MIL-STD-2067(AS)
17 October 1978
SUPERSEDING
AR-49B
30 January 1975

MILITARY STANDARD

AIRCREW AUTOMATED ESCAPE SYSTEMS RELIABILITY AND MAINTAINABILITY (R/M) PROGRAM REQUIREMENTS FOR

FSC 1680

DEPARTMENT OF DEFENSE
Washington, DC 20360

1. This Military Standard is approved for use by the Naval Air Systems Command, Department of the Navy, and is available for use by all Departments and agencies of the Department of Defense.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to:

Engineering Specifications and Standards Department
(Code 93)
Naval Air Engineering Center,
Lakehurst, NJ 08733

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

FOREWORD

This Military Standard is applicable for the proposal, conceptual, development and production phases of the Aircrew Automated Escape Systems and Government in-house development and production of systems and equipment.

CONTENTS

CONTENTS

1. SCOPE

1.1 Purpose. This military standard specifies uniform criteria for AAES (Aircrew Automated Escape Systems) reliability and maintainability programs.

2. REFERENCED DOCUMENTS

2.1 Issues of documents. The following documents of the issue in effect on the date of invitation for bids or request for proposal, form a part of this standard to the extent specified herein:

SPECIFICATIONS

MILITARY

MIL-E-9426	-Escape Systems, Requirements Conformance Demonstrations and Performance Tests for; General Specification for
MIL-S-18471	-System, Aircrew Automated Escape, Ejection Seat Type; General Specification for
MIL-A-23121	-Aircraft Environmental, Escape and Survival Cockpit Capsule System, General Specification for
MIL-A-81815	-Aircrew Automated Escape Systems, General Specification for
AR-30	-Integrated Maintenance Management for Aeronautical Weapons, Weapon Systems, and Related Equipment
AR-105	-Aircrew Automated Escape System In-process Design Conformance Inspection Articles, Standard Procedures for Evaluation of; Requirements for

STANDARDS

MILITARY

MIL-STD-280	-Definitions of Item Levels, Item Exchangeability Models, and Related Terms
MIL-STD-470	-Maintainability Program Requirements
MIL-STD-471	-Maintainability Demonstration
MIL-STD-721	-Definition of Effectiveness Terms
MIL-STD-756	-Reliability Preduction
MIL-STD-757	-Reliability Evaluation from Demonstration Data
MIL-STD-780	-Work Unit Code
MIL-STD-785	-Reliability Program Requirements

STANDARDS

MILITARY

MIL-STD-882	-System Safety Engineering of Systems and Associated Subsystems and Equipment
MIL-STD-1472	-Human Engineering Design Criteria for Military Systems, Equipment and Facilities
MIL-STD-2070	-Procedures for Performing a Failure Mode, Effects and Criticality Analysis for Aeronautical Equipment

PUBLICATIONS

MILITARY

MIL-HDBK-217	-Reliability Stress and Failure Rate Data for Electronic Equipment
MIL-HDBK-472	-Maintainability Prediction

NAVAL AIR SYSTEMS COMMAND

SD-24	-General Specification for Design and Construction of Aircraft Weapon Systems

• 2.2 Availability of documents. (When requesting any of the applicable documents, refer to both title and number. All requests should be made via the cognizant Government quality assurance representative. Copies of this standard and other unclassified standards and drawings required by contractors in connection with specific procurement functions should be obtained upon application to the Commanding Officer, Naval Publications and Forms Center (Code (1051), 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120. All other documents should be obtained from the Government procuring activity or as directed by the contracting officer.)

(Indices indicating the paragraphs in which the above listed specifications are cited begin on page 51.)

3. DEFINITIONS

3.1 General. Technical terms, abbreviations, and acronyms other than those terms defined herein are defined in: MIL-STD-721, MIL-STD-882, and MIL-STD-280. The meanings of other terms used, but not defined herein, are as defined in an unabridged dictionary unless otherwise indicated.

3.2 Terms.

3.2.1 Contractor. The term "contractor" is defined as any corporation, company, association, or individual which undertakes performance under the terms of a contract, letter contract, letter of intent or purchase orders, project orders, and allotment, in which this document may be incorporated by reference. For the purpose of this standard, the term "contractor" includes government operated activities undertaking performance under an airtask, project order, or allotment.

3.2.2 Inspection. The examination and testing of systems, subsystems, components, and items to determine whether they conform to specified requirements.

3.2.3 First article. For the purpose of this standard, the preproduction or first articles shall be defined as the SRT articles identified in MIL-E-9426.

3.2.4 Aircrew automated escape system. An interrelated assemblage of components, assemblies, and subassemblies specifically organized to perform automatically, after manual system initiation, all functions necessary to effect safe aircrew escape from a disabled aircraft and to return the aircrew safely to the earth's surface.

3.2.5 Probability of success. That probability that the total escape system functioning at the extreme required performance envelope limits, will function in a non-degraded manner to effect safe escape and recovery of aircrew.

3.2.6 In-service success rate. That percentage of ejecting aircrew who survived through separation from the escape system and surface contact. Includes many "lucky" or "fluke" saves from among the "out-of-envelope" ejections, unsuccessful (non-malfunction) "out-of-envelope" ejections, other non-malfunction fatalities, and system malfunction caused fatalities. Separation of these effects to correct the success rate to obtain a measure of in-service reliability is a matter of judgmental interpretation of accident data of varying veracity and as such is not as acceptable quantification of AAES reliability.

3.2.7 Single point failure. A single point failure, which, occurring by itself, is capable of preventing successful AAES operation when the AAES is functioning under any condition of escape, including the extreme required performance envelope limits.

3.2.7.1 Catastrophic single point failure. A single point failure which, occurring by itself, precludes continued successful AAES operation.

3.2.7.2 Degraded performance single point failure. A single point failure which, by occurring, reduces AAES performance capabilities from the required extreme envelope.

3.3 Abbreviations, acronyms, and symbols.

AAES	Aircrew Automated Escape System
CDRL	Contract Data Requirement List (DD Form 1423)
DID	Data Item Description (DD Form 1664)
DMMH/FH	Direct Maintenance Man Hours/Flight Hours
EPA	Engineering Proofing Article
FMA	Field Maintainability Evaluation Article
$M_{max_{ct}}$	Maximum Corrective Maintenance Time
MOS	Marginality of Success
MTTR	Mean Time to Repair
MUA	Mock-Up Article
PPA	Production Proofing Article
SFPS	Single Failure Point Summary
SRT	Service Release Test
SSE	Special Support Equipment

3.4 Design evaluation program flow sequence. Figure 1, "Aircrew Automated Escape System Design Evaluation Program Event Flow Sequence Diagram," is provided to illustrate the time and general interrelationships between the program major elements and phases.

4. GENERAL REQUIREMENTS

4.1 Quantitative design requirements. In accordance with the contract and MIL-S-18471, (or MIL-A-23121, if applicable), MIL-A-81815, and SD-24 the AAES shall comply with the following reliability and maintainability requirements.

4.1.1 Reliability. A system reliability program shall be developed and conducted to ensure that the AAES will equal or better the following requirements.

4.1.1.1 System design reliability. The AAES shall be designed to achieve or better the following reliability levels for the specified operational modes. (General information concerning reliability and factors contractors should consider are presented for information in Appendix A.)

4.1.1.1.1 Automatic escape reliability. The system reliability, expressed as the probability that the AAES shall perform successfully and automatically following system manual initiation all escape capabilities (including the extreme limits) requirements specified in the contractual documents, shall be equal to or better than 0.98 at the 90 percent lower confidence level.

4.1.1.1.2 Manual emergency egress reliability. The system reliability, system shall perform successfully upon actuation to permit safe, rapid manual egress, shall be at least 0.98 at 90 percent lower confidence level.

4.1.1.1.3 Non-emergency (mission) reliability. The system reliability, expressed as the probability that the AAES shall perform successfully all aircraft/mission requirements specified in the contractual documents, shall equal or better requirements specified in aircraft subsystems allocations.

4.1.2 Maintainability. A system maintainability program shall be developed and conducted to assure that the AAES will equal or better the following requirements:

4.1.2.1 System design maintainability. The AAES shall be designed to achieve at least the following maintainability levels for operational employment (more stringent maintainability levels may be required by aircraft subsystem allocations):

a. Based upon a flying hour rate of 35 hours/month, the DMMH/FH (Direct Maintanence Man Hours/Flight Hours) at organizational and intermediate maintenance levels for corrective and preventive maintenance, including the preparation of items to be inserted into the AAES, shall not exceed 0.05 hours for a single ejection seat AAES. (The

DMMH/FH may be adjusted by the Government procuring activity for application to a multiple seat system. In addition, the Government procuring activity may adjust the DMMH/FH for different flying rates to assure that the total DMMH/month/aircraft remains less than 1.75 hours.)

b. The MTTR (Mean Time to Repair) shall not exceed 0.85.

c. The $M_{max_{ct}}$ (Maximum Corrective Maintenance Time) for the 95th percentile individual maintenance action, ranked on basis of corrective times, shall not exceed 2.5 hours including time for parachute packing, if required, and time for system removal from re-installation in the crew station, if applicable.

d. Maintenance personnel not previously tested or rated greater than service pay grade E-4 (or civilian equivalent) shall be able to perform at least 95 percent of the total maintenance actions.

4.1.2.1.1 Depot level maintenance. Depot maintenance shall involve total refurbishment of the AAES and shall include, but need not be limited to, the following: Inspection, test, repair, cleaning, repainting, and removal and replacement of subsystems and/or components.

4.2 General demonstrations requirements.

4.2.1 System reliability demonstration. Demonstration of system reliability shall be accomplished through two approaches:

a. System block diagram constructed reliability. Using the system block diagram and math model developed and approved in accordance with 5.2.1 herein and the procedures MIL-STD-757 incorporate the component and subsystem reliabilities (at the 90 percent lower confidence level) determined through tests defined in 5.5.2 herein and available, Government procuring activity approved, component and subsystem reliability history data. This constructed system reliability should be equal to or greater than 0.98. The contractor shall include the following in the documentation of the systems block diagram constructed reliability.

(1) The achieved constructed system reliability.

(2) Using the block diagram format, the block-by-block comparison of the allocated and demonstrated reliabilities.

b. Systems tests. System tested reliability shall be demonstrated by the completion of systems service release tests conforming both in quality and quantity to the requirements of MIL-E-9426 as modified by the contract.

4.2.2 System maintainability demonstration. System maintainability shall be demonstrated in two parts:

a. Maintenance actions. The capability of the system to comply with the requirements for DMMH/FH, MTTR, $M_{max_{ct}}$, and skill level shall be demonstrated during the FMAs established by and conducted in accordance with 5.6 (herein), MIL-E-9426 and AR-105.

b. Maintenance-free life/cycle life. The capability of the system and its elements to meet the stipulated maintenance-free life/cycle life requirements shall be demonstrated by special test programs established and conducted in conformance with testing standards established by MIL-E-9426 for AAES tests.

4.3 General program requirements. To assure maximum impact upon system and element design, test, inspection procedures, and manufacturing and production processes and procedures, and to maximize overall economy of effort, the herein required reliability and maintainability program shall be:

a. Coordinated thoroughly with all other systems effectiveness programs (i.e., vulnerability analyses, system safety, human factors, quality assurance, etc.) in a manner providing the maximum timely interchange and consideration from all viewpoints of the effects of identified potential design/evaluation deficiencies, and

b. Integrated into the system design and system efforts in a manner assuring (1) the timely systematic availability and consideration of identified potential design/evaluation deficiencies, and (2) the timely development and implementation of appropriate remedial actions.

4.3.1 General program plan requirements. The contractor shall prepare, submit for Government procuring activity approval and, following that approval, implement detail reliability and maintainability program plans for effecting the requirements of this standard at all system levels throughout the program. The following general requirements in addition to the specific requirements contained in this standard shall be included in each reliability and/or maintainability program plan:

a. Classification of causes degraded reliability/maintainability affecting, or potentially affecting, escape capability shall be based upon their effect upon the system ability to meet or better the performance requirements herein specified. Degradation of the escape system performance envelope shall require the cause to be classified as a Category I Hazard in accordance with MIL-STD-882.

b. For each cause of degraded reliability/maintainability the effect upon escape capability, effective safe performance of mission tasks, and/or safe performance of escape system and aircraft maintenance tasks shall be defined.

c. For each cause of degraded reliability/maintainability, the probability of its occurence and the basis for that assessment shall be defined.

d. For each cause of degraded reliability/maintainability, the corrective actions considered, the recommended action and the supporting rationale for the selection shall be presented.

e. For each cause of degraded reliability/maintainability, the cost and time to correct or, if reduction of its impact in lieu of correction is recommended, the cost and time to reduce the impact and the resulting change in system reliability/maintainability and probability of occurrence of the degraded reliability/maintainability shall be defined.

f. Planned tasks shall be defined carefully and supported by planned schedule milestones and planned man-loading schedules integrated demonstratively with the overall system program plan.

g. Summary progress reports shall include task-by-task analysis of reliability and maintainability, degradations, cause definitions, analyses and correction progress, and man-hour expenditures.

h. The plan(s) shall identify clearly and completely all deviations from the requirements of this standard and the applicable escape system specification, and shall document clearly the rationale for each such deviation.

i. The plan(s) shall state clearly the procedures for resolving within the contractor's corporate structure risk and benefits associated with hazards and the correction/acceptance/reduction in severity probability of occurrence.

j. Each plan(s) frontispeice shall have provision for Government procuring activity representative or designee approval signature and approval date. Once signed, the plan may not be modified by the contractor without written approval from the Government procuring activity.

k. The plan(s) frontispiece shall bear a statement that:

"Upon (Government procuring activity) approval in accordance with paragraph 3.7.2.1 of MIL-S-18471 (revision letter and amendment number) under Contract ______________, this Aircrew Automated Escape System Reliability (Maintainability) Program Plan shall supercede MIL-STD-2067."

l. The plan shall require that up-to-date interim summary reports shall be submitted to designated activities at least 2 weeks prior to each design review meeting (mock-up, engineering proofing article, field maintainability review article, production proofing article).

m. The plan(s) shall include a post-production release/post-incorporation system reliability/maintainability program plan covering at least the first two years of system service life following first in-service installation flight or through completion of new aircraft full scale development program, whichever is the longest.

n. The System Reliability/Maintainability Program Plan(s) shall ensure a close coordination between the system reliability and maintainability analyses and those analyses conducted for systems effectiveness, human factors, vulnerability, systems safety engineering, quality assurance, and other purposes to ensure full, thorough analysis of each factor by all specialties and to avoid ineffective and costly duplication of efforts.

o. For each cause for degraded performance for which the contractor recommends non-design corrective action or acceptance without any corrective action, the progress summary report shall provide a full supporting rationale and shall identify the final corporate level at which the decision was reviewed and approved.

p. The System Reliability/Maintainability Program Plan(s) shall ensure a documented timely, frequent coordination of the system reliability/maintainability analyses and contractor engineering, manufacturing/production, test, quality assurance, and other affected departments to assure timely, economic initiation of appropriate remedial actions.

q. The plan(s) shall provide for a documented development and/or modification of testing criteria for success/failure classification using the results of the System Reliability/Maintainability analyses.

