

INCH-POUND

MIL-A-24533B(SH)

1 April 1993

SUPERSEDING

MIL-A-24533A(SH)

3 April 1979

(See 6.9)

## MILITARY SPECIFICATION

## ACTUATORS, ROTARY HYDRAULIC RACK AND PINION

This specification is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

## 1. SCOPE

1.1 Scope. This specification covers the requirements for material, design, fabrication, and testing of rack-and-pinion hydraulic rotary actuators for Naval shipboard use. The actuators convert hydraulic power to a rotational output. The primary application for the actuators is in remote operation of various ship systems' components.

1.2 Classification. Rotary actuators will be in accordance with the torque ranges, shaft rotation, and mounting configurations listed in the applicable specification sheets or as specified (see 6.2),

1.2.1 Rotary actuator categories. Rotary actuators furnished under this specification are category 1, II or III as defined in 1.2.1.1, 1.2.1.2 or 1.2.1.3, respectively (see 6.2).

1.2.1.1 Category I rotary actuators. Category I rotary actuators are rotary actuators which are completely defined by a military specification sheet and part number and meet all the requirements specified herein. Category I rotary actuators are preferred for use.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to Commander, Naval Sea Systems Command, SEA 05Q42, 2531 National Center Bldg 3, Washington, DC 20362-5160 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 3010

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1.2.1.2 Category II rotary actuators Category II rotary actuators are rotary actuators which are the same as category I rotary actuators, except for minor differences such as type of shaft, degrees of rotation, seal material or configuration, or minor dimensional variations which do not change the basic design or construction of the qualified actuator. Category II rotary actuators are considered to be nonstandard (see 6.7).

1.2.1.3 Category III rotary actuators. Category III actuators are rotary actuators whose configurations are not defined by specification sheets. All configuration requirements such as envelope, mounting, type of shaft, torque requirements, and operating pressure must be specified in the ordering data (see 6.2).

## 2. APPLICABLE DOCUMENTS

### 2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

## SPECIFICATIONS

### FEDERAL

- GGG-P-781 - Puller, Mechanical Puller Attachment, Mechanical, and Puller Set, Mechanical.
- PPP-F-320 - Fiberboard: Corrugated and Solid, Sheet Stock (Container Grade), and Cut Shapes
- PPP-B-636 - Boxes, Shipping, Fiberboard

### MILITARY

- MIL-P-116 - Preservation, Methods of,
- MIL-B-121 - Barrier Material, Greaseproofed Waterproofed, Flexible.
- MIL-G-5514 - Gland Design; Packings, Hydraulic, General Requirements for.
- MIL-H-6083 - Hydraulic Fluid, Petroleum Base, for Preservation and Operation
- MIL-A-8625 - Anodic Coatings, for Aluminum and Aluminum Alloys
- MIL-S-8805 - Switches and Switch Assemblies, Sensitive and Push (Snap Action), General Specification for.
- MIL-H-17672 - Hydraulic Fluid, Petroleum, Inhibited.
- MIL-L-19140 - Lumber and Plywood, Fire-Retardant Treated.
- MIL-B-22191 - Barrier Materials, Transparent Flexible Heat Sealable
- MIL-P-24441 - Paint, Epoxy-Polyamide, General Specification for
- MIL-P-24441/1 - Paint, Epoxy-Polyamide, Green Primer, Formula 150, Type I
- MIL-P-24441/2 - Paint, Epoxy-Polyamide, Exterior Topcoat Haze Gray, Formula 151, Type I.

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# MILITARY (Continued)

- MIL-A-24533/1 - Actuator, Rotary, Hydraulic 2-Position, Rack-and-Pinion Type 3,000 to 35,000 inch-Pounds Torque 2-Bolt Mounting.
- MIL-A-24533/2 - Actuator, Rotary, Hydraulic 2-Position, Rack-and-Pinion Type 5,000 to 92,000 Inch-Pounds Torque 4-Bolt Mounting.

## STANDARDS

### MILITARY

- MIL-STD-278 - Welding and Casting Standard.
- MIL-STD-1186 - Cushioning, Anchoring, Bracing, Blocking, and Waterproofing; with Appropriate Test Methods.
- MIL-STD-1762 - Bearings and Bushings, Plain, Preferred for Design, Listing of.
- MIL-STD-2073-1 - DOD Material Procedures for Development And Application of Packaging Requirements.
- MIL-STD-2193 - Hydraulic System Components, Ship.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, BLDG. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein, Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

### AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

- 390 03 - Handbook, Gear Classification, Materials and Measuring Methods for Bevel, Hypoid, Fine Pitch Wormgearing and Racks Only as Unassembled Gears.

(Application for copies should be addressed to the American Gear Manufacturer's Association, 1500 King St., Suite 201, Alexandria, VA 22314.)

### AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- B46 1 - Surface Texture (Surface Roughness, Waviness, and Lay).  
(DoD adopted)

(Application for copies should be addressed to the American National Standards Institute, Inc , 1430 Broadway, New York, NY 10018 )

### AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- D 3951 - Standard Practice for Commercial Packaging. (DoD adopted)

(Application for copies should be addressed to the American Society for Testing and Materials 1916 Race St , Philadelphia, PA 19103.)

