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MILITARY HANDBOOK
EVALUATION OF A CONTRACTOR'S
SOFTWARE
QUALITY ASSURANCE PROGRAM



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THIS DOCUMENT CONTAINS 25 PAGES.

This Handbook is to be utilized for training material only. Efforts are underway within the Department of Defense to further refine the definition of Software Quality Assurance (SQA) and to propose changes to the parent document, MIL-S-52779A. Caution should be exercised in applying SQA principles espoused herein since the level and extent of SQA is highly dependent on the end-use function of the software.



DEPARTMENT OF DEFENSE
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Evaluation of a Contractors Software Quality Assurance Program
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1. This standardization handbook was developed by the Department of Defense.
2. This publication was approved on 7 December 1980 for printing and inclusion in the military standardization handbook series.
3. This document provides basic and fundamental information and guidance to personnel concerned with the evaluation of a contractor's software quality assurance program, in connection with MIL-S-52779A. "Software Quality Assurance Requirements." The handbook is not intended to be referenced in purchase specifications, nor shall it supersede any specification requirements.
4. Every effort has been made to reflect the latest information on the evaluation of a contractor's software quality assurance system. It is the intent to review this handbook periodically to insure its completeness and accuracy. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be used in improving this document should be addressed to:

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or by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this handbook.

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INTRODUCTION

This document provides guidance to personnel responsible for the evaluation of a contractor's software quality program when Military Specification, MIL-S-52779A, is invoked in the contract. MIL-S-52779A, "Software Quality Assurance Program Requirements", requires contractors to establish a Software Quality Assurance (SQA) Program which will assure compliance with the requirements of their contract. Since the contract will tailor the application of MIL-S-52779A and other specifications, care must be taken to tailor the application of this document accordingly.

Both MIL-S-52779A and this document are based on established Department of Defense (DOD) concepts and policies which provide that:

a. Contractors are solely responsible for the control of software quality and for offering to the Government for acceptance only software determined by them to conform to contractual requirements.

b. Government representatives are responsible for determining that contractual requirements have, in fact, been complied with prior to acceptance of the software.

c. Final decision of software acceptability is solely the responsibility of the Government.

The contractor, in accordance with MIL-S-52779A, must design and maintain an effective and economical software quality program that includes procedures which makes data available to the Government adequate for use in establishing software acceptance criteria. Facilities and management techniques vary so widely within the broad pattern of National security and industrial establishments that this evaluation document cannot provide detailed checklists for all facets of software quality assurance. Instead, it reflects the software quality program methods currently used in industry. The emphasis throughout this document is on the planning and execution of a comprehensive software quality program. The evaluation of such a program depends on

how well decision criteria have been selected, applied, and enforced.

The Government's evaluation plan should apply to all aspects of a contractor program. Thus, Government representatives should be familiar with all requirements of the procurement to assure themselves that the contractor provides effective quality control coverage throughout the entire program. This may not be limited to the requirements of MIL-S-52779A alone; many contracts will include requirements for software and hardware. In the event that there is a combination of hardware and software, Government representatives should also be familiar with the requirements of MIL-Q-9858A, "Quality Program Requirements".

Quality programs are not intended to correct deficiencies in other contractual requirements. The contractor is not obligated to perform more than the requirements specified in the contract.

Occasionally DOD Components contract for parallel development of software under the concept of Independent Verification and Validation. Even though this type of an effort may be defined as a quality assurance task, MIL-S-52779A should be imposed. Tailoring MIL-S-52779A (imposing all, part or additions) should be accomplished by the Primary Contracting Officer.

A consistent format has been followed throughout this document. In order to relate the program evaluation suggestions as directly as possible to the requirements of MIL-S-52779A, each subsection of the specification is quoted verbatim and followed by appropriate comments, as follows:

SUBSECTION OF MIL-S-52779A

- A. "Review of Requirement" - Discussion of the requirements set forth in the subsection.
- B. "Application" - Description and examples of practices applied by contractors in the past that are

- typical and illustrative rather than all inclusive or mandatory.
- C. "Criteria for Evaluation" - Questions which should be asked to evaluate that particular part of a contractor's quality program.

It is important to note that the questions contained in the various "Criteria for Evaluation" are essentially yes/no questions. Asking and answering them alone will not provide a thorough and complete evaluation of a contractor's quality program. The questions serve only as indicators and reminders of important points to cover; the evaluation is expected to cover them in appropriate depth and detail to assure an effective and complete evaluation. Many questions may not be contractually required, and as

such, are to be considered self-deleting. The evaluation criteria contained in this document are applicable to the Quality Assurance Plans/Programs/Procedures that are designed to satisfy the requirements of MIL-S-52779A during the development or maintenance of computer software systems, i.e.:

1. Stand alone computer software systems and subsystems.
2. Tactical systems that contain embedded computer software.
3. Support software used to assist development and testing of deliverable software.
4. Software used to maintain deliverable/operational software.
5. Software embedded in automatic test equipment either as a deliverable or as a test and acceptance facility for deliverable items.

QUALITY AND RELIABILITY ASSURANCE

CONTRACTOR SOFTWARE QUALITY ASSURANCE EVALUATION GUIDE

1.0 SCOPE

1.1 Applicability. When referenced in the item specification, contract, or order, this specification shall apply to the acquisition of software (computer programs and related data & documentation) where the acquisition involves either software alone or software as a portion of a system or subsystem. This specification shall also apply to non-deliverable design, test, support, and operational software developed under the contract, unless specifically exempted. For purposes of this specification, the term software includes firmware.

A. Review of Requirement. MIL-S-52779A is applicable to computer programs and software systems to assure conformance to contractual requirements through control of the design, development, and testing of the software. Unless otherwise defined in a contract or order, firmware is defined as hardware that contains a computer program that cannot be altered in its use environment. Examples are:

Programmable-Read-Only-Memory (PROM) devices, Read-Only-Memory (ROM) devices and Erasable Programmable-Read-Only-Memory (EPROM) devices.

All computer programs that are, or will be contained in firmware are classified as software.

The chip on which a computer program is burned in, is classified as hardware.

