UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON. D C 20548

B-207640

SEPTEMBER 6, 1983

Vice Admiral E.A. Grinstead
Director, Defense Logistics Agency

Dear Admiral Grinstead:

SUBJECT: Software Problems In The Development of The
Defense Fuel Automated Management System
(GAO/IMTEC-83-5)

We have completed our review of the Defense Fuel Automated
Management System (DFAMS), which is one of the systems included in
our Government-wide study on software obsolescence. DFAMS is de-
signed as a fully automated, integrated system that, when com-
pleted, will handle inventory management, procurement, financial
control, and accounting for bulk fuel products within the Depart-
ment of Defense. The life cycle development cost of the system is
estimated to be more than $481 million.

We recognize that only the financial accounting function of
DFAMS is complete and in operation. However, in our review we
found that DFAMS software is being developed with obsolete and non-
standard techniques that we believe will contribute in a major way
to software maintenance problems if allowed to continue.

We examined 23 operational DFAMS programs and found that the
programs do not comply with established American National Standard
Information (ANSI), Federal Information Processing Standards, or
Defense Logistics Agency programming standards. This appears to be
contrary to your agency's Normalization and Automatic Data Process-
ing Equipment Replacement (ADPER) program's objectives to standard-
ize all DLA applications software for ease in transportability.

In 42 percent of the programs examined, we found programming
deficiencies that, if not corrected, may cause the DFAMS applica-
tions software to become (1) obsolete before it completes its
planned life cycle and (2) economically unacceptable in supporting
the management of bulk fuel products in the Department of Defense.
For example, we found poor structure, organization, and documenta-
tion of the programs.

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OBJECTIVES, SCOPE, AND METHODOLOGY

We conducted our study at DLA headquarters and at the Defense Fuel Supply Center (DFSC), Cameron Station, Alexandria, Virginia. The objectives were to

--identify any instances of software obsolescence and the causes, and

--predict the impact of software obsolescence on mission accomplishment.

For purposes of this project, we defined several types of software obsolescence: Software may be functionally obsolete (does not satisfy user needs), technically obsolete (is difficult to maintain or convert), or economically obsolete (is expensive to operate). Or it can be obsolete in its relationship to personnel--it is so old that personnel lack the training to maintain it or do not want to maintain it because it is not up to state-of-the-art programming standards.

We performed our review in accordance with generally accepted government audit standards. We interviewed senior management officials, programmers, and users of DFAMS. We also reviewed Defense, DLA, and DFSC policies and regulations, technical documents, program master plans, and computer program listings. Although we briefed DLA and DFSC officials on our findings, since this is an interim report we did not request formal agency comments. Our final report will cover the overall subject of software obsolescence Government-wide.

DFSC RESPONSIBILITIES AND SYSTEMS

The Defense Fuel Supply Center, which has management responsibility for bulk fuel, was directed to develop and implement a fully automated, integrated system that would encompass the functions of inventory management, procurement, financial control, and accounting for bulk fuel products in the Department of Defense. DFSC began designing the system in 1975. The financial accounting function, which received General Accounting Office approval in April 1982, was developed first and became operational in October 1982. The supply and procurement functions are now being developed--Phase I is to be implemented in March 1985, Phase II in August 1987, and Phase III at a date yet to be determined.

When the decision was made to develop DFAMS, DLA managers were also realizing that the automatic data processing (ADP) equipment that supported their numerous automated systems was becoming unreliable and needed replacing. Incidents of ADP equipment failure were adversely affecting DLA's ability to provide service to its customers. To solve this problem, DLA developed its Automatic Data Processing Equipment Replacement strategy--referred to as the ADPER program.

ADPER program

The ADPER program was developed to provide DLA with an acquisition strategy that would support its data processing needs throughout a 15-year system life. Existing computer hardware and systems software would be replaced at 20 locations with 32 major computer configurations. Numerous short range problems had to be resolved first, however, so DLA developed a transition program called Normalization.

Normalization program

The Normalization program was developed to minimize the problems that were expected in changing to non-IBM equipment, and to promote competition when the ADPER program was offered to bidders. All applications software, systems software, and hardware had to be standardized and made as machine independent as possible. To do this, DLA is (1) upgrading all its computer hardware to IBM or IBM-compatible equipment, and (2) converting all its applications software to ANSI Common Business Oriented Language (COBOL) 1974, and its operating systems to Operating System/Multiple Virtual Storage (OS/MVS).

The Normalization and ADPER programs appear to be workable management strategies for achieving DLA's goals, but several factors in the development of DFAMS may have an impact on the achievement of these goals.

ESTABLISHED ADP STANDARDS AND POLICY
NOT FOLLOWED IN THE DEVELOPMENT OF DFAMS

We noted serious deviations from established ADP standards and policy in the development of DFAMS. Such deviations are contrary to the objectives of the Normalization and ADPER programs.

DLA regulations[1] state that all automated information systems will be supported by development and documentation standards defined in a series of DLA handbooks (DLAH 4730.1, 'Information Processing Standards") unless the requirement is specifically waived by the program administrator. Without such waiver, the Defense Fuel Supply Center developed its own ADP standards manual, which officials said would be followed for all programs developed in DFAMS. But the DFSC standards manual is not complete--it does not include

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[1]DLA regulation 4630.1, July 2, 1982, "Life Cycle Management of DLA Automated Information Systems" (which superseded DLA regulation 4730.1, Oct. 13, 1967, and implements Defense Standard 7935.1, Sept. 13, 1977, "DOD Automated Data Systems Documentation Standards"), establishes policy, assigns responsibility, and outlines procedures for the management, development and operation of automated information systems that qualify for life cycle management.

all of the Defense Logistics Agency's ADP standards. Consequently, in each of the 23 DFAMS programs we examined, we found numerous diagnostics[2] indicating that DLA standards were not followed. Since the diagnostics still existed, it was also apparent that the program code had not been inspected for compliance with established DLA standards.

