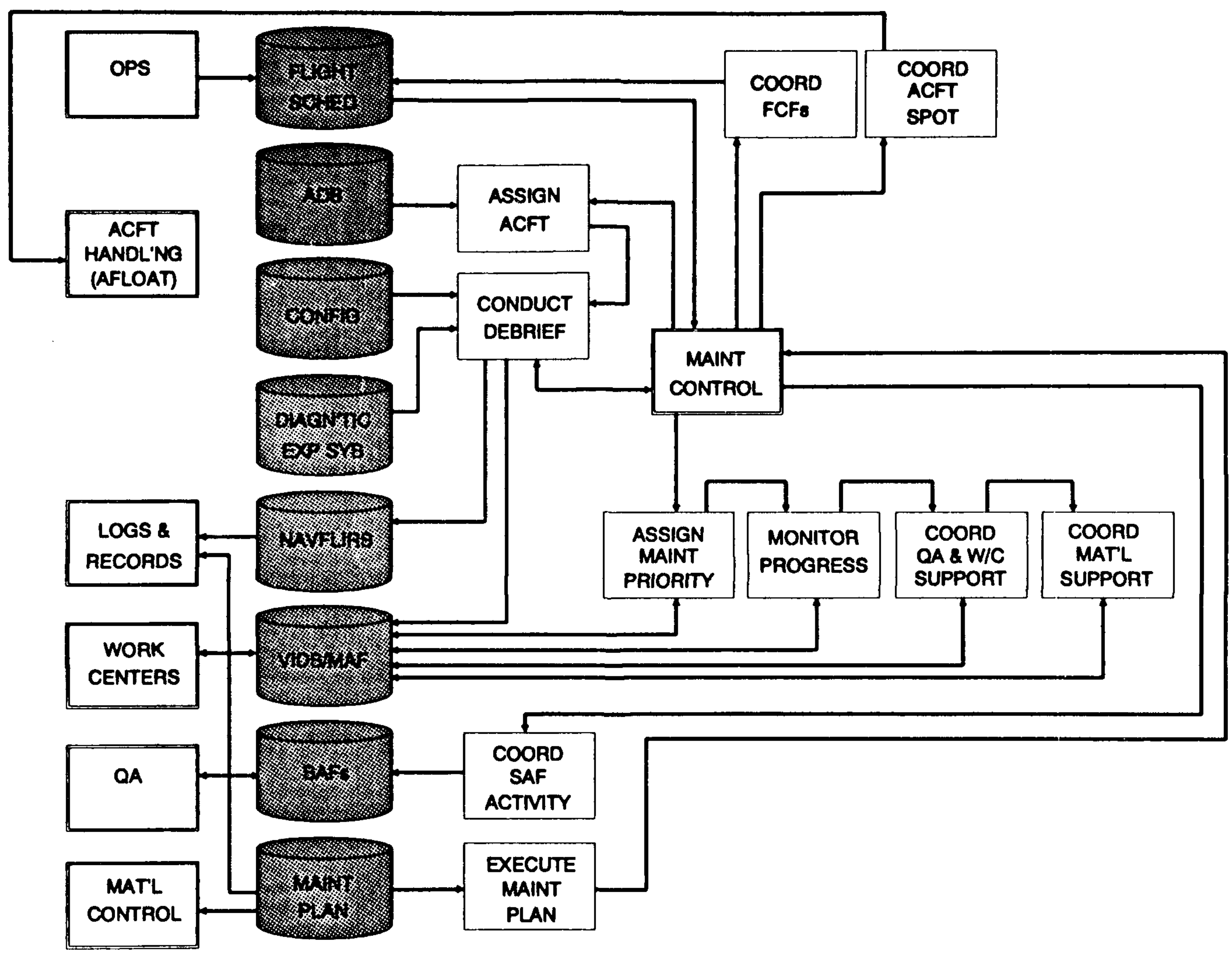

Fig. 4. Maintenance control functions.