B. Application. Among the types of software to which MIL-S-52779A may be applied are:

1. Command and control computer programs (embedded), software systems, and operational software end items.

2. Computer programs and software systems (deliverable/nondeliverable) designed for acceptance testing, checkout, launch, or control weapon or space systems, or other aerospace systems.

3. Firmware in the above systems. Firmware targeted software will be considered the same as any other software under this specification. The hardware quality aspects of firmware are beyond the scope of this specification and should be specified in the contract.

C. Criteria for Evaluation.

1. Is the procurement for computer programs/software systems alone or computer programs/software systems that are part of a larger system which also includes hardware and/or firmware?

2. Does the contract or order specify MIL-S-52779A for software quality assurance program requirements?

3. Has the contractor differentiated between deliverable and non-deliverable software?

4. Is the control of non-deliverable software sufficient to insure product quality?

5. Has the contractor identified what software is to be delivered as firmware?

1.2 Contractual Intent. This specification requires the establishment and implementation of a Software Quality Assurance (SQA) Program (hereafter referred to as the "Program") by the contractor. The purpose of the Program is to assure that software developed, acquired, or otherwise provided under the contract complies with the requirements of the contract. It is intended that the program be effectively tailored and economically planned and developed in consonance with, or as an extension of, the contractor's other quality assurance, administrative, and technical

programs. The term "Program", as used herein identifies the collective requirements of the specification. The Program shall require periodic assessment and, where necessary, realignment of the Program to conform to changes in the acquisition program. The Program is subject to disapproval by the Government whenever it does not accomplish the requirements of this specification.

A. Review of Requirement. MIL-S-52779A requires contractors to establish and use a complete software quality program. This does not mean that the fulfillment of the requirements of the specification is the responsibility of any single contractor's organization, function or person. This program must be designed to assure adequate controls throughout all areas of contract performance, for example, software design, development and testing. All or any part of a contractor's software quality program may be disapproved by the Government when the program does not accomplish the requirements of the contract.

B. Application.

1. A complete software quality assurance program is often the most comprehensive and extensive activity of a contractor. Software development does not lend itself to the deficiency detection and correction techniques of a hardware QA program because it is produced in a one-time program. Therefore, a contractor's software quality assurance program should provide a system to detect a deficiency early and should provide effective corrective action to assure that the software complies with contract requirements.

2. Since software relates to Development over a period of time, the initial planning must be assessed periodically to assure continued and current application of requirements.

3. Completed software products which do not conform to technical requirements shall be rejected. In addition, when a contractor's procedures are found to be unsatisfactory, the procuring activity will immediately notify the contractor and will disapprove all, or part, of the

software quality program if timely, effective corrective action is not taken.

4. It should be noted that paragraph 1.2 states that the program shall be "effectively tailored and economically planned". The criteria for evaluation provided in this handbook are to guide the evaluator and should be tailored to the specific contract requirements being evaluated. Note that considerable differences may exist between software Quality Programs for different contracts. Likely variations exist because of project size, the criticality of the mission application, and the program phase (Technology Development, Validation, Engineering Development, Full Scale Production, etc).

C. Criteria for Evaluation.

1. Does the contractor have a software quality program which assures compliance with the requirements of the contract?

2. Are working level procedures available, as well as the overall program plan?

3. Has the contractor documented a management plan to periodically assess the effectiveness of the quality program.

1.3 Relation to Other Contract Requirements. The contractor is responsible for compliance with all provisions of the contract and for furnishing specified software which complies with all the requirements of the contract. The SQA Program Plan shall reference other plans; e.g., configuration management, test, development, etc., specified under the contract and shall be compatible and consistent with them and not unnecessarily duplicate their provisions. If any inconsistency exists between the terms of the contract and this specification, the Order of Precedence clause of the contract shall govern.

A. Review of Requirement. The requirements of MIL-S-52779A are not intended to cancel or conflict with any other requirements of a contract. Thus,

MIL-S-52779A does not release contractors of any of their contractual responsibility. If there is an apparent conflict between the requirements of the contract and MIL-S-52779A, the contract requirements prevail.

B. Application. Contractors usually review with care all of the technical requirements of a contract to make certain that all requirements are effectively covered by their quality programs. Though many requirements may be standard from contract to contract and from specification to specification and can be dealt with by a standard response, most contractors insist on a total and thorough review because special or new contract clauses may be included. Even in follow-on contracts for software previously furnished, contractors may find specifications requiring compliance to new or different requirements. This handbook acknowledges that specifications and standards such as: MIL-Q-9858A, Quality Program Requirements; MIL-I-45208A, Inspection System Requirements; MIL-STD-1679 (USN), Weapon System Software Development; MIL-STD-1520A (USAF), Corrective Action and Disposition System for Non-conforming Material; and MIL-STD-1535A (USAF), Supplier Quality Assurance Program Requirements, interface with MIL-S-52779A, when they are contractually imposed, and should be used in conjunction with MIL-S-52779A. The interface between Government specifications which have been contractually imposed should be described in the Software Quality Assurance plan.

C. Criteria for Evaluation.

1. Does MIL-S-52779A conflict with any other requirements of the contract, and has the contractor identified the conflict and taken steps to eliminate it?
2. Does the Software Quality Assurance Plan show relationship to other plans, specifications, and requirements rather than duplicate them?

2.0 APPLICABLE DOCUMENTS

- 2.1 Amendments and Revisions. Whenever this specification is amended or revised subsequent to its contractually effective date, the

contractor may follow, or authorize his subcontractors to follow, the amended or revised document provided no impact on schedule or increase in cost, price, or fee is required. The contractor shall not be required to follow the amended or revised document except as a formally authorized modification to the contract. If the contractor elects to follow the amended or revised document, he shall notify the contracting officer in writing of this election. When the contractor elects to follow the provisions of an amendment or revision, he must follow them in full.

- 2.2 Ordering Government Documents. Copies of specifications, standards, and documentation required by contractors in connection with specific procurements may be obtained from the procuring agency, or as otherwise directed by the contracting officer.