Nor has DFSC followed its own internal ADP standards in programming DFAMS applications software. For example, the standards state that no more than 60 lines of code will be in a paragraph; we found paragraphs in DFAMS programs containing 240 lines of code. Such large paragraphs are difficult to maintain and have very high potential error rates.

We also found that inspections are not made and compliance is not enforced on any standards--Defense, DLA, or ANSI/Federal Information Processing Standards--for either code structure or language vocabulary. Management has taken the time to develop effective standards, but then has put very little emphasis or effort into ensuring their use.

RISK OF SOFTWARE OBSOLESCENCE
AND MACHINE DEPENDENCY IN DFAMS

In the 23 DFAMS programs we examined we found evidence of (1) poor program structure, organization, and documentation; (2) a lack of quality control to ensure that established programming standards and techniques are followed; and (3) significant use of vendor extensions.[3] Such programming practices will, over time, cause the programs to become more and more difficult to maintain. Significant use of vendor extensions causes machine dependency and may not be cost effective in the long run.

Software techniques and program organization
are poorly developed

The DFAMS project master plan, dated November 1978, states that structured programming will be used in developing DFAMS to ensure logical and systematic organization of the system. The DLA standards for this are given in DLAd 4730.1, volume IV, part I. Although structured programming techniques are used in the DFAMS application software, the techniques and the program organization are poorly developed. For example, some DFAMS programs lack a key control paragraph, which is supposed to activate other paragraphs.

We believe quality control of programming standards and techniques should be enforced in the development of DFAMS. If the poor

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[2]Indications of malfunctions or mistakes.

[3]Additions to the vocabulary and/or capacity of a computer programming language exceeding that prescribed by the standards for that language.

programming practices we noted are allowed to continue, the programs will become extremely difficult to maintain because (1) the logic will be difficult to follow, and (2) hasty maintenance changes to that logic are likely to make it worse. Maintenance costs will then become exorbitant. Many commercial software tools are available that could be used to improve the quality of DFAMS software and reduce its potential maintenance costs.

Machine independence is not being achieved

DFAMS was first developed on IBM 370/155 hardware using an ANSI 68 COBOL compiler and more than 100 vendor extensions. Under the Normalization program, the hardware was upgraded to IBM 4341 and other compatible equipment, using operating system OS/MVS, and a Model 204 data base management system, which operates only on IBM or IBM-compatible hardware. The plan also called for conversion from ANSI 68 COBOL to ANSI 74 COBOL and removal of vendor extensions to achieve machine independence.

DLA awarded a contract to Integrated Microcomputer Systems for $2.8 million, to convert the DFAMS programs from ANSI 68 COBOL to ANSI 74 COBOL. However, the conversion effort is being done line-by-line with no improvement in structure, organization, or documentation, and many of the vendor extensions are being retained because it is claimed they are needed to operate with the 204 data base management system. DLA and DFSC officials told us that they realize they will have a major conversion cost if hardware that is not IBM-compatible is acquired. This is because DFAMS, as currently developed, is IBM-dependent due to the use of the Model 204 data base management system and the retention of the IBM COBOL extensions.

CONCLUSIONS

DFAMS software is being developed with obsolete and vendor-dependent programming techniques. These techniques will cause the delivered system to be unnecessarily costly to maintain and, if incompatible hardware is acquired, lead to high conversion cost.

Many commercial software tools are available that run on computers which support ANSI COBOL and can assist in the planning and creation of application systems. We believe DLA should consider the use of such tools to improve the quality of the DFAMS application software and reduce potential maintenance cost.

DFAMS developers do not inspect program code for compliance with DLA, Defense, Federal, or ANSI standards. Software tools could greatly reduce the labor of such inspection.

The Normalization and ADPER programs appear to be sound ADP management strategies that should achieve DLA's goals of standardizing its software and becoming as machine independent as possible. However, DLA may have difficulty achieving these goals because, at least with DFAMS, it is not enforcing conformance with the Normalization objectives.

Since our review of DFAMS, the Under Secretary of Defense for Research and Engineering has issued a memorandum to all key Defense agencies announcing that ADA shall become the single, common, computer programming language for Defense's mission-critical applications. The Department wishes to create a high order computer language that will lead to software standardization and portability. DLA may be required eventually to convert DFAMS to ADA. This makes it even more important to develop DFAMS according to established programming standards because that would facilitate eventual conversion of DFAMS to a new language.

RECOMMENDATIONS

To assist the Defense Logistics Agency in achieving its ADP goals, we recommend that the Director, DLA:

--Determine and communicate a policy position on whether DFAMS should (1) comply with the objectives of the Normalization program or (2) justify that its critical mission requires a vendor-dependent approach.

--Act promptly to ensure that programming techniques used in DFAMS applications software comply with established DLA, Defense, ANSI, and Federal standards to facilitate conversion, if required.

--Ensure that quality control over programming techniques is enforced, using available software tools whenever possible.

Our policy is to follow up on our recommendations to see how they have been implemented. We would appreciate receiving a written statement on the actions you have taken or plan to take within 60 days of the date of this report. The statement should contain projected completion dates for all actions not yet completed.

We are sending a copy of this report to the Director of the Office of Management and Budget, the Secretary of Defense, the Administrator of General Services, and the House Committee on Government Operations. We will also make copies available to other interested parties.

Sincerely yours,

Warren G. Reed
Director, Information Management
and Technology Division