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MILITARY SPECIFICATION

ACTUATORS, ROTARY, HYDRAULIC

This specification is approved for use by the Naval Sea Systems Command 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 hydraulic 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 submarine systems components.

1.2 Classification. Hydraulic actuators shall be of the types and classes specified in 1.2.1 and 1.2.2, as specified (see 6.2.1). Requirements for types and classes not listed herein shall be as specified (see 6.2.1).

1.2.1 Types. Actuator types shall be as follows:

Type	Output shaft rotation (plus 3 degrees minus 1/2 degree) (Degrees)
I	90
II	180
III	190
IV	200
V	210
VI	250

1.2.2 Classes. Actuator classes shall be as specified in table I.

TABLE I - Actuator classes.

Type	Class	Maximum torque (inch-pounds) at a gage pressure of 3000 pounds per square inch (lb/in^2)	Minimum torque (inch-pounds) at a gage pressure of 2000 lb/in^2	Shaft diameter (inches) outside diameter	Maximum actuator size in inches	
					Width	Height
I	1	500	260	0.50	3.5	3
I	2	700	400	0.625	4	3.5
I	3	1,000	550	0.750	5	4
I,II	4	1,200	700	0.750	5	4
I,II	5	2,000	1,150	1.000	5	4
I,IV	6	2,300	1,300	0.750	5	6
I	7	2,500	1,400	1.000	6	5
I	8	3,000	1,700	1.250	6	5
I	9	3,500	2,000	1.250	6	5
I,II,IV	10	5,000	2,900	1.375	6	5
I,II,IV,V	11	6,000	3,500	1.375	6	5
I,III	12	8,000	4,600	1.375	6	5

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Ship Engineering Center, SEC 6124, Department of the Navy, Washington, DC 20362 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

TABLE I - Actuator classes. Continued

Type	Class	Maximum torque (inch-pounds) at a gage pressure of 3000 pounds per square inch (lb/in^2)	Minimum torque (inch-pounds) at a gage pressure of 2000 lb/in^2	Shaft diameter (inches) outside diameter	Maximum actuator size in inches	
					Width	Height
I,III	13	10,000	5,700	1.500	7	7
II	14	11,000	6,300	1.500	7	7
II	15	12,000	6,900	1.500	7	7
I,II,III,VI	16	15,000	8,600	1.500	7	7
I,II	17	16,000	9,200	1.750	7	8
I	18	18,000	10,400	1.750	7	8
I	19	20,000	11,500	1.750	7	8
I,III	20	23,000	13,350	1.750	10	8
I,II	21	25,000	14,400	1.750	7	8
I	22	28,000	16,000	1.750	7	8
I,III	23	30,000	17,300	2.250	8	9
I,II	24	35,000	20,000	2.250	8	9
I,II	25	40,000	23,000	2.250	8	9
I	26	45,000	26,000	2.500	8	9
I	27	50,000	29,000	2.500	8	9
I	28	55,000	32,000	2.500	8	9
I	29	60,000	34,000	3.000	9	12
I	30	65,000	37,000	3.000	9	12
III	31	69,000	40,000	2.000	12	9
III	32	69,000	40,000	2.500	12	11
I	33	70,000	40,000	3.000	9	12
I	34	100,000	57,000	4.000	12	14
I	35	130,000	75,000	4.500	17	9
I	36	150,000	86,000	4.000	12	20
I	37	200,000	115,000	4.500	12	20
I	38	210,000	120,000	4.500	17	9
I	39	300,000	175,000	5.000	12	24
I	40	460,000	267,000	5.500	23	11
I	41	500,000	290,000	5.000	12	24

2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

FF-B-171 - Bearings, Ball, Annular (General Purpose).
FF-B-185 - Bearings, Roller, Cylindrical; and Bearings, Roller Self-Aligning.
FF-B-187 - Bearings, Roller, Tapered.
QQ-A-200 - Aluminum Alloy, Bar, Rod, Shapes, Structural Shapes, Tube and Wire, Extruded; General Specification For.
QQ-A-200/8 - Aluminum Alloy Bar, Rod, Shapes, Tube and Wire, Extruded, 6061.
QQ-A-225 - Aluminum and Aluminum Alloy Bar, Rod, Wire, or Special Shapes; Rolled, Drawn, or Cold Finished; General Specification For.
QQ-A-225/8 - Aluminum Alloy Bar, Rod, Wire and Special Shapes; Rolled, Drawn, or Cold Finished, 6061.
QQ-A-367 - Aluminum Alloy Forgings.
QQ-C-390 - Copper Alloy Castings (Including Cast Bar).
QQ-N-281 - Nickel-Copper-Alloy Bar, Rod, Plate, Sheet, Strip, Wire, Forgings, and Structural and Special Shaped Sections.
QQ-Z-325 - Zinc Coating, Electrodeposited, Requirements For.
TT-P-460 - Pigment, Zinc-Dust (Metallic-Zinc-Powder), Dry.
GGG-P-781 - Puller, Mechanical Puller Attachment, Mechanical, and Puller Set, Mechanical.

MILITARY (Continued)

PPP-B-576 - Box, Wood, Cleated, Veneer, Paper Overlaid.
PPP-B-601 - Boxes, Wood, Cleated-Plywood.
PPP-B-621 - Boxes, Wood, Nailed and Lock-Corner.
PPP-B-636 - Boxes, Shipping, Fiberboard.
PPP-B-640 - Boxes, Fiberboard, Corrugated, Triple-Wall.

MILITARY

MIL-P 116 - Preservation-Packaging, Methods of.
MIL-B-121 - Barrier Material, Greaseproofed, Waterproofed, Flexible.
MIL-S-901 - Shock Tests, H.I. (High Impact), Shipboard Machinery, Equipment and Systems, Requirements for.
MIL-S-1222 - Studs, Bolts, Hex Cap Screws, and Nuts.
MIL-E-5272 - Environmental Testing, Aeronautical and Associated Equipment, General Specification for.
MIL-G-5514 - Gland Design, Packings, Hydraulic, General Requirements for.
MIL-A-8625 - Anodic Coatings, For Aluminum and Aluminum Alloys.
MIL-R-8791 - Retainer, Packing, Hydraulic, and Pneumatic, Tetrafluoroethylene Resin.
MIL-S-8805 - Switches and Switch Assemblies, Sensitive and Push, (Snap Action) General Specification for.
MIL-I-8846 - Inserts, Screw-Thread, Helical Coil.
MIL-Q-9858 - Quality Program Requirements.
MIL-L-10547 - Liners, Case, and Sheet, Overwrap, Water-Vaporproof or Waterproof, Flexible.
MIL-B-13239 - Barrier Material, Waterproofed, Flexible, All Temperatures.
MIL-P-15024 - Plates, Tags, and Bands for Identification of Equipment.
MIL-P-15024/5 - Plates, Identification.
MIL-E-15090 - Enamel, Equipment, Light-Gray (Formula No. 111).
MIL-P-15328 - Primer, (Wash), Pretreatment, Blue (Formula No. 117-B for Metals).
MIL-L-17331 - Lubricating Oil, Steam Turbine and Gear, Moderate Service.
MIL-B-22191 - Barrier Materials, Transparent, Flexible, Heat Sealable.
MIL-G-23549 - Grease, General Purpose.
MIL-B-24059 - Bronze, Nickel Aluminum; Rod, Plat Products with Finished Edges, Shapes and Forgings.
MIL-I-24137 - Iron Castings, Nodular Graphitic (Ductile Iron) and Nodular Graphitic (Corrosion Resisting, Austenitic, Low Magnetic Permeability) (For Shipboard Application).
MIL-P-24441 - Paint, Epoxy-Polyamide, General Specification for.
MIL-P-24441/1 - Paint, Epoxy-Polyamide, Green Primer, Formula 150.
MIL-P-24441/2 - Paint, Epoxy-Polyamide, Exterior Topcoat, Haze Gray, Formula 151.
MIL-I-45910 - Insert, Screw Thread-Locked In and Ring Lock Serrated.
MIL-I-45932 - Insert Screw Thread, Thin Wall, Locked In General Specification For.
MIL-R-83248 - Rubber, Fluorocarbon Elastomer, High Temperature, Fluid, and Compression Set Resistant.
MIL-R-83248/1 - Rubber, Fluorocarbon Elastomer; High Temperature Fluid, and Compression Set Resistant, O-rings, Class 1, 75 Hardness.
MIL-R-83248/2 - Rubber, Fluorocarbon Elastomer, High Temperature,Fluid, and Compression Set Resistant, O-rings, Class 2, 90 Hardness.