3.0 REQUIREMENTS

- 3.1 Software QA Program. Upon contract award, the contractor shall plan, develop, and implement a SQA Program which includes practices and procedures to assure compliance with all software requirements of the contract. The Program activities shall be a part of the management reporting system throughout the life of the contract. The contractor shall document the Program in the form of a SQA Plan (hereafter referred to as the "Plan") which meets the requirements of this specification. The Plan shall identify organizational

responsibilities and authorities for its execution and the events critical to its implementation. The Plan shall also identify and make timely provisions for special needs (controls, tools, facilities, skills, etc.) required for the Program and shall provide for detection, reporting, analysis, and correction of software problems and deficiencies. Contractor personnel performing quality functions shall have the responsibility, authority, and organizational freedom to evaluate software activities, identify problems, and initiate or recommend corrective action.

A. Review of Requirement.

1. To establish a software quality program which fulfills the requirements of MIL-S-52779A, contractors must identify the functions and activities that directly affect software compliance and assign specific authority and responsibility for these functions. The assignment is made in terms of decisions and actions to identified elements at all levels of organization.

2. The specification explicitly requires contractors to satisfy certain software quality program requirements, but does not specify an organizational arrangement of any kind for meeting these requirements.

3. Software shall be developed in a disciplined manner. An effective check and balance shall be built into the management system for controlling all key software development tasks. The contractor's quality organization shall be included in this process.

B. Application.

1. Although MIL-S-52779A does not dictate an organizational structure, no single department can satisfy all of the software quality program requirements of MIL-S-52779A. Contractors likely will want to vest authority and responsibility for coordination and management of the

implementation of MIL-S-52779A to a particular organizational component (for example, Software Quality Assurance Department). Typically, the interaction of several departments of a contractor's organization (such as, engineering, program/project office, test, and software quality assurance) is required to effectively implement the software quality program to which MIL-S-52779A applies.

2. A complete software quality program reflects a comprehensive and extensive activity of a contractor. Usually a contractor will have standard procedures for the application of MIL-S-52779A. In addition, relative to each contract, these procedures will be tailored as necessary to provide assurance of compliance with contract requirements in an economical manner. The requirements of MIL-S-52779A described in Section 3, which are contractually required, will be specified in the Software Quality Plan. That Plan will likely reference the applicable company procedures; however, the methods to be utilized may be documented within the Plan itself. The Plan shall also identify and make timely provisions for special needs, controls, tools, facilities, skills, etc., required for execution of the Plan. Other typical documents likely to be referenced include programming standards and conventions, manuals, computer handbooks and other forms of management manuals. The accomplishment of software quality functions typically will be performed by personnel from several different organizations. The key element is that the checks and balances of the software quality program effectively provide for delivery of contractually required software which complies with the design requirements.

C. Criteria for Evaluation.

1. Does the established program identify the organizational element responsible for each of the various software quality efforts? ✓

2. Do the personnel performing the software quality functions have sufficient authority, responsibility, and freedom of action to evaluate software design and production activities, and to initiate and/or recommend changes?

3. Do the personnel performing the software quality functions have specific documented definitions of their assigned duties?

4. Are Software Quality Assurance Program activities included as a part of the contractor's management reporting system?

5. Does the contractor delineate the various software quality efforts?

6. Is the program documented and is such documentation available for Government review?

3.2 Software QA Program Requirements. The Plan shall address the following requirements:

3.2.1 Tools, Techniques, and Methodologies. The Plan shall identify the tools, techniques, methodologies and records to be employed in the performance of the work which will support QA objectives and describe how their use will augment or satisfy QA Program requirements. Examples include: Operations Research - Systems Analysis techniques, functional and performance requirements analysis, error analysis, software optimization tools, specification tracing, and coding convention.

A. Review of Requirement. MIL-S-52779A requires contractors to identify in their Software QA Plan all of the tools, techniques, methodologies, and records that they propose to utilize during the life of the contract to verify the quality of the software. Additionally, the plan will describe how each tool, technique, and methodology identified satisfies or augments software requirements.

B. Application.

1. During the life of a contract, many individual functions are performed to ensure the quality of the software. This includes the reviews of software documentation from the initial specification documents through the final test

reports. Contractors may in some cases have developed automated test aids to verify the quality of the software. Simulation programs may be a part of the contractor's library or can be developed especially for the testing of the software. The contractor describes how the use of these programs actually verifies the quality of the software.

2. The contractor may include manual techniques and methods for such areas as document review. In this case detailed review checklists or guidelines may be employed. The identity of these checklists are given along with how they will be employed and recorded.

3. The contractor may include in the Plan structured design and coding techniques. These techniques in part can be represented by standards and conventions. Also a method of how the contractor will verify the use of these standards and conventions should be identified.

C. Criteria for Evaluation.

1. Has the contractor identified and defined the system/software engineering techniques and methodologies planned for use to support the requirements of quality assurance? (They may be documented in the Computer Program Development Plan.)

2. Are the contractor's automated tools acceptable, or will they be accepted prior to use?

3. Are the automated tools documented and placed under configuration management controls?

4. Does the contractor's Plan describe provisions for identifying, documenting, controlling of revisions, validating, and calibrating the applicable software support tools used to actually verify the quality of deliverable software?

5. Does the contractor have available documentation to support the use of existing test tools?

6. Has the contractor documented those methods of analysis employed in the performance of their contract?

7. Do the above documents describe the initially known limitations of their analysis techniques and are the documents updated during the evolution of the program? If required, are these techniques concurred with, as described in the contract?

8. Are there records of all essential activities?

9. Are records available to Government personnel, and furnished when required?

10. Are there effective means for assuring the currency, completeness, and accuracy of records?

11. Do records include only the numbers and kinds of deficiencies? Is other essential data recorded? How and where?

12. Do records and work instruction compliance records indicate the quantitative degree of acceptance or rejection of product or work effort?

13. If rejection is recorded, do records show resulting action?

14. Do management actions reflect the analysis and use of records?

15. Does the contractor identify design and coding standards and conventions?

16. Does the contractor identify how design and coding standards and conventions are verified?

3.2.2 Computer Program Design.

The Plan shall reference or document the procedures by which design documentation is reviewed to evaluate design logic, fulfillment of requirements, completeness, and compliance with specified standards. Design documentation shall be subjected to independent review prior to its release for coding.

A. Review of Requirement. MIL-S-52779A requires contractors to establish procedures for the review and evaluation of software design documentation. These reviews should emphasize review of the design from the viewpoint that the design should reflect the requirements and are to be accomplished prior to the commencement of coding. Adequate procedures are necessary to assure that each design document is complete, that all requirements have been met, and that the logic of the design is described and substantiated. The Software QA Plan should reference procedures for design review.

