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DETAIL SPECIFICATION

# VALVES, HYDRAULIC DIRECTIONAL CONTROL, 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 directional control valves for use in hydraulic systems. The valves are designed for standard or quiet operation and utilize subplate or manifold mounting that has a quill or sealing sleeve fluid connection configuration.

1.2 Classification. Directional control valves are to be designated using the standard part numbers as identified in the applicable specification sheet.

1.3 Part or identifying number (PIN). The PIN used in acquiring the directional control valve to this specification should be in accordance with the applicable specification sheet (see 3.1).

## 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 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 cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

| | | |
|---|---|---|
| MIL-DTL-868/1 | - | Valves, Hydraulic Directional Control, Four Way, 0-12 GPM |
| MIL-DTL-868/2 | - | Valves, Hydraulic Directional Control , Four Way, 3-25 GPM |
| MIL-DTL-868/3 | - | Valves, Hydraulic Directional Control, Four Way, 10-50 GPM |
| MIL-PRF-19500 | - | Semiconductor Devices, General Specification For |
| MIL-PRF- 19500/240 | - | Semiconductor Device, Diode , Silicon, Rectifier, Types 1N645-1, 1N647 -1, 1N649-1, 1N645UR-1, 1N647UR-1, 1N649UR-1, JAN, JANYTX and JANTXV |

Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy.mil, with the subject line “Document Comment”. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

MIL-PRF-19500/427 - Semiconductor Device, Diode, Silicon, Rectifier, Types 1N5614, 1N5616, 1N5618, 1N5620, 1N5622, 1N5614US, 1N5616US, 1N5618US, 1N5620US, 1N5622US, JAN, JANTX, JANTXV, JANS, JANHC, AND JANKC

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-202 - Test Method Standard for Electronic and Electrical Component Parts

MIL-STD-2193 - Ship Hydraulic System Components

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-454 - General Guidelines For Electronic Equipment

(Copies of these documents are available online at http://quicksearch.dla.mil/ or https://assist.dla.mil.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NATIONAL FLUID POWER ASSOCIATION (NFPA)

T2.6.1 - Method for Verifying the Fatigue and Static Pressure Rating for Pressure Containing Envelope of a Metal Fluid Power Component

(Copies of this document are available from NFPA, 3333 N. Mayfair Road, Milwaukee, WI 53222-3219 or online at www.nfpa.com.)

SAE INTERNATIONAL

SAE AS34521 - (R) Connector, Receptacle, Electric, Box Mounting, Rear Release, Crimp Contact, AN Type With

SAE AS40401 - Solenoid, Electrical, General Specification For

SAE AS50151 - Connectors, Electrical, Circular Threaded, AN Type, General Specification For

(Copies of these documents are available from SAE World Headquarters, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or online at www.sae.org.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, 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 item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

3.2 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.3) in accordance with 4.2.

3.3 General requirements. General requirements and materials shall be as specified herein and in accordance with MIL-STD-2193.

3.4 Design and construction.

3.4.1 General design requirements. Valves shall be in accordance with the general design requirements specified in 3.4.1.1 through 3.4.1.12 (see 6.7).

3.4.1.1 Configuration. Unless otherwise specified (see 3.4.2.2 and 6.2), valves furnished under this specification shall be of the mounting configuration as specified in the applicable specification sheet (see 3.1).

3.4.1.2 Type. The valve shall control fluid flow direction by means of a spool or poppet. The motion of the spool shall be linear or rotary. The spool shall consist of a slide and sleeve assembly or a single slide. The individual valve type shall be identified in the applicable specification sheet (see 3.1).

3.4.1.3 Flow pattern. Unless otherwise specified (see 6.2), the number of ways, positions, flow paths, and center type for valves covered by this specification shall be as specified in the applicable specification sheet (see 3.1). Four-way valves (see 6.9.2) may be used in three-way valve (see 6.9.3) applications.

3.4.1.4 Interflow. Unless otherwise specified (see 6.2), all valves shall be designed such that there is no interflow between the cylinder, pressure, and return ports when shifting from one position to another.

3.4.1.5 Manual operation. Unless otherwise specified (see 6.2), when the handle of a four-way valve is in the position nearest the valve body, fluid shall be directed from the pressure (P) port to the cylinder (CA) port and from the cylinder (CB) port to the return (R) port. When in the opposite position, fluid shall be directed from the P port to the CB port and from the CA port to the R port. For a three-way valve, when the handle is nearest the valve body, fluid shall be directed from the P port to the CA port with the R port blocked. When in the opposite position, fluid shall be directed from the CA port to the R port with the P port blocked.

3.4.1.6 Operation handles and latches. Manually-operated valves shall be provided with an operating handle. Unless otherwise designated by the valve part number description listed in the applicable specification sheet (see 3.1), the handle shall be provided with a latching mechanism to prevent the valve spool from changing position under high-impact shock, vibration, or inadvertent bumping of the handle. The latching positions shall be as described in the applicable specification sheet (see 3.1). The design of the latching mechanism shall be such that the operating handle and latch can be operated simultaneously with one hand.

3.4.1.7 Solenoid operation. Unless otherwise specified (see 6.2), the following conventions shall be applied:

3.4.1.7.1 Single solenoid valves. The solenoid shall be designated “LA”. When energized, the fluid shall be directed from the P port to the CA port. When de-energized, the fluid shall be directed from the CA port to the R port.

3.4.1.7.2 Double solenoid valves. The solenoids shall be designated “LA” and “LB”. When LA is energized, fluid shall be directed from the P port to the CA port. When LB is energized, fluid shall be directed from the P port to the CB port. When both solenoids are de-energized, the valve shall move to its center position.

3.4.1.8 Manual overrides. Unless otherwise specified (see 6.2), all solenoid-operated valves shall be provided with manual overrides equipped with pin locks to allow local operation of the valve without energizing the solenoid. Once actuated, the pin lock shall be utilized to retain the valve in the override position until manually released. The manual override shall not be required to override an energized solenoid or hydraulic pilot. Unless otherwise specified (see 6.2), the overrides shall be protected from inadvertent operation.

3.4.1.9 Hydraulic pilot operation. Unless otherwise specified (see 6.2), when the pilot (PPA) port is pressurized, flow shall be from the P port to the CA port and when the opposite pilot (PPB) port is pressurized, flow shall be from the P port to the CB port.