STANDARDS

FEDERAL

FED-STD-H28 - Screw Thread Standards For Federal Services.
FED-STD-H28/2 - Unified Thread Form and Thread Series for Bolts, Screws, Nuts, Tapped Holes and General Application.

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MIL-STD-9 - Screw Thread Conventions and Methods of Specifying.
MIL-STD-129 - Marking For Shipment and Storage.
MIL-STD-130 - Identification Marking of U.S. Military Property.

MILITARY (Continued)

MIL-STD-167-1 - Mechanical Vibrations of Shipboard Equipment (Type I Environmental and Type II - Internally Excited).
MIL-STD-278 - Fabrication Welding and Inspection; And Casting Inspection and Repair for Machinery, Piping and Pressure Vessels In Ships of the United States Navy.
MIL-STD-740 - Airborne and Structureborne Noise Measurements and Acceptance Criteria of Shipboard Equipment.
MS27595 - Retainer, Packing Backup, Continuous Ring, Tetrafluoro-ethylene.
MS28773 - Retainer, Packing Backup, Tetrafluorethylene, Straight Thread Tube Fitting Boss.
MS16142 - Boss, Gasket Seal Straight Thread Tube Fitting, Standard Dimensions For.
MS28774 - Retainer, Packing, Backup Single Turn, Tetrafluoroethylene.
AN-814 - Plug and Bleeder, Screw Thread.

DRAWING

MILITARY

NAVSHIPS 810-1385884 - Unions Fittings and Adapter, Butt and Socket Welding 6000 PSI, WOG and OXY (IPS).

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

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN GEAR MANUFACTURER'S ASSOCIATION (AGMA)

390.03 - Gear Handbook, Volume 1, Gear Classification, Materials and Measuring Methods for Unassembled Gears.
411.02 - Design Procedure for Aircraft Engine and Power Take-Off Spur and Helical Gears.

(Application for copies should be addressed to the American Gear Manufacturer's Association, 1330 Massachusetts Avenue, N.W., Washington, D.C. 20005.)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

B18.2.1 - Square and Hex Bolts and Screws Including Askew Head Bolts, Hex Cap Screws And Lag Screws.
B18.2.2 - Square and Hex Nuts.
B18.3 - Socket Cap, Shoulder and Set Screws.
B18.12 - Glossary of Terms for Mechanical Fasteners.
B46.1 - Surface Texture.
Y32.3 - Welding Symbols.

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

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

Boiler and Pressure Vessel Code
Section VIII - Pressure Vessels.

(Application for copies should be addressed to the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, New York 10017.)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

Handbook - Standards Information Reports Recommended Practices.
AS568 - Aerospace Size Standard System for O-Rings.

(Application for copies should be addressed to the Society of Automotive Engineers, Inc., 400 Commonwealth Drive Warrendale, PA 15096.)

NATIONAL AEROSPACE STANDARD (NAS)

1638 - Cleanliness Requirements of Parts Used in Hydraulic Systems.

(Application for copies should be addressed to National Standards Association, Inc., 1321 Fourteenth Street, N.W., Washington, D.C. 20005.)

PARKER SEAL COMPANY
Catalog M5001 - Molythane.

(Application for copies should be addressed to the Parker Seal Company, Sealcraft Division, P.O. Box 1505, Salt Lake City, Utah 84110.)

AEROSPACE SUPPLY, INC.

(Application for copies should be addressed to Aerospace Supply, Inc., 5038 Ruffner Street, San Diego, CA 92028.)

POLY SEAL MICRODOT, INC.
Catalog MPS - 2500

(Application for copies should be addressed to Poly Seal Microdot, Inc., P.O. Box 20174, Salt Lake City, UT 94120.)

GREENE, TWEED AND COMPANY
Catalog RSA 76
Catalog GT7-74

(Application for copies should be addressed to Greene, Tweed and Co. North Wales, PA 19545.)

NATIONAL MOTOR FREIGHT TRAFFIC ASSOCIATION INCORPORATED, AGENT
National Motor Freight Classification Rules.

(Application for copies should be addressed to the National Motor Freight Traffic Association, Inc., 1616 P Street, N.W., Washington, D.C. 20036.)

UNIFORM CLASSIFICATION COMMITTEE
Uniform Freight Classification Ratings, Rules and Regulations

(Application for copies should be addressed to the Uniform Classification Committee Agent, G. F. Earl, Tariff Publication Officer, Room 1106, 222 South Riverside Plaza, Chicago, Illinois 60606.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Sample for first article inspection. Prior to beginning production a sample shall be tested as specified in 4.4 (see 6.3).

3.2 Actuators. Actuators, components, and accessories, shall be of the materials, design, construction, and operating requirements as specified herein.

3.3 Material. Materials shall be as specified herein. Government specifications or nationally recognized Industry standards not specified herein shall be listed in the bill of material (see 6.2.1).

3.3.1 Materials shall be corrosion- and galling-resistant and shall be capable of continuous operation in a marine environment, subject to salt spray, salt water or fresh water contamination.

3.3.2 Actuator bodies. The following materials are acceptable for actuator bodies: (a) forged aluminum alloy 6061 in accordance with QQ-A-367, extruded 6061 in accordance with QQ-A-200 and QQ-A-200/8, or rolled drawn, or cold finished 6061 in accordance with QQ-A-225 and QQ-A-225/8; (b) austenitic ductile iron in accordance with MIL-I-24137; and (c) wrought nickel-aluminum bronze in accordance with MIL-B-24059. The types of material to be used for a specific application shall be as specified (see 6.2.1).

3.3.2.1 Actuator body closures (end caps or pinion retainers) shall be fabricated from materials similar to that of the body, except for aluminum alloy bodies. End closures for aluminum alloy bodies shall be wrought nickel-aluminum bronze in accordance with MIL-B-24059.

3.3.2.2 Cast aluminum, magnesium, and alloys of magnesium shall not be used for actuator bodies, closures, or components.

3.3.3 Anodizing. With the exception of identification plates, aluminum shall be anodized in accordance with MIL-A-8625 type I, class 1, for external surfaces only. Internal surfaces shall not be anodized.

3.3.4 Plating. Zinc coating shall be in accordance with QQ-Z-325, class 2, type II. Zinc on parts in contact with hydraulic fluid shall not be permitted.

3.3.5 Brittle material. Materials which are relatively brittle (under 10 percent ductility) shall not be used for fabrication of the actuator unless they are capable of meeting high impact shock or underwater explosion requirements.

3.3.6 Castings inspection. Castings, subject to hydraulic pressure, shall be inspected in accordance with MIL-STD-278, category 2, subcategory D, F, or G, as applicable.

3.3.7 Allowable stresses.

3.3.7.1 Combined stresses. While handling rated output torque through the full actuator travel, the combined stress in any part of the operating mechanism shall not exceed the endurance limit of the material. For calculation purposes, the rated output torque shall be taken as the maximum torque at a gage pressure of 3000 lb/in^2 as listed in table I. The combined stress in any part of the operating mechanism shall not exceed 70 percent of the tensile yield strength of the material used when the equipment is subjected to test pressures and test loads. The term "operating mechanism" applies to, but is not limited to, racks, pinions, levers, and shafts. The calculated stress at the operating conditions in the pressure containing portions of the actuator shall not exceed those as calculated by the method outlined in ASME Pressure Vessel Code, section VIII, division 1, appendix P, with casting quality factors applied as required. A burst test of 400 percent of design operating pressure may be performed in lieu of stress calculations (see 3.13.3).