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(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services )

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

### 3. REQUIREMENTS

3.1 Specification sheets. The individual rotary actuator requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

3.2 First article. When specified (see 6.2), a sample shall be subjected to the first article inspection (see 6.5) in accordance with 4.3.

3.3 Materials and fabrication. Materials and fabrication shall be in accordance with MIL-STD-2193 and applicable specification sheets. Materials shall be compatible with the fluid, temperature, service and performance requirements specified herein,

3.3.1 Materials for extremely corrosive environment. When designated by the applicable specification sheet or specified (see 6.2), rotary actuators for an extremely corrosive environment shall be designed with emphasis on avoiding destructive electrolysis. Direct contact of electrolytically dissimilar metals shall be avoided. Extremely corrosive environment shall be defined as partial or complete submersion of the actuator in seawater, or exposure to conditions conducive for galvanic corrosion.

3.3.2 Recovered materials. Unless otherwise specified herein, all equipment, material, and articles incorporated in the products covered by this specification shall be new and may be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term "recovered materials" means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification,

### 3.4 Desire.

3.4.1 Design pressure. The rotary actuator shall be designed to the operating pressure in the applicable specification sheet or as specified (see 6.2, 6.3, and appendix). Unless otherwise specified, the rotary actuators shall be designed for a rated operating pressure of 20.7 megapascal (MPa) (3,000 pounds per square inch (lb/in<sup>2</sup>) gauge) and shall provide the minimum specified output torque at a differential pressure which is two-thirds the rated operating pressure.

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3.4.1 Proof pressure. The actuator shall withstand a proof pressure of 1.5 times the design pressure without permanent deformation or external leakage sufficient to form a drop.

3.4.2 Compatibility. Unless otherwise specified (see 6.2), rotary actuators shall be compatible with the fluids identified in the compatibility requirements of MIL-STD-2193,

3.4.3 Envelope. Dimensions shall be within the envelope requirements of the applicable specification sheet or as specified (see 6.2).

3.4.4 Orientation. Actuators shall operate in any orientation or position. Actuator mounting bolt and dowel pin patterns shall meet the requirements of the applicable specification sheets.

3.4.5 Rotation. The shaft rotating angle and its tolerance shall be in accordance with the applicable specification sheet or as specified (see 6.2),

3.4.6 Operating cycles. The rotary actuator shall be designed to achieve a minimum operating life of 50,000 cycles unless otherwise specified (see 6.2). For two-position actuators, a cycle shall be defined as the shaft rotating from one extreme position to the other and return. For three-position actuators, a cycle shall be defined as the shaft rotating from the neutral position to one extreme position and back to neutral, followed by rotation to the other extreme position and return to neutral.

3.4.7 Output torque. Minimum and maximum output torques of the actuator at the specified pressures shall be as established in the applicable specification sheet. The minimum torque required shall be obtained at a differential pressure not more than two-thirds the rated operating pressure. The maximum torque developed at a differential pressure equal to the rated operating pressure shall not exceed the minimum output torque specified by more than 175 percent.

3.4.8 Breakaway pressure. Differential pressure required to start motion of the shaft in either direction under no-load conditions shall not exceed 100 pounds per square inch (lb/in<sup>2</sup>). Actuators shall comply with this requirement after being held in either extreme position for at least 1 minute at the design pressure.

3.4.9 Dashpots. When specified in the applicable specification sheet, dashpots shall be designed to decelerate the motion of the piston near the end of the stroke. The dashpot shall be adjustable and operate over approximately the last 15 degrees of rotation, while meeting any applicable noise requirements.

3.4.10 Leakage. Actuator internal leakage shall not exceed the levels specified in the applicable specification sheet under the operating and test conditions specified herein. External leakage shall be insufficient to form a drop under the same conditions.

3.4.11 Seals. Seals, seal glands, and back-up rings shall be in accordance with MIL-STD-2193.

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3.4.12 Noise. The actuators shall not exceed the allowable structureborne noise Limits specified (see 6.2)

### 3.5 Construction

3.5.1 Actuator bodies. Unless otherwise specified herein, actuator bodies shall comply with the general construction requirements of MIL-STD-2193.

3.5.2 Aluminum bodies. Actuators with an output greater than 136 newton meter (N m)(1,200 inch-pound in-lb)) at rated operating pressure that utilize aluminum as the body material shall be furnished with a corrosion-resistant replaceable sleeve to separate the piston from the aluminum body to prevent galling, corrosion, seizing, or excessive wear of the aluminum body. Exterior surfaces of actuator aluminum bodies shall be anodized in accordance with MIL-A-8625 and painted as specified in 3.7.3.

3.5.3 Welding and brazing. Brazing shall not be used in fabrication of actuator parts subject to hydraulic pressure. Welding requirements shall be in accordance with MIL-STD-278, class M.

3.5.4 Chamfers. Methods of undercutting and chamfering for seal lead-in shall be in accordance with MIL-G-5514.

3.5.5 Internal porting. Transfer of hydraulic fluids across the actuator shall be by internal porting within the actuator.

