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DOCUMENTATION REQUIREMENTS
FOR SOFTWARE MAINTENANCE

THESIS

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AFIT/GSS/ENG/91D-9

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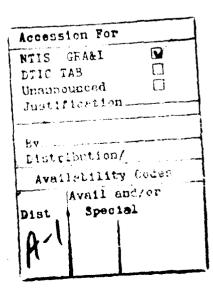
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DOCUMENTATION REQUIREMENTS FOR SOFTWARE MAINTENANCE

THESIS

Presented to the Faculty of the

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Requirements for the Degree of

Master of Science in Software

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Preface

The purpose of this thesis was to determine which documents cited by DOD-STD-2167A are required for the maintenance of a software system. This information is needed to ensure that maintenance personnel can readily access the ideas and requirements used by the original designers.

The research made use of existing information as well as a survey of those personnel involved in the acquisition and maintenance of software systems. The result is a clear picture of where these documents fit in during the maintenance phase of the software life cycle. If properly utilized, this information provides a first step in reducing the tremendous cost of software maintenance.

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Abstract

This study investigated the requirement for documentation during the maintenance phase of the software life cycle. Without proper documentation, maintenance personnel are not able to effectively understand the design of a software system and spend many hours performing design recovery before any type of maintenance can be performed.

A review of existing information showed a wide range of opinion among the experts in the field of software maintenance and was not conclusive. A survey of Air Force software maintenance personnel was then conducted to determine the need, availability, and tailoring results of the documents listed in DOD-STD-2167A. The analysis of this survey data showed that 11 of the 18 documents are required for maintenance. These include the specifications, design documents, user's manuals and programmer's manuals. Plans, reports and background information should be provided to the management of the maintenance organization for initial planning of the maintenance activity. The only documents deemed not needed during the maintenance phase are those that are eventually incorporated into other documents that will be

provided to the maintenance organization. The response to tailoring questions was insufficient and could not be used for a conclusive analysis.

Providing only the documents required by software maintenance personnel will reduce the time required to understand the software and result in lower costs during software maintenance.

DOCUMENTATION REQUIREMENTS FOR

SOFTWARE MAINTENANCE

I. Introduction

General Issue

In 1987 the cost of software maintenance within the
U. S. Government was reported to be approximately $3.5
billion (Caron, 1987). By 1990 this figure had exceeded
$17 billion for the DOD alone (Ferens, 1990). As the
importance of software in weapon systems continues to grow
and budgets continue to decrease, the DOD must find ways
to reduce the amount of money spent on software
maintenance.

The primary impediment to software maintenance is
software complexity (Harrison et al, 1982). In recent
years researchers have spent a great deal of time
attempting to quantify software complexity. While their
metrics may not yet offer a clear solution to the high
cost of maintenance, they have provided an insight into
the software characteristics that are impacted by
complexity (Harrison et al, 1982): understandability,
modifiability, and testability. If these characteristics
can be improved, the complexity of the system will be
reduced and the cost of maintenance will go down.

Software maintainers currently spend 47% to 62% of their time just trying to understand the program (Haley, 1989). Since the organization that maintains the software is generally not the same one that developed it, proper documentation is essential to communicating the abstract ideas and module interactions that exist in a program. If the thoughts of the original developers could be effectively communicated, the maintainers' tasks of modifying and testing the software would be much easier (Schneidewind, 1987:304).

Specific Problem Statement

The largest cost driver in software maintenance (program understandability) can be significantly reduced by supplying proper documentation to the software maintainers (Martin and McClure, 1983). Ironically, the current problems with documentation exist at both extremes: too much documentation, and not enough documentation. When provided all the documentation recommended by DOD-STD-2167A, the maintainers must spend hours sifting through enormous piles of paper to find the information they need. Even for simple projects, there can be a considerable amount of documentation (Buckle, 1984). On the other hand, the developing organization often fails to produce specific documentation needed for maintenance because that documentation is not needed

during the development. In both cases, it is not clear what documents are useful or should be produced (Rubey, 1985).

Research Objectives

The purpose of this research is to provide software maintenance organizations within the Air Force with a basis for determining documentation requirements for the maintenance of software systems. The information obtained provides a justification for documentation requirements during software acquisition and a guide to providing only the right documentation to maintenance personnel.

The research will investigate the following questions:

a. What documents (from DOD-STD-2167A) are needed to maintain software?

b. Is the needed documentation being provided?

c. Does the documentation contain too much information that is not needed?

d. Is other documentation (not listed in DOD-STD-2167A) needed?

Scope of the Research

This research will address only Mission Critical Computer Resources (MCCR). This does not include software for Automatic Data Processing Equipment (ADPE) which is

used for processing personnel records, finance information, and other such business-oriented applications. MCCR includes software that is essential for the deployment of a weapon system. This includes software necessary for the operation of aircraft systems, support equipment, training equipment, and simulators. The study will focus on software that is maintained organically by the Air Logistic Centers (ALCs) and the software that is currently being purchased by the System Program Offices (SPOs).

An investigation of the current state of software maintenance documentation will be presented and existing information will be investigated to provide an initial assessment of what documentation is required. Finally, an evaluation of the opinions of those people within the Air Force who actually maintain software will be provided. This will provide the information needed to categorize the documentation and ensure only the specific documents needed for maintenance are delivered.

II. Background

Definitions

Before starting a discussion of the problems of
software maintenance, it is important to clearly
understand what software maintenance is. The IEEE (1983)
defines software maintenance as:

> "The modification of a software product after
> delivery to correct faults, to improve performance
> or other attributes, or to adapt the product to a
> changed environment."

This divides software maintenance into three distinct
areas which are commonly called corrective (to correct
faults), perfective (to improve performance) and adaptive
(to adapt to a changed environment) maintenance. This
thesis does not differentiate among the three types of
maintenance.

Another aspect of software maintenance is the
maintainability of the software. Maintainability is
defined (IEEE,1983) as the ease with which maintenance on
a software package can be performed and is usually
measured in terms of software complexity. As stated
earlier, though, current measures of complexity, and
therefore maintainability, are immature and do not provide
much insight into the true nature of the software.

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Lastly, we must consider a definition for documentation. IEEE (1983) defines documentation as:

> "Any written or pictorial information describing, defining, specifying, reporting or certifying activities, requirements, procedures, or results."

This definition is very general, and this generality will soon be shown to be a hindrance to the overall software maintenance process.

Why Documentation for Software Maintenance is Important

When maintenance is performed on a software system, the maintainer must first understand all of the workings and interactions of the program. Because of the additional effort needed to understand the software, a change made during maintenance may cost as much as ten times what it would have cost during design (U. S. Congress, 1989:9). Unfortunately, not all faults or future requirements can be found or anticipated during design, so the maintenance phase will play a vital role in the life cycle of the software. Preparations for that maintenance must begin early in the life cycle of the software system.

Traditionally, preparations for maintenance do not begin until the system is delivered, because maintenance is wrongly viewed as a phase completely separate from software development (Martin and McClure, 1983). This

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results in delivery of software that is often unmaintainable and generally undocumented. The lack of planning for maintenance is not a vicious attempt by the developers to undermine the maintenance effort, but more a lack of understanding by the development organization of the impacts of their efforts. Software is no longer (and maybe never was) the easily changed subset of a large system; now it is often the major cost driver and basis of the entire system. In the rush to field a system, the development organization narrows its focus to the development at hand and often doesn't consider future requirements to change the software. The requirements for software maintenance are ignored and the documentation that is needed is not provided because the need to change software has been underestimated.

Proper documentation is the physical representation of the ideas and processes that were used to implement a software system (Evans et al., 1983) and it should enhance the readability and usability of the programs (Martin and McClure, 1983). Because software is intangible and abstract, documentation is essential to communicate the purpose of the code (Fox, 1982). Adequate documentation is useful during both development and maintenance of the software. New personnel, in either phase, will be better

able to understand the program, thus easing a portion (and therefore cost) of both the development and maintenance phases.

Many argue that good documentation is irrelevant because it will not be maintained with the software and will quickly be out of date. This is actually an indication of a weakness in the defined software process rather than an indication of the usefulness of the documentation. Glass and Noiseux make this point very clear (1981:35):

> "The intelligent software maintainer should realize, almost intuitively, that keeping documentation up to date is a vital part of any software change activity. It is a task analogous to the craftsman in another field keeping his toolbox organized and his tools oiled."

Unfortunately, it is often management that pushes the maintainer away from good documentation practices, because the same pressures that existed during the development phase still exist during the maintenance phase.

Problems With Software Maintenance Documentation

Although the software aspect of most new acquisitions is the major cost driver, procurement practices still focus on the hardware (U. S. Congress, 1989:4-5). Even during the maintenance phase, the hardware is still seen as the embodiment of the system, with the software as a minor subset that is wrongly perceived as something that

is easy to add or change. This focus on the hardware, according to Debra Haley (1988:22) of the Air Force Coordinating Office for Logistics Research (AFCOLR), ". . . threatens to undermine US security by consuming more and more defense appropriations."

Because we continually underestimate the complexity and importance of the software aspect of a weapon system, both in development and maintenance, we usually get to a point where it becomes clear that schedules cannot be met. To keep the project moving, a common response is to proceed with the technical tasks and ignore the documentation (Evans et al., 1983:60). Even when the project is progressing smoothly the documentation is generally given a low priority on the schedule of deliverables (Arthur and Stevens, 1989:42). One common practice is to complete the software development, release it to the field, and then produce the documentation that is needed (Arthur and Stevens, 1989:40). The obvious problem with this is that by the time the development is complete, the developers can't remember all the details of what was done. Additionally, by the time the documentation arrives, the organization that maintains the software (which is generally not the same as the developing organization) has already made changes to the system. This can result in very little consistency between the documents and the code (Antonini et al.,

1987:91). Since the documentation is obsolete before it is delivered, the only reliable source of information that exists is the program code (Antonini et al., 1987:91). This problem is not unique to the Department of Defense, though. Even in industry, many programs exist with no documentation (Martin and McClure, 1983).

As stated in chapter 1, the opposite problem, too much documentation, also exists. This is often due to the very general nature of the definition of documentation. Since the definition basically covers anything that can be written or drawn about the software, it provides no limits to what is useful. As some organizations realize the importance of software support requirements, they attempt to improve the quality of the product by adding unnecessary requirements for additional documentation (Haley, 1989:22). What results is voluminous amounts of detailed documentation that add to the maintenance cost by requiring a major documentation update effort each time the software is modified (Martin and McClure, 1983).

The military standard that addresses documenting a software project, DOD-STD-2167A, lists 18 documents needed for the life cycle of the software system. These 18 documents correspond to a maximum effort in software development (Acquisition Logistics Division, 1989). Although not all documents are needed for every phase of the software life cycle, each is needed in some phase.

Many of the documents that are necessary for the original development are not needed during the maintenance phase, and their delivery to the maintenance organization may only detract from the understanding of a program. When the maintainer has every bit of information produced during software development, the needed information becomes lost in piles of paperwork. This practice has resulted in maintainers spending 47% to 62% of their time just trying to understand the documentation (Haley, 1989:22). Like any other craftsman, the software maintainer will eventually sift through all the documents, find the information that is useful, and maintain only that documentation. If the proper documentation had been delivered to begin with, this major effort would have been avoided. One of the costliest problems in software maintenance is determining what documentation is needed (Arthur and Stevens, 1989).

Proposed Alternatives to Proper Documentation

Attempts to develop cost effective tools and methods for the maintenance programmer have met with very little success (Landis et al., 1988:66). Many of these tools and methods rely on reverse engineering the design or documentation from source code input (Antonini et al., 1987:91-100, Fay and Holmes, 1985:194-202, Landis et al., 1988:66-73). Reverse engineering is a common practice in

the world of hardware, but in attempting to transfer that technology to software, two major differences must be considered. First, the goals are different. When reverse engineering a piece of hardware, the goal is generally to duplicate the system. With software, duplication is a simple task usually left to a clerk rather than an engineer. Reverse engineering of software is performed to understand the original design so that it can be modified (Chikofsky and Cross, 1990:14). The second difference deals with the level of abstraction of the system. A piece of hardware is a concrete representation of an understood design, but software is often a representation of some abstract thought process (Fox, 1982:204). Because of these differences, no way has yet been found to extract total knowledge of a design from the program code (Antonini et al., 1987:91).

Conclusion

Good documentation is essential for quality maintenance of software. It is needed during the development phase to counteract personnel turnover, and it is certainly needed during the maintenance phase to communicate the abstract ideas of the designers. The software maintainers may also need documentation that wasn't needed during software development.

There are many reasons adequate documentation is not acquired in a timely manner:

    a.   The cost of documentation often accounts for as much as 15% of the total project cost (Buckle, 1984).

    b.   As schedules slip, programmers are often relieved of documentation tasks to speed up programming tasks (Landis et al., 1988:66).

    c.   The need to change a program is not understood (Martin and McClure, 1983).

Because of the high cost of software maintenance, it is clear that the development and maintenance phases must be treated as being at least equal in importance (Caron, 1987:36). The software process model must consider the maintainability of the system in all phases of the software life cycle and ensure the tools needed to do the job are available. The most feasible way to do this is to ensure that the proper documentation is delivered with all software.

This leaves us with a very important unanswered question: what documents need to be provided? As will be shown in the next chapter, even the experts do not agree on the answer. This thesis attempts to answer the question in a general nature based on the requirements of DOD-STD-2167A.

III. Existing Information

Conversion of Expert Opinion to DOD-STD-2167A

DOD-STD-2167A establishes standard requirements for software development that apply throughout a software system's life cycle. The standard provides the means for establishing, evaluating, and maintaining software and software documentation. Included in DOD-STD-2167A is a list of eighteen Data Item Descriptions (DIDs) which spell out the format and content of the documents required for the life cycle of a software system.

This section reviews articles by authorities in the field of software maintenance to evaluate their perspectives on documentation requirements for software maintenance. These experts' opinions are summarized and mapped to the DIDs listed in DOD-STD-2167A for comparison; then a tentative list of prioritized documents is produced. The order of presentation in this section does not imply a ranking of expert opinion.

Each article or book is listed by author, with a list of that author's view of what documents are required for maintenance. The equivalent DOD-STD-2167A document has been added in parenthesis, based on the content specified in the DID for each document. Some of the DOD-STD-2167A documents may cover more than one of a given author's requirements

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and a given document may contain much more than is required by the author. Tailoring of these documents is not covered in this section.

A list of acronyms is provided in appendix F.

Acquisition Logistics Division (ALD). The Supportable Software Acquisition Guide (ALD,1989) was the product of the Supportable Software Acquisition Working Group chartered by ALD. The working group consisted of project officers, engineers, and software maintainers with considerable experience in the problems of development and maintenance of software. The guide states that ". . . delivered documentation must include at least:

1. Description of what the software will do (SRS, IRS)
2. Description of how the software will do it (SDD, SPS)
3. Performance measures the software must meet to show it meets requirements (SRS)
4. Description of any support software, software engineering environment, or integration support facility used in developing and testing software (SSDD, CRISD)
5. Detailing on using items in 4 (SSDD, CRISD)
6. Specific inputs, scenarios, and acceptance criteria for each performance measure (STP)
7. Details on results of each test (to check if tests rerun) (STR)
8. Details on what was coded, tested, and delivered (VDD)
9. Details on interfaces and methods used by software packages to communicate with each other (IDD)
10. Total system requirements documents (SRS, IRS)
11. Description, data, test procedures, test results, etc., from system integration tests (STD, STP, STR)
12. Description of how an operator uses the software and interprets its results (SUM, CSOM)"

Rubey. The Guide to the Management of Software in Weapon Systems (Rubey, 1985) was developed under contract to the Army and the Air Force as an introduction to software management within the DOD. The guide lists ten documents required for software maintenance.

1. Requirements Specifications (SRS)
2. Design Specifications (SSDD. IDD, SDD)
3. Test Plan (STP)
4. Test Procedures (STP)
5. Test Report (STR)
6. As-Built Description (VDD)
7. System Specification (SPS)
8. Software Interface Specification (IRS)
9. Software Data Base Specification (SDD)
10. Users Manual (SUM, CSOM)

Rubey states that the first six documents listed are also required for development, while the last four listed are additional requirements for maintenance.