3.3.7.2 Mechanical fasteners shall be designed to the stress levels defined in ASME Pressure Vessel Code, section VIII, division 1, appendix P.

3.3.8 Recovered materials. Unless otherwise specified herein, all equipment, material, and articles incorporated in the products covered by this specification shall be new and shall 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 unless otherwise specifically specified.

3.4 Operational environments.

3.4.1 General. Actuators and components shall be capable of continuous performance in marine environments.

3.4.2 Orientation. Actuators shall be capable of operation and orientation in any position. Mounting bolt pattern shall be such that the actuators may be mounted on the valve, etc. in 90 degree quadrants.

3.4.3 Ambient temperature. Actuators shall operate throughout an ambient temperature range of plus 40°F to plus 160°F.

3.4.4 Shock. Unless otherwise specified (see 6.2.1), actuators shall be designed to meet the requirements of MIL-S-901 for grade A, class I shock (see 4.7.5).

3.4.5 Vibration. The actuators shall be designed to meet the requirements of MIL-STD-167-1, type I environmental vibration from 0 to 50 hertz (Hz) (see 4.7.6).

3.4.6 Noise. The actuators shall be designed to meet the requirements of MIL-STD-740. The contractor shall perform airborne and structureborne noise measurements in accordance with the requirements, measurements, and data reporting procedures specified in MIL-STD-740. This equipment shall not exceed the grade A airborne and type 3 structureborne limits for solidly mounted equipments (65 decibels (dB) level) (see 4.7.7).

3.4.7 Salt spray. Actuators shall be designed to withstand the salt spray requirements of MIL-E-5272, procedure I (see 4.7.8).

3.4.8 Underwater explosion. When required by the contracting activity, an underwater explosion test shall be performed in accordance with 4.7.9 (see 6.2.1).

3.5 Design. Actuators shall be of the contractors design and configuration, and shall meet the requirements specified herein. Actuators may be of any hydraulic design single or multiple piston, single or double (acting, single or multiple vane type), that will produce the required rotating motion of an output shaft. Actuators shall be designed for mounting in any position with bolt-type attachments, (through-bolts, socket head screws, centering dowels, etc.), for anchoring to a base or suspended mounting plates. Provision shall be provided in the mounting plates for easy removal of actuators from valves, etc.

3.5.1 Operation. Actuators shall be hydraulically powered in such a manner as to provide a rotary motion at the output shaft.

3.5.1.1 Rotation. Shaft rotation shall be as designated by the actuator type (see 1.2.1). Full shaft rotation in either direction shall occur in a 2 to 3 seconds minimum response time under load and shall not exceed a maximum of 5 seconds response time for each 90 degrees of travel at a minimum fluid supply gage pressure of 2000 lb/in^2 with a constant load equal to 90 percent of the minimum 2000 lb/in^2 torque rating.

3.5.1.2 Rotation tolerances. Tolerances for full shaft rotation shall be as shown in 1.2.1 with plus 3 degrees minus 1/2-degree adjustment.

3.5.2 Shims. Shims may be used as required to adjust shaft rotational travel or alinement for actuators, components, etc. Adjustments due to shimming shall be limited to 3 degrees. If shimming is used, allowance shall be made for minimum thread engagement, where applicable (see 3.8.2). Material shall be as specified in 3.3.1.

3.5.3 Temperature. Actuators shall operate continuously at the ambient temperature specified in 3.4.3, when supplied with hydraulic fluid specified in 4.6.5.

3.5.4 Hydrostatic pressure. Actuators shall be designed for static breakaway gage pressure of 2250 lb/in^2, a dynamic gage pressure of 2000 lb/in^2, and an operating gage pressure of 3000 lb/in^2. The actuator shall operate without binding with a gage pressure of 3000 lb/in^2 and shall withstand the hydrostatic pressure test specified in 4.7.1.

3.5.5 Operating cycles. Actuators shall be capable of a minimum operating life of 30,000 cycles at the system operating pressure before replacement of actuators and component parts are required. Packings (seals) may be replaced every 15,000 cycles.

3.5.5.1 Reliability. The specified mean-time-between-failure (MTBF) of the actuators shall be 30,000 cycles.

3.5.6 Output torque. The output torque, shall not exceed the maximum torque valve listed in table I, for a gage system of 3000 lb/in^2.

3.5.6.1 Minimum output torque shall be at least the minimum listed in table I for a gage pressure of 2000 lb/in^2. The dynamic output torque at 2000 lb/in^2 shall be at least 90 percent of the static torque as specified in 3.5.1.1.

3.5.6.2 Differential pressure no load required to start motion of the unit shaft in either direction shall not exceed 100 lb/in^2. Actuators shall comply with this requirement after being held in either extreme position for an indefinite period of time at a gage pressure of 3000 lb/in^2.

3.5.7 Dashpots. Actuators shall have internal dashpots at their limits of travel which do not interfere with the proper operation of the actuated component. The internal dashpots at the limits of travel shall decelerate the motion and prevent slamming. The design of the dashpots shall be such that the actuator noise level is kept to a minimum (see 3.5.7.1 and 6.2.1).

3.5.7.1 Dashpots for small designs not to exceed 10,000 inch-pounds of torque may be deleted from the actuator design.

3.5.8 Internal porting. Transfer of hydraulic fluids across the actuator shall be by internal porting within the actuator. This porting shall limit fluid velocity to 20 feet per second (ft/s) at 5-second actuator operating time.

3.5.8.1 Relief ports and relief valves. Except for the three-position and the vane type actuators that utilize a pressurized body and gear case (see 6.2.1), relief ports shall be provided for all actuators. A drain relief valve is required for the center chamber for two-position actuators. The relief valve shall be installed at or above the 3/4 full mark of the gear case chamber. The relief valve shall be set to open at a maximum gage pressure of 35 lb/in^2 and to withstand a proof test of 70 lb/in^2.

3.5.8.2 Plugs. Test points and ports not having permanently installed instruments shall be closed with safety plugs in accordance with AN-814.

3.5.9 Leakage.

3.5.9.1 Internal. Internal leakage from one cylinder port to another or the center chamber shall not exceed 0.1 cubic centimeter (cm^3) per 5 minutes at any gage pressure up to 4500 lb/in^2.

3.5.9.2 External. External leakage shall be zero at all times. Actuators shall conform to the test condition specified in 4.3.8.

3.5.9.3 Bodies. Bodies shall be made as a complete unit from forgings, castings, or free cutting and machining materials. Bodies shall not be fabricated by welding.

3.5.9.3.1 Body cylinder bores. Each end of the cylinder bore of bodies consisting of ductile iron or wrought nickel-aluminum bronze materials shall be chamfered 30 degrees by 0.046 of an inch deep on the inside diameter (i.d.) of the bore, (see 3.3.2) to allow for easy installation of nonmetallic seals.

3.5.9.3.2 Body mountings to mating valves and operating components shall have provisions for centering dowels to prevent the body from twisting off center during operation.

3.5.9.4 Aluminum bodies. Aluminum bodies shall have a corrosion-resistant replaceable sleeve installed in each cylinder bore to prevent galling, corrosion, seizing, or excessive wear and shall be of a material compatible with static and dynamic seals specified in 3.9 through 3.9.4.

3.5.9.4.1 Replaceable sleeve. Each end of replacement cylinder bore sleeves shall be chamfered 30 degrees by 0.046 of an inch deep on the i.d. of the sleeve to allow for easy installation of nonmetallic seals.

3.5.10 Shaft. Actuators shall drive mating components through an SAE external 10 spline shaft slide fit when not under load, modified to have one tooth missing, to provide shaft rotational alinement. The shaft shall be in accordance with the requirement of SAE Handbook (see 6.2.1).

3.5.10.1 Materials shall be in accordance with 3.3 and 3.3.1 and shall be selected from materials as defined in the SAE Handbook.

3.5.10.2 Shaft design for special applications not specified in 3.5.10 shall be made when specified by the contracting activity.