5. DETAIL REQUIREMENTS

5.1 First article sample. A first article sample of the AAES shall be tested, as specified in 5.5 and 5.6, to demonstrate compliance with reliability and maintainability design requirements. Acceptance of the test results by the Government procuring activity is required prior to commencement of production.

5.2 Reliability and maintainability programs. In accordance with MIL-STD-785, MIL-STD-470, and this standard, the contractor shall establish, implement, and document the reliability and maintainability programs and plans. The program shall be coordinated with, and shall provide input data for, the integrated Logistic Support Program in accordance with AR-30.

5.2.1 Block diagrams and mathematical models. Reliability and maintainability block diagrams and mathematical models of the AAES for each of the modes in 4.1.1.1 shall be prepared and used in allocations, predictions, and the analyses of maintenance action rates. Whenever design evaluations, engineering analyses, test results, and/or demonstration results reveal and/or create discrepancies between the AAES and the models; the models shall be revised as necessary to reflect the AAES. The models shall relate directly to the quantitative requirements of 4.1.

5.2.1.1 Effect of degraded performance upon system reliability.

5.2.1.1.1 Automated escape. Although when reverting to a redundant or back-up mode of operating, the total escape system may not have incurred a total failure; if the alternative mode is incapable of achieving the herein required extreme performance limits that reversion shall constitute a failure for the purposes of calculating the system automated escape system reliability, i.e.

$$R_{\text{Sys. Auto. Escape}} = 1 - P_{\text{Failure}} - P_{\text{Revision to Degraded Mode}}$$

5.2.1.1.2 Manual emergency egress. In a similar manner, should an element(s) of the manual emergency egress subsystem function in a degraded manner but not actually have failed impeding and/or slowing accomplishment of manner emergency egress, the system manual emergency egress reliability shall be:

$$R_{\text{Sys. Man. Egress}} = 1 - P_{\text{Failure}} - P_{\text{Functioning in Degraded Manner}}$$

5.2.1.1.3 Non-emergency. In a similar manner, should escape system elements, without actually failing, function in a degraded mode impending normal ingress and/or system performance during flight, the reliability shall be:

$$R_{\text{Non-Emerg.}} = 1 - P_{\text{Failure}} - P_{\text{Functioning in Degraded Mode}}$$

5.2.2 Allocations. The quantitative reliability and maintainability requirements of 4.1.1 and 4.1.2 shall be conducted at the level(s) of assembly necessary for design evaluation, interface control, logistic support and maintenance. The definitions used to describe the level of assembly shall be as specified in MIL-STD-280.

5.2.3 Predictions. Reliability and maintainability predictions shall be made for each mode of AAES operation. The predictions shall be made in accordance with MIL-STD-756, MIL-STD-470, and MIL-HDBK-472 using realistic, measured failure rates for items identical or similar to the elements of the design. The failure rates for electronic equipment shall be determined utilizing the prediction methods specified in MIL-HDBK-217.

5.2.4 Failure mode effect and maintenance action rate analyses.

5.2.4.1 Failure mode effect analyses. These analyses shall be performed on each level of assembly for each required environmental condition, and for each operational mode (4.1.1.1), and shall identify and evaluate all failure modes. MIL-STD-2070 provides guidance concerning the failure modes and effects analyses methodologies. In addition, for each failure mode, the likelihood of occurrence shall be determined for the failure identified, a determination shall be made as to its effect and criticality upon part, circuit or subsystem in question and of the ultimate significance of this effect upon the AAES overall system performance, reliability, maintainability and safety. These analyses shall include a description of the factors inherent in the design, or in the quality program, that will minimize the probility of occurrence of those failures having the most significant potential adverse effect on system performance, reliability, maintainability, and safety. (See Figure 2.)

The criticalality of the effects of each identified failure mode upon specific modes of AAES operation will be classified or ranked into the following catagories for AAES operating at the extreme required performance envelopes:

I. Catastrophic - will cause death or severe injury to personnel or system loss.

II. Critical - will cause personnel injury or major system damage, or will require immediate corrective action for personnel or system survival.

III. Marginal - can be counteracted or controlled without injury to personnel or major system damage.

IV. Negligible - will not result in personnel injury or system damage.

5.2.4.2 Maintenance action rate analysis. The failure modes and effects analyses shall be extended to include a maintenance action rate analysis for replacement and repair of failed items and to determine the character and magnitude of the maintenance support values specified in the item specification. The analysis shall be revised as necessary to account for actual demonstrated and approved elapsed maintenance time and maintenance manhours.

5.2.5 Single failure point summary. A SFPS (Single Failure Point Summary) will be prepared for all category I and II failures, as identified in 5.2.4.1. The contractor shall investigate and propose corrective actions for all identified single failure points. Commencing at the MUA, any single failure points remaining unresolved thirty (30) days following identification and inclusion in the SFPS shall be brought to the attention of the Government procuring activity and the alternatives considered and problems encountered in attempting the resolution discussed. All unresolved category I and II single failure points must be submitted to the Government procuring activity for review and a determination whether to accept or reject the contractor's recommendations. As a minimum, the SFPS will contain the following information; See Figure 3.

a. Item identification and nomenclature
b. Failure mode, cause, and effect
c. Rationale for acceptability
d. Probability of occurrence
e. Recurrence control

5.2.6 Marginality of success. To assist in the early detection, identification and correction of AAES operation inconsistent with specification requirements, system requirements and/or good design practices (including adequate safety factors), the contractor AAES reliability program shall provide for, and require, the thorough, detailed post-test evaluation of (a) all test articles and (b) all test data to determine the marginality of success, and, if marginal, the cause(s). The contractor shall prepare, submit to the Government procuring activity for approval, and, following approval, implement a marginality of success plan. The plan may be integrated into the test plan required under MIL-E-9426. Test data shall be recorded and treated in a manner aiding the detection of operating anomalies and shall be examined for operating results and/or statistical distribution of operating results trending near specification limits and/or considerably out of line with previous results. Cause(s) shall be determined for all anomalies identified in the test articles and/or test data. Test articles shall be examined for non-operating components, excessive wear, damage or other signs of unusual behavior, failure and/or incipient failure and the cause(s) shall be determined. In addition, a record shall be maintained for all test articles, presenting for each test the physical relationships (location, orientation, etc.) of test article components to each other and the pretest quality assurance test article assembly/component critical characteristics records. All anomalies identified shall be documented and evaluated to ascertain their potential for inducing failures in service, to ascertain the consequences of such failures, and to determine recommendations for appropriate remedial action and shall be reported to the Government procuring activity.

5.2.6.1 Marginality of success analysis. The Marginality of Success Analysis shall be conducted for each test of the AAES. Subsystems and components Marginality of Success Analysis reports, in accordance with Table VII of MIL-E-9426, shall be appended to the applicable test report. No test report will be considered complete without a Marginality of Success Analysis. In the event a test report is not issued for each test, a brief interim MOS analysis report shall be issued for each test or for each grouping of tests occurring within a one-week period. Each MOS analysis report shall have a cover sheet and as a minimum shall contain the following:

a. Test number and date

b. Test article nomenclature, part number(s)

c. Test conditions (those test condition variables controlled/manipulated and measured by the testing activity, i.e. temperature, humidity, shock, center of gravity, weight, etc.)

d. Whether:

   (1) Failures occurred
   (2) Marginal/anomalous performance was detected

e. Brief synopsis of each failure and/or marginal/anomalous performance detected

f. Date marginal success analysis completed for:

   (1) Test article assembly/component hardware
   (2) Test data

g. Analyzers; names and signatures

h. Design section reviewers; name(s) and signatures

i. Whether design modification deemed necessary

j. Test section reviewers' names and signatures

k. Whether test/instrumentation modification deemed necessary

l. Brief synopsis of each recommended modification

5.2.6.2 Marginality of success program establishment. Figures 4 through 8 outline the phases and typical tasks of an acceptable MOS program. (Appendix B provides general information to assist contractors in developing their MOS programs.)

5.2.7 Environmental study. Using the environmental extremes specified in MIL-S-18471, MIL-A-23121, or MIL-A-81815 as applicable, the contractor shall analyze the results from the environmental conditioning conducted in accordance with 3.8.3 of MIL-E-9426, for detrimental effects to AAES reliability, maintainability and safety. In addition, the contractor shall perform a study defining the operational and maintenance environments for the AAES and for the logistic phases of transportation and storage.

5.2.8 Components, parts and material selection. The selection of components, parts and materials shall be reviewed to ensure that the selections satisfy the AAES system performance, safety, reliability, and maintainability requirements for their intended application.

5.2.8.1 Changes history. The contractor shall maintain, available for inspection by the Government procuring activity or its designee, a changes history of all changes affecting the AAES or directing affecting the system manufacturing processes/procedures or system quality assurance procedures. The history should include at least the following information:

a. Date of problem occurrence

b. Description of how problem was discovered

c. Description of problem

d. List of alternative actions considered

e. Bases for selection/rejection of alternatives (i.e. cost, schedule, technical, contractual, legal, "ilities" analyses, etc.)

f. Remedial action, implementing action taken (i.e. how, when)

5.2.9 Parts and materials (Qualification). Where adequate qualification data are not available on parts and materials to be incorporated in the design, qualification tests shall be performed to determine the adequacy of such parts and materials relative to the specified requirements for performance, reliability, maintainability and safety. Ballistics and other items specifically governed by separate specifications shall be qualified in accordance with those specifications identified in paragraph 3.8.1 of MIL-E-9426.

5.2.9.1 Reliability qualified items list. The contractor shall prepare and maintain available for inspection a current list of items that have been reliability qualified for use in the system. This list shall identify those materials, parts, components, assemblies, or modifications thereto, etc., which, thru tests, have met the specified design qualification requirements. The environmental limits, stresses, etc., to which the item has been subjected will be provided and anotated (whether successful) as a part of the list.

5.2.9.2 Approved non-standard parts and materials. Lists of non-standard parts and material, approved by the Government procuring activity shall be prepared and maintained by the contractor in an up-date status. Upon request, these lists shall be made available to the Government procuring activity, for review. As a minimum, the approved parts and material list shall contain the following information:

a. Name of part

b. Military nomenclature or other applicable part number

c. Procurement specification

d. Reliability rating

e. K-Factor used for derating

f. Test report references

The detailed verification data substantiating this information shall be retained, by the contractor, for total element/system life, and upon request, shall be made available to the Government procuring activity for review.

5.2.10 Commercial equipment. The contractor shall prepare and maintain available for inspection current service and life-test reliability and maintainability data on designated commercial equipment. The information shall include the conditions under which the data were generated; the mean time/cycles between failures; the man-hour rate for each corrective maintenance, preventative maintenance, and servicing task or other reliability and/or maintainability parameters; expected service life of the equipment; and an explanation of the deviations. The data shall be presented in contractor's format in a clear, consise, and easily reproducible for.

5.2.11 Subcontractor, vendor, and supplier control. The contractor, in his program plan, shall stipulate methods for assuring that each subcontractor's and supplier's reliability, maintainability, and safety efforts are consistent with overall AAES requirements; that provisions are made for source selection of subcontractors and suppliers, and for surveillance of their reliability, maintainability and safety activities.

5.2.12 Design reviews. Formal reliability and maintainability design reviews shall be scheduled and conducted periodically during the course of the contract to coincide with major program milestones, e.g. Mock-Up Review, Engineering Proofing Article Review, and at other appropriate program stages. Participants in the reviews shall include Government procuring activity personnel, as well as qualified contractor personnel from management, design, manufacturing, reliability, human factors, safety, maintainability, quality control, parts application, and other areas of the contractor's organization.

The reviews may be held at Government facilities, contractor's facilities, or at those of a major subcontractor if the latter case enhances the effectiveness of the review in question. Prior to each major review the contractor shall prepare and submit a Reliability and Maintainability Design Review Report. As minimum, this report shall contain the following information:

a. Current reliability and maintainability estimates and achievements for each mode of AAES or AAES elements operation.

b. Potential or unresolved design and production problems.

c. Corrective action(s) necessary to assure attainment of the design requirements.

d. Reliability trend analyses with graphical illustrations for the AAES and also for each major subsystem or component of the AAES, as derived from reliability analyses and/or tests.

e. The current status of subcontractor and suppliers reliability and maintainability program.

5.2.13 Program reviews. The contractor and cognizant Government procuring activity personnel shall conduct joint quarterly reviews of the reliability and maintainability programs to assess their progress and effectiveness and to determine the need for changes. These reviews will be scheduled to include safety, system survivability, vulnerability, human factors, and quality assurance program reviews, as well as reviews of available MOS analysis findings.

5.3 Data collection. The reliability and Maintainability Data Collection System shall be compatible with the Naval Aviation

Maintenance and Material Management System (3-M). The identification of data shall include Work Unit Codes in accordance with MIL-STD-780, detailed part numbers, and other applicable identification. All data shall be retained in a form suitable for automatic data processing at the original level of detail and identification.

5.3.1 Failure data collection, analyses, and correction action. The contractor shall have, and shall require subcontractors also to have a closed loop system for identifying, analyzing, and recording all failures that occur prior to production acceptance of the AAES or subsystem. Reports generated by this system shall be made available to the Government procuring activity. As part of the program plan, the contractor shall describe his proposed system for initiating failure reports, the analysis of failures, and feedback of corrective action. The analysis and recording of a failure shall differentiate between, but need not be restricted to, those due to equipment failure and those due to human error, manufacturing, handling, transporting, storing, and maintaining the equipment. The contractor's failure reporting system shall include provisions to assure that effective, corrective actions are taken on a timely basis to reduce or prevent repetition of the failure as noted in paragraph 5.2.4. The program shall include follow-up audit to review all open failure(s) analysis and corrective action, close out dates and subsequent reporting through all phases of design, development, and production.

