

INCH-POUND
MIL-V-24722(SH)
15 June 1990

MILITARY SPECIFICATION

VALVE AND SUBPLATE, SERVO FLOW-CONTROL, ELECTROHYDRAULIC, GENERAL SPECIFICATION FOR

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 electrohydraulic, flow-control servovalves and their associated subplates. This type of valve will be installed into a closed-loop, position control servosystem. The valves are designed for either standard or quiet operation and utilize quill-type or face seal mounting configurations.

1.2 Classification. Electrohydraulic servo-control valves shall be furnished in the configurations, flow ranges, and noise grades listed in the applicable specification sheet. Subplates shall be furnished in accordance with the weight and configuration requirements of the applicable specification sheet.

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).

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 55Z3, Department of the Navy, Washington, DC 20362-5101 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 4810

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SPECIFICATIONS

MILITARY

MIL-V-3	Valves, Fittings, and Flanges (Except for Systems Indicated herein); Packaging of
MIL-W-76	Wire and Cable, Hookup, Electrical, Insulated
MIL-W-16878	Wire, Electrical, Insulated, General Specification for
MIL-W-16878/17	Wire, Electrical, Polyvinyl Chloride (PVC) Insulated, 105 °C, 600 Volts, Polyamide Jacket
MIL-L-19140	Lumber and Plywood, Fire-Retardant Treated
MIL-V-24722/1	Valve and Subplate, Servo Flow-Control, Electrohydraulic, for 0 to 50 Gallons Per Minute (GPM) and 0 to 80 GPM Flow Ranges
MIL-V-24722/2	Valve, Servo Flow-Control, Electrohydraulic, for 0 to 10 GPM Flow Range
MIL-V-24722/3	Valve and Subplate, Servo Flow-Control, Electrohydraulic, for 0 to 80 GPM Flow Range

FEDERAL

J-W-1177	Wire, Magnet, Electrical, General Specification for
PPP-F-320	Fiberboard: Corrugated and Solid, Sheet Stock (Container Grade) and Cut Shapes

STANDARDS

MILITARY

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-202	Test Methods for Electronic and Electrical Component Parts

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MIL-STD-740-2	Structureborne Vibratory Acceleration Measurements and Acceptance Criteria of Shipboard Equipment
DOD-STD-1399 Section 070	Interface Standard for Shipboard Systems, Section 070-Part 1, D.C. Magnetic Field Environment; (Metric)
MIL-STD-2193	Hydraulic System Components, Ship; (Metric)
MS3102	Connectors, Receptacle, Electric, Box Mounting, Solder Contacts, AN Type
MS3112	Connectors, Receptacle, Electric, Series 1, Box Mounting, Flange, Bayonet Coupling, Solder Contact

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.2 Non-Government publications. The following document(s) 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 NATIONAL STANDARDS INSTITUTE (ANSI)

Y32.10 Fluid Power Diagrams, Graphic Symbols for; (DOD Adopted)

(Applications for copies should be made to the American National Standards Institute, 1430 Broadway, New York, NY 10018.)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

ARP 490 Aerospace Recommended Practice – Electrohydraulic
Flow-Control Servovalves

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

(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.)

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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 valve and subplate 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 valve shall be subjected to first article inspection (see 6.6) in accordance with 4.2.1.

3.3 General requirements. General requirements shall be in accordance with MIL-STD-2193. Specific definitions of technical terms used throughout this specification which pertain to servovalve design, construction, performance and testing may be found in the Recommended Terminology section of SAE ARP 490.

3.4 Materials. Materials shall be limited to those specified in MIL-STD-2193 and the applicable specification sheets. Materials shall be compatible with the fluid, temperature, service and performance requirements specified herein.

3.4.1 Internal parts. Flow metering elements within the equipment subject to movement or wear shall be hardened on the friction surfaces to a minimum of Rockwell C-56 or equivalent.

3.5 Design and construction. The general design and construction requirements shall be in accordance with MIL-STD-2193 (see 6.3).

3.5.1 Structural design.

3.5.1.1 Pressure boundary.

3.5.1.1.1 Proof pressure. The valve and subplate pressure boundaries shall withstand proof pressure levels of 1.5 times the design operating pressures required by the applicable specification sheet.

3.5.1.1.2 Fatigue. Valve and subplates shall be rated and tested in accordance with MIL-STD-2193 design requirements when specified in the applicable specification sheet.