3.5.11 Bearings. Anti-friction bearings shall be used for all actuators designed for minimum operating torque of 70,000 inch-pounds, or greater. Anti-friction bearings shall be in accordance with FF-B-171, FF-B-185, or FF-B-187. The maximum design bearing loads shall not exceed the basic dynamic capacity rating (capacity for one million revolutions) of the bearing used.

3.5.11.1 Journal bearings. Journal or sleeve bearings (see 6.2.1), for small designs not to exceed 70,000 inch-pounds torque, may be used in actuator design. Journal bearing material shall be tin bronze in accordance with QQ-C-390, or commerical journal bearings equal to those specified in QQ-C-390.

3.5.12 Gearing. Gearing, when required, shall be fully enclosed and shall operate in an oil bath. Gearing shall be either spur of helical. Material and design shall be in accordance with AGMA 390.03 and 411.02.

3.5.12.1 Gear case or main shaft cavity shall be filled 3/4 full with the systems fluid.

3.5.13 Electrical switches. Actuators shall be complete with visual position indication and remote electrical position indication. Visual position indication shall consist of markings engraved in an area adjacent to the driven component openings (such as switch covers or actuator bodies) and a pointer engraved in or attached to the driven component. Markings shall be similar to the following examples:

(a) For 90 degree, 2-position valve actuators (open and shut).
(b) For 180 degree, 2-position valve actuators (open port AC and open port BC).
(c) For 180 degree, 3-position valve actuators (open port AC and open port BC and shut).

3.5.13.1 Indication position. Remote electrical position indication shall consist of sensitive switches mounted on the actuator body or components attached thereto and activated by a positively secured mechanical component on or attached to the driven component. Moving parts shall be fitted with covers or guards to prevent damage to equipment and injury to personnel. The sensitive switches shall be stamped in accordance with MIL-STD-130. When applicable, sensitive switches shall be in accordance with MIL-S-8805.

3.5.13.2 Materials for electrical switches shall be as specified in 3.3 and 3.3.1.

3.5.14 Actuator ports and bosses. Actuator ports and bosses for pipe connections shall be of the female type designed for straight threads (O-ring type) in accordance with MS-16142 or male union thread connections in accordance with Drawing 810-1385884.

3.5.14.1 Actuator ports and bosses shall receive system pipe sizes as specified in table II (see 6.2.1).

TABLE II. Actuator port sizes.

Actuator maximum-torque (inch-pounds)	System pipe size ips (inches)
1,000 - 10,000	3/8
11,000 - 50,000	1/2
51,000 - 100,000	3/4
101,000 - 460,000	1
461,000 and above	1-1/4

3.5.14.2 Port sizes for internal porting across the actuator shall be as designed by the contractor, to meet operating requirements specified in 3.5.8.

3.5.15 Welding and brazing. Welding and brazing shall not be used in fabrication of actuator parts subject to hydraulic pressure or for actuator repair.

3.5.15.1 Weldments may be used only for body mounting, brackets and bosses as specified (see 6.2.1). Welding requirements and symbols shall be in accordance with MIL-STD-278, class M, and ANSI Y32.3.

3.5.16 Pistons. Each end of the piston shall be chamfered 45 degrees by 0.0625 of an inch.

3.6 Material finishes. Surface roughness shall be in accordance with ANSI B46.1 and as specified herein.

3.6.1 External finishes. External surface finishes shall not exceed 250 microinches. External surfaces shall be smooth, free of burrs, sharp edges and other irregularities. External nonmachined cast surfaces shall be as-cast. External nonmachined forged surfaces shall be as-forged. External wrought bar stock nonmachined surfaces shall be as-worked.

3.6.2 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 less than 8 or 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 (a) and (b), shall not exceed 125 microinches.
(d) Finished surfaces for packing seal grooves, dynamic, or static shall be in accordance with MIL-G-5514.

3.7 Coatings. External surfaces of metal, with the exception of threaded areas and aluminum, shall be coated by painting as follows:

(a) Grease, oil, and dirt shall be removed from external surfaces by solvent wiping, vapor degreasing, or caustic washing, and rinsing.
(b) One coat of primer in accordance with MIL-P-15328 shall be applied to external surfaces.
(c) Two coats of top coat in accordance with MIL-E-15090, type II or III, class 2 shall be applied to external surfaces.

3.7.1 Aluminum coating. External surfaces of aluminum shall be coated with epoxy-polyamide paint in accordance with MIL-P-24441. Apply one coat 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 8.0 mils. Single coats in excess of 4 mils shall be avoided.

3.7.2 Threaded areas. Threads, except those in contact with hydraulic fluid such as fittings and ports, shall be coated with a compound of equal parts by weight of lubricating grease in accordance with MIL-G-23549 and zinc dust of 200 mesh fineness in accordance with TT-P-460.

3.8 Mechanical fasteners. Mechanical fasteners shall conform to the requirements specified in 3.8.1 through 3.8.3.3 and the following:

(a) Glossary of terms for mechanical fasteners shall be as defined in ANSI B18.12.
(b) Fasteners shall be in accordance with the applicable MS, AN, and AND standards or Military specifications.
(c) Fasteners for location in bilge areas shall be nickel-copper alloy in accordance with QQ-N-281.

3.8.1 Screw threads. Screw threads shall be the unified type and shall be in accordance with MIL-STD-9.

3.8.1.1 Unified threads shall be the coarse series unless the component design indicates a necessity for use of the fine thread series.

3.8.1.2 Unified 2A and 2B fits shall be used on all important stationary parts such as nut ends for studs for cylinder heads, casing and housing joints. Unified 3A and 3B fits shall be used only for interchangeable screw thread work, where the necessity for accuracy of lead and angle of thread is required. Pipe connections and bosses shall be as specified in 3.5.14.

3.8.2 Thread. Threaded fasteners shall have at least one thread but not more than five threads protruding beyond the crown of the nut. Washers shall not be used for the purpose of lessening thread protrusion.

3.8.2.1 For materials having similar mechanical properties, the full thread engagement shall be at least one major diameter (1D) of effective thread. For materials having dissimilar mechanical properties, the minimum thread engagement shall be computed in accordance with FED-STD-H28 and FED-STD-H28/2, (using the maximum specified tensile strength of the stud metal and minimum specified tensile strength of the body metal) plus one thread; but in no instance less than 1D. Minimum 1D thread engagement shall be maintained with allowance provided for maximum allowable shimming (see 3.5.2).

3.8.3 Fasteners. Threaded fasteners shall be in accordance with MIL-S-1222 or ANSI B18.2.1, ANSI B18.2.2, and ANSI B18.3.

3.8.4 Inserts. When bolting to aluminum, where through-bolting is not possible, threaded inserts shall be used. The threaded inserts shall be either the helical coil corrosion-resisting type, in accordance with MIL-I-8846, type I, (see 3.8.1.1), or solid wall (bushing) type in accordance with MIL-I-45910 and MIL-I-45932. Solid wall inserts shall be corrosion-resisting steel or zinc-plated alloy steel (see 3.3.4) and shall be pin-, key-, swage-, ring-locked, or nylon-element locked to prevent backing out.

3.9 Hydraulic actuators rack and pinion type gland design for seals. Actuator gland design, dimensions and finishes shall be in accordance with MIL-G-5514 and the following:

(a) The glands for static sealing areas shall be designed to receive an O-ring seal without the use of retainer backup rings.
(b) The glands for dynamic sealing areas shall be designed to receive an O-ring plus two retainer backup rings.

3.9.1 Seals. Seals as specified herein are standard Navy approved seals for use in rack and pinion type hydraulic actuators. Seal applications shall be in accordance with table III. Materials shall conform to the requirements as outlined below and in table IV.

3.9.1.1 O-ring seals. O-ring seal materials shall be in accordance with MIL-R-83248, and O-ring seals shall be in accordance with MIL-R-83248/1. These seals are bidirectional, suitable for use with both petroleum and synthetic base fluids, for all equipment designs except designs requiring boss seals.