3.5.6 Relief ports and relief valves. Unless otherwise specified (see 6.2), rotary actuators that require a sealed, fluid-filled gear chamber shall be equipped with a relief valve or other pressure-limiting device. The operating requirements of the relief valve shall be in accordance with the applicable specification sheet or as specified (see 6.2).

3.5.7 Actuator ports. Actuator ports shall be in accordance with the applicable specification sheet or as specified (see 6.2) Tapered pipe threads such as NPT are not permitted.

3.5.8 Fasteners. Fasteners shall be in accordance with the requirements of MIL-STD-2193.

3.5.9 Shaft. Actuator shaft shall be as specified in the applicable specification sheet. Deviation from the specified shaft is permitted for category II actuators provided it does not change the shaft bearing size or mounting configuration of the qualified actuator.

3.5.10 Bearings. Antifriction or journal bearings shall be selected from the preferred-for-design series listed in MIL-STD-1762. The maximum design bearing loads shall not exceed the basic dynamic capacity rating (capacity for one million revolutions) of the bearing used.

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3.5.11 Gearing, Gearing, when required, shall be fully enclosed and shall operate in an oil bath. Only spur gearing shall be used with material and design in accordance with AGMA 390 03 Pinion gear and rack shall be match-marked for proper assembly.

3.5.11.1 Case fluid level, Unless otherwise specified (see 6.2), the gear case or main shaft cavity shall be filled with fluid as specified in the applicable specification sheet. An air space shall be provided to allow for thermal expansion of the fluid. If no fluid is identified, the gear case shall be filled with fluid in accordance with MIL-H-6083.

3.5.12 Position indication Unless otherwise specified (see 6.2), rotary actuators shall be complete with visual position indication. Remote electrical position indication shall be included when specified in the applicable specification sheet. Visual position indication shall consist of markings stamped or engraved in an area adjacent to the driven component's openings (such as switch covers or-actuator bodies) and a pointer stamped or engraved in or attached to the driven component. Position identification markings shall be provided as specified (see 6.2).

3.5.12.1 Electrical position indication, Remote electrical position indication shall consist of sensitive switches mounted on the actuator body. Moving parts shall be fitted with covers or guards to prevent equipment damage and personnel injury. Unless otherwise specified herein, sensitive switches shall be in accordance with MIL-S-8805.

3.5.13 Shims, Shims may be used as required to adjust shaft rotational travel. Adjustments due to shimming shall not exceed 2 degrees. If shimming is used, allowance shall be made for minimum thread engagement, where applicable. Non-metallic shims shall be installed in actuators where galvanic action may occur between the shims and surrounding material.

3.5.14 Mounting, The mounting interface configuration shall be as specified in the applicable specification sheet For Category I actuators, unless otherwise defined by the specification sheet, the missing tooth on the rotating shaft spline shall be in the position shown when the actuator is at the midpoint of the required rotation angle If a different alignment is required, the actuator becomes Category II and the required alignment must be specified (see 6 2)

3.6 Operational environment The following operational requirements shall be in accordance with MIL-STD-2193:

- (a) Ambient temperature.
- (b) Shock (see 4.6.6).
- (c) Vibration (see 4.6 8).
- (d) Salt fog (see 4.6.10)

3.7 Material finishes Surface roughness shall be determined in accordance with ANSI B46 1 and shall be as specified in 3.7.1 and 3.7 2

3.7.1 External finishes External surface finishes shall not exceed 250 microinches, except castings, which shall be as cast, External surfaces shall be smooth, free of burrs, sharp edges, and other irregularities

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### 3.7.2 Internal finishes Internal surface finishes shall be as follows

- (a) internal cylinder bore or piston rod over which packings or seals must slide shall not be greater than 16 microinches.
- (b) Internal moving parts in wearing contact other than as specified in (a) shall not exceed 32 microinches
- (c) Internal nonmoving parts other than parts designed for applications specified in (a) and (b) shall not exceed 125 microinches.
- (d) Finished surfaces for either dynamic or static packing or seal grooves shall be in accordance with the specifications identified in MIL-STD-2193.

3.7.3 Coatings. External surfaces of non-corrosion resistant metal, with the exception of threaded areas or machined surfaces in rolling or sliding contact shall be coated by paint in accordance with MIL-P-24441 as follows.

- (a) Grease, oil, and dirt shall be removed from external surfaces by solvent wiping, vapor decreasing, or caustic washing and rinsing. (This does not apply to aluminum parts immediately after anodizing.)
- (b) One coat shall be applied in accordance with MIL-P-24441/1 (F150), followed by two coats in accordance with MIL-P-24441/2 (F151), with 2 to 4 mils dry film thickness per coat to produce a minimum total dry film thickness of 8 mils. Single coats in excess of 4 mils shall be avoided.

3.8 Nameplates Nameplates shall be provided and mounted on each actuator. The nameplate shall be in accordance with MIL-STD-2193 The markings on the nameplate shall be in accordance with either 3.8.1 or 3.8.2, as applicable.

