NOT MEASUREMENT
SENSITIVE

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w/ CHANGE 2
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DEPARTMENT OF DEFENSE
STANDARD PRACTICE

FAILURE RATE SAMPLING PLANS
AND PROCEDURES

AMSC N/A

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FOREWORD

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

2.   Comments, suggestions, or questions on this document should be addressed to: DLA Land and Maritime, ATTN: VAT, Post Office Box 3990, Columbus, Ohio 43218-3990 or by email resistor@dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

*   3.   Much of the basic procedure outlined herein is based upon the efforts of the Quality Assurance Practices Committee of the SAE International. Their assistance, as well as those of other industry and military services activities, is herewith acknowledged.

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SUMMARY OF CHANGE 2 MODIFICATIONS

1.   Foreword change "TechAmerica" to "SAE International".

2.   Paragraph 2.2.1; delete the address for DLA Document Services.

3.   Paragraph 4.1.4.1; has been revised.

4.   Paragraph A.2.2.1; delete the address for DLA Document Services.

5.   The following modifications to MIL-STD-690D have been made:

PARAGRAPH	MODIFICATION
Foreword	Changed
2.2.1	Changed
4.1.4.1	Changed
A.2.2.1	Changed

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1. SCOPE

1.1 <u>Purpose</u>. This standard provides procedures for failure rate (FR) qualification, sampling plans for establishing and maintaining FR levels at selected confidence levels, and lot conformance inspection procedures associated with FR testing for the purpose of direct reference in appropriate military electronic parts established reliability (ER) specifications. Figures and tables throughout this standard are based on exponential distribution. Weibull distribution will be acceptable in certain components such as capacitors. Use of Weibull distribution for any component must be approved by the qualifying activity. This standard also provides guidance to specification writers in the use of this standard (see appendix A) and references material for users of ER parts.

1.2 <u>Application</u>. This standard is applicable for reference in electronic parts ER specifications when the following conditions exist:

   a.   Electronic parts are essentially the same design and are manufactured under essentially continuous production; the production process is established and controlled in accordance with MIL-STD-790.

   b.   The part design and manufacturing processes produce a product whose failure rate can reasonably be assumed to be constant with time over its intended life (i.e., an exponential distribution of failures per unit time).

   c.   The qualifying activity administers this standard to provide the consumer with assurance that the qualified FR level is being maintained by a given manufacturer, since these procedures in themselves are not sufficient to assure the qualified FR level.

1.3 <u>Method of reference</u>. This standard can be referenced in ER specifications by specifying the following procedures:

   a.   Procedure I, "Qualification at the initial FR level" (see 5.1).

   b.   Procedure II, "Extension of qualification to lower FR levels" (see 5.2).

   c.   Procedure III, "Maintenance of FR level qualification" (see 5.3).

   d.   Procedure IV, "Lot conformance FR inspection" (when specified) (see 5.4).

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2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in section 3, 4, or 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in section 3, 4, or 5 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are cited in the solicitation or contract.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-790   - Established Reliability and High Reliability Qualified Products List (QPL) Systems for Electrical, Electronic, and Fiber Optic Parts Specifications

*   (Copies of these documents are available online at https://quicksearch.dla.mil.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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3. DEFINITIONS

3.1 Reliability terms. The definitions of all reliability terms used herein are as follows:

a. Burn-in (pre-conditioning). Process of subjecting components to conditions (temperature extreme, power input extremes, etc.) with the intent to either stabilize performance or significantly reduce latent defects.

b. Confidence level. This term denotes the probability of disqualifying a product when the true failure rate of the product is at the failure rate specified for qualification.

c. Corrective action. A documented design, process, procedure, or materials change implemented and validated to correct the cause of failure or design deficiency.

d. Derating. (1) Using an item in such a way that applied stresses are below rated values.

   (2) The lowering of the rating of an item in one stress field to allow an increase in another stress field.

e. Established reliability. A quantitative maximum failure rate demonstrated under controlled conditions specified in a Department of Defense specification and usually expressed as percent failures per thousand hours of test.

f. Failure. The event or inoperable state, in which any item, or part of an item does not, or would not, perform as previously specified.

g. Failure analysis. Subsequent to a failure, the logical systematic examination of an item, its construction, application, and documentation to identify the failure mode and determine the failure mechanism and its basic course.

h. Failure rate (FR) level. This term denotes the maximum percentage of failures (per 1,000 unit hours) based on a specified confidence level.

i. Failure rate (FR) test. This term denotes the test required to accumulate data from which a failure rate is calculated and is used synonymously with the standard specification term "life test".

j. Higher FR level. This term is a relative description of a FR level associated with a higher number of failures per unit time.

k. Inspection lot. A group of electronic parts offered for inspection at one time and in combinations authorized by the applicable ER specifications.

l. Lower FR level. This term is a relative description of a FR level associated with a fewer number of failures per unit time.

m. Mean time to failure (MTTF). A basic measure of reliability for non-repairable items: the total number of life units of an item divided by the total number of failures within that population, during a particular measurement interval under stated conditions.

n. Predicted. That which is expected at some future time, postulated on analysis of past experience and tests.

o. Qualifying activity. The military activity or its agent delegated to administer the qualification program.

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p. Reliability. (1) The duration or probability of failure free performance under stated conditions.

> (2) The probability that an item can perform its intended function for a specified interval under stated conditions. (For non-redundant items this is equivalent to definition (1). For redundant items this is equivalent to definition of mission reliability).

>> a. Mission reliability. The probability that a system is operable and capable of performing its required function for a stated mission duration, or for a specified time into the mission.

q. Screening. A process for inspecting items to be removed, that are unsatisfactory, or those likely to exhibit early failure. Inspection included visual examination, physical dimension measurement and functional performance measurement under specified environmental conditions.

r. Test, acceptance. A test conducted under specified conditions by, or on behalf of, the Government, using delivered or deliverable items, in order to determine the item's compliance with specified requirements. (Includes the acceptance of first production units).

s. Test measurement and diagnostic equipment (TMDE). Any system or device used to evaluate the condition of an item to identify or isolate any actual or potential failures.

t. Test qualification (design approval). A test conducted under specified conditions, by or on behalf of the Government, using items representative of the production configuration, in order to determine compliance with item design requirements as a basis for production approval. (also known as a "Demonstration.")

u. True failure rate. This term describes the failure rate that would be measured if all units of a controlled process were, in fact, tested. A "controlled process" is one in which FR variation about its mean is due to chance causes.

v. Truncation. Truncation is a "cutoff" point for life test data, that establishes a precise point in time in which the manufacturer can choose the elimination of previous extended life test data when:

(1) A life test failures has occurred and the manufacturer has determined the cause and implemented corrective action acceptable to the qualifying activity.

(2) The manufacturer seeks an extension of failure rate on the basis of new design improvements, occurring after a life test failure or failures.

The truncation point is not a random event. There must be an existing clear distinction between the "old" less reliable and the "new" improved design (see 5.5).

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4. GENERAL REQUIREMENTS

4.1 <u>FR levels</u>.

   a. FR levels are related to operation of the part at the stress level specified by their applicable ER specification.

   b. Provisions are made for FR levels ranging from 1.0 to 0.001 percent per 1,000 component part hours. In the event the existing FR level of a current product is higher than 1.0 percent, an additional level (level "L") shall be added which will represent the state-of-the-art for the part.

   c. Although the failure is expressed in percent per 1,000 hours (%/1,000 hr) throughout this standard, sampling plans and statistical tables may be used for FR levels expressed either in terms of percent per 1,000 cycles, operations, or in terms of duty cycle and stress level.

   d. Where a FR level is required for periods other than 1,000 hours, an appropriate conversion factor may be applied.

       Example: 1%/10,000 hours are equivalent to 0.1%/1,000 hours, or when specifying %/10,000 hours, the unit-hour requirement is to be multiplied by 10.

   e. Tables are provided to show the relationship between true failure rates and selected confidence levels.

4.1.1 <u>FR level determination</u>. Determination of FR levels shall be based upon data from all FR tests. Data shall be accumulated from:

   a. The qualification FR sample. The specification designates the number of sample units to be inspected, number of permissible failures, duration of FR test, and other criteria that may apply.

   b. Inspection lots which have been submitted for FR conformance inspection during any qualification period or interval. Data accumulated shall meet the specification requirement referenced in 4.1.1a.

   c. Samples subjected to extended FR tests. The data shall be added at the specified time of measurement and not at the end of the FR test.

4.1.2 <u>Qualification approval for higher FR levels</u>. Qualification approval granted on one of the lower FR levels shall include approval for all of the higher established FR levels. For example: Qualification approval for level "R" shall include approval for levels "P", "M", and "L", (if designated in the ER specification).

4.1.3 <u>Supplying to higher ER levels</u>. Parts qualified and marked (color coded or part numbered) to lower failure rate levels are substitutable for higher failure rate level parts with acquiring activity approval. A manufacturer may supply to all higher FR levels than that to which they are qualified, and may elect to use the sample size associated with the FR level to be supplied on orders or contracts. Election by the manufacturer to apply this option does not negate the requirement to maintain qualification in accordance with procedure III (see 5.3).

4.1.4 <u>FR marking</u>. All parts shall be marked with the FR level to which they are qualified, except when the contract or purchase order specifies higher FR marking under the substitution criteria of 4.1.3.

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*   4.1.4.1 <u>FR marking upgrading</u>. Where parts have been produced for part manufacturer's stock to a specific failure rate level (FRL) and qualification has been subsequently extended to a lower FRL, the existing stock may be remarked to the latest qualified FRL provided:

    a.   The lower FR shall have been achieved solely through the accumulation of FR test data with no change in materials, process controls, process limits, except as accepted by the qualifying activity in accordance with the corrective plan of action requirements of .

    b.   The manufacturer provides a written detail procedure of the remarking process and test data to substantiate that the remarking procedures do not affect the part reliability or performance and the procedure is accepted by the qualifying activity.

    c.   Parts shall have passed the ER specification conformance inspection. The lot of the achieved FRL was not manufactured and have not been in stock longer than the required life test for each ER specification for which a higher FRL is sought (15 months for 10,000 hour life test 3 months for 2,000 hour or 1,000 hour life test). Once the manufacturer achieves an improved lower FRL and is qualified, parts manufactured during the qualification timeframe may be marked with the qualified lower FRL.

    d.   If parts are remarked, date and lot code shall not be changed.

  4.2 <u>Failure criteria</u>. Deviation of one or more specified parameters beyond the specified limits shall constitute a failure. If more than one parameter is to apply to the FR test, failure of more than one parameter on a single sample constitutes one failure in determining conformance to the acceptance criteria.

  4.3 <u>FR test records</u>. Test records shall be maintained for the period required to substantiate the FR level qualification and shall include the data derived from the FR tests. The format is suggested on figure 1. Any measurement that indicates failed parts shall be clearly marked and identified as such in the test record (for exemption of data see 4.4). A sample unit which fails any given time interval shall be recorded as a failure immediately following the previous measurement and for all subsequent measurements. The manufacturer may remove failed sample units from the test. If the "C" number predicted for the maintenance period is exceeded or the failure is attributed to an unusual occurrence, the manufacturer shall immediately notify the qualifying activity (see 5.3.3.). If a failed sample unit is not removed, the test hours accumulated subsequent to its failure shall not be recorded with the cumulative component hours. All failures occurring during any FR test shall be reported to the qualifying activity at the time of failure. All FR data recorded shall be variables type data; attributes type data is not acceptable, except as permitted in the applicable ER specification. Figure 1 type data shall be made available when requested by the Government. A cumulative type record as shown on figure 2 shall be submitted to the qualifying activity at the end of each applicable maintenance period (see 5.3), or when requested by the qualifying activity.

  4.4 <u>Exception of data</u>. Where FR test is known to be faulty as a result of test equipment failure, the test data obtained shall be entered in the test record along with a complete explanation and submitted to the qualifying activity. The qualifying activity shall determine whether the failure will be used in the computation of the FR level. There shall be ample technical and statistical evidence that the cause of equipment failure has been removed and will not recur in future production. No FR sample lots can be removed from test without the approval of the qualifying activity.