3.9.1.1.1 O-ring seals for designs requiring bosses shall be in accordance with MIL-R-83248/2.

3.9.1.1.2 O-ring seals for static and dynamic sealing areas shall be installed with two retainer backup rings. One retainer backup ring shall be installed on each side of the O-ring seal. Retainer backup rings shall be in accordance with table IV.

3.9.1.1.3 O-ring seals for actuators designed to operate on high pressure air systems shall be in accordance with MIL-R-83248 and MIL-R-83248/2.

3.9.2 Elastomeric spring-loaded compression lip seal (ESCL). ESCL, seals are manufacturers patented designs consisting of a polyurethane base with a squeeze type rubber O-ring or four lobed rubber spring. ESCL seals are single direction seals (sealing in one direction only) designed for use without backup rings for hydraulic applications using petroleum base fluids only. The seals provide a better seal than O-ring seals and in most cases are directly interchangeable with O-ring seals (without the use of retainer backup rings or O-ring seals using two retainer backup rings) without equipment modifications. ESCL, seals are provided in two types, standard and deep type B, and are for use as shown in tables III, IV, and the following:

(a) ESCL, standard seals are used as an alternate for O-ring seals used in static sealing areas only.
(b) ESCL, deep type "B" seals are preferred for use in lieu of O-ring seals in dynamic sealing areas only.
(c) ESCL, standard and deep type "B" seals shall fit O-ring gland dimensions as specified in MIL-G-5514 and shall be interchangeable with O-ring seal sizes and dash numbers as specified in SAE AS568 and MIL-R-83248/1.
(d) ESCL, seals must be installed correctly with the O-ring or four lobed rubber spring facing the pressure side of the actuator (see figure 1).

TABLE III. Seal application for rack and pinion type hydraulic actuators.

Type	Seal applications for O-ring glands (MIL-G-5514)	
	Static sealing areas O-ring glands without retainer backup rings	Dynamic sealing areas O-ring glands with 2 backup rings
Standard - ESCL (Without backup rings)	Acceptable	Do not use
Deep type B - ESCL (Without backup rings)	Do not use	Preferred
GT-ring	Do not use	Preferred optional for ESCL deep type "B"
O-ring per MIL-R-83248 and MIL-R-83248/1	Preferred	Acceptable

TABLE IV. Seals and materials.

Seal-type for O-ring seal sizes and dash numbers (AS568) applicable for O-ring gland (MIL-G-5514)	Applicable document
O-ring (for all O-ring dash no's.)	MIL-R-83248, MIL-R-83248/1
ESCL-standard (molythane urethane) (for O-ring dash no's. -210 thru -460)	Parker Co. (cat no. M5001) or equal Aerospace Supply Inc. ASI) or equal Poly Seal/Microdot Inc. (cat no. MPS-2500) or equal
ESCL-deep type "B" (molythane urethane):	
(For O-ring dash no's. -325 thru -349)	Parker Co. (cat no. M5001) or equal
(For O-ring dash no's. -210 thru -349)	Aerospace Supply Inc. (ASI) (pneumatic hydraulics), or equal
(For O-ring dash no's. -210 thru -349)	Poly Seal/Microdot Inc. (cat no. MPS-2500) or equal
(For O-ring dash no's. -210 thru -460)	Greene Tweed and Co., Inc. (cat no. RSA 76) or equal
GT-ring (For O-ring dash no's. -210 thru -460)	MIL-R-83248 Greene Tweed and Co., Inc. (cat no. GT 7-74) or equal
Retainer (backup ring tetrafluoro-ethylene)	MIL-R-8791, MS 27595, MS 28773 or MS 28774

3.9.3 GT-ring seals. GT-ring seals are bidirectional seals (sealing in both directions) for use in dynamic sealing areas for hydraulic applications utilizing petroleum base fluids only. GT-rings utilize backup retainer rings and are furnished as complete assemblies. Assemblies consist of one GT-ring with material in accordance with MIL-R-83248 and two backup retainer rings with materials in accordance with MIL-R-8791. GT-rings are designed to fit all O-ring gland dimensions utilizing two retainer backup rings as specified in MIL-G-5514 and meet standard O-ring seal requirements specified in SAE AS568. GT-rings shall be an optional preferred first choice for ESCL seals for dynamic sealing areas only (see figure 2).

3.9.4 Hydraulic vane type actuators. Vane type actuators shall be of contractors unique designs utilizing special packings and seals. Packings and seals shall be as specified by the contractor.

3.9.4.1 Other than unique design, (special packing and seals), vane type actuators shall meet all of the requirements specified in this specification.

3.10 Identification plates. Identification plates, including mounting hardware, shall be provided for the actuators and shall be furnished as a separate component for attachment to the actuator during ship installation. Provisions shall be provided on actuators to attach identification plates, clearly visible, on all actuator mounting positions. Attachment shall be by means of corrosion-resisting alloy steel, or aluminum self-locking screws, as applicable to the material of the actuator. Identification plates and materials shall be in accordance with MIL-P-15024 and MIL-P-15024/5 type A, B, C, style II, or type H. The following minimum information shall be provided and may appear on two identification plates, one of which may contain the manufacturer's usual identification:

(a) Manufacturer's name and serial number.
(b) Name of actuator.
(c) Rating and range of actuator.
(d) Contract numbers (as specified in the contract or order).
(e) National stock number.
(f) Technical manual number.
(g) Space for Government representative stamp.

3.11 Special tools. Special tools, fixtures, and wrenches necessary for shipboard service and maintenance of equipment shall be furnished by the contractor. 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 Administration Service Management Area (DCASMA). Special tools shall be marked for the service for which they are intended. Markings shall be in accordance with MIL-STD-130. Gear and bearing pullers need not be supplied if standard pullers conforming to GGG-P-781 are suitable for the equipment supplied.

3.12 Technical data. The contractor shall prepare technical data in accordance with the data ordering documents included in the contract or order (see 6.2.2) and as specified in 3.12.1 through 3.12.3.

3.12.1 Drawings. In addition to the drawing content required by the data ordering document (see 6.2.2), the unique features specified in 3.12.1.1 through 3.12.1.3 shall be included.

3.12.1.1 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, etc.).
(f) Dimensional location and size of mounting holes.
(g) Torque values for bolting or fastening devices.
(h) Calculated dry weight of actuator.
(i) Calculated wet weight of actuator.
(j) Center of gravity when wet weight of actuator exceeds 100 pounds.
(k) Transverse and longitudinal cross sectional views showing actuator action and internal working parts.
(l) Detailed sections or views considered necessary to amplify the working parts of the actuator.
(m) Identification plate location, information data, and method of securing.
(n) Tolerance table and notes as applicable.
(o) Complete bill of material including Military or Industry specifications and standards. O-rings shall include SAE AS568 numbers. Retainer (backup ring) shall include MS numbers. Bill of material shall list electrical, mechanical, and hydraulic parts and assemblies.
(p) The volume of fluid required for the specified degrees of rotation.
(q) General notes - Notes should include information pertinent to performance ratings, tolerances, input and output parameters, special tools, support equipment, cautions, warnings, etc.

3.12.1.2 Detail drawings. Detail drawings of parts required for maintenance and overhaul shall be prepared. Materials shall be identified by reference to Federal or Military specifications or to nationally recognized Industry standards. Where this is not possible, physical characteristics and chemical composition of the material shall be shown. Drawings

shall show surface finish and essential fabrication details. Tolerances shall be provided. Heat treat data, hardness, and nondestructive testing and inspection shall be included where required.

3.12.1.3 Preliminary design drawings. Preliminary drawings for new design, research, development and manufacture of prototype actuators, including calculations for design, shall be prepared and submitted to the contracting activity for review prior to manufacture. Preliminary design drawings may be submitted as rough pencil sketches.

3.12.2 Technical manuals. In addition to the general requirements covered by the data ordering document (see 6.2.2), the following features shall apply:

(a) Technical manuals shall be prepared for types and classes specified in 1.2.1 and 1.2.2.
(b) When applicable, the manual shall incorporate a series of similar actuators rather than an individual manual for each actuator.

3.12.3 Calculations. The contractor shall prepare stress calculations in accordance with the data ordering document included in the contract or order (see 6.2.2). When requested by the contracting activity, the calculations shall be forwarded with the drawings.