3.4.1.10 Life. Non-fatigue rated valves shall be designed for at least 150,000 hours (375,000 cycles) before replacement of the total valve is necessary. Fatigue rated valves shall be designed for at least 10 million fatigue cycles (see 3.5.7). When tested in accordance with 4.5.15, replacement of any operating parts with the exception of filters or screens shall constitute a failure. Valve parts shall be designed for the life of the valve with the following exceptions:

a. Filters and screens: No more than four maintenance actions shall be required during the 50,000 cycle endurance test.

b. Solenoids: The life requirement shall be in accordance with SAE AS40401 for continuous duty rated solenoids.

c. Seals: Seals shall be designed for at least 20,000 hours (50,000 cycles) of operation.

3.4.1.11 Maintainability. Valves shall be designed for ease of servicing and maintenance. The times required to accomplish normal corrective maintenance actions shall be established (see 6.2). Normal corrective maintenance shall be limited to replacement of seals (including backup rings), actuator assemblies (solenoids), or subassemblies that can be replaced by using the standard tools that are listed in the Federal Supply Catalog. Copies of this catalog may be consulted in the office of the Defense Logistics Agency (DLA).

3.4.1.12 Nameplates and indicator plates. Unless otherwise specified (see 6.2), each valve shall be supplied with nameplates in accordance with MIL-STD-2193. Nameplates shall be of uniform size for each valve size range and shall contain the following information:

a. Military part or identifying number (PIN)
b. Manufacturer's part or model number
c. Manufacturer's name or trademark
d. Manufacturer's serial number

When specified, manually and solenoid-operated valves shall be provided with indicator plates affixed adjacent to the manual lever or manual override. The indicator plate shall be inscribed with the operating function (such as open and close) or the valve schematic as specified. Double solenoid valves shall have two indicator plates, one for each solenoid.

3.4.2 Physical requirements.

3.4.2.1 Envelope. Unless otherwise specified (see 6.2), the valve envelope shall be such that the valve can be installed within the dimensions for the applicable size and type shown in the applicable specification sheet (see 3.1).

3.4.2.2 Mounting. Unless otherwise specified (see 6.2), valves shall be designed for subplate or manifold mounting and shall accept the interface configuration for the appropriate valve sizes listed in the applicable specification sheet (see 3.1). Unless otherwise specified (see 6.2), the seal interface configurations shall be as shown in the applicable specification sheet (see 3.1).

3.4.3 Electrical requirements. The electrical components associated with the solenoid-operated pilot valves shall comply with the requirements specified herein and should follow the guidance provided in MIL-HDBK-454 for the characteristics listed below:

a. Materials
b. Parts - electrical
c. Encapsulation and embedment (potting)
d. Structural welding
e. Interchangeability
f. Safety
g. Soldering
h. Electrical parts mounting
i. Fungus - inert materials
j. Wiring
k. Schematic diagram

3.4.3.1 Connectors. Unless otherwise specified in the applicable specification sheet (see 3.1), the receptacle shall conform to SAE AS34521, Class W, shell size 16S with P contacts, and shall be mounted on each enclosure where cable entrance is required. Electrical connector's interface shall be in accordance with SAEAS50151. Insert arrangement shall be 4P for LA and 4PX for LB (see figure 1).

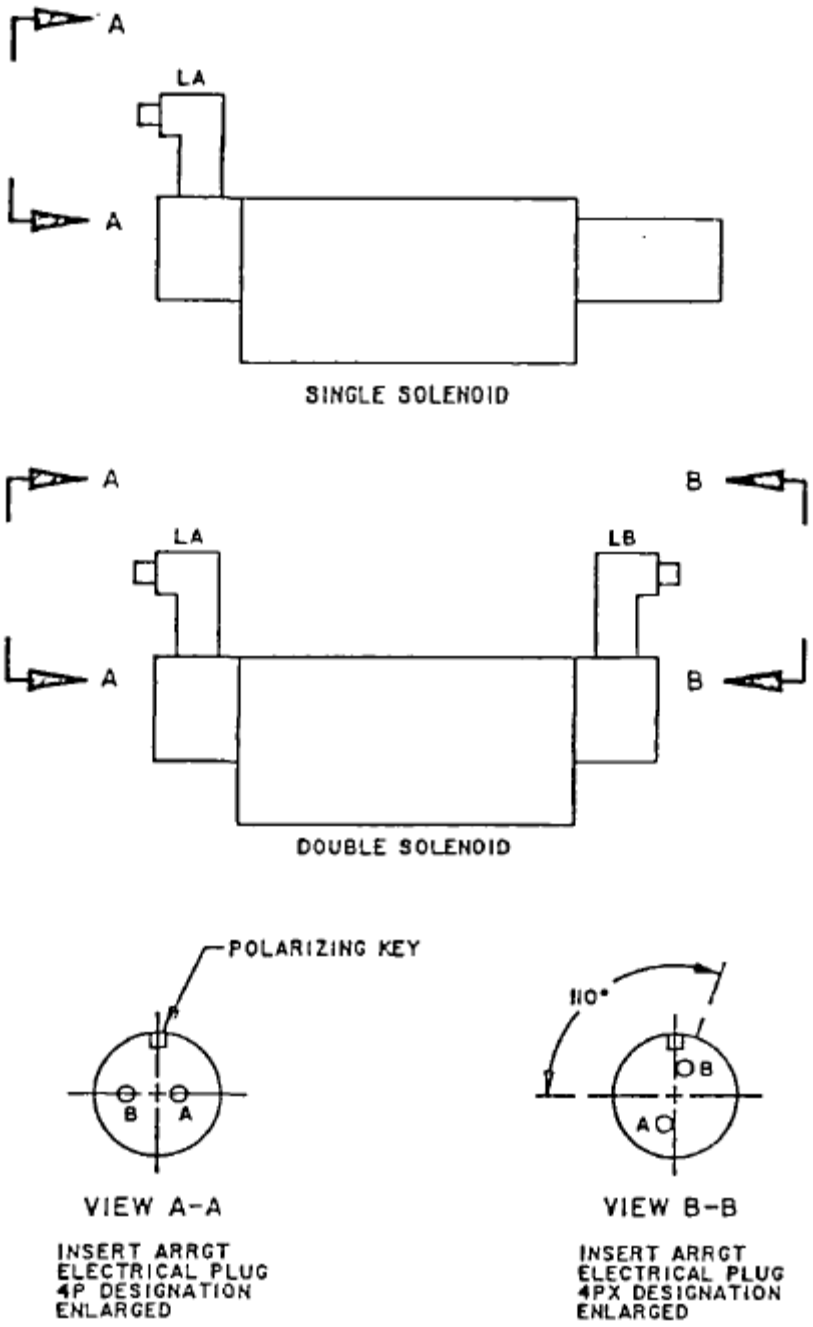


FIGURE 1. Valve orientation.