  4.5 <u>FR qualification procedures</u>. FR qualification is an integral phase of the total qualification requirements in ER specifications. The procedures specified herein pertain only to the reliability requirements of these specifications. Qualification at any FR level shall be specified at either a 60 percent or a 90 percent confidence level. FR qualification procedures are as follows:

    a.   Procedure I, "Qualification at the initial FR level" (see 5.1).

    b.   Procedure II, "Extension of qualification to lower FR levels" (see 5.2).

    c.   Procedure III, "Maintenance of FR level qualification" (see 5.3).

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Lot number __1__ .			Lot size __1,000__ .			Record no. _____ .		
Dates of production _____ .			Sample size __110__ .			Test temperature ____ .		
Type designation in lot			Quantity in lot			Quantity in sample		
CLR25BD600UGM CLR25BE400UGM			500 500			55 55		
Sample No.	Rating (μf-V dc)	Designated test time 1/	Date of measurement _____ . Hours since last measurement ____ .			Date of measurement _____ . Hours since last measurement _____ .			Date of measurement _____ . Hours since last measurement _____ .
			Capacitance	pF	DCL	Capacitance	pF	DCL	Capacitance	pF	DCL
			μF	% change			μF	% change			μF	% change		
			Total failed units 2/ _____ . Total unit hours since last measurement _____ .			Total failed units 2/ _____ . Total unit hours since last measurement _____ .			Total failed units 2/ _____ . Total unit hours since last measurement _____ .

1/ Designated test time shall be entered before life test is initiated.

2/ Only one failure shall be charged per unit regardless of number of parameters failed. NOTE: All measurements which exceed requirements shall be significantly marked as failures by underlining or circling the measurement.

FIGURE 1. Examples of FR test records.

4.6 Lot conformance FR inspection procedure (when specified). A lot conformance FR inspection (procedure IV, see 5.4) may be specified when reliability assurance beyond that guaranteed by procedure III (see 5.3) is required. The lot conformance FR inspection provides the manufacturer with a high assurance of acceptance of product at the specified FR level, and at the same time provides the consumer with reasonable protection against acceptance of products worse than the specified FR level.

4.7 Disposition of sample units. Sample units subjected to extended FR tests shall not be shipped. When the ER specification requires compliance with procedure IV (see 5.4) and allows the shipment of the lot conformance FR inspection samples, these units may be delivered on the contract or order provided:

    a. The lot has passed the FR tests.

    b. The part terminals were not soldered.

    c. The part meets initial tolerance requirements.

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RELAY LIFE TEST RECORD										
Lot date code: Lot size:				Lot record no. Sample size:						
Part numbers in lot			Quantity in lot				Quantity in sample			
Sample serial numbers										
Designated test operations 1/										
Test measurements	Pre-life	Post-life	Pre-life	Post-life	Pre-life	Post-life	Pre-life	Post-life	Pre-life	Post-life
Dielectric										
Insulation resistance										
Coil current										
Coil Resistance										
Contact resistance = 1										
Contact resistance = 2										
Contact resistance = 3										
Contact resistance = 4										
Pickup voltage										
Dropout voltage										
Operate time										
Release time										
Contact pounce										
Failure to operate										
Contact miss										
Contact sticking-welding										
Case fuse blown										
Unit operators										
Failure										
Total number of unit operations:				Total number of failures:						

1/ To be designated prior to start of test.

FIGURE 1. Examples of FR test records – Continued.

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Lot date code:						Lot record number:				
Lot size:						Sample size:				
Part numbers in lot:						Quantity in lot:				
						Quantity in sample:				

Sample serial numbers										
	Initial		100		500		1,000		2,000	
	Before	After	Before	After	Before	After	Before	After	Before	After
Contact resistance										
Insulation resistance										
Unit operating hours										
Total operating hours										
Failures										

FIGURE 1. Examples of FR test records – Continued.

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Lot record number	Number of parts on test	Total number of hours on test	Total number of unit hours without failures since last measurement	Number of failures observed	Cumulative unit hours	Cumulative unit failures

NOTE: A failure is assumed to have occurred immediately after the previous reading. The failure shall be charged but the component hours accumulated on the failed unit since the last measurement shall not be entered.

FIGURE 2. <u>Example of maintenance of FR level record</u>.

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5. DETAILED REQUIREMENTS

5.1 Procedure I, "Qualification at the initial FR level". Qualification at the initial FR level shall be predicated upon accumulation of valid data meeting the requirements of 5.1.2a or 5.1.2b, as applicable. FR tests shall be conducted for the specified duration and single sample size. The qualifying activity may grant qualification at a FR level lower than that specified provided the manufacturer performs all tests required for initial qualification and submits valid data from current production which substantiates lower failure rates.

5.1.1 Applicable data. Data shall be accumulated from sample units selected from a production run and produced with equipment and procedures normally used in production. One of the prerequisites for valid data is that all lots produced during the production period are represented. The data shall be from the same product in current production; i.e., data from products of preceding designs shall not be acceptable.

5.1.2 FR sampling plans (FRSP).

    a. Single sampling plans based on a 60 percent confidence level are provided in table I (see table A-I of appendix A).

    b. Single sampling plans based on a 90 percent confidence level are provided in table II (see table A-I of appendix A).

TABLE I. FRSP-60.

FR level symbol	Qualified FR level 1/	Cumulative unit hours in millions (c = number of failures permitted)										
		c=0	c=1	c=2	c=3	c=4	c=5	c=6	c=7	c=8	c=9	c=10
	%/1,000 hr											
L	2/			("M"	row	divided	by	"L")				
M	1.0	.0916	.202	.311	.418	.524	.629	.735	.839	.943	1.048	1.152
P	0.1	.916	2.02	3.11	4.18	5.24	6.29	7.35	8.39	9.43	10.48	11.52
R or U 3/	0.01	9.16	20.2	31.1	41.8	52.4	62.9	73.5	83.9	94.3	104.8	115.2
S or V 3/	0.001	91.6	202	311	418	524	629	735	839	943	1048	1152

1/ For FR level expressed in terms other than %/1,000 hour, see 4.1c and 4.1d.
2/ Where a FR level greater than 1.0 percent is required, level "L" shall be specified and the cumulative unit hours computed as shown.
3/ See 4.1a.

TABLE II. FRSP-90.

FR level symbol	Qualified FR level 1/	Cumulative unit hours in millions (c = number of failures permitted)										
		c=0	c=1	c=2	c=3	c=4	c=5	c=6	c=7	c=8	c=9	c=10
	%/1,000 hr											
L	2/			("M"	row	divided	by	"L")				
M	1.0	.230	.389	.532	.668	.799	.927	1.054	1.171	1.300	1.421	1.544
P	0.1	2.30	3.89	5.32	6.68	7.99	9.27	10.54	11.71	13.00	14.21	15.44
R or U 3/	0.01	23.0	38.9	53.2	66.8	79.9	92.7	105.4	117.1	130.0	142.1	154.4
S or V 3/	0.001	230	389	532	668	799	927	1054	1171	1300	1421	1544

1/ For FR level expressed in terms other than %/1,000 hour, see 4.1c and 4.1d
2/ Where a FR level greater than 1.0 percent is required, level "L" shall be specified and the cumulative unit hours computed as shown.
3/ See 4.1a

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5.1.2.1 <u>True failure rates for FRSP-60 and FRSP-90</u>. Table III gives two points on each of the operating characteristic curves for FRSP-60 and FRSP-90, as follows:

a.   The true failures rates required of the product so that process will qualify 19 times out of 20; and

b.   The true failure rates of a product whose process will fail to qualify 9 times out of 10

TABLE III. <u>True failure rates for FRSP-60 and FRSP-90</u>
<u>(prepared for 1%/1,000 hr FR level)</u>.

Number of failures permitted	True product failure rate required to qualify a process 19 times out of 20 (%/1,000 hour)		True product failure rate which would fail to qualify a process 9 times out of 10 (%/1,000 hours)	
(c)	FRSP-60	FRSP-90	FRSP-60	FRSP-90
0	0.06	0.02	2.51	1.0
1	0.18	0.09	1.92	1.0
2	0.26	0.15	1.71	1.0
3	0.33	0.20	1.60	1.0
4	0.38	0.25	1.53	1.0
5	0.42	0.28	1.47	1.0
6	0.45	0.31	1.43	1.0
7	0.47	0.34	1.41	1.0
8	0.50	0.36	1.38	1.0
9	0.52	0.38	1.36	1.0
10	0.54	0.40	1.34	1.0

NOTE: For other than "M" (1%) FR level; divide above FR values by 10 for "P" (0.1%) level; by 100 for "R" or "U" (0.01%) level; by 1,000 for "S" or "V" (0.001%) level (see 4.1a).

5.1.3 <u>Failure FR test</u>. All sample units subjected to the specified qualification test shall be maintained on test for the total time specified for the extended FR test.

5.1.4 <u>Failure to qualify</u>. When the number of failures permitted is exceeded; the manufacturer shall discontinue the FR test and shall notify the qualifying activity. The manufacturer may request approval to reinstitute qualification testing on a new set of sample units provided the failures have been analyzed and the cause of failure has been corrected as specified in MIL-STD-790.

5.1.5 <u>Details to be specified</u>. The following details are to be specified in the ER specification:

a.   Initial FR level symbol and FRSP-60 or FRSP-90, as applicable (see 5.1.2).

b.   Duration of ER test (specify rated, and where applicable, accelerated conditions) (see 5.1).

c.   Number of sample units to be inspected and number of failures permitted for FR test (see 5.1).

d.   Duration of extended ER test (specify rated and, where applicable, accelerated conditions) (see 5.1.3).

e.   Number of samples to be continued on FR test (specify rated and, where applicable, accelerated conditions (see 5.1.3).

f.   Failure criteria (see 4.2).

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5.2 Procedure II, "Extension of qualification to lower FR levels". The manufacturer may extend the qualification granted under Procedure I to a lower FR level. Approval by the qualifying activity of such an extension shall be based on the same sampling plan, test duration, and failure criteria of Procedure I and the additional criteria prescribed in the procedure.

5.2.1 Applicable data.

a. Data shall be accumulated from ER tests performed during qualification at the initial FR level maintenance of qualification, and extended FR tests, and when specified, from lot conformance FR inspection.

b. Any data used to extend qualification shall include the results of all FR tests performed during the production period represented by the data. Data shall represent successive inspection tests starting with current production to the date of the oldest data submitted.

c. Unless approved by the qualifying activity in accordance with MIL-STD-790, the data shall represent a product which has not changed significantly (in terms of process, material, design, or construction) during the production period.

d. Extension of qualification to levels "P", "R", "U", "S" or "V" shall not be granted based upon data which are wholly from incomplete FR tests. As a minimum, data from completed FR tests on the same sample size as that required for initial qualification shall be included in the total data submitted. Where the ER specification contains specified life acceleration factors and associated accelerated life tests, data from completed accelerated life test shall be considered as equivalent to data from completed extended FR tests (see 4.1a).

e. Data from FR tests conducted to specifications other than ER specification for which qualification is desired may be submitted for consideration to the qualifying activity. Complete information concerning the specification tested to the test procedures or requirements should be provided to support the validity of the data. Only data generated under conditions equal to or more stringent than those specified in the applicable ER specification shall be considered as valid.

5.2.2 Extent and limitation of coverage. Extension of the initially qualified FR level to the next lower level shall be within the same limits of qualification coverage as the initial qualification submission.

Example: When initial qualification is limited to the individual style submitted, the next lower FR level qualification shall be on the same basis. When extension of a qualified level to lower levels (such as "P" (0.1%/1,000 hrs.) to "R" or "U" (0.01%/1,000 hrs.) or "R" or "U" (0.01%/1,000 hrs.) to "S" or "V" (0.001%/1,000 hrs.)) is involved, consideration may be given to the combining of data from two or more styles of similar construction. In these cases, when permitted by the ER specification, permission to combine the data shall be obtained from the qualifying activity and shall be based on the similarity of design, construction, materials, and requirements of the styles involved. When data from two or more styles are combined, the data shall also be separately recorded for each style. Extension of qualification shall cover only the styles represented by the data (see 4.1a).

5.2.3 Details to be specified. The extent and limitation of coverage (see 5.2) is to be specified in the ER specification.