B. Application.

1. Each computer program that will be individually tested is coded to the requirements contained in a software design document. Independent (other than the designer) reviews of design documentation will be conducted prior to its release for coding. Some contractors establish software design review boards. The boards are convened to conduct design reviews at predetermined points, often identified as: System Requirements Review (SRR), System Design Review (SDR), Software Segment Design Review, Preliminary Design Review (PDR), and Critical Design Review (CDR). The composition of these review boards should contain representatives from varied activities, such as software design, programming, analysis, testing, and software quality assurance (refer to paragraph 3.2.6 for specifics on reviews).

2. Regardless of the methods employed, the Software QA Plan includes procedures for the evaluation of software design to verify that the design meets the requirements. The Plan includes provisions for assuring the effective follow-up on all action items resulting from the review.

C. Criteria for Evaluation.

1. Do the contractor's procedures address the conduct of design documentation reviews?

2. Are the informal and formal reviews scheduled at critical decision points during development?

3. Are design documentation reviews conducted prior to release for coding?

4. Does the contractor have a mechanism to determine if all software requirements are satisfied by the design?

5. Are design problems identified and corrective action taken prior to approval of design?

6. Are design documentation reviews conducted independently of the design group?

3.2.3 Work Certification. The Plan shall reference or document the contractor's procedures for formally approving or certifying the description, authorization, and completion of

work performed under the contract. The Program shall require monitoring to assure compliance with these procedures.

A. Review of Requirement. The contractor's procedures for issuing work instructions should provide for definition and authorization of tasks, tracking and reporting task progress, resource allocation, and steps for closing out completed tasks. Procedures should identify the method employed to monitor compliance.

B. Application. Contractors usually have a formal procedure for describing and authorizing work to be done as well as to stop work in process where appropriate. The procedure's formality and sophistication will depend on a contractor and the contract under consideration. The real significance is whether the procedures provide adequate control. The procedures should depict the allocation of quality resources.

C. Criteria for Evaluation.

1. Is the lowest acceptable organization level for QA involvement specified in the Plan?

2. Is the level of authorization sufficient to provide management control?

3. Are there provisions for monitoring and tracking the progress of tasks?

4. Can the task progress be related to the approved project schedules?

5. Is the relationship between tasks and the Work Breakdown Structure (WBS) element visible, if contractually invoked?

6. Do the tasking procedures call for a detailed description of the tasks related to the Statement of Work (SOW)?

7. Is the responsible manager for each task identified?

8. Are plans/procedures/responsibilities defined to:

-authorize tasks?

-allocate resources?

-close out completed tasks?

3.2.4 Documentation. Documentation standards and programming conventions and practices to be used for all software shall be referenced or

documented in the Plan. The Plan shall reference or document the procedures to be applied to assure compliance with standards, practices, and conventions and delivery of correct documentation and change information to the Government. In addition, the Plan shall provide for the independent review of documentation and designation of contractor approval authority.

NOTE: For the purpose of placing proper emphasis on this section, the Handbook will treat the general subject of Documentation and Programming Standards and/or Coding Conventions as separate items.

General Documentation.

A. Review of Requirement. MIL-S-52779A requires that documentation standards be stated or referenced in the Plan. The method of incorporating changes will also be described in the Plan. The procedure for the review and the contractor's designated approval/disapproval authority shall also be defined. The method for accomplishing required independent reviews shall be described.

B. Application. During the development of a software system, there will be different software personnel preparing documents for the computer programs that are their assigned responsibility. To preclude the publication of documentation that varies in design from one writer to another and to simplify the reviewers and customers task, the contractor must establish the standards to be used. This may be accomplished by referring to DOD Standard 7935.1-S, Automated Data System Documentation Standard; MIL-STD-483, Configuration Management Practices for Systems, Equipment, Munitions and Computer Programs; or MIL-STD-490, Specification Practices. For all documents supporting deliverable software, the contractor will reference or note the prescribed standards to be utilized in writing these documents. The methods for updating and/or changing these documents, once they have been approved and placed

under configuration control, are also described by the contractor.

C. Criteria for Evaluation.

1. Does the contractor identify standards to be followed when preparing the required documentation?

2. Do the procedures call for independent technical review of documentation prior to release?

3. Do the procedures address the control of changes to software documentation?

4. Do the procedures provide for traceability of changes? (Documentation should also be verified for traceability of requirements from one document to another.)

5. Are there provisions for informing design personnel of the latest changes in software documentation?

6. Do the procedures cover the review of software documentation for completeness?

7. Do the procedures cover the review of software documentation for consistency? (Consistency is a measure of understandability for both the user and customer which shows a strict and uniform adherence to prescribed symbols, notations and terminology.)

8. Does the contractor designate the software approval/disapproval authority?

Programming Standards and Conventions.

A. Review of Requirement. The Plan shall include or reference the procedures developed to assure uniformity through programming standards and coding convention. Under this subject, emphasis should be placed on the audit function that will assure compliance to programming standards and coding conventions prior to testing.

B. Application. During the development of Computer Programs, the contractor's Plan shall identify the procedures and standards that cover the methodology used for encoding, structure design notations, flow charts, and the auditing of these functions to assure conformance.

C. Criteria for Evaluation.

1. Has the contractor established a standard for naming conventions and abbreviations?

2. Is there a standard set for entry to and exit from code segments?

3. Is there a coding standard for the number of statements per source line?

4. Is there a standard for grouping of format statements?

5. Has a standard been established for the grouping and arrangement of data?

6. Is there a standard format of error messages?

7. Are there rigorous standards for the control and use of patches?

8. Are there standards for the size of individual code segments? (For example, a code segment might be limited to 50 lines of code.)

9. Is there a standard for the use of comments, their frequency, and their clarity?

10. Is there a coding standard which controls the use of loop variables?

3.2.5 Computer Program Library Controls.

The Plan shall reference or document the contractor's procedures and controls for the handling of source code and object code and related data in their various forms and versions, from the time of their initial approval or acceptance until they have been incorporated into the final media. The objective of these controls is to ensure that different computer program versions are accurately identified and documented, that no unauthorized modifications are made, that all approved modifications are properly incorporated, and that software submitted for testing is the correct version.

