MIL-STD-1635(EC)
3 February 1978

MILITARY STANDARD

RELIABILITY GROWTH TESTING

FSC RELI
AMCS NO. 22333

DEPARTMENT OF DEFENSE
Washington, D.C. 20360

Reliability Growth Testing

MIL-STD-1635(EC)

1. This Military Standard is approved for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Electronic Systems Command, ATTN: 50431, Washington, D.C. 20360, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FOREWORD

Development of this standard is one of several steps designed to enhance equipment readiness and reduce life cycle costs. Reliability growth testing consists of conducting consecutive mission profile cycles under expected service environmental conditions. MIL-STD-781 is used as a guideline for establishing environmental test criteria and other engineering disciplines as appropriate. Comprehensive failure reporting, analysis, and corrective action are integral with this activity. This test program is intended for application in the full-scale development phase of equipment acquisition when the contractor can make design changes for reliability improvement without strict contractual constraints. A successful reliability growth test program may result in the deletion of reliability demonstration tests if reliability requirements are fully achieved prior to production commitment.

CONTENTS (continued)

CONTENTS

CONTENTS (continued)

TABLES

CONTENTS (continued)

FIGURES

APPENDIX A: NOTES ON DUANE RELIABILITY GROWTH MODEL AND AN ALTERNATIVE APPROACH OF MOVING AVERAGE

FIGURES

RELIABILITY GROWTH TESTS

1. SCOPE

1.1 General. This standard covers the requirements and procedures for reliability development (growth) tests. These tests are conducted during the hardware development phase on samples which have completed environmental tests prior to production commitment, and do not replace other tests described in the contract or equipment specification. These tests provide engineering information on the failure modes and mechanisms of a test item under natural and induced environmental conditions of military operations. Reliability improvement (growth) will result when failure modes and mechanisms are discovered and identified and their recurrence prevented through implementation of corrective action.

1.2 Application. This standard is applicable to Naval Electronic Systems Command procurements for development of all systems and equipment subject to contract definition and to the development of other systems and equipment when specified in the equipment specification. When contract definition is not involved, the application of this standard shall be as specified in the Statement of Work (SOW) incorporated in the request for proposal. The requirements and procedures herein shall also be used for Government in-house development of systems and equipment.

1.3 Classification. This standard is applicable to five broad categories of equipment, distinguished according to their field service applications:

Category 1 Fixed ground equipment
Category 2 Mobile ground vehicle equipment
Category 3 Shipboard equipment
A. Sheltered
B. Unsheltered
Category 4 Equipment for jet aircraft
Category 5 Equipment for turbo-prop and helicopter

1.3.1 Ground support equipment (GSE). This standard is applicable to procurements of GSE as specified in the equipment specification or contract. When GSE development is under a weapon system contract, the applicability of this standard to each recommended GSE end item will be determined by the procuring activity after the contractors' technical data and recommendation for reliability development testing have been assessed.

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

MILITARY

MIL-S-8512	Support Equipment, Aeronautical Special: General Specification for Design of
MIL-C-45662	Calibration System Requirement

STANDARDS

MILITARY

MIL-STD-280	Definitions of Item Levels, Item Exchangeability, Models, and Related Terms
MIL-STD-721	Definitions of Effectiveness Terms for Reliability, Maintainability, Human Factors, and Safety
MIL-STD-757	Reliability Evaluation from Demonstration Data
MIL-STD-781	Reliability Design Qualification and Production Acceptance Tests: Exponential Distribution.
MIL-STD-785	Reliability Program for Systems and Equipment
MIL-STD-810	Environmental Test Methods
MIL-STD-847	Format Requirements for Scientific and Technical Reports
MIL-STD-1629	Procedures for Performing a Failure Mode and Effect Analysis for Shipboard Equipment

HANDBOOKS

MILITARY

MIL-HDBK-217	Reliability Prediction of Electronic Equipment

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this standard to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AD-A005667	RADC-TR-75-22, RADC Non-electronic Reliability Notebook Revision (Part Failure Data, Section 2 of RADC-TR-69-458)

(Application for copies should be addressed to the National Technical Information Service, U.S. Department of Commerce, 5385 Port Royal Road, Springfield, VA 22151.)

3. DEFINITIONS

3.1 Terms. Meanings of terms not defined herein are in accordance with the definitions of MIL-STD-781, MIL-STD-721, MIL-STD-280, and MIL-STD-757.

3.1.1 Corrective maintenance (repair). The actions performed as a result of failure to restore an item to a specified condition.

3.1.2 Failure. Details involving failure criteria, to include required functions and performance parameter limits, as stated in the equipment specification and test procedures as approved by the procuring activity. For test purposes, the following general definitions shall apply:

a. Failure is an event in which a previously acceptable item does not perform one or more of its required functions within the specified limits under specified conditions.

b. Failure is also the condition in which a mechanical or structural part or component of an item is found to be broken, fractured, or damaged which would cause failure under operational conditions.

3.1.3 Observed mean-time-between-failures ($\hat{\theta}$). The observed mean-time-between-failures (MTBF) is equal to the total operating time of the equipment divided by the number of relevant failures.

3.1.4 Predicted MTBF (θ_p). Predicted MTBF (θ_p) is that value of MTBF determined by reliability prediction methods and is based on the equipment design and the use environment [and shall be equal to or greater than required MTBF (θ_R) in value to ensure with high probability that the equipment will be accepted during the reliability qualification test].

3.1.5 Predicted reliability. That reliability which is expected at some future date, postulated on analysis of the design and the failure rates or the probability of survival.

3.1.6 Problem. A condition of an item in which one or more characteristics do not conform to the requirements as established by the contract or equipment specifications without the use of unspecified handling or operating procedures. The condition cannot be corrected to specified requirements using controls and procedures normally available to the operator, therefore corrective maintenance and engineering disposition are required. Includes failures, unsatisfactory conditions, discrepancies, defects, and nonconformances.

3.1.7 Reliability growth. The positive improvement of the reliability of equipment through the systematic and permanent removal of failure mechanisms.

3.1.8 Corrective maintenance (repair). The actions performed as a result of failure, to restore an item to a specified condition.

3.1.9 Test, analyze, and fix (TAAF). A test procedure used during a development program to achieve reliability growth by testing the equipment under simulated use environments to induce failures due to weak design or inadequate parts. The failures are analyzed and fixed, that is, corrective action is taken for each failure to prevent recurrence.

4. GENERAL REQUIREMENTS

4.1 General. The reliability growth test is an integral part of a MIL-STD-785 reliability program and is a formal approach to the test, analyze and fix process of reliability growth. The reliability growth test shall be planned and conducted in accordance with the requirements herein to provide data for the evaluation of reliability growth.

4.2 Pre-reliability test requirements.

4.2.1 Prediction, analysis, and test plan. In accordance with the approved reliability program plan, the following items shall have been completed and approval obtained from the procuring activity prior to the initiation of reliability growth testing, unless specifically deleted by contract.

4.2.1.1 Reliability prediction. If directed by the procuring activity and if not already completed as required by other contractual documents, an updated reliability prediction of the test hardware configuration may be required prior to the start of reliability testing. The reliability prediction shall be completed in accordance with the Parts Stress Analysis Prediction paragraph of MIL-HDBK-217. A prediction shall be accomplished for each distinct mission phase or mode of operation of the test hardware. Failure rate data source shall be MIL-HDBK-217. Other failure rate data sources, including contractor in-house data, shall require procuring activity approval. The prediction report shall be approved by the procuring activity prior to the start of testing. Unless otherwise specified in the contract, testing shall not be initiated unless the design has a predicted MTBF (θ_p) equal to or greater than the required MTBF. In the event that the design proposed for testing does not meet this criteria, action shall be as directed by the procuring activity. Unless otherwise specified by the procuring activity, GFE is excluded from the FMEA.

