NASM1312-6
29 August 1997

ADOPTION NOTICE

NASM1312-6, "Fastener Test Methods Method 6 Hardness" was adopted on 29 August 1997 for use by the Department of Defense (DoD). Proposed changes by DoD activities must be submitted to the DoD Adopting Activity: Commander, Naval Air Warfare Center Aircraft Division, Code 414100B120-3 Highway 547, Lakehurst, NJ 08733-5100. DoD activities may obtain copies of this standard from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094. The private sector and other Government agencies may purchase copies from the Aerospace Industries Association, 1250 Eye Street NW, Washington, DC 20005.

NASM1312-6 Should be used instead of MIL-STD-1312-6, which was cancelled on 29 August 1997.

Custodians:
Army - AV
Navy - AS
Air Force - 11

Review Activities:
Army - AV, AR
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Navy - AS
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NATIONAL AEROSPACE STANDARD

NASM1312-6
STANDARD PRACTICE

FASTENER TEST METHODS

METHOD 6

HARDNESS

Aerospace Industries Association

THE INITIAL RELEASE OF THIS DOCUMENT SUPERSEDES MIL-STD-1312-6

DESIGNATION FOR THIS TEST METHOD REMAINS MIL-STD-1312-6

LIST OF CURRENT SHEETS										
NO.	1	2	3	4	5	6	7	8	9	10
REV.	NEW	NEW	NEW	NEW	NEW	NEW	NEW	NEW	NEW	NEW

FSC 53GP

APPROVAL DATE AUGUST 1997

FOREWORD

This standard sets forth a standard test method to determine the hardness of all types of structural fasteners.

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NATIONAL AEROSPACE STANDARD

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1. SCOPE

1.1 Applicability. This test method covers a procedure for testing fastener hardness. This method is applicable to all types of structural fasteners: single and multiple piece, blind, threaded and nonthreaded.

2. REFERENCED DOCUMENTS
Not applicable.

3. DEFINITIONS
Not applicable.

4. GENERAL REQUIREMENTS

4.1 Test apparatus.

4.1.1 Rockwell hardness tester. This instrument measures an increase in depth of penetration from a minor to a major load. Two combinations of indenter and major load are recommended. The B scale utilizes a 1/16-inch ball penetrator with a major load of 100 kilograms. A diamond brale (a spherical-tipped conical diamond of a 120-degree angle and 0.2-millimeter tip radius), with a major load of 150 kilograms, is required for the-C scale.

4.1.2 Rockwell superficial hardness tester. The superficial hardness tester is similar to the instrument specified in 4.1.1, except that the indentation is much shallower. The 30T scale utilizes a 1/16-inch ball penetrator with a major load of 30 kilograms, while the 30N scale utilizes the diamond brale with a 30-kilogram load.

4.1.3 Micro hardness tester. A micro hardness tester shall be used when the size or configuration of the test piece does not permit testing on the Rockwell (normal or superficial) equipment. It shall be used also for molded specimens (where dial gage hardness is subject to the errors of unrecovered vertical motion of the specimen upon release of the major load), or where variation of hardness in small distances is being investigated. The penetrator is a diamond square pyramid with a face angle of 136 degrees (diamond pyramid hardness (DPH)) or a diamond rhombus pyramid with 172 degrees included angle (Knoop).

4.1.4 Calibration. Each tester shall be calibrated with standard test blocks for the applicable testing scales in use and the test results recorded on a daily basis during tester usage. Calibration cards shall be available at the machines. Minimum distance between the impressions during calibration shall be in accordance with 5.1.4.

4.1.5 Condition of indenter. Indenters shall be periodically checked under a microscope for defects. Flattening of steel ball indenters or cracking and chipping of diamond indenters results in error in the hardness numbers.

4.1.6 Micrometer microscope. For micro hardness testing, a micrometer microscope is required. This instrument shall be so constructed that the length of the diagonals of an impression in a properly surface-finished specimen can be measured to within ±0.0005 millimeter or ±0.5 percent, whichever is larger.

4.2 Test specimens.

4.2.1 General. The part will be sectioned with parallel surfaces of the specimen prepared by filing, sanding, grinding, or polishing or a combination thereof as specified and tabulated in table I. Care shall be taken so as not to overheat or work-harden the surface.

4.2.2 Surface condition. For the greatest accuracy, the surface of the specimens should be flat, normal to the axis of the indenter, and representative of sound metal. Plating, scale, paint, or grease shall be removed and the part should be sanded or sectioned. The better the surface condition, the more reliable the hardness reading. The more shallow the indentation, the more critical the surface condition.

4.2.3 Flatness. Wherever possible, the unmounted specimen shall be machined or ground to obtain two flat, parallel (within 3 degrees) surfaces. Hardness readings are taken on one of the two flat surfaces. Sufficient material shall be removed from this surface to eliminate surface effects such as decarburization, plating, oxides, surface irregularities, or a shear edge. After surface preparation, the specimen shall be a minimum of ten times as thick as the depth of the impression to avoid an anvil effect.

4.2.4 Mounted specimens. Parts that cannot be machined with two parallel surfaces (because of size or configuration) shall be imbedded in a thermosetting or thermoplastic material and prepared by sanding and polishing. Precautions shall be taken to ensure parallel (within 1 degree) surfaces of the mount so that symmetrical indentations are obtained.

TABLE I. Recommended standard hardness test for fasteners.