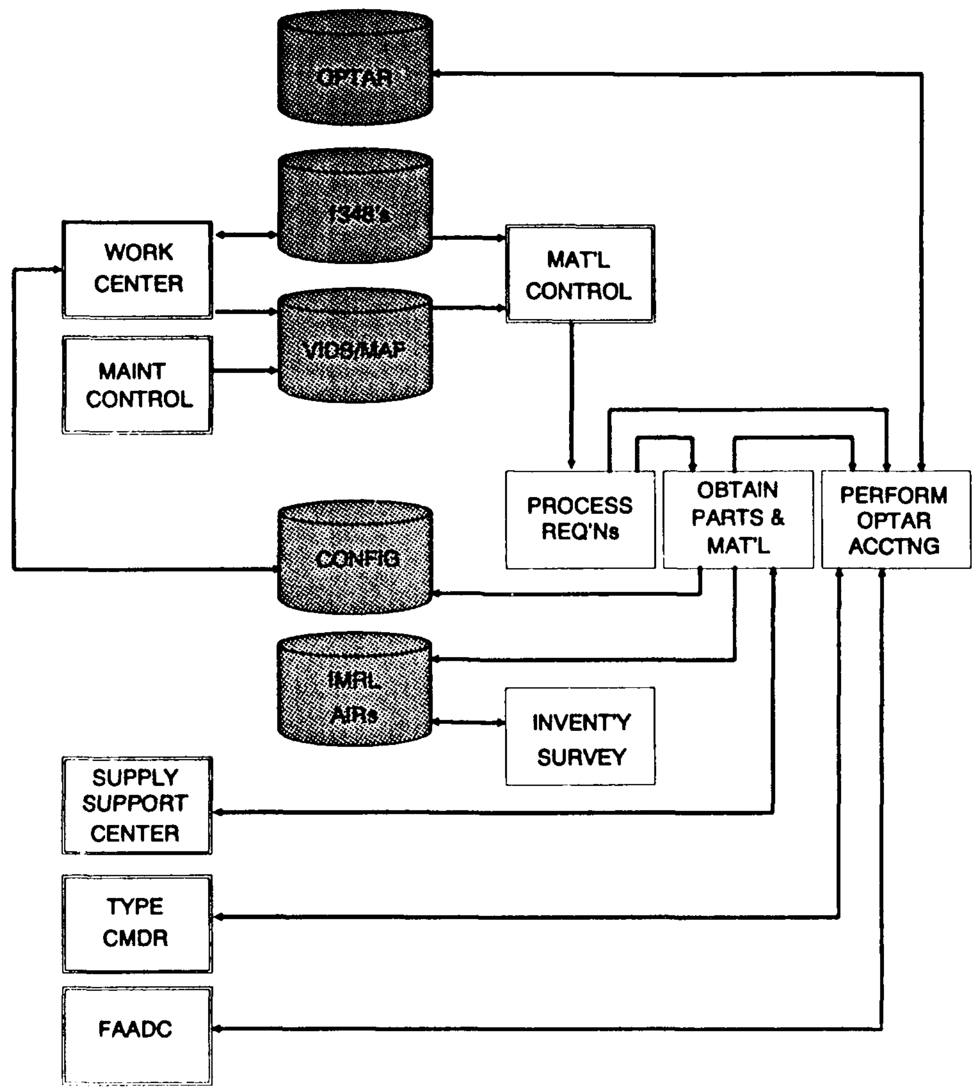

Fig. 5. Material control functions.