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3.5.1.13 External leakage. No sign of external leakage, other than slight wetting insufficient to form a drop shall be exhibited, when subjected to any of the tests required by the applicable specification sheet.

3.5.1.2 Installation interfaces.

3.5.1.2.1 Pattern. The interface pattern for porting and mounting holes shall be in accordance with the applicable specification sheet.

3.5.1.2.2 Envelope. Dimensions shall be within the envelope requirements of the applicable specification sheet.

3.5.1.2.3 Electrical connection. Electrical connection to the valve shall be provided by a circular, environment resistant receptacle. Specific connector sizes and pin-to-pin electrical characteristics shall meet the requirements of the individual specification sheets.

3.5.2 Electrical design.

3.5.2.1 Fungus-resistant materials. Nonmetallic parts shall be inherently nonfungus-nutrient or treated to resist fungus growth.

3.5.2.2 Magnet wire. Unless otherwise specified in the applicable specification sheet, magnet wire shall conform to J-W-1177. Class and Type of insulation shall meet the requirements of the applicable specification sheet.

3.5.2.3 Lead wire. Lead wire shall conform to MIL-W-76 or MIL-W-16878.

3.5.2.4 Coils. Coils shall be evenly wound and insulated to meet the performance requirements specified herein. The coils shall be completely insulated from the frame and other grounded parts. The coil leads shall not be internally grounded. Coils shall be suitably taped and impregnated as required, to prevent damage under prolonged exposure to humidity and salt-fog environmental conditions. Coils shall be securely anchored to the frame or other stationary parts in a manner to prevent coil movement or strain on the coil leads.

3.5.2.5 Case. Unless otherwise specified in the applicable specification sheet, the coil housing shall be enclosed and shall be electrically isolated from any electrical circuit and shall be magnetically shielded.

3.5.2.6 Insulation resistance. The insulation resistance between separate coils of the same electrical device or between the coils and case ground shall be greater than 10 megohms following a 10 to 15 second application of 500 volts direct current (Vdc).

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3.5.2.7 Coil resistance. The servovalve torque motor shall have pin-to-pin resistances as specified in the applicable specification sheet.

3.5.2.8 Dielectric strength. The unit shall be designed to withstand an initial test potential of 450 volts root mean square (V_{rms}) plus the rated voltage at 60 hertz (Hz) for a period of 60 seconds when applied between the input leads and the case.

3.5.2.9 Magnetic field effects. Electrical components of the servovalve shall meet the requirements of this specification when exposed to an ambient or steady state magnetic field of 0 to 20 oersteds (Oe) and a magnetic field rate of change of 20 oersteds per second (Oels) unless deleted or otherwise specified in the applicable specification sheet.

3.5.3 Hydraulic design. The valve shall meet the static, null and dynamic requirements of this specification when operated at the environmental and operating conditions specified in the applicable specification sheet with a test fluid that shall meet the class of cleanliness specified in the applicable specification sheet.

3.5.3.1 Rated flow. Flow from either valve control port shall be adjustable to within rated flow limits specified in the applicable specification sheet when operated at required fluid pressure and temperature conditions.

3.5.3.2 Flow limit adjustments. Unless specifically deleted by the applicable specification sheet, each valve shall have two external, manually adjustable, mechanical devices that shall limit maximum flow to the amount required by the applicable specification sheet. These stops shall not affect the valve operation until the torque motor electrical command signal exceeds the stop setting. All adjustments shall be designed in accordance with MIL-STD-2193 requirements for function adjustment screws.

3.5.3.3 Interflow. Unless permitted by the applicable specification sheet, there shall be no interflow between supply and return ports when shifting from one position to another.

3.5.3.4 Noise. The assembled valve and subplate shall be designed to operate below the structureborne noise level required by the applicable specification sheet.

3.5.3.5 Pilot stage porting. Requirements for multistage valve porting and hydraulic communication shall be satisfied as required by the applicable specification sheet.

3.5.3.6 Internal leakage. The fluid leakage with cylinder ports looped together and with the valve at null shall not exceed the allowable limit of the applicable specification sheet for a new valve. Total internal leakage shall not increase by more than the amount allowed by the applicable specification sheet when retested after 2 million cycles of operation.