3.13 Workmanship. Workmanship shall conform to the requirements for engineering and production processes. The actuator shall withstand any operation specified herein without permanent deformation, breakage, malfunction, or component interference caused by poor workmanship. Parts of the actuator, before and after painting, shall be clean and free of sand, rust, dirt, pits, scale, and other harmful material. Exposed rough edges shall be smooth and round.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements, as specified herein. Except as otherwise specified in the contract, 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 the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Quality program plan. The contractor shall provide and maintain a quality program acceptable to the Government for supplies and services covered by this specification. The quality program shall be in accordance with MIL-Q-9858, (see 6.2.1).

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

(a) First article inspection (see 4.4).
(b) Quality conformance inspection (see 4.5).

4.3 Test conditions.

4.3.1 Fluid contamination level. System fluid for testing purposes shall be contaminated fluid having a minimum contamination level of class 11 as defined in table I of NAS 1638. Particles 100 micrometers or less shall be primarily quartz dust. Particles greater than 100 micrometers shall be metal, plastic, and rubber.

4.3.2 Temperature. Actuators shall be tested at room temperatures, with system test fluid at 100°F ± 20°F. Temperature shall be recorded and submitted with the test reports (see 4.8).

4.3.3 Test pressures. Pressures for testing purposes shall be as follows:

(a) Operating system gage pressure of 3000 lb/in^2.
(b) Hydrostatic gage pressure of 4500 lb/in^2.

4.3.4 Cycle. A complete cycle is defined as "full shut to full open to full shut" for a two-way actuator and "full shut to full open (left) and full shut to full open (right) to full shut" for a three-way actuator.

4.3.5 Air removal. Entrapped air shall be completely removed from all portions of the actuator and test equipment prior to testing.

4.3.6 Actuator fluid relief ports. The gear case or body overflow relief ports specified in 3.5.8.1 shall be vented to an open container for visual examination during all tests. Leakage from this port defines actual actuator leakage.

4.3.7 Internal fluid leakage. Internal fluid leakage up to 0.1 cm^3 in 5 minutes within the actuator is acceptable. Unless otherwise specified herein (see 4.7.1.2.1 and 4.7.1.2.3), measurements shall be taken at the open container outlined in 4.3.6.

4.3.8 External fluid leakage. External fluid leakage other than main shaft internal build up overflow, specified in 4.3.7 shall not be allowed.

4.3.8.1 External fluid leakage shall be interpreted as any leakage to the outside of the actuator, or actuator assembly.

4.4 First article inspection. First article inspection shall consist of the examination of 4.6 and the tests specified in table V.

TABLE V. First article inspection.

Inspection	Requirement paragraph	Test paragraph
Hydrostatic pressure:		
Piston type	3.5.4	4.7.1.1
Vane type	3.5.4	4.7.1.2
Examination (external)	- -	4.7.1.2.1
Torque (piston and vane type)	3.5.1.1 and 3.5.6	4.7.2 and 4.7.2.1
Cycle (piston and vane type)	3.5.5	4.7.2.2
Hydrostatic pressure:	3.5.4	4.7.3
Examination (internal)	- -	4.7.4
Shock	3.4.4	4.7.5
Vibration	3.4.5	4.7.6
Noise	3.4.6	4.7.7
Salt spray	3.4.7	4.7.8
Underwater explosion	3.4.8	4.7.9
Hydrostatic pressure	3.5.4	4.7.11

4.5 Quality conformance inspection. All production actuators shall be subjected to the examination of 4.6 and the tests specified in 4.7.1 through 4.7.1.2.3. The actuators shall be tested in each specified position one time only. A failure in any position shall be cause for rejection.

4.6 Examinations.

4.6.1 External. The actuators shall be examined externally for material, design, overall dimensions, coatings, separate components, special tools, workmanship and compliance to the applicable drawings. Areas that cannot be examined externally due to coatings or coverings, such as bodies or end closures, shall be examined internally as specified in 4.6.2.

4.6.2 Internal. Upon completion of the external examination specified in 4.6.1, completely disassemble the actuator assembly and component parts. Perform an internal examination similar to the examination in 4.6.1. Dimensionally check all parts, measure accurately all parts subject to wear including groove dimensions for packings, dynamic seal packings, and backup rings.

4.6.3 Actuator failure. Any actuator assembly or components, failing to meet the examinations specified in 4.6.1 or 4.6.2, shall be cause for rejection. Replacement of failed parts may be made with new parts and the actuator retested one additional time only. Additional failures shall be cause for complete rejection of the actuator. A complete new actuator will be required to be submitted for any further tests.

4.6.4 Cleaning. Upon successful completion of the examinations specified in 4.6.1 and 4.6.2, interior and exterior components and surfaces shall be thoroughly cleaned and grease and foreign material removed.

4.6.5 Actuator reassembly. Upon successful completion of the examinations and cleaning specified in 4.6.1 through 4.6.4, the actuator shall be reassembled. The gear case (piston type actuators only) shall be 3/4 filled with the systems test fluid in accordance with MIL-L-17331. For fluids other than as specified (see 6.2.1).

4.7 Tests.

4.7.1 Hydrostatic pressure test. A hydrostatic pressure test shall be performed for piston and vane type actuators as specified in 4.7.1.1 through 4.7.1.2.3.

4.7.1.1 Piston type actuators. The hydraulic supply line shall be connected to the inlet port (port 1). The discharge port (port 2) shall be plugged. The piston or pistons shall be extended to their full stroke. The piston or pistons shall be hydraulically locked in their full stroke position by filling the actuator cylinder or cylinders with the systems test fluid specified in 4.6.5. The actuator shall be pressurized and tested as follows:

(a) The actuator shall be pressurized to a gage pressure of 4500 lb/in^2 and maintained for 5 minutes. At the completion of the test, (one time only) relieve the pressure and perform an external visual examination of the actuator. There shall be no evidence of external leakage, loosening, or damage to any part. The external container connected to the gear case, main cavity relief port or discharge port shall be dry.

(b) Upon completion of the test outlined in 4.7.1.1 (a), the cycle shall be reversed. The supply line shall be connected to port 2 and plug port 1. With pistons fully extended and hydraulically locked in the opposite position, re-examine and retest in accordance with 4.7.1.1 (a).

4.7.1.2 Vane type actuators. The hydraulic supply line shall be connected to port 1, leaving the opposite port (port 2) open. Port 2 shall be vented to an open container for visual observation and measurements of fluid build up (see 4.3.7). The vane(s) shall be rotated to the mid point (half rotation) and locked in place. With the open container dry, the supply line shall be pressurized and hydrostatic tested. The actuator shall be pressurized to a gage pressure of 4500 lb/in^2 and maintained for 5 minutes. Upon completion of the test, the examination specified in 4.7.1.2.1 shall be performed.

4.7.1.2.1 External examination. The internal leakage (fluid build up) accumulated in the open container shall be measured. Fluid build up shall not exceed that specified in 4.3.7. The actuator shall be visually examined to assure that there is no evidence of external leakage (see 4.3.8), loosening or damage to any external part.

4.7.1.2.2 Upon completion of the inspection specified in 4.7.1.2 and 4.7.1.2.1, the vane(s) shall be rotated to the fully closed position (full rotation) and shall be retested and reexamined in accordance with 4.7.1.2 and 4.7.1.2.1.

4.7.1.2.3 Upon completion of the inspection specified in 4.7.1.2 through 4.7.1.2.2, the cycle connecting the supply line to port 2 shall be reversed. With port 1 open and vented to the open container, retest and reexamine in accordance with 4.7.1.2 and 4.7.1.2.1.

4.7.1.3 Hydrostatic pressure test failure. Failure of either the piston or vane type actuator to meet any of the inspections specified in 4.7.1.1 through 4.7.1.2.3 shall be cause for rejection of the actuator.

