

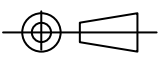
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THIRD ANGLE PROJECTION		CUSTODIAN NATIONAL AEROSPACE STANDARDS COMMITTEE	REVISION 3
PROCUREMENT SPECIFICATION NONE	TITLE TENSION FATIGUE TEST PROCEDURE FOR AERONAUTICAL FASTENERS	CLASSIFICATION SPECIFICATION NAS1069	SHEET 1 OF 25

ISSUE DATE: APRIL 1957 REVISION DATE: NOVEMBER 30, 2012

AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.
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1. PURPOSE, SCOPE, AND USAGE:

1.1 Purpose

The purpose of this procedure is to provide a standardized method of tension fatigue testing of aeronautical fasteners using tension-tension cycles.

1.2 Scope

This procedure applies to such items as bolts, screws, nuts, rivets, blind fasteners, and proprietary items used to perform similar functions.

1.3 Usage

This procedure shall be used when called for in specifications, purchase orders or contracts. It is intended, primarily, for qualification tests of fasteners and for development work on new fasteners.

2. FATIGUE TESTING MACHINES:

2.1 Type

Fatigue testing machines used shall be of the "constant load" type. A standard make, or one capable of giving equivalent performance, shall be used.

2.2 Maintenance of Loads During Test

② The fatigue testing machine shall maintain constant test loads within $\pm 2\%$ or ± 30 lbs., whichever is greater, throughout the entire range of load levels encompassed in the test. When necessary a separate load maintenance device shall be used. Appendix A contains a recommended Load Calibration Procedure.

3. SPECIMEN HOLDING FIXTURES:

3.1 Holding Fixture Requirements

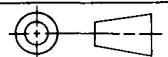
Specimen holding fixtures shall be capable of holding the specimen in alignment during the test so that the requirements of paragraph 5.2 for eccentric loading can be met.

LIST OF ACTIVE SHEETS

Sheet Number	Rev. Number	Sheet Number	Rev. Number
1	2	13	2
2	1	14	2
3	1	15	1
4	None	16	2
5	1	17	2
6	None	18	1
7	1	19	None
8	1	20	None
9	2	21	None
10	2	22	None
11	2	23	None
12	2	24	None

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3. SPECIMEN HOLDING FIXTURES: (CONT'D)

3.1 Holding Fixture Requirements (CONT'D)

Fixtures shall permit the installation of strain gages either on the specimen or a dummy specimen so that bending moments due to eccentric loading may be measured.

3.2 Standard Holding Fixtures and Adapters

The use of standard holding fixtures, adapters and washers illustrated in Figure 3 and Figures 8 through 13 is recommended for threaded fasteners and all other fasteners for which they are suited.

The use of holding fixtures of other designs is permissible if the requirements of paragraphs 3.1 and 5.2 are met. If holding fixtures of other designs are used, it is urgently recommended that the dimensions shown on Figures 9, 10, 12, and 13 be complied with for the testing of fasteners having sufficient grip length to be accommodated by the fixtures.

The holding fixture shown in Figures 8 and 11 and the adapters shown in Figures 9, 10, 12, and 13 are for use in performing fatigue tests on normal grip length fasteners at temperatures up to 600° F.

3.3 Universal Joints

A universal joint may be used at each end of the holding fixture set up but such use is not recommended.

The use of spherical seats immediately under either end of the fastener is not permitted.

3.4 Washers

①

A single washer per Figure 3 shall be used under the head of protruding head fasteners, except when the holding fixture is chamfered (or radiused), to provide clearance for the fastener head to shank fillet. Use of chamfered fixtures is recommended.

4. NUTS TO BE USED FOR THREADED FASTENERS:

4.1 Nuts conforming to Figure 4 through 7 shall be used for fatigue tests of male threaded fasteners unless otherwise stated in the fastener specification, purchase order, or contract.

4.2 For fatigue tests the bearing face of the nut shall be located approximately 2 pitches from the thread termination on the shank for tension fasteners and approximately 1 pitch from the thread termination on the shank for short thread shear fasteners. When a bolt and nut combination provides insufficient threads to meet this requirement, the number of pitches shall be reduced so that the threads in the nut shall be fully engaged on the bolt.