3.8.1 Markings for category I actuators The nameplate for category I actuators shall contain the following information

- (a) Specification part or identifying number (PIN) in accordance with the applicable specification sheet.
- (b) Manufacturer's name, Commercial and Government Entity (CAGE) Code, part number, and serial number
- (c) Relief valve setting, if applicable

3.8.2 Markings for category II actuators. The nameplate for category II actuators shall contain the following information in addition to that required for category I actuators

- (a) Designate as category II after the part identifying number
- (b) Rotating angle if not identified by PIN

3.8.3 Markings for category III actuators The nameplate for category III actuators shall contain the same information as for category I actuators except that there shall be no PIN

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3.9 Special tools. No special tools, fixtures, or wrenches shall be required for disassembly, service or maintenance of the actuators. Special tools are defined as those tools not listed in the Federal Supply Catalog. Copies of this catalog may be consulted in the office of the Defense Contract Management Area Operations (DCMAO). Standard gear and bearing pullers in accordance with GGG-P-781 not considered special tools.

#### 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of the manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

- (a) First article inspection (see 4.3).
- (b) Quality conformance inspection (see 4.4).

4.3 First article inspection. First article inspection shall consist of the tests specified in table I. The sequence of the tests shall be group A, followed by group B, and then group C (see 6.3). At least one actuator of each specific part number shall be tested.

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TABLE I. First article inspection.

Examination or test	Requirement	Test method
<u>Group A</u>		
Visual examination	3.3, 3 4, 3.5, 3 7, 3.8	4.6 1
<u>Group B</u>		
Run-in	3.4.4, 3.4.5, 3 4.10 3.5.12.1	4.6.2
Proof pressure and leakage	3.4.1 1, 3.4.10	4.6.3
Breakaway pressure	3 4 8	4.6 4
Torque	3.4.7	4.6.5
Noise	3.4 12	4.6.9
<u>Group C</u>		
Vibration	3.6 (c)	4.6.8
Shock	3.6 (b)	4.6.6
Endurance	3 4.6	4.6.7
Salt fog	3.6 (d)	4.6.10
Salt spray (if required)	3.3.1	4 6.10.1

4.4 Quality conformance inspection. Quality conformance inspection shall consist of the examinations and tests listed in table II (see 6.3 and 6 6). Each rotary actuator shall be subjected to quality conformance inspection.

TABLE II Quality conformance inspection.

Examination or test	Requirement	Test method
Visual examination	3.3, 3 4, 3.5	4 6.1
Run-in	3 4 5	4.6.2
Pressure and leakage	3 4 1, 3.4.10	4 6.3
Breakaway pressure	3 4 8	4 6.4
Noise testing	3.4 12	4 6.9

4. 5 Test conditions Test conditions shall be as specified herein and in the applicable specification. sheet

4.5.1 Test fluid, Unless otherwise specified (see 6.2), the test fluid shall be in accordance with MIL-H-17672, 2135-T-H

## MIL-A-4336, Sh1

4.5.2 Ambient test conditions. Unless otherwise specified, actuators shall be tested under ambient temperatures between 15 and 40 degrees Celsius (°C)

4.6 Test methods.

4.6.1 Visual examination. The rotary actuator shall be visually and dimensionally examined to verify conformance to this specification and the applicable specification sheet. Deviation from the specified dimensions, finishes, and configuration shall be cause for rejection.

4.6.2 Run-in test. The actuator shall be cycled at least 10 times to ensure the chambers are properly filled with hydraulic fluid and that any trapped air is purged from the actuator. Visual examination shall be made to ensure there are no signs of external leakage and that the rotary actuator can achieve the specified rotation (see 3.4.5). If the actuator is equipped with electrical position indication switches, the switches shall be continuity tested to ensure that they are functioning in response to actuator rotation.

4.6.3 Pressure and leakage test. Unless otherwise specified, the pressure test and leakage test shall be performed as specified herein. When pressurizing each port, the actuator shall be permitted to travel to its full stroke. The test procedure shall be as follows:

- (a) The actuator shall be operated at the rated output torque and operating pressure for a minimum of 30 minutes with the gear chamber open. During this period, the actuator shall be cycled at a rate of two to six cycles per minute and the internal leakage shall be collected. The pressure shall then be relieved and the actuator examined for signs of external leakage, loosening of the fasteners, or damage to any part of the actuator. Internal leakage shall not exceed the values specified (see 3.4.10).
- (b) The port shall then be pressurized to the specified proof pressure for a minimum of 15 minutes. The pressure shall then be relieved and the actuator examined for signs of external leakage, loosening of the fasteners, or damage to any part of the actuator. Internal leakage in excess of three times the specified values (see 3.4.10) shall constitute a failure of the test

The test shall be repeated for each of the actuator ports. Upon completion of the test, the actuator shall be cycled at least five times to ensure the unit is functioning and able to meet its rotational requirement (see 3.4.5). The failure to meet the specified leakage requirement or evidence of loosening, damage, or external leakage shall constitute a failure of the test. For quality conformance, the minimum time to maintain the specified operating pressure shall be reduced from 30 minutes to 15 minutes. The time to maintain the proof pressure shall be reduced from 15 minutes to 5 minutes

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4 6.4 Breakaway pressure. The breakaway pressure shall be obtained by shifting the rotary actuator to one of its extreme positions and maintaining the design pressure for a minimum of 1 minute. The actuator shall then be shifted to the opposite position while observing the differential pressure required to start movement. The test shall be repeated by shifting the actuator in the opposite direction. Breakaway pressure in excess of the specified value (see 3 4.8) shall constitute a failure of the test.

