

Qualifications for Four-Way Subbase Mounted Air Valves for Automotive Manufacturing Applications

Foreword—This document has also changed to reflect the new SAE Technical Standards Board format. Definitions have been changed to Section 3. All other section numbers have changed.

1. Scope—This SAE Recommended Practice describes the requirements necessary for four-way subbase mounted, directional air-control valves to be used in automotive manufacturing applications. It includes minimum performance, operation, and physical requirements to qualify the valves for service in automotive manufacturing applications. Included are spool, poppet, and sliding disc types of air valves for pressures in a range of vacuum to 1034 kPa (150 lb/in²) gage, and temperatures from –18 to 60 °C (0 to 140 °F).

1.1 Rationale—This revision of SAE J2051 incorporates changes to the contaminant, the original of which was found to cause coagulation in the components tested. The revised contaminant is a mixture of 75% iron filings and 25% ferric(ous) oxide; whereas the previous contaminant was 100% ferric(ous) oxide. In addition, the amount of water injected is increased; and a prescribed schedule of injecting these contaminants is provided.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein.

2.1.1 ANSI AND ISO PUBLICATIONS—Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036.

ANSI B93.55M-1981 (R1988)—Hydraulic Fluid Power—Solenoid Piloted Industrial Valves—Interface Dimensions for Electrical Connectors

ANSI B93.9M-1969 (R1988)—Symbols for Marking Electrical Leads and Ports on Fluid Power Valves

ANSI/NEMA ICS-6-1988—Enclosures for Industrial Control and Systems, NA.

ANSI/(NFPA) T3.21.3-1990—Pneumatic Fluid Power—Flow Rating Test Procedure and Reporting Method—For Fixed Orifice Components

ANSI/(NFPA) T3.21.8-1990—Pneumatic Fluid Power—Measurement of Response Time—Directional Control Valves

ANSI/UL 429-1988—Electrically Operated Valves

ISO 5599-1, Second Edition 1989—Pneumatic fluid power—Five port directional control valves—Part 1: Mounting interface surfaces without electrical connector

ISO 5599-2, First Edition, 1990—Pneumatic fluid power—Five port directional control valves—Part 2: Mounting interlace surfaces with electrical connector

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- 2.1.2 **MILITARY STANDARDS**—Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL Standard 202F, Method 303, 6 February 1956—DC Resistance

2.2 Other Publications

Ford NE2-1, December 1989—Pneumatic Valves, Four-Way Solenoid Operated, Common Sub-base Type (copy of this document is available from SAE Referee Materials/Engineering Aids as EA-20. Copies can be obtained by placing an order through Customer Sales and Satisfaction, SAE World Headquarters, 400 Commonwealth Drive, Warrendale, PA 15096-0001.)

3. Definitions

- 3.1 Rated Pressure**—The maximum pressure for which a valve is stated to operate for a specified number of cycles.
- 3.2 Rated Flow**—The average of flow rates passing through each of the four flow paths in the direction normally used for a single-pressure supply application, with a specified pressure applied at the entrance to each flow path and the discharge passing to the atmosphere. This definition is provided for leakage testing methods.
- 3.3 Rated Voltage**—The nominal voltage stated for operation of a solenoid.
- 3.4 Test Chamber**—A vessel of measured volume capable of statically containing an imposed pressure.
- 3.5 Output Volume**—The sum of volumes used in a response test, composed of the test chamber, its connecting conductors, fittings, and the pressure transducer. Internal volume of the valve under test is not included.
- 3.6 Solenoid Enclosure**—The means by which a solenoid is contained on a valve. It can be a removable cover into which the winding is placed or an encapsulated winding that is fastened without a cover.
- 3.7 Flow Coefficient (C_v)**—A dimensionless parameter that represents the flow capacity of a fixed orifice device. For compressed air valves, the parameter is nearly constant among the interdependent variables of system pressure, temperature, atmospheric pressure, flow rate, and a limited pressure drop across the valve.

4. Electrical Requirements

- 4.1 Voltage**—Electrically operated valves will use one of the following rated voltages:

120/60 AC (v/Hz)	12 DC (v)
110/50 AC (v/Hz)	24 DC (v)
	48 DC (v)

Valves shall be capable of operation at +10% or –15% of the rated voltage, in accordance with the conditions in 4.4.