Type of fastener	Fastener size	Material tensile strength range (psi)	Hardness scale to be used	Specimen
Bolts, screws, and studs	#0 to #5	All	Micro	Mounted
	#6, #8	≤110,000	30T	Ground flat
	#6, #8	>110,000	30N	
	#10 and larger	≤110,000	R_B	
	#10 and larger	>110,000	R_C	
Rivets	0.0625 to 0.125	All	Micro	Mounted
	0.156	≤110,000	30T	Ground flat
	0.156	>110,000	30N	
	0.188 and larger	≤110,000	R_B	
	0.188 and larger	>110,000	R_C	
Nuts	#0 to #5	All	Micro	Mounted
	#6 to #10	≤110,000	30T	Ground flat
	#6 to #10	>110,000	30N	
	0.250 and larger	≤110,000	R_B	
	0.250 and larger	>110,000	R_C	
Socket set screws	All	All	Micro	Mounted
Spring pins	0.0625 to 0.219	All	Micro	Mounted
	0.250 to 0.500	≤110,000	30T	Ground flat
	0.250 to 0.500	>110,000	30N	

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5. DETAIL REQUIREMENTS

5.1 Test procedures.

5.1.1 Choice of scale. Select a suitable scale (see table I) and use the proper load and penetrator. The largest load shall be used that is consistent with the dimensions of the specimen and with the maximum allowable size of impression for the indenter.

5.1.2 Specimen. All hardness tests shall be made on a single thickness of the material.

5.1.3 Number of impressions. Size of specimen permitting, four impressions shall be made on each specimen and the first impression should be disregarded. Each of the remaining readings and the averages should be recorded.

5.1.4 Location of impressions. The minimum distance between the center of the impression and the edge of the specimen shall be equal to 2-1/2 times the diameter (or the diameter of the enclosing circle) of the impression. There shall be a minimum distance of 5 diameters between centers of the impressions made with a ball penetrator, and at least 2-1/2 diameters between centers made with a conical or pyramidal indenter. For impressions made with a Knoop indenter, the minimum distance from the center of the impression and edge and between centers shall be two times the length of the minor axis.

5.1.5 Rockwell hardness and Rockwell superficial hardness.

a. Minor load application. Place the piece to be tested on the anvil and apply the load gradually until the proper dial indication is obtained. This shall be understood to be when the pointer has made the proper number of complete revolutions and stands within plus or minus five divisions of the "SET" position at the top of the dial. The proper number of complete revolutions shall be indicated either by a reference mark on the stem of the gage or by an auxiliary hand on the dial. In bringing the penetrator and work into contact, avoid all impact, and the last movement of the elevating or lowering screw shall always be in the direction that will bring penetrator and work together. If the proper setting is overrun, remove the minor load and select a new spot for the test. After the minor load has been applied, set the dial pointer at zero on the black-figure scale.

b. Major load application. Apply the major load by tripping the operating lever without shock. Remove the major load by bringing the operating lever back to its latched position within 2 seconds after its motion has stopped, or unless automatically released (as on a Tukon tester), or according to one of the following alternatives:

1. In the case of materials that do not exhibit plastic flow after application of the major load, the pointer will come to rest before the motion of the operating lever stops, and in this case the operating lever may be brought back to its latched position immediately after the pointer stops in order to reduce possible errors due to externally-caused vibration.

2. In the case of materials that exhibit plastic flow after application of the major load, the pointer will continue to move after the operating lever stops, and in this case the operating lever may be brought back to its latched position at a specified elapsed time between tripping and removal of load. In this case, the specified elapsed time shall be recorded with the Rockwell hardness number.

c. Reading scale for Rockwell hardness. Take the Rockwell hardness number (RHN) as the reading of the pointer on the proper dial figures after the major load has been removed and while the minor load is still applied. These readings are sometimes estimated to one half of a division.

5.1.6 Micro hardness.

a. Magnitude of test load. Test loads of 1 gram to 120 kilograms may be used, depending on the requirements of the test. The magnitude of the test load shall be stated in the test report.

b. Application of the test load. The test load shall be applied and released smoothly without shock or vibration. Unless otherwise specified, the time of application of the full test load shall be at least 15 seconds.

c. Measuring the impression. Both diagonals of the DPH (diamond pyramid hardness) impression shall be measured and their average value used as a basis for calculation of the diamond pyramid hardness number. The length of the major axis of the Knoop impression shall be measured. It is recommended that the measurement be made with the impression centered as nearly as possible within the field of the microscope.

d. Hardness number. The DPH number is the number obtained by dividing the applied

load in kilograms by the surface area of the impression in square millimeters computed from the measured diagonal of the impression. It is assumed that the impression is an imprint of the undeformed penetrator.

The DPH number is computed from the following formula:

$$DPH = (2L \sin [\alpha/2])/d^2 = 1.8544L/d^2$$

where L = load in kilograms
d = mean diagonal of impression in millimeters
α = face angle of diamond = 136 degrees

The Knoop hardness number (KHN) is the number obtained by dividing the applied load in kilograms by the unrecovered projected area of indentation in square millimeters computed from the measured major axis of the impression. The Knoop hardness number is computed from the following formula:

$$KHN = L/\ell^2 c = L/0.0703\ell^2$$

where L = load in kilograms
ℓ = length of major axis of impression in millimeters
c = constant relating length to area = 0.0703

6. NOTES

6.1 Test report. The test report shall contain the following data:

a. Fastener description.

1. Part number.
2. Lot identification.
3. Manufacturer.
4. Material.
5. Heat-treatment level.
6. Measured fastener diameter.

b. Test machine.

   1. Model and serial number.

   2. Calibration date.

c. Test method used.

d. Hardness scale.

e. Hardness readings, including average.

f. Elapsed time between tripping and removal of load (if applicable).

g. Load magnitude on micro hardness.

h. Cause and duration of any interruptions during test.

i. Results of all inspections.