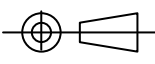


FOREWORD

1. Background. The selection of fasteners in the design and construction phase of weapons systems and equipment and the analysis of fasteners used therein for parameters, such as suitability, standardization, and simplification requires the evaluation and correlation of test data and criteria. In evaluating these functions, it has become increasingly evident that the data and criteria received from prime contractors, fastener producers, private laboratories, military documents, and military laboratories cannot be adequately correlated. The chief reason for this is the absence of unified standards prescribing test methods, procedures, fixtures, data analysis, and data presentation. This disparity encourages and often requires duplication of testing and reduces reliability of weapons systems and equipments, thereby impairing operations involving engineering control, design maintenance, quality assurance, standardization, and logistics simplification. To correct this situation it was established that a unified set of test methods and procedures is required to serve as a basic engineering tool for obtaining and presenting engineering data. As a result, this document was developed and prepared to satisfy this vital need. This standard delineates standard test methods, procedures, conditions, fixtures, and methods of recording, analyzing and presenting test data. The purpose of the resulting test data is to determine the capability of fasteners to withstand the various environmental and mechanical conditions encountered when used in military weapons systems.
2. Benefits. Many benefits are to be expected by unified standard tests for fasteners. The following is a list of benefits that can be expected to accrue from using this standard.
 - a. Availability of testing techniques and criteria necessary for the design and development of increasingly superior structural fasteners. In the past, when a new fastener was needed to solve a problem, the necessary test procedures had to be developed and written; also, the necessary fixtures had to be designed. This always imposed delays, additional expenses, variations in test methods and in test results.
 - b. Increasing incidences of correlation among fastener test data and design engineering techniques and design criteria for weapons systems and equipments. As new systems are designed to achieve higher performance for a given volume and mass of material, it is essential that design data for structural joints (a large portion of which is obtained by testing fasteners) maintain a close correlation with engineering techniques and design criteria. Where weight is of importance, such as in aircraft structures, such close correlation will provide a substantial reduction in weight.
 - c. Availability of testing techniques and criteria necessary to maintain consistent quality in the procurement of fasteners.
 - d. Reduction in the time and effort required for the development of procurement specifications for fasteners by having a series of standard tests available.
 - e. Elimination of duplication in the development of test methods and documents by individual fastener producers, Government contractors, and military activities.

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PROCUREMENT SPECIFICATION	TITLE	CLASSIFICATION
NONE	FASTENER TEST METHODS	STANDARD PRACTICE
		NAS 1312



NAS 1312

SHEET 1 OF 36

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- f. Elimination of duplication of effort in research and evaluation due to lack of unified standard test methods. When test methods are not standard, results cannot be correlated; therefore, producers, prime contractors, and military activities will not accept each other's results and will duplicate research, development, and evaluation work.
- g. For logistics simplification, fastener attributes must be reduced to a common denominator so that variation in type can be compared. Data and the presentation thereof, by means of this standard, will be provided in such form that various types and variations in types of fasteners may be compared to determine their degree of interchangeability, substitutability, and replaceability.
- h. Time and effort required to reach agreement in regard to specific engineering changes will be reduced by providing unified standard tests for use in evaluating new fasteners.
- i. This standard will provide a means for establishing guidelines for evaluating fastener test data and engineering techniques.
- j. Industry and Government design personnel will become thoroughly indoctrinated in the use of a single standard prescribing unified standard test methods.

ACKNOWLEDGMENT

This standard was prepared by the Fastener Testing Development Group (FTDG), consisting of representatives of Government agencies, engineering societies, trade association, independent testing laboratories, the using industry and the fastener producing industries.

With the increased implementation of the International System of Units (SI) or metric system in military specifications and standards, the Department of Defense (DoD) has approved its usage in this standard. Therefore, this issue, prepared under DoD Project Number 53GP-0142-20 by the FTDG includes test methods in the SI and inch-pound (I-P) units.