A. Review of Requirement. MIL-S-52779A requires that contractors establish positive controls for the handling of source and object program materials. The integrity of these program materials is maintained by the application of change control procedures.

B. Application. An important function for a contractor is the maintenance and

control of software materials. The contractor establishes controls to assure that when computer program materials are produced, certified, and placed under configuration control, they are not altered or changed without proper documentation, approval and validation. A secure Computer Program Library is established to maintain this integrity.

C. Criteria for Evaluation.

1. Has the contractor established a computer program library to be used for controlling program materials during development and test?

2. Do the procedures identify how materials are approved and placed under library controls?

3. Do the controls include formal release procedures for internally approved design information?

4. What safeguards have been established to assure that unauthorized alterations are not made to the controlled material?

5. Do the procedures provide directions for ensuring that all approved modifications are integrated?

6. Does the software library assign and track computer programs and documentation identification numbers, including revision codes?

7. Does the software library properly store all released material with provisions for accurate retrieval?

8. Does the library have the ability to capture all information essential to produce distribution records and status reports?

9. Is the proper release authorization documented and followed?

10. Is there an authorized signature list for release documents?

3.2.6 Reviews and Audits. The Plan shall reference or document the contractor's procedures for preparation and execution of reviews and audits, for establishing the traceability of initial contract requirements through the successive baselines, and for ensuring that the reviews and audits are conducted in accordance with the prescribed procedures.

The schedule for review and audits shall be referenced or stated in the Plan.

A. Review of Requirement. The specification requires that the Software QA Plan identify the reviews and the proposed schedule for reviews. A schedule for audits is also established. The reviews and audits are conducted in accordance with the procedures described or referenced in the Software QA Plan, in response to contract requirements, (such as MIL-STD-1521A, Technical Reviews and Audits for Systems, Equipment and Computer Programs).

B. Application.

1. Each individual computer program is coded to the specifications contained in the software design document and program performance specification. Prior to detail design, a Preliminary Design Review is held to provide an evaluation of the design and to verify that the design meets contractual requirements. A Critical Design Review is conducted when the design is essentially complete and the detailed flow charts or other methods of specifying detail design (e.g., Program Design Language (PDL)) are ready for coding. The composition of boards or teams for these reviews should contain expertise from software design, programming, analysis, testing and software quality assurance.

2. The contractor performs Functional and Physical Configuration Audits when required by the procuring agency. These audits are performed to verify that the actual performance of the computer program complies with the Development Specification. Detailed procedures for reviews are contained in MIL-STD-1521A; when contractually imposed, if not imposed, it may be used as a guide.

C. Criteria for Evaluation.

1. Does the contractor's Software QA Plan establish a schedule for reviews and audits?

2. Are the reviews and audits clearly identified, scheduled, and properly sequenced?

3. Does the Plan delineate the specialists within the QA organization who will participate in the reviews and audits?

4. Are the reviews and audits conducted to the contractually imposed requirements?

5. Do the procedures define the types of information to be presented at each review?

6. Are there agreements for follow-up action resulting from the reviews and audits?

7. Will the results of the reviews and audits be documented by the contractor?

8. If MIL-STD-1521A is a contractual requirement, does the contractor:

a. Conduct both the internal and formal reviews and audits on a schedule and within the guidelines of MIL-STD-1521A?

b. Conduct software requirement reviews before the design starts? (Such as the review of the draft development specification which can be reviewed at the System Design Review or at the Software Segment Design Reviews.)

c. Conduct Preliminary Design Reviews (PDRs) prior to detailed design?

d. Conduct Critical Design Reviews (CDRs) prior to coding?

e. Conduct a Functional Configuration Audit (FCA) to verify that actual performance of the Computer Program Configuration Item (CPCI) complies with the Part I Specification?

f. Conduct a Physical Configuration Audit (PCA) to verify that the CPCI Part II documentation correctly and fully describes the Computer Program product configuration baseline?

9. Are the results of reviews and corrective actions adequately documented to provide an audit trail?

3.2.7 Configuration Management (CM). The Plan shall specify the relationships between the SQA and CM Programs and shall reference or document the procedures for assuring that the objectives of the CM program are being attained.

A. Review of Requirement. Government contracts usually require a Configuration Management Plan (CMP), as well as a Software Quality Assurance Plan.

Since there is a particularly strong relationship between the two disciplines, software quality cannot be assured without a disciplined CM Program.

B. Application. Since SQA and CM Programs are intertwined, their respective plans should be coordinated to ensure that all facets are identified and controls are generated. This will eliminate duplication of effort. Some of the contents found in a CM Plan are:

1. Once a baseline has been established for a computer program or supporting documentation, for example, the specification, design, test plan, etc., the integrity of the baseline or documentation is protected to ensure that there are no unauthorized changes.

2. It is important that software configuration plans identify the authority to enter material under configuration control, and to identify the authority for removal of controlled items from the configuration management activity.

3. The configuration management plan provides explicit instructions for the identification of baseline materials and subsequent revisions or versions. The SQA Plan provides procedures that will preclude the control facilities from being used as a repository for unapproved, or uncontrolled computer programs and supporting documentation.

4. Independent audits of the control facilities are performed by the organization designated in the Software QA Plan. The audits are documented to show the date of the audits, discrepancies found, and the completed corrective action.

C. Criteria for Evaluation.

1. Does the SQA Plan depict the relationship between it and the CMP?

2. Do the SQA Plan procedures provide for the review of the CM internal controls to ensure that no unauthorized changes occur to baseline specifications, supporting documentation or the CPCI?

3. Do the SQA Plan procedures provide the methodology for CM to respond to discrepancies found during QA audits?

4. Is the contractor complying with internal procedures for approval authority, for placement of items under configuration control, and for removal of controlled items from the control facility?

5. Are CM instructions for identification of baseline items and subsequent revisions or versions being followed?

6. Does the contractor's CM Plan preclude the control facilities from being used as a repository for unapproved or uncontrolled computer programs, software tools, and supporting documentation?

7. Does the contractor's CM Program/Plan identify membership to the software Configuration Control Board (CCB)? Are Quality Assurance personnel participating?