5.2.4 <u>Extension of failure rate (optional)</u>. Manufacturers may designate, at their option, specific samples to load on life test for the sole purpose of accumulating hours to extend a failure rate. These samples must be randomly selected from the manufacturer's production and cover the full range of values that, upon successful completion, will provide for failure rate extension. The test hours accumulated for this test cannot be used by manufacturers as part of their failure rate maintenance testing (see 5.2.2). If this option is chosen, the manufacturer shall notify the qualifying activity:

    a.   That this option is being used prior to loading samples.

    b.   Details of the sample parts that will be used in the upload (date codes, values, and styles).

    c.   Prior to discontinuing the test for any reason. NOTE: The qualifying activity has the option of requiring the manufacturer to do a complete failure analysis on failed test samples and require the manufacturer to notify customers of affected products.

5.3 <u>Procedure III, "Maintenance of FR level qualification"</u>:

    a.   Maintenance of qualification at the qualified FR level shall be predicted upon compliance with the requirements of 5.3.2. The qualification maintenance period shall be specified in the ER specification, and is not an option to be selected by the manufacturer. At the beginning of each qualification maintenance period, the manufacturer shall elect and record the unit-hour requirements ("C" number) that will be met within the qualification maintenance period specified and notify the qualifying activity. If a manufacturer selects a different unit-hour "C" requirement than used during the previous qualification maintenance period, the manufacturer is required to notify the qualifying activity of this change at the beginning of, or prior to, the new maintenance period.

    b.   The maintenance period in effect shall not be changed, regardless of the unit-hours accumulated. Unit-hours that exceed those required for the maintenance period shall be at the manufacturer's risk (within the original "C" number). However, these unit-hours may be used for failure rate extension.

    c.   Qualification shall be maintained periodically, in accordance with 5.3.2, as long as the product remains qualified at any given FR level.

    d.   The same combination of data permitted in establishing lower FR levels (see 5.2) may be used in maintaining these FR levels. However, the FR level established in accordance with Procedure I shall be maintained separately for each style qualified, unless otherwise specified. If qualification has been granted at the "R", "U", "S" or "V" (see 4.1a) level and production is not sufficient on each style to maintain the unit hours required by table IV, the minimum number of unit hours required for any one style would be the unit hours required to maintain that style at the "P" FR level. These unit hours may be obtained from units which are on extended FR tests or from parts manufactured for test. Data may be combined from all similar styles for the remaining unit hours required for the "R", "U", "S" or "V" (see 4.1a) FR level. In instances where qualification by similarity is not detailed in the applicable specifications, determination of similarity and information regarding consolidation of data is to be obtained from the applicable military specification and the qualifying activity. The qualifying activity has the option of style groupings if excessive failures occur in one particular style.

    e.   Where the manufacturer determines that they will not meet the minimum unit hours required during the maintenance period, the qualifying activity shall be notified immediately.

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5.3.1 <u>Applicable data</u>:

a. Data from all FR tests underway or combined during the applicable qualification maintenance period (see 5.3.2) shall be applicable. Only that portion of the data generated during the maintenance period shall be applicable. Specifically the sources of these data are:

   (1) Data from initial qualification samples that were maintained on test for extended FR testing (see 5.1.3).

   (2) Data accumulated from samples subjected to the FR tests specified for lot conformance FR inspection when this procedure is specified (see 5.4). This includes both data from the relatively short time lot conformance FR test as well as the data generated from those samples continued on the extended FR test.

   (3) Data accumulated from samples subjected to extended FR test in those specifications where lot conformance FR inspection is not specified. In these specifications, test samples shall be selected from each inspection lot. These samples shall be accumulated and placed on the specified extended FR test at least once a month or on a lot by basis. A minimum sample size from each lot shall be specified, however, the manufacturer may increase this sample size so that the unit hours generated within the specified qualification maintenance period meet the applicable requirements of table IV.

b. During the FR tests, parameter measurements shall be made periodically as specified. The data so accumulated since previous measurements shall be recorded and added to the total unit hours accumulated from the beginning of the qualification maintenance period. Data shall be recorded from all samples on test during the maintenance period whether or not they are from inspection lots formed during this period.

c. The data shall be representative of the styles and ranges of values produced over the production period covered by the applicable maintenance period.

d. Data from FR tests completed during previous qualification maintenance periods shall not be used (this data may be used for extension of qualification to a lower FR level).

5.3.2 <u>FR sampling plans</u>. Single sampling plans based on a 10-percent confidence level are provided in FRSP-10 table IV. Table V gives two points on each of the operating characteristic curves for FRSP-10, as follows:

a. The true failure rates required to maintain qualification 19 times out of 20.

b. The true failure rates which would cause disqualification 9 times out of 10.

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TABLE IV. FRSP-10.

FR level symbol	Qualified FR level 1/	Qualification maintenance period (in months)			Cumulative unit hours in millions (c = number of failures permitted)											
		A	B	C	c=0	c=1	c=2	c=3	c=4	c=5	c=6	c=7	c=8	c=9	c=10
L	2/	3	6	3/			("M"	row	divided	by	"L")				
M	1.0	3	6	3/		.0532	.110	.175	.243	.315	.389	.467	.544	.623	.701
P	0.1	6	9	6		.532	1.10	1.75	2.43	3.15	3.89	4.67	5.44	6.23	7.01
R or U 4/	0.01	9	12	24		5.32	11.0	17.5	24.3	31.5	38.9	46.7	54.4	62.3	70.1
S or V 4/	0.001	12	15		10.5 5/	53.2	110	175	243	315	389	467	544	623	701

1/ Expressed in %/1,000 hours. For FR level expressed in terms other than %/1,000 hour, see 4.1c and 4.1d.
2/ Where a FR level greater than 1.0 percent is required, level "L" shall be specified and the cumulative unit hours computed as shown.
3/ Each lot.
4/ See 4.1a.
5/ Applicable to FR level "S" and "V" only.

TABLE V. True failure rates for FRSP-10 (prepared
for 1 percent per 1,000 hours FR level).

Number of failures permitted (c)	True failure rate required to maintain qualification 19 times out of 20 (%/1,000 hrs)	True failure rate which would cause disqualification 9 times out of 10 (%/1,000 hrs)
0	0.49	21.8
1	0.67	7.3
2	0.74	4.8
3	0.78	3.8
4	0.81	3.3
5	0.83	2.9
6	0.84	2.7
7	0.85	2.5
8	0.86	2.4
9	0.87	2.3
10	0.88	2.2

NOTE: For other than M (1 percent) FR level, divide above FR values by 10 for P (0.1 percent) level; by 100 for R and U (0.01 percent); or by 1,000 for S and V (0.001 percent) level (see 4.1a).

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5.3.3 <u>Failure to maintain FR level qualification (see 4.3)</u>. Failure to maintain a qualified FR level in accordance with 5.3 shall result in loss of qualification at that FR level. Loss of qualification to a FR shall take place at any time during the qualification maintenance period when the number of failures recorded exceeds the number of failure permitted. The extent of the product affected by the loss of failure rate will be determined by the qualifying activity and may include all product represented by the unit hours on test during the maintenance period in question. If, however, the number of failures recorded exceeds the number of failures permitted (i.e., "c number") by one, the qualifying activity may permit the manufacturer to modify the test plan in an effort to maintain the original failure rate level. This modification to the test plan shall only be allowed with qualifying activity approval following evaluation of the nature and cause of the failure. FR data shall be reviewed by the qualifying activity to justify reestablishment of qualification at a higher FR level. Reestablishment under these circumstances shall be to FRSP-60 or FRSP-90 (see 5.1.5a). All data generated over the production period (corresponding to the qualification maintenance period in FRSP-10) shall be reviewed in reestablishing qualification. FR data shall include the data which caused disqualification. To extend qualification from the reestablished FR level to the lowest level held, the manufacturer shall be required to meet the same requirements specified for Procedure II (see 5.2). Removal of life test samples that have failed during performance of the life test shall be in accordance with the following:

a. When the failure of a sample is within the "C" number predicted for the maintenance period, the manufacturer is permitted to remove the failed sample unit from the life test. Prior notification and approval by the qualifying activity is not required as long as the "C" number is not exceeded. Life test data associated with the failure as well as the failure itself shall be counted toward meeting the number of unit hours and selected "C" number for the maintenance period. Manufacturers are not permitted to discard any sample(s), life test data, or failures without notification and approval by the qualifying activity.

b. When the failure of a sample results in exceeding the specified "C" number for the maintenance period, the manufacturer is permitted to remove the sample(s) from the life test at the manufacturer's risk and shall notify the qualifying activity immediately. Manufacturers are not permitted to discard any sample(s), life test data, or failures without prior notification and approval by the qualifying activity.

c. When life test failures are attributed to an unusual occurrence (test equipment malfunction or failure) the manufacturer is permitted to remove the sample(s) from the life test at the manufacturer's risk and shall notify the qualifying activity immediately. Manufacturers are not permitted to discard any sample(s), life test data, or failures without prior notification and approval by the qualifying activity.

5.3.4 <u>Sublotting failure rate maintenance procedure, failure rates R, U, S and V (see) only (optional)</u>. The manufacturer may select the sublotting procedure at his option with qualifying activity approval. When selecting the sublotting option, the manufacturer shall submit a sublot procedure plan to the qualifying activity prior to the initiation of the maintenance period. The sublot procedure is used to demonstrate/validate failure rate levels for each sublot in addition to the overall failure rate (see 5.3). The procedure plan shall include:

a. The overall "C" number and unit hours selected for the overall plan.

b. The definition and description of individual sublots (styles, combination of styles, values, and value ranges).

c. The "C" number sublot and unit hours for the individual sub-lot (see 5.3a).

NOTE: The individual sublot unit hours shall meet or exceed the unit hours required by the individual "C" number for the failure rate level (see table IV).

d. The sum of individual sublot unit hours shall meet or exceed the unit hours required by the overall "C" number for the failure rate level (see table IV).

e. The combination of sublots and ranges selected shall meet the requirements of 5.3.1c, except as required to meet the minimum unit-hours requirement.

f. All changes to the previously accepted plan shall be submitted for review and approval of the qualifying activity. The submission and approval shall occur prior to subsequent initiation of a maintenance period.

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5.3.4.1 <u>Failure to meet overall "C" number</u>. The following criteria, only applies where the overall "C" number has been exceeded: Where the combined lot submission exceeds the selected "C" = number, the sublotting plan is reviewed to determine if the submission exceeds the select "C" = number. If failures have occurred in only one style above and beyond the stated limit in the sublotting table, those styles that did not exceed the sublot "C"= number can be released with the qualifying activity's approval. Where a "C" number has been exceeded for more than one sublot, the manufacturer has failed to maintain FR and shall notify the qualifying activity and proceed as stated in 5.4.4.

5.3.4.2 <u>Overall "C" number not exceeded</u>. Where the overall "C" number is not exceeded, evaluation of the individual sublot is not required, even though the individual sublot "C" number is exceeded.

5.3.4.3 <u>Example of sublot calculation</u>. The following example provides guidance for use of the sublot maintenance option (see table VI):

    a. Five styles are combined for "S" or "V" (see 4.1a) failure rate level under period A.

    b. A C = 2 failure rate maintenance plan is established for a 12 month period.

    c. This requires 110 million unit hours for the 12 month period.

TABLE VI. <u>Example of sublot calculation plan</u>.

Unit hours	C = #	Failures occurring				
		A	B	C	D	E
Sublot 1 > or = 10.5 million	0	1	0	2	0	1
Sublot 2 > or = 53.2 million	1	1	2	1	0	0
Sublot 3 > or = 10.5 million	0	1	0	0	0	1
Sublot 4 > or = 10.5 million	0	0	1	0	0	0
Sublot 5 > or = 10.5 million	0	0	0	0	3	0
Total > or = 110.0 million	C = 2					

    A. All sublots affected by reduction of failure rate.

    B. All sublots affected by reduction of failure rate.

    C. Only sublot "1" affected by reduction of failure rate.

    D. Only sublot "5" affected by reduction of failure rate.

    E. Overall "C" number not exceeded; all lots acceptable.

5.3.5 <u>Details to be specified</u>. The following details are to be specified in the ER specification:

    a. Applicable qualification maintenance period (see 5.3.2). For those ER specifications where Procedure IV is specified, the maintenance period letter shall correspond to the lot sampling plan letter of Procedure IV, e.g., period "A", when plan "A" is specified.

    b. Data combinations permitted (see 5.3d).