4.2 External Electrical Connections

- 4.2.1 Electrically operated valves will have provisions to receive an electrical connection from one of the following means:

- a. A potted, oil tight, 5-pin connector in conformance with ANSI B 93.55, and design variations thereof. Pin numbers 1 and 5 shall be connected to solenoid number 14 or B; pin numbers 2 and 4 shall be connected to solenoid number 12 or A (if a second solenoid is provided on the valve, see Figure 1). Pin number 3 shall be connected into the ground path.
- b. A junction box enclosure with a threaded conduit port: Wire leads for field connection shall not be less than 1624 cmil (18 AWG) and shall extend at least 150 mm (6 in) beyond the cover surface. The enclosure shall be of adequate size to accommodate all leads and reasonably sized connections.

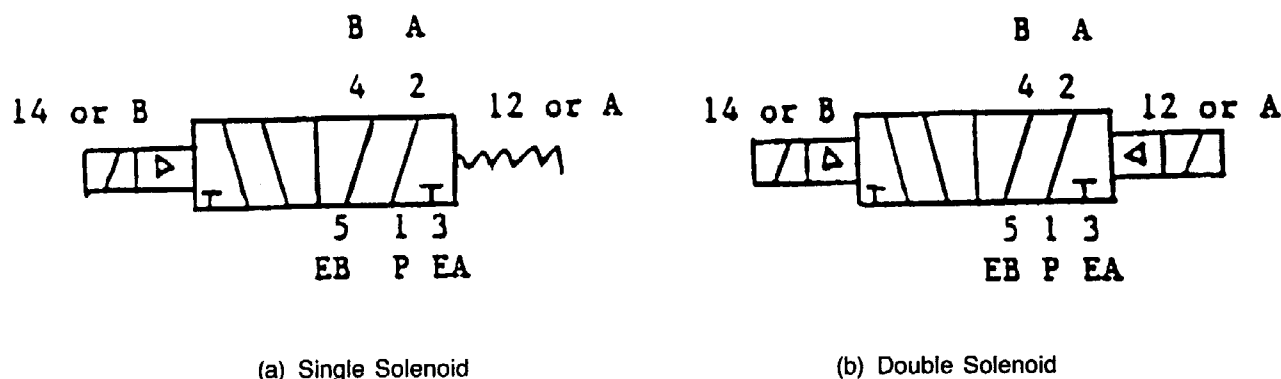


FIGURE 1—SOLENOID IDENTIFICATION

- 4.2.2 Solenoid leads for either the 5 pin connector or the field connection may be of any color except green. A communication indicating their solenoid source must be provided from one of the following:
- a. Observation of the leads emanating directly from the solenoid
 - b. Color-coded leads with a nameplate affixed on the valve identifying the solenoid source
 - c. Markings on the leads (12, 14, A, B) identifying the solenoid source
- 4.2.3 The following wires may not be less than 1624 cmil (18 AWG) in size: leads integral to a solenoid; field connecting leads; spliced leads between an indicator light and its connecting wire; and ground wires. The following internal wires may not be less than 642 cmil (22 AWG), providing their normal current load does not exceed 1 amp: wiring between pin/socket connection; wiring that terminates at a circuit board; and internal circuit connections that are not disconnected during valve field maintenance. Applications not defined previously shall not be less than 1624 cmil (18 AWG). All wiring is to have an insulation temperature rating of not less than 105 °C.

4.3 Grounding

- a. Each solenoid in a valve shall have an electrical conducting path from its magnetic frame to a ground connection. This ground connection may be in a common location for valves mounted in a stack, provided that the resistance of the conducting path from the farthest frame is no greater than 50 mΩ, measured in accordance with MIL Standard 202F, Method 303.
- b. A ground connection terminated inside a junction box enclosure of the valve assembly shall have a green, slotted hex-head type screw, not less than #6–32 in size.
- c. A ground circuit conductor from a terminal pin on a connector or plug must be green and must be at least 1624 cmil (18 AWG), or larger, in diameter. It shall be attached to a terminal screw in the valve.
- d. If the ground circuit is through a disconnect plug, the ground circuit must make first and break last, relative to the other circuits.