4.2.1.2 Failure modes and effects analysis (FMEA). An FMEA shall be performed using procedures similar to MIL-STD-1629. The FMEA will indicate the critical areas of the design and help in the analysis of failures that may occur during the reliability growth test. Futhermore, the failures that occur and their symptoms and causes will help verify the completeness and accuracy of the FMEA, and can be used to update the FMEA. The results of FMEA are used to recommend changes in design, parts, materials, processes, testing, or procedures as early in the system development as possible, so that identified problems can be eliminated or their effects reduced. Although it is the objective of the FMEA to identify all modes of failure within the system, its first purpose is the early identification of all first-order or catastrophic failure possibilities so that modes can be eliminated or minimized through corrective design action at the earliest possible time. GFE is excluded from the FMEA, unless otherwise directed by the procuring activity.

4.2.1.3 Tests. The contractor shall determine the reliability growth (development) tests and obtain approval of these tests from the procuring activity prior to the commencement of testing. The tests shall be determined on the basis of requirements of the contract, equipment specification, and this document. Test planning should consider the time required for failure analysis, and the testing required to verify corrective action implementation. The test planning shall, as a minimum, include the following.

a. Test objective and requirements,

b. test item description and number to be tested.

c. test conditions, environmental, operational, and performance profiles, and the duty cycle.

d. reliability growth model and rationale.

e. test schedules and milestones, including the test program review schedule.

f. test conduct ground rules, failure criteria, and interface boundaries.

g. test facility and equipment descriptions and requirements,

h. data collection and recording requirements.

i. analysis requirements and methods of calculation.

j. Government Furnished Property (GFP) requirements and impact, and

k. description of preventive maintenance to be accomplished during test.

4.2.2 Reliability growth models. As part of the reliability growth test planning, the contractor shall generate a reliability growth model based on previous development programs for systems/equipment of the same type as will be developed under the new procurement. This is necessary to help determine the length of the reliability growth test period and to provide project management with a means of monitoring progress as the test proceeds. Unless otherwise specified, the growth model of 5.3 shall be used.

4.3 Test conditions and stress levels. Since the purpose of reliability growth tests is to induce failures to uncover weakness in design and components, the testing shall be done under the conditions likely to be encountered in field use. Therefore, the stress types and levels shall be selected using the mission and environmental profiles and operational requirements as guides. Typical detailed requirements for specific categories of equipment are given in Appendix B and E of MIL-STD-781 which cover the four types of test conditions, as specified in the Test conditions/levels paragraphs of MIL-STD-781. The test conditions/levels will be applied simultaneously, in so far as possible, and usually in a cyclic manner.

4.4 Test instrumentation and facilities. Test instrumentation and facilities used in conducting the tests shall be capable of providing or meeting the conditions of Appendix E of MIL-STD-781.

4.4.1 Tolerance of test conditions. Unless otherwise specified in the equipment specification, tolerance of test conditions shall be as follows:

a. Temperature: plus or minus 2°C (3.6°F)

b. Vibration amplitude: Sinusoidal, plus or minus 10%; random, as specified in MIL-STD-810 and MIL-STD-781.

4.4.2 Accuracy of test apparatus. The accuracy of instruments and other test equipment used to control or monitor the test parameters shall be verified periodically in accordance with the requirements of MIL-C-45662 and to the satisfaction of the procuring activity. All instruments and test equipment used in conducting the test shall:

a. Conform to laboratory standards whose calibration is traceable to the U.S. Bureau of Standards.

b. Have an accuracy of at least one-fourth the tolerance for the variable to be measured.

c. Be appropriate for measuring the conditions concerned.

4.5 Pre-test and post-test conditions. Unless otherwise specified herein, or in the equipment specification, all pre-test and post-test measurements and tests shall be performed at standard ambient conditions. Standard ambient conditions are:

Temperature	:	23° ± 10°C (73° ± 18°F)
Relative humidity	:	50% ± 30%
Atmospheric pressure	:	725 $^{+50}_{-115}$ mm Hg
		[28.5 + 50.8 mm (+2.0 in.) Hg; − 76.2 mm (−3.0 in.) Hg]

Whenever standard ambient conditions must be controlled in order to obtain reproducible results, the above shall be used with whatever tolerances are required to obtain the desired precision of measurement. Actual test conditions shall be recorded during the test period, whether controlled or not.

4.6 Performance of test.

4.6.1 Pre-test performance. Prior to conducting any test, the performance level of the test item shall be established under standard ambient conditions unless test circumstances totally preclude this. A record shall be made of all data to determine compliance with required performance and to provide reference labels or criteria for checking (when applicable) desired performance of the item during and at the conclusion of the test.

The pre-test performance check may be made after installation of the item in the test facility if installation conditions necessitate it. The conditions of this test will be standard ambient unless otherwise specified.

4.6.2 Performance during test. Operation of the test item is required during the specified test cycle and a record shall be kept of the data for comparison with pre-test and post-test performance. The conditions during the performance check shall be those specified in the equipment specification and defined in the test plan.

4.6.3 Post-test performance. Operation of the test item is required at conclusion of the test and a record shall be kept of the data for comparison with pre-test and during-test performance. The conditions of test will be standard ambient unless otherwise specified.

4.7 Failure recording, analysis, and corrective action system (FRACAS).

4.7.1 Closed-loop system. A closed-loop failure data collection, analysis, and corrective action system is an important part of the TAAF concept of the reliability development test. Therefore, the contractor shall have a comprehensive closed-loop system to identify, report, investigate, analyze, and correct all problems or failures that occur during the reliability development tests, and prevent recurrence of all problems or failures due to design deficiencies. GFE is excluded unless otherwise directed by the procuring activity. The contractor's existing failure reporting, analysis, and corrective action system may be utilized with minimum changes necessary to meet the requirements of MIL-STD-785 and this document. The system shall cover all test items and the interfaces between the test items and the test instrumentation and facilities, test procedures, test personnel, and the handling and operating instructions. The system shall provide for the activities of 4.7.1.1 through 4.7.1.6.

4.7.1.1 Problem and failure action. At the occurrence of a problem or failure that affects satisfactory operation of the equipment, the Failure Action paragraph of MIL-STD-781 shall apply.

4.7.1.2 Problem and failure reporting. The problem and failure reporting shall be in accordance with the Analysis of Failures paragraph of MIL-STD-781. The information to be determined shall include, but not necessarily be limited to, the following:

a. The test operator shall initiate the problem and failure report, recording information which will indicate symptoms of failure, test conditions at time of failure, and identification of failed equipment.

b. The contractor's repair activity shall obtain information for each independent and dependent failure and shall determine the extent of confirmation of the failure symptoms, identify the failures, and confirm all repair action taken.

c. Project or design engineering activity shall analyze and identify all part failures, analyze the equipment design, and the corrective engineering action taken. If no corrective engineering action is taken, then such action must be justified.

d. The contractor's reliability engineering activity shall review the analysis and the corrective action to ensure that reliability design is not degraded and revise the FMEA and reliability prediction, if necessary.

4.7.1.3 Classification of failures. All problems and failures shall be classified as specified in the Failure categories paragraph of MIL-STD-781 as relevant unless determined otherwise by the procuring activity.

4.7.1.4 Problem and failure investigation. All problems, malfunctions, and failures shall be investigated to determine cause of each equipment or part problem or failure, including Government Furnished Property included in or as a part of the test item. The investigation shall consist of any applicable method, including laboratory analysis, necessary to determine the cause of failure. (See 4.7.1.5 for GFE equipment.)