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5.4 Procedure IV, "Lot conformance FR inspection". Where Procedure IV is specified (see 4.6), sample units shall be selected at random from each inspection lot. As far as practicable each style, value, class, and grade allowed in lot formation, which are in the lot formed, shall be represented in the sample in approximately the same proportion as in the inspection lot. Permissible combinations of styles and values represented in the inspection lot shall be the same combinations permitted for Procedures I and II.

a. The minimum number of sample units to be subjected to lot conformance FR inspection shall be as specified in 5.4.1. Manufacturers may test larger sample sizes than indicated herein; the number of failures permitted shall be 1.

b. When the volume of production or the frequency of orders, are such that, temporarily, compliance with this procedure presents an economic problem, the qualifying activity shall be contacted. At the discretion of the qualifying activity, alternate sample sizes and maintenance periods shall be provided.

5.4.1 Sampling plans. Unless otherwise specified in the ER specification, the lot conformance FR sampling plans shall be as specified in table VII.

TABLE VII. Lot conformance FR plan.

FR levels	Sample size for lot conformance plan			Number of failures permitted
	A	B	C	
All levels				
L, M, P, R, S, U, V (see 4.1a)	110	36	21	1

5.4.2 Extended FR tests. A minimum number of sample units as specified shall be selected at random from each inspection lot and subjected to the specified extended FR test. The manufacturer may increase this sample size from lot to lot, if desired, in order to develop the necessary number of unit hours of data required for Procedure III or IV; however, each sample shall be tested for the full length of time specified for Procedure I (see 5.1.5d). The units selected for the extended FR test may be either:

a. From those subjected to lot conformance FR inspection tests of Procedure IV, or

b. From remaining units in the inspection lot. In any case, the units to be subjected to the extended FR test shall be predetermined before any FR tests are initiated. The extended FR test may be either initiated periodically with units accumulated from each inspection lot, or may be initiated on a lot by lot basis. The units selected for extended FR tests from each lot, shall be representative of the styles and values included in the lot to the maximum extent possible.

5.4.3 Action in case of failure:

a. Where the lot conformance FR inspection enables early shipment of an inspection lot, a failure, to the lot conformance failure definition, should result only in disallowing early shipment of the inspection lot. If continuation of the full qualification period does not result in an unacceptable number of failures, to the failure definition, the inspection lot may then be shipped.

b. Those units in a rejected lot which were predesignated for extended FR testing shall either remain or be placed on test for the full length of time.

c. Failures in excess of those permitted during extended FR testing shall be reported to the qualifying activity, and to all known recipients of the parts from the inspection lots represented by the sample.

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5.4.4 <u>Details to be specified</u>. The following details are to be specified in the ER specification when Procedure IV is utilized:

    a.   Lot conformance plan (the plan letter shall correspond to the qualification maintenance period letter of FRSP-10) (see 5.4.1 and 5.3.2).

    b.   Duration of lot conformance test.

    c.   Failure criteria (see 4.2).

    d.   Permissible combination of styles and values that may be represented in an inspection lot (see 5.4).

    e.   Disposition of samples and inspection lot (ship samples with the lot, ship lot at specified test period, keep samples on test, etc.,) (see 4.7).

5.5 <u>Procedure for truncation of life test data</u>. Truncation shall not be used to avoid a change in the FR level. The truncation point shall occur, with the qualifying activity's approval, either:

    a.   After life test failure(s) has occurred and an assignable cause has been found and corrective action acceptable to the qualifying activity has been successfully implemented.

    b.   Following implementation of a new design or process improvement and a failure rate extension is being sought.

An improved FR shall not be granted by the qualifying activity until the first test samples after the truncation point have completed the test. If the truncation procedure is used, no device shall be taken off test even if the data generated by the device on test is not to be used for determination of the "new" FR. FR shall be maintained for the current maintenance period. Random failures are not cause for truncation, and truncation shall not be used to avoid a change in the FR level. Also, truncation shall not be used if the cause of the failure(s) cannot be determined.

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6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 <u>FR level conversion</u>. FR levels may be converted to mean time to failure (MTTF) as follows:

MTTF = 100,000 ÷ %/1,000 hours.

Example: Where FR level P = .1 percent per 1,000 hours.

MTTF = 100,000 ÷ .1 = 1 failure per 10^6 hours.

6.2 <u>Computation of the unit hour requirement</u>. Table VIII is a complete Poisson distribution table that is suitable for computing unit hours. To calculate unit hours with a "C" number of 0 (for table I, table II, or table IV), determine the probability of acceptance (Pa) by subtracting the FRSP value (.60, .90, or .10) from 1.

Example: Pa = 1 - .60 = .40

From the Poisson table, find .40 under the C = 0 column. This value of "m" is found, by interpolation, to be .916 for level M qualification and "m" in the table is the total of failure rate λ (lambda) multiplied by the time (test hours).

m = λ × t

unit hours = m ÷ λ (1%/1,000 hours).

unit hours = m ÷ λ = .916 ÷ .00001 = .0916 million hours.

Values for P, R, U, S and V (see 4.1a levels are found by multiplying the previous level by 10.

6.3 <u>Computation of the true failure rate</u>. Table VIII is used again to compute the true failure rates for qualifying 19 of 20 times and for rejecting 9 of 10 times. To calculate the true failure rate to accept 19 out of 20 times (=.95), look up .95 in the C = 0 column (interpolation is needed). The value of "m" is found to be .051. Referring to 6.2, λ (true failure rate) is found by dividing "m" by the time for FRSP-60.

Example: λ = m ÷ t = .051 ÷ .0916 million hours = .06 percent per 1,000 hours.

Repeat the process to determine the true failure rate for FRSP-90.

To calculate the true failure rate to reject 9 out of 10 times (Pa = 1 - .90) look up .10 in the C = 0 column (interpolation is needed). The value of "m" is found to be 2.30. Referring to 6.2, λ (true failure rate) is found by dividing "m" by time for FRSP-60.

Example: λ = m ÷ t = 2.30 ÷ .0916 million hours = 2.51 percent per 1,000 hours.

Repeat the process to calculate the values in table V.

6.4 <u>Subject term (key word) listing</u>.

Confidence levels	Failure rate sampling plan (FRSP)
Cumulative unit hours	Maintenance of qualification
Established Reliability	Qualification
Extension of qualification	Qualifying activity
Failure rate (FR)	Truncation of data

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6.5 Changes notations. The margins of this standard are marked with asterisks to indicate modification generated by this change. This was done as a convenience only and the Government assumes no liability whatsoever for any in accuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire contact irrespective of the marginal notations.

TABLE VIII. Cumulative poisson probabilities.

C M	0	1	2	3	4	5
0.01	.990	1.000				
0.02	.980	1.000				
0.03	.970	1.000				
0.04	.961	.999	1.000			
0.05	.951	.999	1.000			
0.06	.942	.998	1.000			
0.07	.932	.998	1.000			
0.08	.923	.997	1.000			
0.09	.914	.996	1.000			
0.10	.905	.995	1.000			
0.12	.887	.993	1.000			
0.14	.869	.991	1.000			
0.16	.852	.988	.999	1.000		
0.18	.835	.986	.999	1.000		
0.20	.819	.982	.999	1.000		
0.22	.803	.979	.998	1.000		
0.24	.787	.975	.998	1.000		
0.26	.771	.972	.998	1.000		
0.28	.756	.967	.997	1.000		
0.30	.741	.963	.996	1.000		
0.32	.726	.959	.996	1.000		
0.34	.712	.954	.995	1.000		
0.36	.698	.949	.994	.999	1.000	
0.38	.684	.944	.993	.999	1.000	
0.40	.670	.938	.992	.999	1.000	
0.42	.657	.933	.991	.999	1.000	
0.44	.644	.927	.990	.999	1.000	
0.46	.631	.922	.988	.999	1.000	
0.48	.619	.916	.987	.998	1.000	
0.50	.607	.910	.986	.998	1.000	
0.52	.595	.904	.984	.998	1.000	
0.54	.583	.897	.982	.998	1.000	
0.56	.571	.891	.981	.997	1.000	
0.58	.560	.885	.979	.997	1.000	
0.60	.549	.878	.977	.997	1.000	
0.62	.538	.871	.975	.996	1.000	
0.64	.527	.865	.973	.996	.999	
0.66	.517	.858	.971	.995	.999	1.000
0.68	.507	.851	.968	.995	.999	1.000
0.70	.497	.844	.966	.994	.999	1.000
0.72	.487	.837	.963	.994	.999	1.000
0.74	.477	.830	.961	.993	.999	1.000
0.76	.468	.823	.958	.992	.999	1.000
0.78	.458	.816	.955	.992	.999	1.000
0.80	.449	.809	.953	.991	.999	1.000

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TABLE VIII. Cumulative poisson probabilities – Continued.

M \ C	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
0.82	.440	.802	.950	.990	.998	1.000									
0.84	.432	.794	.947	.989	.998	1.000									
0.86	.423	.787	.944	.988	.998	1.000									
0.88	.415	.780	.940	.988	.998	1.000									
0.90	.407	.772	.937	.987	.998	1.000									
0.92	.399	.765	.934	.986	.997	1.000									
0.94	.391	.758	.930	.984	.997	1.000									
0.96	.383	.750	.927	.983	.997	1.000									
0.98	.375	.743	.923	.982	.997	.999	1.000								
1.00	.368	.736	.920	.981	.996	.999	1.000								
1.10	.333	.699	.900	.974	.995	.999	1.000								
1.20	.301	.663	.879	.966	.992	.998	1.000								
1.30	.273	.627	.857	.957	.989	.998	1.000								
1.40	.247	.592	.833	.946	.986	.997	.999	1.000							
1.50	.223	.558	.809	.934	.981	.996	.999	1.000							
1.60	.202	.525	.783	.921	.976	.994	.999	1.000							
1.70	.183	.493	.757	.907	.970	.992	.998	1.000							
1.80	.165	.463	.731	.891	.964	.990	.997	.999	1.000						
1.90	.150	.434	.704	.875	.956	.987	.997	.999	1.000						
2.00	.135	.406	.677	.857	.947	.983	.995	.999	1.000						
2.20	.111	.355	.623	.819	.928	.975	.993	.998	1.000						
2.40	.091	.308	.570	.779	.904	.964	.988	.997	.999	1.000					
2.60	.074	.267	.518	.736	.877	.951	.983	.995	.999	1.000					
2.80	.061	.231	.469	.692	.848	.935	.976	.992	.998	.999	1.000				
3.00	.050	.199	.423	.647	.815	.916	.966	.988	.996	.999	1.000				
3.20	.041	.171	.380	.603	.781	.895	.955	.983	.994	.998	1.000				
3.40	.033	.147	.340	.558	.744	.871	.942	.977	.992	.997	.999	1.000			
3.60	.027	.126	.303	.515	.706	.844	.927	.969	.988	.996	.999	1.000			
3.80	.022	.107	.269	.473	.668	.816	.909	.960	.984	.994	.998	.999	1.000		
4.00	.018	.092	.238	.433	.629	.785	.889	.949	.979	.992	.997	.999	1.000		
4.20	.015	.078	.210	.395	.590	.753	.867	.936	.972	.989	.996	.999	1.000		
4.40	.012	.066	.185	.359	.551	.720	.844	.921	.964	.985	.994	.998	.999	1.000	
4.60	.010	.056	.163	.326	.513	.686	.818	.905	.955	.980	.992	.997	.999	1.000	
4.80	.008	.048	.143	.294	.476	.651	.791	.887	.944	.975	.990	.996	.999	1.000	
5.00	.007	.040	.125	.265	.440	.616	.762	.867	.932	.968	.986	.995	.998	.999	1.000
5.20	.006	.034	.109	.238	.406	.581	.732	.845	.918	.960	.982	.993	.997	.999	1.000
5.40	.005	.029	.095	.213	.373	.546	.702	.822	.903	.951	.977	.990	.996	.999	1.000
5.60	.004	.024	.082	.191	.342	.512	.670	.797	.886	.941	.972	.988	.995	.998	.999
5.80	.003	.021	.072	.170	.313	.478	.638	.771	.867	.929	.965	.984	.993	.997	.999
6.00	.002	.017	.062	.151	.285	.446	.606	.744	.847	.916	.957	.980	.991	.996	.999
6.20	.002	.015	.054	.134	.259	.414	.574	.716	.826	.902	.949	.975	.989	.995	.998
6.40	.002	.012	.046	.119	.235	.384	.542	.687	.803	.886	.939	.969	.986	.994	.997
6.60	.001	.010	.040	.105	.213	.355	.511	.658	.780	.869	.927	.963	.982	.992	.997
6.80	.001	.009	.034	.093	.192	.327	.480	.628	.755	.850	.915	.955	.973	.990	.996
7.00	.001	.007	.030	.082	.173	.301	.450	.599	.729	.830	.901	.947	.973	.987	.994
7.20	.001	.006	.025	.072	.156	.276	.420	.569	.703	.810	.887	.937	.967	.984	.993
7.40	.001	.005	.022	.063	.140	.253	.392	.539	.676	.788	.871	.926	.961	.980	.991
7.60	.001	.004	.019	.055	.125	.231	.365	.510	.648	.765	.854	.915	.954	.976	.989
7.80	.000	.004	.016	.048	.112	.210	.338	.481	.620	.741	.835	.902	.945	.971	.986
8.00	.000	.003	.014	.042	.100	.191	.313	.453	.593	.717	.816	.888	.936	.966	.983