3.4.3.2 Solenoids. Unless otherwise designated (see 6.2), solenoids shall be of the continuous duty type designated in accordance with SAE AS40401 for either alternating current (AC) operation or direct current (DC) operation through rectifier. The type of solenoid shall be as specified in the applicable specification sheet (see 3.1). The electrical requirements for the solenoid shall be as follows (see 4.5.13):

a. Supply voltage rating – 87 volts AC (VAC) minimum; 122 VAC maximum.

b. Drop-out voltage – 10 VAC minimum.

c. Ambient temperature – 39 to 122 degrees Fahrenheit (°F) [4 to 50 degrees Celsius (°C)].

d. Insulation resistance – 10,000 megaohms at 500 volts DC (VDC) between power input leads and case ground.

e. Frequency range – 0 Hertz (Hz) minimum; 400 Hertz maximum.

f. Dielectric strength or withstanding voltage – 1,500 root mean square (rms) volts plus rated voltage at 60 Hertz for 60 seconds applied between input leads and case ground. When tested in accordance with 4.5.13.2.2, no damage, arcing, breakdown, or leaking current in excess of 0.5 milliamperes (mA) shall be present (see 6.4 regarding restrictions on re-test of solenoids).

g. Current – For AC solenoids, using a nominal 115 VAC, 60-Hertz supply, the in rush current shall not exceed 250 (mA). The holding current shall not exceed 140 mA. For DC solenoids, using a rectified 115 VAC, 60-Hertz supply or a nominal 80 VDC supply, the in rush and holding currents shall not exceed 275 mA.

h. The noise generated by the solenoid, when installed on the valve and actuated, shall not exceed the noise limits specified in 3.5.5.

3.4.3.3 Electrical insulation. Electrical insulation for all solenoids should follow the guidance provided in Guideline 11 of MIL-HDBK-454 for Class H. Continuous duty solenoids shall be designed in accordance with the life requirement of SAE AS40401 for continuous energized operation of 168 hours at an ambient temperature of 122 °F (50 °C) and a supply voltage of 122 VAC maximum.

3.4.3.4 Rectifiers. A rectifier shall be provided for each solenoid designed for DC operation. The rectifier shall be built into the solenoid package and shall be silicon in accordance with MIL-PRF-19500 and MIL-PRF-19500/240 or MIL-PRF-19500/427. Rectifier circuits shall be of the full wave bridge type and designed for continuously energized operation from a normal 115 VAC, 60-Hertz single-phase supply. The device shall operate satisfactorily within the voltage and frequency ranges specified in 3.4.3.2 and shall be removable for replacement.

3.4.4 Hydraulic requirements.

3.4.4.1 Hydraulic fluid. Unless otherwise specified (see 6.2), the valves shall meet the fluid compatibility requirements of the hydraulic fluid listed in the applicable specification sheet (see 3.1).

3.4.4.2 Operating pressure. Unless otherwise specified in the applicable specification sheet (see 3.1), the valves shall be designed to operate with supply pressure ranging from 90 to 210 bars (1,300 to 3,000 pounds per square inch gauge (psig)) and return pressure from 0 to 24 bars (0 to 350 psig) with surges to 40 bars (580 psig) of an indefinite duration. With the 40-bar return pressure surges, the valve spool shall not shift position to degrade the functional setting of the valve.

3.4.4.3 Proof pressure. Valves shall be designed and constructed to withstand specified hydrostatic test pressure without any external leakage or incurring any permanent damage or deformation. Unless otherwise specified in the applicable specification sheet (see 3.1), the hydrostatic test pressure shall be:

a. Pressure and cylinder ports – 310 bars (4,500 psig)

b. Return port – 60 bars (900 psig)

3.4.4.4 Temperature. The valves shall operate within a fluid temperature range of 160 °F (71 °C) maximum to 60 °F (16 °C) minimum under normal conditions. The valves shall operate with fluid temperatures as low as 41 °F (5 °C), but valves controlled by solenoid-operated pilot stages shall not be required to meet the rates of operation specified in 3.4.6.4. When tested in accordance with 4.5.14, there shall be no evidence of external leakage, binding or delayed valve response.

3.4.4.5 Fluid contamination. Valves shall operate (shift) satisfactorily when subjected to the contamination sensitivity test (see 3.5.6).

3.4.4.6 Pilot stage filtration. For pilot stages requiring additional protection, either a throw-away or cleanable type screen or filter shall be built into the valve assembly. The screen or filter shall be serviceable without disassembling the valve or dismounting the valve from its subplate or manifold. The screen or filter element shall not be equipped with a bypass and shall not collapse at less than 230 bars differential (3,300 pounds per square inch differential (psid)). The location of the screen or filter element shall be marked.

3.4.5 Performance.

3.4.5.1 External leakage. There shall be no evidence of external leakage, other than slight wetting insufficient to form a drop, throughout all environmental and operational ranges. Unless otherwise specified (see 6.2), external leakage shall not exceed one drop every 25 cycles where spool shaft extensions or operators penetrate the valve (see 4.4).

3.4.5.2 Internal leakage. Internal leakage shall not exceed the limits listed in the applicable specification sheet (see 3.1).

3.4.5.3 Flow requirements. Valves shall meet the flow rates specified in the applicable specification sheet (see 3.1). The valves shall perform in accordance with the requirements specified herein when mounted in any orientation or attitude.