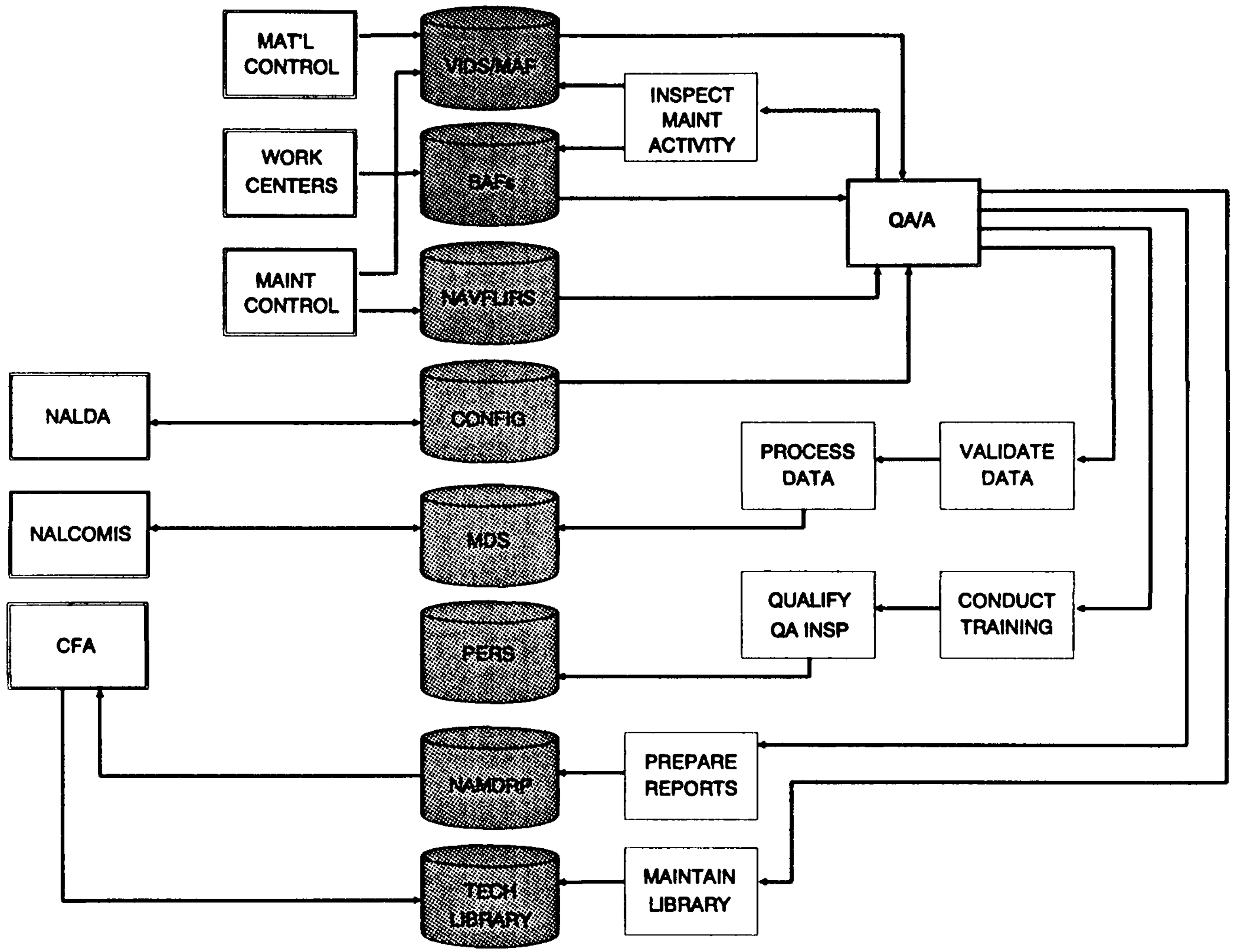

Fig. 6. Quality assurance/analysis functions.