4.6.5 Torque tests. The test pressure (or pressures) as specified in the applicable specification sheet shall be applied to the actuator through the appropriate port (or ports). Maximum and minimum output torque shall be measured and recorded five times (see 6.6). There shall be no evidence of loosening, binding, or damage to the actuator shaft or parts. Temperature of the test fluid shall be maintained at  $40 \pm 20^{\circ}\text{C}$  while performing the torque test. The actuator shall meet the requirements specified in 3.4.7 and 3.4.8.

4.6.6 Shock test. The actuator shall be shock tested to ensure compliance with 3.6(b). The actuator shall be disassembled and inspected for physical damage after completion of the shock test. The actuator shall be considered to have failed the shock test if it does not meet the rotational requirements specified in 3.4.5 and the pressure and leakage requirements specified in 3.4.1 and 3.4.10, respectively, or shows any signs of physical damage upon disassembly. The actuator shall be pressurized to the specified design pressure for the shock test

4.6.7 Endurance test. The actuator shall be endurance tested to the specified number of cycles at the rated output torque and operating pressure. Unless otherwise specified in the applicable specification sheet, the test shall be conducted at a cycle rate of two to six cycles per minute. Periodically during the test, the actuator shall be examined for external leakage, cracks, or loose fasteners. Any of these defects along with the inability to develop the specified torque or premature seal replacement shall constitute a failure of the test. Upon completion of the endurance test, the group B tests in table I shall be repeated. The proof pressure test specified in 4.6.3 need not be repeated. Inability to meet the requirements specified in 3.4.6 shall constitute a failure of the test.

Hydraulic fluid used for the endurance test shall not be cleaner than the limits established by the following minimum particle count:

<u>Particulate size</u> <u>(micrometer)</u>	<u>Minimum number of</u> <u>particles per</u> <u>100 milliliters</u>
greater than 15	3,000
greater than 25	500
greater than 50	90

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4.6.8 Vibration test. Actuator switches shall be subjected to a vibration test in accordance with MIL-S-8805, except that electrical switches qualified to a military specification with vibration test requirements do not require additional testing.

4.6.9 Noise Test. Rotary actuator shall meet the structureborne noise as specified in 3.4.12. The maximum allowable one third octave band structureborne noise level for these test conditions shall not exceed the limits specified. The noise test shall be conducted with the actuator cycled under no-load conditions while limiting actuator rotational speed to less than 2.5 seconds per half cycle, except that linear piston speeds in excess of 12 inches per second are not required.

While monitoring the broadband vibration level, the peak transient noise produced when cycling the actuator shall be recorded. For quality conformance, any actuator that exhibits squealing, grinding, or chattering noises during the run-in test (see 4.6.2) shall be considered to have failed to meet noise requirements. -

4.6.10 Salt fog test. The actuator shall undergo the salt fog test to ensure compliance with the requirements specified in 3.6(d). The salt concentration for the water shall be  $5 \pm 1$  percent. The actuator shall be set-up in its normal operating mode. The duration of the test shall be 48 hours with a period of 24 hours wet and 24 hours drying. After completion of testing and cleaning, the base metal shall not be visible through the coating or finish, nor shall there be any evidence of corrosion (existence of any visible oxide), peeling, chipping or blistering. Any evidence of these defects shall constitute a failure of the test. Approval by similarity may be extended to other actuators from the same manufacturer that use identical material as the actuator tested.

4.6.10.1 Salt spray test for extremely corrosive environment. The actuator shall undergo a salt spray or immersion test for verification of compliance with 3.3.1. The actuator shall be subjected to alternating periods of salt spray or immersions as specified, with equal periods of drying. The periods shall be 3 hours of spray or immersion with 3 hours of drying at room temperature for a total duration of 48 hours. The saltwater solution shall be the same as required for the salt fog test (see 4.6.10). At the completion of the test and cleaning, the actuator shall be examined externally for the conditions specified in 4.6.10. The actuator shall then be disassembled and examined internally for evidence of saltwater entry, corrosion, pitting, or other signs of electrolytic or galvanic corrosion. Any of these defects shall constitute a failure of the test. Actuators subjected to this test need not be subjected to the salt fog test specified in 4.6.10.

4.7 Inspection of packaging. Sample packages and packs, and the inspection of the preservation, packing, and marking for shipment and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

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## 5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition) For the extent of applicability of the packaging requirements of referenced documents listed in section 2, see 6.7 )

### 5.1 General requirements.

5.1.1 Lumber and plywood. Unless otherwise specified (see 6.2), the preservative fluid shall be in accordance with MIL-H-6083 Cleanliness of the preservative fluid shall meet the following requirements:

(a) Particulate count:

<u>Particulate size</u> <u>(micrometers)</u>	<u>Maximum number of</u> <u>particles per</u> <u>100 milliliters</u>
greater than 15	14,000
greater than 25	2,500
greater than 50	400

No particles over 500 micrometers, except fibers are permitted. Fibers are defined as particles with a length at least 10 times the diameter.