4.4 Solenoid Characteristics—Solenoids must comply with the following requirements:

- a. Valve must not be electrically operable if the solenoid enclosures are removed.
- b. Captive type fasteners and seals must be used on covers that enclose wire terminals. Covers must also have a suitable means of attachment to prevent their loss when opened.
- c. Nonprotruding, nonlocking overrides shall be operable without removal of any covers, and positioned to require the use of a tool to operate.
- d. Solenoids shall be capable of compliance with the requirements of NEMA Standard ICS-6, Enclosure Type 2 (indoor, nonhazardous, protection against falling dirt, liquids, and light splashing).
- e. The sound level of a solenoid (quiet hold) at a distance of 610 mm (2 ft) when energized at 85% of rated voltage, with rated pressure if normally open, without pressure if normally closed, will not be greater than when measured under the same conditions when energized at full rated voltage.
- f. When a solenoid is held energized at rated voltage until equilibrium temperatures are attained, and installed as described in paragraph 25.6 of ANSI/UL 429, the temperature rise (using the rise of resistance method) shall not exceed the limits as described in Table 25.1 of ANSI/UL 429. Only one solenoid need be energized for single subbase valves; but three solenoids adjacent to each other shall be simultaneously energized in manifolded valves and the center one tested for compliance if solenoid operated, manifolded valves are to be qualified.

5. Physical Description

5.1 Valve bodies shall be mounted on a subbase, into which all of the connecting pressure conduits are fastened. (However, remote pilot operators may have their signal ports located in their end caps.) The interface surface of these bases shall conform to ISO 5599-1 or ISO 5599-2, dated 1989-1990 (either with or without an electrical plug at the interface); or to Ford NE2-1, dated 1989 (Automotive Interface). The quality of the base surface of either type shall conform to the requirements of ISO 5599-1 or ISO 5599-2.

5.2 Sealing means between the interface shall be captive to the valve body.

5.3 Ports in the base shall be identified by numbers per ISO 5599-1 or ISO 5599-2 or by letters per ANSI B 93.9M-1969. The port identifiers may be located either in the base, adjacent to the ports or on the body in such a location that provides a direct association with the ports.

5.4 Operators shall be identified as 14 and 12, or B and A. They shall position the valve elements to connect the flow paths as shown in Figure 1.

5.4.1 Single solenoid operators shall be identified as number 14 or letter B and, when energized, shall connect ports 1 with 4, or P with B; unless specified differently between customer and supplier.

5.4.2 Double solenoid valves shall have one solenoid identified as number 14 or letter B and, when last energized, shall connect ports 1 with 4, or P with B. A second solenoid shall be identified as number 12 or letter A and, when last energized, shall connect ports 1 with 2, or P with A.

6. Performance Requirements

6.1 Flow Rating—The entire valve assembly, and the separate base, shall each be rated for flow, for each flow path.

6.1.1 VALVE MOUNTED ON A SINGLE SUBBASE—When tested as described in ANSI/(NFPA) T3.21.3-1990, the flow coefficient (C_v) shall not be less than the values in Table 1:

TABLE 1—VALVES MOUNTED ON SINGLE SUBBASE MINIMUM C_v VALUE

Port	Automotive Interface 075	Automotive Interface 125	Automotive Interface 250	Automotive Interface 500	Automotive Interface 1000	ISO Interface 1	ISO Interface 2	ISO Interface 3	ISO Interface 4
1/8	0.75	—	—	—	—	—	—	—	—
1/4	1.00	1.5	—	—	—	1.0	—	—	—
3/8	—	2.0	3.0	—	—	1.0	1.8	—	—
1/2	—	—	5.5	7.0	—	—	2.0	3.2	4.2
3/4	—	—	—	8.5	—	—	—	4.0	6.0
1	—	—	—	9.5	14.0	—	—	—	—
1-1/4	—	—	—	—	17.5	—	—	—	—

- 6.1.2 VALVE BASE—With a test cap mounted to the interface surface as described in 6.1.3, and using the test circuit as described in 6.1.4, the flow coefficient (C_v) through the single subbase shall not be less than the values specified in Table 2.