4.3 Fatigue test nuts shall be used for one test only.

5. TEST SET-UP

5.1 Pre-Load

All test fasteners shall be assembled in the holding fixtures in such a manner that no installation preload exists in the fastener shank prior to application of test loads.

①

5.2 Prevention of Eccentric Loading

Holding fixtures, adapters, linkage components and test fastener shall be centered and aligned before the start of each test series to minimize bending in the fastener during test. The use of an accurate "Dummy" bolt is recommended.

A method of checking the alignment shall be employed which will insure meeting the bending moment requirements stated below. An acceptable method is described in Appendix A.

The alignment shall be adjusted so that the maximum stress in the Dummy bolt due to both axial loads and bending shall not exceed the average stress in the Dummy bolt by more than the values given in the following table.

Holding Fixture No.	Nominal Size	Recommended Dummy Bolt Diameter	Maximum Allowable Stress Due to Bending
1	(3/16" - 3/8")	3/8"	3% above 1500# load
2	(7/16" - 5/8")	1/2"	3% above 3000# load
3	(11/16" - 1")	3/4"	3% above 7000# load
4	(1-1/8" - 1-1/2")	1-1/4"	3% above 17000# load

It shall be demonstrated that the above limitation can be maintained throughout a series of tests.

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5. TEST SET-UP (CONT'D)

- ① 5.3 Dynamic calibration and load monitoring shall be accomplished with equipment which can be read to an accuracy of two percent along the full length of scale.

6. TEST LOADS AND CONDITIONS:6.1 Load Level - Qualification Tests

For qualification tests the load level or levels shall be as specified in the applicable fastener specification. For fasteners whose specifications do not contain fatigue requirements, a load level of 60% of the minimum ultimate tensile strength is recommended.

6.2 Load Levels - Development Tests

For development work the tests shall be conducted at four or more load levels so that an S-N curve may be plotted. When four levels are used, it is recommended that the high loads for the levels be based on approximately 60, 50, 40, and 30% of minimum ultimate tensile strength of the fastener.

Fatigue test data from development tests shall be plotted as described in section 8.0.

6.3 Load Ratios

The ratio of low load to high load shall be one-tenth (0.10) for all fasteners at all load levels.

6.4 Speed of Cycling

The cycling speed shall not exceed 3600 cycles per minute.

6.5 Cycling Duration

Tests need not be continued beyond 2,000,000 cycles at any load level unless otherwise specified in the fastener specification, purchase order or contract.

6.6 Number of Test Specimens

For qualification tests the number of test specimens shall be as stated in the applicable specification or purchase order.

- ① For developmental testing, it is recommended that a minimum of ten specimens be tested at each load level, although twenty-five specimens are recommended for establishing statistical design allowables.

7. SELF-LOCKING AND CONVENTIONAL NUT FATIGUE TESTS

- 7.1 The provisions of all previous paragraphs, as applicable, shall be complied with in the fatigue testing of conventional and self-locking nuts. In addition, the requirements of the following sub-paragraphs shall apply.

7.2 Qualification Tests

The load levels shall be as stated in Paragraph 6.1.

The bolts used for testing the nuts shall be of a strength level that the nuts were intended to be used with, unless otherwise specified in the nut specification.

A bolt shall be used for testing one nut only.

7.3 Development Tests

When fatigue tests are performed for evaluation or comparison of various types of self-locking or conventional type nuts, identical standard bolts from a test lot shall be used for all tests. A test lot of standard fatigue test bolts shall consist of those made in a single production run.

For nuts covered by specification MIL-N-25027 the standard test bolt to be used is the MS20004 through MS20024 series in accordance with MIL-B-7838B.

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7. SELF-LOCKING AND CONVENTIONAL NUT FATIGUE TESTS: (CONT'D)7.3 Development Tests (CONT'D)

For nuts in higher strength classifications, a standard test bolt shall be selected which would normally be used with such nuts.

A bolt shall be used for testing only one nut.

Before initiating fatigue testing of the nuts being evaluated, the standard fatigue test bolts shall be coupled with the special fatigue test nuts, shown in figures 3 thru 7, and samples of each diameter in each test lot of standard fatigue test bolts shall be tested. These tests shall be made at one load level only which shall be the highest load level used for the nuts being evaluated.