M \ C	15	16	17	18	19
5.60	1.000				
5.80	1.000				
6.00	.999	1.000			
6.20	.999	1.000			
6.40	.999	1.000			
6.60	.999	.999	1.000		
6.80	.998	.999	1.000		
7.00	.998	.999	1.000		
7.20	.997	.999	1.000		
7.40	.996	.998	.999	1.000	
7.60	.995	.998	.999	1.000	
7.80	.993	.997	.999	1.000	
8.00	.992	.996	.998	.999	1.000

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TABLE VIII. Cumulative poisson probabilities – Continued.

C\M	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
8.2	.000	.003	.012	.037	.089	.174	.290	.425	.565	.692	.796	.873	.926	.960	.979
8.4	.000	.002	.010	.032	.079	.157	.267	.399	.537	.666	.774	.857	.915	.952	.975
8.6	.000	.002	.009	.028	.070	.142	.246	.373	.509	.640	.752	.840	.903	.945	.970
8.8	.000	.001	.007	.024	.062	.128	.226	.348	.482	.614	.729	.822	.890	.936	.965
9.0	.000	.001	.006	.021	.055	.116	.207	.324	.456	.587	.706	.803	.876	.926	.959
9.2	.000	.001	.005	.018	.049	.104	.189	.301	.430	.561	.682	.783	.861	.916	.952
9.4	.000	.001	.005	.016	.043	.093	.173	.279	.404	.535	.658	.763	.845	.904	.944
9.6	.000	.001	.004	.014	.038	.084	.157	.258	.380	.509	.633	.741	.828	.892	.936
9.8	.000	.001	.003	.012	.033	.075	.143	.239	.356	.483	.608	.719	.810	.879	.927
10.0		.000	.003	.010	.029	.067	.130	.220	.333	.458	.583	.697	.792	.864	.917
10.5		.000	.002	.007	.021	.050	.102	.179	.279	.397	.521	.639	.742	.825	.888
11.0		.000	.001	.005	.015	.038	.079	.143	.232	.341	.460	.579	.689	.781	.854
11.5		.000	.001	.003	.011	.028	.060	.114	.191	.289	.402	.520	.633	.733	.815
12.0		.000	.001	.002	.008	.020	.046	.090	.155	.242	.347	.462	.576	.682	.772
12.5			.000	.002	.005	.015	.035	.070	.125	.201	.297	.406	.519	.628	.725
13.0			.000	.001	.004	.011	.026	.054	.100	.166	.252	.353	.463	.573	.675
13.5			.000	.001	.003	.008	.019	.041	.079	.135	.211	.304	.409	.518	.623
14.0				.000	.002	.006	.014	.032	.062	.109	.176	.260	.358	.464	.570
14.5				.000	.001	.004	.010	.024	.048	.088	.145	.220	.311	.413	.518
15.0				.000	.001	.003	.008	.018	.037	.070	.118	.185	.268	.363	.466
16.0					.000	.001	.004	.010	.022	.043	.077	.127	.193	.275	.368
17.0					.000	.001	.002	.005	.013	.026	.049	.085	.135	.201	.281
18.0						.000	.001	.003	.007	.015	.030	.055	.092	.143	.208
19.0						.000	.001	.002	.004	.009	.018	.035	.061	.098	.150

C\M	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
8.2	.990	.995	.998	.999	1.000										
8.4	.987	.994	.997	.999	1.000										
8.6	.985	.993	.997	.999	.999	1.000									
8.8	.982	.991	.996	.998	.999	1.000									
9.0	.978	.989	.995	.998	.999	1.000									
9.2	.974	.987	.993	.997	.999	.999	1.000								
9.4	.969	.984	.992	.996	.998	.999	1.000								
9.6	.964	.981	.990	.995	.998	.999	1.000								
9.8	.958	.977	.980	.994	.997	.999	.999	1.000							
10.0	.951	.973	.986	.993	.997	.998	.999	1.000							
10.5	.932	.960	.978	.988	.994	.997	.999	.999	1.000						
11.0	.907	.944	.968	.982	.991	.995	.998	.999	1.000						
11.5	.878	.924	.954	.974	.986	.992	.996	.998	.999	1.000					
12.0	.844	.899	.937	.963	.979	.988	.994	.997	.999	.999	1.000				
12.5	.806	.869	.916	.948	.969	.983	.991	.995	.998	.999	.999	1.000			
13.0	.764	.835	.890	.930	.957	.975	.986	.992	.996	.998	.999	1.000			
13.5	.718	.798	.861	.908	.942	.965	.980	.989	.994	.997	.998	.999	1.000		
14.0	.669	.756	.827	.883	.923	.952	.971	.983	.991	.995	.997	.999	.999	1.000	
14.5	.619	.711	.790	.853	.901	.936	.960	.976	.986	.992	.996	.998	.999	.999	1.000
15.0	.568	.664	.749	.819	.875	.917	.947	.967	.981	.989	.994	.997	.998	.999	1.000
16.0	.467	.566	.659	.742	.812	.868	.911	.942	.963	.978	.987	.993	.996	.998	.999
17.0	.371	.468	.564	.655	.736	.805	.861	.905	.937	.959	.975	.985	.991	.995	.997
18.0	.287	.375	.469	.562	.651	.731	.799	.855	.899	.932	.955	.972	.983	.990	.994
19.0	.215	.292	.378	.469	.561	.647	.725	.793	.849	.893	.927	.951	.969	.980	.988

C\M	30	31	32	33	34	35
16.0	.999	1.000				
17.0	.999	.999	1.000			
18.0	.997	.998	.999	.999	1.000	
19.0	.993	.996	.998	.999	.999	1.000

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TABLE VIII. Cumulative poisson probabilities – Continued.

C / M	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
20.0	.000	.001	.002	.005	.011	.021	.039	.066	.105	.157	.221	.297	.381	.470	.559
21.0		.000	.001	.003	.006	.013	.025	.043	.072	.111	.163	.227	.302	.384	.471
22.0		.000	.001	.002	.004	.008	.015	.028	.048	.077	.117	.169	.232	.306	.387
23.0			.000	.001	.002	.004	.009	.017	.031	.052	.082	.123	.175	.238	.310
24.0				.000	.001	.003	.005	.011	.020	.034	.056	.087	.128	.180	.243
25.0				.000	.001	.001	.003	.006	.012	.022	.038	.060	.092	.134	.185
26.0					.000	.001	.002	.004	.008	.014	.025	.041	.065	.097	.139
27.0						.000	.001	.002	.005	.009	.016	.027	.044	.069	.101
28.0						.000	.001	.001	.003	.005	.010	.018	.030	.048	.073
29.0							.000	.001	.002	.003	.006	.012	.020	.033	.051
30.0								.000	.001	.002	.004	.007	.013	.022	.035
31.0								.000	.001	.001	.002	.005	.008	.014	.024
32.0									.000	.001	.001	.003	.005	.009	.016
33.0										.000	.001	.002	.003	.006	.010
34.0											.000	.001	.002	.004	.007

C / M	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
20.0	.644	.721	.787	.843	.888	.922	.948	.966	.978	.987	.992	.995	.997	.999	.999
21.0	.558	.640	.716	.782	.838	.883	.917	.944	.963	.976	.985	.991	.994	.997	.998
22.0	.472	.556	.637	.712	.777	.832	.877	.913	.940	.959	.973	.983	.989	.994	.996
23.0	.389	.472	.555	.635	.708	.772	.827	.873	.908	.936	.956	.971	.981	.988	.993
24.0	.314	.392	.473	.554	.632	.704	.768	.823	.868	.904	.932	.953	.969	.979	.987
25.0	.247	.318	.394	.473	.553	.629	.700	.763	.818	.863	.900	.929	.950	.966	.978
26.0	.190	.252	.321	.396	.474	.552	.627	.697	.759	.813	.859	.896	.925	.947	.964
27.0	.144	.195	.256	.324	.398	.474	.551	.625	.693	.755	.809	.855	.892	.921	.944
28.0	.106	.148	.200	.260	.327	.400	.475	.550	.623	.690	.752	.805	.850	.888	.918
29.0	.077	.110	.153	.204	.264	.330	.401	.475	.549	.621	.687	.748	.801	.846	.884
30.0	.054	.081	.115	.157	.208	.267	.333	.403	.476	.548	.619	.685	.744	.797	.843
31.0	.038	.058	.084	.119	.161	.212	.271	.335	.405	.476	.548	.617	.682	.741	.794
32.0	.026	.041	.061	.088	.123	.166	.216	.274	.338	.406	.476	.547	.615	.679	.738
33.0	.018	.028	.043	.064	.092	.127	.170	.220	.277	.340	.408	.477	.546	.613	.677
34.0	.012	.019	.030	.046	.067	.095	.131	.173	.224	.280	.343	.409	.477	.545	.612

C / M	36	37	38	39	40	41	42	43
20.0	1.000							
21.0	.999	.999	1.000					
22.0	.998	.999	.999	1.000				
23.0	.996	.997	.999	.999	1.000			
24.0	.992	.995	.997	.998	.999	.999	1.000	
25.0	.985	.991	.994	.997	.998	.999	.999	1.000
26.0	.976	.984	.990	.994	.996	.998	.999	.999
27.0	.961	.974	.983	.989	.993	.996	.997	.998
28.0	.941	.959	.972	.981	.988	.992	.995	.997
29.0	.914	.938	.956	.970	.979	.986	.991	.994
30.0	.880	.911	.935	.954	.968	.978	.985	.990
31.0	.839	.977	.908	.932	.951	.966	.976	.984
32.0	.790	.835	.873	.904	.929	.949	.964	.975
33.0	.735	.787	.832	.870	.901	.926	.946	.962
34.0	.674	.732	.783	.828	.866	.898	.924	.944

C / M	51	52	53	54	55
31.0	1.000				
32.0	.999	1.000			
33.0	.998	.999	1.000		
34.0	.996	.998	.999	.999	1.000

C / M	44	45	46	47	48	49	50
26.0	1.000						
27.0	.999	.999	1.000				
28.0	.998	.999	.999	1.000			
29.0	.996	.998	.999	.999	1.000		
30.0	.994	.996	.998	.999	.999	.999	1.000
31.0	.989	.993	.996	.997	.998	.999	.999
32.0	.983	.988	.992	.995	.997	.998	.999
33.0	.973	.981	.987	.992	.995	.997	.998
34.0	.960	.971	.980	.986	.991	.994	.996

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TABLE VIII. Cumulative poisson probabilities – Continued.