8. Does the SQA Plan require audits of configuration management procedures and practices?

9. Does the SQA Plan require that the results of the audits be documented and available for Government review?

10. Does the SQA Plan require that the audits of CM be documented to show the date of the audits, discrepancies found and the completed corrective action?

11. Do the contractor's procedures assure that the CCB addresses all facets of interface, such as specifications, manuals, design, test procedures, etc?

3.2.8 Testing. The Plan shall reference or document procedures for assuring the accomplishment of the following:

a. Analysis of software requirements to determine testability.

b. Review of test requirements and criteria for adequacy, feasibility, and traceability and satisfaction of requirements.

c. Review of test plans, procedures, and specifications for compliance with contractor and contractual requirements and to insure that all authorized and only authorized changes are implemented.

d. Verification that tests are conducted in accordance

with approved test plans and procedures.

e. Certification that test results are the actual findings of the tests.

f. Review and certification of test reports.

g. Ensuring that test related media and documentation are maintained to allow repeatability of tests.

h. The contractor shall ensure that support software and computer hardware to be used to develop and test software and hardware under the contract are acceptable to the Government.

A. Review of Requirement.

1. The testing activities of the software development process should provide explicit assurance that the software performs to its technical and operational requirements. The quality assurance provisions for this activity, therefore, should be aimed at the realization of these objectives in an orderly, cohesive, clear and controlled fashion. The results of this activity will normally provide the acceptability of the delivered products.

2. MIL-S-52779A requires contractors to address the software testing activities in their Software QA Plan. This includes the types of testing to be applied to computer programs and software systems. The organization that is responsible for the preparation of test criteria, test plans, test procedures, and test reports is identified. The methods and requirements for review of the testing activities are defined as well as the methods for tracking the progress of each software component through the testing cycle.

3. The Software QA Plan reflects how the contractor will ensure that support software and related documents are acceptable to the Government. If there is additional support software or computer hardware used in testing the

deliverable software, the contractor identifies such items and shows how these items are insured to be acceptable to the Government, prior to use in testing and validation of the deliverable computer program.

B. Application.

1. The qualification of software can only be accomplished through the application of stringent testing. Each phase of the development of a software system will normally require testing and validation prior to continuing to the succeeding step. For example, some computer programs are tested prior to integration or subsystem testing, and if modules are produced in a top down order, top down testing can be employed.

2. The Software QA Plan identifies the individual types of testing to be utilized in the validation process (for example, development test, verification test, validation test). The contractor identifies the organization that is responsible for the development and preparation of test plans, test procedures, test case data, test reports, and user manuals.

3. Contractors are required to have a procedure to define their review of testing activities to ensure conformance to contractual provisions. These procedures are not required to be a part of the Software QA Plan if the contractor has published a standard procedure that is acceptable to the Government.

4. The identification and certification of tested software, support software, and computer hardware is explained in the Software QA Plan. Forms utilized by quality assurance for test and entry into configuration control are also identified.

5. Many of the difficulties incurred during the software development process have been due to the relegation of QA activities to a formal test phase in the final stage of the process. This test-oriented approach to QA fails to recognize the contribution of lower level test activities to the test objectives and ignores the fact that the final product is only, at best, a reflection of its specifications. An effective QA program for testing must begin with the requirements, and must address the totality of the testing to be performed.

6. For the purpose of this document the definition of Verification and Validation is:

a. Verification.

(1). Computer program verification is the iterative process of determining whether or not the product of each step of the computer program acquisition process fulfills all requirements levied by the previous step. These steps are system specification verification, requirements verification, specification verification and code verification.

(2). The process of determining whether the results of executing the software product in a test environment agree with the specifications. Verification is usually only concerned with the software's logical correctness (i.e., satisfying the functional requirements) and may be a manual or a computer based process (i.e., testing software by executing it on a computer).

(3). The process of ensuring that the system and its structure meet the functional requirements of the baseline specification document.

b. Validation.

(1). The process of determining whether executing the system (i.e., software, hardware, user procedures, personnel) in a user environment causes any operational difficulties. The process includes ensuring that specific program functions meet their requirements and specifications. Validation also includes the prevention, detection, diagnosis, recovery and correction of errors.

(2). Validation is more difficult than the verification process since it involves questions of the completeness of the specification and environment information. There are both manual and computer based validation techniques.

(3). The process of ensuring that specific program functions meet their detailed design requirement specification.

C. Criteria for Evaluation. The contractor's test planning information should not be included or duplicated in the SQA Plan. The contractor's test plans and practices should be documented or referenced in the Computer Program Development Plan (CPDP) and in the Computer Program Configuration Item (CPCI).

Development Test and Evaluation (DT&E) Plan. These documents should be reviewed when evaluating the QA aspects of the test program and answers to the following question determined:

1. Does the Software QA Plan identify the contractor's software test activities?
2. Has testing responsibility been identified and assigned to a specific organization?
3. Does the contractor have procedures and documentation controlling his internal Computer Program Test and Evaluation (CPT&E) activities?
4. Have the various levels of test been identified and scheduled as required by the contract?
5. Does the Software QA Plan provide for review of test plans/procedures/specifications for compliance with contractual requirements?
6. Does the Software QA Plan provide for review of test procedures for compliance with the test specification, hardware manuals, data item descriptions and other contractual requirements?
7. Does the Software QA Plan provide for monitoring of tests and the certification that test results are the actual finding of the tests?
8. Is test-related documentation maintained to allow repeatability of tests?
9. Is all support software and computer hardware that is used to develop the CPGI, acceptable to the Government?

3.1.9 Corrective Action. The Plan shall reference or document procedures which assure the prompt detection, documentation, and correction of software problems and deficiencies. Procedures shall include:

a. Documenting and reporting problems and deficiencies to appropriate management levels.

b. Analysis of data and examination of problem and deficiency reports to determine their extent and causes.

c. Analysis of trends in performance of work to prevent the development of noncompliant products.

d. Review of corrective measures to ensure that problems and deficiencies have been resolved and correctly reflected in the appropriate documents.

e. Analysis or review as otherwise provided for in the contract.