Buckle. In Managing Software Projects (1984:99-102), J.K. Buckle says that the maintenance programmer is not interested in what the original intent was, but rather in what was actually implemented. He lists five documents that are necessary for software maintenance:

1. Design Description (SSDD, IDD, SDD)
2. Hierarchical Design Description (SDD)
3. Design and Implementation Documents for Support Tools (SSDD, CRISD)
4. Compiler Listings (SPM)
5. Testing Documents (STP, STD, STR)

Fox. Joseph Fox states in Software and its Development (1982:202) that flow charts are no longer useful as documentation. He goes on to say that what is needed is:

1. Well-Commented Code (SPS)

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2. Design Diagrams and Narratives (SSDD, IDD, SDD)
3. Structured narratives or process diagrams (SDD)
4. Data Descriptions (SDD)

Glass and Noiseux. In The Software Maintenance Guidebook, the authors maintain that any documentation that is separate from the code will not be maintained and should therefore not be required (1981:159). They do consider a top level overview to be important and agree that it should be maintained as a separate document. This along with the source code would constitute the SPS as the only document required for maintenance. Code that contains all the information needed for maintenance, though, would be so bulky that the actual code may become lost in the comments.

Kempton et al. In this article by UNISYS Defense Systems personnel, the authors are using DOD-STD-2167A as a guide and list the following as required for software maintenance (1988:162):

1. SDP
2. VDD
3. STP
4. STD
5. STR
6. SPS

Fay and Holmes. In their article on updating an undocumented program, the authors (of Lockheed Aircraft Service Company, Software Engineering Department) list the following documents as necessary for maintenance (1985:202):

1. Source Code (SPS)
2. Description Document (SSDD, IDD, SDD)

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3. Users Manual (SUM, CSOM)
4. Version Description Document (VDD)
5. Test Documentation (STP, STD, STR)

Martin and McClure. In their book <u>Software</u>

<u>Maintenance: The Problem and its Solution</u>, the authors cite

the following documents as necessary for software

maintenance:

1. High Level Documentation (SRS, VDD, SSDD)
2. User Documentation (SUM)
3. Operations Documentation (CSOM)
4. Source Code (SPS)
5. External Program Specification (SRS)
6. Design Documents (SSDD, IDD, SDD)
7. System and Program Flowcharts (SSDD)
8. Cross-Sequence Maps (IDD)

<u>DOD-STD-2167A</u>. One final book to review is the DOD

standard for software development. The standard states

that the following five documents are to be developed and

delivered for software support and operation:

1. CRISD
2. CSOM
3. SUM
4. SPM
5. FSM

In addition to this, a review of the DIDs shows only

three described as possibly being used for maintenance.

These are the SPM, the FSM and the SSDD.

<u>Analysis.</u> As can be seen in Table 1, there is not a

great deal of agreement on what documents are required. If

each document is evaluated on the basis of the frequency

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TABLE 1
Summary of Expert Opinion

	DDSS	PDS	SRS	SRI	DDI	DDS	SPS	DDV	PTS
ALD	X		X	X	X	X	X	X	X
RUBEY	X		X	X	X	X	X	X	X
BUCKLE	X				X	X			X
FOX	X				X	X	X		
GLASS & NOISEUX						X	X		
KEMPTON ET AL.		X					X	X	X
FAY AND HOLMES	X				X	X	X	X	X
MARTIN & MCCLURE	X		X		X	X	X	X	
DOD-STD-2167A and DIDs	X								
TOTALS	7	1	3	2	6	7	7	5	5

	DTS	RTS	MOSC	MUS	MPS	MSF	DSIRC	PCE	NCS
ALD	X	X	X	X			X		
RUBEY		X	X	X					
BUCKLE	X	X			X		X		
FOX									
GLASS & NOISEUX									
KEMPTON ET AL.	X	X							
FAY AND HOLMES	X	X	X	X					
MARTIN & MCCLURE			X	X					
DOD-STD-2167A and DIDs			X	X	X	X	X		
TOTALS	4	5	5	5	2	1	3	0	0

with which the experts believe the document is necessary, a tentative prioritization can be established.

Three of the documents were listed in seven of the references. These are the SSDD, the SDD, and the SPS. The IDD was the only document referenced six times. It is reasonable that the design documents would be required, but the SPS actually consists of two documents: the source code and the SDD. Requiring both the SDD and SPS for maintenance would cause two problems. First, both documents would have to be maintained, causing extra (unnecessary) work for the software maintainers, and second, having two separate documents that (allegedly) say the same thing could become a major configuration problem if one document is not updated. Since the SPS contains both the SDD and the source code, the SPS should be supplied for maintenance but a separate SDD should not.

Five of the papers called for the VDD, the STP, the STR, the CSOM, and the SUM; four cited the STD as necessary; three agreed that the SRS and CRISD are needed; and only two believed the IRS and the SPM are important. Only one report stated that the SDP and the FSM are necessary. None of the experts referenced the information included in the ECP, or the SCN. It is understandable that the ECP and SCN were not mentioned, since the information in those documents is added to other documents when a change is performed.

Based on this information, Table 2 shows a tentative prioritization of the documents.

AFOTECP 800-2 Documentation Questions

AFOTECP 800-2 volume 3, the Software Maintainability Evaluation Guide, is used by the Air Force Operational Test and Evaluation Center (AFOTEC) to rate the maintainability of a software system. If the evaluation does provide an adequate assessment of software maintainability, the

TABLE 2

Prioritization Based on Frequency
of Experts Opinions

1. SSDD/SDD or SPS
2. IDD
3. VDD/STP/STR/CSOM/SUM
4. STD
5. SRS/CRISD
6. IRS/SPM
7. SDP/FSM

information the evaluators look for should certainly provide insight into what documents are actually required to perform maintenance. The guide contains 68 questions related to the documentation, 35 of which deal directly with the content of different documents (the remaining 33 questions deal with organization, format, traceability, etc.). All 68 questions are listed in appendix D. Table 3 lists the numbers of the 35 questions that relate to

documentation content and which documents from
DOD-STD-2167A are addressed by each question.

Using DOD-STD-2167A, the frequency with which a
document was referenced can influence the maintainability
rating given by AFOTEC. If all questions are equally
weighted, then the documents that are referenced most often
will have a greater impact on the maintainability rating
given by AFOTEC. A prioritization based on the frequency
of references by these questions is given in Table 4.

Table 3

Relationship between AFOTECP 800-2 and DOD-STD-2167A

Question	Document(s)	Question	Document(s)
D-10	IRS, IDD	D-30	SSDD
D-11	VDD	D-31	SDD, SPS
D-13	SDD, SPS, SSDD	D-32	SDD, SPS
D-14	CSOM, SUM	D-33	SSDD
D-15	CSOM, SUM	D-34	SSDD
D-16	CSOM	D-36	SSDD
D-17	CSOM	D-37	SSDD
D-19	SDD, SPS	D-38	SSDD
D-20	SDD, SPS	D-39	SDD
D-21	SDD, SPS, SSDD	D-40	SPM
D-22	SDD, SPS, SSDD	D-48	STP
D-23	SDD, SPS	D-49	STD
D-24	SDD, SPS	D-50	STD
D-25	SDD, SPS	D-51	STD
D-26	SRS	D-52	STD
D-27	SDD, SPS	D-53	STD
D-28	SDD, SPS, SPM	D-54	STD
D-29	SDD, SPS		

Table 4

Documents Required by AFOTECP 800-2 volume 3

---

1. SDD or SPS
2. SSDD
3. STD
4. CSOM
5. SUM/SPM
6. IDD/VDD/STP/SRS/IRS

Table 4 does not include six of the documents listed in DOD-STD-2167A. As stated earlier, the ECP and SCN should not carry over into the maintenance phase and their exclusion from this list was expected. Likewise, the Software Development Plan (SDP) is a tool used to track contractor performance and although it may be used by the management of a maintenance organization to initially determine the scope of the maintenance effort, it is not useful in the actual maintenance of the system. Surprisingly, the need for the Software Test Report (STR) is not mentioned. Its main purpose is to document previous tests, but it also includes sections about problems encountered and recommendations for future changes. These sections may be of some use to the maintenance programmer, and the STR is needed for regression testing.

The CRISD contains information about the support environment, but again, this information is probably more useful to the maintenance organization management than to the actual maintenance programmer.

Finally, the FSM is not listed in Table 4. As stated earlier, if the system includes firmware, the FSM is an absolute necessity.

In summary, the literature review was not conclusive. The opinions of the authors varied greatly among those reviewed and a new article could change the prioritization given. The analysis of AFOTECP 800-2 provides a better basis for documentation requirements, but does not appear complete.

IV. Survey

Justification

This chapter investigates the opinions of software maintainers and acquisition personnel within the Air Force to determine which documents they consider necessary for software maintenance. Because of the number of responses required and the amount of time available, a mail survey was the only feasible method of obtaining the required information.

Survey Instrument

The survey (Appendix A) asks five questions for each of the 18 documents listed in DOD-STD-2167A. The first question determines the availability of documents to software maintenance personnel:

> Is this (or a similar) document available for maintenance of your software?
>
> a. Yes
> b. No

Since DOD-STD-2167A is relatively new, and most software in existence today was developed under old standards, similar documents must also be included in this investigation.

The second question determines the requirement for each
document during the maintenance phase of the software
life cycle:

> Without this document, maintenance is:
>
> a. not impacted
> b. somewhat difficult
> c. difficult
> d. very difficult
> e. impossible

This provides a range of choices from which the
respondent can choose an answer that shows the relative
importance of the document without necessarily stating that
the document is not required for maintenance. It is
generally believed that if a document is not absolutely
required, it will not be provided. The type of answer
listed above will provide a scaling of responses to
indicate the impact of not having a specific document.

The last three questions address tailoring of the Data
Item Description (DID) for a particular document. Question
three asks:

> If the document is needed for maintenance, was the
> DID tailored to meet maintenance requirements?
>
> a. Yes
> b. No, tailoring was not necessary
> c. No, but it should have been
> d. Don't know

This provides general information about tailoring of
the DID.

Question four addresses the ALC's participation in the tailoring process:

> If the DID was tailored, did the ALC participate in the tailoring process?
>
> a. Yes
> b. No
> c. Don't know

Combined with question five, this will determine the correlation between the ALC's participation in the tailoring process and the usability of the document.

Question five asks about the amount of information present in a document:

> If the DID was tailored, how did the amount of information required for software maintenance compare with other information in the documents?
>
> a. too little maintenance information and an acceptable amount of other information.
> b. an acceptable amount of both maintenance information and other information.
> c. too little maintenance information and too much other information.
> d. an acceptable amount of maintenance information and too much other information.

This provides an assessment of the tailoring done on that document and determines if the needed information is lost in reams of paperwork.

Each document was listed in the survey with its title, DID, and a brief description of the document. This was done to reduce the time required to complete the survey by those personnel who are not currently using DOD-STD-2167A.

The survey also asks the respondent to list any other documentation (not listed in DOD-STD-2167A) that is required for maintenance and what type of organization the respondent works for (ALC or SPO). Space is also provided for comments.

Population to be Sampled

As stated earlier, two different populations were sampled. The survey is limited to those persons responsible for the acquisition and maintenance of MCCR software within each of those organizations. The ALCs provided the basis for determining what documentation is required as well as what is currently available. The response from the SPOs gives an alternate view of the documentation requirements and may indicate whether training is required.

The number of people directly responsible for the maintenance of MCCR software is estimated to be 5149 in AFLC and 1497 in AFSC (AFLC, 1989). To determine the sample size required (for a 90% confidence level), the following general equation applies (HQ USAF/ACM,1974):

$$n = \frac{N(z^2)p(1 - p)}{(N - 1)(d^2) + (z^2)p(1 - p)} \tag{1}$$

where

n = sample size

N = Population size

p = Maximum sample size factor (0.5)

d = Desired tolerance (0.1)

z = Factor of assurance (1.645 for 90% confidence level)

This results in a sample size (n) of 67 for AFLC and 65 for AFSC. Assuming a low return rate, 360 surveys were sent -- 200 to AFLC and 160 to AFSC. The return rate was not consistent between the commands, with 103 responses (51%) received from AFLC and only 27 responses (17%) received from AFSC.

Survey Results

A complete list of the raw survey data is listed in appendix B. Because the response to questions related to document tailoring was insufficient for significant statistical analysis, this paper will not address the issue except to point out that those responses received indicate that adequate tailoring is being performed. This is not to say that tailoring is not needed, but generally speaking, the ALCs are happy with the tailoring that has been performed. For all cases, the number of documents that should have been tailored, but were not, is minimal compared to the documents that were tailored or those that

did not need tailoring. When the ALC assisted in the
tailoring process, the amount of maintenance information
and other information was well-balanced.

Appendix E presents the tailoring information received
in the form of a table for each document that compares the
amount of maintenance information and other information
versus the ALC's participation in the tailoring process.
Table 5 presents the data for the remaining information and
lists the number of responses, the percent availability,
and the mean of the need as perceived by the respondents.
ine responses for the need were converted to a numerical
value where A = 1, B = 2, C = 3, D = 4, and E = 5. This
implies that the higher the need rating, the more crucial
the document is for software maintenance.

The next section will provide an analysis of this data.

Analysis

This section reviews the results of the survey based on
the data presented in Table 5 in order of mean need as
perceived by the ALC. Each document is presented
separately with a brief description and comments on
availability to the ALCs and the perceived need of both
the ALC and the SPO. The analysis is based on the
perceived need of the ALCs since they are the ones to
actually use the documents. The next section will compare
this information with that of the previous chapter and

Table 5.
Survey Data

	Number of Responses	Percent Available	Mean Need (ALC)	(SPO)
SPS	129	81.40	3.939	4.500
SPM	127	72.44	3.551	2.526
SDD	126	71.43	3.305	3.263
FSM	129	48.06	3.187	2.526
SRS	126	75.40	3.120	2.889
SUM	129	76.74	3.081	2.526
IDD	128	54.69	3.020	3.333
IRS	127	59.06	2.970	3.000
CSOM	128	72.66	2.928	2.526
SCN	122	69.67	2.844	2.526
ECP	123	73.17	2.695	2.526
VDD	112	78.57	2.656	2.750
STD	128	76.56	2.590	2.526
CRISD	126	58.73	2.354	2.526
SSDD	128	53.91	2.316	2.278
STP	119	85.71	2.280	2.421
SDP	129	72.87	1.938	2.158
STR	128	75.00	1.860	2.526

finalize the documents requirements list. The documents
are discussed in order of their presentation in
DOD-STD-2167A.

System/Segment Design Document. The SSDD contains the
highest level design information for the system or segment.
It describes the organization of a system or segment as
composed of Hardware Configuration Items (HWCIs), Computer
Software Configuration Items (CSCIs) and manual operations
(DI-CMAN-80534). The DID for this document also states
that the SSDD is used for maintenance of the system. While
this document appears to be required for software

maintenance, almost half of the respondents do not have the document. This may be the cause of the low requirement rating generated by the ALCs (2.316). Those that have the document tended to give it a higher rating that those that do not.

Software Development Plan. The SDP describes a contractor's plans for conducting software development (DI-MCCR-80030A). As stated in chapter 3, the SDP is of little use in the actual maintenance of a software system. This accounts for the low rating given to this document (1.938) by the ALCs. Even though the need for this document is virtually nonexistent, over 70 percent of the maintainers have the SDP.

Software Requirements Specification. The SRS specifies the engineering and qualification requirements for a CSCI and is the basis for the design and formal testing of a CSCI (DI-MCCR-80025A). The impact of not having this document is high (3.120), and most (75.40%) of the maintainers have access to it.

Interface Requirements Specification. The IRS specifies the requirements for interfaces between one or more CSCIs and other configuration items or critical items (DI-MCCR-80026A). Although this document is rated relatively high (2.970), only 59 percent of the maintainers have access to it. Those that have the IRS rated it much higher than those that do not. The lower rating may have

resulted from systems that are composed of a single CSCI and therefore do not require interfaces.

