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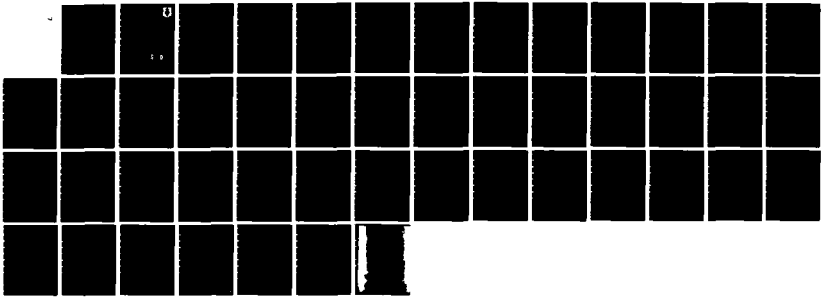

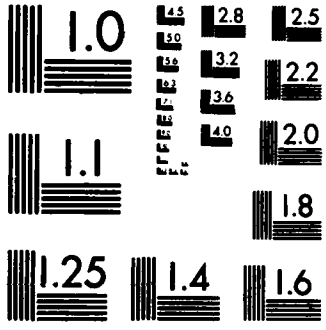

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HANDBOOK FOR EVALUATION AND LIFE CYCLE PLANNING FOR SOFTWARE

Volume IV: Test and Independent Verification and Validation

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1 February 1983

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Prepared for

ELECTRONIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
DEPUTY FOR ACQUISITION LOGISTICS
AND TECHNICAL OPERATIONS
HANSCOM AIR FORCE BASE, MASSACHUSETTS 01731

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This document is Volume 4 of the Handbook for Evaluation and Life Cycle Planning for Software (HELPS). This volume provides the user with comprehensive checklists and guides to validate an independent assessment process for computer programs. It also discusses the requirements and preparation necessary for the various phases of testing. Test plans and procedures are also discussed.

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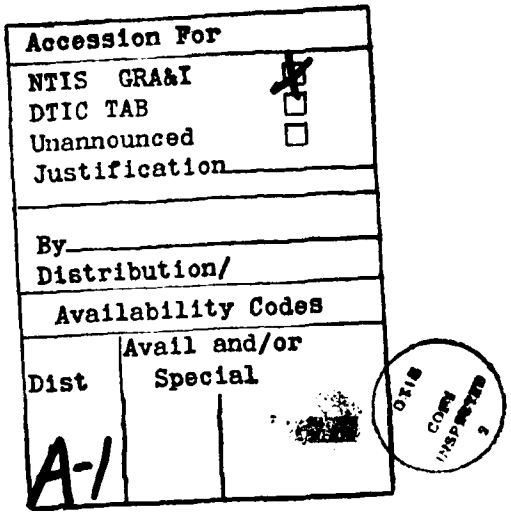
Cont. of Block 18:

DT&E	FOT&E	PQT	IV&V
IOT&E	TPWG	FQT	CPCI
OT&E	TEMP	SIT	DOCUMENTATION
DATA	SAFETY	DEVELOPMENT	SUPPORTABILITY
SECURITY	ANALYSIS	MAINTENANCE	PROGRAMS
MANNING	SCHEDULE	EVALUATION	POST-TESTING

ACKNOWLEDGEMENTS

This book was developed to assist ESD computer resource personnel in the performance of their daily acquisition related activities. It contains a collection of available software related guidelines, checklists, and standard verbage associated with AF 800 series software and computer resources life cycle activities. The activities provided came from many different sources, e.g. guidebooks, Computer Resource Acquisition Management System (CRAMS), MITRE studies, information exchanges with other AFSC product divisions, and most importantly, from experienced software acquisition managers here at ESD.



HANDBOOK FOR EVALUATION AND LIFE CYCLE PLANNING FOR SOFTWARE

VOLUME IV: TEST AND INDEPENDENT VERIFICATION AND VALIDATION

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Section 1. Test and Evaluation (DT&E, IOT&E, OT&E, FOT&E)

1-1. Pre-Testing

a. Review AFR 80-14 for an understanding of responsibilities.

b. Review Test and Evaluation Objective Annex (TEOA) of the PMD.

c. Review T&E section of the PMP and TEMP.

d. Review the Computer Program Configuration Item Development Test and Evaluation Test Report Checklist, Figure IV-1-1.

1-2. Testing Conduct

a. Participate in T&E test conduct functions as a member of the PO Test Team.

b. Coordinate with using/supporting (AFTEC) command participants and resolve comments as appropriate. AFTEC responsibilities are contained in AFR 23-36.

1-3. Post-Testing Activities

c. Review and approve the test reports pertinent to T&E.

d. Monitor resolutions of program trouble reports opened during any T&E test.

Figure IV-1-1 COMPUTER PROGRAM CONFIGURATION ITEM (CPCI) DEVELOPMENT

TEST AND EVALUATION TEST REPORT CHECKLIST

This checklist for reviewing CPCI Development Test and Evaluation (DT&E) Test Reports is based on the requirements stated in ESD/ALEQ's June 1978 Data Item Description (DID) Computer Program Configuration Item (CPCI) Development Test and Evaluation Test Report DID(U)-E-743. In reviewing a CPCI DT&E test report, the reviewer must also be aware of any supplemental or contrary direction for preparation of the computer program test report contained in the Statement of Work (SOW), in the Contract Data Requirements List (CDRL) or in CDRL backup sheets.

The checklist questions are numbered sequentially according to the preparation instructions contained in the cited Data Item Description. The parenthetical numbers following the questions refer to the related paragraphs of the instructions.

1. CPCI DT&E TEST REPORT REQUIREMENTS

	Yes	No
1) Has a separate test report been submitted for preliminary Qualification Testing (PQT) and Formal Qualification Testing (FQT)? (1.a)	( )	( )
2) Is an incremental draft of each test report being submitted in accordance with the planned test phases of increments? (1.b)	( )	( )
3) Was each report submitted following the last test in the phase within the number of days specified on DD Form 1423? (1.b)	( )	( )
4) Does the final version of the PQT Test Report consist of a summation report of the total PQT activities? (1.c)	( )	)
5) Does the final version of the FQT Test Report consist of a summation report of the total FQT activities? (1.c)	( )	( )
6) Have all incremental reports previously submitted and revised, in final form, been resubmitted? (1.c)	( )	( )

2. COMPUTER PROGRAM CONFIGURATION ITEM IDENTIFICATION

7) Has the CPCI to which the test applies been identified by number? (2.a)	( )	( )
8) Has the CPCI to which the test applies been identified by approved nomenclature? (2.a)	( )	( )

2.b. TEST IDENTIFICATION

9) Is the identification of the individual qualification test as shown on the test procedure shown on the test report? (2.b)	( )	( )

2.c. PRIMARY FUNCTION

10) Have all the CPCI's primary functions or Computer Program Components to which the test applies been identified? (2.c)	( )	( )

