



A Division of Lockheed Corporation Marietta.  
Georgia 30063

November 14, 1986  
L86R1480

United States Air Force  
Air Force Systems Command  
Aeronautical Systems Division  
Wright-Patterson Air Force Base, Ohio 45433-6503

Attention: Mr. Charles Silas, ASD/AEKAA

Subject: REQUEST FOR PROPOSAL F33657-86-R-0193, GENERIC INTEGRATED  
MAINTENANCE DIAGNOSTICS (GIMADS) PROGRAM

The Lockheed-Georgia Company views the Generic Integrated Maintenance Diagnostics Program as a vital link to improving and sustaining warfighting capability and look forward to being a partner with the Air Force to develop a generic process to insert integrated maintenance diagnostics into the weapon system design and development process. Integrated diagnostics is already being applied in our current programs, but this program is needed to provide the discipline and structure necessary to institutionalize the process.

We have been active in integrated diagnostics since the early days of the C-5A program when we made a pioneering effort to create an on-board, real-time, interactive, diagnostics and recording subsystem. This became the forerunner of all such projects including the B-1 Central Integrated Test System. The associated ground processing segment was the first example of an interactive maintenance data collection system. The success achieved is being expanded in our present Pilot's Associate and Smart Weapons Programs contracts. Our present concepts stem from over 13 years of manufacturing numerous items of automatic test equipment using integrated diagnostic concepts for the Navy Fleet Ballistic Missile Programs.

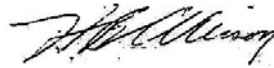
The challenges presented by the Generic Integrated Maintenance Diagnostics Program require that an experienced, innovative team work together for the common goal. Our team consists of the Lockheed-Georgia Company as prime with the Lockheed-California, Company, Allied Bendix Aerospace Company, Sperry Defense Product's Company, General Electric Aircraft Engine Group, - 2 and Detex Systems, Inc., as members. Supplementing this team is a group of companies that have agreed to work on an as needed consulting basis. The consultant companies are Rockwell/North American Aircraft Operations, Grumman Aerospace, and Barron Associates, with Mr. G. J. Montgomery as their chief consultant.

This team and the consultants have the talent and expertise in all of the disciplines needed to successfully conduct the program. In addition, an Industry/University Program is in the planning stages to provide liaison between the Generic Integrated Maintenance Diagnostics Program and the academic community.

The Government and Industry must at some point in time recognize that there are cases where a fixed price contract is inappropriate. The GIMADS program is a perfect example of such a case. The choice of a fixed price contract in this case has resulted in Lockheed including considerable conservatism in its price. Due to the developmental nature of this program, as clearly stated in the GIMADS Statement of Work, and the lack of identifiable criteria to determine an acceptable level of performance, Lockheed has also submitted a cost reimbursement alternate proposal, thereby eliminating the conservatism included in its fixed price. This results in over a \$7,000,000 decrease for the basic program. Lockheed would also consider a Fixed Price Level of Effort form of contract. Lockheed believes that its alternate cost reimbursement proposal is more in line with the FAR and is the preferred way to procure this type of effort and will best serve the interest of the Government.

We look forward to working with the Air Force in the development of the integrated diagnostics process.

LOCKHEED-GEORGIA COMPANY

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M. S. Allison  
Executive Vice President

HBA:bjm



Enclosure (a) to L86R1315

LG86ETP298

GENERIC INTEGRATED MAINTENANCE DIAGNOSTICS  
(GIMADS)

Volume I

Technical Proposal

November 1986

MIL-HDBK-181

APPROVED:

A handwritten signature in cursive script, appearing to read "D. M. Ryle, Jr.", written over a horizontal line.

D. M. Ryle, Jr.  
Chief Engineer  
Research and Technology

This proposal or quotation includes data that shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed in whole or in part for any purpose other than to evaluate the proposal or quotation. If, however, a contract is awarded to this offeror or quoter as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the resulting contract. This restriction does not limit the Government's right to use information contained in the data if it is obtainable from another source without restriction. The data subject to this restriction are contained in Sheets ii through A-12.

