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SURFACE VEHICLE RECOMMENDED PRACTICE

An American National Standard

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QUALIFICATIONS FOR FOUR-WAY SUBBASE MOUNTED AIR VALVES FOR AUTOMOTIVE MANUFACTURING APPLICATIONS

***Foreword*—**This Document has not changed other than to put it into the new SAE Technical Standards Board Format.

***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/in^2) gage, and temperatures from –18 to 60 °C (0 to 140 °F).

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, 11 West 42nd 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 interace surfaces with electrical connector

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 1956DC Resistance

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2.1.3 OTHER PUBLICATIONS—Ford NE2-1, December 1989Pneumatic Valves, Four-Way Solenoid Operated, Common Sub-base Type (on file at SAE Headquarters)

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

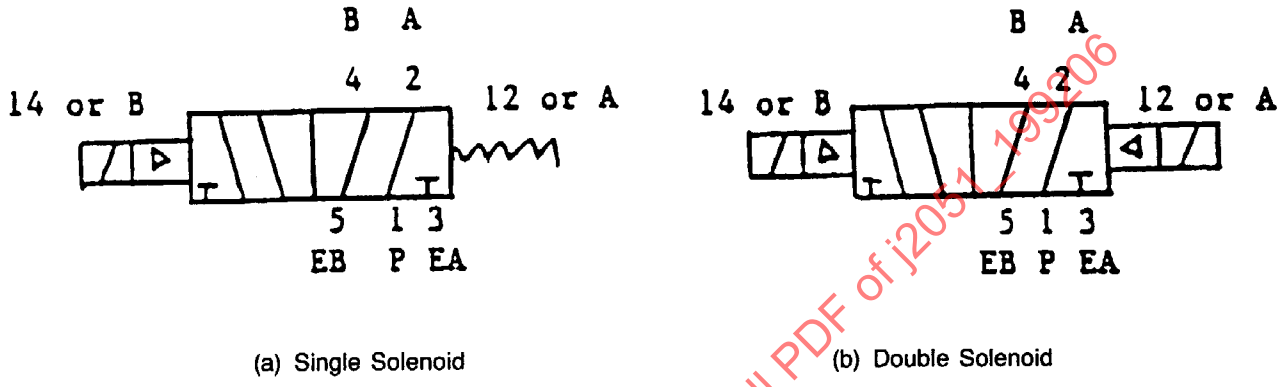
4.2.1 Electrically operated valves will have provisions to receive an electrical connection from one of the following means:

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 selenoid 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.

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



(a) Single Solenoid (b) Double Solenoid

FIGURE 1—SOLENOID IDENTIFICATION

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. (Designs of test caps are available from SAE Headquarters.)

