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The Overview Guidebook is one of a series of Software Acquisition Management (SAM) guidebooks intended to help ESD Program Office personnel in the acquisition of embedded software for command, control and communications systems. The Overview guidebook serves as the introductory volume. It (1) describes the series, placing it in the overall context of the Air Force Guidebook program; (2) defines the intended audience of the series; (3) tells how the guidebooks were developed; (4) makes recommendations concerning guidebook usage; (5) summarizes the contents of each guidebook; (6) provides a subject matter index

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for the series; (7) identifies future guidebook requirements; and (8) provides complete bibliographical citations for each guidebook.

PREFACE

This guidebook was prepared by System Development Corporation under the direction of the Computer Systems Engineering Directorate of the Electronic Systems Division (ESD/TOI, Formerly MCI), Air Force Systems Command. The Overview guidebook is one of a series of Software Acquisition Management guidebooks intended to help ESD Program Office personnel in the acquisition of embedded software for command, control and communications systems. The contents of the guidebook will be revised periodically to reflect changes in software acquisition policies and practices as well as feedback from guidebook users.

The Software Acquisition Management guidebook series is currently planned to cover the following topics (National Technical Information Service accession numbers for those already published are shown in parentheses):

Regulations, Specifications and Standards* (AD-A016401)

Contracting for Software Acquisition (AD-A020444)

Monitoring and Reporting Software Development Status (AD-A016488)

Statement of Work Preparation (AD-A035924)

Reviews and Audits

Computer Program Configuration Management (AD-A047308)

Computer Program Development Specification (Requirements Specification)

Software Documentation Requirements (AD-A027051)

Verification (AD-A048577)

Validation and Certification

Overview of the SAM Guidebooks

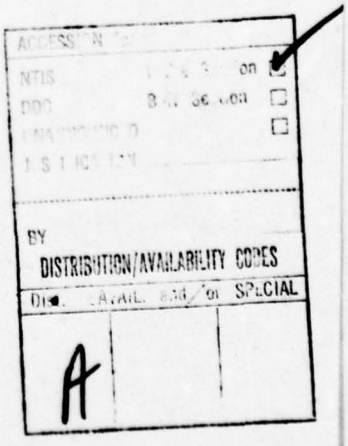
Software Maintenance

Software Quality Assurance (AD-A047318)

Software Cost Estimation and Measurement

Software Development and Maintenance Facilities (AD-A038234)

Life Cycle Events (AD-A037115)



*Revised in March 1978

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SECTION 1 - INTRODUCTION

1.1 PURPOSE

The Overview guidebook serves as the introductory volume to the Command, Control, and Communication System Software Acquisition Management (SAM) Guidebook series. It (1) describes the series, placing it in the overall context of the Air Force Guidebook program; (2) defines the intended audience of the series; (3) tells how the guidebooks were developed; (4) makes recommendations concerning guidebook usage; (5) summarizes the contents of each guidebook; (6) provides a subject matter index for the series; (7) identifies future guidebook requirements; and (8) provides complete bibliographical citations for each guidebook (see Appendix A).

1.2 THE COMMAND, CONTROL, AND COMMUNICATION SYSTEM SAM GUIDEBOOK SERIES

The Command, Control and Communications (C^3) System SAM Guidebook series is one of three such series (see Figure 1) designed to help Air Force Program Office (PO) personnel in the acquisition and management of embedded software procured under Air Force 800-series regulations and related concepts. C^3 software subsystems can be characterized as follows:

- Developed and maintained in an evolutionary environment.
- Large, customized, and unique (normally state-of-the-art).
- On-line, real-time, closed-loop operations.
- Interactive with user displays.
- Employs large data base management component.
- Contains significant doctrinal software which must be tailored to the user and usually cannot rely on off-the-shelf packages.
- Usually uses large, ground-based computers (frequently multi-site).
- Capable of dealing with asynchronous, event-driven environments.
- Services extensive automatic-communication components (often multi-site).
- Must be fault-tolerant with fail safe/soft and recovery attributes.

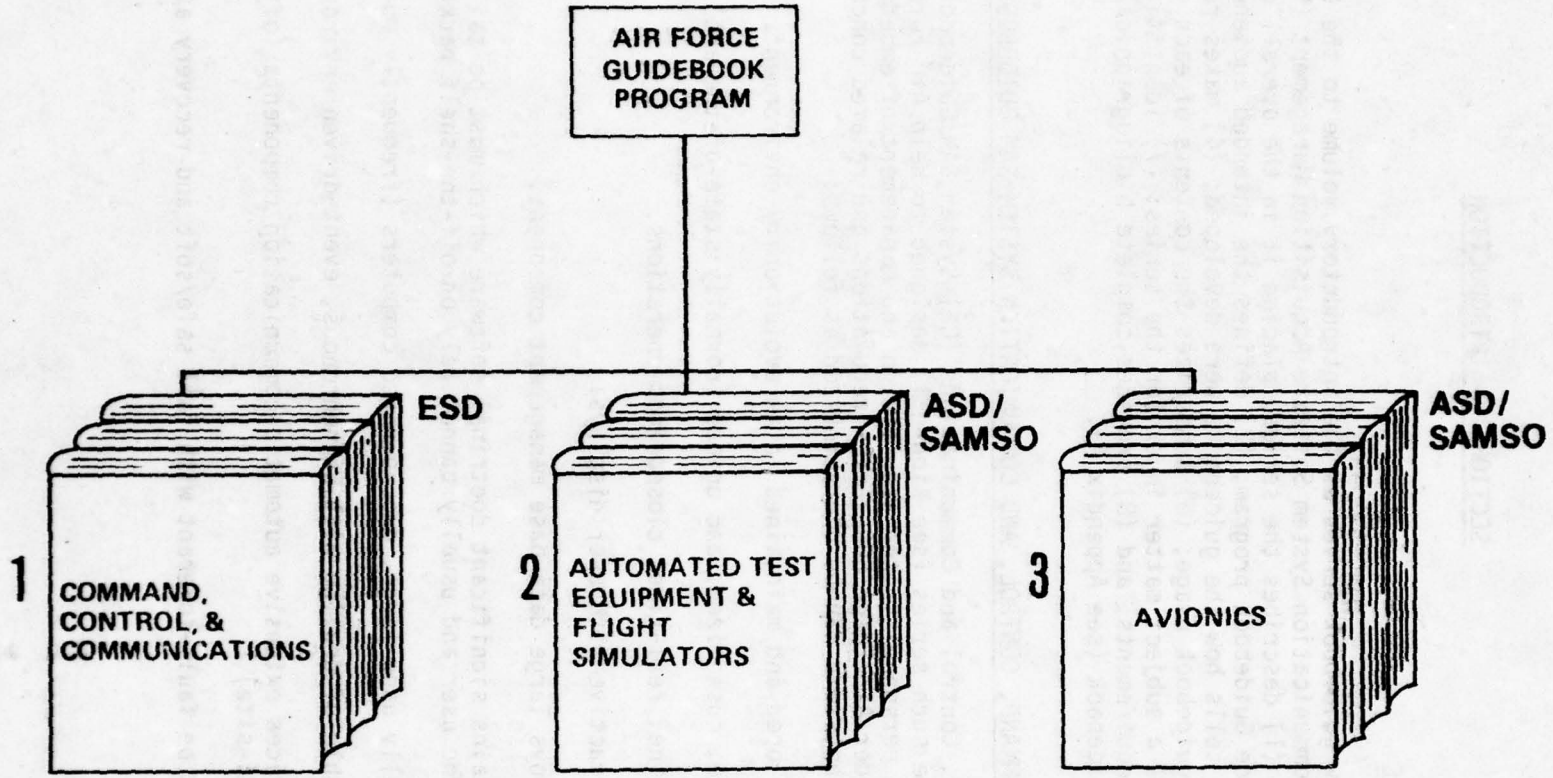

Figure 1. Air Force Guidebook Program

The C^3 series currently consists of 16 volumes covering various aspects of the software acquisition process. The basic purpose of the guidebooks is to:

- Communicate preferred procedures for planning, scheduling, organizing, directing, and evaluating the status of software development programs.
- Instruct PO personnel in the implementation of relevant DoD and Air Force regulations, specifications, and standards (RSS).
- Correlate sources of information concerning management of software development, acquisition, operation, and support.
- Provide references, explanations, and checklists to aid PO personnel in the early detection and resolution of common SAM problems.
- Support training of new personnel.

Based on these objectives the C^3 guidebooks emphasize practical approaches to real-world problems within the context of Air Force and DoD RSS. The guidebooks provide Air Force PO personnel with a comprehensive review of software acquisition management practices and procedures. They provide guidance on how to assess DoD and Air Force RSS; how to determine which RSS apply to a particular aspect of software acquisition; and how to resolve conflicting or overlapping RSS and what problems may arise because of their use. Further, the guidebooks assist PO personnel in detecting early symptoms of common SAM problems. They also provide advice to facilitate communication with contractor and other PO personnel.

To help achieve these objectives, guidance is presented in the context of the system acquisition process. The relationship between the guidebooks and the system acquisition life-cycle establishes a unifying structure over the entire series (see Figure 2). This approach highlights the applicability of individual guidebooks to various phases of the life cycle and emphasizes the relationship between guidebooks.