4.7.1.5 Corrective action. Corrective action shall be as specified in MIL-STD-781. Corrective action shall be developed and implemented for each problem or failure to prevent recurrence. Formal engineering change proposal procedures are not required but the procuring activity will review the corrective actions at the scheduled status reviews prior to implementation. In all cases, the failure analysis and the resulting corrective actions shall be documented by the contractor. The effectiveness of the corrective action should be demonstrated by testing under the same controlled conditions that existed when the original failure occurred. Approval shall be obtained from the procuring activity when GFE failures require corrective action (beyond repair or removal and replacement required).

4.7.1.6 Problem and failure tracking and close-out. The contractor shall include, as an integral part of FRACAS, a method of tracking problems and failures and corrective action implementation. The contractor's existing problem and failure tracking system may be used with minimum changes necessary to meet the requirements herein. The status and results of the corrective action for all problems and failures will be reviewed at the scheduled status reviews. Problem and failure closure technical decisions for each problem and failure shall be reviewed by appropriate contractor technical management personnel to assure adequacy of corrective and close-out action. Problem and failure close-out shall require, as a minimum, that:

a. Cause of problem or failure has been identified and understood.

b. all failed items have been repaired or disposition determined,

c. corrective action was taken to prevent or minimize the recurrence of the problem or failure,

d. if problem or failure is corrected by design change, that the change has been incorporated and tested proving its effectiveness,

e. an analysis was made to determine if any non-failed parts were overstressed and the over-stressed parts replaced, and

f. the problem and failure report close-out has been reviewed by cognizant technical and management personnel to ensure corrective and close-out action adequacy.

4.8 Test program reviews. The contractor shall perform test program reviews that shall be scheduled milestones throughout the reliability test program and shall be identified on the test schedules. Attendance at these reviews will include the procuring activity and contractor and their des-igated representatives. The procuring agency shall be notified at least ten days prior to the scheduled date to confirm the test program review. These reviews shall be documented by the contractor and included as an appendix to the Reliability Status Report.

4.8.1 Test readiness reviews. A test readiness review shall be planned and scheduled at least seven days prior to the start of any test to assure that the test item and all supporting elements are ready to begin test. The test readiness review shall include, to the extent applicable, the following:

a. Results of reliability prediction and analysis,

b. status of design and fabrication,

c. results of all applicable previous tests,

d. summary of the open problems and failure,

e. status of problem and failure closures,

f. availability of test procedures approved by appropriate personnel to indicate technical review,

g. status of previously assigned action items,

h. assignment of action items resulting from the review, and

i. conclusions of review (test start approval/disapproval).

4.8.2 Status reviews. Formal reviews shall be scheduled at preplanned milestones during the reliability development test to permit the contractor and procuring activity to review the status of testing including the results achieved. The status reviews shall be scheduled in accordance with the contract, usually monthly, and shall include, to the extent applicable, but not necessarily be limited to, the following:

a. Current reliability growth assessments and projections based on test results,

b. results of current problem and failure investigations and engineering analyses,

c. preventive and corrective action recommendations,

d. potential design problems based on the preventive and corrective action recommendations,

e. status of subcontractor and supplier, or both, reliability development tests,

f. status of previously assigned action items, and

g. assignment of action items resulting from the review.

4.8.3 Test completion review. A test completion review shall be scheduled at the completion of any test. This review shall be conducted to evaluate the results of the testing in compliance with the requirements of the contract, equipment specification, and this document. This review shall include, to the extent applicable, the following:

a. Current reliability growth assessments and achievements based on test results,

b. status of open problems and failures,

c. status of preventive and corrective actions,

d. status of previously assigned action items,

e. assignment of action items resulting from the review, and

f. conclusions of the review.

4.9 Reports. Reports shall be in accordance with MIL-STD-847 and MIL-STD-781.

4.9.1 Status report. The contractor shall prepare a status report in accordance with MIL-STD-781.

4.9.2 Failure summary report. The contractor shall prepare and maintain a failure summary report in accordance with MIL-STD-781.

4.9.3 Final report. The contractor shall prepare a final report in accordance with MIL-STD-781.

4.10 Government furnished property (GFP). Equipment, facilities, and material furnished by the government will be specified in the contract. Any GFP included in the equipment to be tested will be accompanied by applicable existing reliability test data.

4.11 Inspection. The contractor shall permit free access to his facilities for inspection of facilities and records by Procuring Activity personnel or its designated representative.

5. DETAILED REQUIREMENTS. The detailed requirements shall be as outlined in the equipment specification, the contract or order, or as specified herein.

5.1 Conditions preceding the reliability tests.

5.1.1 Functional and environmental tests. These tests provide a necessary complement to the reliability development tests and shall be completed prior to the start of the reliability development tests, unless otherwise specified by contract.

5.1.2 Thermal survey. A thermal survey shall be performed in accordance with the thermal survey paragraph of MIL-STD-781.

5.1.3 Vibration survey. A vibration survey shall be made prior to the initiation of the reliability growth test. The survey shall include vibration amplitude and frequencies expected in operational use (see the vibration test methods of MIL-STD-810.) The results of the vibration survey shall be documented and shall be an agenda item for the reliability growth test readiness review.

5.1.4 Reliability test procedures. The contractor shall determine the detail test procedures in accordance with the reliability test procedures paragraph of MIL-STD-781.

5.2 Test procedures and requirements.

5.2.1 Equipment performance and operation. The performance and operation requirements and the characteristics to be measured shall be in accordance with the equipment performance paragraph of MIL-STD-781. Equipment operation includes on-off, usage, and equipment input voltage cycling.

5.2.1.1 Equipment on-off cycling. The equipment on-off cycling is the number of times that equipment will be turned ON for preoperational checks on run-ups, plus the number of times turned ON and OFF from the completion of one operational mission to the completion of the next, in normal operational use. Additional on-off cycling for normal maintenance and repair is not included in this definition.

5.2.1.2 Equipment test cycle. The equipment test cycle (usage cycle or performance profile) is the time phase apportionment of modes of operation and function to be performed by the equipment from the completion of one operational mission to the completion of the next, in normal operational use. Test procedures shall be defined to exercise all specified modes of operation during each test cycle. Alternative test cycles or performance profiles, when applicable, may be specified in the equipment specification.

5.2.2 Performance parameters and tolerances. The electrical and mechanical performance outputs and characteristics to be monitored and measured during the test shall be specified in the equipment specification and described in detail in the test plan and test procedures and shall include the quantitative range of acceptable performance for each parameter. Any performance outside these limits will be recorded as a problem or failure, whether or not the equipment ceases to operate.

5.2.2.1 Monitoring. The specified performance parameters should be monitored in order to record problems or failures at any time they occur during the duty cycle. Periodic monitoring schemes appropriate to operational use may be used when approved by the procuring activity. Built-in test (BIT) included as part of the equipment design shall be used as part of the problem or failure detection method.

5.2.2.2 Measurements. Measurements shall be in accordance with the measurements paragraph of MIL-STD-781.

5.2.3 Environmental conditions. Unless otherwise specified, the environmental conditions and the combinations of environmental exposure types and levels to be applied during the test cycle, and their variance as a function of test time shall be as specified in the contract or equipment specifications and the test procedures. Appendix B of MIL-STD-781 discusses the test conditions for reliability qualification and acceptance tests, including the analyses necessary to establish conditions appropriate the the particular system or equipment.