2.d. TEST PLAN AND TEST PROCEDURES REFERENCE

11) Has the DT&E CPCI Test Plan for the test been referenced. (2.d)	( )	( )
12) Have the DT&E CPCI Test Procedures for the test been referenced? (2.d)	( )	( )

	Yes	No
2.e. TEST RESULTS		
13) With the exception of appropriate identification of differences in and exclusions of planned test objectives, has the contractor certified that the qualification of the CPCI was successfully accomplished in accordance with government-approved CPCI Test Plans and Test Procedures? (2.e)	( )	( )
14) Have all planned objectives for which test results differed from expected results beyond specified limits been identified with actual test results shown? (2.e.1)	( )	( )
15) Have any planned test objectives for which no actual results were obtained been identified with reasons for not fulfilling such objectives being stated? (2.e.2)	( )	( )
2.f. RECOMMENDATIONS		
16) Have recommendations based on test results been stated for subsequent actions? (2.f)	( )	( )
17) Are all recommendations one of the following types:	( )	( )
a. revision of the CPCI code to meet specifically identified requirements which were not fulfilled;		
b. revision of the Part I CPCI Development Specification in cases where the test results disclose ambiguity or conflicting requirements;		
c. additional testing to fulfill objectives for which results were not as expected; or		
d. qualification of those functions for which test objectives have been fulfilled. (2.f)		
2.g. TEST CONDUCT LOG		
18) Has a record of each test been prepared? (2.g)	( )	( )
19) Was a test record for each test maintained during the conduct of the test? (2.g)	( )	( )
20) Was the test record for each test submitted with the Test Report? (2.g)	( )	( )
21) Do the test records for each test document actually test progress? (2.g)	( )	( )
22) Are the test records for each test directly traceable to the CPCI DT&E Test Procedures? (2.g)	( )	( )

	Yes	No
23) Does the test record for each test contain the problems encountered? (2.g)	( )	( )
24) Does the test record for each test contain the number of times that individual steps were attempted? (2.g)	( )	( )
25) Does the test record for each test contain the backup points (i.e., steps where tests resumed retesting fixes)? (2.g)	( )	( )
26) Does the test record for each test indicate any impacts of computer program fixes on operator procedures, outputs (new, modified, deleted) or equipment functions (alarms, lights, switches)? (2.g)	( )	( )

2.h. TROUBLE REPORT LOG

27) Has a record of all CPCI malfunctions been prepared? (2.h)	( )	( )
28) Was the CPCI malfunction record maintained during the conduct of the test? (2.h)	( )	( )
29) Was the record of CPCI malfunctions submitted with the Test Report? (2.h)	( )	( )
30) Does the record for each CPCI malfunction include a computer program problem identification? (2.h)	( )	( )
31) Does the record for each CPCI malfunction include a test procedure step number where the problem was detected? (2.h)	( )	( )
32) Does the record for each CPCI malfunction include the resolution (i.e., computer program fix) closing the problem? (2.h)	( )	( )
33) Is the record of CPCI malfunctions traceable to the test conduct log? (2.h)	( )	( )

Section 2. Test Planning Working Group (TPWG)

2-1. Review AFR 80-14/AFSC Sup 1, Para 13 for TPWG compliance requirements.

2-2. Review AFSC DK 4-2, Chapter 5, for computer program testing requirements.

2-3. Assist the TPWG in planning for software testing.

2-4. Coordinate software test issues with users and support agencies.

2-5. Monitor and control all software action items generated by the TPWG.

2-6. Review TEMP when it's updated.

2-7. Review Test Plans/Procedures.

Section 3. Test and Evaluation Master Plan (TEMP)

3-1. Assist with draft TEMP to insure it meets AFR 800-14, Vol II (Chapter 5), and AFR 80-14, AFSC Support Test and Evaluation. (Paragraphs 8 & 14)

3-2. Insure that software testing is adequately planned in the TEMP to include:

a. Addressing S/W critical questions.

b. Areas of risk.

c. S/W test objectives.

d. S/W responsibilities of all participants.

e. S/W schedules.

f. S/W needed test resources.

3-3. Assist in determining software test support items and facilities.

3-4. Coordinate TEMP with Operating Command, Supporting Command plus any other agency involved in T&E (i.e., AFTEC).

NOTE: The TEMP may include hardware information as well as software information.

Section 4. Test Plans

4-1. Review AFR 800-14, Volume II, Chapter 5, Test Plan/Procedures Compliance Requirements.

4-2. Review AFR 800-14 for all test and evaluation requirements.

4-3. Review the DCP for critical questions and issues which must be addressed by the total system test program.

4-4. Review the Computer Program Configuration Item Test Plans Checklist, Figure IV-4-1.

4-5. Review AFSC DH4-2; Design Notes DN5A3; DN5A4, DN5C1, DN5C2, DN5C3, DN5D2, DN5D3, and DN5D4. (Design notes are found in TOET.)

4-6. Review ESD-TR-77-263, Verification Para 2.3.3 for verifying the CPCI DT&E plan.

4-7. Review ESD-TR-77-255, Software Quality Assurance Para 3.4.4 for compliance requirements.

4-8. Review DID DI-T-3703A for Test Planning Information.

4-9. Review documents submitted against respective data item descriptions to ascertain adequacy.

4-10. Insure that all functional and performance requirements of the appropriate B-5 specifications are treated in the CPCI Test Plan, and specific test objectives are assigned to each test.

4-11. Insure that the mechanism for conducting each test, individual responsibilities and deficiency reporting process are described in the appropriate CPCI Test Plan.

Figure IV-4-1 COMPUTER PROGRAM CONFIGURATION ITEM (CPCI) TEST PLANS CHECKLIST

A draft revision of the Development Test and Evaluation (DT&E) CPCI Test Plan is normally submitted after authentication of each CPCIs Computer Program Development Specification (CPDS) and before Preliminary Design Review. It is based on Section 4 of the CPDS. The Data Item Description Computer Program Configuration Item (CPCI) Test Plan recommends that approval of the CPCI Test Plan not be delayed beyond Critical Design Review. This Data Item Description also recommends that (with the exception of a Verification Cross Reference Index (VCRI) in Section 4 of the CPDS) all test requirement information including the method of verification be included in the CPCI Test Plan. The Test Plan should also be submitted as a single data item including information for both Preliminary Qualification Test and Formal Qualification Test.

This checklist for reviewing a DT&E CPCI Test Plan is based on the requirements stated in Data Item Description DI-T-3703A Computer Program Configuration Item (CPCI) Test Plans/Procedures OT-DI-E-30154. In reviewing a CPCI test plan, the reviewer must also be aware of any supplemental or contrary direction for preparation of the computer program test plan contained in the Statement of Work (SOW), in the Contract Data Requirements List (CDRL) or in CDRL backup sheets.