M ＼ C	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
35.0	.000	.001	.001	.002	.004	.008	.013	.021	.032	.049	.070	.099	.134	.177	.227
36.0		.000	.001	.001	.003	.005	.008	.014	.022	.035	.051	.074	.102	.138	.181
37.0			.000	.001	.002	.003	.006	.009	.015	.024	.037	.054	.077	.106	.141
38.0			.000	.001	.001	.002	.004	.006	.010	.017	.026	.039	.057	.080	.109
39.0				.000	.001	.001	.002	.004	.007	.011	.018	.028	.041	.059	.083
40.0					.000	.001	.001	.003	.004	.008	.012	.019	.029	.043	.062
41.0						.000	.001	.002	.003	.005	.008	.013	.021	.031	.045
42.0						.000	.001	.001	.002	.003	.006	.009	.014	.022	.033
43.0							.000	.001	.001	.002	.004	.006	.010	.016	.024
44.0								.000	.001	.001	.002	.004	.007	.011	.017
45.0									.000	.001	.002	.003	.004	.007	.012
46.0									.000	.001	.001	.002	.003	.005	.008
47.0										.000	.001	.001	.002	.003	.005
48.0											.000	.001	.001	.002	.004
49.0												.000	.001	.001	.002

M ＼ C	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
35.0	.283	.345	.410	.478	.545	.610	.672	.729	.780	.825	.863	.895	.921	.941	.958
36.0	.230	.286	.347	.411	.478	.544	.609	.670	.726	.777	.822	.860	.892	.918	.939
37.0	.184	.233	.289	.349	.413	.478	.544	.607	.668	.724	.774	.819	.857	.889	.915
38.0	.145	.187	.237	.291	.351	.414	.478	.543	.606	.666	.721	.771	.816	.854	.886
39.0	.112	.148	.191	.240	.294	.353	.415	.479	.542	.605	.664	.719	.768	.813	.851
40.0	.086	.115	.151	.194	.242	.296	.355	.416	.479	.542	.603	.662	.716	.766	.810
41.0	.064	.088	.118	.155	.197	.245	.299	.356	.417	.479	.541	.602	.660	.714	.763
42.0	.048	.067	.091	.121	.158	.200	.248	.301	.358	.418	.479	.541	.601	.658	.712
43.0	.035	.050	.069	.094	.124	.161	.203	.251	.303	.360	.419	.480	.540	.600	.656
44.0	.025	.037	.052	.072	.097	.127	.164	.206	.253	.305	.361	.420	.480	.540	.599
45.0	.018	.026	.038	.054	.074	.099	.130	.166	.208	.256	.307	.363	.421	.480	.540
46.0	.012	.019	.028	.040	.056	.077	.102	.133	.169	.211	.258	.309	.364	.422	.480
47.0	.009	.013	.020	.029	.042	.058	.079	.105	.136	.172	.214	.260	.311	.366	.423
48.0	.006	.009	.014	.021	.031	.044	.060	.081	.107	.138	.175	.216	.263	.313	.367
49.0	.004	.006	.010	.015	.023	.032	.046	.062	.084	.110	.141	.177	.219	.265	.315

M ＼ C	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
35.0	.970	.979	.985	.990	.993	.996	.997	.998	.999	.999	1.000				
36.0	.955	.968	.977	.984	.989	.993	.995	.997	.998	.999	.999	1.000			
37.0	.937	.953	.966	.976	.983	.989	.992	.995	.997	.998	.999	.999	.999	1.000	
38.0	.913	.934	.951	.965	.975	.982	.988	.992	.994	.996	.998	.998	.999	.999	1.000
39.0	.883	.910	.932	.949	.963	.973	.981	.987	.991	.994	.996	.997	.998	.999	.999
40.0	.848	.880	.908	.930	.947	.961	.972	.980	.986	.990	.993	.996	.997	.998	.999
41.0	.807	.845	.878	.905	.927	.945	.960	.971	.979	.985	.990	.993	.995	.997	.998
42.0	.760	.804	.842	.875	.902	.925	.943	.958	.969	.978	.984	.989	.992	.995	.997
43.0	.709	.758	.801	.840	.872	.900	.923	.941	.956	.968	.977	.983	.988	.992	.994
44.0	.655	.707	.756	.799	.837	.870	.898	.921	.939	.954	.966	.975	.982	.987	.991
45.0	.598	.653	.705	.753	.796	.834	.867	.895	.918	.937	.953	.965	.974	.981	.987
46.0	.539	.597	.652	.703	.751	.794	.832	.865	.893	.916	.935	.951	.963	.973	.980
47.0	.481	.539	.596	.650	.701	.749	.791	.829	.862	.890	.914	.934	.949	.962	.972
48.0	.423	.481	.538	.595	.649	.700	.746	.789	.827	.860	.888	.912	.932	.948	.960
49.0	.368	.424	.481	.538	.594	.647	.698	.744	.787	.824	.857	.886	.910	.930	.946

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TABLE VIII. Cumulative poisson probabilities – Continued.

C / M	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
39.0	1.000														
40.0	.999	1.000													
41.0	.999	.999	.999	1.000											
42.0	.998	.999	.999	.999	1.000										
43.0	.996	.997	.998	.999	.999	1.000									
44.0	.994	.996	.997	.998	.999	.999	1.000								
45.0	.991	.994	.996	.997	.998	.999	.999	.999	1.000						
46.0	.986	.990	.993	.995	.997	.998	.999	.999	.999	1.000					
47.0	.979	.985	.989	.993	.995	.997	.998	.998	.999	.999	1.000				
48.0	.971	.978	.984	.989	.992	.995	.996	.997	.998	.999	.999	1.000			
49.0	.959	.969	.977	.984	.988	.992	.994	.996	.997	.998	.999	.999	.999	1.000	

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APPENDIX A

GUIDANCE FOR SPECIFICATION WRITERS

A.1. SCOPE

A.1.1 <u>Scope</u>. This appendix provides an outline and description of requirements which are to be included in ER specifications. Their use will insure uniform requirements and procedures in all ER specifications. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

A.2. APPLICABLE DOCUMENTS.

A.2.1 <u>General</u>. The documents listed in this section are specified in this appendix of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in appendix of this standard, whether or not they are listed.

A.2..2 <u>Government documents</u>.

A.2.2.1 <u>Specifications, standards, and handbooks</u>. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are cited in the solicitation or contract.

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-217   -   Reliability Prediction of Electronic Equipment.

*   (Copies of these documents are available online at https://quicksearch.dla.mil.)

A.2.3 <u>Order of precedence</u>. Unless otherwise noted or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

A.3. QUALIFICATION

A.3.1 <u>Qualification at the initial FR level</u>. Qualification shall be granted at the FR level representing the state-of-the-art. Unless valid data from current production substantiates other FR levels, qualification shall be granted at the "M" (1.0%) level. Qualification at the "M" (1.0%) level shall be based on results of qualification FR tests on a single sample size. A sampling plan in which the maximum number of failures permitted is greater than zero shall be used. In those ER specifications in which the initial qualification ER test is shorter in time than the extended ER test, all units subject to the qualification FR test shall be maintained on test for the time specified for the extended FR test. It is preferred that qualification be granted at initial failure rate through testing of a specified sample size and that qualification to lower failure rate levels be accomplished by accumulation of data from successive inspection lots. In this manner the failure rate will be more representative of production capability and history.

A.3.2 <u>Extension of qualification to FR levels</u>. Extension of qualification to lower FR level shall be accomplished by accumulating data from FR tests performed on sample selected from successive inspection lots. Qualification at lower failure rates is thus based upon data taken over a long period of production and not a single sample produced at one time. Extension of qualification is granted at the same confidence level (60 percent or 90 percent) as was used for the initial FR qualification.

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A.3.3 <u>Maintenance of FR level qualification</u>. Maintenance of FR level qualification shall be monitored by means of a sampling plan based on a 10 percent confidence level. The sampling plan should provide the necessary number of cumulative unit hours (excluding permitted failures) required over a specified time period to maintain the qualified FR level.

A.3.4 <u>Verification of qualification</u>. Every 6 months the manufacturer shall compile a summary of the results of conformance inspection and extended FR test data, in the form of a verification of qualification report, and forward it to the qualifying activity within 30 days after the end of the reporting period as the basis of continued qualification approval. In addition, the manufacturer shall immediately notify the qualifying activity whenever the FR data indicates that the manufacturer has failed to maintain the qualified FR level or the periodic inspection data indicates failure of the qualified product to meet the requirements of the specification. Continuation of qualification approval shall be based on evidence that over the 6 month period, the following has been met:

   a.   The manufacturer meets the requirements of MIL-STD-790.

   b.   The manufacturer has not modified the design of the item.

   c.   The specification requirements for the item have not been amended so as to affect the character of the item.

   d.   Lot rejection under the applicable inspection groups does not exceed the specified percentage or one lot, whichever is greater (see 5.3).

   e.   Requirements for periodic tests are met, if applicable.

   f.   The records of FR tests substantiate that the "L" (specified percentage), "M" (1.0%), or "P" (0.1%) FR level has been maintained or that the manufacturer continues to meet the "R" or "U" (0.01%) or "S" or "V" (see 4.1a) (0.001%) FR level for which qualified although the total component hours testing does not as yet meets the requirements of 5.3.

When periodic requirements were not met and the manufacturer has taken corrective action satisfactory to the Government, periodic retesting shall be instituted. A summary of the retesting shall be forwarded to the qualifying activity within 30 days after completion of the retest.

A.4. LOT CONFORMANCE FR INSPECTIONS (WHEN SPECIFIED)

A.4.1 <u>Sampling plan</u>. When lot conformance FR inspection is considered necessary, the sampling plans of table VI, provided herein, should be used. They provide reasonable assurance of lot quality and that the lot under inspection is not significantly different from previously accepted lots. In view of the fact that in most ER specifications, 100 percent of the product will have been subjected to burn-in/screening tests which are designed to eliminate early life failures, the need for lot conformance FR tests should be carefully considered. The effect of these lot-by lot tests on the price and delay in delivery of ER parts should be evaluated against the additional verification information to be gained.

A.5. GENERAL

A.5.1 <u>Failure criteria</u>. The failure criteria for the relatively "short-time" FR test used for lot conformance inspection may differ from the failure criteria established for the extended FR test. The data resulting from the lot conformance FR inspection test, therefore should be analyzed in two ways for the two different purposes it will be used. First, for purposes of lot conformance FR inspection, the failure criteria established for the "short-time" FR test would be applied. Secondly, for purposes of adding to the FR test data being accumulated for FR determinations, the failure criteria established for the extended FR test would be applied to determine whether a failure occurred with these criteria. Therefore, a failure in the lot conformance FR inspection test may not necessarily constitute a failure when the unit hours are recorded for the FR determinations. This is necessary since, for FR determination, the failure criteria should be the same for all data used. For FR determination a single failure criteria should be specified for all measurements.

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A.5.2 <u>Duration of FR test</u>. The ER specification shall indicate the duration for the lot conformance FR inspection test and the extended FR test.

A.5.3 <u>Screening tests</u>. In order to provide the consumer with further assurance of the reliability of the products shipped, ER specifications should include, where applicable, screening tests performed on a 100 percent inspection basis. However, before a screening test is included in an ER specification, there should be sound technical basis for its inclusion and sufficient data to support its effectiveness on all types of product included in the specification. These tests should be specified as a prerequisite for conformance inspection and should include a requirement providing for lot rejection when a specified percentage of the lot exceeds the screening requirements. A burn-in test under conditions of accelerated voltage and temperature or other suitable stresses may be specified as part of the screening tests. Screening tests should be performed only once and preferably in conjunction with the Government inspector since it should not be repeated for the purpose of reinspection.

A.5.4 <u>Accelerated FR tests and acceleration factors</u>. If engineering considerations permit the use of valid accelerated test procedures and associated acceleration factors, the acceleration factor should be applied primary to reduce the duration of the FR test and not to reduce sample size. Caution must be exercised where large acceleration factors are involved in reducing the duration of the FR test. The test time should not be reduced below some reasonable period applicable to the individual ER specification. In any case, it is recommended that a portion of the FR test data be developed from unaccelerated test conditions. Depending on the acceleration factor, the type of electronic parts and the type of FR test, a requirement that 25 percent of the samples subjected to FR test be tested at unaccelerated (rated) conditions is considered reasonable. The data generated on testing at rated conditions should be evaluated periodically by the qualifying activity to revalidate the acceleration factors used.

