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Specification Policy Guide		

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SPECIFICATION POLICY GUIDE

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FOREWORD

This Specification Policy Guide was formulated by the EIA Engineering Committee on Quality Assurance Practices (QA) and subsequently was approved by the EIA Management Policy Committee on Reliability in Boston, Massachusetts, on September 24, 1964.

This Guide represents a consensus as of the date of its issue. It is recognized that the material contained herein, dealing as it does with a subject matter in which the changes due to new developments have been frequent and extensive, must be continually reviewed and up-dated to take proper account of such developments.

In order to accomplish this, the EIA Quality Assurance Practices Committee will maintain continual surveillance of the field and institute amendments and modifications to this document as necessitated by such developments.

1. SCOPE

1.1 Purpose

This document has been formulated as a suggested guide in assisting EIA Engineering Department Panels and JEDEC Councils in cooperating with the Defense Department and other Federal agencies in the preparation of suggested reliability requirements for various types of electronic products as part of a program designed to enhance the reliability of defense and related equipment. The document is to be followed merely as a guide and is not intended to limit technical groups in the consideration of the factors to be taken into account in the development of reliability specifications for recommendation to the Government. The document is prepared as a guide to the following EIA Engineering Department Panels and JEDEC Councils:

Component Parts Panel	(P)
Electronic Tube Council	(JEDEC)
Semiconductor Device Council	(JEDEC)

This document is designed to implement the important specification features recommended by the PSMR-1 Report issued by DOD in 1960, and to guide specification writers toward the over-all objectives of making reliability information available in a consistent and orderly form.

1.2 This Guide recognizes two fundamental approaches to assurance of high part reliability, which are:

1.2.1 Procedure No. 1

Procedure No. 1 is based on process qualifications with lot-by-lot assessment of the process for evidence of continued qualification at the specified failure rate level.

In this procedure sufficient data are accumulated to determine whether or not the process is qualified at the specified failure rate level. Having gained qualification, life tests are run on each subsequent lot and these data are accumulated to evaluate the failure rate level of the process on a continuing basis. The accumulated data are compared to a given criterion to determine if the process remains qualified at the specified failure rate level. This decision is made after each lot completed life test. (See Appendix I for examples for existing documents which illustrate applications of Procedure No. 1)

1.2.2 Procedure No. 2

Procedure No. 2 is based on lot-by-lot product acceptance. In this procedure sufficient data are generated on each lot to determine the acceptability of the lot at the specified failure rate level. (See Appendix II for examples from existing documents which illustrate applications of Procedure No. 2).

2. REFERENCED DOCUMENTS
3. DEFINITIONS
4. SELECTION OF PROCEDURE (See 1.2)

The selection of a procedure to be specified on a particular product should be based on appropriate consideration of items such as the following:

1. Expected volume of production
2. Continuity of production
3. All costs involved such as sample sizes, facilities, inventories, ...
4. Expected failure rate for each stress level
5. How sampling plan will operate
6. Rating precedents and traditions in the particular group
7. Product design
8. Manufacturing process
9. Historical data
10. Lot definition
11. Test condition(s)
12. Expected part application
13. Marketing conditions
14. Acceleration factors
15. Failure definition
16. Failure-in-time distribution

More specific guidance toward selection of an optimum procedure for a given product is given in 4.1 and 4.2.

4.1 Procedure No. 1 - Process Qualification

Procedure No. 1 (initial process qualification plus lot-by-lot acceptance and assessment of process for continuing qualification) should be used when product is manufactured in essentially continuous production, in reasonable control, and at reasonably high volume. Production levels constituting high volume must be considered in the context of the product type, the production process, and the industry by which it is made.

- 4.1.1 Where the foregoing conditions of continuity of volume and control are not met, Procedure No. 1 is generally not considered suitable.