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3.5.3.7 Contamination sensitivity. When required by the applicable specification sheet, the valve shall satisfy the internal leakage and hydraulic shifting force requirements of the applicable specification sheet when subjected to a cyclic contamination sensitivity test performed in accordance with specification sheet and MIL-STD-2193 requirements.

3.5.3.7.1 Orifices. Orifices, if required, shall be designed and installed with strainer screen devices in accordance with MIL-STD-2193. The location of each strainer screen shall be marked, and each strainer screen shall be cleanable and replaceable without removing or disassembling the valve.

3.5.3.8 Fluid temperature. The valve shall meet internal leakage, flow gain characteristics and noise requirements of this specification when the specified hydraulic fluid is held within the applicable specification sheet temperature or viscosity limits. When required by the applicable specification sheet, the valve shall also meet the extreme temperature functioning requirements in accordance with MIL-STD-2193.

3.5.3.9 Air removal. Valves designed for quiet operation shall incorporate provisions for removing entrapped air.

3.5.3.10 Special seal design. Gland and seal designs which involve the use of either slipper rings or caps to minimize seizing of smooth surfaces under high pressure must be specifically approved by the contracting activity.

3.5.3.11 Fluid pressure. The valve shall meet internal leakage, flow gain characteristics and noise requirements of this specification when the specified hydraulic fluid is held within the applicable specification sheet pressure limits. When required by the applicable specification sheet, the valve shall also meet extreme pressure functioning requirements.

3.5.4 Static performance.

3.5.4.1 Polarity. Positive voltage applied to pins designated by the applicable specification sheet shall open control port C1 to supply pressure and control port C2 to return pressure.

3.5.4.2 Flow gain. Flow gain shall be within the torque motor current/control flow envelope specified in the applicable specification sheet.

3.5.4.3 Temperature and pressure sensitivity. Requirements which characterize servovalve sensitivity to high and low fluid temperature and surrounding environmental ambient temperature shall be met when required by the applicable specification sheet. When required by the applicable specification sheet, the valve shall also operate in conformance to requirements for specified fluid system pressure levels above and below normal operating levels.

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3.5.4.4 Null lap. Sliding spool lap tolerances shall be controlled to obtain blocked-load, zero-flow cylinder port pressures that are within the allowable limits of the applicable specification sheet.

3.5.4.5 Hysteresis. The valve hysteresis shall be measured in terms of the valve electrical input signal and shall not exceed the percent of the maximum rated current allowed by the applicable specification sheet.

3.5.4.6 Flow threshold. The algebraic difference of the positive and negative torquemotor current required to cause a valve output shift, as defined in the applicable specification sheets, shall not exceed the allowable output limit specified in the applicable specification sheet.

3.5.4.7 Pressure gain. The pressure gain shall meet or exceed the specified percent of the allowable load pressure drop required by the applicable specification sheet.

3.5.5 Dynamic requirements.

3.5.5.1 Amplitude ratio. Amplitude ratio values of the valve output with respect to the sinusoidal torque motor input electrical signal throughout the specified frequency range, as calculated in accordance with SAE ARP 490, shall fall within the acceptance boundaries defined by the applicable specification sheet.

3.5.5.2 Phase lag. Phase angle values of the valve output with respect to the input sinusoidal electrical signal throughout the frequency range required by the applicable specification sheet shall fall within the acceptance boundaries defined by the applicable specification sheet and SAE ARP 490.

3.5.6 Endurance. The valve shall operate for 2 million cycles under normal conditions before replacement of parts, other than seals and strainer screen. Duty cycle magnitude and frequency is defined as a three second sequence of torque motor signal commands which starts from null, steps to maximum C1 flow rated current for one second, reverses to maximum C2 flow rated current for one second, and reverses to null for one second.

3.6 Operational environments.

3.6.1 Ambient conditions. The valve shall meet the operating requirements of this specification throughout the ambient temperature and pressure ranges specified in MIL-STD-2193, unless otherwise specified in the applicable specification sheet.

3.6.2 Ambient pressure range. The valve shall meet the operating requirements of this specification after exposure to an ambient pressure range of 0.7 to 2.0 bars (10.2 to 29 pounds per square inch (psi)).

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3.6.3 Shock. The valve shall meet the requirements of the applicable specification sheet following completion of the shock test performed in accordance with MIL-STD-2193.

3.6.4 Vibration. The valve shall meet the requirements of the applicable specification sheet following completion of the vibration test performed in accordance with MIL-STD-2193.