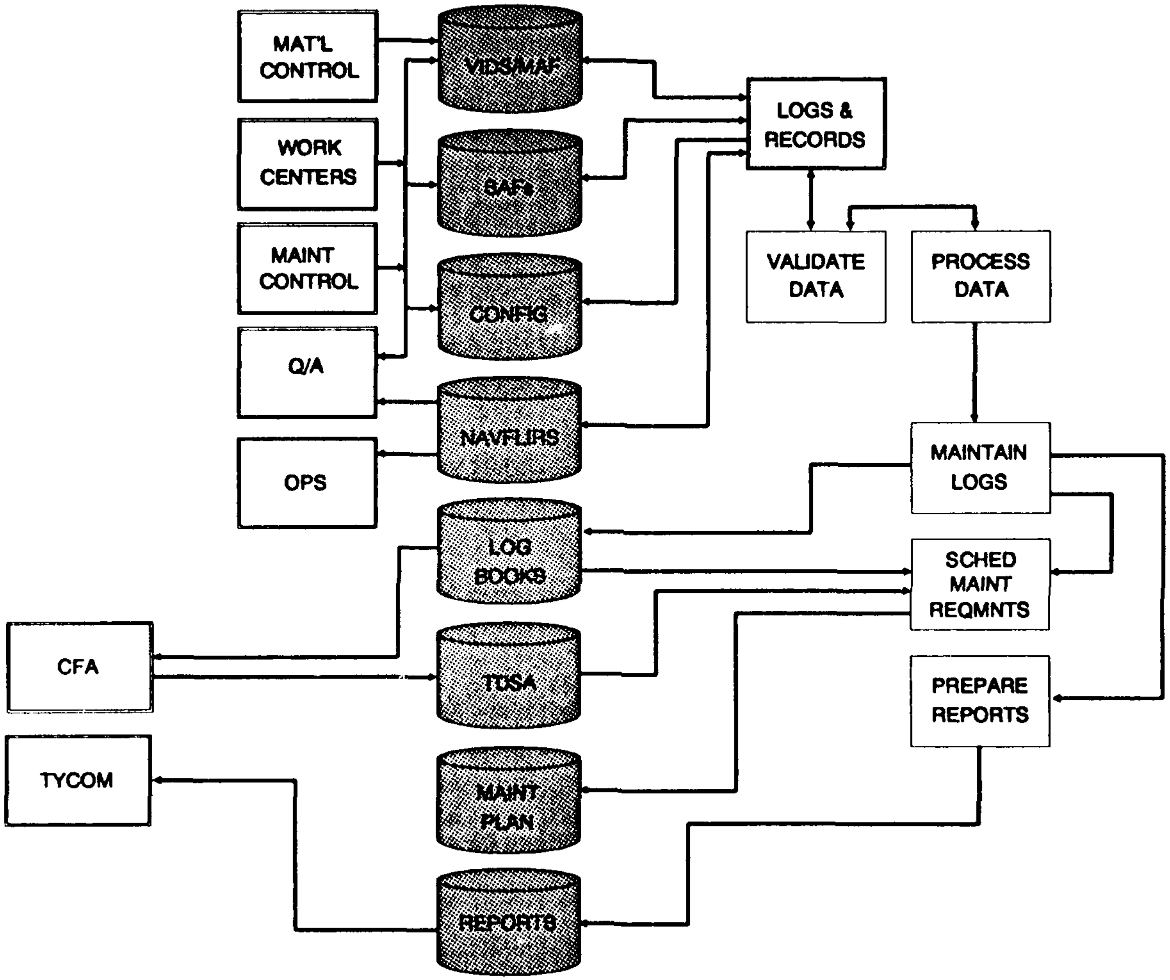

Fig. 7. Logs and records functions.

4. SYSTEM CHARACTERISTICS

4.1 PERFORMANCE CHARACTERISTICS

The ADAM system will provide aircraft support in all environments from CONUS facilities to austere deployed locations both ashore and afloat. It will be subject to, and operate under a wide range of environmental and combat conditions. The operability, deployability and survivability characteristics of the user system will be driven by the employment needs of the weapon system.

4.1.1 System Components

ADAM system components will be operable, reliable, maintainable, deployable, and survivable in all environments in which the weapon system must be operated and maintained.

4.1.1.1 Master Data Base. The IETM data base will be the medium for the development, acquisition, storage, and access of all automated technical data. This data base will be managed so as to consistently provide users with the most current and accurate technical information. To achieve this, ADAM must provide system redundancy, maintain data base integrity, and provide change management.

ADAM will provide redundancy by the duplication and reconstruction of all system software and data bases in the event of data loss due to equipment failure, sabotage or catastrophic event. The time delay from data loss to a return to full system capability will not be more than two hours, with a limited use of data commencing within 30 minutes.

To maintain integrity no local user of ADAM will be able to accidently or purposefully change or otherwise modify the master IETM data base. Changes will only be permitted to be made through the NAVAIR/NATSF/NPPS/NPFC system, either by periodic/emergency changes or as a result of change request/deficiency report submissions.

Change Management tracks and handles the routine periodic information updates/changes are received. ADAM will automatically download/change the local memory of all ADAM users. ADAM will have the capability to inform the user on the currency of the data. Change Management must deal with the following:

1. Emergency Changes.

   Changes which contain safety or emergency data will be distributed to all users immediately upon receipt.

2. Routine Update Notices.

Whenever the data base is updated, affected users will be notified by a displayed message on their screen when they sign on. This notification of update will continue to be given until the user (i.e.; the technician) displays the update notice.

4.1.1.2 Hardware/Software Elements. The ADAM system will incorporate sufficient hardware and software elements to effectively support system capabilities and functional requirements in all environments. These elements include the following:

1. Power Sources.

ADAM components will be capable of operating from various power sources, including common AC, battery, uninterrupted power supply (UPS) and emergency generator. All required power conversion capabilities will be self-contained; only an adaptor cable will be required. Protection against power surges will be provided. ADAM components will possess nonvolatile memory to the extent that data will not be lost when power is removed.

2. Storage Capacity.

The ADAM system will incorporate computer resources with sufficient memory capacity to receive, store, process, and effectively utilize all aircraft data from the various Navy Central Data Bases. Provision will also be made for future expansion to accommodate the system's growth as additional data is digitized or received.

3. Data Transmission.

The system will be designed to allow efficient operation and prompt access to all data without interruption or delay. It will have the capacity to handle large quantities of data at one time at relatively high baud rates.

4.1.2 Data Presentation

ADAM components will have a high resolution, flat panel display which will show text and illustrations that can be clearly and easily read, under multiple lighting conditions, from a viewing distance of at least 5 feet.

For any ADAM device, retrieval and appearance time for text-only frames and frames with moderate graphics, such as line drawings, will not exceed one second. For frames with more detailed text and graphics, including line drawings larger than screen size (for use with pan or scroll), retrieval and appearance time will not exceed two seconds. The system will also be capable of retrieving, generating, and displaying a 20,000 vector graphic from memory within five seconds.