5.2.4 Test cycle (typical). The general features of one complete test cycle, when temperature cycling is specified, are as specified in a through g and illustrated in FIGURE 1. Particular stress levels, rates and frequencies of change, and equipment ON-OFF and test cycles shall be specified in the equipment specification and described in the test plan and test procedure.

a. With test item and vibration OFF, cool chamber to lower temperature and allow equipment temperature to stabilize (cold soak).

b. When test item temperature has stabilized at lower temperature, turn equipment ON and perform specified number of preoperational checks.

c. Upon completing the preoperational checks, heat chamber to higher operating temperature with test item ON and vibration ON and commence specified test cycle for time specified, or if no time is specified for two hours. Unless otherwise specified in the equipment specification, the rate of chamber temperature change shall average 5°C/minute. When specified by the procuring activity, the chamber temperature shall be cycled between the upper and lower operating temperatures of the equipment during this portion of the test cycle at the specified rate and frequency of change.

d. Upon completing the test cycle period, turn test item and vibration OFF and allow test item temperature to stabilize at higher temperature (heat soak).

e. When test item temperature has stabilized, turn equipment ON and commence preoperational checks.

f. Upon completing specified number of preoperational checks, cool chamber to lower operating temperature with test item ON and vibration ON and commence specified test cycle for the time specified, or if no time is specified, for two hours. Unless otherwise specified, the rate of chamber temperature change shall average 5°C/minute. When specified by the procuring activity, the chamber temperature shall be cycled between the upper and lower operating temperature during this portion of the test cycle at the specified rate and frequency of change.

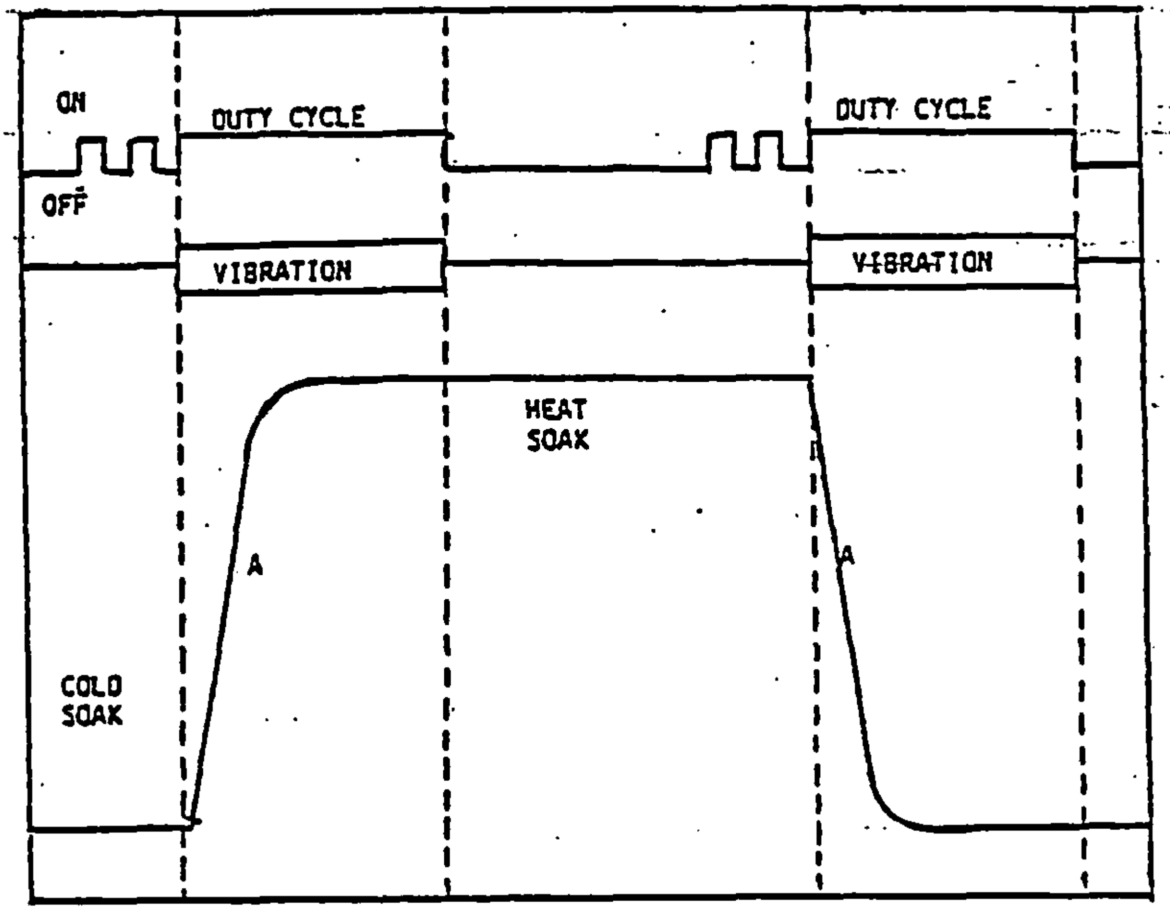
g. Upon completing the test cycle period, turn test item and vibration OFF and allow test item temperature to stabilize at lower temperature (cold soak). Repeat cycle from (a).

5.2.5 Test items. The test items for the reliability development test shall be preproduction equipment as defined in MIL-STD-280. GSE preproduction equipment must be representative of production equipments in design, materials, configuration, and workmanship execution in accordance with MIL-S-8512. Advanced development or engineering development equipment may be used when specifically authorized by the procuring activity. The number of items selected for test shall be based on equipment complexity, program needs, and the program schedule and shall be specified in the contract or equipment specification. Unless otherwise specified in the equipment specification, the number of items selected for testing shall be two and shall be described in the test procedure.

5.2.6 Test length. The total test time devoted to reliability growth testing shall be based on the reliability growth model, the experience of the contractor, and the quantitative requirements of the equipment's reliability specification. The test shall be a fixed length test and shall be approved by the procuring agency (as part of the test plan) before testing starts. It will be the maximum time expected to achieve the growth in the current reliability necessary to reach the predicted reliability (usually in terms of MTBF). Fixed length test times of 5 to 25 multiples of the required MTBF will generally provide a test length sufficient to achieve the desired reliability growth.

5.2.7 Installation of test item. Test item shall be installed in accordance with the Installation of Test Item in Test Facility paragraph in Appendix E of MIL-STD-781.

5.2.8 Testing the set-up. The equipment and the test facility shall be operated after test item installation to determine that the test set-up operates properly under the required test condition.



A. Rate of chamber temperature change shall average 5°C/minute unless otherwise specified.

FIGURE 1. Test cycle (typical).