3.6.5 Salt fog. Valves and subplates shall withstand the salt fog test required by MIL-STD-2193.

3.7 Identification marking.

3.7.1 Component identification. Valves and subplates shall be identified and marked in accordance with the requirements of MIL-STD-2193.

3.7.2 Port identification. Subplate fluid ports shall be clearly and permanently marked. The markings shall be visible when the mating connector flanges are installed. Valves not requiring subplates shall have their port locations indicated by permanent markings on the perimeter of the mounting base, unless otherwise specified in the applicable specification sheet. The port identification shall be as follows:

- a. Main supply port – P
- b. Pilot supply port – PP
- c. Main return port – R
- d. Pilot return port – PR
- e. Control pressure port – C1
- f. Control pressure port – C2
- g. Main stage positioning pressure – PV1
- h. Main stage positioning pressure – PV2

3.8 Interchangeability. Parts having the same manufacturer's part numbers shall be directly and completely interchangeable in accordance with MIL-STD-2193. Parts of components that are manufactured and identified as a matched subassembly, such as a lapped spool and sleeve subassembly shall, however, be interchanged only as a unit.

3.9 Maintainability. Unless otherwise specified in the specification sheet, the mean time to repair (MTTR) of the valve shall not exceed 60 minutes. MTTR is to be limited to fault isolation and repair either by replacing the complete valve assembly or by parts replacement. Parts replacement shall be limited to seals, filter screens, and subassemblies that can be replaced by using standard tools that are listed in the Federal Supply Catalog. (Copies of this catalog may be consulted in the office of the Defense Contract Administration Services Management Area (DCASMA).)

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4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract of 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 the 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 4.2.1)
- b. Quality conformance inspection (see 4.2.2).

4.2.1 First article inspection. First article inspection shall consist of the tests specified in tables I and II (see 6.3). The detailed technical test requirements and tests are specified in the applicable specification sheets. Unless otherwise specified in the applicable specification sheet, the first article tests are to be conducted in sequence by groups in the order listed after completion of the general inspections of tables I and II. (Tests within a group need not be conducted in sequence unless specifically stated.)

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TABLE I. *First article inspection.*

Inspection	Requirement	Test method	Applicable to subplate
A. General examinations and tests			
Visual examination		4.3.1.1	
Envelope	3.5.1.2.2	4.3.1.1	yes
Electrical design	3.5.2	4.3.1.1	no
Flow limit adjustments	3.5.3.2	4.3.1.1	no
Interflow	3.5.3.3	4.3.1.1	no
Pilot stage porting	3.5.3.5	4.3.1.1	yes
Air removal	3.5.3.9	4.3.1.1	no
Special seal design	3.5.3.10	4.3.1.1	no
Orifices	3.5.3.7.1	4.3.1.1	no
B. Detailed tests (see applicable specification sheet)			

TABLE II. *First article and quality conformance inspection.*

Inspection	Requirement	Test method	Applicable to subplate
A. General examinations and tests			
Visual examination		4.3.1.2	
Pattern	3.5.1.2.1	4.3.1.2	yes
Electrical connection	3.5.1.2.3	4.3.1.2	no
Identification marking	3.7	4.3.1.2	yes
Insulation resistance	3.5.2.6	4.3.4	no
Coil resistance	3.5.2.7	4.3.5	no
Dielectric strength	3.5.2.8	4.3.6	no
B. Detailed tests (see applicable specification sheet)			

4.2.2 Quality conformance inspection. Quality conformance inspection shall consist of the tests specified in table II (see 6.3). The detailed technical requirements and tests are specified in the applicable specification sheets.

4.3 Test methods.

4.3.1 Examination.

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4.3.1.1 First article inspection. The selected units shall be specifically identified according to specification sheet number, noise grade, part number and serial number. The units must be visually and dimensionally examined prior to testing to certify form, fit and function conformance to specific critical requirements contained in the documents required by 3.5 and the appendix.

4.3.1.2 Quality conformance. Each valve and subplate shall be subjected to a visual and dimensional examination to verify conformance with the interface and installation dimension requirements of the applicable specification sheet.

4.3.2 Proof pressure test.

4.3.2.1 First article proof test. The unit shall be hydrostatically tested to the pressure test level of the applicable specification sheet for a period of not less than three minutes. The valve shall be visually examined for external leakage while pressurized during the proof pressure test. No sign of external leakage, other than slight wetting insufficient to form a drop shall be acceptable. No permanent deformation is acceptable.