The guidebooks provide three general classes of information:

- Explanations (lessons learned, common pitfalls, and mistaken assumptions) which augment official guidance with useful experience. This kind of information will aid the guidebook user in answering the question: Given this mass of formal definition and procedure, how do I recognize the most significant and valuable pieces of guidance, how can I maneuver effectively and safely among sometimes conflicting sources of guidance, and are there any serious hidden implications within these sources?

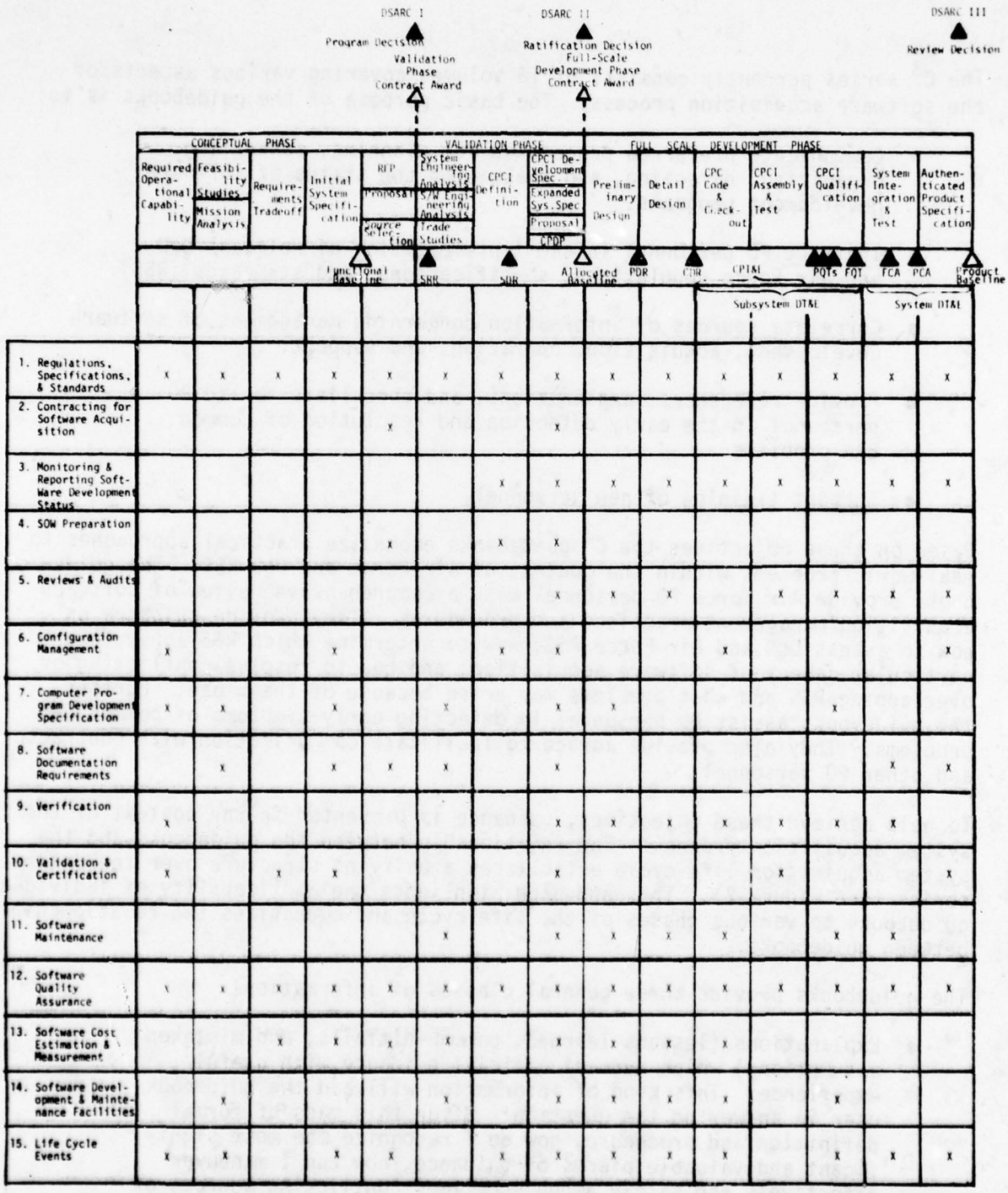

Figure 2. C^3 Guidebooks vs System Acquisition Life Cycle

- Checklists and descriptions of proven software acquisition management techniques which answer the questions: What are the early symptoms of common SAM problems I might encounter in daily operations, and what tools and techniques have proven effective in the past in monitoring status, in identifying problem thresholds, and in re-creating and performing post-mortems on management decisions?

- References and index lists which can be used to access the formal RSS relevant to the topic presented. These aid in answering the question: What are my official management opportunities and constraints in dealing with this particular aspect of software acquisition?

NOTE

Much of the guidance provided in the C^3 guidebook series is applicable to smaller less complex systems, but in all cases, it should be tailored to the needs of individual projects.

1.3 THE INTENDED GUIDEBOOK AUDIENCE

The information provided in the C^3 guidebook series is directed specifically to Air Force PO management personnel and a member of the Engineering Division referred to as the Software Director (SD), who is presumed to be responsible for managing software acquisition. Although the SD is still an evolving position without specifically defined responsibilities, the C^3 guidebook series assumes that the SD has the Air Force management experience implied by the rank of Major. The series assumes that his systems engineering experience ranges from basic to highly advanced.

1.4 HOW THE GUIDEBOOKS WERE DEVELOPED

The C^3 guidebook series was developed as a cooperative effort between the Air Force and industry. The first seven guidebooks were developed by The MITRE Corporation; the other nine were developed by System Development Corporation. The need for the guidebooks was motivated by the concerns expressed by potential software users, by reviewing authorities, and by software designers and implementors. Studies and interviews showed dissatisfaction with software acquisition management in several areas:

- Today's RSS are purposely written in a general manner which allows an experienced SD considerable latitude in tailoring the acquisition to the specific requirements of his program.

- The lack of experienced SDs.
- Standards and regulations which are sometimes unclear or contradictory.
- Known differences between policy and practice.
- SAM principles which are not well applied.
- Software which is often the high risk item of C^3 procurements.
- Schedules and budgets which prove to be unrealistic, or for other reasons are not met.

These and related problems result in high software costs and unreliable project schedules. In addition, new software design techniques, such as structured programming, may influence the ways in which software developments are managed in the future. Although a large body of software development information is available in written form, it is not available as useful guidance for ready reference in concise or focused form. Software issues are often addressed in DoD regulations as an afterthought in areas such as configuration management. These RSS do not sufficiently relate to software-unique situations and are not focused towards the everyday problems experienced by the Program Manager. Furthermore, the experience of varied efforts within DoD to acquire defense system software is not transferred effectively to new personnel. As a result, the same mistakes tend to be repeated in software acquisition programs. Thus, there is a need for guidelines, including checklists, examples, and other how-to-do-it information for the day-to-day use of Program Managers and their staff.

Further, Software Directors and Program Managers often do not have sufficient experience or the training to adequately recognize and solve software management problems. Guidebooks are thus needed to provide a comprehensive, concise review of software acquisition management practices and procedures. Although they can't assure good management, their conscientious use should assure that important questions, actions, and activities won't be overlooked or postponed until they are not effective.

Planning for the C^3 guidebook series began in FY75, using the sources of the ESD Computer Systems Engineering Directorate (TOI*), the MITRE Corporation, and ESD PO experience. The first seven guidebooks were produced by the MITRE Corporation between FY75 and FY77:

*Formerly MCI.

- Regulations, Specifications, and Standards
- Contracting for Software Acquisition
- Statement of Work Preparation
- Software Documentation Requirements
- Software Development and Maintenance Facilities
- Life Cycle Events

In addition, "A Project Guide to Content Requirements and Audience Needs," ESD-TR-75-308, was produced by MITRE to provide guidance for the development of the C^3 guidebook series. It covered such topics as terminology, writing style, depth of topical coverage, and topical scope.

Subsequently, a contract was let to System Development Corporation to produce the rest of the guidebooks in the series. SDC was tasked to review applicable DoD, Air Force, AFSC, and ESD regulations, manuals, pamphlets, MIL specifications, and MIL standards to compile source material for the guidebooks. Annotated outlines for each of the guidebooks were produced by SDC and reviewed by Air Force* and MITRE representatives. Drafts were produced for each guidebook with substantial review inputs from Air Force PO personnel, the Air Force Contracting Offices, and MITRE. Face-to-face reviews of each draft were conducted with the guidebook authors to maximize both Air Force and industry input as well as to assure mutual understanding. Finally, upon Air Force approval, each guidebook was produced as an ESD Technical Report and disseminated to the field through Air Force channels as well as the facilities of the National Technical Information Service (NTIS).

1.5 RECOMMENDED USES OF THE GUIDEBOOKS

The C^3 guidebook series relates the policy expressed in existing DoD and Air Force RSS to current ESD and industry practices. In addition to providing the PO with the guidance described in Paragraph 1.2, the guidebooks provide an interpretation of Air Force policy regarding software acquisition management. They also identify criteria which PO personnel will use to judge contractor performance, thus providing Air Force-published guidance on software acquisition management for industry use. In writing the guidebooks, the following specific PO needs were considered:

*Including AFSC, AFLC, ESD, AFCS, and RADC.