4.1.3 Personnel

The ADAM system will be designed such that organizational level maintenance requirements can be accomplished by one "generalist" technician who has been task qualified on the equipment.

4.2 OPERATING CHARACTERISTICS

ADAM components will be capable of operating within a wide range of climatic conditions. Most of the ADAM system will be confined to indoor locations, however the PMA will be used in outdoor locations both aboard carriers at sea and on the flight line ashore. All components will be sturdy enough to withstand the rigors/abuses of nearly continuous use and an expected operating life equal to that of the specific aircraft.

4.2.1 Environmental Conditions

The entire ADAM will operate under various climatic conditions which include temperature and humidity extremes, dust/dirt/sand, and exposure to ocean salt. Additionally, the PMA will be exposed to rain, ice, snow, and to some extent, solvents and lubricants,

4.2.1.1 Electrostatic Discharge. ADAM components will resist the possibly harmful effects of active electric fields such as those found around generators, radio and radar transmitters, and operating engines. In the absence of a ground, they will withstand electrical arcs as to be explosion proof.

4.2.1.2 NBC Environments. The PMA will be hardened to withstand the effects of, and function within, a Nuclear, Biological, Chemical (NBC) carrier based environment and will be decontaminable using applicable procedures.

4.3 SECURITY

It is anticipated that the supported aircraft will impose no unique security requirements and TI will be classified at no higher than the SECRET GENSER level at IOC. Therefore, a requirement to process some classified maintenance information will almost certainly exist, but as far as the ADAM System is concerned, classified data might be reasonably accommodated through data segregation and with removable magnetic media. The use of perhaps one or two off-network dedicated TEMPEST configured workstations to process classified material should be examined as an alternative. Tempest considerations as appropriate will be incorporated to ensure system functionality in an EMCON environment.

The ADAM will incorporate measures to ensure protection against unauthorized access to computer facilities, to shop or remote terminals, and to the data storage media.

4.4 DESIGN AND CONSTRUCTION

The design and construction of ADAM component elements will be in accordance with "best commercial practices." User system components will consist of existing, off-the-shelf hardware/software conforming to "best commercial practices," and the acquisition of these off-the-shelf components will be in accordance with policies established by DOD Directive 5000.27 and consistent with MIL-STD-1472. MIL-T-28800 will serve as a guide to develop and procure user system hardware. Software will be developed in accordance with MIL-STD-2167A and the DoD IETM specifications currently under coordination.

4.4.1 Ruggedness

ADAM components will be sufficiently ruggedized to withstand the rigors of use aboard carriers at sea. Factors to be considered in the selection of materials for the construction of ADAM components include the requirement for low electromagnetic radiation, durability, heat dissipation, and the environmental considerations specified herein

4.4.1.1 Resistance To Shock. PMAs shall be capable of surviving a drop to concrete from at least wing height and continue to meet operational and functional requirements. They shall be shock resistent up to 40 g's during a transient duration of 6-9 milliseconds (The effective transient duration is the minimum length of time which contains all shock magnitudes exceeding 1/3 of the peak magnitude associated with the shock event).

4.4.1.2 Immersion in Fluids. PMAs will retain their integrity, operating capabilities, and appearance when subjected to any fluids normally present within the maintenance environment. These include fuel, hydraulic fluids, cleaners, solvents, and beverages, but do not include special purpose agents such as acid.

4.4.2 Interchangeability

Hardware components and parts specified for ADAM will be completely interchangeable with other like items, possess identical functional and physical characteristics, and be equivalent in performance and durability. Software will be transportable between like devices and will be designed and written for maximum independence from hardware.

4.4.3 Fail-safe Design

Fail-safe design shall be incorporated within the components of the user system. Control and modular construction will be such that operator/maintenance personnel will be unable to induce failure of the equipment. Malfunctions of the equipment will in no way contribute to the destruction of that equipment or any part of its environment. All ADAM equipment and all packing/packaging materials will be designed to prevent injury to installation, operating, or maintenance personnel.

4.4.4 Human Engineering

ADAM user system design will incorporate human performance/human engineering requirements in accordance with the principles and criteria of MIL-H-46855 and MIL-STD-1472 as applicable. As a minimum, presentation devices must be capable of being easily operated by users under conditions, and in environments that require the wear of special purpose clothing.

4.4.5 Safety

To assure optimum safety, ADAM equipment will meet the safety, health and human performance requirements of MIL-STD-882, MIL-STD-454, MIL-STD-1472, and MIL-H-46855. All safety and human factors relevant in the operating, maintaining, shipping, and handling of ADAM components will be incorporated in the design. These factors will apply in all environments, including potentially explosive environments such as that encountered during fueling, stores loading, fuel cell maintenance, etc.