A. Review of Requirement.

1. In the production of almost all products, some nonconformities will inevitably be discovered. Computer programs are subject to errors, discrepancies, and nonconformances to the procedures. The contractor describes in the Software QA Plan the procedures to be applied in the detection and correction of these problems. When software is produced by a subcontractor, contractor indicate how they will identify and ensure that the subcontractor promptly corrects all detected problems.

2. The method of reporting and analyzing problems and implementing corrections is included in the Software QA Plan with additional procedure for tracking problems, trend analysis, and reviews of the effectiveness of the corrective action program.

B. Application.

1. The detection and correction of nonconformities to contractual requirements in computer programs requires the coordinated efforts of many departments of a contractor's organization. A formal system is required by the contractor for reporting, tracking, analysis, and closure of problems. The contractor's procedures should require that problems be identified in writing to permit tracking and resolution of the problems. This will assure that the necessary corrections are completed in a timely manner. A discrepancy report form is usually used by contractors to report, record, and dispose of software problems.

2. Computer program problems that are not usually considered reportable are

those that occur during the development and debugging phase. Once a program is under configuration control and a baseline has been established, all problems encountered are reported.

3. The methods of analyzing reported problems, recommending solutions, and completing corrective action are defined by the contractor to document nonconformance tests and permit tracking and analysis of trends during software testing. The requirements for corrective action and the reporting efforts of subcontractors are defined by the contractor.

4. Error analysis is a very important tool that should be used as a means of evaluating computer programs, and directing attention to specific needs for corrective action or recovery systems. For the purpose of this handbook the definition of error analysis is:

"The process of locating and assessing conceptual, syntactic, or clerical errors in software which cause (or could cause) the software to manifest a fault (or faults) during test or operational use, or which could cause the software to fail to perform its intended function. Errors may be identified through analysis of design documentation, analysis of test or execution documents (printouts), and through observation of the failure of the software to execute in accordance with test or operational procedures. Software errors can be detected during testing on any level of assembly from routine to full configuration item. The following are examples of software error categories:

- a. Requirements
- b. Documentation (system development or product level specification)
- c. Computational
- d. Logical
- e. Data (input, output, handling)
- f. Interface
- g. Data base
- h. Environment (operating system, support software, test materials and equipment, computer hardware)
- i. Human (operator)

Software error analysis leads to determination of the appropriate corrective action for each error and the

error data may be utilized to provide an assessment of the operational readiness of the software."

C. Criteria for Evaluation. The contractor is required to delineate procedures which will assure the detection, communication and correction of deficiencies and errors. These procedures are intended to avoid noncompliant CPCI's, and as such, any review should consider the following:

1. Has the contractor identified the organizational units involved in the corrective action process? Are their responsibilities and interfaces defined? Is the independence of quality functions maintained?

2. Is the organization responsible for administering the corrective action program identified? Is it vested with the authority to enforce the corrective action program?

3. Is the relationship clearly defined between the corrective action program, the overall quality program, the configuration system, and the program management plan?

4. Does the contractor delineate a corrective action process that is responsive to the requirements of MIL-S-52779A and other contractual requirements?

5. Is there an established policy for reporting and correcting deficiencies in software?

6. Are the products to be controlled identified with specific software development and implementation baselines?

7. Do the baselines permit a systematic incorporation of controlled product into the corrective action system, starting with software documentation, and incorporating code and software media (e.g., storage procedures for disks, decks, and tapes) as coding and debugging are completed?

8. Does the corrective action process involve distinct steps: identifying the discrepancy in writing, documenting the proposed "fix", independent review of the proposed "fix" for adequacy, and, when coding changes are required, retest of the affected code and all interfacing modules and correction of the affected documentation?

9. Does the corrective action system establish a mechanism for feed back of results of error analyses of

individual problems and recurrent problems?

10. Is there a set of written procedures for reporting, following up, and correcting software deficiencies, including forms with instructions for filling them out and transmitting them, analyzing the data for error trends and specifying the nature of corrective action required?

11. Is the system for retrieving, analyzing, and reporting software deficiency data formalized?

12. Does the contractor's corrective action system apply to discrepancies generated by deliverable and nondeliverable software?

3.3 Subcontractor Control. The Plan shall reference or document the procedures to assure that all software acquired from subcontractors conforms to applicable requirements of the contract and this specification. When the Government elects to perform reviews at the subcontractor's facilities, such reviews shall not be used by contractors as evidence of effective control of quality of subcontractors by the contractor. It does not relieve the contractor of his responsibility for furnishing software that meets all contract requirements.

A. Review of Requirement.

1. It is not enough for contractors to control the quality of the computer programs developed and designed in their own organization. The contractor is also responsible for assuring that all software, documentation and programming materials procured from subcontractors conform to the contract requirements. They also are required by MIL-S-52779A to assure control of the quality of software furnished by their subcontractors. Thus, contractors should choose subcontractors who can maintain adequate quality. Furthermore, contractors must develop and use effective methods for communicating applicable Government requirements to their subcontractors.

2. Contractors cannot depend on Government inspection at their subcontractor's facilities; instead it is necessary that they generate their own knowledge and control of subcontractor quality. How often a contractor will assess the subcontractor's quality system depends upon the type and quantity of the software purchases from that subcontractor. The best evidence of subcontractor quality comes from the contractor's continuing evaluation of the software and the services furnished by the subcontractor. Any deficiencies which become known to the contractor should be made known in a timely fashion to the subcontractors for correction.

3. The Government reserves the right to review products and/or services at the subcontractor's facility, although the contractor is solely and exclusively responsible for the quality of the software delivered regardless of the source of the software.

B. Application.

1. The completeness with which contractors control their software purchases determines in a large measure the success of this phase of their quality program. In choosing their subcontractors, contractors should follow the same practice that the Government follows when choosing between qualified competitors; the award goes to the best technically qualified responsible offeror, price and other factors considered.

2. Various methods are used by contractors to assure adequate subcontractor control. A few of the most frequently used are:

- a. Participation in subcontractor design reviews.
- b. Monitoring the effectiveness of the subcontractor's configuration control methods.
- c. Monitoring the subcontractor's discrepancy reporting and corrective action system.
- d. Witnessing subcontractor acceptance testing to verify conformance to test procedures.

3. An open, active, comprehensive flow of quality information between subcontractor and contractor can significantly reduce cost.