Interface Design Document. The IDD specifies the detailed design for interfaces between one or more CSCIs and other configuration items or critical items (DI-MCCR-80027A). Again, this document is rated high (3.020), though few (54.69%) maintainers have it. As with the IRS, those that have the document rate it higher than those that do not. This, again, is probably due to system specific needs.

Software Design Document. The SDD describes the complete design of a CSCI (DI-MCCR-80012A). This is a general overview of the entire system. The SDD received a very high rating (3.305) and is available to most (71.43%) of the maintainers. See analysis for the SPS.

Software Product Specification. The SPS consists of the SDD and source code listings for a CSCI (DI-MCCR-80029A). The SPS received the highest rating of all the documents (3.939) which agrees with the analysis of chapter 3. The document is available to over 80 percent of the maintainers. This again raises the question of whether this document and the SDD should both be maintained. According to the survey results, both are rated very high (the SPS was rated first and the SDD was third). This may be because of tailoring of the SPS. That is, the SPS may only include references to the SDD without actually

including it, but no data is available to substantiate this. As stated in chapter 3, if the SPS includes the SDD, both documents should not be maintained during the software maintenance phase.

Version Description Document. The VDD identifies and describes a version of a CSCI (DI-MCCR-80013A). This document received a need rating of 2.656 and is available to almost 80 percent of the maintainers.

Software Test Plan. The STP describes the formal qualification test plans for one or more CSCI (DI-MCCR-80014A). It also identifies the software test environment resources required for Formal Qualification Testing (FQT) and identifies individual tests performed during FQT. Although this document received a relatively low rating by the ALCs (2.280), it was ranked very high in chapter 3. Compared to the other test documents, though, the STP is more of a management tool than a tool required by the maintainer.

Software Test Description. The STD contains the test cases and test procedures necessary to perform formal qualification testing of a CSCI identified in the STP (DI-MCCR-80015A). Of all the test documents, the STD received the highest rating (2.590) and is available to most of the maintainers (76.56%). Since this document contains the actual test cases, it is of more immediate use to the maintainers than the other test documents.

Software Test Report. The STR is a record of the
formal qualification testing performed on a CSCI
(DI-MCCR-80017A). This document received the lowest rating
of all documents on the survey (1.860) but is available to
fully three quarters of the maintainers. As stated in
chapter 3, the STR does have some maintenance related
information. Specifically, deviations from the test
procedure should be considered, recommended improvements
should be reviewed by the maintenance management, and the
report is needed as a baseline for regression testing.

Computer System Operator's Manual. The CSOM provides
information and detailed procedures for initiating,
operating, monitoring, and shutting down a computer system
and for identifying or isolating a malfunctioning component
in a computer system (DI-MCCR-80018A). Compared to the
other documents, the CSOM received a relatively high rating
(2.928) and is available to over 70 percent of the software
maintainers. Those maintainers that don't have the CSOM
rated it significantly lower than those who have it. This
is probably due to the fact that the information can be
found in Technical Orders (TOs) for many onboard systems.
Although the survey did not address TOs or associate TOs
with the CSOM or SUM, the responses to the CSOM and the SUM
(see below) indicate that user's manuals are very important

to maintenance whether they are in the form of a CSOM, SUM, TOs, or Commercial Off The Shelf (COTS) manuals. This was also obvious from the comments received (see Appendix C).

Software User's Manual. The SUM provides user personnel with instructions sufficient to execute one or more related CSCIs (DI-MCCR-80019A). This document received a high rating (3.081) and is available to most of the maintainers. See the analysis of the CSOM for more details.

Software Programmer's Manual. The SPM provides information needed by a programmer to understand the instruction set architecture of the specified host and target computers (DI-MCCR-80021A). This document is important for the maintainance of any software system and received the second highest rating on the survey (3.551). It is available to over 70 percent of the maintainers.

Firmware Support Manual. The FSM provides the information necessary to load software or data into firmware components of a system (DI-MCCR-80022A). As stated in chapter 3, if firmware exists in a system, then the FSM is an absolute necessity for maintenance. Unfortunately, firmware is often viewed as hardware and considered permanent in its original configuration. This document received a very high rating (3.187), but less than 50 percent of the maintainers have the document. Although no data was collected concerning the existence of firmware,

those who do not have the FSM rated it approximately 2.75, which indicates that it is not always present when needed.

Computer Resources Integrated Support Document. The CRISD provides the information needed to plan for lifecycle support of deliverable software and is used for updating the Computer Resources Life Cycle Management Plan (CRLCMP) (DI-MCCR-80024A). This document received a relatively low rating (2.354), and only 58 percent of the maintainers have it. Since the CRLCMP must be maintained by the maintenance organization, maintaining the same information in the CRISD is not only unnecessary but unwise.

Engineering Change Proposal. The ECP includes both a proposed engineering change and the documentation by which the change is described and suggested (DI-CMAN-80639). This document received a rating of 2.695 which is higher than originally expected. As stated in chapter 3, once an ECP is approved, other documents are modified to include the changes, so ECPs written during design or development should be of little use during maintenance. The unexpected high rating may be due to the requirement to generate new ECPs during the software maintenance phase. The only ECPs written during development that may be of interest would be those that were disapproved. If the decision makers in charge of the maintenance organization have the disapproved

ECPs with the reason each was not incorporated, they will not spend time re-evaluating similar proposals that are submitted during the maintenance phase.

Specification Change Notice. The SCN is used to delineate the exact change(s) in a specification that will be distributed to users when the SCN is approved (DI-CMAN-80643). Again, the rating of 2.844 is unexpectedly high, but probably for the same reason as the ECP. SCNs might be developed during the maintenance phase prior to their incorporation into the required specification. The SCNs produced during the development phase should be of little interest during the maintenance phase.

Conclusion

The current availability of documentation does not correspond to the need for those documents. Documentation that was needed for the development phase, but not useful during software maintenance, is readily available; documents not needed to track development, but required for maintenance, are sometimes scarce. This section divides the documentation into three categories that describe the need during the maintenance phase of the software life cycle. These three categories are:

  1. Documentation needed by the maintenance programmer.

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2. Documentation needed by the management of the maintenance organization.
3. Documentation not needed during the maintenance phase of the software life cycle.

Note that the third category does not imply that the maintenance organization should not be included in the tailoring or review of these documents during the development phase, but that when the system is delivered, these documents are only of historical interest.

The following paragraphs provide guidance for delivery of final documentation to the support organization but should not be interpreted as the final word on the matter. They provide a minimum requirement for software maintenance. The support organization should participate fully in tailoring the DIDs as well as spelling out precisely which documents are required during the maintenance phase. The documentation requirements for software maintenance should be included in both the CRLCMP and the PMRT agreement. The support organization should also be included in the review of preliminary documents and approval of those documents needed for maintenance.

Documentation Needed by the Maintenance Programmer.
The documentation needed for maintenance of a software system can be divided into four categories:

1. General overview of the system.
2. Specifics of the system.
3. Current implementation of the system.
4. Testing of the system.

The general overview of the system includes the SPS, the SRS, the SPM, and the FSM. Although the SPM and FSM could be considered specifics of the system, they are included here because they represent programming practices for the entire system.

The specifics of the system are documented in the IDD, the IRS, and the SSDD.

The current implementation of the system is described in the SUM, the CSOM, and the VDD. Applicable TOs and commercial manuals should also be included in this category.

Testing of the system is covered by the STD.

In summary, Table 6 shows what documents are required by the maintenance programmer and lists them in order of the mean of the need as perceived by the ALCs.

Table 6
Documents Required by Software Maintainers

1. SPS	5. SUM	9. VDD
2. SPM	6. IDD	10. STD
3. FSM	7. IRS	11. SSDD
4. SRS	8. CSOM	

Note: Any other documentation that explains the use of the system (TOs, COTS manuals, etc.) should also be delivered.

Documentation Needed by the Management of the Maintenance Organization. The following documentation should be provided to the management of the maintenance organization for initial planning of the maintenance phase

of the system life cycle. These documents appear to be of limited use to the actual maintenance programmer.

1. SDP
2. STP
3. Disapproved ECPs
4. STR

The management should also have the CRLCMP, but this document generally becomes the responsibility of the maintenance organization when the software is turned over to them.

Documentation Not Needed During the Maintenance Phase of the Software Life Cycle. The following documents are not needed during the maintenance phase of the software system, and to reduce the maintenance burden, should not be maintained after the system is developed.

1. SDD
2. SCN
3. CRISD
4. Incorporated ECPs

The SDD is not needed because it should become part of the SPS. The SCNs are preliminary documents with their content added to the respective specification on approval. Information needed from the CRISD should be incorporated into the CRLCMP. ECPs that were approved and incorporated should be reflected in the appropriate design documents and specifications.

Comparison of Survey Results with Existing Information. All of the documents listed in Table 6 are included in

Table 2 (Prioritization based on frequency of expert opinions) and all except the FSM are in Table 4 (Documents required by AFOTECP 800-2). As explained in chapter 3, if firmware exists then the FSM is required and AFOTEC may have other procedures to deal with firmware. Of those documents required by the management of a maintenance organization, only the disapproved ECPs are missing from Table 2; Table 4 mentions only one of those documents (the STP). The documents listed as not needed during the maintenance phase, with the exception of the SDD, are not present in any of the relevant tables. As stated earlier, the SDD should not exist concurrently with the SPS.

In summary, Table 6 provides a more complete basis for documentation requirements, but as stated earlier, should be used as a minimum requirement, not a complete list. Other documents should be evaluated independently based on specific system requirements.

V. Conclusion

Significance of Research

This research has shown that the Air Force often
provides insufficient or unnecessary information to the
software maintenance organizations. The information most
needed is often not available, while documents that are not
useful during software maintenance are provided. This
results in software maintainers looking through enormous
piles of paperwork trying to understand the software, while
the needed information is often not there. With this
situation, the only way to understand the software is to
reverse engineer the source code and attempt to recreate
the thought process of the original designers. If the
documents listed in Table 6 are properly developed and
provided to the software maintainers, their ability to
understand the system will be greatly enhanced, thus
reducing a large portion of the maintenance cost.

Practical Implications

This thesis provides a starting point for reducing the
amount of documentation provided for software maintenance,
but the list of documents provided in Table 6 should be
viewed as a minimum requirement, not an absolute
requirement. Depending on the domain of the software

system, additional documentation may be required (for example, maintenance of ATL software requires significant information about the Unit Under Test). To effectively use the information provided in this thesis, the acquisition agency and the maintenance organization must work closely together throughout software acquisition.

The maintenance organization must be consulted early in the software life cycle to determine exactly which documents are needed, and this information should be documented in initial PMRT agreements and in the CRLCMP. While the maintenance documents are being developed, the maintenance organization must be allowed sufficient time to review the content to ensure that the information being provided is adequate. The maintenance organization should have approval authority for any documents that are used only for maintenance. Additionally, some way must be found to deliver the proper final documents to the maintenance organization. During the acquisition process, the maintenance organization should be included in the review of all documentation submitted by the contractor, but when the system is delivered, only the final documents that are needed for maintenance should be delivered.

Recommendations

This section makes recommendations needed both to implement the findings of this thesis and for additional

research that may further enhance the software maintenance effort.

Revision of Data Item Descriptions (DIDs). As stated in chapter 3, only three of the DIDs called for by DOD-STD-2167A state that the document may be used for maintenance. The DIDs related to the documents listed in Table 6 should include a statement in block 3 (Description/purpose) that says the document is required for software maintenance. The DIDs for the documents required for management activity should state in block 3 that the document is required by the management of the maintenance organization to initially set up the software maintenance capability.

Content of the Maintenance Documents. During the course of this research, it was found that some information is repeated in different documents (for example, the IRS and the IDD contain many identical sections). This adds to the maintenance burden by requiring that multiple documents be updated during a maintenance action. Further research is needed to determine if the format prescribed by the combined DIDs communicate the ideas of the software designers in the best possible manner.

Training of Personnel. Comments received with the survey responses show a lack of understanding by both acquisition and maintenance personnel of the content of the documents addressed. Many comments concerning additional

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documentation needed listed the same documents that were asked about or information that is contained in the DOD-STD-2167A documents. Comments from the SPOs often stated that the respondents were unfamiliar with the documents or the needs of the maintenance organization. This type of training is available, as a short course, through AFIT/EN (WCSE 474, Software Generation and Maintenance) and will familiarize personnel with the importance and requirements of the maintenance phase of the software life cycle.

Tailoring of the Maintenance Documents. Although the survey responses generally indicated that tailoring was adequate, the response to questions on tailoring was limited and may not be statistically significant. If the documentation is not properly tailored, the delivered documents could contain too much unnecessary information or lack crucial information. Although inclusion of the maintenance organization in the tailoring process should ensure all necessary information is present, the maintenance organization is often not identified until after a new development is placed on contract. Research should be performed that will provide a tailoring plan for the maintenance documents that can be used by the acquisition organization to ensure maintenance requirements are adequately addressed.

Appendix A: Survey

Software Documentation Requirements Survey

DOD-STD-2167A lists 18 documents that should be developed during the acquisition of a software system.   On any major software system, this becomes an enormous amount of paperwork for any organization to understand and maintain.   We would like to know which documents the ALCs use most often in maintaining software, and which documents the SPOs believe are necessary for software maintenance.

This survey is being sent to the Air Logistic Centers (ALCs) and System Program Offices (SPOs) in order to obtain different perspectives on the subject.   Please answer the questions based on the perspective of your organization and the software for which you are responsible.

For the purpose of this survey, software maintenance will be defined as the modification of a software product after delivery to correct faults, improve performance, or to adapt the software to a new environment.

Since DOD-STD-2167A is relatively new, and most systems were developed using other standards, a brief description of each document is listed.   If a document similar to the one listed is available, it should be used as a basis for completing the survey.

Additional comments, explanations, and suggestions are welcome and will be considered in the final report.   Address all questions and comments to Capt Timothy McArthur, AFIT/LSG, Wright-Patterson AFB OH 45433 (Defense Switched Network 785-8989).

Completing the Survey

This survey contains five questions for each of the 18 documents listed in DOD-STD-2167A.   To save room, the complete questions are listed on page 2, and an abbreviated version of the questions is listed on each page.   Each document is then listed with the applicable Data Item Description (DID) number and a brief description of the document.   The right side of the survey provides space to answer the questions prior to filling in the computer answer sheet, if desired.   The first two questions should be answered for each document, the third question should be answered only if the document is required for maintenance, and is available. The last two questions should be answered only if tailoring of the DID was performed.

Complete questions

These five questions will be asked for each of the 18 documents listed in DOD-STD-2167A. Because of the length of the questions, the complete questions are listed here and an abbreviated version is listed on each page of the survey.

I.   Is this (or a similar) document available for maintenance of your software?
    a. Yes.
    b. No.

II. Without this document, maintenance is:
    a. not impacted
    b. somewhat difficult
    c. difficult
    d. very difficult
    e. impossible

III. If the document is needed for maintenance, was the DID tailored to meet maintenance requirements?
    a. Yes.
    b. No, tailoring was not necessary.
    c. No, but it should have been.
    d. Don't know.

IV. If the DID was tailored, did the ALC participate in the tailoring process?
    a. Yes.
    b. No.
    c. Don't know.

V.   If the DID was tailored, how did the amount of information required for software maintenance compare with the amount of other information in the document?
    a. too little maintenance information and an acceptable amount of other information.
    b. an acceptable amount of both maintenance information and other information.
    c. too little maintenance information and too much other information.
    d. an acceptable amount of maintenance information, and too much other information.