3.4.5.4 Flow sensitivity to differential pressure and viscosity. The requirements for a differential pressure (see 6.9.1) across a given size and grade valve shall be as specified in the applicable specification sheet (see 3.1) at the rated flow. The change in flow as a result of change in fluid viscosity shall not be more than that identified in the applicable specification sheet (see 3.1). Valves that do not contain quiet elements or other flow restricting devices are exempt from the requirements for flow sensitivity to fluid viscosity.

3.4.6 Operation.

3.4.6.1 Manual actuation. Manual valves shall be designed for quick operation using only one hand. When manually actuated, the valve shall operate smoothly without any binding or roughness. Unless otherwise specified in the applicable specification sheet (see 3.1), the force required to operate the valve shall not exceed 15 pounds-force (67 Newtons) when tested in accordance with 4.5.8. The force required to operate a manual override shall not exceed 20 pounds-force (90 Newtons) if the manual override is not required to override an energized solenoid or pilot. The force required to override an energized solenoid or pilot shall not exceed 30 pounds-force (134 Newtons).

3.4.6.2 Mechanical actuation. Unless otherwise specified in the applicable specification sheet (see 3.1), the force required to operate the valve shall not exceed 70 pounds-force (311 Newtons) when tested in accordance with 4.5.9. Unless otherwise specified (see 6.2), the valve stem need not be designed to withstand side loads.

3.4.6.3 Hydraulic actuation. Unless otherwise specified in the applicable specification sheet (see 3.1), hydraulically operated valves shall not start to shift for differential pressures less than 25 bars (360 psid) and shall be completely shifted at differential pressures exceeding 69 bars (1,000 psid) for the operating range specified in 3.4.4.2. Unless otherwise specified in the applicable specification sheet (see 3.1), shift time shall not exceed 500 milliseconds when tested in accordance with 4.5.10.

3.4.6.4 Solenoid actuation. Unless otherwise specified (see 6.2), solenoid-operated valves shall shift within the maximum shift time and at the operating conditions required by the applicable specification sheet (see 3.1) when tested in accordance with 4.5.9.

3.5 Operational environments.

3.5.1 Ambient conditions. Unless otherwise specified in the applicable specification sheet (see 3.1), the valves shall operate throughout the ambient temperature of 41 to 160 °F (5 to 71 °C). Unless otherwise specified (see 6.2), the valves shall be designed to meet the ambient pressure conditions specified in MIL-STD-2193.

3.5.2 Shock. When tested in accordance with 4.5.16, the valve shall be considered to have failed the shock test if it does not meet the requirements of any Group 3 test of table I or shows any signs of external or internal damage. Release of locking handles on equipped valves shall also be considered a failure.

3.5.3 Vibration. Valves shall operate to the vibration requirements specified in MIL-STD-2193. The valve shall be considered to have failed the vibration test if it does not meet the requirements of any Group 3 test of table I or shows any signs of external or internal damage. Release of locking handles on equipped valves shall also be considered a failure.

3.5.4 Salt fog. Valves shall withstand, without degradation, the salt fog test specified in 4.5.20 and meet the salt fog requirements specified in MIL-STD-2193.

3.5.5 Noise. Valves shall meet the structureborne noise level as specified (see 6.2).

3.5.6 Contamination sensitivity. Unless otherwise specified (see 3.1 and 6.2), valves shall meet the requirements of this specification when subjected to the contamination sensitivity test specified in 4.5.18. Should the spool stick or the force exceed the limits specified in 3.4.6, the valve shall be considered to have failed this test.

3.5.7 Fatigue. When specified in the applicable specification sheet (see 3.1), the valve shall satisfy the 90 percent assurance and 90 percent confidence levels. When tested in accordance with 4.5.21, there shall be no evidence of structural failure or external leakage in excess of the values specified in 3.4.5.1.

3.6 Recycled, recovered, or environmentally preferable materials, or biobased materials. Recycled, recovered, environmentally preferable, or biobased materials should be used to the maximum extent possible, provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

4. VERIFICATION

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

a. First article inspection (see 4.2).

b. Conformance inspection (see 4.3).

4.2 First article inspection. First article inspection shall consist of the tests specified in table I. Tests in Group 1 shall be completed prior to starting the tests in Group 2, and the tests in Group 2 shall be conducted before starting Group 3 tests. The salt fog and maintainability tests of Group 4 may be conducted anytime. Unless otherwise specified (see 6.2), tests within a group may be conducted in any order. One valve of each specific part number shall be tested. When a number of similar valves are being acquired, the first article inspections shall be subject to approval by extension when technically justified (see 6.3.1.1).

TABLE I. First article inspection.

| Tests | Requirements | Test methods |
|---|---|---|
| **Group 1** | | |
| Examination | 3.4.1 & 3.4.2 | 4.5.1 |
| Proof pressure | 3.4.4.3 | 4.5.2 |
| Run-in/external leakage | 3.4.5.1 | 4.5.3 |
| Internal leakage | 3.4.5.2 | 4.5.4 |
| Flow sensitivity to differential pressure and viscosity | 3.4.5.4 | 4.5.5 |
| Manual actuation (as applicable) | 3.4.6.1 | 4.5.8 |
| Mechanical actuation (as applicable) | 3.4.6. | 4.5.9 |
| Hydraulic actuation (as applicable) | 3.4.6.3 | 4.5.10 |
| Solenoid test (as applicable) | 3.4.3.2 & 3.4.3.3 | 4.5.13.1 |
| Solenoid actuation (as applicable) | 3.4.6.4 | 4.5.11 |
| Noise (as applicable) | 3.5.5 | 4.5.6 |
| High and low temperature | 3.4.4.4 | 4.5.14 |
| **Group 2** | | |
| Endurance | 3.4.1.10 | 4.5.15 |
| Shock | 3.5.2 | 4.5.16 |
| Vibration | 3.5.3 | 4.5.17 |
| Fatigue (as applicable) | 3.5.7 | 4.5.21 |
| **Group 3** | | |
| Rerun internal leakage | 3.4.5.2 | 4.5.4 |
| Rerun flow sensitivity to differential pressure and viscosity | 3.4.5.4 | 4.5.5 |
| Rerun noise (as applicable) | 3.5.5 | 4.5.19 |
| Rerun manual, hydraulic, mechanical, or solenoid actuation (as applicable) | (See above) | (See above) |
| **Group 4** | | |
| Contamination sensitivity | 3.5.6 | 4.5.18 |
| Salt fog | 3.5.4 | 4.5.20 |
| Maintainability demonstration | 3.4.1.11 | 4.5.12 |

4.3 Conformance inspection. Conformance inspection shall consist of the tests specified in table II. These inspections shall be conducted on all valves except for noise test sampling procedure (see 4.5.7).