- Detailed guidance for specific PO activities.
- A summary of the latest SAM techniques.
- Source materials for SAM training courses.
- Orientation materials and references for new PO personnel.

Perhaps the most important use of the guidebooks is that they provide a forum and focus for continuing innovation and improvement of the SAM process.

1.6 AIR FORCE CONTRACT MANAGEMENT DIVISION (AFCMD) COMPUTER SOFTWARE POLICY

Appendix B of this guidebook has been added to provide guidance concerning computer software policy within AFCMD. This discussion is, however, more appropriate to the Contracting for Software Acquisition guidebook and an expanded discussion of this subject will appear in a future version of that guidebook.

SECTION 2 - INDIVIDUAL C^3 GUIDEBOOK SUMMARIES

2.1 INTRODUCTION

This section presents individual summaries of the following guidebooks:

- Regulations, Specifications, and Standards (see 2.2)
- Contracting for Software Acquisition (see 2.3)
- Monitoring and Reporting Software Development Status (see 2.4)
- Statement of Work Preparation (see 2.5)
- Reviews and Audits (see 2.6)
- Configuration Management (see 2.7)
- Computer Program Development Specification (Requirements Specification) (see 2.8)
- Software Documentation Requirements (see 2.9)
- Verification (see 2.10)
- Validation and Certification (see 2.11)
- Software Maintenance (see 2.12)
- Software Quality Assurance (see 2.13)
- Software Cost Estimation and Measurement (see 2.14)
- Software Development and Maintenance Facilities (see 2.15)
- Life Cycle Events (see 2.16)

Each summary highlights the basic purpose of the guidebook, identifies potential uses, and describes its contents.

2.2 REGULATIONS, SPECIFICATIONS, AND STANDARDS*

This guidebook serves as an introduction to the world of military and Government documents pertaining to software acquisition management and development. It begins by identifying the existing types of official documents and providing a table of guides, lists, catalogs, and indexes to the various forms of military and Government publications. It ends with two indexes, the first of which lists keywords with associated military and Government regulations, specifications, and standards (RSS). The second index reverses the first and lists RSS with associated key words.

The RSS guidebook applies to software, whether or not it is acquired as an entity or as a portion of a larger system. Therefore, even though many of the documents cited do not specifically refer to software management or development tasks, the software element of a system assumes the same measures of management control and development quality as does the system. Further,

*Reflects the contents of the October 1975 version.

some referenced publications deal specifically with software while others apply to software on a broader scale (e.g., cost control systems, or WBSs).

A major section of the RSS guidebook is devoted to software development in the system life cycle, as defined by Air Force 800-series regulations. This section identifies a series of sequential software development tasks that can be applied to any software development effort regardless of the system life cycle or managment controls that are applied.

A second major section differentiates between the types of programs governed by Air Force 300-series regulations and those governed by Air Force 800 series regulations. This section provides lists of 300-series and 800-series regulations and manuals and identifies distinguishing characteristics between the two series.

Two other major sections list (1) documents pertaining to software acquisition management and (2) software development tasks, while an appendix presents abstracts of selected software acquisition RSS.

The RSS guidebook was revised in March 1978.

2.3 CONTRACTING FOR SOFTWARE ACQUISITION

This guidebook provides an introduction to the process of contracting for the development of computer programs acquired under Air Force 800-series regulations. It starts out by describing the Armed Services Procurement Regulation (ASPR), "the bible for all contracting by the Department of Defense."

A major section is devoted to preliminary procurement planning, including selection of the basic procurement approach, formal procurement planning, and the bid package. This section provides a checklist for the Software Director to use in planning his basic procurement approach and discusses the Advanced Procurement Plan, negotiated procurements, and Determinations and Findings.

Another section addresses the selection of a contractor, including contacts with contractors, RFPs, proposal evaluation, contract negotiation, and contract award.

Still another section discusses contract management. It summarizes the responsibilities of the Air Force Contracting Officer, the Procuring Contracting Officer, the Administrative Contracting Officer, the Defense Contract Administrative Services, the Air Force Plant Representative Offices, and the Software Director. It also discusses contract changes and contract termination.

The last section lists ASPR references that are directly applicable to this guidebook. It also abstracts selected RSS of particular relevance to contracting for software acquisition.

Finally, an appendix provides a list of source selection dos and don'ts.

2.4 MONITORING AND REPORTING SOFTWARE DEVELOPMENT STATUS

This guidebook provides information for managers and technical personnel engaged in the planning, monitoring, and reporting of the technical status of a software development project. Both formal procedures, found in official regulations and manuals, and informal methods, from military, industrial, and academic experience, are discussed to provide a concise reference for the software manager to assure that important questions, actions, and activities will not be overlooked or postponed until they are no longer effective. Using these procedures and methods, the manager should be able to identify the kinds of information relevant to his project, where to obtain it, how to use it to determine status, and what problems may be associated with using this information.

The Monitoring and Reporting Software Development Status guidebook is relevant to all Air Force activities responsible for planning, developing, and acquiring computer software in systems managed under the concepts of AFR 800-2. A major section of the guidebook is devoted to status-monitoring tools and status reporting. It discusses both formal and informal milestones, periodic status meetings, contractor and Government reports, interviewing, and project schedule representations.

Another section discusses contractual planning to ensure Government visibility. It addresses program management planning and the procurement package, including statement of work, contract data requirements list, schedule, and independent monitoring agencies.

An appendix describes new software methodologies and their effect on management visibility. The discussion addresses top-down and bottom-up implementation approaches, modularity, structured design, requirements traceability, structured programming, and functional organization of personnel.

Finally, an appendix is included that provides summaries of selected status factors that can be used to evaluate project progress. Included in the appendix are discussions of documentation quality, stability of the requirements baseline, interfaces, programming languages, programming practices and standards, project complexity, and operating systems. In addition, the appendix addresses data management, personnel, development facility quality, project management, and non-subjective data.

2.5 STATEMENT OF WORK PREPARATION

This guidebook explains the preparation of a software-related statement of work (SOW). It contains a major section covering planning for SOW preparation and then presents model Full-Scale Development Phase SOW tasks.

The section on planning heavily emphasizes the use of work breakdown structures in SOW preparation and discusses SOW-preparation requirements, general suggestions for SOW preparation, and configuration item definition.

The section on model SOW tasks includes a table of contents and the software-related paragraphs of a hypothetical Full-Scale Development Phase SOW. The SOW presumes to prescribe the work desired from a single contractor (at the system level) to develop a postulated one-of-a-kind digital communications message switch. The SOW-prescribed tasks include interfacing the system with numerous local and remote digital data sources and sinks. The hypothetical planned contract covers site activation, support equipment, and administrative data, as well as software acquisition, computer equipment acquisition, and system engineering.

Three appendixes are included in the guidebook. The first addresses work breakdown structures, which it defines, describes their use, and summarizes the various types. The second discusses source selection plan requirements. And finally, the third appendix presents extensive guidance regarding the contents of RFPs.

2.6 REVIEWS AND AUDITS

This document provides detailed guidance concerning the use of engineering design reviews and configuration management audits as tools to monitor a developing organization's technical progress. It covers the following formal reviews and audits:

- System Requirements Review (SRR)
- System Design Review (SDR)
- Preliminary Design Review (PDR)
- Critical Design Review (CDR)
- Functional Configuration Audit (FCA)
- Physical Configuration Audit (PCA)
- Formal Qualification Review (FQR)

Major sections are devoted to general requirements for reviews and audits, engineering design reviews, and configuration management audits. Each of these sections discusses such subjects as location and scheduling, the responsibilities of participating organizations, and the conduct of reviews and audits. In addition, the materials to be reviewed or audited are listed and suggested evaluation criteria are presented.

Another major section presents modified sample forms from MIL-STD-1521A (USAF) which can be used to identify and record critical data during reviews and audits.

Finally, a section on the more common reviews and audits problem areas is included. This section deals with responsibility and authority, the CPCI (Part I) Development Specification, and the scheduling of PDRs and CDRs.

2.7 CONFIGURATION MANAGEMENT

This guidebook provides basic instructional and reference materials to support the application of Air Force/DoD-prescribed configuration management techniques. The Configuration Management guidebook is one of the largest of the C^3 series and includes seven sections.

The first section presents information of a background and introductory nature, reviewing general concepts, principles, special terms, and the status of Air Force/DoD configuration management standards.

The second section discusses the requirements and criteria for selecting assemblies of computer program code to be identified as Computer Program Configuration Items (CPCIs), and includes a subsection summarizing the sources and coverage of standards for identification numbers and markings.

A third section is devoted to specifications. It addresses: specification types and forms; the specification tree; the System Specification; Computer Program Development and Product Specifications; other types/forms of specifications applicable to computer programs; and comparisons between software and hardware with respect to the roles of their specifications in the system acquisition cycle.

The fourth section covers requirements and procedures for processing changes to approved specifications. It identifies organizational factors, explains change classification, describes standard forms, and discusses procedures involved in the preparation and processing of change proposals. It includes a subsection dealing with concepts of interface control and the documentation of interfaces involving software.