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REVISION
1
NAS 1312
SHEET 2



NAS 1312

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TABLE OF CONTENTS

Paragraph		Page
1.	SCOPE	4
1.1	Applicability	4
2.	REFERENCED DOCUMENTS	4
2.1	Government Documents	4
2.1.1	Specifications, Standards and Handbooks	4
3.	DEFINITIONS	4
4.	GENERAL REQUIREMENTS	4
4.1	Test Method Numbering System	4
4.2	Document Format Structure	5
4.3	Method of Revision	5
4.3.1	Revision to Test Method Number	5
4.4	Selection of Tests	5
4.5	Method of Reference	6
5.	DETAIL REQUIREMENTS	6

APPENDICES

Appendix		Page
A	LIST OF AVAILABLE TEST METHODS IN I-P SYSTEM OF MEASUREMENT	7
B	LIST OF AVAILABLE TEST METHODS IN SI SYSTEM OF MEASUREMENT	8
C	ALIGNMENT AND LOAD VERIFICATION OF AXIAL-LOAD FATIGUE TESTING MACHINES	9

1. SCOPE

- 1.1 Applicability. This standard establishes methods for testing fasteners, covering both the SI and I-P units, to determine their physical and mechanical properties. These standard test methods will yield reproducible data for use in research, development, procurement or product application. These test methods shall be observed when specifically referenced in the applicable documents. In case of conflict between the provisions of these methods and the individual test procedure in the specification for a particular item, the latter shall take precedence. This document exists as a dynamic standard subject to addition and changes as reflected by the "state-of-the-art."

2. REFERENCED DOCUMENTS

2.1 Government Documents.

- 2.1.1 Specifications, Standards and Handbooks. Unless otherwise specified, the following specifications, standards and handbooks of the issue listed in the current Department of Defense Index of Specifications and Standards (DoDISS) and the supplement thereto (if applicable), form a part of this standard to the extent specified herein.

MILITARY STANDARD

MIL-STD-962 Defense Standards Format and Content

Copies can be obtained from the Department of Defense Single Stock Point (DODSSP). <http://dodssp.daps.dla.mil>

- 2.1.2 Documents applicable to a particular test method bookform standard part or section shall be listed therein.

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

3. DEFINITIONS

- 3.1 SI - The International System of Units (from the French "Le Systeme International d'Unites"), as modified for use in the United States by the Secretary of Commerce.
- 3.2 Inch-Pound Units - Units based upon the yard and the pound commonly used in the United States of America and defined by the National Bureau of Standards.
- 3.3 Definitions applicable to a particular test method bookform standard part or section shall be listed therein.

4. GENERAL REQUIREMENTS

- 4.1 Test method numbering systems. This standard consists of a general basic document and supporting parts or sections. Each part addresses a specific test method which is designated by a dash number commencing with number 1 for the I-P system of measurement and number 101 for the SI system of measurement. A different dash number is assigned to each test method.

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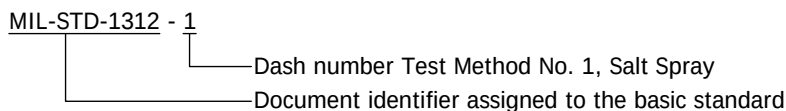


NAS 1312
SHEET 4

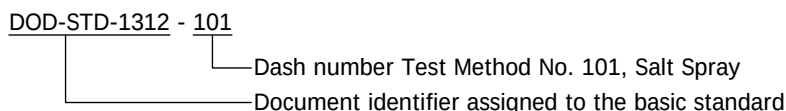
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- 4.2 Document format structure. Each test method is prepared as an individual document in the format of a bookform standard in accordance with the guidelines of MIL-STD-962. The individual bookform standard part is identified by the basic document identifier, MIL-STD-1312 for the I-P system of measurement and DOD-STD-1312 for the SI system of measurement, followed by a sequential dash number. The dash number is identical to the number of the test method. Examples:

I-P System

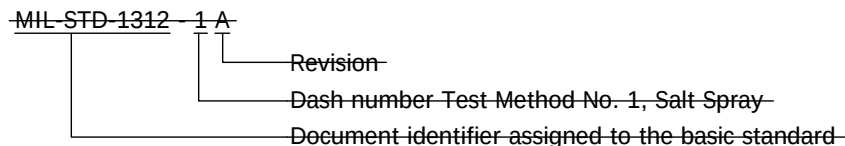


SI System

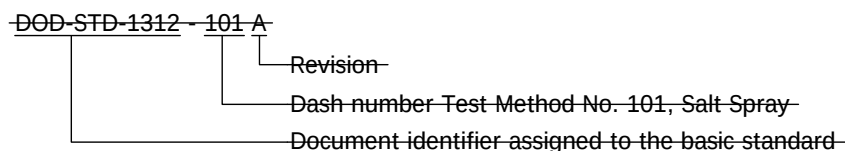


- 4.3 ~~Method of Revision. The individual bookform standard part is revised and issued independent of the other parts. Revisions are identified by a capital Gothic letter immediately following the document identifier dash number. Examples:~~

I-P System



SI System



~~Changes to individual pages shall be accomplished in accordance with the change notice guidelines of MIL-STD-962.~~