4.2 Procedure No. 2 - Lot-by-Lot Product Acceptance

Procedure No. 2 (product acceptance based on lot-by-lot testing) should be used under any of the following conditions:

- 4.2.1 Procedure No. 1 is not applicable
- 4.2.2 The specification failure rates are at a level where this approach is economically feasible
- 4.2.3 Acceleration factors are available which permit lot evaluation using this approach
- 4.2.4 When the process may yield more than one distinguishable reliability level and it is desired to identify these levels on an individual lot basis.

4.3 Time-Independent Tests (Cycle-Based, etc.)

Procedures 1 and 2 may be considered equally applicable for time-independent as well as time-dependent parameter variations. The reference in this guide to time-based testing derive from the fact that time-based failure rate assessments are most common. The procedures, however, are equally valid for those products whose failure rate assessments can more properly be expressed in other terms (such as cycles). Where the life characteristic is measured in terms of cycles (or some other parameter) rather than hours, the term "cycle" may be substituted for "time". The criteria for selecting either Procedure 1 or Procedure 2 are independent of the form in which failure rate may be specified.

5. LIFE TESTING METHODS

The election of a life test method for incorporation in the specification will be dependent upon the failure-in-time distribution for the particular type part and also upon the state-of-knowledge relating to acceleration factors applicable to the part type.

5.1 Expected Failure-In-Time Distribution

Failure-in-time distribution may be categorized as constant, increasing, decreasing or unknown. The approach to failure rate life testing will, in part, be dependent on the nature of such distributions and the particular methods selected should be in accordance with Table 1.

5.2 Stress Acceleration Factors

In all cases, a position should be established with regard to stress acceleration factors. This position may range from a situation where it is known that there are no stress acceleration factors, to one in which such factors are known to exist and can be quantitized, to one in which there is either no knowledge of their existence or magnitude. The life testing method chosen will be dependent on this position as indicated in Table 1.

Stress "acceleration" factors may also be considered to exist for products whose failure rate assessments are more properly expressed in terms such as "number of cycles". It is recommended that, when acceleration factors are not already well established, provision be made in the specification for testing at several stress levels in order to provide a basis for their generation. Such testing may be called for on a periodic basis (such as quarterly or semi-annually) rather than on a lot-by-lot basis. In this event, sampling of all production lots, to make up the test samples should be specified.

Table 1

<u>Expected Failure-In-Time (or Cycle) Distribution</u>	<u>Stress Acceleration Factors</u>		
	<u>None</u>	<u>Unknown</u>	<u>Known</u>
Unknown	2	2 and 3	2
Constant	1 or 2	(1 or 2) & 3	1 or 2
Increasing or Decreasing	2 or 4	(2 or 4) & 3	2 or 4

Life Test Methods

- 1 = Accumulated Unit Hour (or Cycle) Testing
- 2 = Fixed Time (or Cycle) Interval Testing
- 3 = Multiple Stress Level Testing
- 4 = Failure-in-Time (or Cycle) Based Testing

6. FAILURE RATE LEVELS

A statement of the established Failure Rate Levels for a particular part specification be included under its' scope. This statement should be in the form of a probability statement and clearly indicate the failure rate level(s), the risk(s), involved, and the applicable stress level(s). Each failure rate level shall be identified with specific acceptance test requirements.

6.1 Standard Failure Rate Levels

Provision shall ordinarily be made for failure rate levels of 1%, .1%, .01%, and .001% per 1000 component part hours.

In the event that intermediate failure rate levels are desirable for a particular part class, such levels may be specified provided that each failure rate level is identified with specific acceptance test requirements. In any event no more than five levels shall be provided for in a particular part specification. It is not intended that failure rate levels lower than the foreseeable state of the art for a particular part class be specified.