Another major section is devoted to the requirements and practices of document identification and maintenance which are significant to configuration management functions, and to formal reports/records of status for documents, change proposals, and CPCIs.

Still another section addresses factors which come into play following completion of development and initiation of the CPCI operations at a field location. Using a sample System Development Test and Evaluation situation for illustration, it identifies the nature of questions to be anticipated and shows how centralized controls and procedures described in the preceding sections relate to that expanded framework.

The last section contains notes written in response to questions raised by reviewers of a draft version of this guidebook, and pertaining to a few of the topics covered in the preceding sections. Its coverage includes: computer programs as data vs Configuration Items (CIs); "software" and the DoD directive; system segments; problems with Chapter 2, Volume II, of AFR 800-14; and Configuration Index questions.

2.8 COMPUTER PROGRAM DEVELOPMENT SPECIFICATION (REQUIREMENTS SPECIFICATION)

This guidebook is a detailed development guide for the Computer Program Development (Part I or Type B5) Specification. It provides extensive information on both the contents and purpose of each major paragraph of a Development Specification. It describes the general process of developing technical requirements and outlines, in general, the roles and objectives of specifications, placing them in the context of the software acquisition life cycle.

A major section of the guidebook is devoted to general guidelines for planning the Development Specification. It addresses: the specification preparation team; source documents for format, style, and classified materials; and summary rules for general emphasis and content. This section also provides detailed guidance for Development Specification structure and outline.

The bulk of this guidebook consists of a detailed paragraph-by-paragraph discussion of the required contents of a Development Specification. It is arranged so that each paragraph's basic content and purpose is defined, followed by a discussion of the specific types of information to be provided.

2.9 SOFTWARE DOCUMENTATION REQUIREMENTS

This guidebook addresses requirements for documentation of software developed in a large system acquisition, including the documentation associated with its development, acquisition, and use. It emphasizes the determination of documentation needs, the preparation of the Contract Data Requirements List (CDRL), and the specification of Data Item Descriptions (DID)s.

The bulk of this guidebook is presented in four sections. A major section addresses software documentation requirements. In this section, the author discusses how to determine these requirements. He describes the purpose of documentation and identifies RSS which provide guidance on the determination of documentation requirements for software. In addition, he discusses specific factors which impact documentation requirements and presents a series of guidelines that can be used to determine documentation requirements.

Another major section describes key software documents. It identifies and describes the major standard Air Force data items which apply to software, its development, its acquisition, and its use. It also discusses the tailoring of DIDs to meet the requirements of specific programs. In addition, it discusses alternative sets of software documentation (documents used by DoD agencies other than the Air Force) that may be applicable to some programs.

Still another section of the guidebook is devoted to the contractual aspects of data item acquisition. This section addresses contractual specification of the documents desired, including their content, format, delivery dates, numbers, and conditions of acceptance. This section emphasizes the relationship among the SOW, CDRL, and DIDs.

The final section of the guidebook presents general conclusions and recommendations regarding the determination of documentation requirements.

A series of three appendixes provide summary material on data items relevant to software acquisition.

2.10 VERIFICATION

The Verification guidebook provides guidance for planning and managing the implementation of software verification concepts and requirements as they relate to software acquisition management. It provides a review of the verification practices and procedures employed by industry and set forth in relevant RSS and describes those CPCI-oriented system engineering and test activities which lead to verification.

The Verification guidebook starts out by defining the term verification and distinguishing it from the terms validation and certification. It then goes on to a major section which addresses those system engineering activities carried out to ensure that the CPCI Development Specifications reflect the requirements allocated from the System Specification (requirements verification).

The next section is devoted to the design evaluation activities carried out to ensure that the CPCI design continues to meet the requirements of the Development Specification as the design proceeds to greater levels of detail (design verification).

The last section is concerned with the informal testing performed by the contractor, at his discretion, to assist in development, provide progress visibility, and prepare for formal testing (computer program verification).

An appendix describes selected commonly used support tools and techniques for computer program development and testing. The appendix stresses the applicability of these aids to distinct verification tasks.

2.11 VALIDATION AND CERTIFICATION

This guidebook summarizes the software acquisition implications of validation and certification. It begins by defining validation and certification. It then goes on to describe those system engineering activities carried out to ensure that the requirements documented in the System Specification accurately respond to the operational needs called for in the Required Operational Capability (validating the System Specification).

The next section addresses those Configuration Item (CI) integration activities performed to assemble and check out previously qualified CIs as a fully functioning system (installation and checkout).

Another section examines the software aspects of system validation carried out during System Development Test and Operation (DT&E) and Initial Operational Test and Evaluation (IOT&E) to demonstrate that the completed system meets the requirements called for in the System Specification (validating the system).

The last section discusses the software-related requirements of system turnover, transfer of management responsibility, and system certification.

2.12 SOFTWARE MAINTENANCE

This guidebook addresses those acquisition and development activities, occurring throughout the SAM cycle, which impact software maintenance. It includes discussions of system turnover to the using command and the transfer of program management responsibility to the supporting command. The computer program life cycle is also considered. Most of the information provided in this guidebook covers the implementing command's responsibilities during the SAM cycle. However, software maintenance during the Deployment Phase is also discussed to provide the background for proper planning. Current programming concepts are discussed as well as RSS. Within these constraints, this guidebook emphasizes the specification and procurement of maintainable software, including procurement of the facilities, support tools, and documentation necessary to support software maintenance activities.

Major sections are devoted to the acquisition of maintainable software and to applicable RSS. The former addresses: the definition and specification of maintainable software; monitoring the evolving software and evaluating contractor effectiveness; design change and error correction during Subsystem DT&E; transfer and turnover; and maintenance during the Deployment Phase. The latter, discusses those RSS that impact software maintenance. As used in this guidebook, the definition of software maintenance includes the ability to modify the software. This section therefore relates some of the configuration management RSS to software maintenance.

An appendix devoted to designing maintainable software is also included in this guidebook. It describes the properties of maintainable software, including conceptual organization, modular design, self-monitoring computer programs, program hooks for future extensions, and design methodology. In addition, it covers specific techniques that facilitate software modification, including computer program legibility, parametric organization, stable code, and development methodology, e.g., structured programming.

2.13 SOFTWARE QUALITY ASSURANCE

The Software Quality Assurance (QA) guidebook uses the definition of QA expressed in AFR 74-1, i.e., "A planned and systematic pattern of all actions necessary to provide adequate confidence that material, data, supplies, and services conform to established technical requirements and achieve satisfactory performance." Within this context, the entire concept of software acquisition management is concerned with the development of quality software. Special attention is given to:

- The relationship of QA to the other acquisition management disciplines.
- The integration of QA requirements within the system acquisition process.
- Contractual aspects of QA.
- Monitoring the implementation of QA requirements.
- Common problems and proposed solutions.
- Pitfalls, risk areas, and danger signals as they occur during the System Acquisition Life Cycle.

The Quality Assurance guidebook is organized into three sections covering Air Force Program Office (PO) QA, contractor QA, and software QA at ESD.

The first section relates the Air Force QA program to the major milestones of the system acquisition cycle as they occur during the Conceptual, Validation, and Full-Scale Development Phases. It treats objectives, activities, and QA considerations for each phase. Discussions are supplemented by flow charts depicting major activities within each phase.

The second section provides discussions designed to assist the PO in evaluating a contractor's proposal and the status of his software QA program. It discusses software QA responsibilities, necessary activities conducted prior to award of a Full-Scale Development Phase contract, and contractor QA program implementation.

The last section describes how ESD assists its POs in meeting their QA requirements. It covers the evolving QA role within ESD and discusses specific QA aids.

An appendix discusses various software quality issues. It begins by distinguishing between the terms software QA and quality software. The subjects covered include measuring software quality, quality vs program delays, how much QA is enough, and independent support contractors.

2.14 SOFTWARE COST ESTIMATION AND MEASUREMENT

This guidebook provides a basic understanding of the current methodologies used in the formation of Air Force and contractor software cost estimates. It provides insight into some of the problems (and reasons for the problems) associated with software cost estimates made by both Government and industry. It also discusses the process of monitoring software costs and schedules while providing guidance to relevant military RSS and supporting literature.

In this guidebook, careful attention is paid to the definition of cost estimation terms. The guidebook is organized so as to introduce the reader to the global concept of cost analysis and proceed from there to more specific levels of detail directly concerned with software cost estimation.

A major section is devoted to those factors associated with the PO that directly contribute to the formation of the system cost estimate, with particular emphasis on the software element portion of that estimate. The topics covered range from the end of the Conceptual Phase and subsequent program decision to submission of the RFP for Full-Scale Development.

Another section addresses the various contractor tasks associated with preparing a software cost proposal in response to an RFP for Full-Scale Development. This section presents an overview of the numerous software cost estimating techniques used, the project-dependent factors that impact software development costs and analyses, and task specification and scheduling with regard to the WBS.

The last section discusses the evaluation of contractor cost proposals in response to an RFP. It also discusses issues relating to the requirements and procedures for cost reporting and performance measurement of C^3 system acquisition during Full-Scale Development.

An appendix summarizes some of the software estimation models currently used by both Government and industry.