TABLE II. Conformance inspection.

| Tests | Requirements | Test methods |
|---|---|---|
| Examination | 3.4.1 & 3.4.2 | 4.5.1 |
| Proof pressure | 3.4.4.3 | 4.5.2 |
| Run-in/external leakage | 3.4.5.1 | 4.5.3 |
| Internal leakage | 3.4.5.2 | 4.5.4 |
| Manual actuation | 3.4.6.1 | 4.5.8 |
| Mechanical actuation | 3.4.6. | 4.5.9 |
| Hydraulic actuation | 3.4.6.3 | 4.5.10 |
| Solenoid tests | 3.4.3.2 | 4.5.13.2 |
| Solenoid actuation | 3.4.6.4 | 4.5.11 |
| Noise | 3.5.5 | 4.5.7 |

4.4 Test conditions.

4.4.1 Test fluid and fluid viscosity. The test fluid and the required fluid viscosity shall be as specified in the applicable specification sheet (see 3.1). For fluid viscosity at various temperatures, see 6.5.

4.4.2 Fluid contamination. Unless otherwise specified (see 6.2), the test fluid shall not exceed the component cleanliness requirements in accordance with MIL-STD-2193.

4.4.3 Test pressure. Unless otherwise specified in the applicable specification sheet (see 3.1) or specific test paragraph, the supply pressure shall not be less than 200 bars (2,900 psig) or more than 215 bars (3,100 psig), and the return pressure shall be atmospheric.

4.4.4 Test assembly. A valve shall be tested as a complete assembly, including solenoids, handles, and manual overrides. The valve assembly shall be mounted on a subplate for the H.I. shock, vibration, and noise (non-Grade B valves only) tests. The conformance inspection on valves, acquired with manifolds or subplates, may be conducted on the complete assembly.

4.5 Test methods. Test methods shall be in accordance with 4.5.1 through 4.5.21.

4.5.1 Examination. Each valve shall be subjected to a visual and dimensional examination to determine conformance with the requirements of this specification, applicable specification sheet (see 3.1), and manufacturer's valve assembly drawings.

4.5.2 Proof test. Each valve shall be hydrostatically tested in accordance with the requirements specified in 3.4.4.3. The pressure shall be applied to the P port with the cylinder ports blocked and the return port R connected to the reservoir or open to atmosphere. The test pressure shall be held for two minutes minimum in each valve position. The test pressure shall be relieved to system pressure or lower prior to shifting the valve. The test is repeated with the specified pressure on the return port R with pressure port P connected to the reservoir or open to atmosphere.

4.5.3 Run-in. Each valve shall be cycled at least 25 cycles at test pressure specified in 4.4.3. For conformance, each production valve shall be cycled at least 25 cycles by its normal control method of actuation. During this test, the general function of the valve shall be observed. External leakage shall not exceed the requirement of 3.4.5.1. Internal flow paths of valves and proper port markings shall also be confirmed.

4.5.4 Leakage test. Each valve assembly shall be tested for internal leakage under the conditions specified in 4.4.1 through 4.4.3 following the last cycle of the run-in exercise specified in 4.5.3. The first article and conformance leakage test shall be conducted in accordance with MIL-STD-2193. Failure to meet the requirements specified in 3.4.5.2 shall constitute a failure of this test.

4.5.5 Flow sensitivity to differential pressure and viscosity. The differential pressure shall be measured in the valve positions for which rated flow is required. A flow meter or other accurate means of measuring flow and pressure drop shall be utilized. The valves shall meet the flow and pressure drop requirements in the applicable specification sheet (see 3.1). The test fluid and viscosity for this test shall be in accordance with 4.4.1.

4.5.6 First article noise tests. Valves shall meet the structureborne noise requirements of 3.5.5 when tested under the conditions specified below and in the specification sheet (see 3.1). The maximum allowable one-third octave band structureborne noise level for these test conditions shall not exceed limits specified herein (see 3.5.5). If data taken in these tests indicate higher noise levels than specified for certain test conditions, additional tests shall be run in that area to ensure that the noise levels specified herein (see 3.5.5) are not exceeded.

4.5.6.1 Test conditions. Unless otherwise specified (see 6.2), the valves shall be tested in accordance with MIL-STD-2193, and the following conditions shall apply.

4.5.6.1.1 Frequency range. One-third octave band measurements shall be made over the frequency range between 10 Hertz and 20,000 Hertz.

4.5.6.1.2 Mounting of valves. Standard test subplates may be used in place of actual valve subplates, where appropriate for all noise testing.

4.5.6.1.3 Shift time. For transient noise tests, valves shall meet the shift times in 3.4.6 for transient noise tests using fluid that meets the noise testing fluid viscosity requirement in the applicable specification sheet (see 3.1). Manual and mechanical valves shall be shifted within one second.

4.5.6.1.4 Test positions. For three-position valves, the peak reading of the transient noise produced when shifting the valve shall be measured while shifting from the neutral position to all other positions and while shifting from all other positions to the neutral position. For two-position valves, the peak reading of the transient noise produced when shifting the valve shall be measured while shifting from one position to the second position and while shifting from the second position to the original position.

4.5.6.1.5 Blocked line test. This test shall only be performed as a first article inspection test in accordance with section 4.3. In this test, one cylinder line contains a relatively small trapped volume and the other cylinder line contains a larger volume representative of the fluid that might be in the system between the control valve and the actuator. For this test the return pressure shall be 60 psig maximum and the supply pressure shall be 2,800 psig minimum. Stroke limiters shall be set at their extreme positions to allow maximum spool motion. The cylinder port volumes specified in table III shall be used for blocked line tests.