- 4.3.1 ~~Revision to Test Method. Revision to the document will also reflect a change to the test method number. The revision to the test method shall be denoted by a letter following the original number. For example: The original test method number assigned "Test Method 1, Salt Spray" shall be changed to "Test Method 1A, Salt Spray" or "Test Method 101 Salt Spray" shall be changed to "Test Method 101A Salt Spray" when revised.~~

- 4.4 Selection of Tests. The Tests contained herein are intended to be used to provide uniform testing methods and presentation of data for fasteners and fastening. These tests shall be applicable for research, development and procurement of weapons systems, equipments, and fasteners. In selecting the tests that are to be applicable to fasteners in a specific category or type, it is required that those fastener properties be determined that are needed for incorporation of specific fasteners in specific types of weapons systems and equipments and those properties that are essential for fabrication of a satisfactory fastener. After these essential properties have been determined, the appropriate test shall be selected and specified for each property. Care shall be taken to specify only those tests that are needed.

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NAS **SM1312**

SHEET 5

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- 4.4.1 The test methods available for reference and selection are outlined in the following appendices:
- a. APPENDIX A - List of available test methods in the I-P system of measurement.
 - b. APPENDIX B - List of available test methods in the SI system of measurement.
- 4.5 Method of Reference. This standard shall be referenced in general and detailed specifications or other documentation for military weapons systems. Tests shall be referenced in the individual fastener specification, fastener specification control drawing, etc., by specifying:
- a. The standard number with the applicable dash number but without the revision number. For example:
"the fastener shall be tested for stress durability in accordance with NASM1312-5."
 - b. Test criteria or property values required.
5. DETAIL REQUIREMENTS
- 5.1 Detail requirements shall be incorporated in the individual test method, bookform standard part or section.

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SHEET 6

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APPENDIX A

LIST OF AVAILABLE TEST METHODS IN I-P SYSTEM OF MEASUREMENT

10. Test methods. The following test methods in the I-P system are available for selection and reference:

NASM1312-1	Fastener Test Methods, Method 1, Salt Spray
NASM1312-2	Fastener Test Methods, Method 2, Interaction
NASM1312-3	Fastener Test Methods, Method 3, Humidity
NASM1312-4	Fastener Test Methods, Method 4, Lap Joint Shear
NASM1312-5	Fastener Test Methods, Method 5, Stress Durability
NASM1312-6	Fastener Test Methods, Method 6, Hardness
NASM1312-7	Fastener Test Methods, Method 7, Vibration
NASM1312-8	Fastener Test Methods, Method 8, Tensile Strength
NASM1312-9	Fastener Test Methods, Method 9, Stress Corrosion
NASM1312-10	Fastener Test Methods, Method 10, Stress Rupture
NASM1312-11	Fastener Test Methods, Method 11, Tension Fatigue
NASM1312-12	Fastener Test Methods, Method 12, Thickness of Metallic Coatings
NASM1312-13	Fastener Test Methods, Method 13, Double Shear
NASM1312-14	Fastener Test Methods, Method 14, Stress Durability (Internally Threaded Fasteners)
NASM1312-15	Fastener Test Methods, Method 15, Torque-Tension
NASM1312-16	Fastener Test Methods, Method 16, Clamping Force for Installation Formed Fasteners
NASM1312-17	Fastener Test Methods, Method 17, Stress Relaxation
NASM1312-18	Fastener Test Methods, Method 18, Elevated Temperature Tensile Strength
NASM1312-19	Fastener Test Methods, Method 19, Fastener Sealing
NASM1312-20	Fastener Test Methods, Method 20, Single Shear
NASM1312-21	Fastener Test Methods, Method 21, Shear Joint Fatigue, Constant Amplitude
NASM1312-22	Fastener Test Methods, Method 22, Receptacle Push-out, Panel Fasteners
NASM1312-23	Fastener Test Methods, Method 23, Tensile Strength of Panel Fasteners
NASM1312-24	Fastener Test Methods, Method 24, Receptacle Torque-out, Panel Fasteners
NASM1312-25	Fastener Test Methods, Method 25, Driving Recess Torque (Quality Conformance Test)
NASM1312-26	Fastener Test Methods, Method 26, Structural Panel Fastener Lap Joint Shear
NASM1312-27	Fastener Test Methods, Method 27, Panel Fastener Sheet Pull-up
NASM1312-28	Fastener Test Methods, Method 28, Elevated Temperature Double Shear
NASM1312-29	Fastener Test Methods, Method 29, Shank Expanding
NASM1312-30	Fastener Test Methods, Method 30, Sheet Pull-up of Blind Fasteners
NASM1312-31	Fastener Test Methods, Method 31, Torque

