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AEROSPACE STANDARD

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Superseding AS39631

Universal Joint, Antifriction Bearings

FSC 3010

CANCELLATION NOTICE

This document has been declared "CANCELLED" as of May 2005. By this action, this document will remain listed in the Numerical Section of the Aerospace Standards Index.

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NOTICE

This document has been taken directly from U.S. Military Specification MIL-U-3963-A and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE technical standards. The initial release of this document is intended to replace MIL-U-3963-A. Any part numbers established by the original specification remain unchanged.

The original Military Specification was adopted as an SAE standard under the provisions of the SAE Technical Standards Board (TSB) Rules and Regulations (TSB 001) pertaining to accelerated adoption of government specifications and standards. TSB rules provide for (a) the publication of portions of unrevised government specifications and standards without consensus voting at the SAE Committee level, and (b) the use of the existing government specification or standard format.

Under Department of Defense policies and procedures, any qualification requirements and associated qualified products lists are mandatory for DOD contracts. Any requirement relating to qualified products lists (QPL's) has not been adopted by SAE and is not part of this SAE technical document.

1. SCOPE:

1.1 Scope:

This specification covers anti-friction bearing universal joints for intermittent and continuous operation suitable for use in military applications.

1.2 Classification:

The universal joints shall be of the sizes as specified in table I.

2. APPLICABLE DOCUMENTS:

2.1 The following specifications and standards, of the issue in effect on date of invitation for bids, shall form a part of this specification:

SPECIFICATIONS

FEDERAL

QQ-P-416	Plating, Cadmium (Electro-deposited)
PPP-B-585	Boxes, Wood, Wirebound
PPP-B-591	Boxes, Fiberboard, Wood-Cleated
PPP-B-601	Boxes, Wood, Cleated-Plywood
PPP-B-621	Boxes, Wood, Nailed and Lock-Corner
PPP-B-636	Boxes, Fiber
PPP-T-60	Tape; Pressure Sensitive Adhesive, Waterproof - for packaging and Sealing

MILITARY

JAN-P-100	Packaging and Packing for Overseas Shipment, General Specification
MIL-P-116	Preservation, Methods of
MIL-B-138	Boxes, Wood, Fiberboard-Lined for Overseas Shipment (for Weight of Contents Not Exceeding 500 Pounds)
MIL-G-3278	Grease; Aircraft and Instruments (for Low and High Temperatures)
MIL-B-4229	Boxes; Paperboard, Metal-Stayed
MIL-I-6866	Inspection, Penetrant Method of
MIL-I-6868	Inspection Process, Magnetic Particle
MIL-A-8625	Anodic Coatings, for Aluminum and Aluminum Alloys
MIL-B-10377	Box, Wood Cleated, Veneer, Paper Overlaid
MIL-L-10547	Liners, Case, Waterproof
MIL-C-16232	Coatings, Phosphate, Heavy (Manganese and Zinc Type) and Phosphate Treating Solutions

2.1 (Continued):

STANDARDS

FEDERAL

FED. TEST METHOD STD. NO. 151 Metals; Test Methods

MILITARY

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-130	Identification Marking of U.S. Military Property
MS24312	Universal Joint, Antifriction Bearing, Round Hub
MS24313	Universal Joint, Antifriction Bearing, Flange Hub
MS24314	Universal Joint, Antifriction Bearing, External Spline
MS24315	Coupling, Flange, Round Hub
MS24316	Coupling - Keyway, Flange, Round Hub

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

2.2 Other publications:

The following document forms a part of this specification. Unless otherwise indicated, the issue in effect on date of invitation for bids shall apply.

NAS 516 Fittings - Lubricator 1/8 Inch Drive, Flush Type

(Copies of NAS publications may be obtained from Aircraft Industries Association of America Inc., 610 Shoreham Building, Washington 5, D.C.)

3. REQUIREMENTS:

3.1 Preproduction sample:

Prior to beginning quantity production, preproduction samples shall be subjected to preproduction testing (see 4.2.1 and 6.2).

3.2 Materials:

The materials used in the manufacture of anti-friction bearing universal joints and flange hubs shall be of the highest quality and entirely suitable for the purpose. The material shall be open-hearth or electric-furnace process steel.

3.2.1 Material defects: Steels shall be free from pipes, cracks, seams, inclusions, or other discontinuities detrimental to the operation or life expectancy of the parts (see 4.4.2.).

3.3 Design and construction:

3.3.1 Dimensions and weights: Dimensions and weights shall be as specified in Standards MS24312, MS24313, MS24314, MS24315, and MS24316.