A.6. FR QUALIFICATION DATA

A.6.1 <u>Expanding FR sampling plan</u>. Table A-I provides the number of cumulative unit hours for determining the probability of qualification when the true failure rate is 1%/1,000 hours. This table may be used to expand the FR sampling plans specified in section 5 of this standard or to develop additional FR sampling plans.

A.7. APPLICATION INFORMATION

A.7.1 <u>Reliability data</u>. ER specifications or associated military standards should contain as much valid application and use information as is available to the preparing activity. Reference to MIL-HDBK-217, "Reliability Prediction of Electronic Equipment", should be made when appropriate.

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TABLE A-I. FR qualification data in unit hours (based on exponential
Distribution and computed at 1%/1,000 hr).

Confidence level	Cumulative unit hours C = Number of failures permitted						Probability of qualification 1/
	C = 0	C = 1	C = 2	C = 3	C = 4	C = 5	
.01	1,000	14,844	43,750	82,500	128,125	178,750	.99
.05	5,125	35,547	81,719	136,563	197,031	261,250	.95
.10	10,547	53,203	110,000	174,531	243,281	315,156	.90
.20	22,305	82,422	153,516	229,688	308,906	390,313	.80
.30	35,664	109,727	191,406	276,406	363,359	451,719	.70
.40	51,094	137,656	228,516	321,094	414,766	509,063	.60
.50	69,297	167,813	267,422	367,188	467,109	567,031	.50
.60	91,641	202,266	310,547	417,500	523,672	629,219	.40
.70	120,391	243,906	361,563	476,250	589,063	700,625	.30
.80	160,938	299,375	427,969	551,563	672,188	790,625	.20
.90	230,313	389,063	532,188	668,125	799,375	927,344	.10
.95	299,375	474,375	629,375	775,625	915,625	1,050,000	.05
.99	460,000	660,000	840,625	1,000,000	1,159,375	1,309,375	.01
	C = 6	C = 7	C = 8	C = 9	C = 10		
.01	233,125	290,625	351,250	412,500	477,500		.99
.05	328,438	398,125	469,375	542,500	616,875		.95
.10	389,531	465,625	543,281	622,188	702,188		.90
.20	473,438	557,656	642,813	728,906	815,625		.80
.30	541,094	631,250	722,031	813,281	905,078		.70
.40	603,906	699,141	794,688	890,430	986,426		.60
.50	666,953	766,875	866,895	966,797	1,066,797		.50
.60	734,219	838,965	946,359	1,047,559	1,151,563		.40
.70	811,133	920,898	1,030,078	1,138,672	1,246,875		.30
.80	907,617	1,023,242	1,137,891	1,251,953	1,365,039		.20
.90	1,053,125	1,176,953	1,299,609	1,420,703	1,540,625		.10
.95	1,184,375	1,314,844	1,443,750	1,570,313	1,696,191		.05
.99	1,450,000	1,600,000	1,740,625	1,877,344	2,014,063		.01

1/ Computed with a tolerance of ±.0001.

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TABLE A-II. <u>True failure rates for C = 0 (level M)</u>.

Probability of qualification	True failure rates at confidence level:											
	99%	95%	90%	80%	70%	60%	50%	40%	30%	20%	10%	5%
.99	.002	.003	.004	.006	.008	.011	.014	.020	.028	.045	.095	.195
.95	.011	.017	.022	.032	.043	.056	.074	.100	.144	.230	.486	1.000
.90	.023	.035	.046	.066	.088	.115	.152	.206	.296	.473	1.000	2.058
.80	.048	.074	.097	.139	.185	.243	.322	.437	.625	1.000	2.115	4.352
.70	.078	.119	.155	.222	.296	.389	.515	.698	1.000	1.599	3.381	6.959
.60	.111	.171	.222	.317	.424	.558	.737	1.000	1.433	2.291	4.844	9.970
.50	.151	.231	.301	.431	.576	.756	1.000	1.356	1.043	3.107	6.570	13.521
.40	.199	.306	.398	.569	.761	1.000	1.322	1.794	2.570	4.109	8.689	17.881
.30	.262	.402	.523	.748	1.000	1.314	1.737	2.356	3.376	5.398	11.415	23.491
.20	.350	.538	.699	1.000	1.337	1.756	2.322	3.150	4.513	7.215	15.259	31.402
.10	.501	.769	1.000	1.431	1.913	2.513	3.324	4.508	6.458	10.326	21.837	44.939
.05	.651	1.000	1.300	1.860	2.487	3.267	4.320	5.859	8.394	13.422	28.385	58.415
.01	1.000	1.537	1.997	2.858	3.821	5.020	6.638	9.003	12.898	20.623	43.615	89.756

NOTE: For other than M (1.0%) failure rate level, divide above values by 10 for P (0.1%) level, by 100 for R or U (0.01%) level, by 1,000 for S or V (0.001%) level, or by 10,000 for T (0.0001%) level (see 4.1a).

TABLE A-III. <u>True failure rates for C = 1 (level M)</u>.

Probability of qualification	True failure rates at confidence level:											
	99%	95%	90%	80%	70%	60%	50%	40%	30%	20%	10%	5%
.99	.022	.031	.038	.050	.061	.073	.088	.108	.135	.180	.279	.418
.95	.054	.075	.091	.119	.146	.176	.212	.258	.324	.431	.668	1.000
.90	.081	.112	.137	.178	.218	.263	.317	.386	.485	.646	1.000	1.497
.80	.125	.174	.212	.275	.338	.407	.491	.599	.751	1.000	1.549	2.319
.70	.166	.231	.282	.367	.450	.542	.654	.797	1.000	1.331	2.062	3.087
.60	.209	.290	.354	.460	.564	.681	.820	1.000	1.255	1.670	2.587	3.873
.50	.254	.354	.431	.561	.688	.830	1.000	1.219	1.529	2.036	3.154	4.721
.40	.306	.426	.520	.676	.829	1.000	1.205	1.469	1.843	2.454	3.802	5.690
.30	.370	.514	.627	.815	1.000	1.206	1.453	1.772	2.223	2.959	4.584	6.862
.20	.454	.631	.769	1.000	1.227	1.480	1.784	2.175	2.728	3.632	5.627	8.422
.10	.589	.820	1.000	1.300	1.595	1.924	2.318	2.826	3.546	4.720	7.313	10.946
.05	.719	1.000	1.219	1.585	1.945	2.345	2.827	3.446	4.323	5.755	8.916	13.345
.01	1.000	1.391	1.696	2.205	2.706	3.263	3.933	4.795	6.015	8.008	12.405	18.567

NOTE: For other than M (1.0%) failure rate level, divide above values by 10 for P (0.1%) level, by 100 for R or U (0.01%) level, by 1,000 for S or V (0.001%) level, or by 10,000 for T (0.0001%) level (see 4.1a).

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TABLE A-IV. True failure rates for C = 2 (level M).

Probability of qualification	True failure rates at confidence level:											
	99%	95%	90%	80%	70%	60%	50%	40%	30%	20%	10%	5%
.99	.052	.070	.082	.102	.121	.141	.164	.191	.229	.285	.398	.535
.95	.097	.130	.154	.191	.226	.263	.306	.358	.427	.532	.743	1.000
.90	.131	.175	.207	.257	.304	.354	.411	.481	.575	.717	1.000	1.346
.80	.183	.244	.288	.359	.425	.494	.574	.672	.802	1.000	1.396	1.879
.70	.228	.304	.360	.447	.529	.616	.716	.838	1.000	1.247	1.740	2.342
.60	.272	.363	.429	.534	.632	.736	.855	1.000	1.194	1.489	2.077	2.796
.50	.318	.425	.502	.625	.740	.861	1.000	1.170	1.397	1.742	2.431	3.272
.40	.369	.493	.584	.726	.859	1.000	1.161	1.359	1.622	2.023	2.823	3.800
.30	.430	.574	.679	.845	1.000	1.164	1.352	1.582	1.889	2.355	3.287	4.424
.20	.509	.680	.804	1.000	1.184	1.378	1.600	1.873	2.236	2.788	3.891	5.237
.10	.633	.846	1.000	1.244	1.472	1.713	1.990	2.329	2.780	3.467	4.838	6.512
.05	.749	1.000	1.183	1.471	1.741	2.027	2.353	2.754	3.288	4.100	5.722	7.702
.01	1.000	1.336	1.580	1.964	2.325	2.707	3.143	3.679	4.392	5.476	7.642	10.287

NOTE: For other than M (1.0%) failure rate level, divide above values by 10 for P (0.1%) level, by 100 for R or U (0.01%) level, by 1,000 for S or V (0.001%) level, or by 10,000 for T (0.0001%) level (see 4.1a).

TABLE A-V. True failure rates for C = 3 (level M).

Probability of qualification	True failure rates at confidence level:											
	99%	95%	90%	80%	70%	60%	50%	40%	30%	20%	10%	5%
.99	.082	.106	.123	.150	.173	.198	.225	.257	.298	.359	.473	.604
.95	.137	.176	.204	.248	.287	.327	.372	.425	.494	.595	.782	1.000
.90	.175	.225	.261	.316	.366	.418	.475	.544	.631	.760	1.000	1.278
.80	.230	.296	.344	.416	.482	.550	.626	.715	.831	1.000	1.316	1.682
.70	.276	.356	.414	.501	.580	.662	.753	.861	1.000	1.203	1.584	2.024
.60	.321	.414	.481	.582	.674	.769	.874	1.000	1.162	1.398	1.840	2.351
.50	.367	.473	.550	.666	.771	.879	1.000	1.144	1.328	1.599	2.104	2.689
.40	.418	.538	.625	.757	.877	1.000	1.137	1.300	1.510	1.818	2.392	3.057
.30	.476	.614	.713	.863	1.000	1.141	1.297	1.483	1.723	2.073	2.729	3.487
.20	.552	.711	.826	1.000	1.158	1.321	1.502	1.718	1.996	2.401	3.160	4.039
.10	.668	.861	1.000	1.211	1.403	1.600	1.820	2.081	2.417	2.909	3.828	4.892
.05	.776	1.000	1.161	1.406	1.629	1.858	2.112	2.416	2.806	3.377	4.444	5.680
.01	1.000	1.289	1.497	1.813	2.100	2.395	2.723	3.114	3.618	4.354	5.730	7.323

NOTE: For other than M (1.0%) failure rate level, divide above values by 10 for P (0.1%) level, by 100 for R or U (0.01%) level, by 1,000 for S or V (0.001%) level, or by 10,000 for T (0.0001%) level (see 4.1a).

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TABLE A-VI. <u>True failure rates for C = 4 (level M)</u>.

Probability of qualification	True failure rates at confidence level:											
	99%	95%	90%	80%	70%	60%	50%	40%	30%	20%	10%	5%
.99	.111	.140	.160	.191	.218	.245	.274	.309	.353	.415	.527	.650
.95	.170	.215	.246	.293	.334	.376	.422	.475	.542	.638	.810	1.000
.90	.210	.266	.304	.362	.413	.465	.521	.587	.670	.788	1.000	1.235
.80	.266	.337	.386	.460	.524	.590	.661	.745	.850	1.000	1.270	1.568
.70	.313	.397	.455	.541	.617	.694	.778	.876	1.000	1.176	1.494	1.844
.60	.358	.453	.519	.617	.704	.792	.888	1.000	1.141	1.343	1.705	2.105
.50	.403	.510	.584	.695	.793	.892	1.000	1.126	1.286	1.512	1.920	2.371
.40	.452	.572	.655	.779	.889	1.000	1.121	1.263	1.441	1.695	2.153	2.658
.30	.508	.643	.737	.876	1.000	1.125	1.261	1.420	1.621	1.907	2.421	2.990
.20	.580	.734	.841	1.000	1.141	1.284	1.439	1.621	1.850	2.176	2.763	3.412
.10	.689	.873	1.000	1.182	1.357	1.526	1.711	1.927	2.200	2.588	3.286	4.057
.05	.790	1.000	1.145	1.362	1.554	1.748	1.960	2.208	2.520	2.964	3.764	4.647
.01	1.000	1.266	1.450	1.725	1.968	2.214	2.482	2.795	3.191	3.753	4.766	5.884

NOTE: For other than M (1.0%) failure rate level, divide above values by 10 for P (0.1%) level, by 100 for R or U (0.01%) level, by 1,000 for S or V (0.001%) level, or by 10,000 for T (0.0001%) level (see 4.1a).