5.3.2 Failure summaries. The contractor shall include on a quarterly basis, a detailed failure report summary as part of the monthly status report. As a minimum these reports shall identify the failed parts by part number and location in system and shall identify the cause of failure and any investigative reports.

5.4 Reliability and maintainability interface compatibility. Reliability and Maintainability Programs shall be coordinated with other interface efforts (including but not limited to those listed below) to assure an integrated and effective contractual effort:

a. Human resources (personnel subsystems) including human engineering (MIL-STD-1472) human factors, and training.

b. System Safety engineering (MIL-STD-882).

c. Quality assurance and quality control

d. Standardization program plans

e. System engineering

f. Configuration management

g. System Survivability/Vulnerability (MIL-S-18471 para 3.7.2.3)

5.5 Reliability testing and demonstration.

5.5.1 Reliability test plans. The integrated test and demonstration plans prepared in accordance with MIL-E-9426 shall be reviewed prior to submittal to the Government procuring activity for approval to ensure that the plan includes all reliability testing and longevity demonstrations to be performed during the program. These test plans shall be designed to make maximum use of data and reliability information obtainable from all relevant sources, and the procedures for the utilization of such data. Approval of the test plan by the Government procuring activity shall be obtained prior to the initiation of tests. The reliability test program shall be integrated with other system/equipment test programs to the maximum extent practical in order to avoid costly duplicate testing (e.g., performance testing, flight testing, reliability and maintainability, demonstration, etc.). In the test plan, the ground rules shall be established for conduct of testing (including GFE impact), and for accept/reject criteria in accordance with 4.2 of MIL-E-9426 and the accepted test standards. The reliability test plans (or reliability portion of test plans) shall require the preparation of reliability test analyses reports which may be combined with test reports prepared and submitted under MIL-E-9426.

5.5.1.1 Development testing. A planned and scheduled program of operational environmental testing of equipment, shall be conducted during design and develpment phases to estimate achieved reliability improvements. These tests shall be integrated with other such programs to the extent that different objectives can be integrated without loss. In addition, reliability maintainability requirements shall be superimposed upon, and included in the plans and procedures for all MIL-E-9426, environmental tests. Unless given specific written prior approval by the Government procuring activity no environmental conditionings (3.8(c) and 3.8.3 of MIL-E-9426) are to be conducted solely for reliability purposes. Data obtained from all environmental tests shall be subjected to reliability and maintainability analysis and shall be employed in reliability and maintainability analyses of the AAES and AAES elements.

5.5.1.2 Reliability demonstration. A plan for demonstration of achieved reliability at contractually specified milestones, including planned number of test articles, accept/reject criteria, discrimination rationale, or the associated confidence or risk levels, shall be prepared and submitted to the Government procuring activity for consideration. The plan for demonstrating achieved reliability shall comply with the provisions of MIL-E-9426 and shall include the test procedures and the ground rules and criteria for deciding whether a test shall be classified as a success or as a failure, or whether the test shall be nullified due to invalid data, or other factors interfacing with the established test conditions as described in MIL-E-9426.

5.5.2 Subsystem and component tests. Prior to commencement of the AAES Service Release Tests, subsystem and component test programs developed and approved in accordance with MIL-E-9426 shall be conducted and implemented by the contractor and/or specified Government or independent test activity. All available component and subsystem test data and test results, including data and results obtained in other programs and accepted by the Government procuring activity in accordance with MIL-E-9426, shall be utilized to determine both the component/subsystem reliabilities and the constructed reliability in accordance with 4.1.1.2, herein. Test results of all individual tests and test series conducted within the reporting period, shall be reported in the quarterly report.

5.5.3 System reliability tests. The system service release (SRTs) performance tests (3.8.4.3.2.1 of MIL-E-9426) using the production configured AAES manufactured in accordance with production processes and procedures, specified in MIL-E-9426 shall be utilized to assess attainment of the specified reliability requirements for the AAES. Due to the destructive nature and expense of the AAES system tests, except as provided in 3.8.4.3.2.1 and 4.2 of MIL-E-9426, such tests shall not be conducted solely for the purpose of statistically demonstrating compliance with 4.1 without the written prior approval of the Government procuring activity.

5.6 Maintainability demonstration tests. The contractor shall prepare and submit to the Government procuring activity for approval a maintainability demonstration test plan in accordance with MIL-STD-471 and this document. The maintainability demonstrations shall be coordinated and conducted in conjunction with, and shall utilize, the same personnel, equipment, materials, and facilities as required for the FMA evaluations. The demonstration plan shall be divided into two separate phases, each having three separate parts:

a. The phases shall be:

(1) Phase I will be conducted with an EPA configured escape system thirty days prior to the contractually required EPA. Early identification of design deficiencies, maintenance problems, and safety hazards will permit incorporation and verification of required corrective actions prior to system tests. Phase I evaluation results will be reported during the EPA review.

(2) Phase II will be conducted utilizing the PPA production configuration including SSE (Special Support Equipment) and contractually required documentation and will be divided into two parts.

b. The parts applicable to each of the phases shall be:

(1) Part "A" will include all maintenance that will be performed on the installed systems.

(2) Part "B" will include all maintenance tasks that will be performed on the AAES and AAES elements removed from the aircraft or in the shop.

(3) Part "C" will include evaluation of system susceptibility to malmaintenance through evaluator deliberate introduction of maintenance errors, misuse of tools and equipments, use of improper tools and equipments, misinstallation of parts, ommission of parts, etc.

The actual testing/evaluation shall be conducted in accordance with the Government procuring activity approved maintanability demonstration test plan by Government selected personnel having the requisite skills and skill levels. The results of these demonstration tests shall be evaluated by the contractor and reviewed by the Government procuring activity to determine whether the specified objectives of 4.1.2 have been met. A final report shall be submitted to the Government procuring activity.

5.7 Production proofing article and field maintainability review Article II approval. Reliability and maintainability approval of the production proofing article and field maintainability review Article II shall be by the Government procuring activity upon satisfactory completion and demonstration of all tests specified herein.

5.7.1 Service release. Failure of an AAES to achieve the herein specified maintainability and reliability requirements shall constitute grounds, as provided in MIL-S-18471, MIL-A-23121, MIL-A-81815 and MIL-E-9426 for the Government procuring activity to disapprove the AAES for service release and to require the contractor to undertake such additional design and/or testing as is required to achieve these requirements.

5.8 Quality conformance test. All tests of subsystems and components manufactured for production equipment shall provide assurance that the production AAES will comply with the reliability design requirement and shall be reviewed by the Government procuring activity. In addition, the data derived from all such testing shall be employed to track the reliability trend.

5.9 Status reports. The reliability and maintainability programs shall include the submission of quarterly and final status reports as specified by the Government procuring activity. The reports should provide a complete accounting of progress on elements defined by the reliability program plan, results achieved, and status of actions to resolve major problems and correct weak links. Charts may be included which compare objectives, minimum requirements, predictions, and the level of achieved reliability for the system, subsystem and equipments.

6. SUPPLEMENTAL INFORMATION

6.1 General. This section contains information of a general or explanatory nature and is intended for use by the Government only. No contractor requirements appear within this section.

6.2 Intended use. This standard is intended for incorporation in whole or in part, by reference or appendage to contracts and internally by the Naval Air System Command for aircrew automated escape systems operationally in use or being procured for future use.

6.3 Precedence of documents. When the requirements of the contract, this standard, or applicable subsidiary documents are in conflict, the following order or precedence shall apply:

a. The contract

b. The system or equipment detail specification

c. This standard. Any deviation from this standard, or from subsidiary specifications, where applicable, must be specifically approved in writing by the Government procuring activity.

d. Any reference document shall have precedence over all applicable subsidiary documents referenced therein. All referenced documents shall apply only to the extent specified.

6.4 Reports. Reports shall be provided to the Government procuring activity in accordance with the CDRL (DD Form 1423) and the following DID (Data Item Descriptions).

	DID NO.	DID TITLE	PARA. NO.
a.	UDI-R-21131	REPORT, RELIABILITY AND MAINTAINABILITY PROGRAM	5.2
b.	UDI-R-21132	RELIABILITY AND MAINTAINABILITY BLOCK DIAGRAM AND MATHEMATICAL MODELS	5.2.1
c.	UDI-R-21133	REPORT, RELIABILITY AND MAINTAINABILITY ALLOCATION	5.2.2
d.	UDI-R-21134	REPORT, RELIABILITY AND MAINTAINABILITY PREDICTION	5.2.3
e.	UDI-R-21140	REPORT, ANALYSIS, FAILURE MODES AND EFFECTS	5.2.4.1

	DID NO.	DID TITLE	PARA. NO.
f.	DI-E-5251	SINGLE FAILURE POINT SUMMARY	5.2.5
g.		MARGINALITY OF SUCCESS PLAN	5.2.6
h.		MARGINALITY OF SUCCESS REPORT	5.2.6.1
i.	UDI-R-21138	REPORT, ENVIRONMENT	5.2.7
j.	DI-R-1733	LIST, RELIABILITY QUALIFIED ITEMS	5.2.9.1
k.	DI-R-3547/ R-115-1	REPORTS, RELIABILITY AND MAINTAINABILITY ON COMMERCIAL EQUIPMENT	5.2.10
l.	UDI-R-21141	REPORT, FAILURE	5.3.1
m.	UDI-R-21139	REPORT, DEVELOPMENT AND PRODUCTION FAILURE SUMMARY	5.3.2
n.	UDI-R-21135	REPORT, RELIABILITY AND MAINTAINABILITY TEST PLAN	5.5
o.	UDI-R-21136	REPORT, RELIABILITY AND MAINTAINABILITY TEST RESULTS	5.5

6.5 Special information. Appendices A and B furnish general information concerning (1) reliability and factors which should be considered when formulating an AAES program reliability policy and (2) background information concerning the intent and function as well as information concerning the conduct of a marginality of success (MOS) program.

Preparing Activity
Navy-AS
(Project No. 1680-N447)

AIRCREW AUTOMATED ESCAPE SYSTEM
DESIGN EVALUATION PROGRAM EVENT FLOW SEQUENCE DIAGRAM

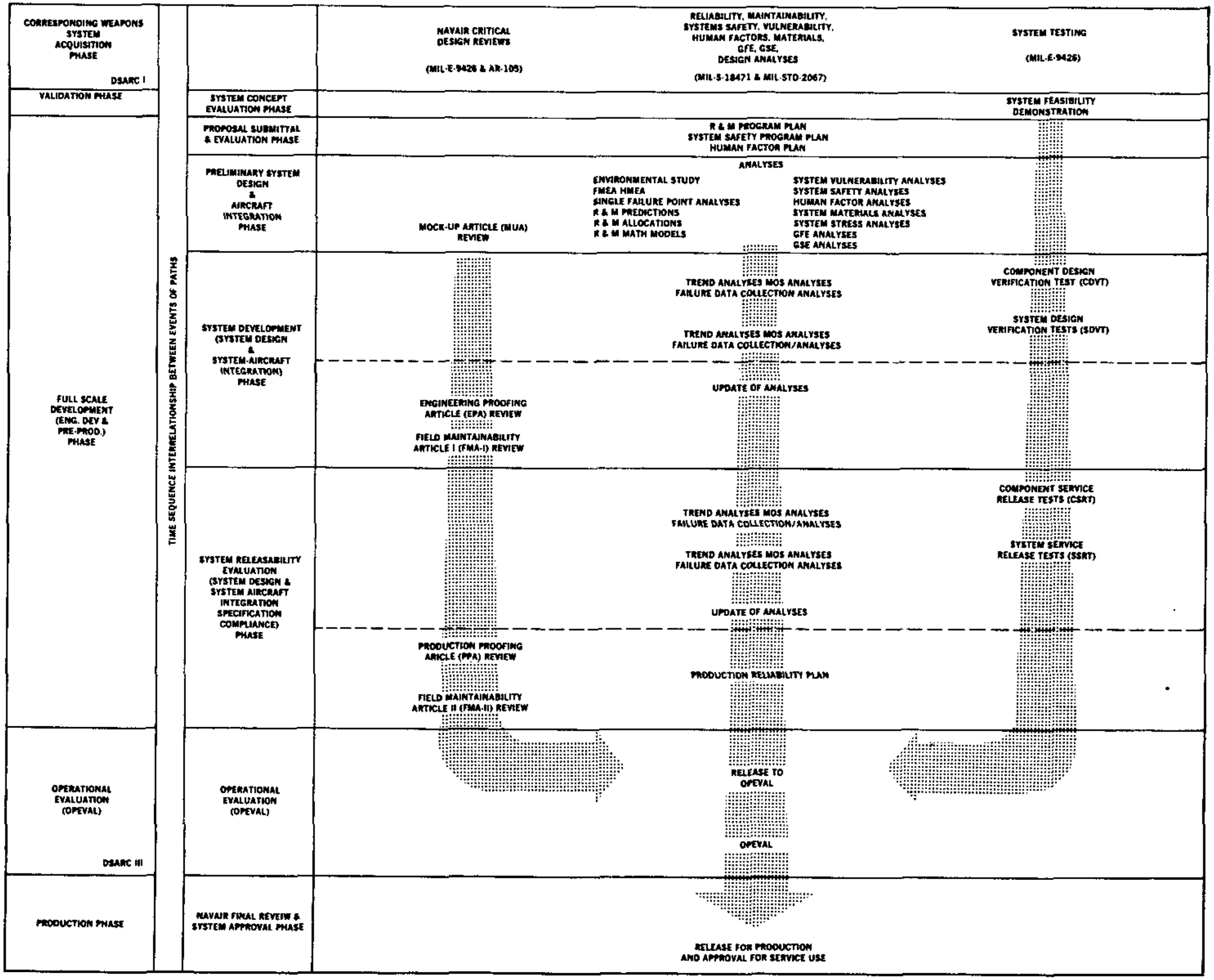


FIGURE 1

FMEA NO.	ITEM NOMENCLATURE AND PART NUMBER	FAILURE MODE	FAILURE CAUSE	OPERATING MODE		CRITI-CALITY	REMARKS	MAINTENANCE ACTION RATE
				ASSEMBLY FAILURE EFFECT	SYSTEM FAILURE EFFECT		FAILURE ELIMINATION & DETECTION	

FIGURE 2. Failure mode and effects analysis.