3.3.2 Assembly: The joints shall be assembled with cross assembly and bearings locked into place to prevent disassembly of the finished joint.

3.3.3 Hardness: The hub section of the joints and flange hubs shall not exceed a Rockwell Hardness of C-40.

3.3.4 Plating: Unless otherwise specified, all external steel parts of the joint or flange hubs, except the spline end of MS24314 joints, shall be cadmium plated in accordance with Specification QQ-P-416, Type I, Class 2. All external aluminum parts of the joint or flange hub shall be anodized in accordance with the requirements of Specification MIL-A-8625. The spline ends of MS24314 joints shall be phosphate coated in accordance with Type I, of Specification MIL-C-16232.

3.3.5 Lubrication: Unless otherwise specified, the bearings of the joints shall be lubricated with grease conforming to Specification MIL-G-3278. Relubrication of the bearings shall be provided for by utilizing lubricator fittings conforming to Standard NAS 516. Adequate sealing for lubricant retention and prevention of contamination shall be provided.

3.4 Performance:

3.4.1 Angularity: The joints shall be operable to an angle of not less than 25 degrees measured between the axis of the hubs.

3.4.2 Tightness: The moment of force required to move one end of the joint through a minimum angle of 25 degrees shall be no more than 1.0 pound-inch.

3.4.3 Torsional, end, and side play: The torsional play in the joint shall be no more than the pertinent limit shown in table I. Maximum end and side play shall be 0.0024 and 0.0056 inch, respectively.

3.4.4 Axial load: The joints shall support the axial tensile and axial compressive loads, as shown in table I, for 30 seconds (with angle A as shown on figure 1 equal to zero) without tightness in excess of the specified limit (3.4.2), after the load is removed. The flange hubs shall support the specified axial tensile loads without permanent deformation.

3.4.5 Maximum static torque: The joints and the flange hubs shall withstand the maximum static torque shown in table I without structural failure of the specimen.

3.4.6 Strength and endurance: The fatigue strength and endurance life of the joints shall be such that they will satisfactorily withstand the tests specified in 4.4.10 and 4.4.11.

3.4.7 Friction torque: The friction torque in the joints during operation at lowered temperatures shall be no greater than 2 pound-inches in a test specimen made up as shown in figure 2 and tested in accordance with 4.4.12.

3.5 Identification of product:

Each joint shall be marked in accordance with Standard MIL-STD-130. The nomenclature shall be as follows:

Size MS
Manufacturer's name and part number
U.S. Property

3.6 Workmanship:

Joints shall be sound and of uniform quality and condition, free from scale and injurious defects, such as cracks, seams, tears, grooves, laminations, pits, blisters, and any other defects which might affect serviceability.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Classification of tests:

The inspection and testing of universal joints shall be classified as follows:

(a) Preproduction tests (see 4.2)
(b) Acceptance tests (see 4.3)

TABLE I - Loads

Nominal size of joint (inches)	Torsional play limit (degrees)	Axial load tension and compression (pounds)	Fatigue test reverse load		Maximum static torque (in.-lb)	Operability test		
			Torque (in.-lb)	Cycles		Static torque (in.-lb)	Endurance torque phase I (in.-lb)	Endurance torque phase II (in.-lb)
¾	0.45	1,750	1,000	50,000	1,500	1,000	500	167
1	0.30	3,500	1,400	50,000	3,000	2,000	1,000	333
1¼	0.24	5,000	1,800	50,000	7,500	5,000	1,500	500
1½	0.21	7,000	2,200	50,000	11,000	8,000	2,000	667
1¾	0.18	10,000	2,600	50,000	15,000	11,000	2,500	833
2	0.15	15,000	3,000	50,000	20,000	15,000	3,000	1,000

