



AEROSPACE RECOMMENDED PRACTICE

ARP5812™

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Actuators, Linear Mechanical, General Specification Guide

RATIONALE

ARP5812 has been reaffirmed to comply with the SAE Five-Year Review policy.

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Full document details: SAE ARP5812

For more information on this standard, visit
<https://www.sae.org/standards/content/ARP5812/>

Documents

Standard, visit Sharing Hub

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1. SCOPE

This SAE Aerospace Recommended Practice (ARP) establishes design, manufacturing performance and test requirements for linear mechanical actuators intended to be used for linear motion applications in response to manual or automatic power control system inputs.

It is applicable, but not confined to, ball screws, sliding contact screws, roller screws, helical splines, rack and pinion assemblies, and skewed roller actuators.

It is a reference for preparing detail specifications for mechanical actuators compatible and applicable to military or commercial aircraft systems.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and 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.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AS567	Safety Cable, Safety Wire, Key Washers, and Cotter Pins for Propulsion Systems, General Practices for Use of
ARP4386	Terminology and Definitions for Aerospace Fluid Power, Actuation and Control Technologies
AS4536	Safety Cable Kit Procurement Specification and Requirement for Use
ARP4752	Aerospace - Design and Installation of Commercial Transport Aircraft Hydraulic Systems
AS4941	Aerospace - General Requirements for Commercial Aircraft Hydraulic Components
ARP5311	Aerospace - Interface Definition for Mechanical Actuation Subsystems
AS8775	Hydraulic System Components, Aircraft and Missiles, General Specification for
AS8879	Screw Threads - UNJ Profile, Inch Controlled Radius Root with Increased Minor Diameter
AS94900	Aerospace - Flight Control Systems - Design, Installation and Test of Piloted Military Aircraft, General Specification for
AMS2419	Plating, Cadmium-Titanium
AMS2430	Shot Peening, Automatic
AMS2432	Shot Peening, Computer Monitored
AMS2460	Plating, Chromium
AMS2770	Heat Treatment of Wrought Aluminum Alloy Parts

AMS-C-8837 Coating, Cadmium (Vacuum Deposited)

2.1.2 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ANSI/NCLZ Z540.3 Calibration Laboratories and Measuring and Test Equipment - General Requirements

2.1.3 ASME Publications

Available from American Society of Mechanical Engineers, 22 Law Drive, P.O. Box 2900, Fairfield, NJ 07007-2900, Tel: 973-882-1170, www.asme.org.

ASME Y14.38 Abbreviations and Acronyms

2.1.4 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM E 1417 Standard Practice for Liquid Penetrant Testing

ASTM E 1444 Standard Practice for Magnetic Particle Testing Examination

ASTM E 1742 Standard Practice for Radiographic Examination

2.1.5 ISO Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO-10012 Measurement Management Systems - Requirements for Measurement Processes and Measuring Equipment

2.1.6 NAS Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org.

NASM 33540 Safety Wiring, Safety Cabling, Cotter Pinning, General Practices for

2.1.7 RTCA Publications

Available from Radio Technical Commission for Aeronautics Inc., 1828 L Street, NW, Suite 805, Washington DC 20036, Tel: 202-833-9339, www.rtca.org.

RTCA DO160 Environmental Conditions and Test Procedures for Airborne Equipment

2.1.8 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, <http://assist.daps.dla.mil/quicksearch/>.

MIL-STD-129 Military Marking for Shipment and Storage

MIL-STD-130 Identification Marking of U.S. Military Property

MIL-STD-810	Environmental Engineering Considerations and Laboratory Tests
MIL-STD-889	Dissimilar Materials
MIL-STD-1537	Electrical Conductivity Test for Verification of Heat Treatment of Aluminum Alloys, Eddy Current Method
MIL-STD-2073-1	Standard Practice for Military Packaging
MIL-I-8500	Interchangeability and Replaceability of Component Parts for Aerospace Vehicles
MIL-A-8625	Anodic Coatings for Aluminum and Aluminum Alloys
MIL-PRF-32014	Grease, Aircraft and Instrument
MIL-STD-31000	Technical Data Packages
MIL-DTL-32119	Coatings, Electroless Nickel, Special Applications
MIL-HDBK-275	Guide for Selection of Lubricants, Fluids, and Compounds
MIL-HDBK-831	Test Reports, Preparation of
MIL-HDBK-838	Lubrication of Military Equipment
JSSG-2006	Aircraft Structures - DOD Joint Service Specifications Guide
DOT/FAA/AR-MMPDS	The Metallic Materials Properties Development and Standardization Handbook (Available from Battelle, 505 King Ave. Columbus, OH 43201, Tel: 614-424-6496, www.MMPDS.ORG)

2.2 Definitions

For definition of terms not defined below see SAE ARP4386.