4.7.2 Torque and cycle tests. Upon completion of the hydrostatic test specified in 4.7.1 through 4.7.1.2.3, a torque and cycle test shall be performed as specified in 4.7.2.1 and 4.7.2.2, for either the piston or vane type actuators. Unless otherwise specified in the contract or order, the systems test fluid to be utilized shall be as specified in 4.6.5. Temperatures shall be in accordance with 4.3.2.

4.7.2.1 Torque test for piston and vane type actuators. The test fluid shall be applied at its rated operating gage pressure of 3000 lb/in^2 to the actuator through the appropriate actuator port or ports. Maximum output torque shall be measured and recorded 5 times. The above procedure shall be repeated using 2000 lb/in^2 and 2500 lb/in^2. There shall be no evidence of loosening, binding, or damage to the actuator shaft or parts. The actuators shall meet the requirements specified in 3.5.1.1 and 3.5.6.1.

4.7.2.1.1 Results of the torque test performed for each operating gage pressure specified in 4.7.2.1 shall be recorded. A set of curves shall be developed to reflect all pressures applied and output torque obtained for each measurement. The recorded results and curves shall be submitted with the test reports (see 4.8).

4.7.2.2 Cycle test.

4.7.2.2.1 Piston and vane type actuator minimum life cycle test. The actuator shall be cycle tested to a load equal to the rated output torque and cycled 30,000 continuous times in 15,000 cycle increments at a rate of 4 to 6 cycles per minute to the systems gage pressure of 3000 lb/in^2 applied to the actuator. During each 15,000 cycle testing period, the actuator shall be periodically examined for external leakage, body cracks, and loose bolts. The actuator shall also be examined for excessive internal leakage. Measurements for internal leakage shall be made at the open container in accordance with 4.3.7. Packings and backup rings shall meet a minimum life of 15,000 cycles and may be replaced at the completion of each 15,000 cycle test only. Removed packings shall be dimensionally examined for damage. Dimensions and findings shall be compared to the condition of the packings and backup rings in their original condition and findings forwarded with the test reports (see 4.8). Failure to complete each 15,000 cycle test without packing and back up ring replacement, external leakage, permissible internal leakage, cracks, loosening of bolts, etc., shall be cause for rejection of the actuator.

4.7.3 Repeat hydrostatic pressure test. Upon completion of the cycle test specified in 4.7.2.2, without disassembling or tightening of the actuator external bolts, or other fastening devices, a repeat (one time only) hydrostatic test shall be conducted in accordance with 4.7.1 (a) and (b) and 4.7.1.2 through 4.7.1.2.3. At the completion of the cycle test, port lines shall be considered as being in their port 1 position and do not have to be disconnected and reconnected for the first position test. However, port lines shall be connected to the proper ports for the reversed position. Failure of the actuator to meet the inspection specified in 4.7.1.1 (a) or 4.7.1.2.1 shall be cause for rejection of the actuator.

4.7.4 Internal examination. Upon completion of the tests specified in 4.7.2 through 4.7.3, the actuator shall be disassembled and examined for internal wear, cracks, and ruptures. Actuator internal surfaces subject to wear, and packings and backup rings, shall be examined for damage, the dimensions shall be measured and recorded and the findings submitted with the test reports (see 4.8). Internal wearing parts shall be compared with the original recorded dimensions specified in 4.6.2. Excessive wear, scoring, cracks, damage, or binding shall be evidence of failure to meet the minimum 30,000 life cycle test and shall be cause for rejection of the actuator.

4.7.5 Shock test. The actuator shall be shock tested to assure compliance with the requirements specified in 3.4.4. Actuators which have passed the underwater explosion test (see 4.7.9) shall be exempt from the shock test.

4.7.6 Vibration test. The actuator shall be vibration tested to assure compliance with the requirements specified in 3.4.5. The actuator shall be tested under normal loaded conditions to duplicate shipboard installation. Submittal of a detailed test "setup" for review shall be required prior to testing.

4.7.7 Noise test. The actuators shall be noise tested to assure compliance with the requirements specified in 3.4.6. The actuator shall be tested under normal operating conditions to duplicate shipboard installation. Prior to testing, the contractor shall submit a detailed drawing of the test "setup" for review.

4.7.8 Salt spray test. The actuator shall be tested for salt spray to assure compliance with the requirements specified in 3.4.7.

4.7.9 Underwater explosion test. When specified (see 3.4.8), the actuator shall withstand an underwater explosion test as specified in the contract or order. Additional engineering parameters and guidelines needed to complete the test shall be provided by the contracting activity (see 6.2.1).

4.7.10 Test failure. Failure to meet either the shock, vibration, noise, salt spray, and underwater explosion tests specified in 4.7.5 through 4.7.9 shall be cause for rejection of the actuator.

4.7.11 Final hydrostatic pressure test. Upon completion of the shock, vibration, noise, salt spray, and underwater explosion tests specified in 4.7.5 through 4.7.9, a final hydrostatic test shall be performed on the actuator in accordance with 4.7.1.1 and 4.7.1.2 through 4.7.1.2.3. Failure of the actuator to meet this test shall be cause for rejection of the actuator.

4.8 Test procedures and test reports. The contractor shall prepare test procedures and test reports in accordance with the data ordering documents included in the contract or order (see 6.2.2).

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

5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government acquisitions. For the extent of applicability of the preparation for delivery requirements of referenced documents listed in section 2, see 6.4).

5.1 General requirements.

5.1.1 Cleaning and drying. Cleaning and drying of hydraulic actuators, and related accessories, shall be accomplished in a continuous uninterrupted manner. Any cleaning process or drying procedure of MIL-P-116 may be used that is not detrimental or will have no effect on packing, O-rings, or gaskets. Equipment disassembly shall be the minimum necessary to make accessible for cleaning all machined or critical surfaces. A clean lint free surface shall be used to support the disassembled parts. After cleaning and drying, parts shall be handled with clean, lint free, cloths or gloves.

5.1.1.1 Cleanliness and sealing of the units shall conform to the following:

(a) Particulate count:

Particulate size range	Number of particles per 100 million
25 - 100	7,500
100 - 500	100
Over 500	8

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

(b) Water content shall be not more than 0.03 percent by volume.

5.2 Preservation-packaging. Preservation-packaging shall be level A or C, as specified (see 6.2.1).

5.2.1 Level A. Immediately after the cleaning and drying cycle (see 5.1.1), actuators shall be preserved by a fill and flush method that will insure complete coverage of the movable parts within the actuator. Pistons shall be extended and rotated to the fullest operational mode. Preservatives used shall be filtered through a 5 - 10 micrometer filter and shall be compatible with the system fluid specified in 4.6.5 or fluids, as specified (see 6.2.1). 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 that contamination is not introduced into the actuator during this operation. Exposed surfaces of the piston and bare metal surfaces of accessories and repair parts shall be coated with preservative conforming to P-2 of MIL-P-116. Each actuator shall be tagged as specified in 5.4.1.

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 the 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 Level C. Immediately after the cleaning and drying cycle (see 5.1.1) preservation-packaging of equipment and accessories shall be accomplished to afford protection a against system contamination, corrosion, deterioration and physical damage during shipment from the supply source to the first receiving activity for immediate use. The contractor's normal retail or wholesale preservation-packaging methods may be utilized when such meets the requirements of this level.

5.3 Packing. Packing shall be level A, B, or C, as specified (see 6.2.1).

5.3.1 Level A. Actuators with accompanying accessories when required, preserved-packaged as specified (see 6.2.1) shall be packed in containers conforming to any one of the following specifications at the option of the contractor:

Specification	Classification
PPP-B-576	Class 2
PPP-B-601	Overseas type
PPP-B-621	Class 2
PPP-B-640	Class 2

Unless otherwise specified (see 6.2.1), shipping containers shall have caseliners conforming to MIL-L-10547. Barrier material conforming to MIL-B-13239 may be used to fabricate the caseliner. Caseliners shall be closed and sealed in accordance with the appendix to MIL-L-10547. Caseliners for fiberboard boxes conforming to PPP-B-640, may be omitted provided all center and edge seams and manufacturer's joint are sealed and waterproofed with pressure sensitive tape in accordance with the applicable fiberboard box specification. Shipping containers shall be closed, strapped, or banded in accordance with the applicable box specification or appendix thereto, except that metal strapping shall not be used on fiberboard containers.