The load levels for the nuts being evaluated shall be as stated in Paragraph 6.2.

Fracture of the standard fatigue test bolt in the threaded area or breakdown of either test nut or bolt threads to the extent that they fail to support loads applied by the fatigue test machine shall constitute failure. Fracture of the test bolt in any area or location other than that described above shall not be considered failure.

8. TEST REPORTS:

Unless otherwise required by the specification, purchase order, or contract a test report shall be prepared which gives the data called for in the following paragraphs of this section.

8.1 Qualification Tests

The data called for in Figure 14, as applicable, shall be included in the test report.

8.2 Development Tests

In addition to the data called for in Figure 14, the test results shall be plotted as described in the following sub-paragraphs.

8.21 Plotting of Test Data

For all fasteners load data shall be plotted in pounds vs. cycles.

The test data shall be plotted on 5 cycles x 70 division semi-logarithmic paper with the ordinate as pounds and the abscissa as cycles, as illustrated in Figures 1 and 2.

8.22 The Fatigue Curves

The fatigue curves for the mean and minimum of scatter band shall be constructed as follows:

At any load level determine the mean-log-life, ($\bar{X}_L$), and a "weighted" minimum, (X_m). The mean-log-life is computed as follows:

Calculate the mean of the logs of the lives of each individual specimen.

$$\log \bar{X}_L = \frac{\sum \log x_i}{n} = \log \bar{X}$$

The antilog of this is the mean-log-life, $\bar{X}_L$

The weighted minimum of any load level is calculated as follows:

$$\log X_m = \log \bar{X}_L - A (\log x_1 - \log x_s)$$

where $\bar{X}_L$ = mean-log-life

A = factor from log life calculation table.

x_1 = Value of x with longest life.

x_s = Value of x with shortest life.

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8. TEST REPORTS: (CONT'D)

8.22 The Fatigue Curves (CONT'D)

This might be written:

$$\log X_m = \log \bar{X}_L - AR_L$$

Where $R_L = \log x_1 - \log x_s = \text{range of the logs}$

The antilog of this is the weighted minimum, X_m .

The determination of mean and minimum curves can be computed graphically.

See Figure 1, Example 1.

On this type of graph paper the linear distance along the X axis is directly proportional to the log of X. Therefore, by measuring the X distances at each load level, adding them together and dividing by the number of test specimens, a number will be given which will be proportional to the $\log \bar{X}_L$. Plotting this number on the graph and reading from the cycles to failure scale, you will find the approximate value of the mean-log-life, $\bar{X}_L$. Any scale may be used, but the scale cannot be changed within a given calculation.

A value proportional to the log of the weighted minimum, X_m , is found by subtracting A times the linear value of R_L from the linear measurement of $\log \bar{X}_L$. R_L is found by using the same scale and measuring the distance between the shortest and longest life.

Plotting the resulting value on the graph and reading from the cycles to failure scale will give the approximate value of X_m , the weighted minimum life.

Points representing weighted minimum and mean-log lifetime should be plotted on the S-N diagram using the computed measurements and measured from the ordinate.

LOG LIFE CALCULATION TABLE

N (NO. OF SAMPLES)	A	N (NO. OF SAMPLES)	A
2	1.458	9	.553
3	.971	10	.535
4	.801	11	.518
5	.708	12	.505
6	.649	13	.493
7	.608	14	.483
8	.578	15	.474

NOTE: These calculations are the best estimate of a ninety-five percent (95%) probability level. In other words, ninety-five percent (95%) of a very large number of specimens would exceed the weighted minimum in the average case. (Calculation examples are given in Figure 1.)

9. INSPECTION REQUIREMENTS

All fastener fatigue test specimens shall be selected from lots that have passed the inspection requirements of the applicable specification or standard.

Each test fastener shall be inspected for the following items, as applicable, and record made of the results:

- ①
 - a. Rockwell hardness (on threaded end of bolt) if required by procurement specification.
 - b. Angle between the bolt shank and the bearing face of the head.
 - c. Depth of recess and head angle for 100° head bolts.
 - d. Head to shank fillet radius.
 - e. Conformance of threads to specification requirements, especially the root radius and runout of incomplete threads.
 - f. Conformance of surface roughness to drawing requirements.
 - g. Shank straightness.
 - h. The perpendicularity of the nut thread axis to the bearing face of each test nut.
 - i. Any discrepancies noted which are not in accordance with specification.