TABLE 2—BASE WITHOUT VALVE BODY MINIMUM C_v VALUE

Port	Automotive Interface 075	Automotive Interface 125	Automotive Interface 250	Automotive Interface 500	Automotive Interface 1000	ISO Interface 1	ISO Interface 2	ISO Interface 3	ISO Interface 4
1/8	1.1	—	—	—	—	—	—	—	—
1/4	1.5	2.3	—	—	—	1.5	—	—	—
3/8	—	3.0	4.5	—	—	1.5	2.7	—	—
1/2	—	—	8.2	10.5	—	—	3.0	4.8	6.3
3/4	—	—	—	12.7	—	—	—	6.0	9.0
1	—	—	—	14.2	21.0	—	—	—	—
1-1/4	—	—	—	—	26.2	—	—	—	—

- 6.1.3 TEST CAP—Provide a test cap for each size of interface as described in Figure 2. (A set of drawings for these test caps is available from SAE Referee Materials/Engineering aids as EA-21 Designs of Test Caps) (SAE of 26 Drawings) by placing an order through Customer Sales and Satisfaction, SAE World Headquarters, 400 Commonwealth Drive, Warrendale, PA 15096-0001.)

Orient test blocks 1 and 2 over the flow path to be tested and position blocks 3 and 4 to take up the spacing. Plug the ports in the base not tested, including pilot ports.

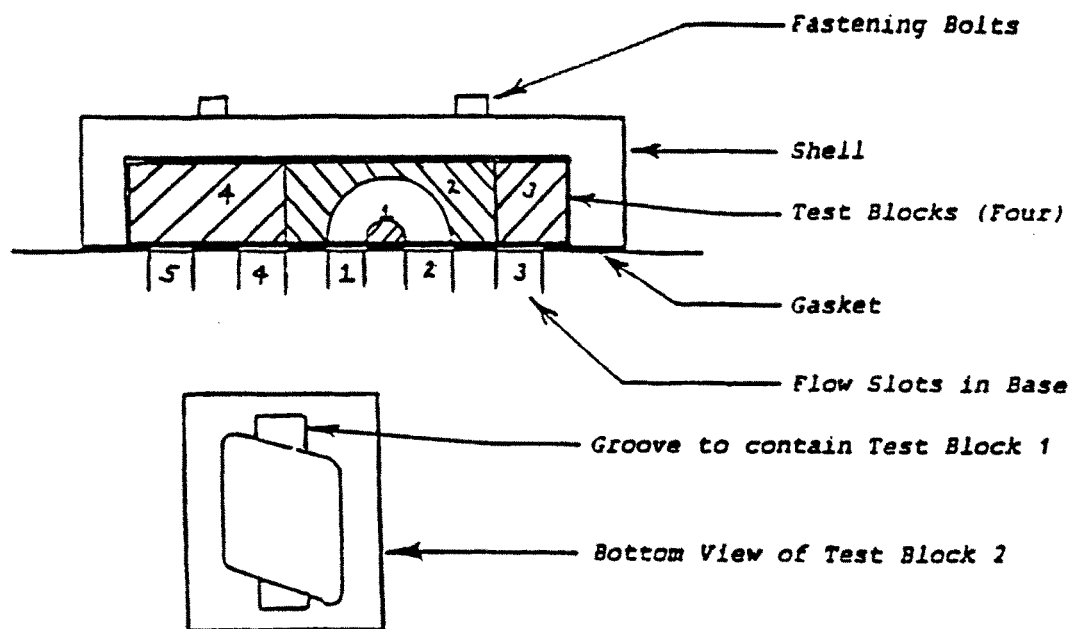


FIGURE 2—TEST CAP

- 6.1.4 **TEST CIRCUIT**—Install bases in a manner that provides an in-line arrangement of the flow path. Use the flow tubes described in ANSI/(NFPA) T3.21.3-1990, with fittings, as shown in the connection arrangements of Figure 3.