ITEM	PART NAME	PART NUMBER	FAILURE MODE OPERATIONAL	FAILURE CAUSE	FAILURE EFFECT	RATIONALE FOR ACCEPT-ABILITY	RECURRANCE CONTROL CORRECTIVE ACTION (DESIGN)

FIGURE 3. Single failure point summary.

PHASES OF MOS ACTIVITIES (I)

- PRE-TEST PLANNING
  - REVIEW "ILITIES" ANALYSES
    - ▲ POSSIBLE TEST CONDITION IMPACT UPON ARTICLE OPERATION
    - ▲ TYPES OF ARTICLE CONDITION CHANGES (TRANSITORY & PERMANENT)
      - ■ CORRECT OPERATION
      - ■ PARTIALLY INCORRECT OPERATION
      - ■ INCORRECT OPERATION
    - ▲ TYPES OF DATA NEEDED TO DOCUMENT ARTICLE CONDITION CHANGES
  - REVIEW MOS ARCHIVAL DATA
  - REVIEW TEST PLANS & DATA PROGRAM PLANS
    - ▲ TEST DATA ACQUISITION PROCEDURES & SYSTEM ADEQUACY
      - ■ TEST SET-UP DOCUMENTATION PLANS
      - ■ TEST DATA ACQUISITION SYSTEM
        - — — DATA PRIORITIES
        - — — BACK-UP DATA ACQUISITION
        - — — SYSTEM CHECK-OUT
        - — — SYSTEM CALIBRATION
      - ■ POST-TEST DATA ACQUISITION PLANS
        - — — TEST SITE PROTECTION/ACCESS CONTROL PLANS
        - — — TEST SITE SAFETY INSPECTION/DOCUMENTATION PLANS
        - — — MOS ON-SITE DATA ACQUISITION PROVISIONS
        - — — MOS TEST ARTICLE RECOVERY/TRANSPORT PROVISIONS

FIGURE 4.

PHASES OF MOS ACTIVITIES (II)

- TEST SITE
  - PRE-TEST
    - ▲ REVIEW TEST SET-UP DOCUMENTATION FOR ADEQUACY
      - ■ TEST ARTICLE PRE-TEST CONDITION/COMPLIANCE WITH PLAN
      - ■ TEST EQUIPMENT PRE-TEST CONDITION/COMPLIANCE WITH PLAN
      - ■ TEST SITE PRE-TEST CONDITION/COMPLIANCE WITH PLAN
    - ▲ REVIEW TEST DATA ACQUISITION SYSTEM DOCUMENTATION FOR ADEQUACY
      - ■ SYSTEM COMPLIANCE WITH PLAN
      - ■ SYSTEM CALIBRATION
  - POST-TEST
    - ▲ REVIEW TEST DATA ACQUISITION SYSTEM POST-TEST CALIBRATION CHECKS
    - ▲ CHECK TEST SITE SAFETY INSPECTOR DOCUMENTATION
      - ■ ELEMENTS DISTURBANCE DOCUMENTATION
        - — — ELEMENT IDENTIFIED
        - — — ELEMENT LOCATION & CONDITION DESCRIBED
        - — — NATURE OF DISTURBANCE DESCRIBED (I.E. MOVED, SAFETIED, ETC.)
      - ■ SITE DECLARED SAFE
    - ▲ CONDUCT ON-SITE DOCUMENTATION OF POST-TEST CONDITION OF ARTICLE, EQUIPMENT & SITE
      - ■ LOCATE MAP & IDENTIFY ALL ELEMENTS
      - ■ PHOTOGRAPH UNDISTURBED ELEMENTS
      - ■ DESCRIBE UNDISTURBED CONDITION OF ELEMENTS
      - ■ PREPARE ELEMENTS FOR TRANSPORTATION
        - — — DESCRIBE CHANGES OCCURRING IN ELEMENTS CONDITION

FIGURE 5.

PHASES OF MOS ACTIVITIES (III)

- POST-TEST INVESTIGATION
  - PRELIMINARY TEST ARTICLE POST-TEST CONDITION DESCRIPTION
    - ▲ PREPARE UTILIZING ALL PRE-TEST & ON-SITE DOCUMENTATION
    - ▲ IDENTIFY ALL KNOWN ANOMALIES
      - ■ TRANSITORY CONDITIONS & CONDITION INTERRELATIONSHIPS
      - ■ PERMANENT CONDITIONS & CONDITION INTERRELATIONSHIPS
    - ▲ IDENTIFY ALL KNOWN NON-ANOMALOUS CONDITIONS
    - ▲ DEVELOP TEST ARTICLE AUTOPSY PLANS & SUPPORTING RATIONALE
      - ■ TO EXPLORE ANOMALOUS CONDITIONS IN DEPTH
      - ■ TO DOCUMENT PRESENCE/ABSENCE OF PREVIOUSLY EXPERIENCED ANOMALIES
    - ▲ AUTOPSY PLAN REVIEW
      - ■ DESIGNERS
      - ■ "ILITIES"
      - ■ MANUFACTURING
      - ■ QUALITY ASSURANCE
      - ■ PROGRAM MANAGEMENT
  - CONDUCT TEST ARTICLE AUTOPSY
    - ▲ STEP-BY-STEP DOCUMENTATION OF PROCEDURES FOLLOWED/CONDITIONS OBSERVED
  - CONDUCT ANALYSIS OF DATA
    - ▲ ARCHIVAL REFERENCE FOR PAST EXPERIENCE
    - ▲ ASCERTAIN MOST LIKELY SETS OF CONDITIONS & SEQUENCES OF EVENTS LEADING TO OBSERVED DATA
  - PREPARE PRELIMINARY MOS REPORT

FIGURE 6.

PHASES OF MOS ACTIVITIES (IV)

- MOS REVIEW
  - MOS REVIEW BOARD
    - ▲ COMPOSED OF REPRESENTATIVES OF
      - ENGINEERING
      - "ILITIES"
      - MANUFACTURING
      - PURCHASING
      - QUALITY ASSURANCE
      - TESTING
      - MOS INVESTIGATOR
    - ▲ IDENTIFY
      - PROBABILITY OF ANOMALY OCCURRENCE
      - ANOMALY CONSEQUENCE POTENTIAL SEVERITY
      - COST TO FIX
      - TIME TO FIX
      - NEED FOR, COST & TIME FOR, AND TYPE OF ADDITIONAL INVESTIGATION
    - ▲ FINALIZE REPORT
      - IDENTIFYING ALL OBSERVED ANOMALIES WHETHER UNDERSTOOD OR NOT
      - IDENTIFYING ALL RECOMMENDED ADDITIONAL INVESTIGATION
      - IDENTIFYING ALL FINDINGS CONCERNING OBSERVED ANOMALIES
      - INCLUDING ALL RECOMMENDATIONS CONCERNING REMEDIAL ACTIONS
  - PROGRAM MANAGEMENT/CORPORATE REVIEW
    - ▲ CONTRACTUAL SCOPE
    - ▲ IMPLEMENTATION DECISIONS
    - ▲ REFERRAL DECISIONS
  - GOVERNMENT PROCURING AGENCY OR DESIGNEE REVIEW

FIGURE 7.

PHASES OF MOS ACTIVITIES (V)

- ARCHIVAL
  - IDENTIFY PARTS CONTAINING ANOMALIES & RETAIN FOR PROGRAM
  - IDENTIFY ALL OTHER PARTS & HOLD IN REFERENCE RESERVE
    - ▲ NON-PERMANENT (HOLD FOR SEVERAL TESTS)
    - ▲ HELD IN EVENT NEW ANOMALY OBSERVED IN LATER TEST
  - INITIATE ANOMALY TRACKING SYSTEM
    - ▲ UPDATE AFTER EACH TEST
    - ▲ RECORD MARGIN BY WHICH ELEMENT/SYSTEM FAILURE AVOIDED
  - MAINTAIN FAMILIAL DATA SYSTEM
    - ▲ UPDATE AFTER EACH TEST
    - ▲ RECORD TRENDS AND/OR STATISTICAL RELATIONSHIP TO FAILURE LIMITS

FIGURE 8.

APPENDIX A

RELIABILITY: ITS ACHIEVEMENT AND QUANTIFICATION

Reliability is considered to be an inherent feature of a product's design, as much so as its weight, size or shape. It represents an expression of confidence in the design of a product since reliability is the probability that the product will function in a manner that satisfactorily accomplished the product's specific mission.

Problems, however, arise when attempting to quantify a product's reliability since unlike physical features, i.e. weight, size or shape, it can neither be seen nor measured directly. Accordingly, a product's reliability must be quantified through estimations. And since reliability is an inherent feature of a product's design, achievement of desired/required high levels can be assured only through deliberate efforts to introduce reliable design from the beginning by thorough, continuing systematic product design analysis and the employment of techniques known to produce reliable designs.

The process of reliability estimation starts during the conceptualization of a product and continues throughout the product's development, evaluation and service. The function of the earliest reliability estimates is to assist the designer by indicating the reliabilities that the product's elements must have if the full product is to have a specific desired/required reliability. This iterative estimation process is accomplished through block diagramming the product by elements operating along functional trains (Figure A-1) and then allocating the product reliability downward to each of the elements along the trains, successively tier by tier, mathematically.

Through this process a designer, using historical data, can determine for each element whether it is likely that the element can have the necessary reliability and, if not, whether a substitution or design modification is required to assure achievement of the full product desired/required reliability.

Among other often employed techniques available to designers for assuring reliable product design are various negative approaches in which failure is presumed, for instance:

(a) Fault Tree Analysis(FTA) In FTA, specific failures are presumed to occur and the design analyzer attempts to develop a logical sequence of events likely to occur with the design and capable of producing the presumed failure. In this approach the analyzer starts at the top and works downward toward the lowest element level analyzing the functional failures which must occur at successively lower element levels to produce specified failures at their next higher level in the functional trains (Figure A-2).

(b) Failure Modes and Effects Analysis (FMEA) In FMEA, specific failures are presumed to occur and the design analyzer attempts to develop a logical series of consequences (or effects) which could result from such a failure. In this approach the analyzer starts at the lower element levels analyzing how a presumed failure would affect successively higher tiers in the functional train of elements (Figure A-3).

(c) Single Point Failure Point Analysis SPFP In SPFP analysis, using information generated through the FTA and FMEA and separate design functional analyses, the design analyzer attempts to identify those design elements which, should they fail singly to perform their specific functions in an acceptable manner, will cause the product to fail its mission.

Combining the information generated through these review approaches, provides the designer means for ascertaining the location and nature of design changes and element substitutions necessary to assure achievement of highly reliable product designs.

A point often made, validly so, is that reliability cannot be tested into a design; it must be deliberately designed into that design. This becomes more apparent as one examines the function of testing in providing estimates of product reliability.

Testing generally is conducted to accomplish economically a multiplicity of roles: engineering checkout of design, verification of compliance with contractual parameter values, develoment of user and performance data, and demonstration of product reliability, for example.

In demonstrating product reliability, tests are employed to ascertain measures of how often the product functions in a manner assuring the satisfactory performance of specific missions and these measures, in turn, are employed in projecting estimates of the product's capability to continue to do so in future usages. As the tests of a series (N) are conducted an actual observed reliability (R_o) occurs where:

$$R_o = \frac{N_s}{N_T} = \frac{N_T - N_f}{N_T}$$

N_s is the number of successes experienced

N_T is the total number of tests conducted

N_F is the number of failures experienced

However, although this is an estimate of reliability of the product being tested (assuming that no design variances other then those associated with normal production tolerances are introduced in the series of test articles), it has major shortcomings. For instance, whenever a failure occurs, the actual observed reliability (R_o) is subject to large variations, sometimes quite significant in magnitude, particularly when the total numbers of tests (N) is small. Therefore, R_o represents a reliability estimate that may rise or fall often and rapidly especially when N_T is small (Figure A-4).

To reduce this problem of estimating the system true reliability (R_T), a statistical concept of confidence limits is employed in an effort to describe the probability that the R_T is bounded by the upper and lower reliability estimates ($R_{U.C.L.}$ and $R_{L.C.L.}$, respectively). That is:

$$R_{U.C.L.} \geqslant R_T \geqslant R_{L.C.L.}$$

For example, the lower single sided confidence limit $R_{L.C.L.}$ of 95 percent indicates that, based upon the data obtained, ielieved that 95 percent of the likely values of R_T are e or greater than $R_{L.C.L.}$ (Figure A-5). In a similar manner (Figure A-6), an $R_{U.C.L.}$, where the upper single sided confidence limit is 95 percent, represents a probability of 95 percent that the likely values of R_T are equal to or less than the $R_{U.C.L.}$. Thus, in these instances it is believed that the probability of R_T being less than $R_{L.C.L.}$ is no greater than 5 percent and the probability that the R_T being greater than $R_{U.C.L.}$ is no greater than 5 percent and the combined probability that R_T is either less than $R_{L.C.L.}$ or greater than $R_{U.C.L.}$ (Figure A-7) is no greater than 10 percent. This gives, then, a 90 percent probability that R_T is bounded by the combined $R_{L.C.L.}$ and $R_{U.C.L.}$ estimatFor zero failures, the relationship between confidence level and reliability is defined by the following mathematical expression (for binomial distribution which characterizes single shot devices and systems):

$$L.C.L. = 1 - R^N$$

where

L.C.L. is the lower confidence limit of the R estimates

R is the reliability estimate at the lower confidence limit

N is the number of tests conducted.

Manipulation of this expression permits evaluating a number of factors pertinent to demonstrating some level of reliability based upon testing. For example, assuming no failures during the testing:

(a) Where the L.C.L. is arbitrarily defined and N is known, the demonstrated system $R_{L.C.L.}$ may be calculated through

$$R_{L.C.L.} = e^{\frac{\ln(1-L.C.L.)}{N}}$$

where ln indicates natural logarithms
e is the base of natural logarithms.