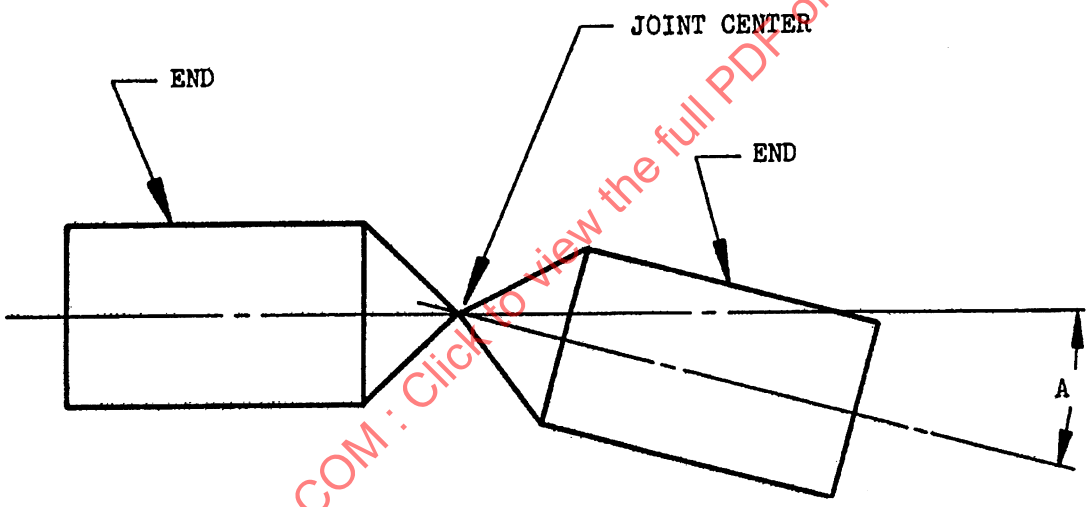

FIGURE 1. Joint.

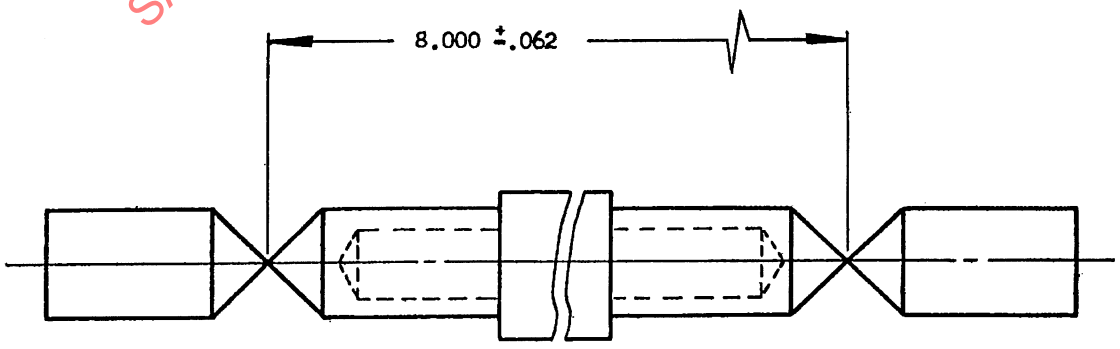

FIGURE 2. Specimen for fatigue, friction torque, and operability test.

4.2 Preproduction tests:

4.2.1 Sampling instructions: The Preproduction test samples shall consist of models representative of the production equipment. They shall be tested at a laboratory designated by the procuring activity or, when so stated in the contract at the contractor's plant under the supervision of the procuring activity. Test samples shall consist of specimens of the same size and part number in quantities as follows:

(a) MS24312, MS24313, and MS24314, 16 joints
(b) MS24315 and MS24316, 10 flanges

4.2.2 Tests: All joints and flanges submitted for test shall be examined for conformance to the applicable MS standard. In addition, universal joints shall be subjected to all the tests specified under "Test methods" (4.4). Flange hubs shall be subjected to the tests specified in 4.4.8 and 4.4.9 only.

4.2.3 Preproduction test report: After the completion of Preproduction Tests, the contractor shall furnish to the procuring activity three complete copies of a test report containing all test results. The report shall also include part numbers of samples, detailed information on materials, heat treatment, finish and lubrication, and a complete set of detail and assembly drawings.

4.3 Acceptance tests:

The Acceptance tests of universal joints and individual component parts shall be as follows.

4.3.1 Universal joints: Universal joints shall be examined for conformance to the requirements of this specification and applicable MS standards as to:

(a) Dimensions and weights (3.3.1)
(b) Assembly (3.3.2)
(c) Lubrication (3.3.5)
(d) Angularity (3.4.1)
(e) Tightness (3.4.2)
(f) Identification of product (3.5)
(g) Workmanship (3.6)

4.3.2 Individual component parts: Individual component parts shall be inspected for Hardness (4.4.1) and Material defects (4.4.2), as described under "Test methods" (4.4), after heat treatment and prior to assembling of the items by the manufacturer.

4.3.3 Sampling: Sample universal joints shall be selected in accordance with Standard MIL-STD-105 at Inspection level II. Each sample shall be inspected in accordance with 4.3.1 and lots shall be accepted or rejected in accordance with AQL (Acceptable Quality Level) 1.0 percent defective.