The checklist questions are numbered sequentially according to the preparation instructions contained in the cited Data Item Description. The parenthetical numbers following the questions refer to the related paragraphs of the instructions in the DID Computer Program Configuration Item (CPCI) Test Plan.

NOTE: Whenever a "no" answer appears, exceptions should be listed with accompanying explanations on the attached backup sheets.

A. PURPOSE	Yes	No
(1) Is the CPCI identified by approved number and nomenclature? (a.)	( )	( )
(2) Is the purpose of the Development Test and Evaluation (DT&E) CPCI Test Plan stated in terms of establishing detailed requirements, criteria, general methods, responsibilities, and overall planning to confirm that the requirements of Section 3 of the Part I CPCI Specification (CPDS) are verified in accordance with Section 4 of the CPDS? (a.)	( )	( )
(3) If only portions of the CPCI are being tested, are those portions correctly designated? (a.)	( )	( )
(4) Have reasons for excluding any portion of the CPCI from test been stated? (a.)	( )	( )

B. REFERENCES	Yes	No
(5) Have all documents basic to or significantly related to the DT&E CPCI Test Plan been listed? (b.)	( )	( )
(6) Have all documents defining the CPCI configuration to which the test plan applies specifically been identified? (b.)	( )	( )
C. TEST CONCEPTS		
(7) Is there sufficient background information to substantiate the test philosopny? (c.)	( )	( )
(8) Is there sufficient information (e.g., definition of test objectives and approach) for understanding and evaluating the Test Plan? (c.)	( )	( )
D. QUALIFICATION REQUIREMENTS AND CRITERIA		
D.1 Detailed Qualification Requirements		
(9) Has all detailed qualification information or test objectives based on each of the functional and performance requirements of Section 3 of the CPDS been presented (or attached in appendices or additional volumes)? (d.1)	( )	( )
D.2 Qualification Conditions		
(10) Have all conditions under which qualification of each functional and performance requirement must be achieved been specified in terms of the ranges for input values, specific initial values, and amount of different types of input data? (d.2)	( )	( )
(11) Do these test conditions describe each CPCI parameter which must be tailored to accomplish specified test objectives? (d.2)	( )	( )
D.3 Acceptance Criteria		
(12) Have acceptance criteria for each identified performance and functional requirement been stated in terms of presence or absence of specified outputs and tolerance limits for calculated values? (d.3)	( )	( )
(13) Are all acceptance criteria traceable to specific test objectives? (d.3)	( )	( )
D.4 Performance Methods		
(14) Have all methods (including, for example, analysis of data, and examination of displays, and equipment response to computer program operation) for determining correspondence of program performance to these parameters been stated for each performance and functional requirement? (d.4)	( )	( )

E. QUALIFICATION OBJECTIVES/TEST PHASE SUMMARY	Yes	No
(15) Does the Test Plan indicate that some qualification testing must occur prior to Formal Qualification Testing (FQT)? (e.)	( )	( )
E.1 Computer Programming Test and Evaluation Requirements		
(16) Have all functional and performance requirements against which the operation of selected modules are to be qualified during Computer Programming Test and Evaluation (CPT&E) been listed? (e.1)	( )	( )
E.2 Preliminary Qualification Testing		
(17) Have all functional and performance requirements against which the Computer Program Components (CPCs) are to be qualified during Preliminary Qualification Test (PQT) been listed? (e.2)	( )	( )
E.3 Formal Qualification Testing Requirements		
(18) Have all the functional and performance requirements against which the operation of the CPCI is to be qualified during Formal Qualification Testing (FQT) been listed? (e.3)	( )	( )
E.4 System DT&E Requirements		
(19) Have all the functional and performance requirements against which the operation of the CPCI is to be qualified but must be deferred until system DT&E testing been listed and included in the system DT&E Test Plan? (e.4)	( )	( )
F. DT&E CPCI QUALIFICATION TEST IMPLEMENTATION		
F.1 Location and Schedule		
(20) Has the location at which the qualification tests will be conducted been specified? (f.1)	( )	( )
(21) Has the schedule for the tests been established in terms of one or more of the following: dates for particular tests or sets of tests; general periods (weeks or months) for various tests or phases of testing; and periods relative to milestones in overall acquisition schedule? (f.1)	( )	( )
(22) If the CPCI is to be developed incrementally, is the PQT schedule concurrent with such incremental development? (f.1)	( )	( )
(23) If the PQT or FQT are to be accomplished incrementally (in phases), are specific test plan paragraphs to be included with each test phase defined? (f.1)	( )	( )

F.2 Limitations and General Comments	Yes	No
(24) Have general comments relative to test implementation and accomplishment of test objectives been included? (f.2)	( )	( )
(25) Have all limitations (if any) relative to test implementation and accomplishment of test objectives been identified? (f.2)	( )	( )
F.3 Preparation of Inputs		
(26) Have methods for preparation of all qualification test data been defined? (f.3)	( )	( )
(27) Have the simulation and/or test case generation vehicles to be used for preparation of all test input data been identified? (f.3)	( )	( )
(28) Have requirements for review or validation of all test input data been specified? (f.3)	( )	( )
(29) Have requirements for all agencies (other than the contractor) involved in preparation of test input data been specifically identified? (f.3)	( )	( )
(30) Have responsibilities for these other agencies been specifically defined? (f.3)	( )	( )
F.4 Conduct of the Tests		
(31) Have general procedures for test conduct been established? (f.4)	( )	( )
(32) Have responsibilities for test direction, operation, and observation been delineated? (f.4)	( )	( )
(33) Has a test conduct log to record actual test events been indicated? (f.4)	( )	( )
(34) Have requirements for pre-test briefings and post-test debriefings been identified? (f.4)	( )	( )
F.5 Analysis of Results		
(35) Have general procedures for analysis of qualification test results been described? (f.5)	( )	( )
(36) Have all computer programs to be used for data reduction and analysis been identified? (f.5)	( )	( )
(37) Have all requirements and responsibilities of agencies other than the contractor been specifically identified? (f.5)	( )	( )

F.6 Equipment and Computer Program Requirements

	Yes	No
(38) Have requirements for all computer programs (other than the CPCI being tested) involved in CPCI qualification testing been summarized (f.6)	( )	( )
(39) Have requirements for all support equipment to be used on CPCI qualification testing been summarized? (f.6)	( )	( )

F.7 Personnel Requirements

(40) Have the personnel requirements for each agency or contractor or contractor involved in qualification testing been summarized? (f.7)	( )	( )
(41) Have the personnel requirements for each agency or contractor involved in testing been specified in terms of the following? (f.7)	( )	( )

	Responsibility Defined?		Authority Defined?		Knowledge/Skills Defined?	
Test Agency 1#	Yes	No	Yes	No	Yes	No
Position 1	( )	( )	( )	( )	( )	( )
Position 2	( )	( )	( )	( )	( )	( )
Position 3#	( )	( )	( )	( )	( )	( )

Repeat this table on backup sheets for each agency or contractor and each personnel position.