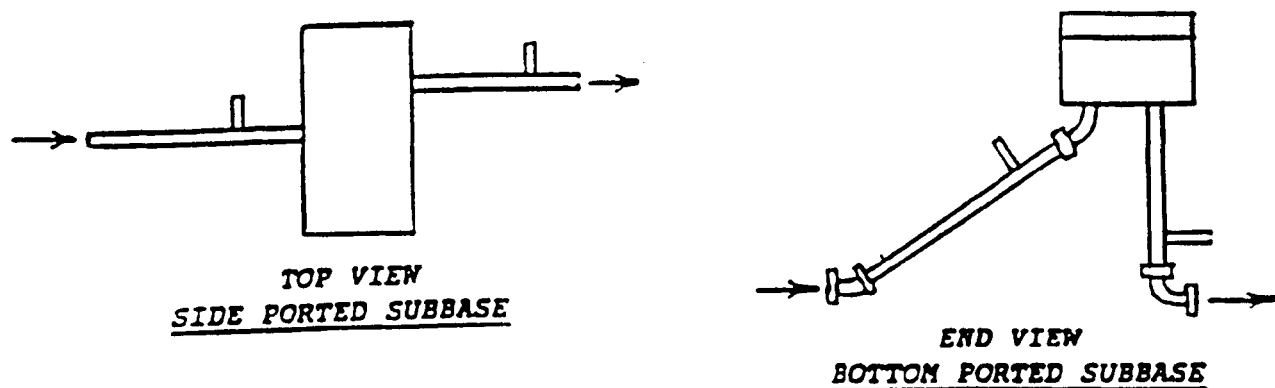


FIGURE 3—TEST CONNECTIONS

- 6.2 **Response Time**—Single solenoid valves shall be tested for response time in accordance with ANSI/(NFPA) T3.21.8-1990, except that the supply reservoir shall be maintained at 414 kPa (60 lb/in²) gage. Response time at the specified volume shall not exceed the values listed in Tables 3 and 4.

**TABLE 3—MAXIMUM RESPONSE TIME (MILLISECONDS)—
AUTOMOTIVE INTERFACE 414 kPa (60 psi) INLET PRESSURE⁽¹⁾**

Base Port With SCH-40 Pipe	Output Volume Liters (in ³)	Size 075 T _F	Size 075 T _E	Size 125 T _F	Size 125 T _E	Size 250 T _F	Size 250 T _E	Size 500 T _F	Size 500 T _E	Size 1000 T _F	Size 1000 T _E
1/8	0	—	—	—	—	—	—	—	—	—	—
	0.41 (25)	—	—	—	—	—	—	—	—	—	—
1/4	0	20	20	60	60	—	—	—	—	—	—
	0.41 (25)	120	280	100	230	—	—	—	—	—	—
3/8	0	—	—	60	60	100	90	—	—	—	—
	0.82 (50)	—	—	180	420	150	170	—	—	—	—
1/2	0	—	—	—	—	60	80	60	70	—	—
	1.64 (100)	—	—	—	—	120	280	110	120	—	—
3/4	0	—	—	—	—	—	—	60	70	—	—
	1.64 (100)	—	—	—	—	—	—	100	280	—	—
1	0	—	—	—	—	—	—	60	70	80	80
	3.28 (200)	—	—	—	—	—	—	120	250	110	170
1-1/4	0	—	—	—	—	—	—	—	—	80	80
	3.28 (200)	—	—	—	—	—	—	—	—	110	280

1. Response times will be longer at higher inlet pressures.

**TABLE 4—MAXIMUM RESPONSE TIME (MILLISECONDS)—
ISO INTERFACE 414 kPa (60 psi) INLET PRESSURE⁽¹⁾**

Base Port With SCH-40 Pipe	Output Volume Liters (in ³)	Size 1 T _F	Size 1 T _E	Size 2 T _F	Size 2 T _E	Size 3 T _F	Size 3 T _E	Size 4 T _F	Size 4 T _E
1/8	0	—	—	—	—	—	—	—	—
	0.41 (25)	—	—	—	—	—	—	—	—
1/4	0	100	110	—	—	—	—	—	—
	0.41 (25)	230	290	—	—	—	—	—	—
3/8	0	100	110	60	60	—	—	—	—
	0.82 (50)	300	380	130	200	—	—	—	—
1/2	0	—	—	130	140	100	110	80	80
	1.64 (100)	—	—	260	320	180	210	140	160
3/4	0	—	—	—	—	40	70	200	200
	1.64 (100)	—	—	—	—	130	180	260	270
1	0	—	—	—	—	—	—	—	—
	3.28 (200)	—	—	—	—	—	—	—	—

1. Response times will be longer at higher inlet pressures.