EXAMPLE

```
+====================================================================+
|                    Abbreviated Questions                           |
|              (for complete question, see page 2)                   |
|                                                                    |
| I.   Document is:              IV. ALC _____ help tailor DID      |
|      a. available                  a. did                          |
|      b. not available              b. did not                      |
|                                    c. don't know                   |
| II.  Without document,                                             |
|      maintenance is:           V.  Document contained:             |
|      a. not impacted               a. too little maintenance       |
|      b. somewhat difficult            information                  |
|      c. difficult                  b. acceptable amount of         |
|      d. very difficult                maintenance information      |
|      e. impossible                 c. too little maintenance       |
|                                       information/too much         |
| III. Tailoring was:                   other information           |
|      a. performed                  d. acceptable amt of            |
|      b. not performed/not needed      maintenance information/     |
|      c. not performed/needed          too much other              |
|      d. don't know                    information                 |
+====================================================================+
```

Question #	I	II	III	IV	V
System/Segment Design Document	1.	2.	3.	4.	5.
DI-CMAN-80534	a	a	a	a	a
Describes the organization of a	b	b	b	b	b
system or segment as composed of		c	c		c
Hardware Configuration Items (HWCIs),		d			d
Computer Software Configuration Items		e			
(CSCIs) and manual operations.					

This example asks for information about the System/Segment Design Document. The left side of the example shows the name of the document, the DID for this document, and a brief description of the document. The right side shows which questions should be answered, and the possible answers, for this document.

If the document is available: 1 A B C D E

If maintenance cannot be performed
without this document: 2 A B C D E

If the DID was tailored: 3 A B C D E

If the ALC did not help tailor

the DID: 4   A   B   C   D   E

If the information needed for
software maintenance is available,
but lost in a lot of needless
information: 5   A   B   C   D   E

Abbreviated Questions
(for complete question, see page 2)

I. Document is:
  a. available
  b. not available

II. Without document, maintenance is:
  a. not impacted
  b. somewhat difficult
  c. difficult
  d. very difficult
  e. impossible

III. Tailoring was:
  a. performed
  b. not performed/not needed
  c. not performed/needed
  d. don't know

IV. ALC _____ help tailor DID
  a. did
  b. did not
  c. don't know

V. Document contained:
  a. too little maintenance information
  b. acceptable amount of maintenance information
  c. too little maintenance information/too much other information
  d. acceptable amt of maintenance information/too much other information

	Question No.	I	II	III	IV	V
System/Segment Design Document DI-CMAN-80534 Describes the organization of a system or segment as composed of Hardware Configuration Items (HWCIs), Computer Software Configuration Items (CSCIs) and manual operations.		1. a b	2. a b c d e	3. a b c	4. a b	5. a b c d
Software Development Plan DI-MCCR-80030A Describes the contractor's plans for conducting software development.		6. a b	7. a b c d e	8. a b c	9. a b	10. a b c d
Software Requirements Specification DI-MCCR-80025A Specifies the engineering and qualification requirements for a CSCI. Specifies the requirements allocated to a CSCI.		11. a b	12. a b c d e	13. a b c	14. a b	15. a b c d

Software Documentation Requirements Survey

Abbreviated Questions
(for complete question, see page 2)

I. Document is:
  a. available
  b. not available

II. Without document,
  maintenance is:
  a. not impacted
  b. somewhat difficult
  c. difficult
  d. very difficult
  e. impossible

III. Tailoring was:
  a. performed
  b. not performed/not needed
  c. not performed/needed
  d. don't know

IV. ALC _____ help tailor DID
  a. did
  b. did not
  c. don't know

V. Document contained:
  a. too little maintenance
    information
  b. acceptable amount of
    maintenance information
  c. too little maintenance
    information/too much
    other information
  d. acceptable amt of
    maintenance information/
    too much other
    information

Question No.	I	II	III	IV	V
Interface Requirements Specification DI-MCCR-80026A Specifies the requirements for one or more interfaces between one or more CSCIs and other configuration items or critical items.	16. a b	17. a b c d e	18. a b c	19. a b	20. a b c d
Interface Design Document DI-MCCR-80027A Specifies the detailed design for one or more interfaces between one or more CSCI(s) and other configuration items or critical items.	21. a b	22. a b c d e	23. a b c	24. a b	25. a b c d
Software Design Document DI-MCCR-80012A Describes the complete design of a CSCI. It breaks the CSCI into Computer Software Components (CSCs) and Computer Software Units (CSUs).	26. a b	27. a b c d e	28. a b c	29. a b	30. a b c d