2.2.1 LINEAR MECHANICAL ACTUATORS

Linear mechanical actuators are mechanical transformers capable of converting rotary shaft input to linear outputs (or vice-versa). These actuators are configured to primarily transmit axial load but may also be designed to support some amount of transverse (side) loads.

2.2.2 EXTERNAL LOADS

Loads imposed on the actuator output (they vary generally as a function of surface displacement, rate of displacement, and operating conditions).

2.2.3 LIMIT LOAD

The maximum load to be expected in service (i.e., the highest load expected in normal operations). The structure must be able to support limit loads without detrimental, permanent deformation. At any load up to limit loads, the deformation may not interfere with safe operation.

2.2.4 ULTIMATE LOAD

Ultimate load is the limit load multiplied by a safety factor. The structure must be able to support ultimate loads without failure for a duration to be specified by the procuring organization.

2.2.5 STIFFNESS

Actuator stiffness is the ratio of the applied load to the load path deflection expressed N/mm (lbf/in). Unless otherwise specified by the design specification, the deflection for static stiffness should be considered the elastic load path unidirectional deflection excluding free play. The deflection for dynamic stiffness should be considered one half the total bi-directional deflection including free play. Deflection measurements are to be taken from the input shaft to the output excluding connections/couplings with sufficient loading to be on the nominal linear portion of the elastic load deflection curve.

2.2.6 ACCEPTANCE TESTS

Those tests performed on production components to assure the continuance of the quality of that component.

2.2.7 DEVELOPMENTAL TESTS

Tests are performed on initial unit(s) to provide a basis for preliminary design approval to proceed with the production program.

2.2.8 QUALIFICATION TESTS

Tests are performed on production configuration actuators to confirm full compliance with the requirements of the detail specification.

2.2.9 LOSS OF FUNCTION

Considered damage resulting in fracture or failure of a particular component sufficient to prevent the unit from meeting the specified performance, strength or reliability requirements. When a component has suffered damage of an extent that renders the part unacceptable for continued use, it is considered to have failed. The loss of the ability to provide proportional control of the output position.

2.2.10 DESIGN LIFE

The summation of a specified number of operational service lives, as defined in 3.6.4.1, which form the design and analysis criteria for determining life dependent characteristics and safety margins.

2.2.11 SLIDING CONTACT SCREW

A screw utilizing a sliding contact such as Acme screws, square threads, buttress threads, standard 60 degree threads and others. These screws may also be referred to as lead screws, power screws, Acme screws, etc.

2.2.12 JACKSCREW

A generic name associated with any form of screw, rolling contact or sliding contact, which converts rotary motion into linear motion.

2.2.13 DISCONNECT FAILURE

The loss of the ability to restrain the actuator output position.

3. REQUIREMENTS

Requirements are outlined covering the designs of linear mechanical actuators, which may be integrated into a detail specification to be prepared by the procuring agency.

3.1 Interface Definition

This paragraph should describe the linear mechanical actuator's function in the system. It should reference all applicable structural and mechanical interfaces. A list of associated equipment should be added using part and assembly identifying numbers and specifying who is responsible for them. Use ARP5311 for reference.

3.2 Configurations

The linear mechanical actuator serves as the output device for, and is part of, a mechanical actuation system. A typical actuation system may contain one or more of the following components:

1. Prime Mover (Hydraulic, Pneumatic, Electric, Manual)
2. Connecting Members (Torque Shafts, Angle Gear Boxes, Couplings, U-Joints)
3. Safety Devices (No-Backs, Torque Limiters, Brakes)
4. Sensors (RVTs, RVDTs, Tachometers, Hall Effects, Encoders, Limit Switches)
5. Miscellaneous Devices (Clutches, Sequencers, Accessory Drives, etc.)

These components may be configured and specified apart from or integrated with the linear mechanical actuator assembly. Guidelines for specifying these items are outside the scope of this document.

3.3 Characteristics

3.3.1 Performance

The detail specification shall specify the performance requirements of the linear mechanical actuator with respect to its function within the mechanical actuation system. As a minimum, the following performance criteria should be specified:

1. Output Travel Authority
2. Output Rate
3. Efficiency - Specify as necessary according to system performance requirements
4. Tare Losses at Specific Operating Point(s) to define no-load performance
5. Hand of Thread (where applicable - right hand or left hand)

Other performance requirements specific to the application should be included as necessary.

3.3.2 Lead and Pitch

Actuator lead and pitch (and number of thread starts where applicable) may be specified by the user to correspond with motor and/or gear train combination to meet output travel rates. Preferably, an acceptable range will be given for lead and pitch such that the supplier may balance load requirements with appropriate lead/pitch options.

3.3.3 Integrated Components

Specify performance characteristics of components integrated into the actuator assembly as required by the system configuration.