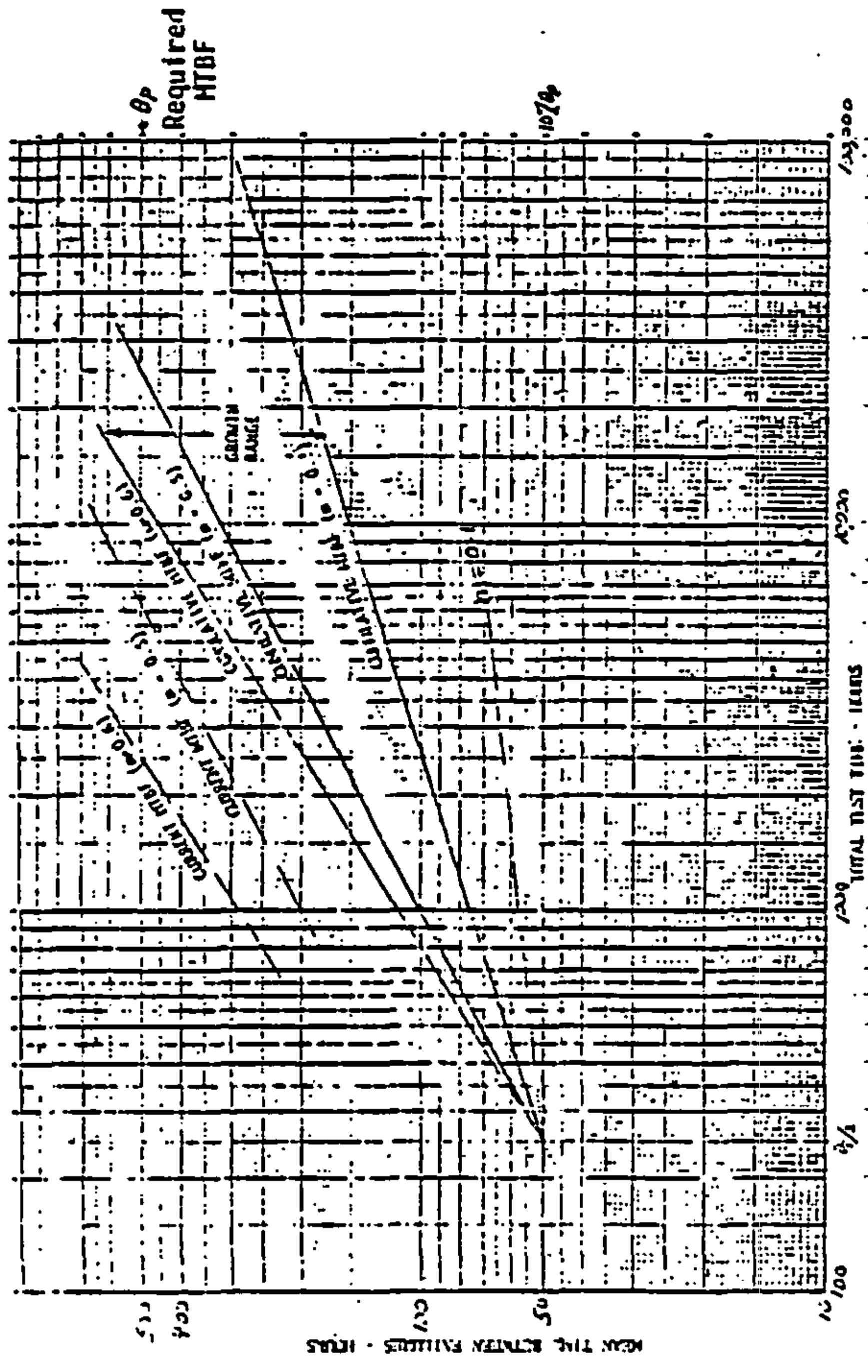


FIGURE 2. Reliability growth model.

5.3 Reliability growth model. The Duane[1/] reliability growth model shall be used in planning the TAAF program and as the basis for reliability growth measurement and projection. This model is based on the premise that, if corrective actions are implemented during the course of a development test program, the reliability growth (in terms of MTBF improvement) is approximately proportional to the square-root of cumulative test (operating) times. With MTBF plotted on log-log paper, using MTBF as the ordinate and cumulative test time as the abscissa, reliability growth approximates a straight line. The slope of the line, m, is a measure of the growth rate. FIGURE 2 illustrates the Duane reliability growth model. Referring to FIGURE 2, the probable range of reliability growth is represented by the two lines with m of 0.3 and 0.6, respectively. A lower slope than 0.3 would indicate a relatively poor failure corrective action plan and an m of 0.1 would represent no planned reliability growth program. A slope of 0.6 to 0.7 represents the maximum growth rate to be expected when strong failure analysis and corrective action implementation activities are carried out in conjunction with the test program. The growth rate that can be expected for a particular piece of equipment depends on the complexity of the hardware, the experience of the manufacturer in developing such hardware, and the efficiency of his failure analysis and corrective action system.

The steps in developing a reliability growth test model are:

a. Using two or three cycle log-log graph paper, draw horizontal lines at the required MTBF value and at the predicted MTBF value (θ_p)[2/], if the two values differ.

b. Plot growth curve start point at 100 test hours and 10 percent of predicted MTBF value (for MTBFs of 200 hours or less). If the θ_p is greater than 200 hours, the growth curve should start at a test time equal to 50 percent of the MTBF.

c. Draw line representing selected growth rate (which determines the slope of the line, m). The selected growth rate curve is considered the baseline against which reliability growth can be evaluated during the reliability development test. Appendix A discusses typical growth rates.

d. The intersection of the selected growth rate curve and required MTBF line yields an approximation of total test time required.

1/ E.O. Codier "Reliability Growth in Real Life", Proceedings, 1968 Annual Symposium on Reliability, New York: IEEE, Jan., 1968

2/ Some contractors establish an equipment design goal of 125 percent θ_s for the predicted value of MTBF.

During actual testing, cumulative values of MTBF versus cumulative test hours are plotted and compared with the selected growth rate curve. Assessment of the reliability growth is described in 5.4. In the event that no failures occur, an alternative would be to permit test termination at some fixed time such as when 90 percent confidence in the upper test MTBF is achieved. This point is reached at 2.3 times the upper test MTBF with zero failure. This alternative would necessitate adding a fourth acceptance condition to the three conditions listed in 5.4.1.

5.4 Reliability assessment. Reliability assessment shall be a continuing activity throughout the reliability program but during the reliability growth test period, it shall consist primarily of monitoring the reliability growth by comparing the achieved reliability progress with the planned reliability growth test model. As long as the achieved reliability growth corresponds favorably with the planned growth, as presented in the reliability growth test plan procedures, satisfactory performance may be assumed. If the growth is significantly less than planned (after enough data has been collected to establish a growth rate), a careful analysis must be made to determine the reasons for the poor performance. Probably an increased effort will be necessary to implement a corrective action plan. This plan shall be subject to approval by the procuring activity.

5.4.1 Reliability growth monitoring. The reliability growth shall be monitored throughout the test using a graphic plot of the observed MTBF expressed as a point estimate. The point estimate is the cumulative MTBF and is calculated by dividing the cumulated test time by the total of the failures that have occurred up to that time. The plot shall be made on the same graph as the reliability growth test model, described in 5.3. This plot shall not be adjusted by negating past failures because of present or future design changes. This curve shall be identified as Cumulative MTBF. The best fit (the method of least squares may be used) straight line through the first few (3 to 6) plotted MTBF points will establish the growth rate and can be compared directly with the planned growth line. The slope (m) of the best-fit straight line drawn through the plotted points represents the growth rate.

5.4.1.1 Reliability growth test conditions. The reliability growth test and its associated failure analysis and corrective action activity can be considered satisfactory if any of the conditions of a through c exist.

a. The plotted MTBF values remain on or above the planned growth line.

b. The best-fit straight line is congruent with or above the planned line.

c. The best-fit straight line is below the planned line but its slope is such that a projection of the line crosses the horizontal required MTBF line by the time that the planned growth line reaches the same point.

If none of the above conditions exist, it can be assumed that the planned reliability growth cannot be achieved with the current level of activity. This situation requires that a corrective action plan be generated and, after approval by the procuring activity, implemented. Before the corrective action plan can be determined, a careful analysis of the equipment design and related failures shall be accomplished to ascertain the problem areas and possible design modifications.

5.4.2 Current reliability. As the reliability growth test continues, the current MTBF growth line should be constructed and progress toward the predicted MTBF noted. The current MTBF is the cumulative MTBF divided by 1 - m. This line will parallel the best-fit cumulative MTBF line and indicate MTBFs at a factor of $\frac{1}{1-m}$ above the cumulative MTBFs. This will provide an indication of what the smoothed present reliability is at the current cumulative test time and will represent the probable value of MTBF if no further corrective action were implemented. Therefore, when the current MTBF reaches the predicted MTBF value, the reliability growth necessary to demonstrate the specified reliability at a reasonable confidence level, during a formal reliability demonstration test, has been achieved. If this occurs before the planned termination of the growth test, the procuring activity may approve an early termination date.