2.15 SOFTWARE DEVELOPMENT AND MAINTENANCE FACILITIES

This guidebook examines the need for software development and maintenance facilities, discusses policy affecting their acquisition, identifies key management decisions and technical issues involved in this planning, surveys existing software development and maintenance facilities, and identifies potential problems.

A major section of this guidebook is devoted to explaining the roles of software development and maintenance facilities within the context of the acquisition and computer program life cycles.

Another section presents the results of a survey of 14 C^3 systems to determine what types of development and maintenance facilities currently exist or are planned. It identifies characteristics and trends and summarizes the facilities of each system.

Another section addresses the planning and acquisition of development and maintenance facilities. It discusses the management decisions and technical issues to be considered and identifies applicable RSSs.

Finally, a section is devoted to potential problems and recommendations for avoiding them or minimizing their impact.

Three appendixes are included in this document. The first provides brief descriptions of the C^3 systems surveyed. The second provides survey data regarding the development and maintenance facilities planned or in use with the systems surveyed. The third appendix describes representative examples of the various types of support software encountered in the survey.

2.16 LIFE CYCLE EVENTS

This guidebook explains the chief activities, events, products, and software-related efforts that normally occur during the life cycles of major electronic systems acquired within the framework of the 800-series of Air Force regulations and manuals. The 800-series normally governs acquisition of computers and software which are embedded in weapons or C^3 systems. Some of this software (e.g., application programs) may be built expressly for the weapons or C^3 system. Some (e.g., certain operational executives) may be modified versions of off-the-shelf software. The 800-series covers the research, design, development, engineering, testing, and production of tactical and strategic systems for the operational inventory. In contrast, the acquisition of off-the-shelf, commercially-marketed data processing equipment and its associated support (non-functional) software for business-like applications (e.g., payrolls, logistics, personnel records, and management reporting) is normally governed by the 300-series of Air Force regulations and manuals. This guidebook does not address acquisition managed in accordance with the 300-series, although some of its principles may apply.

Two potential uses are anticipated for this guidebook:

- As a tutorial for persons relatively inexperienced in the acquisition of large systems that include software.
- As a summary of material relevant to software acquisition for those otherwise quite familiar with the acquisition of large systems.

Major sections are devoted to the acquisition life cycle including an overview of the life cycle and one section each for the Conceptual Phase, the Validation Phase, the Full-Scale Development Phase, and the Production and Deployment Phases. Each section discusses phase objectives, initiating events, primary activities and related products, and terminating events.

Another section discusses less elaborate acquisitions.

The last section summarizes the activities and products of the computer program life cycle. It distinguishes between this cycle and the system acquisition life cycle and relates the two.

An appendix summarizes the major specification provisions affecting software. This appendix should be compared with the similar discussions in the Configuration Management guidebook.

SECTION 3 - ESD CRITICAL ASSESSMENT FACTORS AND SELECTED SUBJECT INDEXES

3.1 INTRODUCTION

This section provides indexes to the guidebooks for the 36 Critical Assessment Factors (CAFs) (see Figure 3) and 15 additional selected subjects added during the development of this guidebook (see Figure 4). CAFs are defined events or products that are essential to the system acquisition process and indicate the current status of the software during its development and acquisition cycles (for further discussion of CAFs, see 4.4 of the Quality Assurance guidebook).

In using the indexes, the viewpoint of more than one author should be considered because there are some differences in definitions and in guidance from guidebook to guidebook. In addition, all discussions tend to reflect the emphasis of the guidebook in which they appear and a particular point of view may be unique to a specific guidebook.

Many of the topics included in the indexes were discussed extensively in several guidebooks while others were only fleetingly mentioned. This led to differences in the depth of discussion referred to in the index. For example, the Required Operational Capability (ROC) is only briefly mentioned in the entire C^3 guidebook series whereas the Computer Program Development Specification has an entire guidebook devoted to it, in addition to extensive discussions in several other guidebooks.

Please note that the Regulations, Specifications, and Standards guidebook is not covered in the indexes. It was purposely left out because indexes to the RSS covering the 51 subjects of Figures 3 and 4 are beyond the scope of this guidebook.

CAF	GUIDEBOOK	TEXT REFERENCE
Required Operational Capability	Configuration Management	3.2.2.
	Computer Program Development Specification	See Figure 1-2.
	Verification	1.2.2, Figure 3.
	Validation & Certification	1.2.1, 2.2, Figure 1.
	Software Quality Assurance	2.2.2.1, 2.2.2.1.1, Figure 2.
	Life Cycle Events	3.2, Table 1.
Costing/Sizing	Statement of Work Preparation	See Entire Volume.
	Software Documentation Requirements	See Section II (Page 21).
	Software Cost Estimation & Measurement	See Entire Volume.
Program Management Directive	Monitoring & Reporting Software Development Status	3.1, 3.2.
	Validation & Certification	4.2, 5.1.
	Software Maintenance	3.1, 3.2.
	Software Quality Assurance	2.2.1, 2.2.2.1, 2.2.2.1.2, 4.5.
	Software Development & Maintenance Facilities	4.1.2, 4.4, 5.
	Life Cycle Events	See Tables 1, 2, & 3, and 2, 3.2, 4.2, 4.4, 4.4.1, 4.4.3, 5.2

Figure 3. ESD CAF Index

CAF	GUIDEBOOK	TEXT REFERENCE
Program Management Plan	Monitoring & Reporting Software Development Status	3.2.
	Statement of Work Preparation	2, 2.2.
	Software Documentation Requirements	See Section II (Page 23), and Section IV (Page 47).
	Validation & Certification	4.2, 4.2.1, 4.2.3.
	Software Maintenance	3.1, 3.2.
	Software Quality Assurance	2.1, 2.2.2.1.2, 2.2.2.2, 2.2.2.2.1, 2.2.2.2.2, 4.5.
	Software Cost Estimation & Measurement	2.1.
	Software Development & Maintenance Facilities	4.1.2, 4.4.
	Life Cycle Events	See Tables 1, 2, & 3, and 4.4, 4.4.1, 4.4.3.
Procurement Plan	Contracting for Software Acquisition	2 thru 2.4.
	Statement of Work Preparation	2.
	Software Quality Assurance	2.2.2.2.1, 2.2.2.3.2, 4.5.
	Software Cost Estimation & Measurement	1.2.
	Life Cycle Events	See Tables 1, 2, & 3.

Figure 3. ESD CAF Index (cont'd)

CAF	GUIDEBOOK	TEXT REFERENCE
System Specification	Monitoring & Reporting Software Development Status	1.5, 2.2, 2.2.1.
	Statement of Work Preparation	2.2, 2.3, Exhibit 1, Appendix C.
	Reviews & Audits	See Entire Volume.
	Configuration Management	2.2, Section 3, 4.3.1, Section 5, 7.4.
	Computer Program Development Specification	1.2, 1.3.1.
	Software Documentation Requirements	See Tables 1 & 2, Section III (Pages 56 & 108), Appendix I (Page 140).
	Validation & Certification	2.1, 2.2, 4.2.3.
	Software Maintenance	See Figure 1.
	Software Quality Assurance	2.2.1, 2.2.2.2.2, 2.2.2.3 thru 2.2.2.3.2, 2.3.1.1.2, 2.3.1.3, 2.3.1.3.2, 4.5.
	Software Cost Estimation & Measurement	See Figure 1.
	Life Cycle Events	Tables 1 thru 4, 3.3, 4.3, Appendix A.
Computer Resources Integrated Support Plan	Contracting for Software Acquisition	3.2.
	Monitoring & Reporting Software Development Status	3.2.
	Statement of Work Preparation	2.
	Configuration Management	2.1.2, 4.3.
	Software Documentation Requirements	See Sections II (Page 23) & III (Pages 26, 39, 46, 47) and Tables I, VI, & VII.
	Validation & Certification	5.1, 5.2.

Figure 3. ESD CAF Index (cont'd)

CAF	GUIDEBOOK	TEXT REFERENCE
Computer Resources Integrated Support Plan (cont'd)	Software Maintenance	1.2, 1.3.2, 2.1, 2.1.1, 2.4, 2.4.1, 2.5, 3.1, 3.2.
	Software Quality Assurance	2.2.2.2.2, 2.3, 2.3.1.3, 2.3.1.3.1, 4.1.2, 4.2, 4.4, 4.5.
	Life Cycle Events	See Tables 2 & 3 and 4.4, 4.4.2, 6.4.
Statement of Work	Contracting for Software Acquisition	2.4.
	Monitoring & Reporting Software Development Status	2.2.1, 3.3, 3.3.1.
	Statement of Work Preparation.	See Entire Volume.
	Software Quality Assurance	2.2.2.3.2, 3.3, 4.5.
	Software Cost Estimation & Measurement	3.3.1, 4.2.
	Software Development & Maintenance Facilities	4.5.
	Life Cycle Events	1.
Contract Data Requirements List	Contracting for Software Acquisition	2.4.
	Monitoring & Reporting Software Development Status	2.2.1, 2.4, 3.3, 3.3.1, 3.3.2.
	Statement of Work Preparation	1, 1.2, 2, 2.1.5, 2.1.6, 2.2, Exhibit 1, Appendix C.
	Reviews & Audits	4.2.2.
	Configuration Management	7.1.