(b) Water content shall be not more than 0.05 percent by volume,

### 5.1.2 Navy fire-retardant requirements.

5.1.2.1 Lumber and plywood When specified (see 6.2), all lumber and plywood including laminated veneer material used in shipping container construction members, blocking, bracing, and reinforcing shall be fire-retardant treated material conforming to MIL-L-19140 as follows

Levels A and B - Type II - weather resistant.  
Category 1 - general use

Level C - Type I - non-weather resistant  
Category 1 - general use

5.1.2.2 Fiberboard When specified (see 6.2), fiberboard used in the construction of class-domestic, non-weather resistant fiberboard and cleated fiberboard boxes including interior packaging forms shall meet the flamespread and the specific optic density requirements of PPP-F-320 amendments thereto

5.2 Preservation. Preservation shall be level A or commercial, as specified (see 6.2)

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5.2.1 Level A. Actuators shall be preserved by a fill and i-lush/drain method that will ensure complete coverage of the movable pares within the actuator. Actuators shall be rotated to the full operational positions. Preservative fluid shall meet the cleanliness requirements specified in 5.1.1. The piston shall be returned to the full retract position and the cylinder filled with fluid, allowing space for expansion. Ports shall be plugged and detached parts reassembled to the actuator, Care shall be exercised to prevent contamination of the actuator during this operation. Exposed bare metal surfaces of repair parts shall be coated with preservative conforming to P-2 of MIL-P-116. Each actuator shall be marked as specified in 5 6 2.

5 2.1.1 Wrapping. Exposed preserved surfaces shall be wrapped with barrier material conforming to grade A of MIL-B-121 or type II of MIL-B-22191. Barriers shall be secured by heat sealing or pressure-sensitive tape. Wrapped actuators shall be further cushioned, blocked, or braced and packed for che level specified in 5.3. Accessories accompanying each actuator shall be individually wrapped and secured as specified above and consolidated in a fiberboard box conforming to PPP-B-636, class domestic. Parts shall be cushioned to prevent movement within the box. Box closure shall conform to method I as specified in the appendix to the box specification.

5.2.2 Commercial. Presentation of equipment and accessories shall be in accordance with ASTM D 3951 to afford protection against contamination, corrosion, deterioration, and physical damage during shipment from the supply source to the first receiving activity for immediate use.

5.3 Packing. Packing shall be level A, B, or commercial, as specified (see 6 2).

5.3 1 General requirements for level A. B. or commercial. Containers selected shall be of minimum weight and cube consistent with the protection required, of uniform size, and contain identical quantities.

5 3.2 Levels A. B, and commercially preserved. Actuators preserved as specified (see 5 2) shall be packed in exterior shipping containers in accordance with MIL-STD-2073-1, table VII of appendix C, for the level of packing specified (see 5 3) Unless otherwise specified (see 6 2). container selection including container options shall be the contractor's option

5 3 2 1 Closure gross weight, and waterproofing.

5.3 2.1.1 Closure Container closure, reinforcing, or banding shall be in accordance with the applicable container specification or appendix thereto except that weather-resistant fiberboard boxes shall be closed in accordance with method V and reinforced with non-metallic or tape banding and domestic nonweather-resistant fiberboard boxes shall be closed in accordance with method I using pressure sensitive tape

5.3,2 1 2 Weight Wood, plywood, and wood cleated type containers exceeding 200 pounds gross weight. shall be modified by the addition of skids in accordance with MIL-STD-7073-1 appendix F, or the applicable container specification or appendix thereto

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5.3.2.1.3 Waterproofing Unless otherwise specified (see 5.2, , level A and when specified (see 6 2) level B shipping containers shall be Fret'lded with caseliners. linings, wraps, or shrouds in accordance with the waterproofing requirements of MIL-STD-1186.

5.3.3 Commercial Actuators preserved as specified (see 5,2) shall be packed for shipment in accordance with ASTM D 3951 and herein.

5.3.3.1 Container modification Shipping containers exceeding 200 pounds gross weight shall be provided with a minimum of two, 3- by 4-inch nominal wood skids laid flat, or a skid- or sill-type base which will support the material and facilities handling by mechanical handling equipment during shipment, stowage, and storage.

#### 5.4 Cushioning, filler, dunnage, and wrapping materials.

5.4.1 Level A preservation and levels A and B Packing, Use of all types of loose-fill materials for packaging and packing applications such as cushioning, filler, or dunnage is prohibited for materials destined for shipboard installation or stowage.