5.4.3 Alternative: moving average reliability assessment. A moving average of achieved reliability may be constructed by arranging the failure times (accumulated test times between failures) for the equipment on test in chronological order of occurrence. The moving average for any specific number of failures is computed as the arithmetic mean of the failure times selected sequentially and in reverse order. For example, the moving average for two failures is obtained by adding the last two failure times and dividing by two; for three failures, by summing the last three failure times and dividing by three; and so forth. The number of failures to be used in the computation is arbitrary but is restricted to ten or less (see Appendix A). This curve, if used, will be identified as Moving Average and the number of failures used for computation shall be noted.

5.4.4 MTBF estimation from fixed-length test plans. MTBF estimation from fixed-length test plans shall be in accordance with MIL-STD-781.

5.5 Failure analysis and corrective action. A closed-loop system shall have been implemented before the start of the growth test to identify, report, investigate, analyze, and correct all problems or failures that occur during the reliability development tests, and prevent recurrence of all problems or failures due to design deficiencies. This system is described in 4.7. Reliability growth will not be attained unless an effective FRACAS is implemented and rigorously pursued.

5.6 Maintenance. Maintenance during this test shall be limited to correction of failures except as follows. Preventive maintenance shall be performed only to the extent specifically defined in the test plan or on the equipment drawing or specification. Adjustment of operator's controls shall not be considered preventive maintenance. Suspicion of an incipient failure shall not be used as justification for replacing a part prior to its actual failure, unless specified by the procuring activity that these may be removed or corrected during maintenance to prevent failures during the next operating period. If parts are replaced during a non-operating period, the incident shall be classified as a failure and appropriate action taken.

5.7 Test records. When not specified, test records shall be maintained continuously in general accord with Appendix D of MIL-STD-781.

5.8 Combined environments test criteria. The environmental criteria to be used for reliability development testing shall be based on actual environments that will be encountered by the equipment in the field. Typical combined environments versus equipment usage categories are presented in 4.3 and Appendix B and E of MIL-STD-781.

6. NOTES AND CONCLUDING MATERIAL.

6.1 Ordering data. Procurement documents should specify the following:

a. Title, number, and data of this standard.

b. Application (see 1.2).

c. Classification (see 1.3).

d. If testing may be initiated when the design does not have a predicted MTBF (θ_p) equal to or greater than the upper test MTBF (θ_0) (see 4.2.1.1).

e. If GFE is not excluded (see 4.2.1.2).

f. Growth model if other than the one specified in 5.3 (see 4.2.2).

g. Tolerance of test conditions if other than those of 4.4.1.

h. Equipment, facilities, and material furnished by the Government (see 4.10).

i. If functional and environmental tests are not required to be completed prior to start of reliability development tests (see 5.1.1).

j. Alternative test cycles or performance profiles, when applicable (see 5.2.1.2).

k. The electrical and mechanical performance outputs and characteristics to be monitored and measured during the test (see 5.2.2).

l. The environmental conditions and the combinations of environmental exposure types and levels to be applied during the test cycle, and their variance as a function of test time (see 5.2.3).

m. If the rate of chamber temperature change is not required to average 5°C/minute (see 5.2.4 c and f).

n. If number of items selected for testing if other than two (see 5.2.5).

o. Extent of preventive maintenance (see 5.6).

6.2 Data requirements. Deliverable data required by this standard is cited in the following paragraphs.

Paragraph	Data Requirement	Applicable DID
4.6.2,5.2.2, 5.2.4,5.2.6,5.4	Plan, Reliability Test	DI-R-7033
4.7.1.5,5.4.1.1	Plan, Corrective Action	DI-R-7038
4.8	Report, Reliability Status	DI-R-2119
5.1.2	Report, Thermal Survey	DI-R-7036
5.1.3	Report, Vibration Survey	DI-R-7037
5.1.4,5.2.2, 5.2.4,5.2.5,5.4	Procedures, Reliability Tests	DI-R-7035
5.6	Report, Failure Summary and Analysis	DI-R-7041

Preparing activity:
Navy - EC
(Project No. RELI-N007)

APPENDIX A

NOTES ON DUANE RELIABILITY GROWTH MODEL AND AN ALTERNATIVE APPROACH OF MOVING AVERAGE

10. Scope. The information in this appendix is instructional in nature for the guidance of the procuring activity and the contractor in planning a reliability growth test. It does not contain direct requirements of this standard.

20. Duane reliability growth model.

20.1 General. In 1962 J. T. Duane 1/ issued a report that postulated a growth model which easily utilizes and explains growth test results, and gives an early reliable indication of where the test is headed and how fast it's getting there.

Duane's postulate was that as long as reliability improvement effort continues, his mathematical expression would hold, equation C-1. 2/

$$\lambda\Sigma = \frac{F}{H} = K H^{-m} \qquad \text{C-1}$$

$\lambda\Sigma$ = cumulative failure rate
H = total test hours
F = failures during H
K = constant determined by circumstances
m = growth rate 3/

The original mathematical model was expressed in terms of cumulative failure rate; but, currently, since equipment reliability is generally expressed in terms of MTBF, the C-2 equation 4/ is used.

$$M_R = M_I \left(\frac{T_t}{t_I}\right)^m \qquad \text{C-2}$$

M_R = MTBF - required
M_I = MTBF - initial
t_I = time at which initial data point is plotted (pre-conditioning time)

1/ Duane, J. T. Technical Information Series Report DF 62MD300, General Electric Co., DCM&G Dept., Erie, PA 1 Feb. 1962.

2/ E. O. Codier "Reliability Growth in Real Life", Proceedings, 1968 Annual Symposium on Reliability; New York, IEEE, Jan., 1968.

3/ m has been substituted for ∝, since ∝ is the symbol for producer's risk.

4/ ASD-TR-7:-22 "Research Study of Radar Reliability and Its Impact on Life-Cycle costs for the APQ-113, -119, -120 & 144 Radars", April, 1973 AESD, General Electric, Utica - pg. 41

T_t = time at which the instantaneous MTBF of the equipment under test will reach the MTBF requirement

m = growth rate

Normally, the cumulative MTBF (M_c) is measured in test and converted to instantaneous (or current) MTBF (M_i) by dividing by 1 - m, that is,

$$M_i = \frac{M_c}{1 - m}$$

The cumulative MTBF is plotted versus cumulative test time, a straight line is fitted to the data and its slope, m, is measured. The current MTBF line is then drawn parallel to the cumulative line but displaced upward by an offset equal to $\frac{1}{1 - m}$. The corresponding test time at which this line reaches the required MTBF is the expected duration of the growth test. Much evidence has been accumulated since Duane's original report that verifies the adequacy of the Duane model in representing the real world of reliability growth testing. Futhermore, failure to provide the time and dollar resources necessary for reliability growth is an error committed much too often in research, development, test, and evaluation planning.

20.2 Growth rate factors. The m is the average slope of the cumulative MTBF curve, M_c, plotted on log-log paper. Where a systematic and deliberate reliability improvement effort is being made, m is usually found to be in the range 0.3 to 0.6. The value is:

a. Higher for analog hardware than for digital hardware.

b. Higher in equipment of low maturity than in production hardware.

c. Higher in equipment exposed to severe test conditions than in equipment (for example) undergoing bench tests (in other words; the ability to detect a problem is directly related to the ability of a particular test program to cause the failure to occur).

d. Higher in proportion to the effort expended in the hardware-oriented reliability improvement program. (See footnote 2/ on pg. 25)

The growth rate is influenced by: (see footnote 4/ on pg. 25)

(1) The systematic and permanent removal of failure mechanisms through taking corrective action.