Software Documentation Requirements Survey

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+--------------------------------------------------------------------+
|                     Abbreviated Questions                          |
|            (for complete question, see page 2)                     |
|                                                                    |
| I.   Document is:            IV. ALC _____ help tailor DID        |
|      a. available                a. did                            |
|      b. not available            b. did not                        |
|                                  c. don't know                     |
| II.  Without document,                                             |
|      maintenance is:         V.  Document contained:               |
|      a. not impacted             a. too little maintenance         |
|      b. somewhat difficult          information                    |
|      c. difficult                b. acceptable amount of           |
|      d. very difficult              maintenance information        |
|      e. impossible               c. too little maintenance         |
|                                     information/too much           |
| III. Tailoring was:                 other information             |
|      a. performed                d. acceptable amt of              |
|      b. not performed/not needed    maintenance information/       |
|      c. not performed/needed        too much other                |
|      d. don't know                  information                   |
+--------------------------------------------------------------------+
```

Question No.	I	II	III	IV	V
Software Product Specification DI-MCCR-80029A Consists of the Software Design Document (SDD) and source code listings for a CSCI.	31. a b	32. a b c d e	33. a b c	34. a b	35. a b c d
Version Description Document DI-MCCR-80013A Identifies and describes a version of a CSCI.	36. a b	37. a b c d e	38. a b c	39. a b	40. a b c d
Software Test Plan DI-MCCR-80014A Describes the formal qualification test plans for one or more CSCI. Identifies the individual tests that shall be performed during Formal Qualification Testing.	41. a b	42. a b c d e	43. a b c	44. a b	45. a b c d

Software Documentation Requirements Survey

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┌─────────────────────────────────────────────────────────────────────┐
│                      Abbreviated Questions                            │
│               (for complete question, see page 2)                     │
│                                                                       │
│  I.  Document is:              IV. ALC _____ help tailor DID        │
│      a. available                  a. did                             │
│      b. not available              b. did not                         │
│                                    c. don't know                      │
│ II. Without document,                                                 │
│     maintenance is:             V. Document contained:                │
│      a. not impacted               a. too little maintenance          │
│      b. somewhat difficult            information                     │
│      c. difficult                  b. acceptable amount of            │
│      d. very difficult                maintenance information         │
│      e. impossible                 c. too little maintenance          │
│                                       information/too much            │
│ III. Tailoring was:                   other information               │
│      a. performed                  d. acceptable amt of               │
│      b. not performed/not needed      maintenance information/        │
│      c. not performed/needed          too much other                  │
│      d. don't know                    information                     │
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Question No.	I	II	III	IV	V
Software Test Description DI-MCCR-80015A Contains the test cases and test procedures necessary to perform Formal Qualification Testing (FQT) of a CSCI identified in the software test plan.	46. a b	47. a b c d e	48. a b c	49. a b	50. a b c d
Software Test Report DI-MCCR-80017A A record of the formal FQT performed on a CSCI.	51. a b	52. a b c d e	53. a b c	54. a b	55. a b c d
Computer System Operator's Manual DI-MCCR-80018A Provides information and detailed procedures for initiating, operating, monitoring, and shutting down a computer system and for identifying/ isolating problems.	56. a b	57. a b c d e	58. a b c	59. a b	60. a b c d

Software Documentation Requirements Survey

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+------------------------------------------------------------------+
|                      Abbreviated Questions                        |
|                (for complete question, see page 2)                |
|                                                                    |
|  I.  Document is:              IV. ALC _____ help tailor DID     |
|      a. available                  a. did                          |
|      b. not available              b. did not                      |
|                                    c. don't know                   |
|  II. Without document,                                             |
|      maintenance is:           V.  Document contained:             |
|      a. not impacted               a. too little maintenance       |
|      b. somewhat difficult            information                  |
|      c. difficult                  b. acceptable amount of         |
|      d. very difficult                maintenance information      |
|      e. impossible                 c. too little maintenance       |
|                                       information/too much         |
|  III. Tailoring was:                  other information            |
|      a. performed              d. acceptable amt of                |
|      b. not performed/not needed      maintenance information/     |
|      c. not performed/needed          too much other               |
|      d. don't know                    information                  |
+------------------------------------------------------------------+
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	Question No.	I	II	III	IV	V
Software User's Manual DI-MCCR-80019A Provides user personnel with instructions sufficient to execute one or more related CSCIs. Provides steps for executing the software, expected output, and errors.		61. a b	62. a b c d e	63. a b c	64. a b	65. a b c d
Software Programmer's Manual DI-MCCR-80021A Provides information needed by a programmer to understand the instruction set architecture of the specified host and target computers.		66. a b	67. a b c d e	68. a b c	69. a b	70. a b c d
Firmware Support Manual DI-MCCR-80022A Provides the information necessary to load software or data into firmware components of a system.		71. a b	72. a b c d e	73. a b c	74. a b	75. a b c d

55

Software Documentation Requirements Survey

Abbreviated Questions
(for complete question, see page 2)

I. Document is:
   a. available
   b. not available

II. Without document,
    maintenance is:
   a. not impacted
   b. somewhat difficult
   c. difficult
   d. very difficult
   e. impossible

III. Tailoring was:
   a. performed
   b. not performed/not needed
   c. not performed/needed
   d. don't know

IV. ALC _____ help tailor DID
   a. did
   b. did not
   c. don't know

V. Document contained:
   a. too little maintenance information
   b. acceptable amount of maintenance information
   c. too little maintenance information/too much other information
   d. acceptable amt of maintenance information/ too much other information

	Question No.	I	II	III	IV	V
Computer Resources Integrated Support Document - 80024A Provides the information needed to plan for the life cycle support of deliverable software.		76. a b	77. a b c d e	78. a b c	79. a b	80. a b c d
Engineering Change Proposal DI-CMAN-80639 Provides a complete analysis of the technical, interface, cost, schedule and logistics impacts of a proposed change.		81. a b	82. a b c d e	83. a b c	84. a b	85. a b c d
Specification Change Notice DI-CMAN-80643 Delineates the exact change(s) in a specification that will be distributed to users when the Specification Change Notice is approved.		86. a b	87. a b c d e	88. a b c	89. a b	90. a b c d

91. Are other documents required for software maintenance that are not listed above?

    a. Yes (please list)
    b. No

92. For which type of organization do you work?

    a. ALC
    b. SPO

93. Was the documentation that you use developed using DOD-STD-2167A?

    a. Yes
    b. No

Optional information

Name: _____

Organization: _____

Title: _____

Phone: _____

Additional Comments:

Appendix B: Survey Responses

Response No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
									Question								
1	B	C				B	A				B	B				b	D
2	A	B	D	C	D	B	A	C	B	C	B	A	D	C	A	A	B
3																	
4	A	A	A	A	B	A	A	A	A	B	A	A	A	A	B	A	B
5	A	C	B	C	D	A	C	B	C	D	A	C	D	C	D	A	C
6	A	A	B	B	B	A	D	B	C	B	A	B	B	B	B	A	B
7	B	A	B	A	B	A	B	A	A	D	A	D	A	A	B	B	B
8	B	D	D	C		B	A	D	C		B	D	D	C		B	D
9	B					A	A	D	C		A	D	A	A	A	B	
10	B	A				A	B	D	C		A	C	A	A	B	B	A
11	A	A				A	A				A	A				A	A
12	B	A				A	A				A	D	A	A	A	B	A
13	B	C	D	B	A	B	B	D	B	A	B	B	D	C	C	B	B
14	B	D				B	A				B	A				B	D
15	B	C				B	A				B	B				B	C
16	B	A				B	A				A	B	D	C	A	B	C
17	B	A	D	C	A	A	A	C	C	A	A	A	C	C	A	A	A
18	A	B	A	A	B	A	A	A	A	B	B	B				B	B
19	B	D	D	B		A	D	A	A	B	A	E	D	C	B	A	E
20	A	E	A	A		A	D	I	A		A	E	B			A	E
21	A	B		C	D	B	A		C	A	A	D	D	C	B	A	C
22	B	A	D	C		B	A	D	C		B	A	D	C	B	B	A
23	A	A				B	A				B	A				B	A
24	B	A	B	B	B	A	B	B	b	B	B	A	B	B	B	B	A
25	B	D	D	B		A	D	A	A	B	A	E	D	C	B	A	E
26	A	A	D	B	B	A	B	D	C	A	B	B	D	D	A	A	C
27	A	A	B			A	C	B			A	D	B			A	C
28					A	B	A	D	C	A		D	C		A		C
29	B	D	D	B		A	D	A	A	B	A	E	D	C	B	A	E
30	A	A	D	C	B	A	A	D	C	B	A	A	A	C	B	A	A
31	A	B	D	D	B	B	C	D	B	A	A	C	B	B	C	B	C
32	A		D	C	B	B		D	C	B	A	C	D	C	B	A	B
33	A	B	C	A	B	B					A	B	A	A	B	A	B
34	B	A	B			B	A	B			B	A	B			B	C
35	B					B					A	A	D			A	A
36	B	A				A	B				A	C				B	A
37	A	E	B	B	B	A	D	A	B	C	A	E	A	B	C	A	E
38	B	A	D	C		B	A	D	C		B	A	D	C		B	A
39	A	D	B			A	D	A	A	D	A	D	B			A	C
40	B	D				B	D				B	D				B	C
41	A	B	D			A	A	D			A	B	D			A	C
42	A	B	A	C	B	A	A	A	C	B	A	B	A	C	B	A	D
43	B	A	D	C		B	A	D	C		B	A	D	C		B	A

Response No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
44	B	B				A	D	B	A	D	B					A	D
45	A	C				A	C									A	C
46	B	A				A	A				A	C	B		B	B	A
47	B	D	A	A		B	D	A	A		B	E	A	A		B	E
48	B	B	B			A	C	A	B	B	B	C	A	C	B	B	C
49	A	C	D			B	B				A	C	B			A	D
50	A	A	D			A	A	D			A	A	D			A	C
51	B	A				A	A	B			A	C	B			A	C
52	A	B	B			A	A	A	A	A	A	B	A	A	D	B	C
53	A	C	B	A	B	A	B	A	A	B	A	E	B	A	B	A	E
54	B	A	D	C	A	A	B	D	C	A	A	B	D	C	A	A	B
55	B	C	D	C		A	A	D	C		B	A	D	C		A	C
56	A	B	D	B	B	B	A	D	C	A	D	A	A	B	D	A	B
57	A	B	B	B	B	A	C	B	B	B	A	C	B	B	B	A	D
58	A	B	D	C		A	A	D	C		A	C	D	C		B	A
59	A	C	B			A	A	D			A	B	D			A	B
60	A	A	D			A	A	D			A	C	D			A	C
61	B	A				A	A				A	D	B			A	E
62	B					A	B	B	B	B	B					B	
63	A	A				A	B	A	A	A	A	E	A	A	B	A	E
64	A	C	B			A	D	B			A	D	B			A	D
65	B	B	D	C	A	B	A	D	C		B	B	D	D		B	A
66	B	D				B	D				B	D				B	D
67	A	B	C	B	A	A	B	C	B	D	A	D	C	B	A	A	E
68	B	B				A		A	A	B	B	C				B	C
69	B	E				A	A	B	B	B	A	B	A	B	B	A	B
70	A		D			A		B			A	A	D			A	A
71	B	B				A	A	B			A	A	B			B	A
72	A	C	A	A	B	A	C	D	C	B	A	C	B	C	B	A	C
73	A	E	D	C	C	A	A	D	C	A	A	D	D	C	C	A	E
74	A	A				A	C	A	A	C	B	C				B	C
75	A	A				A	A				A	A				A	C
76	B	A				B	A				A		D	C	A	B	C
77	A	B	B			A	A				A	C	B			B	A
78	A	B	B			A	A				A	C	B			B	A
79	A	E	B			A	B	B			A	E	C				
80	B	A				B	A				B	A				B	A
81	B	B				A	A				A	C	B			A	C
82	A	C	D	C	C	A	A	D	C	A	B	A	D	C	A	B	C
83	B	C				A	A				A	C	A	C	B	A	A
84	B	A	A	A	B	A	E	A	A	B	A	B	D	A	B	A	C
85	B	B				A	C	D	C		A	C	D	C		A	D
86	B	B				B	B				B	C				B	D
87	B	C	D			A	A	B			A	B	B			B	C
88	B	B	A	B	A	A	E	A	B	B	B	B	A	B	A	B	D
89	B	A				A	C	D	B		A	E	C			A	D
90	A	C	C			B	A				A	D	A	A	B	A	A
91	A	A	D			A	B	C	B	A	A	E	A	A	A	A	E

59

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
92	A	D	D	A	B	A	D	D	A		B	E	D	C		A	D
93	A	B	A	B		A	A	A	B		A	D	A	B		A	D
94	A	B	D	C		A	A	D	C		A	C	D	C		B	
95	A	C	A	A	B	A	B	A	A	B	A	C	A	A	B	A	E
96	B	D	D	B		A	D	A	A	B	A	E	D	C	B	A	E
97	A	D	B			A	A	A	B	B	A	D	B			A	D
98	A	A	D	C	A	A	B	A	C	B	A	E	D	B	B	A	E
99	A	B	B	B	B	A	A	B	B	A	A	B	A	B	B	A	B
100	B	A	D	C		B	A	D	C		B	C	D	C		B	B
101	A	D				A	B				A	E				A	E
102	A	D	B	B	C	A	D	B	C	A	A	D	D	C	C	A	C
103	A	E	D			A	B	D			A	D	D			A	D
104	A	B	D	C	B	A	A	D	C	B	A	C	D	C	A	A	C
105	A	B	D			A	B	D			A	D	D			A	C
106	A	B	A	A	D	A	B	A	A	D	A	B	A	A	D	A	B
107	B	A	D			B	A	D			B	B	D			B	C
108	A	B	B			A	A	B			A	C	B			B	B
109	A	C	D	C	B	A	C	D	C	A	A	C	D	C	B	A	E
110	A	D	D	C	B	B					A	C	D	C	B	A	C
111	A	A	A	C		A	C	A	C	D	A	E	A	C	B	B	B
112	B	B				A	B	D	C	A	A	E	A	A	A	A	D
113	B	A				A	B	D			A	E	D			A	D
114	B	A				A	C	D			A	E	D			A	E
115	B	B	D	C	A	B	A	D	C	A	A	D	A	A	B	B	C
116	A	B	A	B	A	A	A	A	A	A	A	C	A	B	B	B	B
117	A	D	A	A	B	A	A	A	A	B	A	D	A	A	B	B	D
118	A	D	A	A	B	A	A	A	A	B	A	D	A	A	B	B	D
119	A	C	B	C	B	A	B	D	C	C	A	E	D	C	B	B	A
120	A	C	D			A	B	D			A	E	D			A	E
121	B	B	D	C	B	B	B	D	C	B	A	C	D	C	B	B	B
122	B					A	B	A	B	A	A	B	A	B	B	A	B
123	B	A				A	C	B	A	B	A	D	B		B	B	C
124	A	A				A	A				A	B	A	A	B	B	A
125	A	C	A	C	B	B	A		A		A	C	A	A	B	B	B
126	B	B	C	B	B	B					A	C	B	B	B	A	C
127	A	B	A	A	B	A	B	A	A	C	A	D	A	B	A	A	D
128	B	D	D			A	C	D	B	C	A	D	D	B	C	A	D
129	A	C	A	A	B	A	D	D	C	C	A	D	D	D	B	A	C
130	B	B				A	A	D	C	A	A	E	D	C	B	A	D

Response No.	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
1				B	C				B	C				A	E		
2	C	C	C	A	B	D	C	A	A	C	D	B	B	A	A	D	C
3																	
4	A	A	B	A	C	A	A	B	A	C	A	A	B	A	D	A	A
5	B	B	D	A	B	B	C	B	A	C	B	C	B	A	C	B	B
6	B	B	B	A	D	B	B	B	A	E	B	B	B	A	E	B	B
7	C	A	A	B	C	C	A	A	A	D	A	A	B	A	D	A	A
8	D	C		B	D	D	C		B	D	D	C		Ƃ	D	D	C
9				B					B					A	C	A	A
10	D	C		B	A	D	C		A	C	A	A	B	A	D	A	A
11				A	A				A	A				A	A		
12				B	A				B	A				A	C	B	
13	D	C	C	B	B	D	C	C	B	B	D	C	C	B	B	D	C
14				B	D				B	E				B	B		
15				B	C									B	E		
16				B	C				B	B				A	C	D	C
17	C	C	A	A	A	C	C	A	A	A	C	C		A	A	C	C
18				A	B	A	A	B	A	C	A	A	B	A	E	A	A
19	D	B	B	A	E	D	B	B	A	E	D	C	B	A	E		B
20	B			A	E	A	A		A	E	A	A		A	D	D	
21	D	C	A	A	C	D	C	B	A	B	D	C	B	A	B	D	C
22	D	C		B	A	D	C		A	D	D	C		A	E	D	C
23				B	C				A	B				A	A		
24	B	B	B	B	A	B	B	B	B	A	B	B	B	B	A	B	B
25	D	B	B	A	E	D	B	B	A	E	D	C	B	A	E	D	B
26	A	B	B	A	C	A	C	B	A	C	A	C	B	A	E	A	C
27	B			B	B	B			A	D	B			A	E	B	
28	D	C	A	B	C	D	C	A		D	D	C	A	A	E	D	C
29	D	B	B	A	E	D	B	B	A	E	D	C	B	A	E	D	B
30	A	C	B	B	A	D	C	B	A	A	D	C	B	A	B	A	C
31	B	B	C	B	A	D	C	B	B	A	D	C	B	B	A	D	C
32	D	C	B	A	B	D	C	B	A	C	D	C	B	A	B	D	C
33	A	A	B	B					B					A	C	A	A
34	B			B	C	B			B	C	B			B	B	B	
35	D			A	D	D			A	B	D			A	D	D	
36				B	A				A	C				A	E		
37	A	B	B	A	D	B	B	B	A	D	A	B	B	A	D	A	B
38	D	C		B	A	D	C		B	A	D	C		B	A	D	C
39	B			A	E	B			A	E	B			A	E	B	
40				B	D				B	D				B	D		
41	D			A	A	D			A	D	D			A	E	D	
42	A	C	A	A	D	A	C	B	A	D	A	C	B	A	E	A	C
43	D	C		A	B	D	C	B	B	A	D	C		B	A	D	C

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No.	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
44	B			A	E	B			A	E	C			A	E	B	
45				A	C				A	C				A	E		
46				B	A				A	C	B		B	A	C	B	
47	A	A		B	E	A	A		B	E	A	A		B	E	A	A
48	B			B	D	B			B	D	A	C	B	B	D	B	
49	B			A	D	B			A	C	B			A	D	B	
50	D			A	B	D			A	A	D			A	C	D	
51	B			A	C	B			A	C	B			A	D	A	A
52				B	C				B	D	A	A	B	B	C		
53	B	A	B	A	E	B	A	B	A	E	B	A	B	A	E	B	A
54	D	C	A	A	C	D	C	A	A	C	D	C	C	B	E	D	C
55	D	C	B	B	C	D	C		A	D	D	C	B	A	D	D	C
56	B	D	B	A	B	A	A	B	B	A	B	B		A	E	A	A
57	B	B	B	A	C	A	A	B	A	D	A	A	B	A	E	A	A
58	D	C		A	C	D	C		B	A	D	C		A	D	D	C
59	D			A	D	B			A	C	B			A	D	B	
60	D			A	C	D			A	D	D			A	E	D	
61	B			A	E	B			A	E	B			A	E	B	
62				B					B					A	B	B	B
63	A	A	B	A	D	A	A	B	B	B				A	E	A	A
64	B			A	B	B			A	A	B			A	D	B	
65	D	C		B	A	D	C		B	A	D	C		B	A	D	C
66				B	D				B	D				B	D		
67	C	B	C	A	C	C	B	C	A	E	C	B	C	A	D	C	B
68				B	C				B	B				A		A	A
69	A	B	B	B	A		B		B	A				A	D	A	B
70	D			A	E	D			A	C	D			A	E	B	
71				A	C	A	A		A	C	B			A	E	B	
72	D	C	B	A	C	A	A	B	A	C	A	A	B	A	C	A	A
73	D	C	B	A	D	D	C	B	A	C	D	C	C	A	E	D	C
74				B	C				B	C				B	D		
75	B			A	C	B			A	D	B			A	E	B	
76				B	C				A		D	C	A	A		C	C
77				A	D				A	D	B			A	E	B	
78				A	D				A	D	B			A	E	B	
79				A	E	C								A	E	C	
80				B	A				B	A				B	A		
81	B			A	C	B			A	D	B			A	E	B	
82	D	C	A	A	D	D	C	B	A	D	D	C	C	B	A	D	C
83				B	C				A	C	A	C	B	B	C		
84	D	A	B	A	B	D	A	B	A	A	D	A	B	A	C	A	A
85	D	C		A	D	D	C		A	C	D	C		A	D	D	C
86				B	D				B	C				A	D	B	B
87	D			B	C	D			A	D	A	A	B	A	E	A	A
88	D	B	A	A	D	A	B	A	A	D	A	B	A	A	D	A	B
89	C			A	D	D	B		A	E	C			A	E	B	
90	C			A	B	C			A	D	A	A	B	A	D	B	
91	A	A	A	A	C	A	A	A	A	D	A	A	A	A	D	A	A

Response No.	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
92	D	C		A	B	D			A	E	D			A	E	D	
93	A	B		A	C	A	B		A	C	A	B		A	E	A	B
94	D	C		B		D	C		B	A	D	C		A	E	D	C
95	A	A	B	A	D	A	A	B	A	D	A	A	B	A	E	A	A
96	D	B	B	A	E	D	B	B	A	E	D	C	B	A	E	D	B
97	B			B	D	B			B	D	B			B	D	B	
98	A	A	C		D	D	C		A	D	D	C	A	A	E	A	A
99	A	B	B	A	C	D	C	B	A	C	D	C	B	A	E	B	B
100	D	D		B	B	B	D	D	B	A	D	D		A	C	D	D
101				A	E				A	C				A	C		
102	D	C	A	A	C	D	C	A	A	D	D	C	A	A	E	D	C
103	D			A	E	D			A	E	D			A	E	D	
104	D	C	B	A	E	D	C	B	A	C	D	C	B	A	E	D	C
105	D			A	C	D			A	D	D			A	E	D	
106	A	A	D	A	B	A	A	D	A	B	A	A	D	A	B	A	A
107	D			B	C	D			B	A	D			B	D	D	
108				B	B				B	B				A	E	B	
109	D	C	A	A	C	D	C	B	A	C	D	C	B	A	D	D	C
110	D	C	B	B					B					A	E	D	C
111	A	C		B					A	E	A	C	B	A	E	A	C
112	A	A	D	A	D	A	A	B	A	E	A	A	A	A	E	A	A
113	D			B	B				A	D	D			A	E	D	
114	D			B	B				A	E	C			A	E	D	
115	D	C	A	B	C	D	C	A	A	D	A	C	A	A	D	A	C
116				B	B				A	D	A	B	D	A	C	B	B
117				B	D				A	D	A	A	B	A	D	A	B
118				B	D				A	D	A	A	B	A	E	A	B
119				B	A				A	C	D	C	C	A	D	D	C
120	D			A	E	D			A	D	D			A	E	D	
121	D	C	B	B	B	D	C	B	A	C	D	C	B	A	C	D	C
122	A	A	B	A	B	A	A	B	B					B			
123	B		B	B	A				A	E	B		B	A	E	B	
124				B	A				A	D	A	A	B	A	E	A	A
125	A	A		B	B	A	A		A	D	A	A	B	A	D	A	A
126	B	B	B	B	C				A	E	B	B	B	A	E	B	B
127	A	B	A	B	D	A	C	A	B	C	A	C	A	A	E	A	C
128	D	C	C	A	D	C	B	C	A	E	D	C	C	B	D		
129	A	C	B	A	C	A	C	B	A	D	A	A	B	A	C	A	A
130	D	C	D	A	E	D	C	B	A	C	D	C	D	A	E	D	C