Figure 3. ESD CAF Index (cont'd)

CAF	GUIDEBOOK	TEXT REFERENCE
Contract Data Requirements List (cont'd)	Software Documentation Requirements	See Sections II (Pages 15, 16, 20, & 21) & IV (Pages 130-132).
	Software Maintenance	2.1, 2.1.2, 3.1, 3.2.
	Software Quality Assurance	3.3, 4.5.
	Software Cost Estimation & Measurement	4.2.
	Software Development & Maintenance Facilities	4.3.1.5, 4.5.
Source Selection Plan	Contracting for Software Acquisition	3.0, 3.3.
	Statement of Work Preparation	See Appendix B.
	Software Quality Assurance	4.5.
Source Selection	Contracting for Software Acquisition	3.0, 3.1, 3.3, 3.4, 5.0, Appendix.
	Statement of Work Preparation	See Appendix B.
	Software Quality Assurance	2.3.1.3, 4.3, 4.5.
	Software Cost Estimation & Measurement	See Section 4.
	Life Cycle Events	See Tables 1 & 2.
Contract	Contracting for Software Acquisition	2.2.
	Monitoring & Reporting Software Development Status	See Section 3.
	Statement of Work Preparation	See Section 1 & Appendix C.

Figure 3. ESD CAF Index (cont'd)

CAF	GUIDEBOOK	TEXT REFERENCE
Contract (cont'd)	Software Documentation Requirements	See Section IV (Pages 130-132).
	Software Quality Assurance	2.4.1.1, 2.4.1.1.1, 3.3, 3.4, 4.5.
	Software Cost Estimation & Measurement	2.3.
	Software Development & Maintenance Facilities	4.5.
	Life Cycle Events	4.3.1.3, 4.4, Tables 2 & 3, Appendix A.
Computer Program Development Plan	Contracting for Software Acquisition	See Appendix.
	Monitoring & Reporting Software Development Status	3.2, 3.3.1.
	Statement of Work Preparation	2.1.7, Exhibit 1, Appendix C.
	Reviews & Audits	3.3.2.
	Computer Program Development Specification	1.3.2c.
	Software Documentation Requirements	See Section III (Pages 31-40, 51-53).
	Verification	2.2.1, 2.3, 2.3.1.
	Software Maintenance	1.3.2, 2.2.2, 2.2.3.
	Software Quality Assurance	2.3.1.3, 2.3.1.3.2, 2.3.2.1, 3.3, 3.4, 3.4.4, 3.4.9, 3.4.10, 3.4.11.
	Software Cost Estimation & Measurement	3.3, 4.2.
	Software Development & Maintenance Facilities	4.1.2, 4.2, 4.4.
	Life Cycle Events	See Tables 2 & 3 and 4.4.5.

Figure 3. ESD CAF Index (cont'd)

CAF	GUIDEBOOK	TEXT REFERENCE
CPCI Structure	Statement of Work Preparation	2 3, 3, Appendix A.
	Configuration Management	See Section 2.
	Life Cycle Events	4.3.1.3.
Configuration Management Plan	Monitoring & Reporting Software Development Status	3.2, 3.3.1.
	Statement of Work Preparation	See Exhibit 1.
	Configuration Management	See Section 4.
	Software Documentation Requirements	See Section III (Page 54) & Appendix I (Page 139).
	Software Quality Assurance	3.4.3, 3.4.1.1.
Configuration Control	Contracting for Software Acquisition.	4.2.
	Statement of Work Preparation	2.3, Exhibit 1.
	Configuration Management	See Entire Volume (especially Sections 4 & 6).
	Software Maintenance	2.4.1, 2.4.2.
	Software Development & Maintenance Facilities	4.2.
	Life Cycle Events	4.3.1.2.

Figure 3. ESD CAF Index (cont'd)

CAF	GUIDEBOOK	TEXT REFERENCE
System Requirements Review	Reviews & Audits	See Entire Volume.
	Computer Program Development Specification	1.3.2.
	Verification	2.2.2, 4.1.1.
	Validation & Certification	2.2.
	Software Quality Assurance	2.3.1.1, 2.3.1.1.2.
	Life Cycle Events	See Table 2.
System Design Review	Monitoring & Reporting Software Development Status	2.2, 2.2.1, 3.3.1.
	Reviews & Audits	See Entire Volume.
	Computer Program Development Specification	1.3.2.
	Verification	1.2.1, 2.2.3.
	Validation & Certification	2.2.
	Software Maintenance	See Figure 1.
	Software Quality Assurance	2.3.1.2, 2.3.1.2.2.
	Software Cost Estimation & Measurement	See Figure 1.
	Life Cycle Events	See 5.3 and Tables 2 & 3.
Development Specification	Monitoring & Reporting Software Development Status	1.5, 2.2, 2.2.1.
	Reviews & Audits	See Entire Volume.
	Configuration Management	2.2, Section 3, 4.3.1, 4.4, 4.5.2, Section 5.
	Computer Program Development Specification	See Entire Volume.

Figure 3. ESD CAF Index (cont'd)

CAF	GUIDEBOOK	TEXT REFERENCE
Development Specification (cont'd)	Software Documentation Requirements	See Table I and Section III (Page 62).
	Verification	2.3.2.
	Software Maintenance	See Figure 1, 1.3.2, 2.1.2.
	Software Quality Assurance	2.2.2.2.2, 2.3, 2.3.1.3, 2.3.1.3.2, 2.3.2, 2.3.2.1, 2.4 thru 2.4.1.1.2, 2.4.1.4.1, 2.4.2.
	Life Cycle Events	See Table 2, 3, & 4, and 4.3.1.1, 4.3.1.2, Appendix A.
Design	Monitoring & Reporting Software Development Status	See Appendix II & Appendix III (Pages 6-8).
	Computer Program Development Specification	1.3.1.
	Software Documentation Requirements	See Section III (Pages 87, 92).
	Verification	See Appendix A (2.1 thru 2.1.4).
	Validation & Certification	5.1.
	Software Maintenance	See Figure 1, 1.3.2, 2.3.1.2, Appendix A.
	Software Quality Assurance	2.4.1 thru 2.4.1.4.2, 3.4.7.
	Life Cycle Events	4.3.1. thru 4.3.2.

Figure 3. ESD CAF Index (cont'd)

CAF	GUIDEBOOK	TEXT REFERENCE
Training Plan	Software Documentation Requirements	See Table II, Section III (Page 55), Appendix I (Page 144).
	Validation & Certification	5.2, 5.3.
	Life Cycle Events	See 4.4, 4.4.4 and Tables 2 & 3.
Test Plan	Monitoring & Reporting Software Development Status	2.2, 3.3.1.
	Reviews & Audits	3.1.2.2, 3.2.1.
	Computer Program Development	3.19, 3.19.1.
	Software Documentation Requirements	See Tables I & II, Section III (Pages 94, 97, 113), Appendix I (Page 148).
	Verification	2.2.1, 2.3.3.
	Validation & Certification	3.2, 4.2.4, 5.1.
	Software Maintenance	2.2.1.
	Software Quality Assurance	2.2.2.3, 2.3, 2.3.1.2.1, 2.3.1.3.2, 2.4.1.1.2, 2.4.1.2, 3.3, 3.4.4.
	Life Cycle Events	Tables 1, 2, 3, & 4 and 4.3.1.2, 4.4, 4.4.3.
Preliminary Design Review	Monitoring & Reporting Software Development Status	2.2, 2.2.1, 3.3.1.
	Reviews & Audits	See Entire Volume.
	Computer Program Development Specification	1.3.2.
	Verification	1.2.1, 3.2.1.

Figure 3. ESD CAF Index (cont'd)

CAF	GUIDEBOOK	TEXT REFERENCE
Preliminary Design Review (cont'd)	Software Maintenance	See 2.2.1 and Figure 1.
	Software Quality Assurance	2.4.1.1, 2.4.1.1.2, 2.4.1.2.1, 2.4.1.4.2.
	Software Cost Estimation & Measurement	See Figure 1.
	Software Development & Maintenance Facilities	2.4, 4.6.
	Life Cycle Events	Tables 3 & 4 and 5.3.
Interim Progress Reviews	Monitoring & Reporting Software Development Status	2.3, 2.3.1, 2.3.2, 3.3.1.
Product Specification	Monitoring & Reporting Software Development Status	1.5, 2.2, 2.2.1.
	Reviews & Audits	See Entire Volume.
	Configuration Management	See Section 3, 4.3.1, 4.4, 4.5.2, Section 5.
	Computer Program Development Specification	1.2.
	Software Documentation Requirements	See Table I & Section III (Page 66).
	Software Maintenance	See Figure 1, 1.3.2.
	Software Quality Assurance	2.4, 2.4.1.4, 2.4.1.4.1, 2.4.1.4.2, 2.4.2, 2.4.2.1.
	Life Cycle Events	See Tables 3 & 4, 5.3, Appendix A.
Test Procedures	Monitoring & Reporting Software Development Status	2.2, 3.3.1.
	Computer Program Development Specification	3.19, 3.19.1.