(b) Where both L.C.L. and the $R_{L.C.L.}$ are arbitrarily defined, the number of tests (N) without failure necessary for demonstrating that $R_{L.C.L.}$ may be calculated through

$$N = \frac{\ln(1-L.C.L.)}{\ln(R)}$$

Table I presents a small sample of calculations of N. It is interesting to note the patterns, i.e. increasing L.C.L. from .90 to .99 doubles the N required and from .900 to .999 trebles the N required; while changing the $R_{L.C.L.}$ from .90 to .99 requires increasing N ten times, from .900 to .999 requires increasing N one hundredfold, and from .9000 to .9999 requires increasing N one thousandfold. As can be observed increasing either the L.C.L. or the $R_{L.C.L.}$ or both can exert a dramatic impact upon N.

Another important relationship is defined as follows:

$$P_f = 1-P_s = 1-R_T^N$$

Where P_f is the probability that at least one failure will occur in a series of tests.

P_s is the probability that the series of tests will be completed successfully (i.e. without any failures)

R_T is the true system reliability

N is the number of tests in the series

Thus, once the management decision is made concerning the acceptable level of risk of experiencing at least one failure during a specific series of tests (N), the minimum system R_T necessary to assure that the risk is no greater can be calculated through:

$$R_T = e^{\left[\frac{\ln(1-P_f)}{N}\right]}$$

Figure A-8 illustrates the R_T versus N relationship for specific values of p_f (P_f = 10%, 5%, 2% and 1%). To further illustrate this relationship, Figure A-9 shows the relationship between P_f and N for specific values of R_T (R_T = 90%, 95%, 98%, 99%, 99.5% and 99.9%).

From this information on reliability, goals representing trade-offs amongst risk of failure, cost, time, reputation,, damage, etc., can be made and the designer presented a specific system reliability goal representing a management optimization of these generally disparate factors.

Figure A-10 combines information calculated using these basic relationships:

(a) $$R_T = e^{\frac{\ln(1-P_f)}{N}}$$

(b) $$R_{L.C.L.} = e^{\left[\frac{\ln(1-L.C.L.)}{N}\right]}$$

and demonstrated the very large differential existing between the system R_T necessary to assure a risk of failure no greater than 10 percent during N tests and the maximum R achievable for specific values of L.C.L. (L.C.L. = 90%, 95%, 98% and 99%) in the case where N tests are completed without failure. From this comparison, it should be readily apparent that reliability can only be designed into a product and cannot be tested into a product.

Referring to Figure A-11 depicting the interrelationship between L.C.L. and demonstrated $R_{L.C.L.}$ when N is given (assuming no failures) and remembering the function of the L.C.L. in defining the probability that R_T is greater than or equal to $R_{L.C.L.}$, it should be apparent that the demonstrated $R_{L.C.L.}$ is a direct function of the acceptable level of risk that R_T is, in fact, less than $R_{L.C.L.}$ rather than greater than or equal to $R_{L.C.L.}$. As that acceptable risk level declines (i.e. L.C.L. 100%), the demonstrated $R_{L.C.L.}$ must decline. As that acceptable risk level increases, however, (i.e. L.C.L. 0), the demonstrated $R_{L.C.L.}$ increases. It becomes very important, then in employing $R_{L.C.L.}$ estimates of R_T to understand the risk concept underlying the L.C.L. and to define deliberately the acceptable level of that risk, otherwise the $R_{L.C.L.}$ merely becomes a meaningless numbers game.

From the preceing, it should be apparent that an understanding of a stated specific $R_{L.C.L.}$ requires an appreciation of several important relationships, among the more critical of which are:

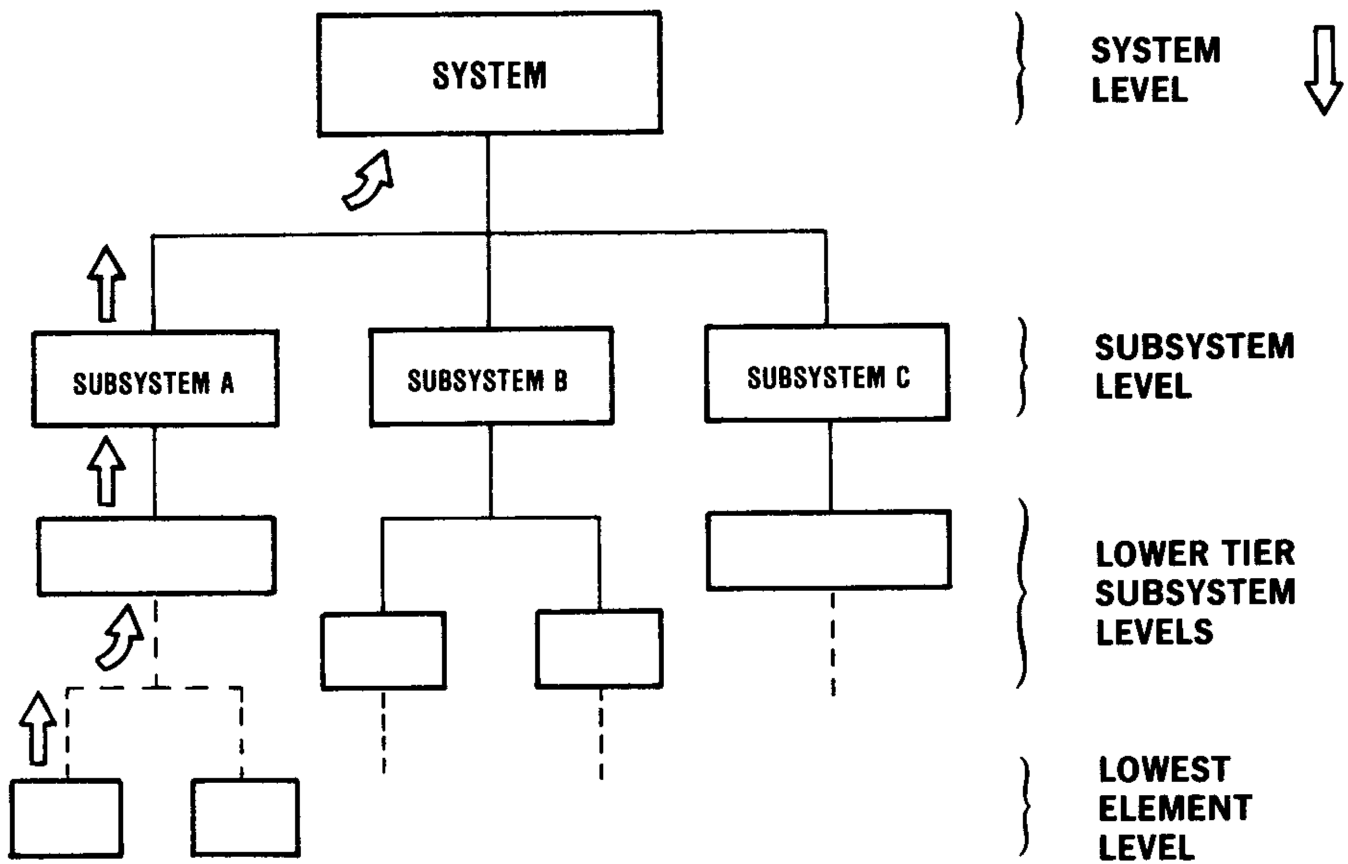
(a) Degree of risk accepted that the system R_T is not bounded by the demonstrated $R_{L.C.L.}$ and $R_{U.C.L.}$

(b) Degree of risk accepted that within a specific series of tests (or uses) there will be experienced one or more failures.

(c) The actual observed system reliability as a direct function of failures experienced within a specific series of tests.

Finally in evaluating system reliability, it must be borne constantly in mind that all of the measures employed to quantify the system reliability are but estimates of R_T predicated upon specific assumptions and ground rules acceptable to specific individuals and organizations. Others approaching the estimating task with different assumptions and ground rules can expect to obtain quite different estimates.