TABLE III. Blocked line test cylinder port volumes.

| **Rated flow [gallons per minute (GPM)]** | **C1 port volume (cubic inches)** | **C2 port volume (cubic inches)** |
|---|---|---|
| 0 – 6.0 | 0 – 5 | 30 – 40 |
| 6.1 – 12.0 | 0 – 6 | 100 – 120 |
| 12.1 – 30.0 | 0 – 8 | 200 – 220 |
| 30.1 – 45.0 | 0 – 10 | 330 – 360 |
| 45.1 – 80.0 | 0 – 12 | 330 – 360 |
| Over 80.0 | 0 – 16 | 3,000 – 3,350 |

4.5.6.1.6 Shift at rated flow test. This test shall be conducted in accordance with the applicable specification sheet (see 3.1).

4.5.7 Conformance noise tests. Production valves that have structureborne noise requirements in accordance with 3.5.5 shall be tested in accordance with 4.5.6 to those requirements. Unless otherwise specified (see 6.2), the following sampling procedure for production valve noise testing shall be applied:

a. The first three valves of each part number shall be tested. Where different part number valves use the same spool or slide and sleeve assembly under identical specification flow test conditions, they may be grouped together and treated as a single part number.

b. If all three valves tested passed the noise test, then every fifth valve shall be noise tested.

c. If one of the valves tested failed the noise test and requires rework other than seal replacement, then the next five valves shall be tested. If all five of these valves pass the noise test, then every fifth valve shall be noise tested. If any of the five valves tested fail, the process shall be repeated until the requirement specified is met. Ambient noise measurements are not required for production valves.

4.5.8 Manual actuation. Each valve shall be actuated using manual control or manual override by applying force to the end of the operating handle through the operating range specified in 3.4.4.2, as applicable. Manual actuation of the valve shall satisfy the requirements specified in 3.4.6.1.

4.5.9 Mechanical actuation. Each mechanically operated valve shall operate within the limits specified in 3.4.6.3 by applying force to the valve stem to offset the valve from one position to another for the operating range specified in 3.4.4.2 with return pressure at atmospheric and 40 bars (580 psig). For conformance, the test shall be conducted with return pressure at atmospheric.

4.5.10 Hydraulic actuation. The differential pressure required to shift hydraulically operated valves shall be within the limits specified in 3.4.6. when tested with any return pressures up to 24 bars (350 psig). For conformance, the test may be conducted with return pressure at atmospheric. Hydraulically actuated valves shall shift within the time limits specified in 3.4.6.3 when the supply pressure is 2,500 psig ±100 psi and the return pressure is 100 psig ±40 psi. The beginning of the shift event is defined as the time at which the pilot line pressure near the valve reaches 250 psig, and the end of the shift event is defined as the time at which 95 percent of the total pressure increase or decrease is observed at one of the cylinder ports (CA or CB).

4.5.11 Solenoid actuation. Unless otherwise specified (see 6.2), valves controlled by a solenoid-operated pilot stage shall shift the main stage to its full offset position, as determined by a 95 percent pressure increase or decrease at one of the cylinder ports (CA or CB), within the maximum shift time and at the operating conditions required by the applicable specification sheet (see 3.1) after energizing the pilot stage solenoid. Unless otherwise specified (see 6.2), the valve main stage shall return to neutral, as determined by a 95 percent pressure increase or decrease at one of the cylinder ports (CA or CB), within the maximum shift time and at the operating conditions required by the applicable specification sheet (see 3.1) after de-energizing the solenoid.

4.5.12 Maintainability demonstration test. The maintainability requirements specified in 3.4.1.11 shall be demonstrated. The demonstration shall include time required to accomplish normal corrective maintenance actions and ease of disassembly/assembly. Failure to comply with any or all of the specified requirements shall result in rejection.

4.5.13 Solenoid tests.

4.5.13.1 First article tests. The following tests of SAE AS40401 shall be conducted as first article tests:

a. Group 1 tests (all)

b. Group 2 tests:

1. Vibration
2. Hi-impact shock
3. Life (solenoid shall be tested under normal valve operating loads and may be installed in a valve or test block with mass no greater than mass of valve which will utilize the solenoid)

c. Group 3 tests:

1. High temperature (altitude requirement not applicable)

2. Low temperature

NOTE: The vibration and shock tests specified herein may be substituted for the SAE AS40401 tests, and the number of samples may be reduced to three.

4.5.13.2 Conformance tests.

4.5.13.2.1 Insulation resistance. Solenoids shall be tested in accordance with Method 302 of MIL-STD-202 to ensure that the requirements of 3.4.3.2(d) are met. The following details shall apply:

a. Test condition B – test potential – 500 volts ±10 percent.

b. Point of measurement – between coil input leads and case.

4.5.13.2.2 Dielectric strength. The dielectric strength or withstanding voltage of solenoids shall be tested in accordance with Method 301 of MIL-STD-202 to ensure that the requirements of 3.4.3.2.f are met. The following details shall apply:

a. Magnitude of test voltage equals 1,500 volts root mean square (Vrms) plus rated voltage at 60 Hertz.

b. Nature of potential – AC rectified.

c. Duration of test voltage – 5 to 15 seconds (conformance); 60 seconds (first article).

d. Point of application of test voltage – between the coil input leads and case.

4.5.13.2.3 Voltage, current, and frequency. Each solenoid used shall be tested to ensure that the electrical features specified in 3.4.3.2.a, b, e, and g are met. The solenoid shall be assembled to the valve which is under operating pressure (see 4.4.3) and viscosity (see 4.4.1) at time of electrical tests.

4.5.14 High and low temperature. Unless otherwise specified in the applicable specification sheet (see 3.1), each valve shall be tested for operation at extreme fluid temperatures as follows:

a. High temperature operation. With the test system bled and charged to a supply pressure of 207 bars (3,000 psig), the entire set-up shall be maintained at 149±9 °F (65±5 °C), for not less than 3 hours. After this time, the valve shall be cycled by all means of actuation at least five times to ensure that no binding of moving parts occur.

b. Low temperature operation. The above test shall be repeated with the entire set-up maintained at 41 °F (5 °C) maximum. Pilot-operated valves shall not be required to meet the rate of operation specified in 3.4.6.4.