Figure 3. ESD CAF Index (cont'd)

CAF	GUIDEBOOK	TEXT REFERENCE
Test Procedures (cont'd)	Software Documentation Requirements	See Tables I & II, Section III (Pages 94, 97).
	Verification	3.2.3.
	Validation & Certification	4.2.4.
	Life Cycle Events	See Tables 3 & 4, 4.3.1.2.
Critical Design Review	Monitoring & Reporting Software Development Status	2.2, 2.2.1, 3.3.1.
	Reviews & Audits	See Entire Volume.
	Verification	1.2.1, 3.2.2.
	Software Maintenance	See Figure 1, 2.2.2.
	Software Quality Assurance	2.4.1.2, 2.4.1.2.2.
	Software Cost Estimation & Measurement	See Figure 1.
	Software Development & Maintenance Facilities	2.2, 4.6.
	Life Cycle Events	See Tables 3 & 4, 5.3.
Coding	Monitoring & Reporting Software Development Status	See Appendix III (5 thru 5.2.5).
	Verification	See Appendix A (3.1 thru 3.1.4, 3.2 thru 3.2.2).
	Software Maintenance	See Figure 1, 2.2.3, Appendix A (Section 3).
	Software Quality Assurance	2.4.1.3.
	Software Cost Estimation & Measurement	See Figure 1.

Figure 3. ESD CAF Index (cont'd)

CAF	GUIDEBOOK	TEXT REFERENCE
Coding (cont'd)	Software Development & Maintenance Facility	2.2.
	Life Cycle Events	See Table 4.
Preliminary Qualification Tests	Monitoring & Reporting Software Development Status	2.2, 2.2.1.
	Computer Program Development Specification	3.20.
	Verification	1.2.1, 4.1, 4.1.3, 4.2, 4.2.1.
	Software Quality Assurance	2.4.1.3 thru 2.4.1.3.2, 2.4.1.4.1, 2.4.1.4.2, 2.4.1.2.
	Software Development & Maintenance Facility	2.2.
	Life Cycle Events	See Tables 3 & 4.
Formal Qualification Tests	Monitoring & Reporting Software Development Status	2.2, 2.2.1.
	Reviews & Audits	2.1.
	Computer Program Development Specification	3.2.1.
	Verification	1.2.1, 4.1, 4.1.3, 4.2, 4.2.2.
	Software Maintenance	2.2.4.
	Software Quality Assurance	2.4.1.3.1, 2.4.1.4, 2.4.1.4.1.
	Software Cost Estimation & Measurement	See Figure 1.
	Software Development & Maintenance Facilities	2.2.
	Life Cycle Events	Tables 3 & 4, 5.3.

Figure 3. ESD CAF Index (cont'd)

CAF	GUIDEBOOK	TEXT REFERENCE
Functional Configuration Audit	Monitoring & Reporting Software Development Status	2.2.
	Reviews & Audits	See Entire Volume.
	Verification	1.2.1.
	Software Maintenance	2.2.5.
	Software Quality Assurance	2.4.1.4, 2.4.1.4.2.
	Life Cycle Events	See Table 3, 5.3.
Users Manuals	Software Documentation Requirements	See Table I and Section III (Pages 81, 110).
	Life Cycle Events	See Table 3.
Physical Configuration Audit	Monitoring & Reporting Software Development Status	2.2.
	Reviews & Audits	See Entire Volume.
	Software Maintenance	2.2.6.
	Software Quality Assurance	2.4.1.4, 2.4.1.4.2.
	Life Cycle Events	See Table 3, 5.3.
System/Integration Tests	Monitoring & Reporting Software Development Status	1.6, 2.2.1.
	Reviews & Audits	3.1.2.2.
	Configuration Management	See Section 6.
	Computer Program Development Specification	3.2.2.
	Software Documentation Requirements	See Tables I & II, Section III (Pages 54, 97, 104), Appendix I (Page 148).
	Verification	1.2.2.

Figure 3. ESD CAF Index (cont'd)

CAF	GUIDEBOOK	TEXT REFERENCE
System/Integration Tests (cont'd)	Validation & Certification	1.2, 3.1, 3.2, Section 4, 5.1, 5.2.
	Software Maintenance	See Figure 1.
	Software Quality Assurance	2.4.1.3.1.
	Software Cost Estimation and Measurement	See Figure 1.
	Software Development & Maintenance Facilities	2.2.
	Life Cycle Events	See Tables 3 & 4, 4.4.3, 5.3.
Formal Qualification Review	Monitoring & Reporting Software Development Status	2.2.
	Reviews & Audits	See Entire Volume.
	Verification	1.2.1.
	Life Cycle Events	5.3.
Transition/Turnover Agreement	Validation & Certification	See Section 5.
	Software Maintenance	1.2, 2.4 thru 2.4.3, 3.1.
	Life Cycle Events	4.2, 6.4.

Figure 3. ESD CAF Index (cont'd)

SELECTED SUBJECT	GUIDEBOOK	TEXT REFERENCE
Structured Programming	Monitoring & Reporting Software Development Status	See Appendix III (Section 5).
	Software Maintenance	See 3.4 & Figure 9.
Trade/Design Studies	Software Documentation Requirements	See Section III (Page 92).
	Software Quality Assurance	2.2.2.3.2, 2.3.1.1.2.
	Software Development & Maintenance Facilities	2.2.
Work Breakdown Structure	Monitoring & Reporting Software Development Status	3.3.1.
	Statement of Work Preparation	1, 1.4, 2, 2.1.1, 2.1.3, 2.2, 2.3, 3, 3.2, Exhibit 1, Appendix A.
	Software Maintenance	2.1.3.
	Software Cost Estimation & Measurement	2.1.1, 2.1.2, 3.3, 3.3.1, 3.3.2, 4.3.
	Life Cycle Events	See Table 1 & 3.3, 4.3.1.2.
Schedule	Contracting for Software Acquisition	2.4.
	Monitoring & Reporting Software Development Status	2.7, 3.3, 3.3.1, 3.3.3.
	Statement of Work Preparation	1.
	Software Documentation Requirements	See Section II (Page 20) & Appendix I (Page 137).
	Software Quality Assurance	2.4.1.4.2.

Figure 4. Selected Subject Index

SELECTED SUBJECT	GUIDEBOOK	TEXT REFERENCE
Schedule (cont'd)	Software Cost Estimation & Measurement	3.2.7, 3.2.7.1, 3.3, 3.3.2, 4.2.
	Software Development & Maintenance Facilities	4.3.1.5.
Verification	Verification	See Entire Volume.
Validation & Certification	Validation & Certification	See Entire Volume.
Conceptual Phase Activities	Computer Program Development Specification	1.3.1.
	Validation & Certification	See Section 2.
	Software Maintenance	1.2.
	Software Quality Assurance	2.2 thru 2.2.3.1.
	Software Cost Estimation & Measurement	See Figure 1.
	Software Development & Maintenance Facilities	2.1.
	Life Cycle Events	See Section 3.
Validation Phase Activities	Reviews & Audits	1.5, 2.4, 3.1 thru 3.2.3.
	Computer Program Development Specification	1.3.2.
	Verification	1.2, 2.1 thru 2.2.3.
	Validation & Certification	See Section 2.
	Software Maintenance	1.2, 2.1.2.
	Software Quality Assurance	2.3 thru 2.3.2.1.

Figure 4. Selected Subject Index (cont'd)

SELECTED SUBJECT	GUIDEBOOK	TEXT REFERENCE
Validation Phase Activities (cont'd)	Software Cost Estimation & Measurement	See Figure 1.
	Software Development & Maintenance Facilities	2.1.
	Life Cycle Events	See Section 4.
Full-Scale Development Phase Activities	Statement of Work Preparation	See Section 3.
	Reviews & Audits	2.4, 3.3 thru 3.4.3, Section 4.
	Verification	2.3 thru 2.3.3, Section 3, Section 4.
	Validation & Certification	See Sections 3 & 4.
	Software Maintenance	1.2, 2.1.2, 2.2. thru 2.2.6, 2.3 thru 2.4.3.
	Software Quality Assurance	2.4 thru 2.4.2.1.
	Software Cost Estimation & Measurement	See Figure 1.
	Software Development & Maintenance Facilities	2.1.
	Life Cycle Events	See Section 5.
Deployment (Operational/ Support) Phase Activities	Validation & Certification	See Section 5.
	Software Maintenance	1.2, 2.3, 2.5.
	Software Cost Estimation & Measurement	See Figure 1.
	Software Development & Maintenance Facilities	2.1.
	Life Cycle Events	See Section 6.

Figure 4. Selected Subject Index (cont'd)

SELECTED SUBJECT	GUIDEBOOK	TEXT REFERENCE
Test/Support Tools	Verification	4.1.2.4, Appendix A.
	Software Maintenance	1.3.2.
	Software Quality Assurance	3.4.10.
	Software Development & Maintenance Facilities	4.3.1 thru 4.3.1.9, Appendix C.
Facility (Support/Development/Maintenance) Planning	Contracting for Software Acquisition	2.2.
	Software Development & Maintenance Facilities	See Entire Volume.
Coding Standards/ Conventions	Monitoring & Reporting Software Development Status	See Appendix III (5 thru 5.2.5).
Operational Test/ Evaluation	Monitoring & Reporting Software Development Status	See Figure 1 and 2.2.1 (Page 30).
	Verification	1.2, 1.2.3, Figure 3.
	Validation & Certification	1.2, 1.2.1, 12.2., Section 5.
	Software Development & Maintenance Facilities	2.2.
	Life Cycle Events	4.4.3, 8.3.
Software Maintenance	Software Maintenance	See Entire Volume.
	Software Development and Maintenance Facilities	4.3.1.9.