BLOCK DIAGRAM



NOTE:
ARROWS (⇨) DEPICT ONE OF THE FUNCTIONAL TRAINS

FIGURE A-1

FTA

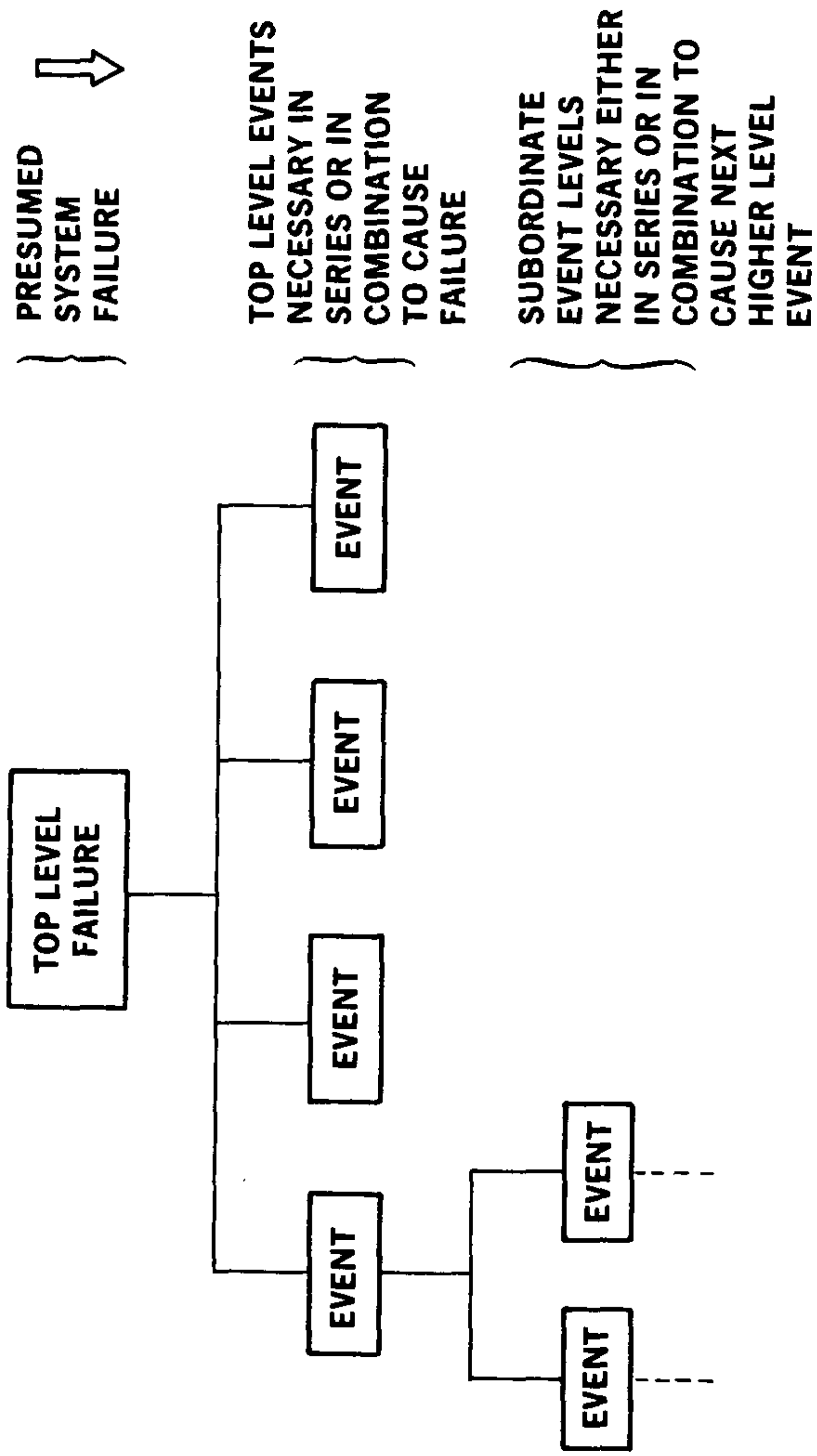


FIGURE A-2

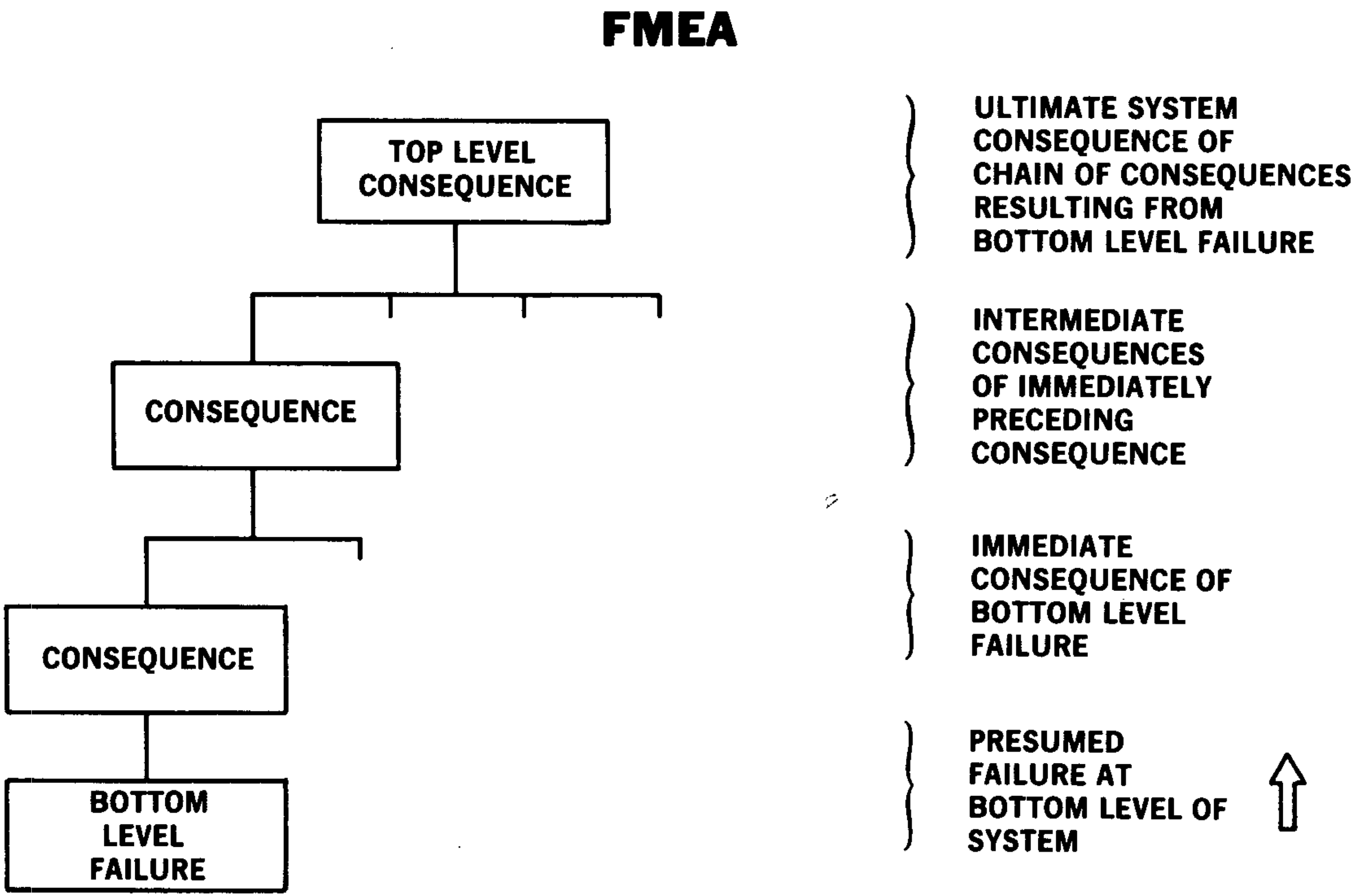
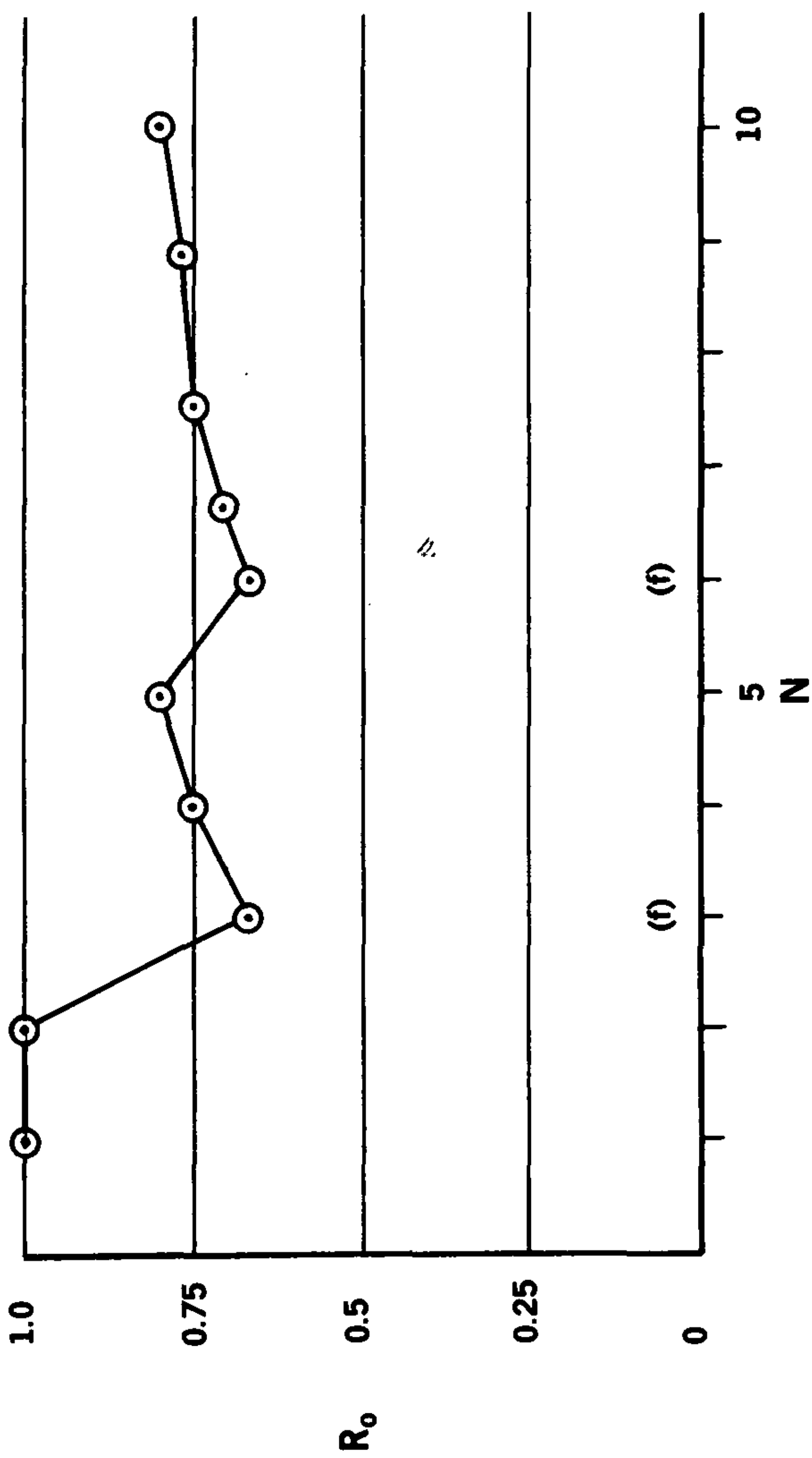
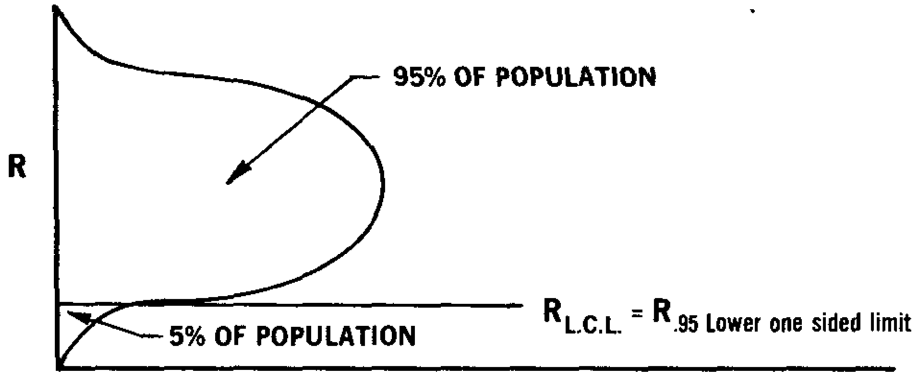

FMEA
TOP LEVEL CONSEQUENCE
CONSEQUENCE
CONSEQUENCE
BOTTOM LEVEL FAILURE
ULTIMATE SYSTEM CONSEQUENCE OF CHAIN OF CONSEQUENCES RESULTING FROM BOTTOM LEVEL FAILURE
INTERMEDIATE CONSEQUENCES OF IMMEDIATELY PRECEDING CONSEQUENCE
IMMEDIATE CONSEQUENCE OF BOTTOM LEVEL FAILURE
PRESUMED FAILURE AT BOTTOM LEVEL OF SYSTEM

FIGURE A-3



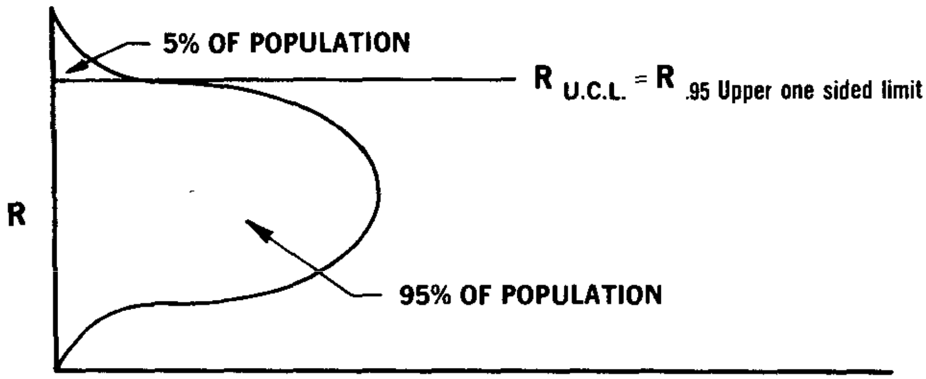
Effect of Failures (f) on R_o

FIGURE A-4



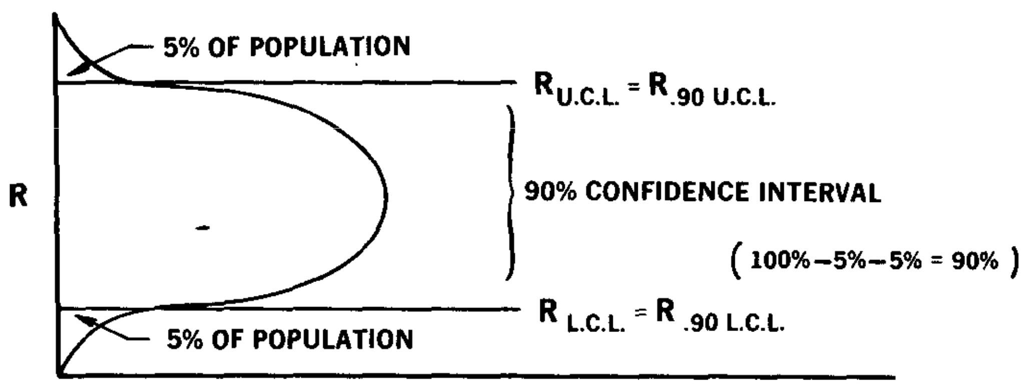
LOWER ONE SIDED LIMIT

FIGURE A-5



UPPER ONE SIDED LIMIT

FIGURE A-6



COMBINED LOWER AND UPPER ONE SIDED LIMITS WITH LOWER AND UPPER CONFIDENCE INTERVAL LIMITS

FIGURE A-7

TABLE I
NUMBERS OF TESTS WITHOUT ANY FAILURES NECESSARY TO DEMONSTRATE SPECIFIC LOWER CONFIDENCE LEVEL RELIABILITIES

L.C.L. \ R_D	.90	.95	.98	.99	.995	.999	.9995	.9999
.90	22	45	114	230	460	2,301	4,604	23,025
.95	29	59	149	298	598	2,994	5,990	29,956
.99	44	90	228	458	919	4,603	9,208	46,050
.995	51	104	263	527	1,057	5,296	10,594	52,981
.999	66	135	342	688	1,379	6,905	13,813	69,075

Where $N = \frac{\ln (I-C.L.)}{\ln R}$

TRUE SYSTEM RELIABILITY NECESSARY TO ASSURE SPECIFIC MINIMAL (NOT TO EXCEED) LEVELS OF P_f (PROBABILITY OF FAILING TO COMPLETE A TEST SERIES (N) SUCESSFULLY)