(2) The rate and efficiency in failure removal.

(3) The statistics of the underlying distribution of failure mechanisms whose failure rates prevent the initially released system from achieving its full potential.

Removal of every systematic failure mechanism from a uniformly distributed set of sources results in a growth slope of $m = 0.6$. Removal of alternate failure mechanisms from the same source distribution causes a growth slope of $m = 0.23$.

20.3 Removal of systematic failure mechanisms. Available data from industry show conclusively that products initially released for manufacture exhibit a MTBF that is near 10 percent of the inherent, or latent, product capability as predicted from parts performance. If M_p is the predicted MTBF, $M_p/10$ is the initial performance and $10\lambda p$ is the initial failure rate. Furthermore, regardless of the underlying failure distribution, the initial performance is evidently $M_p/10$. This fact implies that the underlying failure distribution is bounded, constrained, such that the sum of the failure rates of all the systematic failure mechanisms which dilute equipment early performance and the non-pattern failures which one accepts and identifies as λp is $10\lambda p$, that is:

$$\sum_{s=1}^{s=n} \lambda_s + \lambda_p = 10\lambda_p = \frac{10}{M_p}$$

Thus, $$\sum_{s=1}^{s=n} \lambda_s = 9\lambda_p.$$

These systematic, or pattern, failure mechanisms have an associated failure rate λ_s that is relatively close to the equipment failure rate λ_p, but which is several orders of magnitude above and, therefore, distinguishable from the failure rates of the parts themselves. The removal of these systematic failures through an orderly and planned program of test, analyze , and fix (TAAF) is one of the basic principles of reliability growth management. As the systematic failures are removed and corrected, the MTBF of the equipment will approach the predicted MTBF, or $\frac{1}{\lambda_p}$, based on part failure rates adjusted for actual use environments.

There are many practical factors which tend to limit the value of m:

a. Failure rates of pattern problems are destributed on both sides of λ_p.

b. The distributions are rarely symmetric.

c. Corrective actions are not always perfect.

d. Failures do not occur at the same time.

e. The corrective action cycle time for each failure mechanism is really not the same.

f. Every failure cause is not discovered and eliminated.

These real-life considerations have led to the conclusion that a practical achievable upper growth limit of m is 0.6, a number borne out by extensive reliability test data on a variety of electronic and electromechanical products.

20.4 Notes on plotting. In general, only data points corresponding to the occurrence of failures should be retained on the analysis plot for the purpose of determining slope. For presentation purposes it is desirable to update to time now and plot a point which includes all of the test time accumulated up to time now, even though the last failure occurred some time ago. This is a reasonable procedure for presentation but yields (theoretically) a slightly optimistic point which does not have the same information content as a failure point, and should not be included in curves used for slope determination. When fitting a straight line to a Duane plot, the cumulative nature of the data points should be borne in mind. The later points, having more information content, must be given more weight than earlier points, and the normal curve-fitting procedure of drawing the line through the center of gravity of all the points should not be used. Unless the data is exceptionally noisy, the best procedure is to start the line on the last data point and seek the region of highest density of points to the left of it.

20.4.1 What to plot. For the basic analytical curve, the ordinate is cumulative failure rate (or MTBF) and the abscissa is cumulative something -- whatever is being done to define failure rate. It may be test operate time, temperature cycles, number of tries or thousands of rounds of ammunition fired. The model is sensitive to the relationship among failure rate, improvement effort, and duration of effort, but does not appear to care how the duration is measured.

20.5 An example of a growth test plan. A hypothetical example of an equipment reliability growth test will be presented based on the following assumptions:

Required MTBF	=	400 hours (also the predicted value)
Initial MTBF (M_i)	=	40 hours
Growth rate, m	=	0.5

FIGURE 3 shows the plan, $m_5 = 0.5$, cumulative MTBF (M_C) growth line, starting at M_I and 200 hours[5/], drawn at a slope of 0.5. This crosses the 400 hour (θ_o) MTBF level at 20,000 hours. However, to obtain the expected test time at which the current MTBF would reach 400 hours, the plan line (heavy dashed line) for current MTBF is drawn parallel to and displaced by a factor of $\frac{1}{1-m}$ above the M_C line, that is, at values of MTBF = 2 x M_C. The test time corresponding to the point where the current MTBF crosses the 400 hour MTBF line is the expected test time to achieve the indicated MTBF. In this case, it is 5,000 hours of 12.5 time θ_o.

20.6 Monitoring the growth test. The failure data from the hypothetical growth test presented in TABLE A-I has been plotted (X) on FIGURE 3 to show what might occur in monitoring an actual TAAF test. There were many early failures and the M_I at 200 hours was only 16 hours instead of 40. To get an early indication of the growth rate, the first seven points for the cumulative MTBF were plotted in the upper left quadrant of the graph and a best-fit straight line drawn through the points. A line with this slope was then drawn from the 100 test hours and 10 hours MTBF point to project the measured growth existing at 100 hours. However, observing the cumulative MTBF's plotted between 100 and 1000 hours, it is evident that the rate increased (m = 0.73) and the projected line through those points would come much closer to the planned cumulative MTBF line than the first one based on 100 hours of data.

Instead of measuring the slope to arrive at m, the following mathematical equation may be used.

$$m = \frac{\mathrm{LOG}\ \theta_T - \mathrm{LOG}\ \theta_1}{\mathrm{LOG}\ T - \mathrm{LOG}\ T_1}$$

Where T = cumulative operating time
θ_T = observed mean time between failure at time T
θ_1 = initial observed mean time between failure at T_1
T_1 = operating time to the initial observed failure
m = a constant representing the rate of reliability growth

Picking of θ_1 at 400 hours for T_1 and at 1000 hours for T:

$$m = \frac{\mathrm{LOG}\ 52 - \mathrm{LOG}\ 26.5}{\mathrm{LOG}\ 1000 - \mathrm{LOG}\ 400} = \frac{1.716 - 1.423}{3 - 2.6} = .73$$

This particular data tends to indicate, which is normal for growth tests, that the first 100 hours of test data need not be plotted but should be used to start the cumulative MTBF plot, that is, $\frac{104\ \text{hours}}{10\ \text{failures}}$ = 10 hours MTBF. Now using the additional data up to 1000 hours, the current MTBF line should be constructed to determine if the projection of this line could intersect the plan for current MTBF line. The current MTBF line is drawn through