4.3.2.2 Quality conformance proof test. Each valve and subplate shall be hydrostatically tested to the pressure test levels of the applicable specification sheet for a period of not less than one minute. The valve shall be visually examined for external leakage while pressurized during the proof pressure test. No sign of external leakage, other than slight wetting insufficient to form a drop shall be acceptable. No permanent deformation is acceptable.

4.3.3 Run-in. The valve control pressure ports shall be connected across a throttling valve and cycled plus or minus 100 percent of rated torque motor current for at least 100 cycles while in a test configuration which generates maximum design operating fluid pressures, unless otherwise specified in the applicable specification sheet. There shall be no evidence of external leakage during the run-in period. The valve shall demonstrate the necessary polarity and functionality to ensure that it is ready for the remainder of either the first article or quality conformance inspection test program.

4.3.4 Insulation resistance. Insulation resistance between separate coils or between the coils and case ground shall be performed in accordance with method 302 of MIL-STD-202 and must be greater than 10 megohms after 500 Vdc have been applied between the coil terminations for a period of 10 to 15 seconds. Unacceptable damage to insulation may result if more than 60 seconds of cumulative test time is imposed.

4.3.5 Coil resistance. The resistance of each coil of the valve shall be measured separately after the valve has been filled with fluid that has been allowed to stabilize at room temperature. A resistance/temperature correction may be required in order to compare the measured values to the resistance value required by the applicable specification sheet at design conditions.

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4.3.6 Dielectric strength. The dielectric strength of the valve shall be tested in accordance with method 301 of MIL-STD-202 by applying 450 volts alternating current (Vac) (rms) plus rated design voltage at 60 Hz between the coil terminations and the fluid filled servovalve body. The first article test unit shall withstand this condition for a period of 60 seconds. Production units shall withstand quality conformance testing under this condition for a period of 5 to 15 seconds. Satisfactory performance shall be that no damage, arcing, breakdown, or leaking current in excess of 0.5 milliamperes is present (see 6.7).

4.3.7 Magnetic field effects. The valve flow gain characteristic shall, when required by the applicable specification sheet, remain within the required limits while being subjected to the specified magnetic field conditions per section 70-Part 1 of DOD-STD-1399.

4.3.8 Flow gain. Each valve shall be tested at pressure and fluid temperature conditions required by the applicable specification sheet to generate torque motor current/flow gain curves. After cross-connecting the control pressure ports, increase torque motor current from zero to the first torque motor current test set point and then adjust supply pressure (P) until net valve pressure drop is within the limits allowed by the applicable specification sheet. No further servovalve adjustments shall be made. Maintain pilot pressure (PP) within the limits required by the applicable specification sheet. Measured flows at intermediate torque motor current level settings and at both the positive and negative rated torque motor current level shall be within limits required by the specification sheet.

4.3.9 Rated flow. During the flow gain test (see 4.3.8), verify that the rated discharge flow from each control port is within the required limits of the applicable specification sheet at the specified pressure and fluid temperature conditions.

4.3.10 Flow limit adjustments. During the flow gain test (see 4.3.8), verify that the flow control limiting adjustments of the valve are operational throughout the specified range of flows and satisfy the requirements of the applicable specification sheet at specified pressure and fluid temperature conditions.

4.3.11 Internal leakage. Control ports C1 and C2 shall be initially cross-connected and torque motor current oscillations reduced from 25 percent to zero before blocking C1 and C2 and removing the torque motor signal. Fluid temperature shall be maintained within the limits required by the applicable specification sheet. Pilot pressure (PP) and main pressure (P) shall be set in accordance with the applicable specification sheet. Internal leakage over a period of 3 to 5 minutes shall not exceed the allowable limit of the applicable specification sheet.

4.3.12 Null lap. Pressures, temperature and torque motor current shall be set per requirements of the applicable specification sheet. Testing and evaluation shall be performed in accordance with SAE ARP 490. Zero-flow cylinder port pressures (C1 and C2) shall be within the allowable limits of the applicable specification sheet.

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4.3.13 Hysteresis. Pressures and fluid temperature shall be set in accordance with requirements of the applicable specification sheet. The valve output measurement procedures specified by the applicable specification sheet shall be followed while varying the servo input current between the required limits. Hysteresis shall not exceed the percent of the maximum rated current required by the applicable specification sheet.