	Yes	No
(42) Has the organization responsible for the conduct of testing been described? (f.7)	( )	( )

G. CONTROL AND REPORTING PROCEDURES. Control procedures and documentation may be specified by reference to existing procedures or requirements and by specific identification of necessary exceptions or changes. Such references shall be made only to other contractually delivered documents, such as the Configuration Management Plan or the Computer Program Development Plan.

G.1 Control of the DT&E CPCI Test Program

(43) Have procedures for revising or updating the DT&E CPCI Test Plan as a result of schedule changes, changes to design requirements or CPCI detail design, revised provisions for supporting the test program, etc., been specified? (g.1)	( )	( )
(44) Have provisions for retesting due to design changes or correction of errors found in earlier testing been included? (g.1)	( )	( )

	Yes	No
(45) Have requirements and procedures for controlling the interrelation between the DT&E CPCI Test Program and configuration control of the CPCI design requirements been established? (g.1)	( )	( )

G.2 Documentation of Test Procedures

(46) Have provisions for maintaining traceability between corresponding CPCI Test Plans and Test Procedures been specified? (g.2)	( )	( )
(47) Have provisions for maintaining currency between the corresponding CPCI Test Plan and Test Procedures described? (g.2)	( )	( )
(48) Has the approach for handling last minute redline changes (i.e., changes generated immediately before, or during, any test) to the Test Procedures been described? (g.2)	( )	( )

G.3 Documentation of Test Reports

(49) Have provisions for preparing reports of individual qualification tests been specified? (g.3)	( )	( )
(50) Have provisions for reviewing reports of individual qualification tests been specified? (g.3)	( )	( )
(51) Have provisions for preparing other reports which may be related to the DT&E CPCI Test Program been specified? (g.3)	( )	( )
(52) Have provisions for reviewing other reports which may be related to the DT&E CPCI Test Program been specified? (g.3)	( )	( )
(53) Have provisions for preparing separate test reports for PQT and FQT, as well as for any increment or test phase been described? (g.3)	( )	( )

Section 5. Test Procedures

5-1. Review OT-DI-E-30153, Computer Program Configuration Item CPCI Test Procedures.

5-2. Review ESD-TR-77-263, Verification Para 3.2.3 for verifying the CPCI DT&E procedures.

5-3. Insure that all step-by-step procedures, specific success criteria and data reduction/analysis techniques and results are given for each test case, in the appropriate CPCI Test Procedures.

5-4. Coordinate with contractor to resolve document deficiencies.

5-5. Review all changes to the documents as a result of Government comments.

5-6. Review Computer Program Configuration Item (CPCI) Test Procedures Checklist, Figure IV-5-1.

Figure IV-5-1 COMPUTER PROGRAM CONFIGURATION ITEM (CPCI) TEST PROCEDURES CHECKLIST

This checklist for reviewing CPCI Test Procedures is based on the requirements stated in DT-DI-E-30154, Computer Program Configuration Item (CPCI Test Procedures. In reviewing CPCI test procedures, the reviewer must also be aware of any supplemental or contrary direction for preparation of the computer test procedures contained in the Statement of Work (SOW), in the Contract Data Requirements List (CDRL) or in CDRL backup sheets.

The Development Test and Evaluation (DT&E) CPCI Test Procedures are normally submitted after Government approval of the corresponding DT&E CPCI Test Plan and should be directly traceable to this Test Plan. It is recommended that a separate data item submission of Test Procedures be accomplished for Preliminary Qualification Testing and Formal Qualification Testing.

The DID requires the contractor to prepare a separate DT&E Test Procedure for each individual DT&E qualification test. A copy of this checklist should be completed for each such DT&E Test Procedure. However, question (1), below, need be completed for only the first of these.

The checklist questions are numbered sequentially according to the preparation instructions contained in the cited Data Item Description. The parentnetical numbers following the questions refer to the related paragraphs of the instructions in DT-DI-E-30154, Computer Program Configuration Item (CPCI) Test Procedures.

Whenever a "no" answer appears, exceptions should be listed with accompanying explanations on the attached backup sheets.

GENERAL	Yes	No
(1) Is there a Development Test and Evaluation (DT&E) Test Procedure for each individual DT&E Computer Program Configuration Item (CPCI) qualification test? (10)	( )	( )
A. CAPTION		
(2) Does the test procedure include an identifying caption? (a.)	( )	( )
A.1 Test Identification		
(3) Is the individual test for which the test procedure is written uniquely identified in that test procedure's caption? (a.1)	( )	( )
(4) Does the caption indicate whether the test procedure is for a Preliminary or Formal Qualification Test? (a.1)	( )	( )
A.2 Contract Item		
(5) Does the caption contain the identification number of the CPCI to which the test applies? (a.2)	( )	( )

	Yes	No
(6) Has the approved nomenclature for the CPCI to which the test applies been specified in the caption? (a.2)	( )	( )
A.3 Primary Function		
(7) Have all the CPCI's primary functions or segments to be tested been identified in the caption? (a.3)	( )	( )
B. LOCATION AND SCHEDULE		
(8) Have the location and schedule for briefings been specified? (b.1)	( )	( )
(9) Have the location and schedule for tests been specified? (b.2)	( )	( )
(10) Have the location and schedule for debriefings been specified? (b.3)	( )	( )
(11) Have the location and schedule for data reduction and analysis been specified? (b.4)	( )	( )
C. REFERENCES		
(12) Is there a reference to the DT&E CPCI Test Plan? (c.1)	( )	( )
(13) Are there references to the CPCI Computer Program Development Specifications for each of the functions to be tested? (c.2)	( )	( )
(14) Are there references to appropriate users' manuals or positional handbooks for the CPCI being tested? (c.3)	( )	( )
(15) Are there references to users' manuals for the test or support computer programs? (c.4)	( )	( )
D. TEST OBJECTIVES		
(16) Have the detailed test objectives been specified by functional description and references to the Qualification Requirements and Criteria section (see the DID on the CPCI Test Plan, Section d) of the DT&E CPCI Test Plan? (d.)	( )	( )
E. MANNING AND RESPONSIBILITIES		
(17) Have requirements and responsibilities for all essential test personnel (including console operators, test directors, technical consultants, data analysts, and any others) been specified? (e.)	( )	( )
(18) Have special knowledge and skills requirements been stated for all test personnel needing them? (e.)	( )	( )

	Yes	No
(19) Have individual contractors or agencies responsible for supplying personnel been identified? (e.)	( )	( )
(20) Have the responsibilities for each such individual contractor or agency been defined? (e.)	( )	( )
(21) Have personnel requirements identical to those stated in the DT&E CPCI Qualification Test Implementation section (see the DID on the CPCI Test Plan, Section f) of the DT&E Test Plan been indicated by reference to the test plan? (e.)	( )	( )