4.4.6 Documentation

Documentation will be provided to support the development, validation, verification, utilization, and maintenance of ADAM. The quantities and types of documentation will be specified in subsequent appendix to this document.

4.5 ADAM SYSTEM MAINTENANCE

The ADAM user system will emphasize innovative maintenance concepts in its design to ensure optimum reliability, maintainability, and supportability throughout its life-cycle. Factors to be considered in planning the maintenance requirements for the life of the system include, but are not limited to: levels of repair, repair times, test requirements, support equipment needs, manpower skills, facilities, and repair responsibilities.

4.5.1 Maintenance Environment

ADAM components will be maintained in all environments including severe temperature, humidity, vibration, and mechanical shock conditions; intense combat scenarios; and under difficult combinations of adverse weather, at austere locations by very limited numbers of technicians with only deployable support equipment.

4.5.2 Workstation and Shop Computers

ADAM standard computers and workstations will be maintained through contractor logistic support. These devices will provide for minor operator care through a self-contained diagnostic capability to instruct operator intervention and/or furnish the repairing agency with a more complete problem description. The contractor will be responsible for assisting the user in resolving problems or taking the appropriate actions necessary to return the system to full operating capability. Contractor performance requirements will be in accordance with the terms of the maintenance contract established by the Navy.

4.5.3 Portable Devices

To the extent that PMA's will not be ruggedized versions of commercially available portable micro-computers, they will be designed to be maintained by the technicians who use them. PMA's will perform a functional self-test upon power-up and will have selectable built-in-test (BIT) capabilities. They will be designed for positive identification of replacement modules, as well as of module locations to prevent incorrect installation of replacements. Technical information for checkout or repair of a portable device will be accessible through another working portable or a workstation. No special tools or test equipment will be needed for fault isolation or repair. Maintenance of ruggedized versions of commercially available portable micro-computers will be the same as that identified in section 4.5.2.

4.5.4 Scheduled Maintenance

Traditional scheduled maintenance, including scheduled inspections, for ADAM components will not be required.

4.5.5 Facilities and Facilities Equipment

No new or special technical repair facilities or facilities equipment will be required for the repair of ADAM components.

4.5.6 Component Availabilities

The user system at an operating base will have to-be-determined component availabilities achieved by the most cost effective combination of reliability, redundancy, testability, and maintainability.

4.5.6.1 Availability Definition. Availability (A) is defined as the required mean time between failure (MTBF) divided by the sum of the mean time to repair (MTTR) and the mean time between failure.

$$A = \frac{MTBF}{MTBF + MTTR}$$

4.5.6.2 Mean Time Between Failure (MTBF). MTBF is the mean operating time between failures when operated within specified operating range(s). Failures are categorized as relevant and non-relevant. Relevant failures are contractor controlled. Non-relevant failures cannot be controlled by the contractor (e.g., handling abuse, operation beyond equipment specification, induced failures).

4.5.6.3 Mean Time To Repair (MTTR). MTTR is defined as the mean time required for replacement of major components at the organizational level. This includes the time required to localize, isolate, disassemble, interchange/replace, reassemble, and check out an item after a failure. Administrative and/or logistic time is excluded.

4.6 PACKAGING, HANDLING AND TRANSPORTATION (PH&T)

ADAM components will not require any special facilities or equipment for sheltering, protecting, or packaging, other than shipping containers. All components will be ruggedized and capable of being exposed to severe environments without receiving damage. Packaging and marking in standard PH&T configurations will be adequate to protect them from corrosion, deterioration, and physical damage during shipment, handling, and storage. All components will be easily and efficiently transportable by truck, rail, or aircraft.

4.7 STORAGE

All ADAM components will be capable of being stored in any orientation unless specifically marked to indicate otherwise.

5. APPLICABLE DOCUMENTS

5.1 APPLICABLE DOCUMENTS

Following is a list of documents referenced in, and/or applicable to this concept of operations. These documents are intended to augment the information herein. This is not an all-inclusive list of documents.