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APPENDIX B

LIST OF AVAILABLE TEST METHODS IN SI SYSTEM OF MEASUREMENT

10. Test Methods. The following test methods in the SI system are available for selection and reference.

NAM1312-105	Fastener Test Methods, Metric, Method 105, Stress Durability
NAM1312-107	Fastener Test Methods, Metric, Method 107, Vibration
NAM1312-108	Fastener Test Methods, Metric, Method 108, Tensile Strength
NAM1312-109	Fastener Test Methods, Metric, Method 109, Stress Corrosion
NAM1312-111	Fastener Test Methods, Metric, Method 111, Tension Fatigue
NAM1312-113	Fastener Test Methods, Metric, Method 113, Double Shear

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APPENDIX C

ALIGNMENT AND LOAD VERIFICATION OF AXIAL-LOAD FATIGUE TESTING MACHINES

10. SCOPE

- 10.1 This procedure covers the techniques and equipment to be used to verify proper machine and fixture alignment and cyclic-load application for axial-load fatigue testing machines. Examples of typical fixtures are included.
- 10.2 General Procedure. The general procedure for alignment and load verification of axial-load fatigue testing machines consists of the following steps:
- Select proper equipment for static alignment.
 - Check calibration of equipment.
 - Check machine alignment and make adjustments as required.
 - Select proper equipment for dynamic load verification and install in test machine.
 - Apply static loads and verify.
 - Operate machine dynamically, record indicated loads and compute amplitude and maximum load errors.

20. APPLICABLE DOCUMENTS

SAE International

AS8879	Screw Threads – UNJ Profile, Inch Controlled Radius Root with Increased Minor Diameter
AMS6280	Steel Bars, Forgings, and Rings 0.50Cr - 0.55Ni - 0.20Mo (0.28 - 0.33C) (8630) (UNS G86300)
AMS6304	Low-Alloy Steel, Heat-Resistant, Bars, Forgings, and Tubing 0.95Cr - 0.55Mo - 0.30V (0.40 - 0.50C) (UNS K14675)
~~AMS6485~~	~~Steel Bars and Forgings 5.0Cr - 1.3Mo - 0.50V (0.38 - 0.43C)~~
AMS6487	Steel, Bars, and Forgings 5.0Cr - 1.3Mo - 0.50V (0.38 - 0.43C) (H-11) Consumable Electrode Vacuum Melted (UNS T20811)

Copies can be obtained from SAE International, 400 Commonwealth Dr., Warrendale, PA 15096-0001. www.sae.org

Military Specifications

MIL-C-15074	Corrosion Preventive, Fingerprint Remover
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Copies can be obtained from the Department of Defense Single Stock Point (DODSSP). <http://dodssp.daps.dla.mil>

ASTM International

ASTM E4	Standard Practice for Force Verification of Testing Machines
ASTM E 74	Standard Practice for Calibration of Force-Measuring Instruments for Verifying the Force Indication of Testing Machines

Copies can be obtained from ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959. www.astm.org

ASME

ASME B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)
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Copies can be obtained from ASME, Three Park Ave., New York, NY 10016-5990. www.asme.org