F. EQUIPMENT AND COMPUTER PROGRAM REQUIREMENTS

(22) Have requirements for all computer programs needed for the test, other than the CPCI being tested, been specified? (f.)	( )	( )
(23) Have requirements for all equipment necessary to support the test been specified? (f.)	( )	( )
(24) Have any equipment and computer program requirements identical to those stated in the DT&E CPCI Qualification Test Implementation section (see the DID on the CPCI Test Plan, Section f) of the DT&E CPCI Test Plan been specified by reference to the test plan? (f.)	( )	( )

G. TEST OPERATING PROCEDURES

G.1 Computer Program Initiation

(25) Have procedures for reading the program to be tested into the computer been specified? (g.1)	( )	( )
(26) Have procedures for establishing the operation mode required by the computer program being tested been specified (g.1)	( )	( )
(27) Have procedures for initializing the parameters required been specified? (g.1)	( )	( )
(28) Have procedures for providing the inputs required been specified? (g.1)	( )	( )
(29) Have procedures for collecting, storing and displaying the outputs produced been specified? (g.1)	( )	( )
(30) Have procedures for beginning operation of the computer program being tested been specified? (g.1)	( )	( )
(31) Have listings of the input material (e.g., card decks) to accomplish the initiation of computer program operation been provided as an appendix? (g.1)	( )	( )

	Yes	No
G.2 Maintaining Computer Program Operation		
(32) Have all procedures for operator intervention (such as maintaining input data flow and replenishing card and tape supplies) required to maintain program operation been specified? (g.2)	( )	( )
G.3 Computer Program Termination and Restart		
(33) Have adequate procedures for normal termination of the computer program being tested been specified? (g.3)	( )	( )
(34) Have satisfactory procedures for unscheduled termination of the computer program being tested been specified? (g.3)	( )	( )
(35) Have adequate procedures for restarting program operation to insure that necessary output data shall be obtained been specified? (g.3)	( )	( )
H. DETAILED TEST DESCRIPTION		
H.1 Test Results		
(36) Has a detailed description of all test outputs been given? (h.1)	( )	( )
(37) Has a detailed description of all unexpected test events been given? (h.1)	( )	( )
(38) Has a detailed description of all expected test results been given? (h.1)	( )	( )
(39) Have all test objectives satisfied or partially satisfied by each test result been identified by reference to the Qualification Requirements and Criteria section (see the DID on the CPCI Test Plan, Section d) of the DT&E CPCI Test Plan? (h.1)	( )	( )
(40) Have all test events been described in the order in which they are planned to occur? (h.1)	( )	( )
(41) Have all dependencies among test events been indicated? (h.1)	( )	( )
(42) If more than one operating or monitoring position is involved, has the sequence of events for each position been indicated? (h.1)	( )	( )
(43) Has the interdependence of operating positions with respect to specific test events been described? (h.1)	( )	( )

Yes No

H.2 Test Inputs

(44) Have the listings of test inputs or listings produced in the preparation of test inputs (e.g., execution of a test case generation program) been included in an appendix? (h.2) ( ) ( )

I. DATA REDUCTION AND ANALYSIS

I.1 Recording and Reduction Requirements

(45) Have all data which must be recorded during the test by program, manually, or by instrumentation been specified? (i.1) ( ) ( )

(46) Have formatting requirements for all the data resulting from the reduction and analysis processes been specified? (i.1) ( ) ( )

(47) Have the content requirements for all the data resulting from the reduction and analysis processes been specified? (i.1) ( ) ( )

(48) Have the requirements for data recording and reduction been specified in sufficient detail and in a manner such that the resulting information will clearly show whether the test objectives have been met? (i.1) ( ) ( )

I.2 Data Reduction Analysis Procedures

I.2.a General

(49) Have the procedures to be employed in reducing and analyzing test data been specified by references and exceptions to the CPCI Test Procedure's References section (see DID Section c)? (i.2.a) ( ) ( )

I.2.b Computer Data Reduction and Analysis

(50) Has the data reduction and analysis to be accomplished by computer programs been identified? (i.2.b) ( ) ( )

I.2.b.1 Computer Program Initiation

(51) Have acceptable procedures to read the data reduction and analysis program into the computer been specified? (i.2.b.1) ( ) ( )

(52) Have satisfactory procedures to establish the mode of operation required by the data reduction and analysis program been specified? (i.2.b.1) ( ) ( )

(53) Have reliable procedures to initialize the parameters required by the data reduction and analysis program been specified? (i.2.b.1) ( ) ( )

	Yes	No
(54) Have acceptable procedures to provide the inputs required by the data reduction and analysis program been specified? (i.2.b.1)	( )	( )
(55) Have adequate procedures to collect, store and display the outputs required by the data reduction and analysis program been specified? (i.2.b.1)	( )	( )
(56) Have satisfactory procedures for beginning operation of the data reduction and analysis computer program been specified? (i.2.b.1)	( )	( )
(57) Have listings of all input materials (e.g., card decks, tapes) for the above initialization of computer programs been provided in an appendix? (i.2.b.1)	( )	( )

I.2.b.2 Maintenance of Computer Program Operation

(58) Have procedures for operator intervention (such as maintaining input data flow and replenishing card and tape supplies) required to maintain computer program operation been specified? (i.2.b.2)	( )	( )

I.2.b.3 Computer Program Termination and Restart

(59) Have adequate procedures for normal termination of the data reduction and analysis program been specified? (i.2.b.3)	( )	( )
(60) Have satisfactory procedures for unscheduled termination of the data reduction and analysis program been specified? (i.2.b.3)	( )	( )
(61) Have adequate restart procedures for obtaining necessary output from the data reduction and analysis program been specified? (i.2.b.3)	( )	( )

I.2.c Manual Data Reduction and Analysis

(62) Has any data reduction and analysis to be accomplished manually been specified? (i.2.c)	( )	( )
(63) Have adequate procedures for accomplishing any manual data reduction and analysis been established? (i.2.c)	( )	( )

Section 6. Preliminary Qualification Testing (PQT)

6-1. PQT Preparation.

A. Review Section 4 of the Development Specification to understand the testing responsibilities of the contractor.

B. Review AFR 800-14, Vol II, Chapter 5.

C. Review ESD-TR-77-327, Software Maintenance, Formal Qualification Test, Para 2.2.4, Pgs 24-25.

D. Review and approve the appropriate CPCI Test Plan and Test Procedures, making sure that explicit test objectives and success criteria are described for each test case; and that the mechanism for conducting the test and resolving discrepancies is understood by all participants.

6-2. PQT Conduct.

A. Answer the following questions with respect to software maintenance implications:

1) Do the test procedures call for adequate inspection of the specified maintainable software attributes i.e, module size, language, structured code, adherence to programming standards, code reliability?

2) What impacts on the software structure have design changes, requirement changes, and error corrections made?

3) Are the traceability matrix and test procedures current with design and requirement changes?