6.2 Test Stress Level

- 6.2.1 In general, the test stress level specified for the life test shall be the maximum rated stress level for the part. In this event, the Established Failure Rate for the part will be that demonstrated directly by the results of tests such as those exemplified in Appendix I or II.
- 6.2.2 When acceleration factors are known, a test stress level may be specified above maximum rated conditions in order to reduce sample size. The life testing shall be reduced in accordance with known acceleration factors, with the same number of failures permitted in the smaller sample (See Appendix I or II for examples). The acceleration factors may be applied to either reduce the sample size, or the test time, or a combination of both. In the event that acceleration factors are used, some testing should be provided for at rated maximum conditions in order to continue verifying the acceleration factor used.
- 6.2.3. In those industries where it has been traditional to specify maximum rated stress for a part at levels substantially above typical use levels, four alternatives are possible.
- 6.2.3.1 The life test may be specified at what is judged to be the typical use stress for demonstrating failure rates indicated in Paragraph 6.1. In this event, the Established Failure Rate shall be specifically stated to apply to these "typical use stress conditions" and not to maximum rating.
- 6.2.3.2 The life test may be specified at maximum rated conditions, with the Established Failure Rate stated for these conditions.
- 6.2.3.3 The life test may be specified at maximum rated conditions and the Established Failure Rate stated for typical use conditions, provided a factor is known to convert the test results to an Established Failure Rate for specifically defined typical use stress conditions in terms of the allowable failure rate at maximum rated conditions.

- 6.2.3.4 The life test may be specified above maximum rated conditions with the same limitations given in paragraph 6.2.3.3.
- 6.2.3.5 In the event that the provisions of paragraph 6.2.3.3 or 6.2.3.4 are invoked, provision shall be made for securing data at the specified "typical use stress conditions", in order to continuously verify the acceleration factors used. Samples for the generation of "typical use stress condition" data should be required to be drawn from a number of (preferably all) lots offered for acceptance during the sampling period.

6.3 Failure Determination

The obligation to define failure of a part subjected to the life test rests primarily with the specification writer. However, in order that Established Failure Rate may have a meaning which is intelligible to the part user, the following restrictions are required.

- 6.3.1 Failure of a part shall be defined as deviation of any one or more of the specified parameters beyond the specified limits. If more than one parameter is specified to apply to the life test, failure of more than one parameter on a single specimen shall constitute one failure in determining conformance to the acceptance criteria. (See Appendix I or II for examples).
- 6.3.2 Where appropriate, two or more failure rates may be allowed for a given parameter of a given part: at least one failure rate shall apply to inoperative (catastrophic) failure of the part. In any case, an inoperative failure shall be counted also as a degradation failure. The Established Failure Rate then refers to the number of degradation failures allowed.
- 6.3.3 Only those parameters judged to be important under the typical use conditions for which the part is designed shall be specified to be measured for determining conformance to the life test.

- 6.3.4 Under certain conditions, it may be desirable to specify multiple failure rates for parts having several parameters specified as defining part failure. Different failure rates may be specified for different parameters but if this is done, the Established Failure Rate of the part shall be taken as the square root of the sum of the squares of these separate failure rates rounded to the next higher failure rate as provided for in Paragraph 6.1.
- 6.3.5 The use of a variables method for determining conformance to an Established Failure Rate level expressed in attributes should be encouraged where the conditions for their applicability are met. In general, these conditions include:
- (1) Detailed knowledge of the distribution involved, with particular emphasis on knowledge of the shape of the distribution tails.
 - (2) Use of a procedure for incorporating into the attribute failure rates derived from the variables data the failures observed as "sports" or "mavericks" atypical to the distribution.
- 6.3.6 For those parts which are expected to exhibit a monotonic degradation of the failure - determining parameter(s) at a known and predictable rate during life testing, failure acceleration may be achieved by tightening the failure - determining limit(s) for the parameter(s), in addition to acceleration by stress increase.

7. ADDITIONAL TESTING FOR INFORMATION GENERATION

The principles outlined in this section are strongly recommended for consideration in all specifications. Examples of the procedures recommended are given in the Appendices.