30. SIGNIFICANCE OF ALIGNMENT AND DYNAMIC VERIFICATION

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NAS1312
SHEET 9

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- 30.1 While it is relatively easy to measure the forces applied to a specimen under static condition, it is essential to ensure that excessive bending loads are not induced and to verify that the amplitude of the dynamic forces applied to the specimen agrees with the amplitude of the indicated loads within acceptable limits.
- 30.2 The presence of unknown and undesirable bending loads induced through fatigue machine and/or fixture misalignment may severely reduce the fatigue life of test specimens and, hence, must be controlled within reasonable limits.
- 30.3 The accuracy of the indicated loads may be dependent upon several factors which include:
- Configuration of the specimen, including dimensions.
 - Configuration of the testing machine fixtures and specimen adapters.
 - Specimen material properties, including density, static and dynamic stress-strain characteristics, and material damping coefficient.
 - Load settings of the testing machine controls.
 - The waveform of the load cycle.
 - The frequency of the load cycle.
- 30.4 Ideally, the loads applied to a specimen in a fatigue test should be verified for each combination of the above factors. It is recognized, however, that within certain limits of variation, the effects of an individual factor on the loads may be small or reasonably predictable.
40. DEFINITIONS
- 40.1 Fatigue-Testing Machine. A device for applying repeated load cycles to a specimen.
- 40.2 Load. The force applied to the specimen. In the case of fatigue-testing machines, load is usually measured in units of pound-force or newtons.
- 40.3 Load Cycle. The smallest segment of the load-time function which is repeated periodically.
- 40.4 Maximum Load. The load having the highest algebraic value in the load cycle, tensile load being considered positive and compressive load being considered negative.
- 40.5 Minimum Load. The load having the lowest algebraic value in the load cycle, tensile load being considered positive and compressive load being considered negative.
- 40.6 Mean Load. The algebraic average of the maximum and minimum loads in the load cycle.
- 40.7 Load amplitude. One half of the algebraic difference between the maximum and minimum loads in the load cycle.
- 40.8 Set Loads. The maximum and minimum loads (or the mean load and the load amplitude) that relate to the settings and adjustments of the controls of a fatigue-testing machine, according to an existing set of guidelines. These guidelines may have been furnished by the manufacturer of the machine or they may have been developed by the user.
- 40.9 Indicated Loads. The maximum and minimum loads (or the mean load and the load amplitude) that relate to the readings obtained from the indicating or recording equipment associated with the fatigue testing machined, according to an existing calibration. This calibration may have been furnished by the manufacturer of the machine, or may have been developed by the user. In the case of fatigue-testing machines having no provision for load readout, the indicated loads shall be determined by introducing an appropriate sized dynamometer into the load chain.

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NAS 1312

SHEET 10

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4.10 Dynamometer. An elastic calibration device for use in verifying the indicated loads applied by a fatigue testing machine. It shall consist of an instrumented member having mass, stiffness, and end displacements such that the inertial effects of the specimen and its attachments to the test machine, for which the verification of loads is desired, are duplicated as nearly as is reasonable. The instrumentation shall permit an accurate determination of the magnitude of the average strain, in a region of uniform transverse cross section, when the dynamometer is subjected to a tensile or compressive force along its longitudinal axis.

40.11 Dynamometer Range. The range of loads for which the dynamometer may be used for verification purposes. A dynamometer for use in tension and in compression will have two dynamometer ranges, one in tension and one in compression.

40.12 Alignment Cell. An elastic device, normally cylindrical in cross section, with strain gages affixed to the outer surface so as to provide indications of axial strain at 90° intervals around the circumference. Comparison of strain readings at a constant load provides a measure of bending induced by the loading system.

50. FATIGUE TEST MACHINES

50.1 Load Measuring System. The dynamic load measuring system shall be accurate within $\pm 2\%$ of the indicated maximum load and amplitude, for loads greater than 10 % of the maximum capacity of the dynamometer.

50.2 Loading Maintaining System. The load maintaining system shall be capable of maintaining the required load within $\pm 2\%$. Machines operating without load maintainers shall be monitored at intervals by the operator. The intervals shall be determined according to the expected cycle life and equipment capability.

50.3 Static Alignment. Static alignment of each fatigue test machine shall be verified at any time necessary to ensure meeting the alignment requirements of this appendix. Alignment check may be accomplished by mechanical or strain gaged alignment cell systems. The method employed (See Section 7) shall be capable of providing that the stress caused by misalignment (eccentric loading) shall not exceed 6 % of the average stress.

50.4 Dynamic Load Verification. The load accuracy of each machine shall be verified after each 1000 hours of operating time or every 6 months, whichever occurs first, and after any machine modification which could affect the load accuracy. The verification procedure shall be in accordance with Section 8.

60. EQUIPMENT AND CALIBRATION OF ALIGNMENT AND DYNAMIC LOAD VERIFICATION EQUIPMENT

60.1 General. A dynamometer of any suitable configuration and material may be used. The dynamometer should normally have dimensions such that a strain in the range from .0012 to .0015 in/in is obtained at the maximum load of the dynamometer range. The dynamometer shall have a length of uniform cross section for attachment of the transducer (See Figure 1).

a. The verification procedure consists of the following principal steps:

1. Obtain the static load - strain (or a quantity proportional to strain) relationship for the dynamometer using a static testing machine or dead weights.

NOTE 1. Whenever the term "strain" is used in this recommended practice, it is understood that any quantity proportional to strain is acceptable.

2. Measure the strains in the dynamometer during cyclic loading at each of the desired maximum and minimum loads and test frequencies in the fatigue testing machine.
3. Convert the measured strains or appropriate instrumentation readings to loads using the static load-strain relationship. This approach assumes that the load strain relationship for the dynamometer is the same under cyclic loading as it is under static loading. The extent to which this assumption is justified is not known precisely at this time.

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