4) Have time sensitive portions of the software been adequately identified and documented for maintenance programming?

5) Are the listings:

a. readable?

b. reasonably self-documented?

c. adequately commented?

d. easily reviewable?

e. clear as to what each area of code is intended to do?

6) Are the data for references symbolic, and are they meaningful?

7) Are the date and version of the listing compatible with the contractor's list of materials to be qualified?

8) Are all development and test tools acceptable?

B. Participate in the PQT Test Conduct Functions.

6-3. Post-Testing Requirements.

A. Review and approve the CPCI Test Report pertinent to PQT, if applicable.

B. Monitor resolution of program trouble reports opened during the testing.

Section 7. Formal Qualification Testing (FQT)

7-1. Pre-Testing Requirements

A. Review ESD-TR-75-85, Monitoring and Reporting Software Development Status, Para 2.2.1, Pg 31 for a comprehensive list of what is expected from the contractor.

B. Review AFR 800-14, Vol II, Chapter 5.

C. Review appropriate CPCI Test Plans and Test Procedures making sure that explicit test objectives and success criteria are described for each test case; that the mechanism for conducting the test and resolving discrepancies is understood by all test participants; and specification will be tested.

7-2. FQT Conduct

A. Participate in the FQT Test Conduct functions as a member of the PO Test Team.

B. Note all program discrepancies and problems.

7-3. Post-Test Requirements

A. Review and approve the CPCI Test Report pertinent to FQT.

B. Monitor resolution of Program Trouble Reports opened during the test.

Section 8. System Intergration Tests

8-1. Review ESD-TR-77-254, Configuration Management, Section 6, for control during system testing.

8-2. Review Section 4.1.5 of the Development Specification for an understanding of contractors commitments.

8-3. Review all appropriate Test Plans and procedures for pertinent CPCI qualification information.

8-4. Maintain a Government test log/notebook of significant test events and countersigned by an official witness.

8-5. Review the hardware/software baseline and document any changes during testing.

8-6. Monitor and analyze any discrepancy reports generated during testing.

8-7. Review report.

Section 9. Independent Verification and Validation (IV&V)

9-1. Review AFR 800-14, Vol I, AFSC Sup.

9-2. Review IV&V Guide, Figure IV-9-1.

9-3. Review AFR 80-14, 12 Sep 80, Para 8, Computer Software Test and Evaluation.

Figure IV-9-1. Independent Verification and Validation Guide (IV&V)

A. Hq USAF/RD and Hq USAF/LE have established a policy (Figure IV-9-2) for the use of Independent Verification and Validation (IV&V) for Embedded Computer Systems (ECS). This policy will be incorporated into a revision to AFSC Supplement 1 to AFR 800-14, Management of Computer Resources in systems. All ESD Program Offices will consider the use of IV&V on new acquisitions and for retrofit or modification of existing systems.

B. IV&V can span the whole life cycle, performing requirements analysis, design analysis, code inspection, and actual testing of the computer programs. It is up to the program office to determine the level of IV&V for their particular program. Individual Computer Program Configuration Items (CPCIs) might require a different level of IV&V because of their criticality. Again, this has to be assessed by the program office. The following methodology provides a guide for both.

C. This methodology is based on the impact software errors can have on the system. The objective is to help you arrive at a good estimate of the total need for IV&V, from requirements analysis through independent testing of the code itself.

D. The first and most important step of the methodology requires the determination of criticality values for each CPCI. The criticality value is obtained by multiplying the criticality class by the probability of occurrence for each decision factor. (See Table IV-9-1 for the definitions of what the different criticality classes are and the values for both the criticality class and the probability of occurrence.) The decision factors, such as equipment malfunctions, are specific to individual programs. The factors should be based on what could go wrong with a specific CPCI which would impact the system.

E. The final step consists of adding up the criticality values for each CPCI and dividing by the number of factors to get an IV&V value. The corresponding IV&V level is obtained from Table IV-9-3. The following ESD example is provided for your information. (See Table IV-9-4.)

F. An important thing to remember is that this is only a guide for applying IV&V. It is ultimately the responsibility of the program manager to determine whether the IV&V that is to be applied is adequate or not.

Table IV-9-1. Decision Table

CRITICALITY CLASS	ASSIGNED VALUE	PROBABILITY OF OCCURRENCE	ASSIGNED VALUE
Negligible	1	Impossible	0
Marginal	2	Improbable	1
Critical	3	Probable	2
Catastrophic	4	Frequent	3

Where:

Negligible: Failure of software related to the factor/subsystem under evaluation would create inconvenience, rerun of batch programs, minor cost, etc.

Marginal: Failure of software related to the factor/susbsystem under evaluation would create degradation of secondary missions, some schedule delay and/or software cost overrun, etc.

Critical: Failure of software related to the factor/subsystem under evaluation would create degradation of the operational mission to a degree that the program manager would not use the system if forewarned, damage of equipment/property, injury to personnel, substantial schedule delay and/or software cost overrun, etc.

Catastrophic: Failure of software related to the factor/susbsystem under evaluation would create loss of life, mission failure, injury to personnel, critical equipment loss, excessive delay and/or cost overrun.

Table IV-9-2. Possible/Factor/Subsystem Criticality Values

Probability of Occurrence	Criticality Class			
	Negligible	Marginal	Critical	Catastrophic
Impossible	0	0	0	0
Improbable	1	2	3	4
Probable	2	4	6	8
Frequent	3	6	9	12

Table IV-9-3. IV&V Level Selection Chart

IV&V VALUE	SUGGESTED IV&V LEVEL
0-2	None - C
2-3	C
3-6	B
6-12	A

Where:

Level C: Constructively critique developer's documentation. Participate in milestone reviews. Identify critical requirements and design problems and reocmmend solutions. Monitor equipment.

Level B: Same effort as in Level C. In addition, using appropriate tools as necessary: Analyze selected critical functions. Spot check design performance. Conduct limited testing. Evaluate critical development test results. Perform selected audits.

Level A: Same effort as Level B: In addition, using appropriate tools as necessary: Independently analyze requirements and design. Re-derive key algorithms. Confirm technical adequacy. Independently test and evaluate operational software. Conduct stress tests. Conduct special studies. Support Configuration and Data Management.

Figure IV-9-2 Independent Verification and Validation (IV&V)
for Embedded Computer Systems (ECS)

1. Background: The IV&V concept was originated during the early days of the Ballistic Missile and Space Systems Division. It was applied to missile systems' embedded computer programs that were involved in the activation and control of nuclear weapons and in the launching of space vehicles. The purpose of the IV&V, conducted by the independent contractor, was to insure that the software properly performed all intended functions and, or equal importance, that it performed no unintended functions. The IV&V concept proved highly successful by permitting critical embedded computer programs to function more reliably. Because of its success, the IV&V techniques spread to other embedded computer applications.