4.3.14 Threshold. The amount of control signal current required to cause a detectable valve output reversal shall not exceed the percent of maximum rated current allowed by the applicable specification sheet.

4.3.15 Pressure gain. The pressure gain slope, as defined in SAE ARP 490, shall be greater than the value specified in the applicable specification sheet. The pressure gain shall be calculated in terms of percent of load pressure drop divided by percent of maximum rated current at 40 percent of maximum load pressure drop in both the positive and negative torque motor current directions with control ports blocked.

4.3.16 Amplitude ratio. A signal generator capable of supplying a pure sine wave input with an amplitude of not less than 25 percent of rated input current about electrical null shall be set up in accordance with SAE ARP 490 to drive the servovalve. The ratio of the measured valve output amplitude with respect to the amplitude of the input command signal over a frequency range specified in the applicable specification sheet shall be plotted on a Bode diagram. This data shall satisfy the requirements of the applicable specification sheet.

4.3.17 Phase lag. The phase angle response of the valve output with respect to the input command signal shall satisfy the requirements of the applicable specification sheet within the frequency range required by the applicable specification sheet when utilizing the same equipment, input signal and Bode diagram as used in the amplitude ratio test (see 4.3.16).

4.3.18 Noise test.

4.3.18.1 First article noise test. When required, the valve shall be subjected to a structureborne noise test in accordance with MIL-STD-740-2 and the requirements of the applicable specification sheet (see 6.3). The description of the test procedure, facility, and measurement system must have NAVSEA approval in advance of the test (see 6.3). If the valve fails to meet first article test requirements for reasons other than seal replacement, the contractor shall identify the cause of failure and recommend corrective action (see 6.3).

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4.3.18.2 Quality conformance noise test. Valves that have specified noise levels shall be assembled and tested with their subplate (see 6.3). A production series of 10 or fewer valves that have a specified noise level shall require full compliance structureborne noise testing of each valve. A production series shall be defined as valves with same spool/sleeve assembly and same flow requirements. A production series of more than 10 valves that have a specified noise level shall be sampled for quality conformance structureborne noise testing according to the following sampling procedure:

- a. Unless otherwise specified in the specification sheet or contract, 3 valves chosen at random by the Government from each production series shall be tested (where more than one configuration exists within a production series at least one of each configuration must be tested).
- b. If all 3 valves tested passed the noise test, use a sampling plan in accordance with MIL-STD-105, general inspection level II.
- c. If one of the valves tested failed the noise test and required rework other than seal replacement, then the next five valves shall be tested. The 5 valves must pass the noise test to implement the sampling plan from MIL-STD-105.
- d. If any of the 5 valves tested failed, then the process is repeated, starting from step (c), until the requirement is met.

Each valve shall be installed and instrumented in accordance with MIL-STD-740-2. With the valve operated in offset positions of 5, 10, 25, 50, 75, and 100 percent of maximum rated torque motor current on either side of neutral, record the structureborne noise levels for the valve in each one-third octave band and flow position for test conditions specified in the applicable specification sheet. When required by the applicable specification sheet, the narrowband (1/10 octave) structureborne noise level shall also be recorded for the noisiest offset position associated with each of the test conditions. The peak transient noise produced when shifting from each position to every other position, with the valve adjusted for the maximum rated flow, shall be recorded while monitoring the broadband vibration level (10 Hz - 10 kilohertz (kHz)). The shift time shall be within the requirements specified in the applicable specification sheet. Valves shall meet the structureborne noise level requirements specified in the applicable specification sheet. The cause and corrective action associated with valve repair required to correct unacceptable noise levels shall be identified for each valve tested (see 6.3).

4.3.19 Maintainability demonstration test. Conformance to the requirements specified in 3.9 shall be demonstrated. The demonstration shall include MTTR and ease of disassembly/assembly. Failure to comply with any or all of the specified requirements shall result in rejection.

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4.3.20 Endurance. The valve shall be subjected to an endurance test of 2,000,000 cycles with periodic measurement of valve characteristics in accordance with the applicable specification sheet at intervals of 25, 50, 75, and 100 percent throughout the duration of the test. The duty cycle characteristics shall be defined and administered in accordance with the applicable specification sheet. Replacement of any operating parts, with the exception of filters or screens at 25, 50, and 75 percent test completion, shall constitute a failure of the test.