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No.	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
1		B	B				B	B				B	C				B
2	D	A	B	D	A	C	B	A	D	A	C	A	A	B	C	D	A
3																	
4	B	A	E	A	A	B	A	C	A	A	B	A	C	A	A	B	A
5	B	A	C	B	B	B	A	C	B	B	C	A	D	B	B	C	A
6	B	A	D	B	B	B	A	D	B	B	B	A	C	B	B	B	A
7	B	B	C	D	C	A	A	C	D	C	A	A	C	D	C	C	B
8		B	D	D	C		B	D	D	C		B	D	D	C		B
9	C	B					A	A	D	C		A	A	D	C		A
10	B	A	C	D	C		A	C	A	A	B	A	C	D	C		A
11		A	A				A	A				A	A				A
12	A	B	A				A	A	B			A	A				A
13	C	B	B	D	C	C	A	C	C	B	C	A	C	C	B	C	A
14		B	B				B	A				B	A				B
15		B	E				B	C				B	C				
16	A	B	B				A	B	D	C	A	A	A	D	C	D	A
17	A	A	A	C	C	A	A	A	C	C	A	A	A	C	C	A	A
18	B	B	A				A	A				A	B	A	A	B	A
19	B	A	E	D	B	B	A	E	D	B	B	A	E	D	B	B	A
20		A	D	B			A	C	B			A	D	B			A
21	B	A	D	D	C	B	A	B		C	A	A	C	D	C	B	A
22	B	A	C	D	C		A	C	D	C		A	C	D	C		B
23		A	A				A	A				A	A				A
24	B	B	A	B	B	B	B	A	B	B	B	B	A	B	B	B	B
25	B	A	E	D	B	B	A	E	D	B	B	A	E	D	B	B	A
26	B	A	D	A	C	B	A	A	A	C	D	A	C	A	C	B	A
27		A	B	B			A	B	B			A	B	B			A
28	A	A	E	D	C	A	B		D	C	A	B	D	D	C	A	B
29	B	A	E	D	B	B	A	E	D	B	B	A	E	D	B	B	A
30	B	A	B	A	C	B	A	B	A	C	B	A	A	A	C	B	B
31	B	B	A	B	B	B	B	C	B	D	A	C	B	D	C	B	B
32	B	A	B	D	C	B	A	C	D	C	B	A	C	D	C	B	A
33	B	A	C	A	A	B	A	E	A	A	B	A	D	A	A	B	A
34		B	A	B			B	B	B			B	B	B			B
35		A	A	D			A	A	D			B					A
36		A	C				A	C				A	C				A
37	B	A	D	A	B	B	A	C	A	B	B	A	A	A	B	B	A
38		B	A	D	C		B	A	D	C		B	A	D	C		B
39		A	E	B			A	C	B			A	C	B			A
40		B	D				B	D				B	D				B
41		A	D				A	D	D			A	D	D			A
42	A	A	C	A	C	A	A	A	A	C	A	A	B	A	C	A	A
43		B	A	D	C		A	A	D	C		A	A	D	C		A

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Response No.	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
44		A	B	B			A	D	B			A	D	B			A
45		A	C				A	C	A	A	B	A	C	A	A	B	A
46	B	A	A				A	B	B		B	A	B	B		B	A
47		B	E	A	A		B	D	A	A		B	D	A	A		B
48		B	C	B			B	A	B			B	A	B			B
49		A	C	A	C	B	A	A	B			A	A	B			A
50		A	B	D			A	A	D			A	A	D			A
51	B	A	A	B			A	A	B			A	B	B			A
52		B	B				B	A				B	C				B
53	B	A	D	A	A	B	A	C	A	A	C	A	C	A	A	C	A
54	A	A	A	D	C	A	A	A	D	C	A	A	A		C	A	A
55	B	A	C	D	C		A	A	D	C		B	A	D	C		B
56	B	B					A	A	A	C	B	A	A	A	C	A	A
57	B	A	A	B	A	B	A	A	A	A	A	A	A	A	A	B	A
58		A	B	D	C		A	A	D	C		A	C	D	C		A
59		A	B	B			A	A	D			A	A	B			A
60		A	C	D			A	C	D			A	C	D			A
61		A	C	B			A	D	B			A	D	B			A
62	B	A	B	B	B	B	B					B					B
63	B	A	D	A	A	B	A	B	A	A	B	A	C	A	A	B	A
64		A	C	B			A	C	B			A	C				A
65		B	A	D	C		B	B	D	C		B	B	D	C		B
66		B	A				B	A				B	A				B
67	C	A	A	D	B	D	A	D	C	B	B	A	D	C	B	C	A
68	B	A		A	A	B	B	A				B	B				B
69	B	A	B	B	B	B	A	D	B	B	B	A	D	A	B	B	A
70		A	E	B			A	B	A			A	B	A			A
71		A	C	B			A	A	A	A		A	A	B			A
72	B	A	C	A	A	B	A	C	B	C	B	A	C	A	A	B	A
73	C	A	E	D	C	B	A	A	D	C	A	A	C	D	C	B	A
74		A	D				A	E	A	A	C	A	D	A	A	C	B
75		A	A				A	A				A	A				A
76	A	A		C	C	D	A		D	C	A	B	B	D	C		A
77		B	A				A	A				B	A				B
78		B	A				A	A				B	A				B
79							A	B	C			A	B	C			A
80		B	A				B	A				B	A				B
81		A	B				A	A				A	B				A
82	B	B	C	D	C	A	A	A	D	C	A	A	D	D	C	A	B
83		A	A				A	A				A	A				A
84	B	A	A	D	A	B	A	E	A	A	B	A	E	A	A	B	A
85		A	B	D	C		A	C	D	C		A	D	D	C		A
86		A	B	D	B	B	B	C				A	D	D	B	B	B
87	B	A	B	C			A	C	A	A	C	A	C	A	A	B	A
88	A	A	C	A	B	B	B	D	C	B	A	B	D	C	B	A	B
89		A	E	B			A	C	D	B		A	C	D	B		A
90		B	A				A	D	A	A	B	A	D	A	A	B	B
91	A	A	C	A	A	A	A	C	A	A	B	A	C	A	A	A	A

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Response No.	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
92		A	B	D			A	D	D			A	A				A
93		A	A	A	B		A	C	A	B		A	D	A	B		A
94		A	A	D	C		A	A	D	C		A	A	D	C		A
95	B	A	E	A	A	B	A	D	A	A	B	A	D	A	A	B	A
96	B	A	E	D	B	B	A	E	D	B	B	A	E	D	B	B	A
97		B	D	B			B	B	A	B		B	B	A	B		B
98	A	A	C	D	C	A	A	D	D	C	A	B	D	D	C	A	A
99	B	A	B	B	B	B	A	B	B	B	B	A	C	B	B	B	A
100	B	A	A	D	D	D	A	A	D	C		B	A	D	C		B
101		A	E				A	C				A	E				A
102	A	A	C	D	C	A	A	C	D	C	A	A	C	D	C	B	A
103		A	C	D			B	C	D			A	D	D			A
104	A	A	C	D	C	D	A	B	D	C	B	A	D	D	C	A	A
105		A	D	D			A	A	D			A	B	D			A
106	D	A	B	A	A	D	A	B	A	A	D	A	B	A	A	D	A
107		B	B	D			B	A	D			B	C	D			B
108		A	A	C			A	A	B			B	A				A
109	B	A	B	D	C	B	A	A	D	C	B	A	A	D	C	B	A
110	B	B					A	B	D	C	D	A	B	D	C	D	A
111	B	B					A	B	A	C	C	A	D	A	C	B	A
112	A	B	B	D	C	D	A	C	A	A	B	A	C	A	A	B	A
113		A	B	D			A	D	D			A	D	D			A
114		A	B	A	B	B	A	B	D			A	B	D			A
115	A	B	D	D	C	A	A	A	A	C	B	A	A	A	C	B	A
116	D	B	A				A	A	A	B	B	A	B	A	B	B	A
117	B	B	B				A	A	A	A	A	A	A	A	A	A	A
118	B	B	B				A	A	A	A	A	A	A	A	A	A	A
119	C	A	A	D	C	A	A	B	D	C	A	A	D	D	C	B	A
120		A	E	D			A	A	D			A	B	D			A
121	B	B	B	D	C	C	A	C	D	C	B	A	C	D	C	B	A
122		B					A	B	A	A	B	B					A
123	B	A	C	B		B	A	B	B		B	A	B	B		B	A
124	B						B	A				A	B	A	A	A	A
125	B	A	A	A	A	B	A	A	A	A	B	A	B	A	A	B	A
126	B	A	E	B	B	B	A	B	B	B	B	A	C	B	B	B	A
127	A	A	B	A	C	B	B	B	B	C	A	A	D	A	C	B	A
128	A	C	D				B	D				B	D				B
129	B	A	C	C	C	B	A	B	D	C	B	A	C	D	C	B	A
130	B	A	C	D	C	A	A	C	D	C	C	A	B	D	C	C	A

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Response No.	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
1	B				B	C				B	B				B	D	
2	A	D	C	D	A	C	A	B	C	A	C	B	C	D	A	C	B
3					A	E	D			A	E	D			A	E	D
4	B	A	A	B	A	E	A	A	B	A	E	A	A	B	A	E	A
5	D	B	B	C	A	D	B	B	C	A	D	B	B	C	A	D	B
6	A	B	B	B	A	D	B	B	B	A	B	B	B	B	A	B	B
7	B	D	C	A	A	B	A	A	C	A	C	A	C	A	A	D	A
8	D	D	C		B	D	D	C		B	D	D	C		B	D	D
9	C	D	C	B	A	B	D	C	C	A	B	D	C	C	A	B	D
10	C	A	A	B	A	C	D	C		A	C	D	C		A	C	D
11	A				A	A				A	A				A	A	
12	B				A	D	C			A	D	C			A	E	B
13	B	C	B	C	A	E	C	B	C	A	E	C	B	C	A	E	C
14	A				B	B				B	C				B	C	
15					A	D	B	B	C	A	D	A	B	A	B	D	C
16	A	D	C	A	A	B	D	C	A	A	C	D	C	A	A	D	D
17	A	C	C	A	A	A	C	C	A	A	A	C	C	A	A	A	C
18	B	A	A	B	A	B	A	A	B	B	A			.	A	B	
19	A	D	B	B	A	C	D	B	B	A	B	D	B	B	A	D	D
20	C	B			A	D	B			A	D	B			A	D	B
21	B	D	C	B	A	C	D	C	B	A	D	D	C	B	A	D	D
22	A	D	C		A	E	D	C		A	E	D	C		A	E	D
23	A				A	B				A	C				A	B	
24	A	B	B	B	B	A	B	B	B	B	A	B	B	B	B	A	B
25	A	D	B	B	A	C	D	B	B	A	B	D	B	B	A	D	D
26	C	B	C	B	B	C	D	C	A	A	C	A	C	B	A	D	A
27	B	B			A	B	B			A	C	B			A	E	B
28	C	D	C	A	A	E		C	A	A	E	D	C	A	A	E	
29	A	D	B	B	A	C	D	B	B	A	B	D	B	B	A	D	D
30	A	D	C		A	E	A	A	A	A	C	A	A	A	B	E	D
31	B	C	B	C	D	B	C	B	D	B	A	C	B	D	B	C	A
32	C	D	C	B	A	C	D	C	B	A	B	D	C	B	A	B	C
33	B	A	A	B	B					A	D	A	A	B	A	D	A
34	A	B			A	C	B			A	D	B			B	A	B
35	A	D			A	C	D			A	D	D			A	D	D
36	B				B	A				B	A				B	A	
37	A	A	B	B	A	A	B	B	B	A	D	A	B	B	A	D	A
38	A	D	C		B	A	D	C		B	A	D	C		B	A	D
39	C	B			A	D	B			A	E	A	A	C	A	C	B
40	D				B	D				B	D				B	D	
41	A	D			A	B	D			A	B	D			A	E	D
42	A	A	C	B	A	D	A	C	A	A	C	A	C	B	A	E	A
43	A	D	C		A	C	D	C		B	A	D	C		A	D	D

Response No.	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
44	D	B			A	E	B			A	E	B			A	E	B
45	C				A	D				A	C				A	D	
46	A				A	A				A	A				A	C	A
47	D	A	A		B	E	A	A		B	E	A	A		B	E	A
48	A	B			B	C	B			B	C	B			B	D	A
49	A	B			B	A				B	A				B	A	
50	A	D			A	A	D			A	D	D			A	A	D
51	C	B			A	D	A	A	B	A	B	B			A	C	B
52	A				A	D	B		B	A	D	D		B	B	B	B
53	C	A	A	C	A	D	A	A	A	A	D	A	A	D	A	D	A
54	A	D	C	A	A	E	D	C	A	A	E	D	C	A	A	E	
55	A	D	C		A	D	D	C		A	E	D	C		A	C	D
56	A	A	C	B	A	A	A	C	A	A	C	A	A	B	A	C	A
57	A	B	B	B	A	E	B	B	B	A	D	B	B	B	A	E	B
58	C	D	C		A	B	D	C		A	B	D	C		A	E	D
59	A	D			A	A	D			A	A	D			A	D	B
60	C	D			A	E	D			B	E	D			B	E	D
61	A	B			B	A				B	A				A	C	B
62					B					A	B	B	B	B	A	C	B
63	A	A	A	B	A	D	A	D	E	A	D	A	A	B	A	D	A
64	A	B			A	D	C			A	D	C			A	D	C
65	A	D	C		A	B	D	C	A	B	B	D	C	A	B	B	D
66	A				B	A				B	A				B	D	
67	C	D	C	B	B	A	D	C	A								
68	A				A		A	A	B	A		A	A	B	A		A
69	D	A	B	B	A	E	A	B	B	B						A	D
70	A	A			A		B			A		B			A		B
71	A	B			A	A	B			A	C	A	A		B	B	
72	C	A	A	B	A	C	A	A	B	A	C	A	C	B	A	C	A
73	B	D	C	A	A	E	D	C	B	A	E	D	C	B	A	E	D
74	C				B	E				B	D				A	D	
75	A				A	B	A	A	A	A	C	C			A	D	B
76		D	C	A	A		D	C	D	A		D	C	D	A		D
77	A				A	C	B			A	C	B			A	E	B
78	A				A	C	B			A	C	B			A	E	B
79	B	C								A	C	C					
80	A				B	A				B	A				B	A	
81	A				B	A				A	A				A	C	B
82	A	D	C	A	B	B	D	C	A	A	D	D	C	A	A	A	D
83	A				A	D	A	C	B	A	D	A	C	B	A	D	A
84	A	A	A	B	A	E	D	A	B	A	B	D	A	B	A	A	E
85	B	D	C		B	A				B	A				A	D	D
86	A				A	A	A	B	B	A	A	A	B	B	B	D	
87	B	B			A	D	B			A	D	A	A	B	A	D	B
88	D	C	B	A	B	D	C	B	A	A	A	A	B	B	A	C	A
89	B	D	B		B	B	D	B		B	C	D	B		A	D	B
90	A				A	E	B			A	C	B			B	A	
91	C	A	A	B	A	E	A	A	A	A	E	A	A	A	A	E	A

68

No.	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
92	A				A	E	D			A	E	D			A	E	D
93	B	A	B		A	B	A	B		A	A	A	B		A	E	A
94	A	D	C		A	C	D	C		B	A	D	C		A	D	D
95	D	A	A	B	A	E	A	A	B	A	E	A	A	B	A	E	A
96	A	D	B	B	A	C	D	B	B	A	B	D	B	B	A	D	D
97	B	A	B		B	C	A	B		B	C	A	B		B	D	A
98	B	D	C	A	B	B	D	C	A	A	D	D	C	A	A	D	D
99	B	B	B	B	A	B	D	C	B	A	B	D	C	B	A	B	D
100	A				A	D	C	C	A	A	C	D	C	A	A	C	C
101	D				A	E				A	D				A	E	
102	C	D	C	B	A	C	D	C	B	A	D	D	C	A	A	D	D
103	C	D			A	D	D			A	D	D			A	E	D
104	C	D	C	A	A	B	D	C	B	A	B	D	C	B	B	A	
105	B	D			A	D	D			A	D	D			A	D	D
106	B	A	A	D	A	B	A	A	D	A	B	A	A	D	A	B	A
107	A	D			A	D	D			A	B	D			A	E	D
108	A	B			B	B				B	B				B	C	
109	B	D	C	B	A	B	D	C	B	A	B	D	C	B	A	D	D
110	B	D	C	D	B					A	B	D	C	D	B		
111	B	A	C	B	B					B					A	D	A
112	C	A	A	B	B	A				A	C	A	A	B	A	C	A
113	B	D			B	E				A	D	D			A	D	D
114	B	D			B	A				A	B	D			B	B	
115	B	D	C	B	B	D	D	C	A	B	D	D	C	A	B	D	D
116	B	B		B	A	C	A	B	A	A	B	A	B	A	B	D	
117	A	A	A	A	A	B	A	A	B	A	B	A	A	B	B	B	
118	A	A	A	A	A	B	A	A	B	A	B	A	A	B	B	B	
119	C	D	C	A	A	D	D	C	B	A	D	D	C	B	B	C	
120	C	D			A	B	D			A	C	D			A	D	D
121	C	D	C	B	B	C	D	C	B	A	C	D	C	B	B	C	D
122	B	A	A	B	A	C	A	A	A	B					B		
123	B	B		B	B	A				A	D	B		B	A	C	B
124	A				A	B	A	A	B	A	C	A	A	B	B	A	
125	A	A	A	B	A	B	A	A	B	A	B	A	A	B	A	D	A
126	C	B	B	B	B	C				B	E	B	B	B	A	E	B
127	B	A	C	B	A	C	A	C	A	B	D	A	C	A	A	D	A
128	C	D			A	B	D			A	D	D			A	B	D
129	B	D	C	B	A	E	A	A	B	A	D	A	A	B	A	C	A
130	B	D	C	C	A	B	D	C	A	A	B	D	C	A	A	D	D

Response No.	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
1			A	E				B	B				B	C			
2	C	C	A	D	D	C	D	A	B	D	A	D					
3			A	E	D												
4	A	B	A	D	A	A	B	A	D	A	A	B	A	D	A	A	B
5	B	C	A	E	B	B	A	A	E	B	B	A	A	E	A	A	A
6	B	B	B	A	B	B	A	B	A	B	B	B	A	B	B	B	A
7	C	A	B	A	D	C	B	B	B	D	C	A	A	B	D	C	A
8	C		B	D	D	C		B	D	D	C		B	D	D	C	
9	C	C	B					B					A	E	D	C	C
10	C		B					B					A	A	D	C	
11			A	A				A	A				A	A			
12			B	A				B	A				A	C			
13	B	C	B	E	C	B	C	B	C	C	B	C	B	D	C	B	C
14			A	B				B	A				B	A			
15	B	C	A	D	A	B	A	B	A				B	A			
16	C	A	B	A				3	C				A	A	D	C	C
17	C	A	A	A	C	C	A	A	A	C	C	A	A	A	C	C	A
18			B	A				B	A				A	A			
19	B	B	B	E	D	C	A	A	C	A	A	B	A	C	A	A	B
20			A	C	B			A	D	A	A		A	C	B		
21	C	B	A	C	D	C	B	A	A	D	C	A	A	A	D	C	C
22	C	B	B	A	D	C		B	B	D	C		A	E	D	C	D
23			B	D				B	B				A	D			
24	B	B	B	A	B	B	B	B	A	B	B	B	B	A	B	B	B
25	B	B	B	E	D	C	A	A	C	A	A	B	A	C	A	A	B
26	C	B	B	A	D	C	B	A	A	D	C	C	A	B	A	C	B
27			A	B	B			B	B	B			A	B	B		
28	C	A	A	E	D	C	A	B	E	D	C	A	B	E	D	C	A
29	B	B	B	E	D	C	A	A	C	A	A	B	A	C	A	A	B
30	B		B		D	C		A	D	D	C	A	B	B	D	C	
31	D	B	B	D	A	C	B	D	A	B	C	B	C	B	C	A	C
32	C	B	A	B	D	C	B	A	B	D	C	B	B		B		
33	A	B	A	B	A	A	B	A	B	A	A	A	A	E	A	A	B
34			B	A	B			B	A	B			B	A	B		
35			B					A	B	D			A	C	D		
36			A	C				A	C				A	A			
37	B	A	A	D	A	B	B	A	A	A	B	B	A	D	B	B	B
38	C		B	A	D	C		B	A	D	C		B	A	D	C	
39			A	D	B			A	B	B			A	E	B		
40			B	D				B	D				A	E	B		
41			A	B	D			A	A	D			A	E	D		
42	C	B	A	D	A	C	B	A	A	A	C	B	A	A	A	C	B
43	C		B	A	D	C		B	A	D	C		B	A	D	C	

Response No.	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
44			A	E	B			A	D	B			B				
45			A	C				A	A				A	B			
46	C	B	B	C				A	B	D	C	B	A	A			
47	A		B	E	A	A		B	D	A	A		B	E	B		
48	C	B	B	D	B			B	B	A	C	B					
49			B	A				A	B	B			A	B	B		
50			A	A	D			A	D	D			A	D	D		
51			A	D	A	A	A	B	B				A	A	B		
52			B	A	A			A	A	A	A	A	A		B	C	B
53	A	D	A	B	A	A	C	A	B	A	A	C	B	D			
54	C	A	B	E	D	C	A	A	E		C	A	A		D	C	A
55	C		A	D	D	C		A	C	D	C		B	D	D	C	
56	A	B	B				B						A	B	B	B	B
57	B	B	A	E	B	B	B	A	B	B	B	A	A	D	A	A	A
58	C		B	A	D	C		A	B	D	C		B				
59			A	D	B			A	D	B			A	D	B		
60			A	D	D			A	B	D			A	C	D		
61			B	A				A	C	B			A	E	B		
62	B	B	B					A	C	B	B	B	A	C	B	B	B
63	A	B	A	E	A	A	E	A	A				A	E	A	A	B
64			A	D	C			A	D	C			A	C	C		
65	C	A	B	B	D	C	A	B	A	D	C	A	B	A	D	C	A
66			B	C				B	C				B	A			
67																	
68	A	B	A		A	A	B	A		A	A	B	A		B	A	B
69	A	B	B					A	B	B	B		A	A			
70			A		B			A	A	A							
71			B	D				B	A				A	A	D	D	
72	A	B	A	C	A	A	B	A	C	A	A	B	A	C	A	A	B
73	C	B	A	E	D	C	B	A	C	D	C	B	A	C	D	C	C
74			B	E				B	C				B	E			
75			A	D	B			A	B				A	A			
76	C	C	A		D	C	C	B	C				A		D	C	
77			A	E	B			B	B				A	B			
78			A	E	B			B	B				A	B			
79			A	D	C			A	C	C			A	C	C		
80			B	A				B	A				B				
81			A	C	B			A	A				A	A			
82	C	A	B	D	D	C	A	A	A	A	A	D	A	C	D	C	A
83	C	E	A	D	A	C	B	B					A	D	D	C	B
84	A	B	B	B	A	A	B	A	A	A	A	B	A	A	A	A	B
85	C		A	D	D	C		A	A	D	C		A	C	D	C	
86			B	D				B	A				A	C	D	B	
87			A	E	A	A	D	A	A	B			A	E	B		
88	B	B	A	E	A	B	B	A	E	A	B	B	B	A	B	B	B
89			B	A				B	E	A	B	A	A	A	B		
90			A	E	B			A	E	D			A	E	A	A	B
91	A	A	A	E	A	B	A	A	C	A	A	B	A	D	D	C	A

71

Response No.	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
92			B	E	D			A	D	D			A	D	D		
93	B		A	E	A	B		A	D	A	B		A	A	A	B	
94	C		A	D	D	C		A	A	D	C		B		D	C	
95	A	B	A	E	A	A	B	A	D	A	A	B	A	E	B		
96	B	B	B	E	D	C	A	A	C	A	A	B	A	C	A	A	B
97	B		B	D	A	B		A	C	B		A	A	D	A	B	B
98	C	B	B	B	D	C	A	A	D	C	C	A	B	B	D	C	A
99	C	B	B	A	B	B	A	B	A	B	B		A	C	B	B	B
100	C	A	B	E	D	C		B	A	D	C		A	E	D	C	
101			A	D				A	C				A	C			
102	C	B	B					A	A	D	C	B	A	B	D	C	B
103			A	E	D			B	D	D			A	D	D		
104			A	E	D	C	A	B	A				A	A	D	C	B
105			A	D	D			A	C	D			A	C	D		
106	A	D	A	B	A	A	D	A	B	A	A	D	A	B	A	A	D
107			B	B	D			B	A	D			B	A	D		
108			B	A				A	D	B			A	A	B		
109	C	B	A	D	D	C	B	A	E	D	C	B	A	D	D	C	B
110			B					B					B				
111	C	B	B					A	D	A	C	B	A	B	D	C	B
112	A	B	B	C				B	B				A	C	A	A	A
113			B	B				A	B	D			A	D	D		
114			B	A				A	B	D			A	B	D		
115	C	A	B	D	D	C	A	B	C	D	C	A	A	D	D	C	A
116			B	B				B	C				B	C			
117			B	A				B	A				B	A			
118			B	A				B	A				B	A			
119			B	A				A	D	D	C	B	B	A			
120			A	C	D			A	A	D			A	E	D		
121	C	B	B	C	D	C	B	B	C	D	C	B	A	B	D	C	C
122			B					B					A	B	A	A	B
123		B	A	E	B		B	A	B	B		B	A	C	B		B
124			B					B	A				B	A			
125	A	B	A	B	A	A	B	B	A				A	A	A	A	B
126	B	B	B	E	B	B	B	B	D	B	B	B	B				
127	C	A	A	C	A	C	C	B	B	A	C	A	A	B	A	C	B
128			A	C	D			A	D	D			B	A	D		
129	A	B	A	C	A	A	B	A	B	A	A	B	A	B	A	A	B
130	C	B	B	E				A	A	D	C	A					

72

Response No.	86	87	88	89	90	91	92	93
1	B	C				B	A	B
2								
3						A	A	
4	A	E	A	A	B	B	A	A
5	A	E	A	A	A	B	A	A
6	A	B	B	B	B	B	B	B
7	B	D	D	C	A	B	A	B
8	B	D	D	C		A	A	B
9	A	C	D	C	C		A	
10	A	A	D	C		A	A	C
11	A	A				B	A	B
12	A	B				B	A	B
13	A	B	C	B	C	B	A	B
14	B	C				A	A	B
15	A	E	A	B	A	B	A	
16	B	C				A	A	B
17	A	A	C	C	A	B	A	A
18	A	A				B	A	B
19	A	B	D	C	B	B	A	B
20	A	C	B			A	A	A
21	B	A	D	C	A		A	
22	A	E	D	C		B	A	C
23	A	E				B	A	B
24	B	A	B	B	B	A	A	A
25	A	B	D	C	B	B	A	B
26	B	A	D	C	B	B	A	A
27	B	B	B			B	A	B
28	B	C	D	C	A	A	A	B
29	A	B	D	C	B	B	A	B
30	B	B	D	C		A	A	B
31	B	D	B	C	A	B	A	A
32	B		B					
33	A	C	A	A	B	B	A	B
34	B	A	B			B	A	A
35	A	A	D			A	A	B
36	A	B				B	B	A
37	A	D	B	B	B	B	A	A
38	B	A	D	C		B	A	B
39	A	E	B			A	A	
40	A	D	B			B	A	B
41	A	E	D			B	A	B
42	A	C	A	C	B	A	A	B
43	B	A	D	C		A	A	B

Response No.	86	87	88	89	90	91	92	93
44	B					B	B	B
45	A	B				A	A	A
46	A	C	D	C	B	B	B	B
47	B	E	A	A		A	B	A
48						B	B	A
49	A	B	B			A	B	B
50	A	C	D			B	A	A
51	A	C	B			B		A
52	A		D		B			
53	B	D				A	A	A
54	A	B	D	C	A	B	A	B
55	A	E	D	C		B	A	
56	A	B	B	B	B	B	A	A
57	A	B	B	B	B	A	B	A
58	B					B	A	B
59	A	D	B			B	A	B
60	A	E	D			B	A	A
61	A	C	B			B	A	B
62	A	B	B	B	B	B	B	A
63	B	A				B	B	A
64	A	C	C			B	A	A
65	B	A	D	C	A	B	A	
66	B	B				B	A	B
67								
68	A		B	A	B	B	A	A
69	A	A				B	B	
70						A	B	B
71	B	C				B	B	B
72	A	C	A	A	B	B	A	A
73	A	E	D	C	D	B	A	B
74	B	C				A	A	A
75	A	B				B	A	A
76	A		D	C		A	A	A
77	A	B	B			B	A	B
78	A	B	B			B	A	B
79						B	A	B
80	B	A				A		B
81	A	A				A	A	B
82	A	C	D	C	A	B	A	B
83	B	A						
84	A	E	A	A	B		A	B
85	A	D	D	C		B	A	A
86	A	D	D	B		B	A	B
87	A	D	B			A	A	A
88	B	A	B	B	B	B	B	B
89	A	B	B			A	A	B
90	A	D	A	A	B	B	A	∴
91	A	C	D	C	A	B	A	B

74

Response No.	86	87	88	89	90	91	92	93
92	A	D	D			B	A	A
93	A	A	A	B			B	
94	B		D	C		B	B	B
95	A	E	A	A	B	B	B	A
96	A	B	D	C	B	B	A	B
97	B	D	B			A	B	A
98	B	D	D	C	A	A	A	
99	A	D	B	B	B	B	B	A
100	A	D	D	C			A	B
101	A	C				B	A	B
102	A	B	D	C	B	B	A	B
103	A	D	D			A	A	B
104	B	A				B	A	B
105	A	C	D			B	A	A
106	A	B	A	A	D		A	A
107	A	A	D			B	A	B
108	A	A	B			B	B	B
109	A	C	D	C	B	B	A	B
110	B						A	
111	A	D	D	C	B	A	A	B
112	A	C	A	A	A	B	A	B
113	A	D	D			B	A	A
114	A	B	D			B	A	B
115	A	D	D	C	A	B	A	A
116	B	C				B	A	A
117	B	A				B	A	A
118	B	A				B	A	A
119	A	C	D	C	B	B	A	A
120	A	E	D			B	A	B
121	A	A	D	C	C		A	B
122	A	B	A	A	B	B	A	A
123	A	E	B		B	B	A	B
124	B	B				B	A	A
125	A	A	A	A	B	B	A	A
126		B				B	A	
127	A	C	A	C	B	B	A	
128	A	C	D			A	A	B
129	A	D	A	A	B	A	A	A
130							A	

Appendix C: Survey Comments

USAF Survey Control Number SCN 91-12

This appendix is a complete list of all comments received (in raw form) with the survey responses. Additional information was added in square brackets.

Other Documentation Needed

Use AFOTEC Pamphlet 800-2 vol. 3 as a guide during development.

The other documents required for software maintenance are software problem reports or software deficiency reports.

The software and system engineering design rationale (why it was done) is often required to prevent redundant development efforts later in the life cycle and to assist in understanding the design. This information can be captured in software development files.

ECP's and SCNs are used by ¡the contractor¿ in OFP development, but not by the ALC for code maintenance.

Non-Complex Computer Specifications that are updated for current configuration.

Flow charts, Detailed Test Instructions, Test procedure instructions.

DI-QCIC-80572 ¡Software Quality Program Plan¿.

MATE STDs
DI-MCCR-80011 ¡Software Standards and Procedures. This document was superseded by the Software Development Plan (SDP), DI-MCCR-80030A, which was covered by the survey¿.

Technical orders (T.O.s)
Vendor Hardware Manuals for COTS hardware/software.

For ATE (Automatic Test Equipment) Maintenance: Source code on deliverable media, Schematic of unit under test (UUT) and interface devices (ID), top assembly drawing and parts list of UUT and ITA, and engineering data/spec drawings for unique devices (i.e. PAL, PROM data).

Test Requirements Document.

Computer Program Identification Number.

Technical Orders.

Computer Resources Life Cycle Management Plan (CRLCMP).

Other documents required are a Software Development Manual
(How do you change, modify, fix this software's source
code, then regenerate the executable?) and Special
Development Considerations (What special knowledge does a
programmer need to develop this software). Many of my
software documents are very sketchy. They don't begin to