4.5.15 Endurance. Unless otherwise specified (see 6.2), valves shall be endurance tested to meet the 50,000 cycle replaceable parts requirement of 3.4.1.10. The valve shall be cycled under pressure (see 4.4.3) by its normal means of operation. For two-position valves, a cycle shall start with the spool at one position and shall consist of moving the valve spool to the second position and then returning the valve spool to the original position. The cycling rate for two-position valves shall not exceed 19 cycles per minute. For three-position valves, a cycle shall start with the spool in the center position and shall consist of moving the valve spool to one fully offset position, then to the other fully offset position and back to the center position. The cycling rate for three-position valves shall not exceed 12 cycles per minute to permit pressure to reach its maximum value and hold for a minimum of 2 seconds.

4.5.16 High shock test. The valve shall be subjected to the Grade A, Class 1 shock test specified in MIL-STD-2193.

4.5.17 Vibration. The valve shall be vibration tested up to and including 50 Hertz in accordance with MIL-STD-2193.

4.5.18 Contamination sensitivity. Valves shall be tested in accordance with MIL-STD-2193 with the test fluid and viscosity specified in 4.4.1 and pressure specified in 4.4.3. Additionally, the valve shall be installed in such manner to permit flow to at least one cylinder port (CA or CB) when actuated, and the system shall be cleaned to the specified level with the test valve isolated from the system and its bypass valve open. With the system cleaned to the specified level and with the filter on line, the valve shall be actuated at 6 cycles per minute for 60 minutes. At the completion of the run-in period, the valve performance level shall be measured as specified in herein. The filter shall then be bypassed and the first contaminant sample injected. The valve shall remain in the continuous flow position without cycling for 30 minutes. The valve performance level shall be measured, then the filter shall be replaced on line and the system shall be operated in the cleaning mode for 30 minutes. The sequence shall be repeated until all contaminant samples have been injected. The valve performance level shall be measured as follows:

a. For all manually and mechanically operated valves, the force to move the spool shall be measured at the intervals specified in 3.5.6. For a valve with an operating handle, the force shall be measured at the end of the handle.

b. For valves that are hydraulically operated, the pilot pressure to shift the spool shall be measured at the intervals specified in 3.5.6.

c. For solenoid-operated valves, a measurement of pressure (at CA or CB port), flow, position, or other means (see 6.2) versus time shall be obtained. The measurement shall be sufficient to analyze the opening transient response in detail.

4.5.19 Noise retest requirements. At the conclusion of Group 1 and 2 tests, each first article valve shall be noise tested in accordance with the applicable testing procedure of 4.5.6. If the valve's noise level has increased above the allowable levels, the manufacturer shall disassemble the valve to determine why the noise level increased. The correction shall be made and the noise test repeated until the allowable noise levels are obtained.

4.5.20 Salt fog. The salt fog test shall be conducted in accordance with MIL-STD-2193. The salt concentration for the water used for testing shall be 5±1 percent. The valve shall be set up in its normal operating mode. The duration of the test shall be 48 hours with a period of 24 hours wet and 24 hours drying. After completion of testing and cleaning, the solenoid shall be examined for compliance to 3.5.4 and the voltage insulation test of table I shall be performed. The valve shall be considered to have failed this test if it does not meet any of these requirements.

4.5.21 Fatigue. When specified herein, the fatigue test shall be conducted in accordance with NFPA T2.6.1 to verify compliance to 3.5.7.

## 5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of material is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

## 6. NOTES

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

6.1 Intended use. The valves covered by this specification are intended for use in shipboard hydraulic systems utilizing petroleum base hydraulic fluids.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.

b. Title, number and date of the applicable specification sheet.

c. The specific issue of individual documents referenced (see 2.2.1 and 2.2).

d. When first article is required (see 3.2).
e. If pin locks and guards are required (see 3.4.1.8).
f. Nameplate and indicator plate data required (see 3.4.1.12).
g. Mounting requirements, if other than specified (see 3.4.1.1 and 3.4.2.2).
h. Flow pattern requirements, if other than specified (see 3.4.1.3).
i. Interflow requirements, if other than specified (see 3.4.1.4).
j. Manual operation requirements, if other than specified (see 3.4.1.5).
k. Solenoid operation requirements, if other than specified (see 3.4.1.7).
l. Manual overrides requirements, if other than specified (see 3.4.1.8).
m. Hydraulic pilot operation requirements, if other than specified (see 3.4.1.9).
n. Normal corrective maintenance action time requirements (see 3.4.1.11).
o. Valve envelope requirements, if other than specified (see 3.4.2.1).
p. Solenoid type, if other than specified (see 3.4.3.2).
q. Hydraulic fluid compatibility requirements (see 3.4.4.1).
r. Maximum allowable external leakage, if other than specified (see 3.4.5.1).
s. Mechanical actuation requirements, if other than specified (see 3.4.6.3).
t. Solenoid actuation requirements, if other than specified (see 3.4.6.4 and 4.5.11).
u. Ambient pressure range requirements, if other than specified (see 3.5.1).
v. Required structureborne noise levels (see 3.5.5).
w. Test circuit for contamination sensitivity test, if other than specified (see 3.5.6).
x. Sequence of tests within a first article inspection group, if required (see 4.2).
y. Fluid contamination requirements, if other than specified (see 4.4.2).
z. Conformance noise test, if other than specified (see 4.5.7).
aa. Endurance requirements, if other than specified (see 4.5.15).
bb. Contamination sensitivity test measurement (see 4.5.18.c).
cc. Test condition requirements, if other than specified (see 4.5.6.1).
dd. Packaging requirements (see 5.1).

6.3 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 set of production items (number in set to be determined by the contracting officer), or a standard production item from the contractor's current inventory (see 3.2), and the number of items to be tested as specified in 4.3. 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 a product which has been previously acquired or tested by the Government and that bidders offering such products, who wish to rely on such production or rest, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation.