4.3.21 Shock. The valve shall be subjected to a shock test in accordance with the requirements of MIL-STD-2193, unless otherwise specified in the applicable specification sheet.

4.3.22 Vibration. The valve shall be filled with hydraulic fluid and subjected to a vibration test in accordance with the requirements of MIL-STD-2193, unless otherwise specified in the applicable specification sheet.

4.3.23 Temperature and pressure sensitivity. When required by the applicable specification sheet, the valve shall be subjected to above and below normal temperature and pressure operating conditions to monitor and assess its temperature and pressure sensitivity.

4.3.24 Contamination sensitivity. The "test component" shall be replaced with a test valve loop in the MIL-STD-2193 test circuit. The test valve loop shall consist of test valve, by-pass loop and isolation valves. The isolation valves shall be located before and after the test valve and in the by-pass line. The MIL-STD-2193 test circuit shall be initially cleaned to the level required by the applicable specification sheet while operating in the by-pass mode with the test valve isolated. After the system has been cleaned to the prescribed level, and the filter placed on-line, the valve shall be actuated at 6 cycles per minute (c/m) for 60 minutes. Flow, pressure and temperature operating requirements shall be in accordance with the applicable specification sheet. At the completion of the run-in period, the valve performance criteria required by the applicable specification sheet shall be measured. The filter shall then be by-passed and the first contaminant sample shall be injected. The valve shall remain in the continuous flow position without cycling for 30 minutes. Valve performance shall be re-measured and be within the allowable limits required by the applicable specification sheet. Then the filter shall be replaced on-line and the system operated in the cleaning mode for 30 minutes. The sequence shall be repeated until all contaminant samples have been injected.

4.3.25 Salt fog. Valves and subplates shall be subjected to a salt fog test in accordance with the requirements of MIL-STD-2193.

4.3.26 Fatigue test. Valves and subplates shall be subjected to a fatigue test in accordance with the requirements of MIL-STD-2193, unless otherwise specified in the applicable specification sheet.

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4.3.27 First article noise retest. At the conclusion of the contamination sensitivity test and other tests required by the applicable specification sheet the valve shall be retested for structureborne noise in accordance with 4.3.18. If the unit's noise level has increased above the applicable specification sheet allowable levels, the contractor shall use additional narrow band noise evaluation techniques before proceeding to disassemble the unit, check dimensions, and so forth, to determine why the noise level increased. The findings shall be verified by replacing or refurbishing, as required, until a successful noise test can be completed (see 6.3). The Government will have the option of requiring further testing before the first article test is considered to be satisfactorily completed.

4.3.28 Burst pressure test. When a burst test is specified in lieu of the fatigue test (see 4.3.26), the valve and subplate assembly shall be hydrostatically tested to the pressure test levels of the applicable specification sheet, and in accordance with the requirements and acceptance criteria of MIL-STD-2193.

4.4 Inspection of packaging. Sample 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 herein.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition. For extent of applicability of the packaging requirements of referenced documents listed in section 2, see 6.8.7.)

5.1 Packaging requirements. Valves shall be preserved level A, C, or commercial, packed level A, B, C, or commercial, marked in accordance with MIL-V-3, and shall include bar codes and applicable packaging acquisition options therein as specified (see 6.2). In addition, for Navy acquisitions, the following applies:

a. Navy shipboard stowage fire-retardant requirements

- (1) *Treated lumber and plywood.* Unless otherwise specified (see 6.2), all lumber and plywood including laminated veneer material used in shipping containers and pallet 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 I - general use

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

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- (2) *Fiberboard.* Unless otherwise 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 Critical close tolerance equipment. In addition to any preservation and packaging requirements specified by the product specification or packaging requirements code, equipments which are identified to MIL-STD-740 shall be protected against damage resulting from environmental conditions, multiple handling and the hazards of transportation (rough handling, shock, vibration, and so forth). Shipping containers or method of packing utilizing shock and/or vibration mitigation systems shall only use mounts which have "captive features" incorporated in their design. Unit packs and shipping containers shall be marked as specified in 5.2.1.