LOCKHEED-GEORGIA COMPANY  
A Division of Lockheed Corporation, Marietta, Georgia

## 1.0 TRODUCTION AND SUMMARY

### BACKGROUND

Improvements in maintainability, reliability, training, and maintenance diagnostics have put the Air Force in the best position it has ever been in to do its job of supporting a diversity of aircraft and support equipment types. Even with these improvements and the high aircraft availability rates that have been achieved, however, there are still many areas which could be improved. Currently there are gaps in fault isolation and detection at all levels of maintenance: high false alarm rates, high "cannot duplicate" rates, and high "retest OK" rates. These problems must be resolved before any significant improvements in aircraft availability can be achieved.

The most promising option for solving current problems, while supporting revised maintenance organizational structure and reduced manpower levels, is the inclusion of integrated maintenance diagnostics (ID) into future aircraft procurement programs. Although this is an excellent approach, it introduces a new set of issues associated with the integration process.

Recent advances in electronics, avionics and artificial intelligence appear to offer the needed solutions to integrating ID but, to date, it is difficult to compute their "value added." The immediate need is for a means to evaluate the requirements for implementing ID into future procurement programs. Some experience is being gained now as ID is inserted into current programs but the process is unstructured and undisciplined. The question still to be answered is what is the most effective way to implement ID.

Some of the problems associated with implementing ID are the decisions that must be made regarding requirements for new designs. Future weapon systems requirements will include intelligent prognostic/diagnostic systems on the aircraft to evaluate the impacts of failures (and projected failures) on the mission and aircraft performance, to integrate failure information with aircraft algorithms (such as algorithms for computing mission success and survivability), and to reconfigure subsystems based on failures and/or battle damage.



The ability to provide these capabilities in new aircraft depends on the weapon systems engineers being able to make optimum tradeoffs among the hundreds of interrelating factors involved in design decisions. Mission-driven analytical techniques will be required to optimally integrate the numerous requirements of weapon system design to maximize warfighting capability. It is becoming widely recognized that techniques such as life-cycle cost analysis are inadequate to determine the "most effective" mix of ID and weapon system capabilities. More and more, the evaluation is based on how effectively the ID system satisfies the objectives in R&M 2000.

Before solutions to the existing and future ID problems can be defined and implemented, a thorough analysis of current methods and problems in the development process and in the field must be performed. The anticipated impacts of new technology must be assessed in terms of the new problems that can be expected to arise and in terms of how this new technology can be applied to

solve these new problems. The existing data (military standards and specifications) must be reviewed and the applicable documentation identified. The procedures and verifications needed to integrate the ID process into the weapon system design and development must be determined based on the above analysis.

The GIMADS Program provides the opportunity to develop the system engineering process needed to optimally integrate ID into the overall weapon system design through the development of comprehensive documentation including a MIL-PRIME Standard, a Specification, and supporting Handbooks, and through the conduct of the Fill Technology Application Gaps Tasks. It is through the applications of GIMADS that further improvements in Air Force prognostics and diagnostics capabilities will be made.

#### GIMADS TEAM

Lockheed-Georgia has assembled a team of six companies with state-of-the-art expertise in technologies required to meet the challenges of the ASD Generic Integrated Maintenance Diagnostics

(GIMADS) Program. The core Lockheed GIMADS Team consists of Lockheed-Georgia (prime), Lockheed-California/Advanced Development Projects (ADP), Allied Bendix Aerospace, Sperry Corporation, General Electric, and Detex Systems. This complementary team represents nationally recognized expertise in all essential GIMADS topics. Figure 1-1 summarizes this expertise. Supplementing the core team are several companies that have agreed to

work with Lockheed on an as-needed consulting basis. The unique expertise furnished to the program by the consultants is summarized in Figure 1-2.