5.1.1 Navy Directives

SECNAVINST 5219.2A	Technical Manual Program Management
NAVAIRINST 4160.2	Technical Manual Program Management
OPNAVINST 4790.2	Naval Aviation Maintenance Program

5.1.2 Specifications

MIL-D-28000	Digital Representation for Communication of Product Data
MIL-D-28003	Digital Representation for Communication of Illustration Data, Computer Graphics Metafile (CGM)
MIL-H-46855	Human Engineering Requirements for Military Systems, Equipment, and Facilities
MIL-M-28001	Markup Requirements and Generic Style Specification for Electronic Printed Output and Exchange of Text
MIL-M-38784	Manuals, Technical, General Style and Format, Requirements for

5.1.3 Standards

MIL-STD-210	Climatic Information to Determine Design and Test Requirements for Military Systems and Equipment
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-461	Electromagnetic Emission and Susceptibility Requirements for Control of Electromagnetic Interference
MIL-STD-810	Environmental Test Methods and Engineering Guidelines

MIL-STD-100	Engineering Drawing Practices
MIL-STD-1388	Logistics Support Analysis Record
MIL-STD-12	Abbreviations for Use on Drawings, Specifications, Standards and in Technical Documents
MIL-STD-882	System Safety Program Requirements
MIL-STD-1472	Human Engineering Design Criteria for Military Systems, Equipment and Facilities
MIL-STD-1777	Internet Protocol
MIL-STD-1778	Transmission Control Protocol
MIL-STD-1780	File Transfer Protocol
MIL-STD-1840A	Automated Interchange of Technical Information
DoD-STD-2167A	Defense System Software Development
DoD-STD-2168	Defense System Software Quality Program

5.1.4 Department of Defense (DOD) Publications

DoDI 5010.12	Procedures for the Acquisition and Management of Data
DoDD 5000.27	Logistics Data Element Standardization and Management Program
DoDI 4151.9	Technical Manual Program Management

5.1.5 Draft DoD Specifications

MIL-M-GCSFUI	General Content, Format, Style and User Interaction Requirements for IETMs
MIL-D-IETMDB	Revisable Data Base for Support of IETMs
MIL-M-IETMQA	Quality Assurance Program Requirements for IETMs and Associated Technical Information
MIL-HDBK-VP	Guidelines for Developing Specifications for IETM View Packages

5.1.6 Draft Navy Handbooks

MIL-HDBK-EDS	Electronic Display Systems for IETMs

6. DATA ACQUISITION

The criteria, delivery instructions, applicable standards and specifications, and generic tailoring of the specifications and standards, for the development and acquisition of technical data specifically for the program will be defined upon issuance of the DoD IETM specifications which are currently in coordination.

7. QUALITY ASSURANCE PROVISIONS

7.1 GENERAL

This section establishes the requirements and criteria for verification of ADAM performance, design characteristics, and system operability. Verification shall be accomplished to determine compliance with system requirements. Verification shall be performed at the functional area and system level, as required, and shall include design evaluation, integrated system evaluation, and system operational capability. Verification of system requirements shall be determined by one or more of the procedures of inspection, analysis, demonstration, and test. Verifications of software requirements shall be a major consideration of the quality assurance program of ADAM. Quality assurance for the ADAM data base will be specified by the DoD IETM specification regarding QA when issued.

7.1.1 Responsibility for Inspection

Unless otherwise specified in the contract, the contractor is responsible for the performance of all verification requirements. Except as otherwise specified, the contractor shall utilize facilities and services acceptable to the procuring agency. Ninety days prior to the start of any verification activity, the contractor shall provide a complete verification test plan for procuring agency review and approval. The procuring agency reserves the right to perform any of the verifications deemed necessary to assure conformance to prescribed requirements.

7.1.2 Special Tests and Examinations

Concept demonstrations of IETMs and integrated diagnostic technologies which have not been previously fielded must be conducted during the acquisition program to verify feasibility and demonstrate cost effectiveness. These demonstrations shall verify that maintenance technicians are better able to accomplish their job tasks using IETM data delivered by the ADAM system and is a prerequisite to production of the ADAM system.

7.2 QUALITY CONFORMANCE INSPECTIONS

Requirements for formal tests of performance and operational capabilities as defined herein shall be accomplished. Tests and demonstrations shall be accomplished in accordance with test plans and procedures approved by the procuring agency.

7.3 VERIFICATION METHODS

Verification methods shall consist of inspection, analysis (review of analytical data), demonstration, and test.

7.4 DELIVERY

Preparation for delivery shall be accomplished by the contractor in accordance with the contract. The method of delivery shall be specified by the Navy. Delivery shall be within the U.S. continental limits.