5.2.1 Critical close tolerance equipment. Unit packs and shipping containers and unpacked shipments shall be marked with the following:

CRITICAL

**CLOSE TOLERANCE OPERATING EQUIPMENT
HANDLE WITH CARE
DO NOT DROP OR SUBJECT TO SHOCKS OR JARS**

Markings, including arrows and the word "UP," shall be stenciled, red color, and applied on two sides and both ends of the container or shipment, letters shall be of minimum 1 1/2" high, except for small containers with insufficient space, in which case letters shall be of such size as to be legible.

6. NOTES

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

6.1 Intended use. Valves and subplates covered by this specification are intended for use in shipboard hydraulic systems utilizing petroleum base hydraulic fluids. With proper selection of preservative fluid, the valves and subplates can be used in hydraulic systems utilizing other hydraulic fluids compatible with MIL-R-83248 seals.

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6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number and date of this specification
- b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of the individual documents referenced (see 2.1.1 and 2.2)
- c. Quantity of items required with applicable standard part number (see applicable specification sheet)
- d. Requirements for first article testing (see 3.2)
- e. When fire-retardant treated materials are not required (see 5.1)
- f. Level of packaging, packing and marking required (see 5.1)
- g. Nameplate data
- h. Preservative fluid if other than MIL-H-6083 for petroleum based systems.

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 (DIDs) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DIDs 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.

Reference paragraph	DID number	DID title	Suggested tailoring
3.5	DI-DRPR-80651	Engineering drawings	—
4.2.1	UDI-T-23790	First article test report	—
4.2.2	DI-T-2072	Test reports	—
4.3.18.1	DI-HFAC-80273	Equipment structureborne vibratory acceleration measurement plan	—

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Reference paragraph	DID number	DID title	Suggested tailoring
4.3.18.1, 4.3.18.2 and 4.3.27	DI-HFAC-80271	Sound test failure Notification and recommendation report	—
6.3	DI-T-23731	Notification of tests	—
4.3.18.1 and 4.3.18.2	DI-HFAC-80274	Equipment structureborne vibratory acceleration measurements test report	—

The above DIDs 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 DIDs are cited on 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 separate contract line item in the contract.

6.5 Provisioning. Provisioning Technical Documentation (PTD), spare parts, and repair parts should be furnished as specified in the contract.

6.5.1 When ordering spare parts or repair parts for the equipment covered by this specification, the contract should state that such spare parts and repair parts should meet the same requirements and quality assurance provisions as the parts used in the manufacture of the equipment. Packaging for such parts should also be specified.

6.6 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerors whether the item(s) should be a preproduction sample, a first article sample, a first production item, a sample selected from the first production items, a standard production item from the contractor's current inventory (see 3.2), and the number of items to be tested as specified in 4.2.1. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering

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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. Bidders should not submit alternate bids unless specifically requested to do so on the solicitation.

6.7 Material safety precautions. The dielectric strength test of 4.3.6 is degrading and is not to be applied to delivered valves. If a dielectric strength test is to be applied at valve overhaul the applied voltage shall be in accordance with the original manufacturer's recommendations but not less than 500 volts.

6.8 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.

6.9 Subject term (key word) listing.

Hydraulic
Quiet Operation
Torquemotor

Preparing activity:
NAVY - SH
(Project 4810-NO75)

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APPENDIX

Engineering Drawings Technical Content Requirements

10. Scope.

10.1 Scope. This appendix covers the technical requirements that shall 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

(This section is not applicable to this appendix.)

30. Drawings

30.1 Assembly Drawings. When required by the contract or order, assembly drawings shall show a cutaway section of details and subassemblies. The following data shall be furnished on, or together with, the assembly drawings:

- a. Outline dimensions of complete valve assembly
- b. Dimensional locations of all ports
- c. Dimensional locations and sizes of all mounting holes
- d. Dimensional locations and sizes of all valve-to-subplate interfaces
- e. Cross-sectional views of regulating, metering and adjustment assemblies
- f. Internal porting and flow paths
- g. Port identification markings
- h. Location of nameplates and indicator plates
- i. Torque requirements for all fasteners
- j. Complete list of all parts and their material of construction and part number
- k. Details of new or nonstranded materials and processes
- l. Fluid power symbol of the valve in accordance with ANSI Y32.10
- m. Identification of subassemblies which require match marks to avoid improper assembly
- n. Cross-sections of electrical devices
- o. Electrical circuits, connector pin/key orientation, electrical parameters, and operational requirements.