5.3.2 Level B. Actuators with accompanying accessories when required preserved-packaged as specified (see 6.2.1), shall be packed in containers specified for level A except that the domestic type or class shall be used and caseliners are not required.

5.3.3 Level C. Actuators and accessories, packaged as specified (see 6.2.1), shall be packed in containers acceptable to the common carrier which will insure safe delivery at destination in a satisfactory condition at the lowest applicable rate. Containers, packing, or method of shipment shall comply with Uniform Freight or National Motor Freight Classification Rules or other carrier rules as applicable to the mode of transportation.

5.4 Cushioning, filler, dunnage, and wrapping materials.

5.4.1 Level A preservation-packaging 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/stowage.

5.4.2 Level C preservation-packaging 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 labelled 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 Cushioning, filler, dunnage and wrapping materials selected, whenever available, shall exhibit improved performance for resistance to fire.

5.5 Marking. In addition to the special marking required herein or by the contract or order (see 6.2.1), interior packages and exterior shipping containers shall be marked in accordance with MIL-STD-129.

5.5.1 Special marking. A tag shall be attached to each actuator listing the following information:

(a) Unit has been cleaned, flushed, and date of flushing.
(b) Type of hydraulic fluid used for flushing and preservation (brand name and type) and Military specification number.
(c) Date fluid installed in actuator.
(d) Manufacturer of the fluid.
(e) Recommended replacement date, if warranted.

5.6 Technical manuals. Technical manuals which accompany shipments that are packed level A or B shall be packaged in transparent waterproof plastic bags, minimum 4 mil thick. 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 6.2.1).

6. NOTES

6.1 Intended use. The actuators covered in this specification are intended for use in submarine hydraulic systems to operate missile, torpedo, weapon handling, valve equipment or components. The actuators are not restricted to submarine use; they may be used, where applicable, for general Navy use.

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

(a) Title, number, and date of this specification.
(b) Type and class required (see 1.2).
(c) Special requirements for types and classes not covered in this specification (see 1.2).
(d) Materials required (see 3.3 and 3.3.2).
(e) Shock requirements, when not required (see 3.4.4).
(f) Underwater explosion, when required (see 3.4.8 and 4.7.9).
(g) Dashpots, when not required (see 3.5.7).
(h) When relief ports are not required (see 3.5.8.1).
(i) Shaft design (see 3.5.10).
(j) Whether journal or sleeve bearings are required (see 3.5.11.1).
(k) Type of switches required (see 3.5.13.1).
(l) Pipe sizes for ports and bosses (see 3.5.14.1).
(m) Weldments required (see 3.5.15.1).
(n) Seals (see 3.9.1 through 3.9.4).
(o) Fluids, if other than as specified (see 4.6.5).
(p) Levels of preservation-packaging and packing required (see 5.2 and 5.3).
(q) System fluid, if other than as specified (see 5.2.1).
(r) When caseliners are not required (see 5.3.1).
(s) Special marking required (see 5.4).

6.2.2 Data requirements. When this specification is used in a contract which invokes the provision of the "Requirements for Data" of the Defense Acquisition Regulation (DAR), the data identified below, which are required to be developed by the contractor, as specified on an approved Data Item Description (DD Form 1664), and which are required to be delivered to the Government, should be selected and specified on the approved Contract Data Requirement List (DD Form 1423) and incorporated in the contract. When the provisions of the "Requirements for Data" of the DAR are not invoked in a contract, the data required to be developed by the contractor and required to be delivered to the Government should be selected from the list below and specified in the contract.

Paragraph	Data requirement	Applicable DID	Options
(a) 3.13.1	Drawings, engineering and associated lists	DI-E-7031	Level 2 Design activity designation - Contractor Drawing number - Contractor Delivery of hard copies - Contracting activity
(b) 3.13.2	Manual, technical, preliminary	DI-M-2043	Type I of MIL-M-15071
(c) 3.13.2	Manual, technical, standard	DI-M-2044	Option 10.3a
(d) 3.13.3	Calculations	UDI-E-23213	- -
(e) 4.8	Test procedures	UDI-T-23732	- -
(f) 4.8	First article inspection report	DI-T-4902	- -
(g) 4.8	Report first article test	UDI-T-23790	- -
(h) 4.8	Reports, test	DI-T-2072	- -
(i) 4.8	Vibration testing report	UDI-T-23762	- -
(j) 4.8	Component shop noise tests report	UDI-T-23764	- -

(Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.)

6.2.2.1 The data requirements of 6.2.2 and any task in section 3, 4, or 5 of the specification required to be performed to meet a data requirement may be waived by the contracting/acquisition activity upon certification by the offeror that identical data were submitted by the offeror and accepted by the Government under a previous contract for identical item acquired to this specification. This does not apply to specific data which may be required for each contract regardless of whether an identical item has been supplied previously (for example, test reports).

6.3 First article inspection. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection as 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 test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

6.4 Sub-contracted material and parts. The preparation for delivery 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.

6.5 Changes from previous issue. The symbol "Φ" is 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
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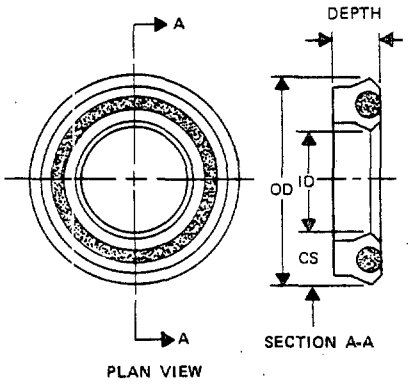
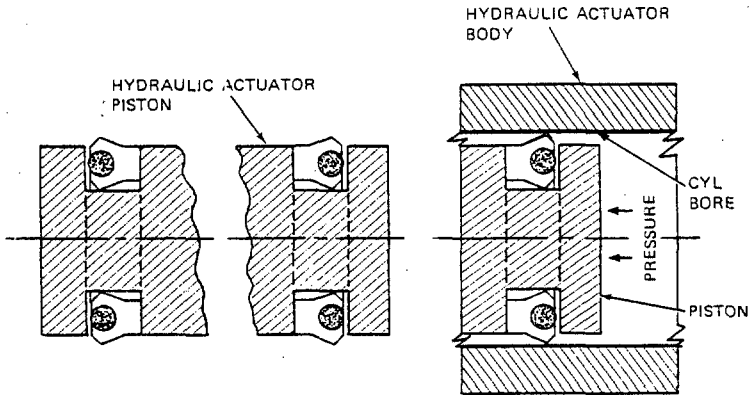


ESCL TYPE B



ESCL INSTALLED IN HYDRAULIC ACTUATOR PISTON

PISTON AND ESCL INSTALLED IN HYDRAULIC ACTUATOR CYLINDER BORE

FIGURE 1. Elastomeric spring-loaded compression lip seal (ESCL)

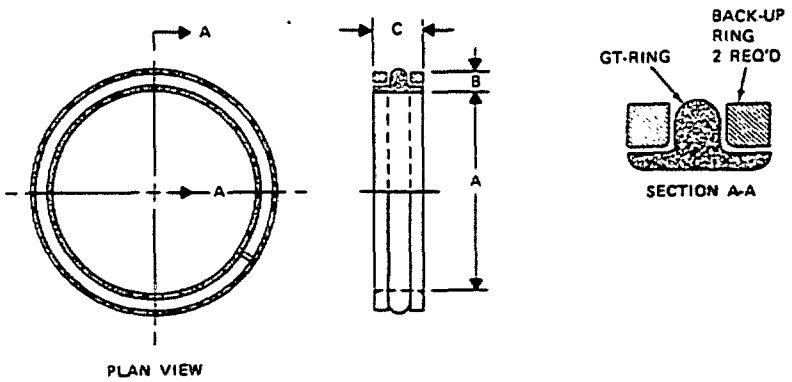


FIGURE 2. GT rings.

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