5.4.2 Level C preservation and packing. When loose fill type materials are used for packaging and packing applications such as cushioning, filler, and dunnage, all containers (unit, intermediate, and shipping) shall be marked or labeled with the following information-

#### CAUTION

"Contents cushioned with loose-fill material shall not be taken onboard ship. Remove and discard loose-fill material. If required, recushion with cellulosic material, bound fiber, fiberboard, or transparent flexible cellular material. "

5 4 3 Resistance to fire Cushioning, filler, dunnage, and wrapping materials selected, whenever available, shall exhibit improved performance for resistance to fire

5.5 Palletized unit loads When specified (see 6 2), containers shall be palletized in accordance with MIL-STD-2073-1, appendix F

#### 5 6 Marking.

5.6.1 Levels A B, C, anti commercial, In addition to any special marking required [see 5 6 2) interior (unit) packs, shipping containers and palletized unit loads be marked in accordance with MIL-STD-2073-1, appendix F, and shall include bar codes and applicable packaging acquisition requirements as specified (see 6.2)

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5.6.2 Special marking, Preserved assemblies shall be tagged, and the exterior shipping container marked or labeled with the following

"The interior of this item has been coated (or filled, as applicable) with (list preservative, fluid brand or Military specification as applicable) on (provide date of preservation)."

5.7 Technical manuals. Technical manuals which accompany shipments that are packed level A or B shall be packaged in transparent, waterproof plastic bags, minimum of 4 mil thickness. Closure shall be by heat sealing. Technical manuals shall not be placed with any sealed flexible barrier material used to enclose the items. Manuals, when shipped in bulk quantities, shall not be individually wrapped, but shall be packed in accordance with the requirements of the applicable manual specification or packed in containers conforming to the requirements for level A, B, or C, as specified (see 5.3).

## 6 NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The actuators covered in this specification are intended for use in ship hydraulic systems. Actuators are suitable for use in systems using either petroleum-based, water-glycol, or triaryl phosphate ester hydraulic fluids.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- (a) Title, number, and date of this specification.
- (b) Classification of rotary actuators (see 1.2).
- (c) Category of rotary actuator required (see 1.2.1).
- (d) Those minor differences or variations of basic design which characterize the rotary actuator as category 11 (see 1.2.1.2, 3.4.6, and 3.5.7).
- (e) All configuration and performance requirements for category III actuators (see 1.2.1.3, 3.4.1, 3.4.3, 3.4.4, 3.4.6, 3.4.7, 3.5.6, 3.5.7, and 3.5.9).
- (f) Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
- (g) When first article inspection is required (see 3.2).
- (h) When materials for extremely corrosive environment are required (see 3.3.1).
- (i) Piston seal requirements for category II and III rotary actuators, if other than specified (see 3.4.2 and 3.4.11).
- (j) Requirements for system and test fluids, if other than specified (see 3.4.2, 3.5.11.1, and 4.5.1).
- (k) Shaft rotating angle requirements for category II and III rotary actuators (see 3.4.5).
- (l) The minimum number of operating life cycles when greater than that identified in the specification or applicable specification sheet (see 3.4.6),

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- (m) Structureborne noise limits if different than those identified (see 3.4,12)
- (n) Shaft spline missing tooth alignment versus rotational angle for Category II and III actuators (see 3.5.14).
- (o) Position indicator markings, if required (see 3.5.12).
- (p) Presentation fluid, if other than specified (see 5.1.1),
- (q) Levels of preservation and packing required (see 5.1.2, 5.2, and 5.3).
- (r) When fire-retardant material is required (see 5.1.2.1).
- (s) When fiberboard must meet flamespread and specific optic density requirements (see 5.1.2.2).
- (t) When caseliners are not required for level A and level B packed shipping containers (see 5.3.2.1.3).
- (u) When palletization is required (see 5.5).
- (v) Special marking required in addition to that specified in 5.6.2 (see 5.6.1).

6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DID's are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DoD FAR Supplement 27 475-1 exempts the requirement for a DD Form 1423

<u>Reference Paragraph</u>	<u>DID Number</u>	<u>DID Title</u>	<u>Suggested Tailoring</u>
3.4 and appendix	DI-DRPR-80651	Engineering drawings	---
4 3	DI-NDTI-80809	Test/inspection reports	---
4.4	DI-MISC-80678	Certification/ data report	---

The above DID's were those cleared as of the date of this specification, The current issue of DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

6.4 Technical manuals. The requirement for technical manuals should be considered when this specification is applied on a contract. If technical manuals are required, military specifications and standards that have been cleared and listed in DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL) must be listed on a separate Contract Data Requirements List (DD Form 1423), which is included as an exhibit to the contract. The technical manuals must be acquired under a separate contract line item in the contract.

6.4.1 Additional requirements for technical manuals. In addition to the general requirements covered above, the following features apply to technical manuals for rotary actuators,

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- (a) Technical manuals should be prepared for all standard and nonstandard actuator models in accordance with MIL-M-15071 type I
- (b) When applicable, the manual should incorporate a series of similar actuators rather than an Individual manual for each type of actuator.

6 5 First article. When first article inspection is required, unless specific guidance is provided by the contracting officers to offerors (see 6.2) the first article item(s) may be a preproduction sample, a first article sample, a first production item, a sample selected from the first production items or a standard production item from the contractor's inventory. The contracting officer should include specific instructions in the acquisition documents regarding the number of items to be tested (if more than one), arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provided that the Government reserves the right to waive the-requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government and that bidders offering such products, who wish to rely on such production or rest, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation.