7.1 Elimination of Life Testing Unknowns

At regular intervals samples should be drawn from production for submission to matrix life testing. The axes of the matrix should be appropriate major stresses. Choices of the axes, the stress levels, the sample sizes, the test intervals, etc., are left to the individual specification writing groups.

7.1.1 Acceleration Factors

As differences in failure rate are observed, an effort should be made to determine the underlying pattern governing these differences, so that proven acceleration factors may be introduced into life testing.

7.1.2 The Distribution of Time Ordered Failures

If the distribution of failures in time is unknown or merely assumed, an effort should be made to determine the distribution and to use the knowledge in specifying life test procedures and acceptance criteria.

7.2 Applications Information

Where possible, tests should be introduced to determine the responses to all stimuli which may produce parameter drift, or part failure, or otherwise affect the usefulness of the part. A partial list of those environments which should be considered are: shock, vibration, acoustic noise, acceleration, moisture, temperature cycling, sand, dust, salt spray, barometric pressure, nuclear radiation, voltage, current, power, and frequency. At each environment, testing to destruction should be used whenever possible, to provide maximum knowledge of part capability.

8. QUALITY ASSURANCE PROVISIONS

Individual specifications should contain sufficiently detailed operating rules to establish for all failure rate (reliability) levels:

- (a) The specific methods for data gathering, processing and computational procedures to establish conformance of product.
- (b) The specific methods for processing non-conformance. Procedures for reprocessing and resubmission of lots shall be included.
- (c) The procedures for recheck of the data and product to avoid weighting of the data by inclusion of "out-of-line" test results which are judged not to reflect the process average quality of the product, such as those attributable to measuring to testing error, human error, or infrequently occurring grossly defective batches of product which are established to be caused by manufacturing error and which are not intended to be shipped as Established Failure Rate product.

9. THE APPENDICES TO THIS GUIDE

To clarify and expand the principles embodied in this Guide beyond the concisely stated preceding sections, Appendices have been prepared and are included with the Guide. It is intended that additional Appendices will be added as they become available. Presently available Appendices are:

- Appendix I - Illustration of Procedure 1 (Para. 1.2.1 of Guide)
- Appendix II - Illustration of Procedure 2 (Para. 1.2.2 of Guide)
- Appendix III - Factors in Choice of Test Failure Rate Levels, Stress Levels, and Testing Time
- Appendix IV - Additional Testing for Information Generation

It is recommended that these Appendices be studied thoroughly, and that the pertinent examples and considerations therein be examined closely before the writing of specifications intended to be consonant with the principles of this Guide is begun.

APPENDIX I

SPECIFICATION POLICY GUIDE Illustration of Procedure 1

INTRODUCTION:

This Appendix contains examples, chosen from existing specifications by members of the EIA/QAP Committee, of the application of Procedure 1 (Para. 1.2.1) of the EIA Policy Guide. They have been selected from both industry and government specification sources to illustrate several current ways in which the principles of the Policy Guide may be expressed to suit the special requirements of the many classes of electronic parts.

The QAP Committee endorses the writing of high-reliability part procurement specifications in the formats familiar to the spec users for each part class, with only sufficient alteration of historical spec patterns to encompass the Policy Guide principles, as exemplified in the following sample specs.

The QAP Committee, as a staff Committee composed of members from many industry groups, is not sufficiently expert in any one part class either to endorse or to disclaim the validity of the particular numbers (allowable defect percentages, stress acceleration factors, etc.) incorporated in the illustrative specifications of this Appendix for particular part classes.

It is considered mandatory by the Committee that those interested in applying and understanding the approach used in any of the spec examples in this Appendix arrange to obtain and review the complete sample spec(s), to avoid the hazard of error inherent in out-of-context application of portions of these carefully integrated documents.

Under the added column heading "Policy Guide Paragraph References" on each page of each illustrative spec in this Appendix will be found the number of the Policy Guide paragraph the principle of which, in the opinion of the QAP Committee, is exemplified by the adjacent wording of the specification.