provide the information needed to understand the design and
operation of a CPCI. Furthermore, if the software
interfaces to hardware, the interface is not clearly
explained.

High Order Language Standards, Test Requirements Documents
(TRDs), and Engineering Support Data (DI-MCCR-80285).

The Software Integration Requirements Document (SIRD) is a
document that the ¡contractor¿ uses. This is the most
important document in the development process and is not
deliverable to the government.

The SDFs which have not been a CDRL or DID item contaiı the
rationale behind the design of the software, which is
critical for effective software support on complex or large
systems.

General Comments

By focusing on "maintenance only" and defining it narrowly,
the results of this survey may be difficult to interpret.
The questions do not recognize the documentation
requirements for maintenance related activities such as
establishing an organic capability; monitoring contractor
development activities; fielding the software; and
operating the system. Therefore, answers provided for
documents such as the CRISD, STP and SCN may be misleading
if respondents do not expand their focus.

I answered based on personal experience at an ALC as well
as personal experience (of almost 20 yrs) listening to ALC
software maintainers talk about what they need to do their
job. I have not personally worked on software maintenance
projects (other than pc type) for several years.

I've never heard of most of these documents. I don't know
if any of these documents were tailored to meet maintenance

requirements, and if they were, who participated. Therefore, I could not answer question #5 for most cases. The ones I did answer were based only on my knowledge of the document and not any tailoring.

As a S/W and F/W development and maintenance group, we typically have to work with S/W programs and systems that are poorly documented or sometimes not documented at all. I attribute this to the acquisition cycle and the acquisition office "Saving Money" by not buying the documentation on the front end and often having "Contractor Maintenance" sustain the S/W for several years after acquisition. This causes two long term problems: 1. Loss of configuration control of the S/W and 2. Lack of meaningful documentation for the S/W system (if the documentation was ever acquired). With these two problems under consideration the long term maintenance of the S/W system becomes extremely costly due to the need to reverse engineer the deliverables in order to enhance, change or sustain the S/W. The original acquisition office "Doesn't Care" because the "Did their job" in acquiring the system (at a good price) and now are working on "New Systems". Meanwhile "another" section or branch of the acquisition office has to foot the bill for maintenance and organic support. Force acquisition offices to use the DOD standard!!!

Updates to the type of software that we maintain should be supportable if design documents, user manual and test documentation are available. Configuration control is through CPIN system, not Version Description Document. DOD-STD-2167A and documentation also allows government control and insight into contractual effort.

The software type and environment plays an important role in documentation requirements for maintenance. Believe should be differentiation between weapon system software and records/payroll/accounting.

My organization is primarily performing hardware and software development for a space system. All our work to date has involved reverse engineering the system with very little, to no, documentation.

It seems to me that many of the documents that we require are unnecessary and if properly thought out, we could reduce the amounts required of contractors and require more detail in the documents we receive. This would be even better if the means documents are delivered was electronic rather than hardcopy.

Survey is really applicable to system operational software and not ATE test programs. Items answered on scan sheet were educated guesses as to operational software needs.

The ¡project¿ involved reverse engineering the controller using a HEX microcode listing, a set of electronic schematics, the technical order, and a partly commented program listing in basic. Our emphasis in this particular effort was not involved with 2167A. Our participation in this survey is therefore marginally valid.

Question 92 has both answers marked. My organization is an ALC organization. However, we are both the SPO (acquisition agency) and maintenance organization for many ground electronic warfare weapon systems.

TRDs for digital TPS development have often been deemed useless. Analog TRDs have been useful. Let's tell the SPO this and use this saved money to buy COTS ATE which is by far the best TPS development tool. SPOs should "pool" their resources together on like systems instead of telling the depot they don't have dollars for a tester. Individually, that probably is true but together great things can be accomplished.

All documents that were marked as "(b) not available" will be available later in our program.

Information on tailoring available, but in a different location. Consequently marked "don't know." Similar reasoning for some documents marked "not available." ECPs/SCNs were accomplished for this project, but not applicable for software I am cognizant of.

The particular software we maintain is very old, often predating the use of such documents. There are internal counterparts to many of the documents.

Answers to this survey were derived from experience on several projects. My involvement on any one project did not include all aspects represented by the documents listed. Further, not all documents were available for any one project.

We applied heavy tailoring to the SRS and SDD to accommodate object oriented design for Ada. We used CASE tools to prepare these documents. 2167A is not easy to use in these circumstances. It asks for too much information that is automatically generated and checked by the CASE tool. Ada specs tell all we need about internal interfaces. System diagrams and external interfaces are

much more important. We use equivalent documents for the
following IRS/IDD, STP/STD/STR, CSOM, SUM, FSM (commercial
off the shelf), ECP/SCN.

The documentation used here was developed with many DIDs
rolled together into one document. This improves
traceability and "defragments" the document; however, the
content of the DIDs is distorted and in many cases lost.

The Software Development Plan and the Software Test Plan
are not needed for maintenance. They are vital documents
from a contract monitoring perspective. The provide an
insight into whether the contractor really understands the
task at hand and provide a means for the government to
correct deficiencies early in the contract.

One thing that seems to be missing in all documentation is
an explanation of algorithms used. Many times we must
reverse engineer the software to understand what the
contractor was trying to do when complex equations are
used.

We have developed our own in-house TPS maintenance guide.

My organization performs Automatic Test Equipment software
maintenance. Obviously, this is not what 2167 was written
to support. Current development practice is to follow
2167, tailoring where necessary. This practice doesn't
address most of my maintenance because the initial
development happened over the past 20 years and 2167 didn't
exist or wasn't used. Additionally there are several
alternative and in some cases general procedures we follow.

Because the ¡program¿ is not in FSD at this time, these
documents are not available. Maintenance content of these
deliverables is not known at this time since the ¡program¿
has not entered FSD.

I can't fill out your survey because your DID numbers are
new and haven't filtered down to the working level yet. I
can't answer maintenance questions, but can tell you that
ALCs almost never have input into DID selection.

Appendix D: AFOTECP 800-2 Documentation Questions

Questions from AFOTECP 800-2 Vol 3, 31 October 1989

D-1. A useful software documentation master list is available.

D-2. Each physically separate part of the documentation includes a useful table of contents.

D-3. Each physically separate part of the documentation includes a useful index.

D-4. Each physically separate part of the documentation includes a useful list of major terms and acronyms used in that document.

D-5. The documentation has been physically separated into (sets of) volumes each with a distinct part.

D-6. Major parts of the documentation are essentially self-contained.

D-7. A numbering scheme has been adopted which allows for easy addition or deletion of narrative parts of the documentatio.i and graphic materials.

D-8. Graphic materials (figures, charts, lists, etc..) are physically separate (e.g., on separate pages) from narrative description.

D-9. The documentation includes a separate part for the description of external interfaces.

D-10. The documentation adequately describes the external interfaces.

D-11. The documentation includes a useful version description document.

D-12. The documentation includes a separate part for the description of each major function.

D-13. The documentation adequately describes each major system function.

D-14. The documentation adequately describes how program initialization is performed.

D-15. The documentation adequately describes how program termination is performed.

D-16. Recovery from externally generated error conditions is adequately described in the documentation.

D-17. Recovery from internally generated error conditions is adequately described in the documentation.

D-18. The documentation includes a separate part for the description of the program data definitions.

D-19. The documentation adequately describes program data definitions.

D-20. The global data master list includes useful information about each global data item such as type, range, scaling, units, usage, etc.

D-21. Inputs/outputs for each program are adequately described in the documentation.

D-22. Program data partitioning is adequately described in the documentation.

D-23. The procedures for altering basic data storage sizes are adequately explained in the documentation.

D-24. The documentation adequately explains any use of shared memory.

D-25. The timing scheme designed for the program is adequately explained in the documentation.

D-26. The documentation adequately describes the timing requirements for each major function of the program.

D-27. Any dynamic allocation of resources is explained in the documentation.

D-28. The documentation adequately explains how interrupts are processed.

D-29. The documentation adequately describes memory allocation for the program.

D-30. Storage requirements for each major function of the program are adequately described in the documentation.

D-31. The documentation adequately explains how external I/O is processed.

D-32. The documentation adequately describes how the control flow is organized.

D-33. The documentation adequately describes the purpose of each module.

D-34. Parameters for each module are adequately described in the documentation.

D-35. The order of arguments for this program as described in the documentation corresponds to the order of arguments as shown in this programs source listing.

D-36. Data for each module are adequately described in the documentation.

D-37. The processing done by each module is adequately explained in the documentation.

D-38. Special processing considerations of each module are adequately explained in the documentation.

D-39. The use of any complex mathematical model (technique, algorithm) is adequately explained in the documentation.

D-40. Any use of recursive or reentrant programming is adequately described in the documentation.

D-41. A useful set of standards has been followed for the development of the documentation.

D-42. A set of useful standards has been followed for the construction of all flowcharts or procedural processing descriptions.

D-43. Documentation of each major functional part of the program follows the same format.

D-44. The format of the documentation reflects the program structure.

D-45. The documentation is organized as a systematic description of the program from levels of less detail to levels of more detail.

D-46. Each part (sentence, paragraph, subsection, section, chapter, volume, etc.) of the documentation tends to express one central idea.

D-47. The terminology used in the documentation to describe the program is easily understood.

D-48. The program test plan is adequately described in the documentation.

D-49. A useful set of test procedures for high levels of program testing is contained in the documentation.

D-50. A useful set of test procedures for low levels of program testing is contained in the documentation.

D-51. The limitations and incompleteness of the test procedures are described in the documentation.

D-52. The sample test data are adequately described in the documentation.

D-53. Program support tools that aid in testing the program are adequately described in the documentation.

D-54. The documentation describes software test probes that aid in identifying processing performance.

D-55. System specifications are easily traceable to the actual functions that implement the specification.

D-56. A functions description is easily traceable to the detailed descriptions of the module(s) performing that function.

D-57. An algorithm described in the documentation can be easily traced to its representation in the source listings.

D-58. Variables and constants used in an algorithm can be easily traced to their source code equivalent.

D-59. It is easy to trace the program control flow at all system levels. (program calling structure)

D-60. It is easy to trace the data flow of the program at all system levels.

D-61. Global data items and data structures are easily traceable to the modules which use them.

D-62. Data items and data structures in the database are easily traceable to the modules which use them.

D-63. Specific information is easily traceable from document to document and from document to source listings.

D-64. It is easy to locate specific information within the documentation.

D-65. The documentation organization contributes to the maintainability of the program.

D-66. Software descriptiveness as reflected in the documentation contributes to the maintainability of the program.

D-67. Software traceability as reflected in the documentation contributes to the maintainability of the program.

D-68. Overall it appears that the characteristics of the program contribute to the maintainability of the program.

Appendix E: Document Tailoring Responses

System/Segment Design Document

Document was tailored: 14
Tailoring not needed: 15
Should have been tailored: 3

Amount of		ALC Tailoring	
		Yes	No
Maintenance Information	too little	0	3
	acceptable	13	5
Other Information	too much	1	1
	acceptable	12	7

Software Development Plan

Document was tailored: 23
Tailoring not needed: 3
Should have been tailored: 2

Amount of		ALC Tailoring	
		Yes	No
Maintenance Information	too little	3	6
	acceptable	15	1
Other Information	too much	5	2
	acceptable	13	5

Software Requirements Specification

Document was tailored: 23
Tailoring not needed: 16
Should have been tailored: 3

Amount of		ALC Tailoring Yes	No
Maintenance Information	too little	4	4
	acceptable	13	6
Other Information	too much	1	4
	acceptable	16	6

Interface Requirements Specification

Document was tailored: 15
Tailoring not needed: 15
Should have been tailored: 4

Amount of		ALC Tailoring Yes	No
Maintenance Information	too little	3	2
	acceptable	7	9
Other Information	too much	3	2
	acceptable	7	9

Interface Design Document

Document was tailored: 14
Tailoring not needed: 13
Should have been tailored: 5

Amount of		ALC Tailoring	
		Yes	No
Maintenance Information	too little	2	1
	acceptable	9	6
Other Information	too much	1	1
	acceptable	10	6

Software Design Document

Document was tailored: 23
Tailoring not needed: 16
Should have been tailored: 3

Amount of		ALC Tailoring	
		Yes	No
Maintenance Information	too little	2	0
	acceptable	15	4
Other Information	too much	1	1
	acceptable	16	3

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Software Product Specification

Document was tailored: 27
Tailoring not needed: 21
Should have been tailored: 3

Amount of		ALC Tailoring	
		Yes	No
Maintenance Information	too little	4	0
	acceptable	15	11
Other Information	too much	2	1
	acceptable	17	10

Version Description Document

Document was tailored: 14
Tailoring not needed: 13
Should have been tailored: 4

Amount of		ALC Tailoring	
		Yes	No
Maintenance Information	too little	1	0
	acceptable	8	11
Other Information	too much	1	0
	acceptable	8	11

Software Test Plan

Document was tailored: 24
Tailoring not needed: 14
Should have been tailored: 3

Amount of		ALC Tailoring	
		Yes	No
Maintenance Information	too little	5	2
	acceptable	11	8
Other Information	too much	4	2
	acceptable	12	8

Software Test Description

Document was tailored: 26
Tailoring not needed: 10
Should have been tailored: 3

Amount of		ALC Tailoring	
		Yes	No
Maintenance Information	too little	6	2
	acceptable	11	9
Other Information	too much	3	2
	acceptable	14	9

Software Test Report

		Document was tailored:	19
		Tailoring not needed:	13
		Should have been tailored:	4

Amount of		ALC Tailoring Yes	No
Maintenance Information	too little	3	3
	acceptable	11	7
Other Information	too much	2	3
	acceptable	12	7

Computer System Operator's Manual

		Document was tailored:	21
		Tailoring not needed:	12
		Should have been tailored:	6

Amount of		ALC Tailoring Yes	No
Maintenance Information	too little	6	4
	acceptable	11	8
Other Information	too much	2	4
	acceptable	15	8

Software User's Manual