6.5.1 First article and drawing approval. For items which will be used on U. S. Navy ships, first article and drawing approval by the Hydraulic System and Component Standardization branch of the Naval Sea Systems Command (NAVSEA 56W16) is required. Acquisition activities will not be required to obtain and submit first article test reports and drawings to NAVSEA when the offeror provides evidence that the item being offered has been approved by NAVSEA and the offeror attests that such approval is still valid and has not been rescinded. Any changes to the revision of a drawing approved by NAVSEA will require resubmittal for NAVSEA review and approval of the change and any applicable first article test requirements resulting from the change Unless otherwise specified in the contract, drawings and first article test reports may be submitted to NAVSEA by either the acquisition activity or the offeror When an offeror wishes to obtain first article approval on similar items, he may submit a first article test report for NAVSEA approval in which the number of tests are minimized in order to eliminate duplicate testing of identical and similar items

6.6 Technical content requirements for certification/data reports. Results of the torque test performed for each operating gauge pressure specified in 4.6.5 should be recorded The recorded results should be submitted with the certification/data report. Ambient temperatures for all tests should be recorded and submitted with the certification/data report,

6 7 Sub-contracted material and parts. The packaging requirements of referenced documents listed in section 2 do not apply when material and parts are acquired by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

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6.8 Subject term (key word) listing.

Hydraulic system  
Petroleum-based fluid  
Rack-and-pinion  
Triaryl phosphate ester fluid  
Water-glycol fluid

6.9 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes

Preparing activity:  
Navy - SH  
(Project 3010-N012)

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## APPENDIX

## ENGINEERING DRAWINGS TECHNICAL CONTENT REQUIREMENTS

## 10. SCOPE

10.1 Scope. This appendix covers the technical content requirements that should be included on drawings when required by the contract or order. This appendix is mandatory only when data item description DI-DRPR-80651 is cited on the DD Form 1423

## 20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1:1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

## SPECIFICATION

## MILITARY

MIL-T-31000 - Technical Data Packages, General Specification for.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, BLDG 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094. )

## 30. DRAWINGS

30.1 Drawing content. In addition to the drawing content required by MIL-T-31000, drawings shall contain the following:

- (a) overall outline dimensions of the complete actuator.
- (b) Dimensional location of ports
- (c) Port sizes and connections.
- (d) Internal porting and flow paths
- (e) Port identification markings (example C-1, C-2, and so forth).
- (f) Dimensional location and size of mounting holes.
- (g) Torque values for bolting or fastening devices
- (h) Calculated dry weight of actuator
- (i) Calculated fluid volume of actuator.
- (j) Center of gravity when wet weight (fluid filled) of actuator exceeds 100 pounds
- (k) Transverse and longitudinal cross-sectional views showing actuator action and internal working parts
- (l) Detailed sections of views considered necessary to amplify the working parts of the actuator

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- (m) Identification plate location, information data, and method of securing
- (n) Tolerance table and notes, as applicable.
- (o) Complete bill of materials, including military or industry specifications and standards.
- (p) The volume of fluid required for the specified degrees of rotation.
- (q) General notes - Notes should include information pertinent to performance ratings, coatings, input and output parameters, special tools, support equipment, cautions, warnings, and so forth.
- (r) For all category II actuators, completely identify all deviations from the standard item.
- (s) Procedure for adjustments,
- (t) Shaft rotational angle and rotational tolerance.
- (u) Match-marking of pinion and rack

# STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

## INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given
2. The submitter of this form must complete blocks 4, 5, 6, and 7
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

<b>1. RECOMMEND A CHANGE:</b>		<b>1. DOCUMENT NUMBER</b> MTL-A-24533B	<b>2. DOCUMENT DATE (YYMMDD)</b> 1993 April 1
<b>3. DOCUMENT TITLE</b> ACTUATORS, ROTARY, HYDRAULIC, RACK AND PINION			
<b>4. NATURE OF CHANGE</b> (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed)			
<b>5. REASON FOR RECOMMENDATION</b>			
<b>6. SUBMITTER</b>			
<b>a. NAME (Last, First, Middle Initial)</b>		<b>b. ORGANIZATION</b>	
<b>c. ADDRESS (Include Zip Code)</b>		<b>d. TELEPHONE (Include Area Code)</b> (1) Commercial (2) AUTOVON (if applicable)	<b>7. DATE SUBMITTED (YYMMDD)</b>
<b>8. PREPARING ACTIVITY</b>			
<b>a. NAME Technical Point of Contact (TPOC):</b> Wayne Wilcox, NAVSEA 05W16 PLEASE ADDRESS ALL CORRESPONDENCE AS FOLLOWS:		<b>b. TELEPHONE (Include Area Code)</b> (1) Commercial (2) AUTOVON TPOC: (703) 602-1595 332-1595	
<b>c. ADDRESS (Include Zip Code)</b> Commander, Naval Sea Systems Command ATTN: SEA 05Q42, 2531 Jefferson Davis Hwy Arlington, VA 22242-5160		<b>IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:</b> Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041 3466 Telephone (703) 756-2340 AUTOVON 289-2340	