TABLE A-VII. <u>True failure rates for C = 5 (level M)</u>.

Probability of qualification	True failure rates at confidence level:											
	99%	95%	90%	80%	70%	60%	50%	40%	30%	20%	10%	5%
.99	.137	.170	.193	.226	.255	.284	.315	.351	.396	.458	.567	.684
.95	.200	.249	.282	.330	.373	.415	.461	.513	.578	.669	.829	1.000
.90	.241	.300	.340	.399	.450	.501	.556	.619	.698	.807	1.000	1.206
.80	.298	.372	.421	.494	.557	.620	.688	.767	.864	1.000	1.238	1.494
.70	.345	.430	.487	.571	.645	.718	.797	.887	1.000	1.157	1.433	1.729
.60	.389	.485	.549	.644	.727	.809	.898	1.000	1.127	1.304	1.615	1.949
.50	.433	.540	.611	.717	.809	.901	1.000	1.114	1.255	1.453	1.799	2.170
.40	.481	.599	.679	.796	.898	1.000	1.110	1.236	1.393	1.612	1.997	2.408
.30	.535	.667	.756	.886	1.000	1.113	1.236	1.376	1.551	1.795	2.223	2.682
.20	.604	.753	.853	1.000	1.128	1.257	1.394	1.553	1.750	2.026	2.509	3.026
.10	.708	.883	1.000	1.173	1.324	1.474	1.635	1.822	2.053	2.376	2.942	3.550
.05	.802	1.000	1.132	1.328	1.499	1.669	1.852	2.063	2.324	2.690	3.332	4.019
.01	1.000	1.247	1.412	1.656	1.869	2.081	2.309	2.572	2.899	3.355	4.155	5.012

NOTE: For other than M (1.0%) failure rate level, divide above values by 10 for P (0.1%) level, by 100 for R or U (0.01%) level, by 1,000 for S or V (0.001%) level, or by 10,000 for T (0.0001%) level (see 4.1a).

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TABLE A-VIII. <u>True failure rates for C = 6 (level M)</u>.

Probability of qualification	True failure rates at confidence level:											
	99%	95%	90%	80%	70%	60%	50%	40%	30%	20%	10%	5%
.99	.161	.197	.221	.257	.287	.318	.350	.386	.431	.492	.598	.710
.95	.227	.277	.312	.362	.405	.447	.492	.544	.607	.694	.843	1.000
.90	.269	.329	.370	.429	.480	.531	.584	.645	.720	.823	1.000	1.186
.80	.327	.400	.450	.522	.584	.645	.710	.784	.875	1.000	1.215	1.442
.70	.373	.457	.514	.596	.667	.737	.811	.896	1.000	1.143	1.389	1.647
.60	.416	.510	.573	.665	.745	.823	.905	1.000	1.116	1.276	1.550	1.839
.50	.460	.563	.633	.734	.822	.908	1.000	1.104	1.233	1.409	1.712	2.031
.40	.506	.620	.697	.809	.905	1.000	1.101	1.216	1.357	1.551	1.885	2.235
.30	.559	.685	.770	.894	1.000	1.105	1.216	1.343	1.499	1.713	2.082	2.470
.20	.626	.766	.862	1.000	1.119	1.236	1.361	1.503	1.677	1.917	2.330	2.763
.10	.726	.889	1.000	1.160	1.298	1.434	1.579	1.744	1.946	2.224	2.704	3.206
.05	.817	1.000	1.125	1.305	1.460	1.613	1.776	1.961	2.189	2.502	3.041	3.606
.01	1.000	1.224	1.377	1.598	1.788	1.975	2.174	2.401	2.680	3.063	3.722	4.415

NOTE: For other than M (1.0%) failure rate level, divide above values by 10 for P (0.1%) level, by 100 for R or U (0.01%) level, by 1,000 for S or V (0.001%) level, or by 10,000 for T (0.0001%) level (see 4.1a).

TABLE A-IX. <u>True failure rates for C = 7 (level M)</u>.

Probability of qualification	True failure rates at confidence level:											
	99%	95%	90%	80%	70%	60%	50%	40%	30%	20%	10%	5%
.99	.182	.221	.247	.284	.316	.346	.379	.416	.460	.521	.624	.730
.95	.249	.303	.338	.389	.432	.475	.519	.569	.631	.714	.855	1.000
.90	.291	.354	.396	.455	.506	.555	.607	.666	.738	.835	1.000	1.170
.80	.349	.424	.474	.545	.606	.665	.727	.798	.883	1.000	1.198	1.401
.70	.395	.480	.536	.617	.685	.752	.823	.903	1.000	1.132	1.356	1.586
.60	.437	.532	.594	.683	.759	.833	.912	1.000	1.108	1.254	1.502	1.756
.50	.479	.583	.652	.749	.833	.914	1.000	1.097	1.215	1.375	1.647	1.926
.40	.524	.638	.713	.820	.911	1.000	1.094	1.200	1.329	1.504	1.802	2.107
.30	.576	.700	.782	.900	1.000	1.098	1.201	1.317	1.459	1.651	1.978	2.313
.20	.640	.778	.869	1.000	1.111	1.220	1.334	1.464	1.621	1.835	2.198	2.570
.10	.736	.895	1.000	1.150	1.278	1.403	1.535	1.683	1.864	2.111	2.528	2.956
.05	.822	1.000	1.117	1.285	1.428	1.567	1.715	1.881	2.083	2.358	2.824	3.303
.01	1.000	1.217	1.359	1.564	1.737	1.907	2.086	2.289	2.535	2.869	3.436	4.019

NOTE: For other than M (1.0%) failure rate level, divide above values by 10 for P (0.1%) level, by 100 for R or U (0.01%) level, by 1,000 for S or V (0.001%) level, or by 10,000 for T (0.0001%) level (see 4.1a).

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TABLE A-X. <u>True failure rates for C = 8 (level M)</u>.

Probability of qualification	True failure rates at confidence level:											
	99%	95%	90%	80%	70%	60%	50%	40%	30%	20%	10%	5%
.99	.202	.243	.270	.309	.341	.373	.405	.442	.486	.546	.647	.748
.95	.270	.325	.361	.412	.456	.498	.541	.591	.650	.730	.864	1.000
.90	.312	.376	.418	.477	.527	.576	.627	.684	.752	.845	1.000	1.157
.80	.369	.445	.495	.565	.624	.681	.742	.809	.890	1.000	1.183	1.370
.70	.415	.500	.556	.635	.701	.765	.833	.909	1.000	1.123	1.329	1.538
.60	.457	.550	.611	.698	.771	.842	.917	1.000	1.101	1.236	1.463	1.693
.50	.498	.600	.667	.761	.842	.919	1.000	1.091	1.201	1.349	1.596	1.847
.40	.542	.653	.726	.826	.916	1.000	1.088	1.187	1.307	1.468	1.736	2.010
.30	.592	.713	.793	.905	1.000	1.902	1.188	1.296	1.427	1.602	1.896	2.195
.20	.654	.788	.876	1.000	1.105	1.206	1.313	1.432	1.576	1.770	2.094	2.424
.10	.747	.900	1.000	1.142	1.262	1.378	1.499	1.635	1.800	2.022	2.392	2.769
.05	.829	1.000	1.111	1.269	1.402	1.530	1.665	1.817	2.000	2.246	2.657	3.076
.01	1.000	1.206	1.339	1.530	1.690	1.845	2.008	2.190	2.411	2.708	3.204	3.708

NOTE: For other than M (1.0%) failure rate level, divide above values by 10 for P (0.1%) level, by 100 for R or U (0.01%) level, by 1,000 for S or V (0.001%) level, or by 10,000 for T (0.0001%) level (see 4.1a).

TABLE A-XI. <u>True failure rates for C = 9 (level M)</u>.

Probability of qualification	True failure rates at confidence level:											
	99%	95%	90%	80%	70%	60%	50%	40%	30%	20%	10%	5%
.99	.220	.263	.290	.329	.362	.394	.427	.463	.507	.566	.663	.760
.95	.289	.345	.382	.433	.476	.518	.561	.609	.667	.744	.872	1.000
.90	.331	.396	.438	.497	.546	.594	.644	.699	.765	.854	1.000	1.169
.80	.388	.464	.513	.582	.640	.696	.754	.819	.896	1.000	1.172	1.344
.70	.433	.518	.572	.650	.714	.776	.841	.913	1.000	1.116	1.307	1.499
.60	.474	.567	.627	.711	.782	.850	.921	1.000	1.095	1.222	1.431	1.641
.50	.515	.616	.681	.772	.849	.923	1.000	1.086	1.189	1.326	1.554	1.782
.40	.558	.667	.737	.837	.920	1.000	1.084	1.176	1.288	1.437	1.684	1.931
.30	.607	.725	.801	.910	1.000	1.087	1.178	1.279	1.400	1.562	1.830	2.099
.20	.667	.797	.881	1.000	1.099	1.195	1.295	1.406	1.539	1.718	2.012	2.308
.10	.757	.905	1.000	1.135	1.248	1.356	1.469	1.596	1.747	1.949	2.283	2.619
.05	.836	1.000	1.105	1.254	1.380	1.499	1.624	1.764	1.831	2.154	2.524	2.895
.01	1.000	1.196	1.321	1.500	1.649	1.792	1.942	2.108	2.308	2.576	3.017	3.461

NOTE: For other than M (1.0%) failure rate level, divide above values by 10 for P (0.1%) level, by 100 for R or U (0.01%) level, by 1,000 for S or V (0.001%) level, or by 10,000 for T (0.0001%) level (see 4.1a).

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TABLE A-XII. <u>True failure rates for C = 10 (level M)</u>.
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Probability of qualification	True failure rates at confidence level:											
	99%	95%	90%	80%	70%	60%	50%	40%	30%	20%	10%	5%
.99	.237	.282	.310	.350	.382	.415	.448	.484	.528	.585	.680	.774
.95	.306	.364	.400	.452	.495	.536	.578	.625	.682	.756	.879	1.000
.90	.349	.414	.456	.514	.563	.610	.658	.712	.776	.861	1.000	1.138
.80	.405	.481	.529	.598	.654	.708	.764	.827	.901	1.000	1.162	1.322
.70	.449	.534	.587	.663	.726	.786	.848	.918	1.000	1.110	1.289	1.467
.60	.490	.582	.640	.723	.791	.857	.925	1.000	1.090	1.209	1.405	1.599
.50	.530	.629	.692	.782	.856	.926	1.000	1.081	1.179	1.308	1.519	1.729
.40	.572	.679	.747	.844	.924	1.000	1.079	1.167	1.272	1.412	1.640	1.867
.30	.619	.735	.809	.913	1.000	1.083	1.169	1.264	1.378	1.529	1.776	2.021
.20	.678	.805	.886	1.000	1.095	1.185	1.280	1.384	1.508	1.674	1.944	2.213
.10	.765	.908	1.000	1.129	1.236	1.338	1.444	1.562	1.702	1.889	2.194	2.497
.05	.842	1.000	1.101	1.243	1.360	1.473	1.590	1.720	1.874	2.080	2.416	2.750
.01	1.000	1.187	1.307	1.475	1.615	1.749	1.888	2.042	2.225	2.469	2.868	3.265

NOTE: For other than M (1.0%) failure rate level, divide above values by 10 for P (0.1%) level, by 100 for R or U (0.01%) level, by 1,000 for S or V (0.001%) level, or by 10,000 for T (0.0001%) level (see 4.1a).

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Custodians:
  Army – CR
  Navy – EC
  Air Force – 85
  DLA - CC

Preparing activity:
  DLA-CC

(Project SESS-2018-015)

Review activities:
  Army – AR, MI
  Navy – AS, CG, MC, OS, SH
  Air Force – 11, 19, 70

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.