Figure 4. Selected Subject Index (cont'd)

SECTION 4 - FUTURE GUIDEBOOK REQUIREMENTS

4.1 INTRODUCTION

As the guidebooks were prepared, several issues arose which were beyond the original intent and scope of the series. These issues are briefly presented in this section with the hope that they will be considered for incorporation in revised or consolidated guidebooks.

4.2 THE SYSTEM AND SOFTWARE ENGINEERING PROCESSES

Although these topics were partially addressed in several of the guidebooks (i.e., Life Cycle Events, Quality Assurance, Verification) they should be more thoroughly covered in a single guidebook. The systems and software engineering activities which lead to the System Specification and to the Development (Part I) Specification are critical to the success of all software-embedded systems. Also, a thorough discussion of the systems and software engineering activities can provide detailed guidance to be mapped and evaluated against the requirements of MIL-STD 490. Special attention should be given to identifying, evaluating, and minimizing risks in the development of software. However, emphasis must be placed upon the identification and specification of system requirements, and the temptation toward early detailing of software requirements without proper system definition should be avoided.

4.3 DIFFERING PROCUREMENT STRATEGIES

More research, analysis, and guidance is needed to help the PO determine the most appropriate procurement strategies for any given program. Topics requiring further discussion include:

- What types of contracts (Fixed Price, Cost Plus) are most appropriate for differing types of procurements?
- Under what conditions is it beneficial to the Government to contract with two or more competitive organizations? When is such an arrangement most likely to be unnecessary?
- How should the PO contract for sufficient visibility throughout the System Acquisition Cycle?
- What are the most appropriate activities to request from a Verification and Validation (V and V) contractor? How should V&V proposals be evaluated?

4.4 SOFTWARE ASPECTS OF THE SYSTEM SPECIFICATION

The Requirements Specification guidebook focuses primarily upon the CPCI Development (Part I) Specification. Further guidance is needed regarding the software aspects of the System Specification. Currently some agencies are placing added emphasis on software requirements as part of the System Specification; not only performance requirements, but upon requirements for standards and for maintainability as well. To what extent does this emphasis benefit the Government, and to what extent will added costs or added risks likely ensue? These issues should be addressed in conjunction with the issues described in 4.2.

4.5 THE BUDGETING AND SCHEDULING DILEMMA

Although the Software Cost Estimation and Measurement guidebook covers current practices and discusses state of the art techniques, it does not adequately address one of the most difficult problems: budgets and schedules for most software embedded C^3 systems are originally generated early in the system acquisition cycle often before the System Specification is available. However, successful cost estimation and scheduling depends upon an accurate definition of requirements to a fine level of detail. Approaches to this dilemma require the development of a clear and agreed upon statement of the problem followed by the development and evaluation of several alternatives. This problem should be addressed by a team containing personnel with a thorough understanding of procurement policy and strategy, system and software acquisition management, software technology, and software configuration management.

4.6 FIRMWARE ACQUISITION MANAGEMENT

This C^3 guidebook series is notably lacking in specific guidance about the acquisition of firmware. However, paragraph 3, m, (8) of AFSC Supplement 1 to Volume I of AFR 800-14 states that "computer firmware will be managed as Computer Program Configuration Items..."

4.7 AN AIR FORCE GLOSSARY OF TERMS

Although each guidebook contains a glossary of the terms used in that guidebook, it is evident that many software-related terms are not consistently used throughout the guidebook series, throughout the RSS, or throughout the Air Force. For example, the words software, verification, and validation are defined differently from publication-to-publication. Reliability and maintainability mean one thing for hardware, another for software. The solution to

this problem requires the adoption of standard and agreed upon terminology by both software acquisition management and technical personnel.

4.8 VALIDATING THE GUIDEBOOK SERIES

Now that the guidebooks have been written, they must be validated through use by the POs. Questions such as the following should be addressed:

- To what extent are the guidebooks useful for new PO personnel, for experienced PO personnel? How can they be made more useful?
- To what extent should the guidance be expanded or elaborated upon, condensed, corrected, or deleted?

4.9 APPLYING THE GUIDEBOOKS TO OTHER DOD AGENCIES

This series was sponsored by ESD and is primarily directed toward ESD POs. However, much of the guidance should be applicable throughout the Air Force for 800-series, software-embedded system procurements. ESD/TOI* will appreciate feedback from other DoD agencies, as well as from industry, regarding their usefulness and suitability.

*Formerly MCI.

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APPENDIX B - AFCMD COMPUTER SOFTWARE POLICY

(RETYPED)

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CONTRACT MANAGEMENT DIVISION, AFSC
KIRTLAND AIR FORCE BASE, NEW MEXICO 87117

REPLY TO ATTN OF: EN

SUBJECT: AFCMD Computer Software Policy

16 SEP 1977

TO: AFSC/XRF

1. The AFCMD mission is three-fold: Perform the contract management functions at our assigned contractor plants per ASPR 1-406; provide support to program managers and buying agencies in accordance with Memoranda of Agreement (MOA) or Letters of Delegation, per ASPR 20-703.3 and AFSC Supplement thereto; and evaluate the contractors' management systems via our Contractor Management System Evaluation (CMSE) Program.

2. All three mission responsibilities, from their inception, have been interpreted by most concerned parties as pertaining primarily to hardware. Acquisition of computer software relative to weapon systems (computer programs, computer data, and associated documentation) has been recognized as a major concern within the Air Force since 1972 and was given DOD emphasis in 1976 with the publication of DOD 5000.29, "Management of Computer Resources in Major Defense Systems."

. The DOD Directive implies the Services should treat computer software with the same degree of importance as they do hardware. This emphasis on software changes our AFCMD engineering workload significantly. Therefore, for the present and in the immediate future, AFCMD must adopt a policy compatible with our manpower levels and the shortage of technically knowledgeable manpower resources in the area of computer software. Eleven of our twenty AFPROs administer contracts with significant computer software requirements, but we have very few personnel who can perform their ASPR 1-406(c) engineering functions relative to computer software with the same level of expertise that they currently do with respect to hardware.

4. Due to manpower limitations and skill shortage, AFCMD can only provide surveillance of in-plant computer software as described below:

a. Engineering Surveillance of Computer Software Accomplished VIA the CMSE Program. The AFPRO Engineering Divisions now provide surveillance of computer software relative to ASPR 1-406(c) engineering functions 32, 34, 35, 38, 41, the engineering change system portion of 42, and function 43 via the CMSE Program. Function 39, monitor contractor value engineering programs, will be incorporated into the CMSE Program in the next revision of AFCMDR 178-1, "Contractor Management System Evaluation Program."

b. Engineering Surveillance of Computer Software Not Accomplished VIA the CMSE Program. The remainder of the ASPR 1-406(c) engineering functions (33, 36, 37, 40, all of 42 except the engineering change system mentioned above, and functions 44, 45 and 46) cannot be accomplished relative to computer software, via the CMSE Program. Concerning these ASPR functions, AFPRO

Engineering Divisions will perform the related surveillance concerning deliverable, nondeliverable, and support software only to the extent definitized in the applicable MOA. This means that for each SAR/PAR/CAR program with computer software efforts required of the contractor, the program office and the AFPRO must specifically negotiate into the MOA for that program, all computer software tasks to be performed by the AFPRO Engineering Division and which (if any) of these ASPR functions are to be performed by the Program Office, third party contractors, or in-house laboratories.

c. Procurement Quality Assurance. ASPR 1-406(c) function 47 (perform procurement quality assurance) comprises a multifaceted responsibility relative to deliverable, nondeliverable, and support computer software. This responsibility will be accomplished by review and evaluation of the contractor's quality assurance management systems via the CMSE Program, verification of the quality assurance requirements of the contract via AFCMDR 74-1, and performance of specific computer software quality assurance tasks delineated in the MOA.

d. Other ASPR 1-406 Contract Management Functions. The AFPROs will perform the remaining ASPR 1-406(c) functions (1 through 31, and 48 through 69) for contracts involving computer software as they currently accomplish these functions for hardware. The nature of these ASPR functions does not usually require special procedures for the computer software aspects of the contracts.

5. A key ingredient to successful contract management is the precise understanding of respective roles and responsibilities by program offices and AFPROs. The MOA is the vehicle for this. It is a logical approach for delineating responsibilities and ensures that AFPRO support is responsive to specific program office needs.

6. The requirement for MOAs is particularly important in the area of computer software tasks. Program offices and AFPROs should negotiate, in detail, via the MOA, computer software tasks to be accomplished by both the AFPRO Engineering and Quality Assurance Divisions because they entail the largest computer software roles in the AFPROs.

7. We believe the adoption of this policy is the best way to accomplish Air Force requirements without requiring a substantial increase in AFCMD manpower. Therefore, we request your dissemination of this information to the AFSC product divisions.

ORIGINAL SIGNED BY:

MERTON W. BAKER
BRIGADIER GENERAL, USAF
COMMANDER

COMMENT SHEET

Overview to the Guidebook Series

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