4.3.3.1 Lot: The lot definition, formation, and size shall be in accordance with Standard MIL-STD-105.

4.4 Test methods:

4.4.1 Hardness: Hardness tests shall be conducted on samples in accordance with Method 243 of Federal Test Method Standard No. 151. Tests shall be made at or near the point of "end" arrows on figure 1.

4.4.2 Material defects: Component parts shall be inspected in accordance with Specification MIL-I-6868.

4.4.3 Plating: With the exception of the spline ends of Standard MS24314, all external steel parts shall be tested for plating in accordance with Specification QQ-P-416, Type I, Class 2. Excepted spline ends shall be tested in accordance with Specification MIL-C-16232, Type I. All external aluminum parts shall be tested for conformance with Specification MIL-A-8625. Two joints of each MS size submitted shall be tested.

4.4.4 Lubrication: Lubricant shall be tested for conformance with Specification MIL-G-3278. Tests shall be made on two joints.

4.4.5 Tightness and angularity: The moment of force required to move one end of the joint in a horizontal plane through the minimum angle of 25 degrees shall be measured with the other end of the joint clamped in a horizontal position. The moment of force shall not exceed 1.0 pound-inch. Sixteen joints shall be tested.

4.4.6 Torsional play: An 8 pound-inch torque shall be applied to the joint, to obtain an initial reading, then the torque load shall be reversed and a second reading taken. The difference between the two readings shall not exceed the pertinent limit shown in table I. Sixteen joints shall be measured.

4.4.7 End and side play: A 5-pound load shall be applied alternately in either the endwise or sidewise direction to obtain an initial reading, then the load shall be reversed and a second reading taken. The total play is the play recorded between the two readings. The side play shall be measured in the same plane as an inspection hole, then the joint rotated through an angle of 90 degrees and measured again. The maximum allowable end play is 0.0024 inch. The maximum allowable side play is 0.0056 inch. Sixteen joints shall be measured.

4.4.8 Axial load: Two joints, except MS24314 joints, shall be subjected to the axial tension and compression tests at zero angularity. Two flange hubs shall be subjected to the axial tension test. The specimens shall be subjected to the load specified in table I for a period of 30 seconds. There shall be no permanent deformation of flange hubs and no excessive tightness of universal joints after the load is removed (see 3.4.2).

4.4.9 Maximum static torque: The maximum static torque load specified in table I shall be applied to each of two joints and to two coupling flanges. Two mating flanges shall be used for this test. Fracture of the material shall constitute failure.

4.4.10 Fatigue test: At least eight joints and flange hubs of each size shall be subjected to the fatigue test. One-half of the test specimens shall be subjected to the test at a 5-degree angularity; the remaining test specimens shall be tested at a 20-degree angularity. Joints shall withstand reversal of the specified torque load for the number of cycles specified in table I.

The application of the load and reversal of the load shall constitute one cycle. The maximum rate of load and application shall not exceed 150 cycles per minute. At 10,000-cycle intervals during the test, each specimen shall be inspected for fatigue cracks in accordance with the method prescribed by Type I of Specification MIL-I-6866. After completion of 50,000 cycles in the fatigue test, each test specimen shall be inspected for fatigue cracks in accordance with Specification MIL-I-6868. The initial appearance of fatigue cracks shall be considered failure of the joint. After the fatigue test, but prior to magnetic particle inspection, the joint shall be inspected for tightness as specified in 4.4.5.

4.4.11 Operability test:

4.4.11.1 Phase I: Six joints of each size shall be subjected to the operability test. The operability test shall consist of a combination of operability static torque, endurance, environmental, and friction torque tests on the same specimen. The joints shall be subjected to the static torque load specified in table I for a period of 30 seconds. After completion of the static torque tests, the joints, in pairs, shall be subjected to the endurance torque specified in table I at 500 rpm and 15 degrees angularity, continuously loaded in a clockwise direction for 50,000 revolutions. After completion of the initial 50,000 revolutions, the endurance test shall be continued for an additional 50,000 revolutions, but with intermittent reversal of loading. The intermittent reversal of loading shall consist of rotation with torque loading for 15 seconds followed by rotation and torque loading in a counterclockwise direction for 2 minutes. After completion of a total of 100,000 revolutions, the bearings in the joints shall be purged with lubricant conforming to Specification MIL-G-3278 and the joints shall be subjected to the environmental tests as specified in phase II.