$$R_T = e^{\frac{\ln(1-P_f)}{N}}$$

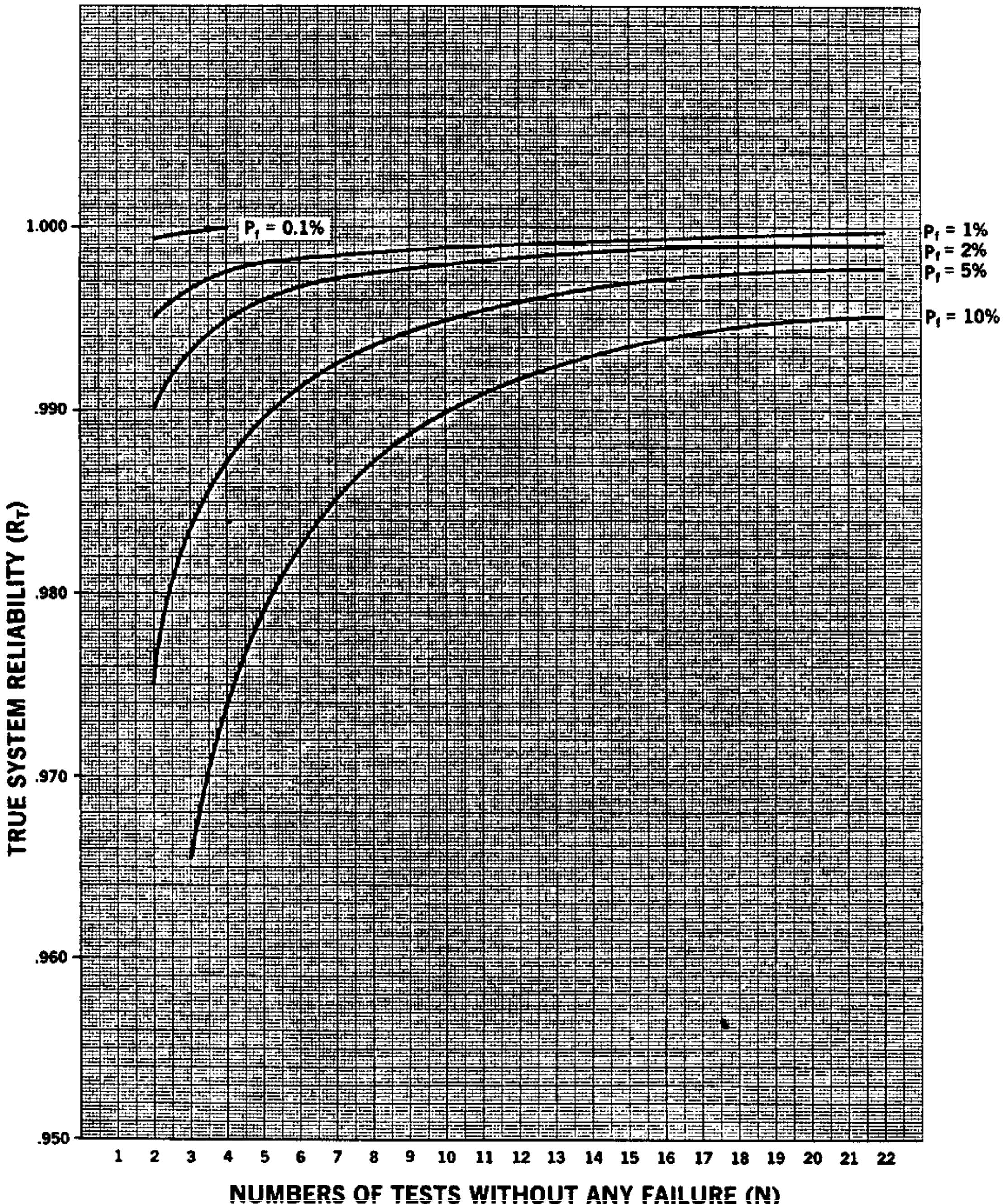


FIGURE A-8

PROBABILITY OF FAILING TO COMPLETE SUCCESSFULLY A SERIES OF N TESTS FOR GIVEN TRUE SYSTEM RELIABILITIES

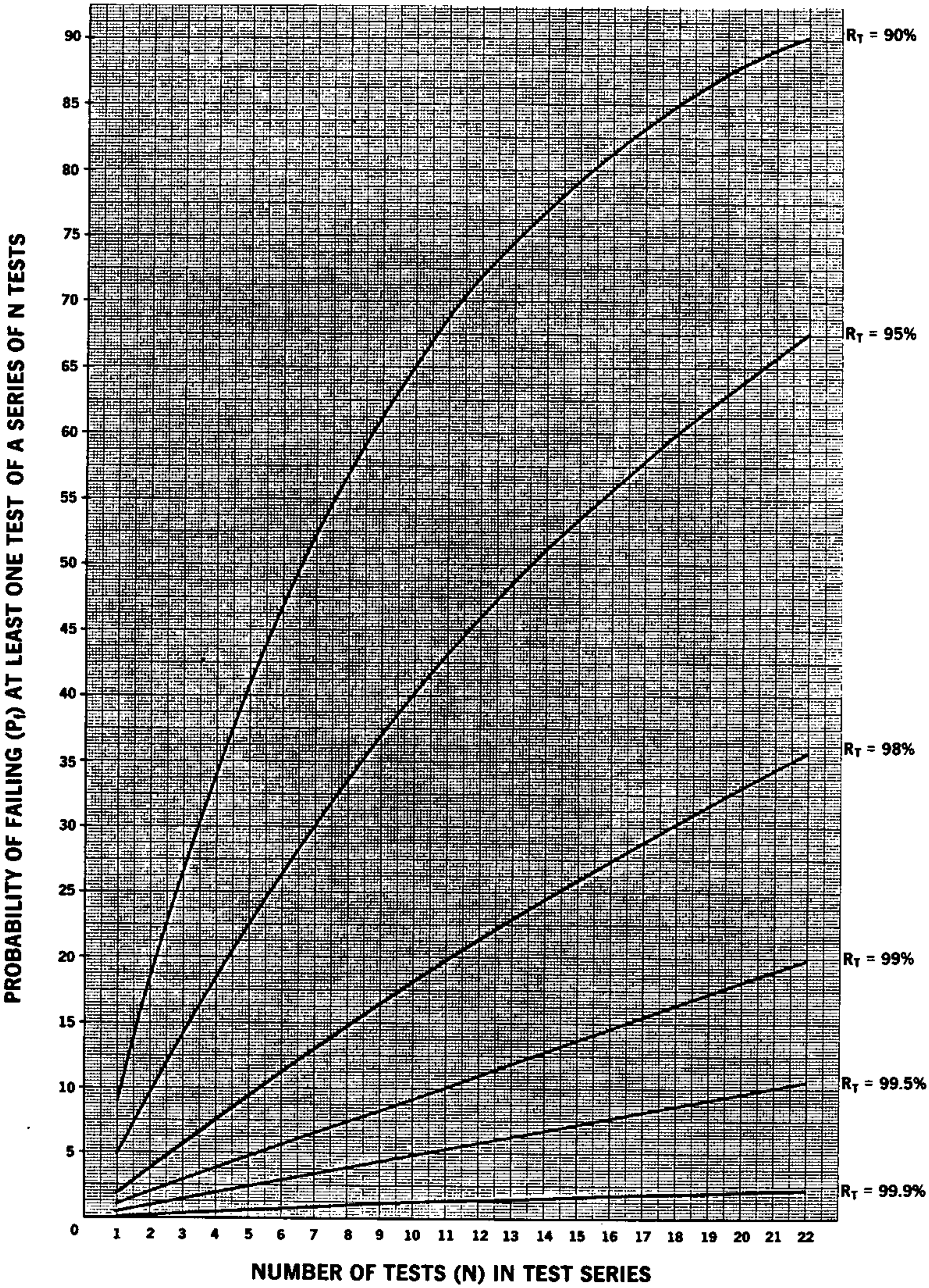
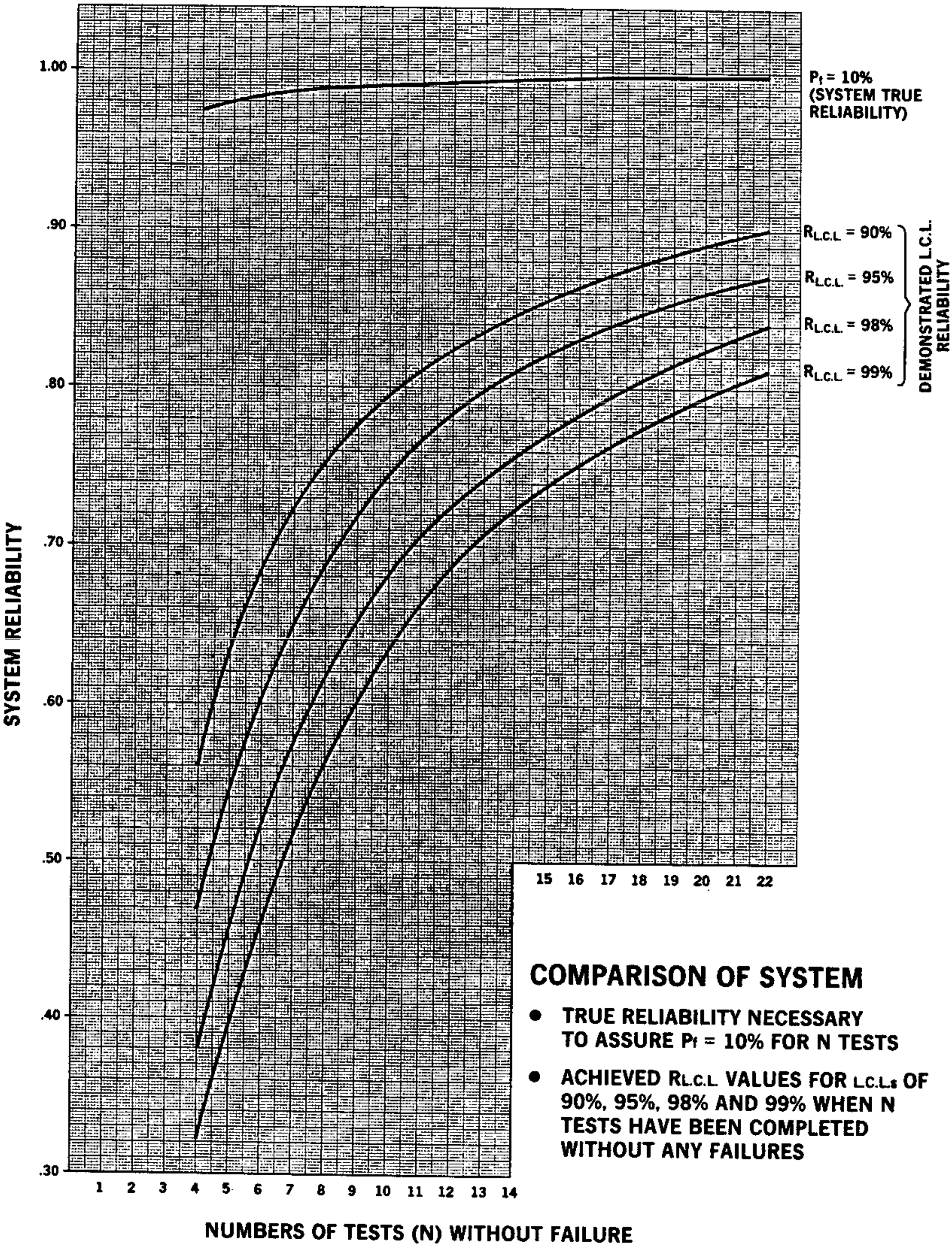


FIGURE A-9



COMPARISON OF SYSTEM

- TRUE RELIABILITY NECESSARY TO ASSURE P_f = 10% FOR N TESTS
- ACHIEVED $R_{L.C.L.}$ VALUES FOR L.C.L.s OF 90%, 95%, 98% AND 99% WHEN N TESTS HAVE BEEN COMPLETED WITHOUT ANY FAILURES

FIGURE A-10

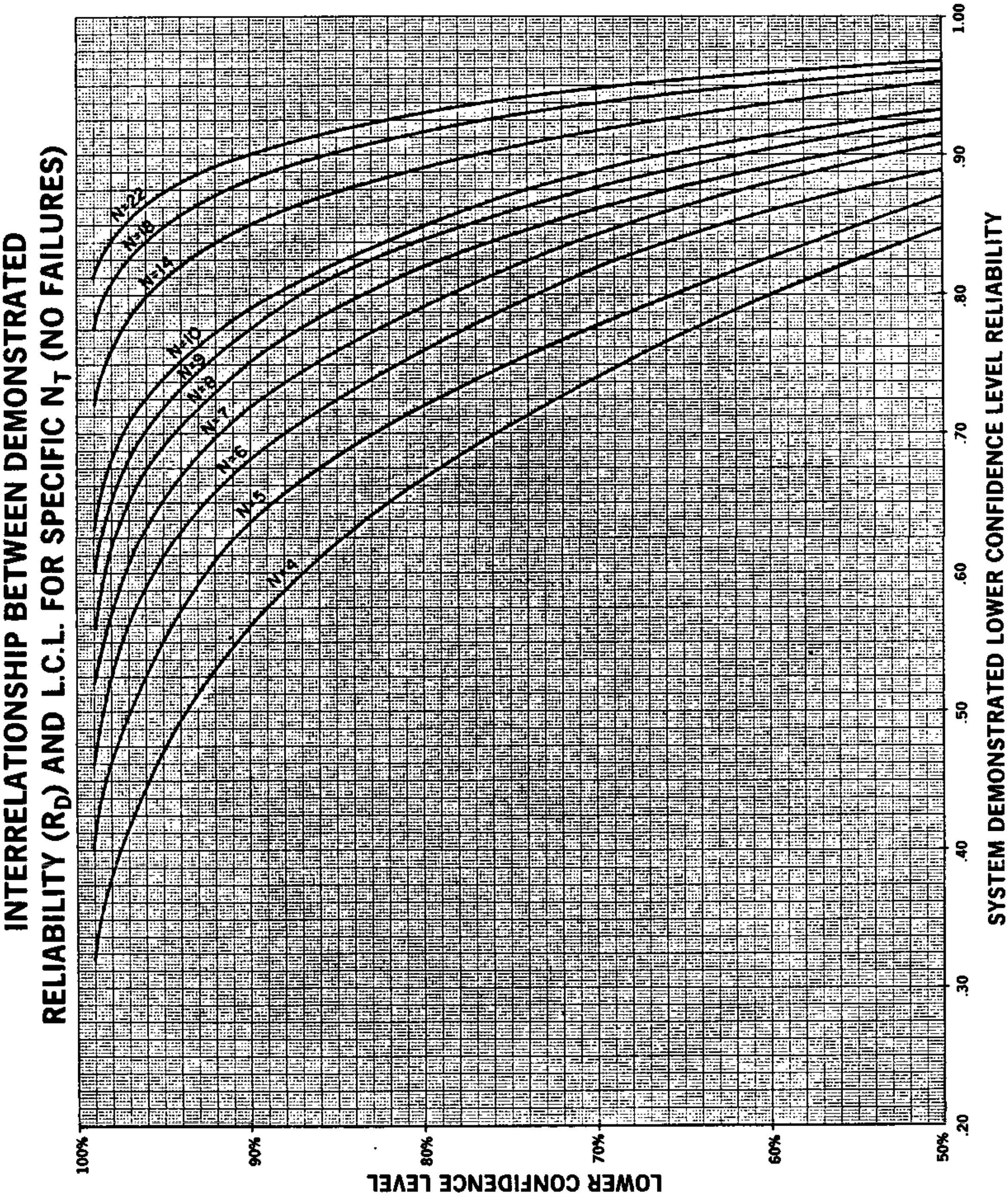

INTERRELATIONSHIP BETWEEN DEMONSTRATED
RELIABILITY (R_D) AND L.C.L. FOR SPECIFIC N_T (NO FAILURES)
N=22
N=18
N=14
N=10
N=9
N=8
N=7
N=6
N=5
N=4
SYSTEM DEMONSTRATED LOWER CONFIDENCE LEVEL RELIABILITY
.20
.30
.40
.50
.60
.70
.80
.90
1.00
LOWER CONFIDENCE LEVEL
100%
90%
80%
70%
60%
50%

FIGURE A-11

APPENDIX B

MARGINALITY OF SUCCESS

In every test, whether successful or not, there occurs a myriad of observable results or consequences, whether in fact observed or not, usually manifesting themselves in the form of either changed or unchanged conditions of the test article, test equipment and/or test site. Some of these results or consequences are transitory, occurring but briefly before being changed again, sometimes in ways which obliterate many or all traces of intermediate conditions and frequently in ways precluding post-test observations revealing exact sequences and interrelationships among the intermediate and final conditions.

The task of the marginality of success (MOS) investigator is to observe and record faithfully, or to assure the faithful observation and recording, of these results or consequences and, then, to ascertain the most probable sets of conditions and sequences of events (condition changes) leading to those results observed.

Thus MOS in fact begin long before a test actually is conducted to assure that transitory conditions likely to occur during a successful or during an unsuccessful test are anticipated and that adequate provision has been made for their faithful observation and recording. During the pre-test period the MOS investigator must examine completely both the results of "ilities" analyses performed upon the article to be tested and the test planning to assure that the analyses appear complete and that the test planning has taken into account and benefited from the results of the "ilities" analyses particularly concerning test condition impact upon test article condition changes, both transitory and permanent. The MOS investigator must ensure that test planning ensures adequate post-test site protection to permit observing and recording the post-test undistrubed in site condition, location and interrelationships of the test article, test equipment and test site.