4. There are many ways to assure quality in purchased software. Selecting

suppliers with a reputation for quality is a good start. Participation in subcontractor software design reviews, witnessing/monitoring subcontractor acceptance tests, and auditing subcontractor software quality system procedures and records are some of the techniques used by contractors to assure quality of software. Of course, contractor effort alone is not enough; subcontractors are expected to possess the motivation, knowledge, and capability to control quality.

5. For some purchases, DOD requires the contractor to include on the purchase order a requirement for Government subcontract inspection. When such actions are deemed necessary by the Government Representative, it is necessary that specific instructions be provided to the Government Representative at the subcontractor's facility. The Government Representative at the contractor's facility must advise the contractor concerning any Government subcontract inspection plans as early as possible.

C. Criteria for Evaluation.

1. Are there adequate procedures for source selection?
2. Are there adequate procedures for source inspection?
3. Does the contractor review their subcontractor's quality efforts at intervals consistent with the complexity and quality of the software?
4. Do the contractor's procedures describe and mandate the methodology to assure that the applicable requirements established in the prime contract are passed down to subcontractors?
5. Does the contractor plan to accomplish receiving inspection of procured software to ensure that the proper configuration of the subcontractor's product was delivered?
6. Does the contractor require subcontractors to prepare and maintain, a SQA Plan, a CPDP, and a configuration management plan?
7. Does the contractor review and approve the subcontractor's plans?
8. Does the contractor participate in the subcontractor's design reviews and audits?
9. Does the contractor monitor testing performed by the subcontractor?

10. Are there procedures for assuring that subcontractors correct all nonconformances?

11. Is there an established system for corrective action with subcontractors prior to, as well as subsequent to delivery of software? Is it included as a requirement in the subcontractor's quality assurance plan?

4.0 QUALITY ASSURANCE PROVISIONS.

4.1 Contractor. Nothing specified herein relieves the contractor from the obligation to submit, to the Government for acceptance, end products that conform to all contract requirements.

4.2 Government Review at Contractor, Subcontractor, or Vendor Facilities. The Government reserves the right to review, at their sources, all products or services, including those not developed or performed at the contractor's facility, to determine the conformance of products or services with contract requirements.

A. Review of Requirement. A contractor is solely and exclusively responsible for the quality of the software that is delivered to the Government regardless of the sources of the software.

B. Application. Therefore, though the Government may conduct inspections at subcontractor's facilities, the prime contractor's responsibilities remain unchanged. It should be noted that only Government representatives can authorize Government inspections at subcontractor's facilities. When such inspections are required, the Government Quality Assurance Representative (QAR) at the contractor's facility shall handle all subcontracts in accordance with their respective Procurement Quality Assurance Program (PQAP).

C. Criteria for Evaluation.

1. Do contractor purchasing documents require Government review of subcontractors only when the Government so requests?

5.0 PREPARATION FOR DELIVERY.
The Plan shall reference or document procedures for assuring integrity of software products during handling, storage, preservation, packaging and shipping.

A. Review of Requirement. Documented work instructions are necessary for both the operation and the inspection of the shipping function. The material handling aspect of shipping requires monitored work instructions. Methods used to preserve and protect items must be compatible with the intended use of the items, yet protect the items against damage or deterioration in storage. Special requirements, such as a controlled storage environment, must also be carefully devised, maintained, and monitored to assure full protection of quality. Labeling which clearly indicates special handling and storage requirements is imperative. Loading practices must conform with the requirements of common carriers and with specified Government (e.g., Interstate Commerce Commission, U. S. Post Office) or industry regulations. Contractual requirements for the identification and movement of shipments must be met. The contractor's quality program must establish effective practices for protecting quality during shipping. In addition, all handling, storage, and delivery requirements must be covered by documented work instructions.

B. Application. Control during handling, storage, and delivery is an important aspect of satisfactory quality programs. Manufacturers and users of products which are subject to damage and deterioration when improperly handled and stored, carefully plan their preservation, packaging, packing and storage efforts. They conduct regularly scheduled inspections of all stored material. Shipping and storage control departments usually develop documented work and inspection instructions for

handling, storing, preserving, packaging, packing, marking, and shipping materials to prevent damage, loss, deterioration, substitution, degradation, or any other quality defects.

C. Criteria for Evaluation.

1. Are adequate work and inspection instructions prepared and implemented for the handling, storage and delivery of material?

2. Are handling, storage and delivery procedures monitored in accordance with established quality program requirements?

3. Are there procedures and regular schedules for the inspection of products in storage, and are these procedures adequate to prevent deterioration or damage?

4. Are all required critical environments maintained within packaging?

5. Is all material to be stored or shipped properly identified and labeled?

6. Are all shipments prepared and transported in compliance with contractual requirements and applicable Government and carrier regulations?

6.0 NOTES. (The following information is provided solely for guidance in using this specification. It has no contractual significance.)

6.1 Intended Use. This document will apply specifically to the acquisition of computer software where the acquisition involves either software alone, or software as a portion of a system or subsystem.

6.2 Ordering Data. The procuring activity should consider specifying the following:

6.2.1 Procurement Requirements.

a. Title, number, and date of this specification.

b. Software QA Program Plan. Consideration should be given to requiring the

contractor to deliver a Software QA Program Plan in response to the invitation for bid, or request for proposal, or request for quotation and as a Contract Data Requirements List item (see 6.2.2). The Plan should define the methods and procedures which the contractor proposes to use in fulfilling the requirements of this specification. Note: The Software QA Program Plan may be included as part of other plans, see paragraph 1.3.

c. The application of this specification should be carefully tailored to meet the minimal essential needs of the acquisition.

d. Consideration should be given to citing current standards and specifications for configuration management, documentation, review, audit, development

practices, work breakdown structures, etc.

e. Application of this specification to software maintenance contracts is encouraged.

f. Rapidly changing technology may require the acquiring activity to clarify use or application of the term "firmware".

6.2.2

Contract Data Requirements.
ATT plans, documentation, and reports which are required to be delivered to the Government will be specified on a DD Form 1423, Contract Data Requirements List (CDRL) or authorized equivalent. The format, type of copy, number of copies, degree of detail required, delivery schedules, and purpose of submission should be specified on the CDRL.