2. Purpose and Objective: This letter establishes Air Force policy for Independent Verification and Validation for computer programs and associated documentation used in embedded computer systems pending revision of the appropriate Air Force regulations. This policy is designed to achieve the following objective:

Reduce acquisition risk and increase software reliability and maintainability through the use of Independent Verification and Validation on embedded computer systems.

3. Definition:

a. Independent Verification and Validation (IV&V) (of computer programs and associated documentation) - An independent assessment process structured to ensure that computer programs fulfill the requirements stated in system and subsystem specifications and satisfactorily perform the functions required to meet the user's and supporter's requirements. IV&V consists of three essential elements: independence, verification, and validation.

(1) Independent - an organization/aency which is separate from the development activity from a contractual and organizational standpoint.

(2) Verification - the evaluation to determine whether the products of each step of the computer program development process fulfill all requirements levied by the previous step.

(3) Validation - the integration, testing, and/or evaluation activities carried out at the system/subsystem level to evaluate the developed computer program against the system specifications and the user's and supporter's requirements.

b. Embedded Computer Resources - Computer resources incorporated as integral parts of, dedicated to, required for direct support of, or for the upgrading or modification of, major or less than major system(s). (Excludes ADP resources as defined and administered under AFR 300 series.)

4. Applicability and Scope: This guidance applies to embedded computer resources in systems developed for new acquisitions, retrofit, modification, or update of existing systems. This policy applies to all functions which are integral to deployed systems. Specifically excluded are commercial computer programs and associated documentation used in support of program development or administration, and procured in accordance with Air Force 300 series regulations.

5. Development and Acquisition Policy:

a. Effective immediately, consideration will be given to the use of IV&V in new acquisitions and for retrofit or modifications of existing systems. AFSC and AFLC should each, within 90 days of the date of this letter, designate a single organization to centrally review and coordinate IV&V of embedded computer resource planning.

b. The designated computer program support organization should be a prime source for accomplishing an IV&V. Due to program constraints such as schedule, insufficient support resource availability, support organization not yet designated, etc., it may in some instances be necessary to identify other sources to accomplish the IV&V. These sources include qualified independent contractors, federal contract research centers, AFSC laboratories and centers, product division engineering resources, Air Logistics Center engineering and technical resources, other military services or Government agencies, etc. Emphasis must be placed on a qualified organization/agency that has high level systems engineering expertise and knowledge that goes beyond basic code checking.

c. An early decision will be rendered regarding the extent of Independent Verification and Validation of computer programs and associated documentation acquired or supported under 800-series regulations. This decision process will be initiated as part of the early planning for computer resource acquisition or modification. This will occur during concept formulation and must be completed prior to the release of the full-scale development Request for Proposal (RFP). Specifically:

(1) The program/systems manager will convene the Computer Resources Working Group (CRWG). The CRWG will use the IV&V criteria (see Attachment) to formulate their recommendations as to the extent and level of IV&V, and will recommend a method of accomplishment.

(2) The program/systems manager will use the CRWG recommendations in structuring a play for risk abatement as reported in program reviews (e.g., PARs, CARs, AFSARCs, DSARCs, etc.).

(3) Where IV&V is to be performed, the program/systems manager will direct the CRWG to prepare a plan for accomplishing IV&V. This plan will become part of the Computer Resources Integrated Support Plan (CRISP).

(4) The program/systems manager will ensure that the RFP for the system to be developed includes appropriate provisions to support IV&V. The program/systems manager will define IV&V technical requirements in accordance with the recommended extent and level as defined in 5c(1) above. In selecting the IV&V organization/agency, the program/systems manager will consider the degree to which system/mission expertise, rigorous IV&V methodology, and operational certification are required.

6. Effective Date: This policy will be incorporated into AFR 800-14, is effective immediately and will be reviewed annually.

7. Waivers: None authorized.

Figure IV-9-3. CRITERIA FOR EXTENT OF IV&V

The IV&V decision will be based on the extent to which computer programs could affect the following criteria:

Criteria	Risk	
a. Safety	H	Failure of software may cause catastrophic equipment damage or loss of life includes: nuclear safety, range safety, flight safety of non-rated avionics, air traffic control, etc.
	M	Failure of software may contribute to equipment damage or personnel hazards - includes: controls & display indicators that may prompt incorrect commands, etc.
	L	Failure of software does not affect personnel or equipment
b. Mission Essentiality	H	Potential error impact: mission failure
	M	Potential error impact: degraded performance
	L	Potential error impact: inconvenience
c. Technical Risk	H	Complex, unproven
	M	Complex; proven before but not on current system or similar system
	L	Non-complex; proven on current system or similar system
d. Supportability	H	No established support structure, considerable resources required for support, organic support, high change frequency anticipated
	M	Support concept broadly defined but not specific to the system, moderate support resources required, organic support, moderate change frequency anticipated
	L	Support concept specifically defined, stable

e. Cost/Schedule Impact	H	Large program; complex, on critical path or may become critical path
	M	Small program; complex or moderately complex, may or may not be on critical path
	L	Off-the-shelf or non-complex
f. Security	H	Potential unauthorized access to classified data or unauthorized modification to CPCI or data base
	M	Inadvertent loss or contamination of classified data base
	L	No classified data involved

g. Other criteria will be considered as appropriate by the CRWG or the program/systems manager.

Table IV-9-4

OTH-B

FACTOR	TOTAL	IV&V
CPCI	SCORE	VALUE
AIRCRAFT DETECTION TRACKING		
CORRELATION/ IDENTIFICATION		
RADAR CONTROL AND MONITOR		
ENVIRONMENTAL ASSESSMENT		
RECORD/PLAYBACK FUNCTION		
SWITCH RECORDING		
SYSTEM EXERCISE FUNCTION		
AUTOMATIC FAULT ISOLATION		
ECCM CAPABILITIES		

REFERENCES

AIR FORCE REGULATIONS

AFR 57-4	Modification Program Approval	15 Dec 77
AFSC Sup 1	Retrofit Configuration Changes	1 Apr 74
AFR 65-3	Configuration Management	11 Jul 74
AFSC Sup 1	Configuration Management	25 Jul 75
AFR 66-12	Aircraft and Missile Equipment Accountability	15 Aug 78
AFR 70-15	Source Selection Policies and Procedures	16 Apr 80
AFSC Sup 1	Source Selection Policies and Procedures	18 Feb 77
AFR 80-14	Test and Evaluation	12 Sep 80
AFSC Sup 1	Test and Evaluation	19 Feb 81
AFR 80-45	Distribution Statements on Technical Documents	26 Mar 71
AFSC Sup 1	Distribution Statements on Technical Documents	22 May 80
AFR 300-10	Computer Programming Languages	15 Dec 76
AFSC Sup 1	Computer Programming Languages	2 Sep 80
AFR 310-1	Management of Contractor Data	30 Jun 69
AFSC Sup 1	Management of Contractor Data	11 Mar 74
AFR 800-2	Acquisition Program Management	14 Nov 77
AFSC Sup 1	Program Management	18 Oct 74
AFR 800-4	Transfer of Program Management Responsibilities	15 Jun 82
AFSC Sup 1	Transfer of Program Management Responsibilities	11 May 75
AFR 800-8	Integrated Logistics Support Plan	7 Feb 80
AFR 800-14, Vol I	Management of Computer Resources in Systems	12 Sep 75
AFSC Sup 1	Management of Computer Resources in Systems	8 Aug 77
AFR 800-14, Vol II	Acquisition and Support Procedures for Computer Resources in Systems	26 Sep 75
AFR 800-19	System or Equipment Turnover	27 May 75
AFR 800-21	Interim Contractor Support for Systems and Equipment	26 Sep 78
AFSC Sup 1	Interim Contractor Support for Systems and Equipment	28 Jan 80