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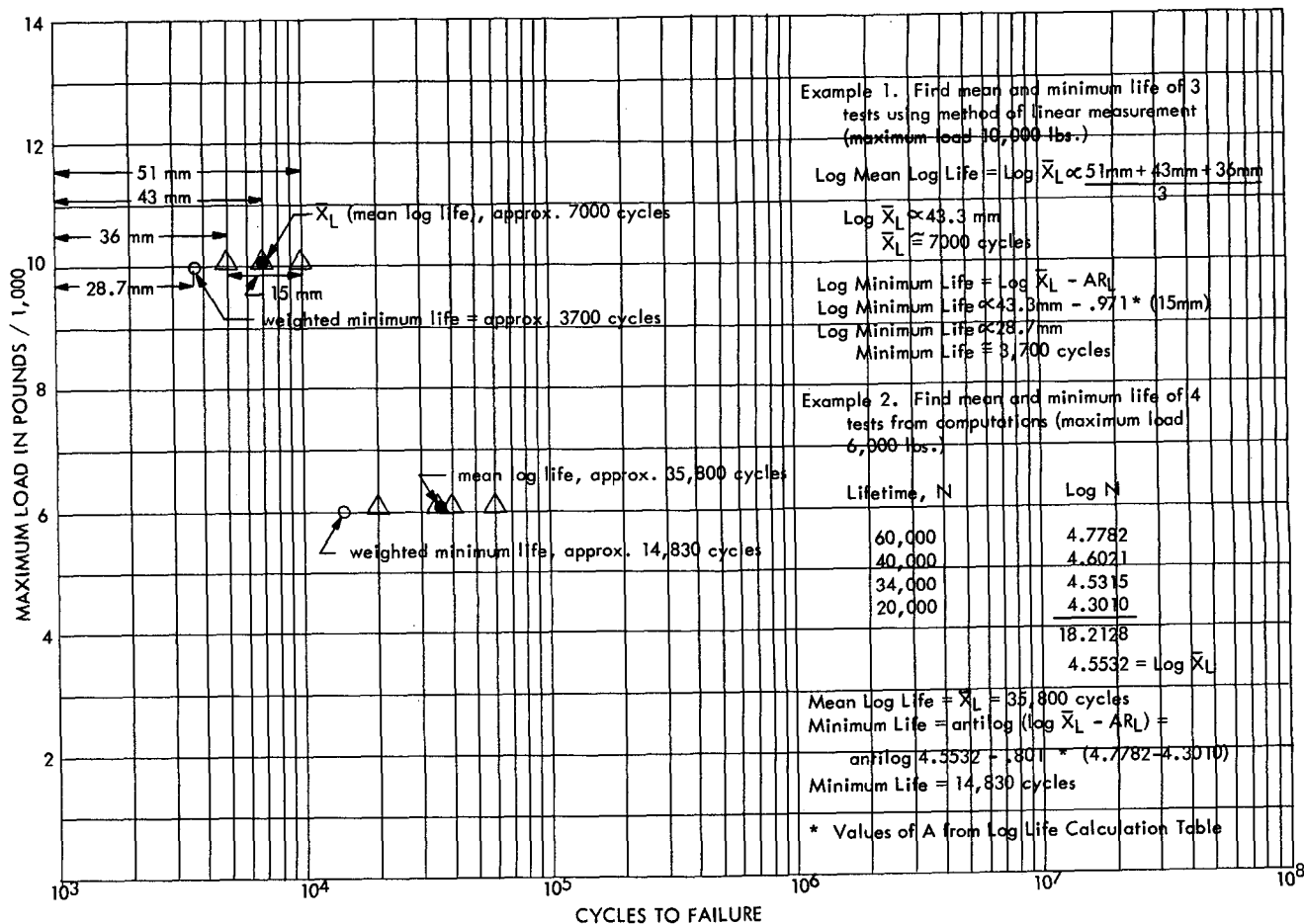
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NOTE: 1. DO NOT SCALE.