6.3.1 First article and drawing approval. For items which will be used on U.S. Navy ships, first article and drawing approval by the Hydraulics Control System and Component Standardization branch of the Naval Sea Systems Command (NAVSEA 05Z46) is required. Acquisition activities will not be required to obtain and submit first article test reports and drawings to NAVSEA when the offeror provides evidence that the item being offered has been approved by NAVSEA and the offeror attests that such approval is still valid and has not been rescinded. Any changes to the revision of a drawing approved by NAVSEA will require resubmittal for NAVSEA review and approval of the change and any applicable first article test requirements resulting from the change. Unless otherwise specified in the contract, drawings and first article test reports may be submitted to NAVSEA by either the acquisition activity or the offeror. When an offeror wishes to obtain first article approval on similar items, he may submit a first article test report for NAVSEA approval in which the number of tests is minimized in order to eliminate duplicate testing of identical and similar items. Offerors wishing to obtain first article approval on a whole family of similar valves are encouraged to submit a test plan for approval in advance of testing. If a test plan has been approved in advance of testing, first article test reports should cite the test plan as the basis for approval by extension. Whenever approval based on extension from a previous test is requested, the test report from which extension is sought must be identified. The test report from which extension is requested need not be submitted with the request for extension but must be provided when requested by the approving activity.

6.3.1.1 Extension of first article tests. In general, NAVSEA will consider approval of the following extensions of tests between similar valves. Where extension approval is believed to be warranted, despite the fact that one or more extension conditions cannot be fulfilled, a full explanation of why extension should be granted should be provided for NAVSEA consideration. This explanation should be accompanied by supporting documentation (e.g., an analysis). If the equipment size and weight impedes excitation by environmental vibration then an analysis may be submitted to NAVSEA for approval showing the equipment or machinery response is outside the excitation frequency range specified in 4.5.17, such that environmental vibration testing is not warranted.

a. Proof pressure. Extension will be considered when pressures, areas subject to pressure, and fasteners and parts used to contain the pressure are equivalent.

b. Leakage. Extension will be considered when the parts subject to leakage are the same as those used in the tested assembly.

c. Flow sensitivity to differential pressure and viscosity. Extension will be considered when the valves use the same spool and sleeve assembly.

d. Actuation. The various types of actuation tests can be considered for extension when the actuators are basically identical and the valve spool is of the same diameter as in the tested assembly.

e. Noise. Extension of noise tests from tested assemblies will be considered when the slide and sleeve assembly is the same as in a tested assembly and the test conditions for fluid, temperature, and flow rate are identical.

f. High and low temperature. Extension requirements will be subject to review, but it is expected that extension will be considered when the method of actuation and the spool/sleeve configuration is similar and the spool diameter is identical to the tested item.

g. Endurance. While this is subject to specific review, it is expected that extension may be possible from testing a solenoid-operated valve of each size.

h. High shock. It is expected that extension from the test of a valve of each type of actuation and size will be considered.

i. Vibration. It is expected that extension from the test of one solenoid-operated valve and one manually-operated valve of each size will be considered.

j. Contamination sensitivity. Extension from testing one solenoid-operated and one hydraulically operated valve for each size spool will be considered.

k. Fatigue. The similarity between the tested valve and items to be extended on the basis of similarity will be carefully reviewed. Items with similar bodies will be considered for extension.

l. Salt fog. Extension will be considered for similar equipment with the same base and coating materials and equivalent coating thickness.

m. Solenoid continuous duty test. The solenoid continuous duty test for a solenoid will be considered for extension to any valve assembly on which the solenoid is used.

6.3.2 Disposition of first article samples. Unless otherwise prohibited by the contract, the offeror may deliver first article items which meet or have been refurbished to meet the specification requirements for new items except those pressure containing items (bodies, end caps, fasteners, seals, etc.) that have been subjected to a fatigue test must not be used. Items subjected to fatigue testing must be marked as not suitable for use. Items that do not meet the specification requirements (including noise) for new items should not be installed in shipboard applications.

6.4 Material safety precautions. The application of the dielectric strength test of 4.5.13.2.2 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 should be in accordance with the original manufacturer's recommendations but not less than 500 V.

6.5 Fluid viscosity - fluid temperature data. The test conditions specified in the specification sheets are stated in terms of fluid viscosity since the viscosities of the fluids specified for testing can vary by 10 percent or more at 104 °F (40 °C). The manufacturer may determine test temperature based on viscosity test of the fluid being used. However, in order to facilitate testing and minimize the necessity for determination of test temperature based on actual fluid viscosity, the Government will accept test data for viscosity requirement identified below without data showing actual fluid viscosity. The manufacturer must periodically verify that the actual viscosity is within the applicable specification requirements for the fluid being used.

TABLE IV. Acceptable fluid temperature range.

| Viscosity requirement | MIL-PRF-17672 (2075-T-H) | MIL-PRF-17331 (2190 TEP) |
|---|---|---|
| 50 centistokes (maximum) | Above 85 °F (29 °C) | Above 125 °F (52 °C) |
| 75 centistokes (maximum) | Above 70 °F (21 °C) | Above 110 °F (43 °C) |
| 75 to 97 centistokes | 65 to 70 °F (18 to 21 °C) | 104 to 110 °F (40 to 43 °C) |

6.6 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.

6.7 Drawing recommendations. The specification sheets identify all technical requirements and ensure interchangeability of various manufacturers' valves. Therefore, drawings are not normally required for reacquisition purposes. Data is recommended which will permit emergency repair of the valves when the manufacturer is unable to repair or provide repair parts within the required time. Accordingly, only limited technical data rights are required when the items being acquired are completely identified by the specification sheets. Level 3 drawings are not required for proprietary quieting technology except as necessary to permit emergency repair. A contractor with the right to furnish limited data may furnish such limited data directly to the Government rather than through the prime contractor.

6.8 Existing valve designs. To minimize the frequency of new valve development projects, the valve ordering activity or their designated agent should compare the features of an existing Navy valve design to the requirements of this specification to determine compliance. Minor modifications of existing Navy valve designs that neither impair component form, fit, or function (such as a pilot valve pinlock feature) nor violate the requirements of this specification similarly should be evaluated to determine compliance.

6.9 Definitions.

6.9.1 Differential pressure. The difference between the supply pressure and the return pressure.

6.9.2 Four-way valve. Four-way valves consist of four ports: P, R, CA, and CB.

6.9.3 Three-way valve. Three-way valves consist of three ports: P, R, and CA.

6.9 Subject term (key word) listing.

Control valve

Hydraulic component

Hydraulic control

Hydraulic operated

Solenoid-operated

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

Preparing Activity:
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NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.