5/ one half θ_o

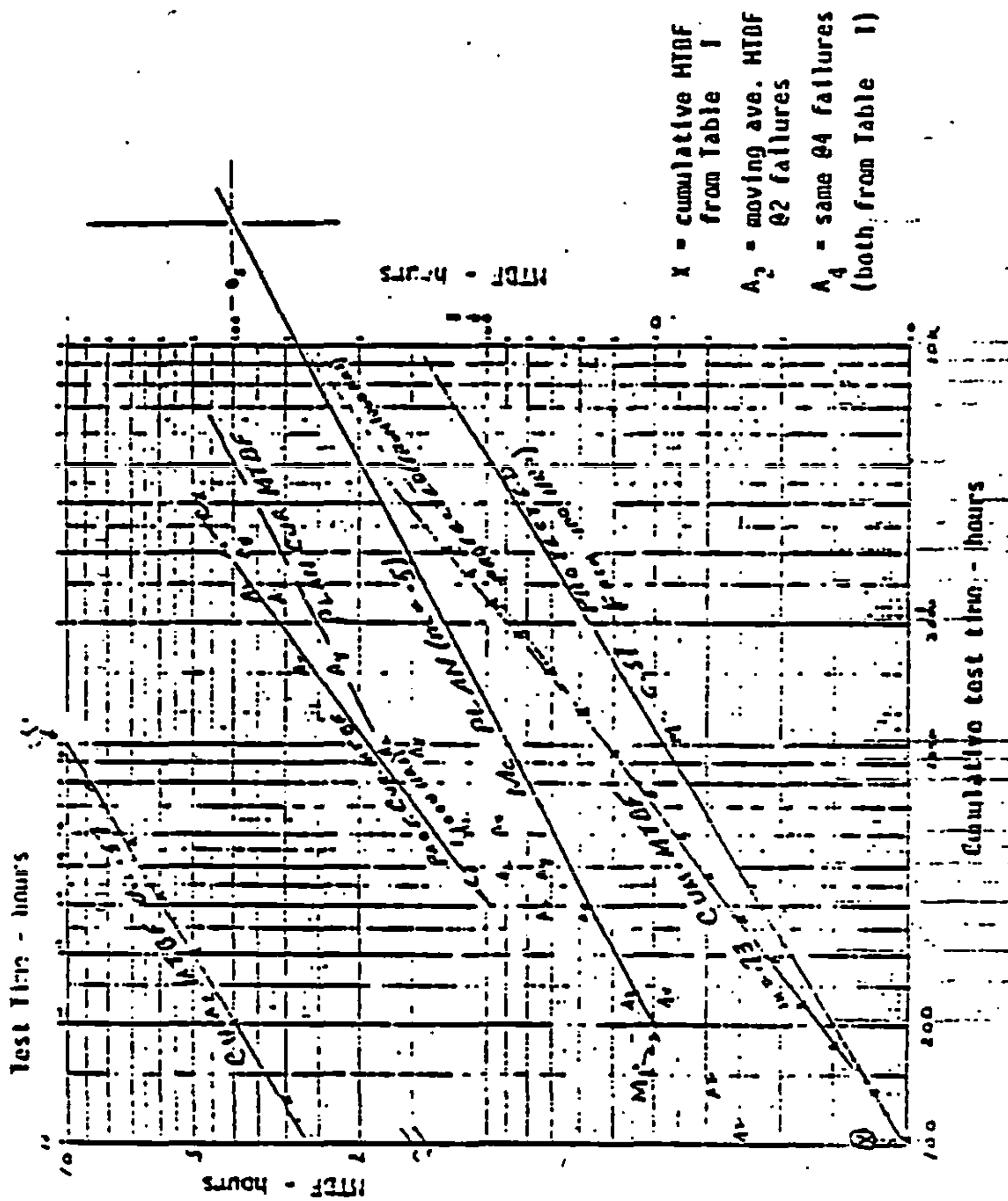


FIGURE 3. Duane Growth Model

TABLE I. Hypothetical Data for Reliability Development Test.

Cumulative Failure Count	Cumulative Test Time	Time Between Failure	Cumulative MTBF	MOVING AVERAGE MTBF USING LAST (N) FAILURES (N IS TABLE INDEX)				
				2	3	4	5	6
1	1	1	1	0	0	0	0	0
2	4	3	2	2	0	0	0	0
3	8	4	3	4	3	0	0	0
4	13	5	3	5	4	3	0	0
5	20	7	4	6	5	5	4	0
6	30	10	5	9	7	7	6	5
7	42	12	6	11	10	9	8	7
8	57	15	7	14	12	11	10	9
9	78	21	9	18	16	15	13	12
10	104	26	10	24	21	19	17	15
11	136	32	12	29	26	24	21	19
12	177	41	15	37	33	30	27	25
13	228	51	18	46	41	38	34	31
14	292	64	21	58	52	47	43	39
15	372	80	25	72	65	59	54	49
16	473	101	30	91	82	74	67	52
17	599	126	35	114	102	93	84	77
18	757	158	42	142	129	115	106	97
19	956	199	50	179	161	146	133	121
20	1205	249	60	224	202	183	157	152
21	1518	313	72	281	254	230	209	191
22	1879	361	85	337	308	291	256	234
23	2262	383	98	372	352	327	301	277
24	2668	406	111	395	383	366	342	319
25	3099	431	123	419	407	395	379	357

MTBF values equal to $\frac{1}{1-m}$ x cumulative MTBF values at the 400 and 1000 hour test time points:

at 400 hours : $\frac{1}{1-.73}$ = 3.7 x 26.5 = 98 hours

at 1000 hours: 3.7 x 52 = 192 hours

This is line - C_x -, labeled projected cumulative MTBF, and is observed to cross the Plan current MTBF line at 800 hours and crosses the 400 hour MTBF line at 2850 hours, well ahead of the plan. This is due to the higher than normal growth rate.

It will be noted that the cumulative MTBF plot never got higher than 123 hours using the 25 total failures that occurred in the 3099 hours of test time. It is necessary to count all failures when calculating the cumulative MTBF to maintain the nearly constant growth rate (straight line) as failures are accumulated and to enable a realistic projection of the current MTBF.

In the test data plot, another slope change occurred after 1000 hours of testing indicating a slightly higher growth rate. A new current MTBF projection could be constructed based on the new slope but the sample is small (six failures) and would give an overly optimistic value for current MTBF. (In fact, the growth rate for this hypothetical test is considerably higher than usually encountered in actual practice.) The final result after 3099 hours of test time indicates a current MTBF of about 415 hours and a cumulative MTBF of 123 hours.

30. The moving average approach. An alternative method of monitoring a reliability development (growth) test is to record all failures and the times of failure occurrence as was done in TABLE I and calculate a moving average MTBF by using the last few failures that have occurred and the corresponding elapsed test time. The right-hand portion of TABLE I presents the moving averages utilizing 2, 3 ... 6 failures in the computation. The moving average for a given number of failures is computed as the arithmetic mean of the corresponding times between selected sequentially and in reverse order of occurrence. For example, the moving average of two failures is obtained by adding the last two failure times and dividing by two; for three failures, by summing the last three failure times and dividing by three; and so forth. The number of failures used in the computation is arbitrary but should be restricted to ten or less. Initially, of course, moving averages cannot be computed until enough failures have occurred. The times between failures, selected arbitrarily for this example, are arranged in chronological order and indexed by the cumulative failure count. The cumulative test time is the total of all time between failures up to and including the failure time indexed.

40. Comparison of moving average MTBF and Duane current MTBF. In comparing this approach with the previous log-log plot, it should be noted that there is no easy way to project the reliability growth and to estimate the test hours required to reach the required MTBF. For comparison purposes the moving average MTBFs for two and four failures were plotted on the chart of FIGURE 3 as A_2 and A_4. It will be observed that near the end of test, the A_2 and A_4 points straddle the projected current MTBF line. Therefore, it appears that the current MTBF value obtained from a Duane plot is equivalent to the moving average of MTBF based on the last two or three failures.

Another advantage of maintaining a continuous plot, deviations from the established growth rate are easily discerned and, if a falling-off in growth rate is noted, increased effort should be applied to expedite corrective activity. Also, if a fixed test length has been specified, the Duane current MTBF projection will indicate if the present improvement effort is adequate to reach the desired MTBF. However, the moving average does not indicate success until the actual value calculated reaches the desired MTBF, which may take the entire test length as required in the sample of TABLE I. The 24th failure at 2668 hours did indicate that the 400 hour MTBF had been attained, but this is based on only one sample and therefore, has a very low level of confidence.

(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.