FIGURE 1

MEAN AND WEIGHTED MINIMUM LIFE CALCULATION EXAMPLES

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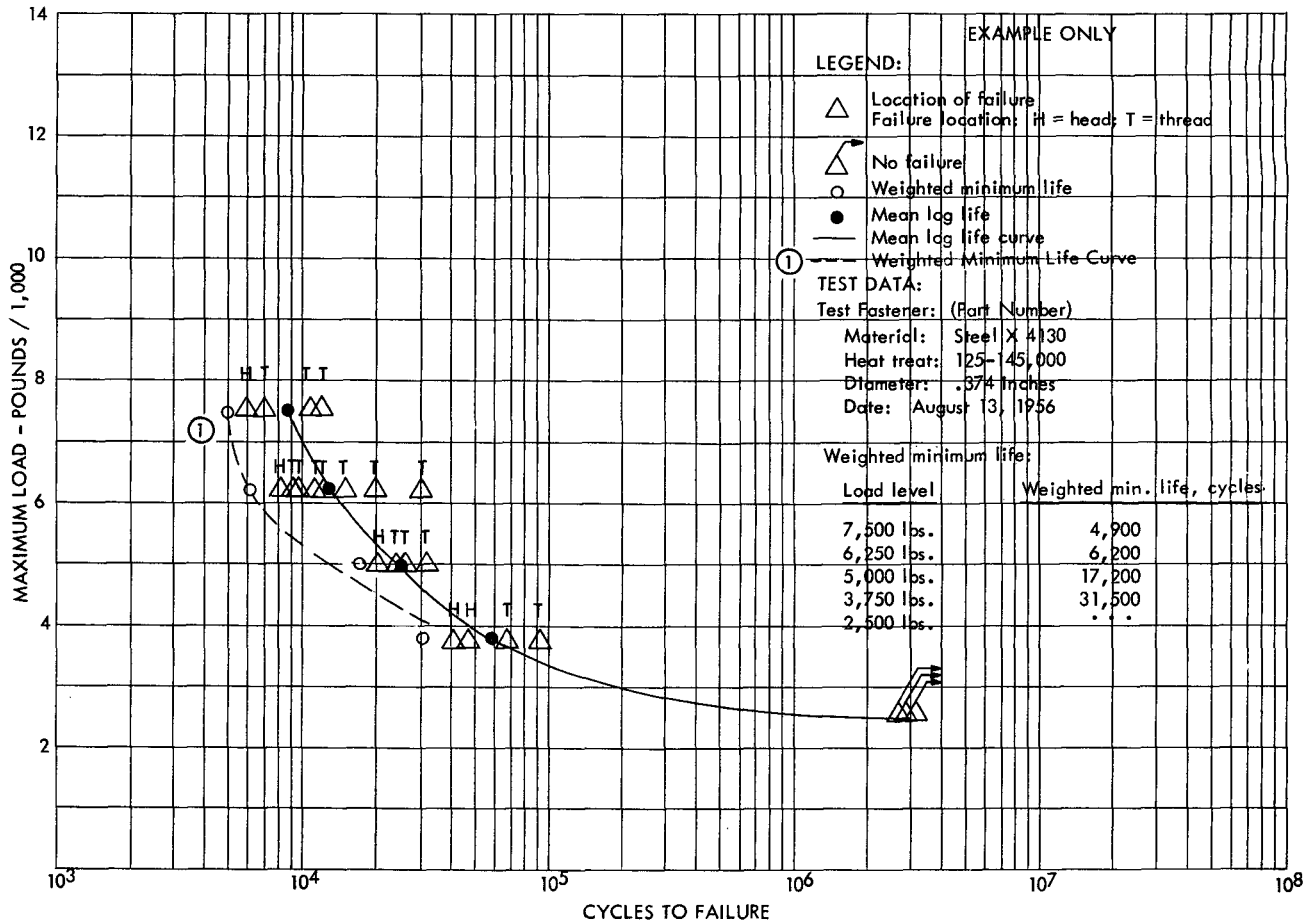
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NOTE: 1. DO NOT SCALE

FIGURE 2

① MEAN AND MINIMUM LOG LIFE CURVES

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