```
Document was tailored:            25
Tailoring not needed:             10
Should have been tailored:         7
```

Amount of		ALC Tailoring	
		Yes	No
Maintenance Information	too little	3	4
	acceptable	14	9
Other Information	too much	3	3
	acceptable	14	10

Software Programmer's Manual

```
Document was tailored:            18
Tailoring not needed:             17
Should have been tailored:         5
```

Amount of		ALC Tailoring	
		Yes	No
Maintenance Information	too little	1	4
	acceptable	11	6
Other Information	too much	2	3
	acceptable	10	7

Firmware Support Manual

Document was tailored: 16
Tailoring not needed: 14
Should have been tailored: 4

Amount of		ALC Tailoring	
		Yes	No
Maintenance Information	too little	1	4
	acceptable	9	3
Other Information	too much	3	1
	acceptable	7	6

Computer Resources Integrated Support Document

Document was tailored: 20
Tailoring not needed: 11
Should have been tailored: 5

Amount of		ALC Tailoring	
		Yes	No
Maintenance Information	too little	2	3
	acceptable	12	3
Other Information	too much	3	1
	acceptable	11	5

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Engineering Change Proposal

Document was tailored: 18
Tailoring not needed: 14
Should have been tailored: 5

Amount of		ALC Tailoring	
		Yes	No
Maintenance Information	too little	3	1
	acceptable	14	3
Other Information	too much	2	1
	acceptable	15	3

Specification Change Notice

Document was tailored: 14
Tailoring not needed: 17
Should have been tailored: 3

Amount of		ALC Tailoring	
		Yes	No
Maintenance Information	too little	2	2
	acceptable	10	3
Other Information	too much	1	1
	acceptable	11	4

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Appendix F: Acronyms

AFCOLR   Air Force Coordinating Office for Logistics Research

AFIT   Air Force Institute of Technology

AFLC   Air Force Logistics Command

AFOTEC   Air Force Operational Test and Evaluation Center

AFSC   Air Force Systems Command

ALC   Air Logistic Center

ALD   Acquisition Logistics Division

CDRL   Contract Data Requirements List

COTS   Commercial Off The Shelf

CPIN   Computer Program Identification Number

CRISD   Computer Resources Integrated Support Document

CRLCMP   Computer Resources Life Cycle Management Plan

CSCI   Computer Software Configuration Item

CSOM   Computer System Operator's Manual

DID   Data Item Description

DOD   Department Of Defense

ECP   Engineering Change Proposal

FQT   Formal Qualification Test

FSD   Full Scale Development

FSM   Firmware Support Manual

HWCI   Hardware Configuration Item

IDD   Interface Design Document

IRS   Interface Requirements Specification

ITA	Interface Test Adapter
OFP	Operational Flight Program
PMRT	Program Management Responsibility Transfer
SCN	Specification Change Notice
SCN	Survey Control Number
SDD	Software Design Document
SDF	Software Development File
SDP	Software Development Plan
SIRD	Software Integration Requirements Document
SPM	Software Programmer's Manual
SPO	System Program Office
SPS	Software Product Specification
SRS	Software Requirements Specification
SSDD	System/Segment Design Document
STD	Software Test Description
STP	Software Test Plan
STR	Software Test Report
SUM	Software User's Manual
TO	Technical Order
TRD	Test Requirements Document
UUT	Unit Under Test
VDD	Version Description Document

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DI-MCCR-80017A.   Data Item Description for the Software
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DI-MCCR-80018A.   Data Item Description for the Computer
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DI-MCCR-80019A.   Data Item Description for the Software
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DI-MCCR-80021A.   Data Item Description for the Software
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DI-MCCR-80022A.   Data Item Description for the Firmware
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DI-MCCR-80024A.   Data Item Description for the Computer
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Vita

Captain Timothy S. McArthur was born on 17 May 1956 in Dayton, Ohio. He graduated from Tecumseh High School in New Carlisle, Ohio in 1974 and enlisted in the Air Force in September 1977. He was accepted for commissioning through the Airman's Education and Commissioning Program in 1984 and, after completing a Bachelor of Science in Electrical Engineering at Ohio University, was commissioned through Officers Training School in October 1986. He was assigned to the B-1B SPO at Wright-Patterson AFB, Ohio, where he managed the acquisition of the B-1B Maintenance Training Equipment, the Central Integrated Test System Expert Parameter System, the B-1B Avionics Integrated Support Facility, and was the B-1B Computer Resources Manager. He was the logistics focal point for the development of the Central Integrated Test System, and co-chaired the Computer Resources Working Group. Captain McArthur entered the School of Systems and Logistics, Air Force Institute of Technology, in May 1989.

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13. ABSTRACT (Maximum 200 words)

The purpose of this thesis was to determine which documents cited by DOD-STD-2167A are required for the maintenance of a software system. This information is needed to ensure that maintenance personnel can readily access the ideas and requirements used by the original designers. The research made use of existing information as well as a survey of those personnel involved in the acquisition and maintenance of software systems. The result is a clear picture of where these documents fit in during the maintenance phase of the software life cycle. If properly utilized, this information provides a first step in reducing the tremendous cost of software maintenance.

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a. Yes   b. No

2. Do you believe this research topic is significant enough that it would have been researched (or contracted) by your organization or another agency if AFIT had not researched it?

a. Yes   b. No

3. The benefits of AFIT research can often be expressed by the equivalent value that your agency received by virtue of AFIT performing the research. Please estimate what this research would have cost in terms of manpower and/or dollars if it had been accomplished under contract or if it had been done in-house.

Man Years _____ $_____

4. Often it is not possible to attach equivalent dollar values to research, although the results of the research may, in fact, be important. Whether or not you were able to establish an equivalent value for this research (3 above), what is your estimate of its significance?

a. Highly   b. Significant   c. Slightly   d. Of No
    Significant   Significant   Significance

5. Comments

Name and Grade   Organization

Position or Title   Address