Immediately following a test, the initial task of the MOS investigator is the thorough, careful observation of the undisturbed in sites condition, both changed and unchanged, of the test article, test equipment and test site. The scope of this effort includes such post-test tasks as assuring proper observation and recording of test data acquisition equipment calibration, as well as a thorough, careful examination of the test article, test equipment and test site. Following completion of the in-site observation and recording task, the MOS investigator should identify (permanently, if possible) and transport to a controlled-access post-test investigation laboratory the test article with care given to prevent condition changes resulting from handling and transportation. Occasionally, (usually in the case of a test article or test equipment failure), it may be necessary to treat test equipment in a similar manner to assure adequate data collection.

Prior to initiation of the second phase of observing and recording the test article final condition, the MOS investigator should conduct a preliminary analysis of all available data to ascertain which specific test article elements should be examined further, what conditions might be observed, how best to conduct the more detailed examinations, and the priorities for each planned detailed examination. Many of the detailed analyses may be pre-established procedures based upon pre-test MOS analyses planning and/or past experience, however, all such pre-planned detailed examinations should be reconsidered during this preliminary analysis. The results of this preliminary analysis along with all supporting rationale and all data should be presented to the responsible designers and "ilities" personnel for consideration and concurrence or recommendations before the detailed examinations are initiated.

Performance of the approved detailed examinations or the subsequent analysis of the recorded observations, may suggest either changes to the approved detailed examinations or additional detailed examinations which, prior to initiation, should be documented completely, reviewed and approved in a manner identical to that for the preliminary analyses. The only valid exception to the normal methodical approach, is when a detailed examination results in a transitory condition not subject to the control of the MOS investigator and requiring rapid follow-through to assure observing and recording the transitory condition and its results or consequences.

Upon completion of all observations of test article (and, if appropriate or reqiored, test equipment) condition, the MOS investigator must then analyze the data to ascertain the most probable sets of conditions and sequences of events capable of producing the observed conditions. This analysis along with complete supporting rationale and all data should be reviewed thoroughly and critiqued carefully by responsible design and "ilities" personnel. The result of the review may be to order either further MOS investigation, bench testing to corroborate preliminary findings or to assist in resolving uncertainties, modifications to the proposed MOS findings, or concurrence with the proposed MOS findings. Care must be exercised to ensure that the critiques do not become rubber stamp reviews since problems can emanate from correcting a non-existing problem or from not correcting an existing problem. Both situations can occur easily during an analysis, particularly when the investigator misunderstands aspects of designed operation.

Throughout the MOS process, the participants should bear in mind that the prime function of MOS is the identification of failures and incipient failures, their consequences, and their likelihood of occurrence so as to focus management attention upon the failures and incipient failures and to assist management make crucial resource allocation decisions.

INDEX OF PARAGRAPHS CITING SPECIFICATIONS BY SPECIFICATION NUMBER

REFERENCED SPECIFICATIONS NUMBER	REFERENCED SPECIFICATIONS TITLE	PARAGRAPH NUMBER	PARAGRAPH SUBJECT	PAGE
MIL-E-9426	Escape Systems, Requirements Conformance Demonstrations and Performance Tests for: General Specification for	3.2.3	First article	4
		4.2.1 b	System reliability demonstration	8
		4.2.2 a	System maintainability "	8
		4.2.2 b	System maintainability "	8
		5.2.6	Marginality of success analysis	14
		5.2.6.1	Marginality of success analysis	15
		5.2.7	Environmental study	16
		5.2.9	Parts and materials (Qualification)	17
		5.5.1	Reliability test plans	20
		5.5.1.1	Development testing	20
		5.5.1.2	Reliability demonstration	20
		5.5.2	Subsystem component tests	20
		5.5.3	System reliability test	21
		5.7.1	Service release	22
MIL-S-18471	System, Aircrew Automated Escape, Ejection Seat Type: General Specification for	4.1	Quantative design requirements	6
		4.3.1 k	General program plan requirements	10
		5.2.7	Environmental study	16
		5.4g	Reliability and maintainability interface compatibility	19
		5.7.1	Service release	22
MIL-A-23121	Aircraft Environmental, Escape and Survival Cockpit Capsule System, General Specification for	4.1	Quantative design requirements	6
		5.2.7	Environmental study	16
		5.7.1	Service release	22
MIL-A-81815	Aircrew Automated Escape Systems, General Specification for	4.1	Quantative design requirements	6
		5.2.7	Environmental study	16
		5.7.1	Service release	22
AR-30	Integrated Maintenance Management for Aeronautical Weapons, Weapon Systems, and Related Equipment	5.2	Reliability and maintainability programs	12

INDEX OF PARAGRAPHS CITING SPECIFICATIONS BY SPECIFICATION (Continued)

REFERENCED SPECIFICATIONS		PARAGRAPH		PAGE
NUMBER	TITLE	NUMBER	SUBJECT	
AR-105	Aircrew Automated Escape System In-process Design Conformance Procedures Evaluation of: Requirements for	4.2.2 a	System maintainability Demonstration	8
MIL-STD-280	Definitions of Item Levels, Item Exchangeability, Models, and Related Terms	3.1	General	4
		5.2.2	Allocations	13
MIL-STD-470	Maintainability Program Requirements	5.2	Reliability and maintainability programs	12
		5.2.3	Predictions	13
MIL-STD-471	Maintainability Demonstration	5.6	Maintainability demonstration tests	21
MIL-STD-721	Definition of Effectiveness	3.1	General	4
MIL-STD-756	Reliability Prediction	5.2.3	Predictions	13
MIL-STD-757	Reliability Evaluation from demonstration data	4.2.1 a	System block diagram constructed reliability	7
MIL-STD-780	Work Unit Code	5.3	Data Collection	19
MIL-STD-785	Reliability Program Requirements	5.2	Reliability and maintainability program	12
MIL-STD-882	System Safety Engineering of Systems and Associated Subsystems and Equipment	5.4 b	Reliability and maintainability interface capability	19
MIL-STD-1472	Human Engineering Design Criteria for Military Systems, Equipment and Facilities	5.4 a	Reliability and maintainability interface capability	19

INDEX OF PARAGRAPHS CITING SPECIFICATIONS BY SPECIFICATION (Continued)

REFERENCED SPECIFICATIONS		PARAGRAPH		PAGE
NUMBER	TITLE	NUMBER	SUBJECT	
MIL-STD-2070	Procedures for Performing a Failure Mode, Effects and Criticality Analysis for Aeronautical Equipment	5.2.4.1	Failure mode effect analyses	13
MIL-HDBK-217	Reliability Stress and Failure Rate Data for Electronic Equipment	5.2.3	Predictions	13
MIL-HDBK-472	Maintainability Prediction	5.2.3	Predictions	13
SD-24	General Specification for Design and Construction of Aircraft Weapon Systems	4.1	Quantative design requirements	6

INDEX OF CITED SPECIFICATIONS BY CITING PARAGRAPH

PARAGRAPH NUMBER	PARAGRAPH SUBJECT	PAGE	REFERENCED SPECIFICATION NUMBER	REFERENCED SPECIFICATION TITLE
3.1	General	4	MIL-STD-721	Definition of Effectiveness Terms
			MIL-STD-882	System Safety Engineering of Systems and Associated Subsystems and Equipment
			MIL-STD-280	Definitions of Item Levels, Item Exchangeability, Models, and Related Terms
3.2.3	First article	4	MIL-E-9426	Escape Systems, Requirements Conformance Demonstrations and Performance Tests for: General Specification for
4.1	Quantitative design requirements	6	MIL-S-18471	System, Aircrew Automated Escape Ejection Seat Type: General Specification for
			MIL-A-23121	Aircraft Environmental, Escape and Survival Cockpit Capsule System, General Specification for
			MIL-A-81815	Aircrew Automated Escape Systems, General Specification for
			SD-24	General Specification for Design and Construction of Aircraft Weapon Systems
4.2.1 a	System block diagram constructed reliability	7	MIL-STD-757	Reliability Evaluation from Demonstration data
4.2.1 b	Systems tests	8	MIL-E-9426	Escape System, Requirements Conformance Demonstrations and Performance Tests for: General Specification for
4.4.2 a	Maintenance actions		MIL-E-9426	Escape Systems, Requirements Conformance Demonstrations and Performance Tests for: General Specification for

INDEX OF CITED SPECIFICATIONS BY CITING PARAGRAPH (Continued)

PARAGRAPH NUMBER	PARAGRAPH SUBJECT	PAGE	REFERENCED SPECIFICATION NUMBER	REFERENCED SPECIFICATION TITLE
4.2.2 a	Maintenance actions	8	AR-105	Aircrew Automated Escape System In-process Design Conformance Procedures for Evaluation of: Requirements for
4.2.2 b	Maintenance-free life/cycle life		MIL-E-9426	Escape Systems, Requirements Conformance Demonstrations and Performance Tests for: General Specification for
4.3.1 a	General program plan requirements	9	MIL-STD-882	System Safety Engineering of Systems and Associated Subsystems and Equipment
4.3.1 k	General program plan requirements	10	MIL-S-18471	System, Aircrew Automated Escape, Ejection Seat Type: General Specification for
5.2	Reliability and maintainability programs	12	MIL-STD-785	Reliability Program Requirements
			MIL-STD-470	Maintainability Program Requirements
			AR-30	Integrated Maintenance Management for Aeronautical Weapons, Weapon Systems, and Related Equipment
5.2.2	Allocations	13	MIL-STD-280	Definitions of Item Levels, Item Exchangeability, Models and Related Terms
5.2.3	Predictions	13	MIL-STD-756	Reliability Prediction
			MIL-STD-470	Maintainability Program Requirements
			MIL-HDBK-472	Maintainability Prediction
			MIL-HDBK-217	Reliability Stress and Failure Rate Data for Electronic Equipment

INDEX OF CITED SPECIFICATIONS BY CITING PARAGRAPH (Continued)

PARAGRAPH NUMBER	PARAGRAPH SUBJECT	PAGE	REFERENCED SPECIFICATION NUMBER	REFERENCED SPECIFICATION TITLE
4.2.4.1	Failure mode effects analyses	13	MIL-STD-2070	Procedures for Performing a Failure Mode, Effects and Criticality Analysis for Aeronautical Equipment
5.2.6	Marginality of success	14	MIL-E-9426	Escape Systems, Requirements Conformance Tests for: General Specification for
5.2.6.1	Marginality of success analysis	15	MIL-E-9426	Escape Systems, Requirements Conformance Tests for: General Specification for
5.2.7	Environmental study	16	MIL-S-18471	System, Aircrew Automated Escape, Ejection Seat Type: General Specification for
			MIL-A-23121	Aircraft Environmental Escape and Survival Cockpit Capsule System, General Specification for
			MIL-A-81815	Aircrew Automated Escape Systems, General Specification for
			MIL-E-9426	Escape Systems, Requirements Conformance Demonstrations and Performance Tests for: General Specification for
5.2.9	Approved non-standard parts and materials	17	MIL-E-9426	Escape Systems, Requirements Conformance Demonstrations and Performance Tests for: General Specification for
5.3	Data collection	19	MIL-STD-780	Work Unit Code
5.4a	Reliability and maintainability interface capability	19	MIL-STD-1472	Human Engineering Design Criteria for Miltary Systems, Equipment and Facilities

INDEX OF CITED SPECIFICATIONS BY CITING PARAGRAPH (Continued)

PARAGRAPH NUMBER	PARAGRAPH SUBJECT	PAGE	REFERENCED SPECIFICATION NUMBER	REFERENCED SPECIFICATION TITLE
5.4 g	Reliability and maintainability	19	MIL-S-18471	System, Aircrew Automated Escape, Ejection Seat Type: General Specification for
5.5.1	Reliability test plans	20	MIL-E-9426	Escape Systems, Requirements Conformance Demonstrations and Performance Tests for; General Specifications for
5.5.1.1	Development testing	20	MIL-E-9426	Escape Systems, Requirements Conformance Demonstrations and Performance Tests for; General Specification for
5.5.1.2	Reliability demonstration	20	MIL-E-9426	Escape Systems, Requirements Conformance Demonstrations and Performance Tests for; General Specification for
5.5.2	Subsystem and component tests	20	MIL-E-9426	Escape Systems, Requirements Conformance Demonstrations and Performance Tests for; General Specification for
5.5.3	System reliability test	21	MIL-E-9426	Escape Systems, Requirements Conformance Demonstrations and Performance Tests for: General Specification for
5.6	Maintainability demonstration tests	21	MIL-STD-471	Maintainability Demonstration
5.7.1	Service release	22	MIL-S-18471	System, Aircrew Automated Escape, Ejection Seat Type: General Specification for
			MIL-A-81815	Aircrew Automated Escape Systems General Specification for

INDEX OF CITED SPECIFICATIONS BY CITING PARAGRAPH (continued)

PARAGRAPH		PAGE	REFERENCED SPECIFICATION	
NUMBER	SUBJECT		NUMBER	TITLE
			MIL-A-23121	Aircraft Environmental Escape and Survival Cockpit Capsule System, General Specifications for
			MIL-E-9426	Escape Systems, Requirements Conformance Demonstrations and Performance Tests for: General Specification for

INSTRUCTIONS: In a continuing effort to make our standardization documents better, the DoD provides this form for use in submitting comments and suggestions for improvements. All users of military standardization documents are invited to provide suggestions. This form may be detached, folded along the lines indicated, taped along the loose edge *(DO NOT STAPLE)*, and mailed. In block 5, be as specific as possible about particular problem areas such as wording which required interpretation, was too rigid, restrictive, loose, ambiguous, or was incompatible, and give proposed wording changes which would alleviate the problems. Enter in block 6 any remarks not related to a specific paragraph of the document. If block 7 is filled out, an acknowledgement will be mailed to you within 30 days to let you know that your comments were received and are being considered.

NOTE: This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

(Fold along this line)

(Fold along this line)

DEPARTMENT OF THE NAVY

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 12503 WASHINGTON D. C.

POSTAGE WILL BE PAID BY THE DEPARTMENT OF THE NAVY

Commanding Officer
Naval Air Engineering Center
Engineering Specifications & Standards
Department (ESSD) Code 93
Lakehurst, NJ 08733

(TO DETACH THIS FORM, CUT ALONG THIS LINE.)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR ☐ USER ☐ MANUFACTURER ☐ OTHER *(Specify)*: ______
b. ADDRESS *(Street, City, State, ZIP Code)*	

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

DD FORM 1426, 82 MAR — PREVIOUS EDITION IS OBSOLETE.