4.4.11.2 Phase II: After completion of phase I, the joints, in pairs, shall be subjected to the following conditions in the order given:

Step 1. Endurance test. Intermittent reversal of torque loading at 1,500 rpm, 15 degrees angularity and the torque specified in table I, phase II, for an "ON" period of 40 seconds (1,000 revoluations) and an "OFF" period minimum time of 15 seconds for a total of 100,000 revolutions.

Step 2. Salt spray test. The joints shall be rotated in the test chamber at 3 rpm, with the angle "A" as shown on figure 1 equal to 20 degrees, for a period of 50 hours. The temperature in the test chamber shall be maintained at 35° C. (95° F.) throughout the test period.

Salt solution. The salt used shall be sodium chloride containing on the dry basis not more than 0.1 percent of sodium iodide and not more than 0.2 percent of total impurities. The solution shall be prepared by dissolving 20 ±2 parts by weight of salt in 80 parts by weight of distilled or other water containing not more than 200 parts per million of total solids. The solution shall be kept free from solids by filtration or decantation. The solution shall be adjusted to and maintained at a specific gravity of from 1.126 to 1.157 and at a pH of between 6.5 and 7.2 when measured at a temperature between 33° and 36° C. (92° and 97° F.). Only C.P. hydrochloric acid or C.P. sodium hydroxide shall be used to adjust the pH. The pH measurement shall be made electrometrically using a glass electrode with a saturated potassium chloride bridge or by a colormetric method such as bromothymol blue, provided the results are equivalent to those obtained with the electrometric method.

Atomization. The conditions maintained in all parts of the exposure zone shall be such that a suitable receptacle placed at any point in the exposure zone will collect from 0.5 to 3 ml of solution per hour for each 80 sq cm of horizontal collecting area (10-cm diameter) based on an average of at least 16 hours. The solution thus collected shall have a sodium chloride content from 18 to 22 percent (sp gr from 1.126 to 1.157 when measured at a temperature between 33° and 36° C. (91° and 97° F.)). At least two clean fog collecting receptacles shall be used, one placed nearest to any nozzle and one farthest from all nozzles. Receptacles shall be so fastened that they are not shielded by specimens so that no drops of solution from specimens or other sources will be collected.

Step 3. Repeat endurance test in step 1, phase II.

4.4.11.2 (Continued):

Step 4. Altitude and humidity test. The joints shall be rotated in the test chamber at 3 rpm, with the angle "A" as shown in figure 1 equal to 20 degrees for a period of 16 hours. Throughout the test period, the relative humidity shall be maintained at a minimum of 95 percent and the pressure shall be varied conforming to the following hourly cycle. A gradual reduction during the initial 10 minutes from atmospheric pressure to between 30 to 20 inches Hg. The pressure shall then be maintained between 20 to 29 inches Hg for 50 minutes, followed by a gradual pressure increase to atmospheric during the final 5 minutes. During the initial 8 hours, the temperature shall be maintained at -54° C. (-65° F.). During the final 8 hours, the temperature shall be maintained at 71° C. (160° F.).

Step 5. Repeat endurance test outlined in step 1, phase II.

Step 6. Sand and dust test. The joints shall be rotated in the test chamber for 8 hours at 3 rpm with angle "A" shown on figure 1 equal to 20 degrees and the sand and dust density throughout the chamber shall be maintained between 0.1 and 0.5 grams per cubic foot. This sand and dust velocity through the chamber shall be maintained between 900 and 1,100 feet per minute. During this test, the test chamber temperature shall be maintained at 71° ±5° C. (160° ±10° F.).

Sand dust. The sand and dust used in the test shall be of angular structure and shall have characteristics as follows:

(a) 100 percent of the sand and dust shall pass through 100-mesh screen, U.S. Standard Sieve Series.
(b) 98 ±2 percent of the sand and dust shall pass through a 140-mesh screen, U.S. Standard Sieve Series.
(c) 90 ±2 percent of the sand and dust shall pass through a 200-mesh screen, U.S. Standard Sieve Series.
(d) 75 ±2 percent of the sand and dust shall pass through a 325-mesh screen, U.S. Standard Sieve Series.
(e) Chemical analysis of the dust shall be as follows:

Substance	Percent by weight
SiO_2	97 to 99
Fe_2O_3	0 to 2
Al_2O_8	0 to 1
TiO_2	0 to 2
MgO	0 to 1
Ign Losses	0 to 2

Step 7. Repeat endurance test outlined in step 1, phase II.