The Air Force GIMADS Program Office, with the Lockheed GIMADS Team, will develop a systems engineering process for inserting prognostics and diagnostics design into weapon systems and their support systems. The most challenging part of the GIMADS







TEAMMATE	PRIMARY EXPERTISE
	GIMADS PRIME CONTRACTOR, LARGE AEROSPACE PRIME, MILITARY AIRLIFT COMMAND (MAC) AIR LOGISTICS COMMAND (ALC), AND AIR TRAINING COMMAND (ATC) EXPERIENCE. INTEGRATION OF COMPLEX AVIONIC, ELECTRONIC, SOFTWARE SYSTEMS. PRIME CONTRACTOR FOR PILOT'S ASSOCIATE - AI DIAGNOSTICS. PRIME CONTRACTOR FOR SMART WEAPONS PROGRAM - AI/ RECONFIGURABLE DIAGNOSTICS. MADARS II AIR AND GROUND SYSTEMS - INTERACTIVE INTEGRATED DIAGNOSTICS-ADVANCED PROGRAMS IN RELATIONAL DATA BASES.
	PRIME CONTRACTOR FOR ATF, TACTICAL AIR COMMAND (TAC) EXPERIENCE. TESTABILITY AND INTEGRATED DIAGNOSTICS AUTOMATED ALLOCATION TOOLS DEVELOPMENT. PAVE PILLAR CONTRACTOR. BIT CATEGORIES AND ALLOCATIONS. MATE TEST PROGRAM, SET PROCEDURES AND COST ALGORITHMS.
	USE OF EXPERT SYSTEMS IN TEST EQUIPMENT. SUITCASE TESTERS. OFF-EQUIPMENT A/C DIAGNOSTICS AND TEST. TEST REQUIREMENTS DOCUMENTATION. STANDARDIZATION OF DIAGNOSTICS INFORMATION INTERFACES. SMART FLIGHT-LINE TEST EQUIPMENT. MANUAL/AUTOMATIC TEST EQUIPMENT SELECTION CRITERIA. MAINTENANCE DIAGNOSTIC AND PREVENTIVE MAINTENANCE PRACTICES. DIAGNOSTIC/PREVENTIVE MAINTENANCE TECHNIQUES FOR SYSTEMS USING AI. VERTICAL TEST METHODS. SIMPLIFIED TEST EQUIPMENT DESIGN FACTORS. DIAGNOSTIC/PREVENTIVE MAINTENANCE TECHNIQUES FOR SYSTEMS USING AI.
	ENGINE SYSTEMS. ENGINE HEALTH MONITORING SYSTEMS. RECONFIGURABLE FLIGHT CONTROL SYSTEMS. PILOT'S ASSOCIATE. TESTABILITY AND APPLICATION METHODS. ENGINE PREVENTIVE MAINTENANCE TECHNIQUES APPLICABILITY TO AVIONICS. SOFTWARE BUILT-IN FAULT TOLERANCE AND TESTABILITY METHODS.
	TEST RESOURCES ALLOCATION MODEL (TRAM) FOR SURFACING THE COST DRIVERS FOR A SELECTED DESIGN BASED UPON INHERENT TESTABILITY AND MAINTAINABILITY. EXTENSIVE MATE EXPERIENCE; PRIME CONTRACTOR, MATE INTEGRATION PROGRAM. MATE DATA BASE. BIT ALLOCATION TRADE STUDIES. BIT ERROR FAULT DETECTION/ISOLATION METHODS. TECHNICAL DATA BASE REQUIREMENTS. TEST REQUIREMENTS DOCUMENTATION. VHSIC AND VLSI IMPACT ON TEST EQUIPMENT, CAMS, CSAS.
	TESTABILITY ANALYSIS TOOLS. LOGMOD. IDSS CONTRACT. EFFECTS OF BATTLE DAMAGE IN BIT SYSTEMS. ASSESSMENT OF IDSS PROGRAM'S AUTOMATED ANALYSIS TOOLS.

Figure 1-1. GIMADS Team Member Expertise