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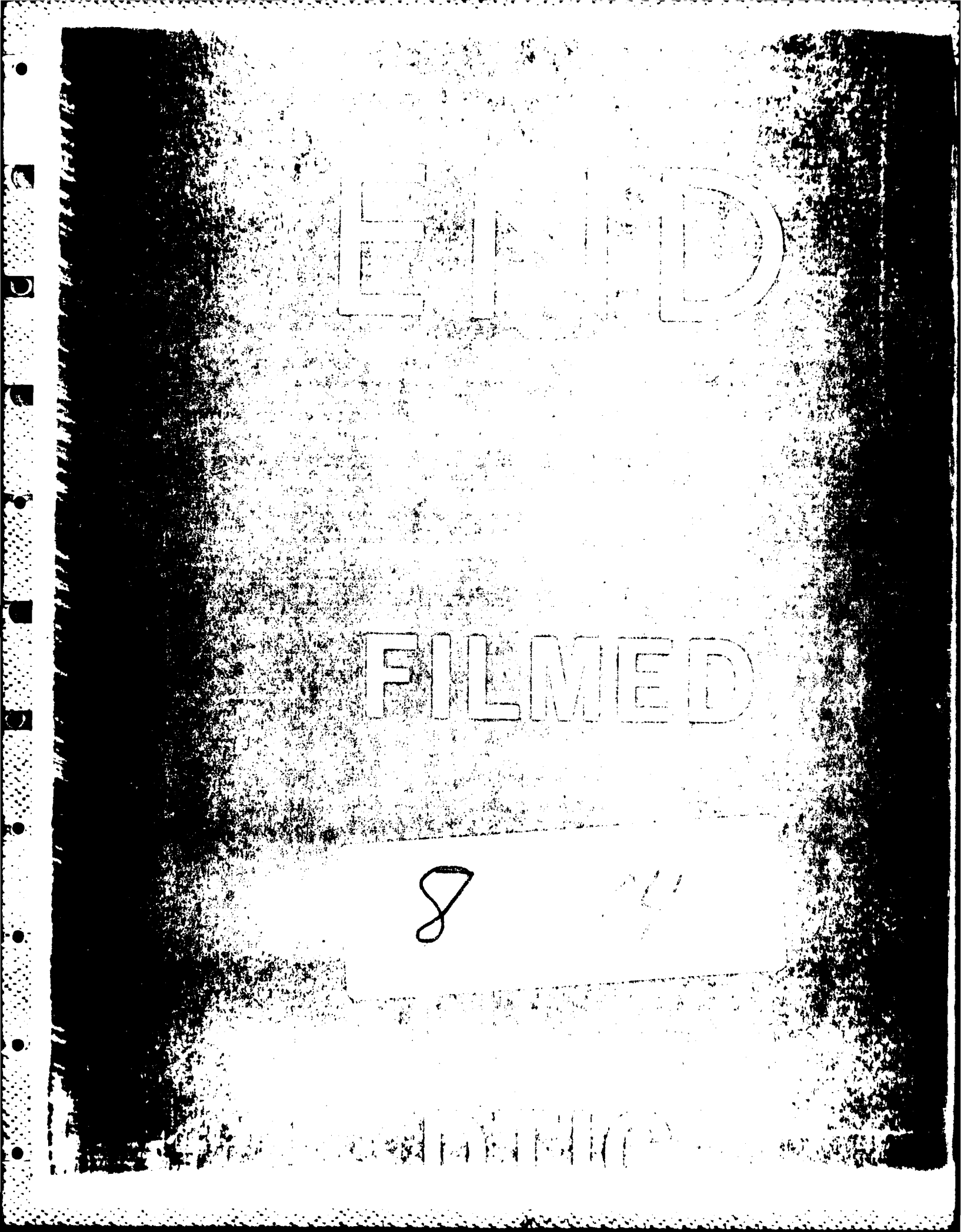
AFSCR 310-1	Management of Contractor Data	11 Mar 74
AFSCR/AFLCR 800-2	Management Multi-Service Systems, Programs, and Projects	4 Sep 73
AFSCP 800-3	A Guide for Program Management	9 Apr 76
AFSCP 800-7	Configuration Management	1 Dec 77

Military Standards & Handbooks

AFSC Design Handbook 4-2	Electronic Systems Test & Evaluation	10 Apr 71
MIL-HDBK-334	Evaluation of a Contractor's Software Quality Assurance Plan	15 Jul 81
MIL-STD-483 and Notice 2	Configuration Management Practices for Systems, Equipment, Munitions, and Computer Programs	31 Dec 70
MIL-STD-490	Specification Practices	30 Oct 68
MIL-STD-1521A	Technical Reviews & Audits for Systems, Equipment, and Computer Programs	1 Jun 76
MIL-STD-1679(NAVY)	Weapon System Software Development	1 Dec 78
MIL-S-52779A	Software Quality Assurance Program Requirements	1 Aug 79

ESD DOCUMENTS

ESD-TR-75-85	ADA016488	An Air Force Guide for Monitoring Software Development Status	Sep 1975
ESD-TR-76-159	ADA027051	An Air Force Guide to Software Documentation Requirements	Jun 1976
ESD-TR-77-16	ADA035924	Statement of Work Preparation	Jan 1977
ESD-TR-77-22	ADA037115	Life Cycle Events	Feb 1977
ESD-TR-77-130	ADA038234	Software Acquisition Management - Software Development and Maintenance Facilities	Apr 1977
ESD-TR-77-254	ADA047308	An Air Force Guide to Computer Program Configuration Management	Aug 1977
ESD-TR-77-255	ADA047318	Software Quality Assurance	Aug 1977
ESD-TR-77-263	ADA048577	Verification	Aug 1977
ESD-TR-77-326	ADA053039	Validation and Certification	Aug 1977
ESD-TR-77-327	ADA053040	Software Maintenance	Oct 1977
ESD-TR-78-117	ADA052567	Reviews and Audits	Nov 1977
ESD-TR-78-139	ADA055573	An Air Force Guide to the Computer Program Development Specification	Mar 1978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