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ACRONYMS

AC	Alternating Current
ACFT	Aircraft
ADAM	Aviation Diagnostics and Maintenance
ADB	Aircraft Discrepancy Book
AFHRL	Air Force Human Resources Laboratory
AIMD	Aircraft Intermediate Maintenance Department
AIR	Aircraft Inventory Record
APML	Assistant Program Manager, Logistics
APU	Auxiliary Power Unit
ATE	Automatic Test Equipment
AWM	Awaiting Maintenance
AWP	Awaiting Parts
BIT	Built-in-Test
CAD	Cartridge Activated Device
CAMS	Core Automated Maintenance System
CALS	Computer-Aided Acquisition and Logistic Support
CASS	Consolidated Automatic Support System
CBW	Chemical-Biological Warfare
CDI	Collateral Duty Inspector
CD-ROM	Compact Disk, Read Only Memory
CDQAR	Collateral Duty Quality Assurance Representative
CFA	Cognizant Field Activity
CLS	Contractor Logistics Support
COMPRAK	Composite Tracking System
CONUS	Continental United States
CPU	Central Processor Unit
CSCI	Computer Software Configuration Item
CTF	Central Tracking Facility
CTMIP	CALS Technical Manual Improvement Plan
CV	Aircraft Carrier Designation (e.g., CV-68)
DLA	Defense Logistics Agency
DoD	Department of Defense
DSU	Data Storage Unit
ECAMS	Enhanced Computer Assisted Maintenance System
ECU	Engine Control Unit
EMCON	Emissions Control
EWP	Electronic Work Package
FAADC	Fleet Accounting And Dispersing Center
FIRMS	Flight Information and Recording System
FOD	Foreign Object Damage
FSD	Full Scale Development

ACRONYMS (Continued)

GFE	Government Furnished Equipment
GOSIP	Government Open Systems Interconnection Profile
ID	Interface Device
IECM	In-flight Engine Conditioning Monitoring
IETM	Interactive Electronic Technical Manual
I-Level	Intermediate Level Maintenance
IMA	Intermediate Maintenance Activity
IMRL	Individual Material Readiness List
JUSTIS	Joint Uniform Service Technical Information System
LAN	Local Area Network
LCC	Life Cycle Costs
LCN	Logistics Control Number
LUI	Life Used Indices
MDS	Maintenance Data System
MO	Maintenance Officer
MOMS	Map, Operator Maintenance Station
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
NADC	Naval Air Development Center
NADEP	Naval Aviation Depot
NALDA	Naval Aviation Logistics Data Analysis
NALCOMIS	Naval Aviation Logistics Command Management Information System
NAMDRP	Naval Aviation Maintenance Discrepancy Reporting System
NAMP	Naval Aviation Maintenance Program
NATSF	Naval Air Technical Service Facility
NAVFLIRS	Naval Flight Record Subsystem
NBC	Nuclear, Biological, Chemical
NDI	Non-Destructive Inspection
NDS	Non-Developmental Software
NETMS	Navy Electronic Technical Manual System
NPFC	Naval Publications and Forms Center
NPPS	Navy Printing and Publication Service
OFP	Operational Flight Program
O-Level	Organizational Level Maintenance
OPTAR	Operating Target (funding)
PC	Personal Computer
PEB	Pre-Expended Bin
PH&T	Packaging, Handling and Transportation
PIN	Personal Identification Number
PLTS	Parts Life Tracking System

ACRONYMS (Continued)

PMA	Portable Maintenance Aid
PME	Precision Measuring Equipment
PMS	Planned Maintenance System
POSIX	Portable Operating System Interface Standard
QA	Quality Assurance
QA/A	Quality Assurance/Analysis
QAR	Quality Assurance Representative
RCS	Radar Cross Section
R&R	Remove and Replace
SAF	Support Action Form
SAFE	Structural Analysis and Fatigue Effects
SDC	Signal Data Computer
SE	Support Equipment
SGML	Standard Generalized Markup Language
SHIPALT	Ship Alteration
SLM	Structural Life Monitoring
SNAP	Shipboard Non-tactical ADP Program
SNT	Serial Number Tracking
SPC	Statistical Process Control
SQL	Structured Query Language
SRA	Shop Replaceable Assembly
SSC	Supply Support Center
SUADPS	Shipboard Uniform Automated Data Processing System
TAMS	Test And Monitoring System
TAMPS	Tactical Mission Planning Station
TDSA	Technical Directive Status Accounting
TEDS	Trend and Event Diagnostic System
TI	Technical Information
TM	Technical Manual
TPDR	Technical Publication Deficiency Reporting System
TPI	Test Program Instruction
TPM	Test Program Medium
TPS	Test Program Sets
TQM	Total Quality Management
UPS	Uninterrupted Power Supply
VIDS/MAF	Visual Information Display System/Maintenance Action Form
VMARS	V-22 Maintenance Analysis and Reporting System
WRA	Weapon Replaceable Assembly
3M	Maintenance, Material, Management

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