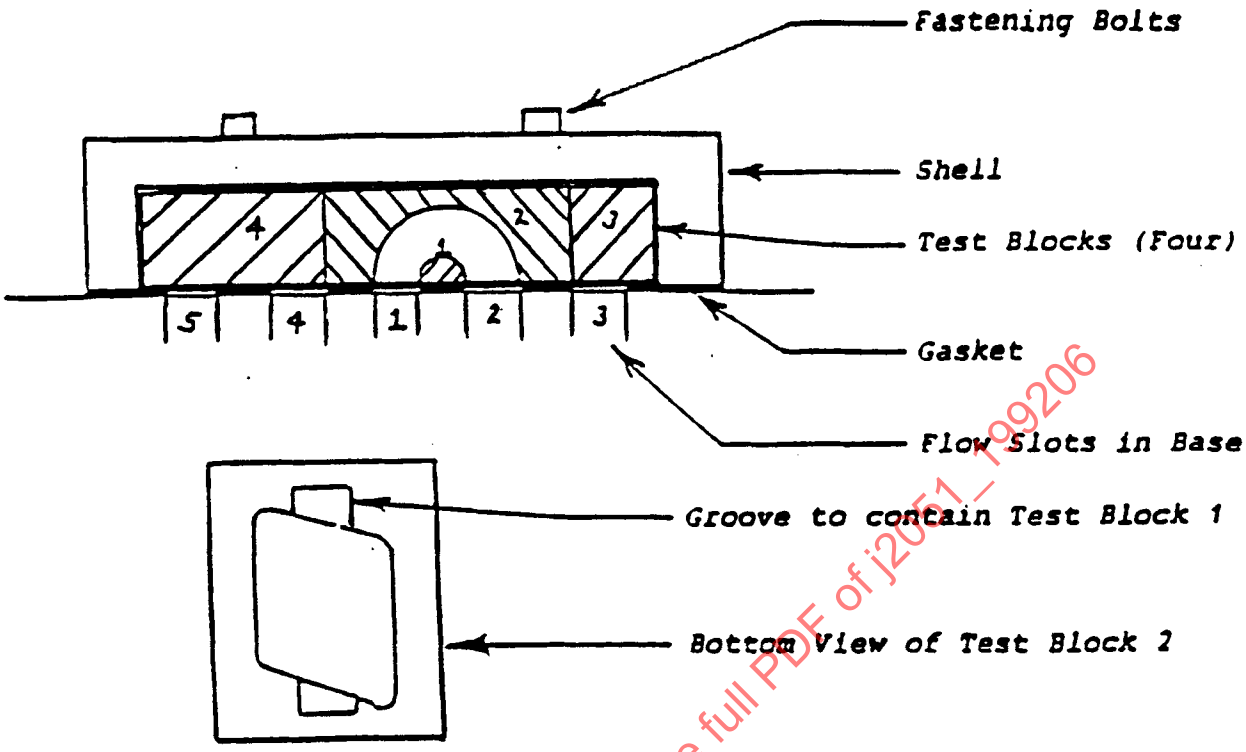


FIGURE 2—TEST CAP

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.

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.

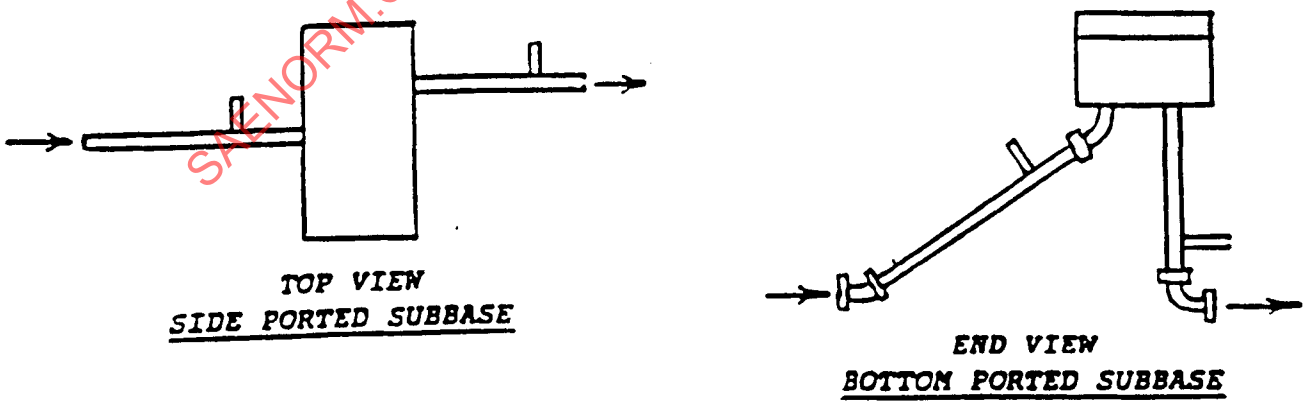


FIGURE 3—TEST CONNECTIONS

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/in^2) 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.

6.3 Minimum Shift Pressure—Valves with nominal or unspecified detents, in a new condition, shall have a shift pressure no greater than 241 kPa (35 lb/in^2) gage for the single solenoid or single air operator, when tested under the following conditions:

a. Lubrication shall be only that which is applied at the time of valve assembly.
b. Four sample valves shall be pressurized at their maximum rated levels; two in energized and two in de-energized positions, all for 65 h.
c. Pressure will then be slowly reduced to zero.

NOTE—Energized spring return valves may perform a return shift at this step.

d. Operators on the sample valves, without pressure, will be either energized or de-energized to change into a state opposite that which they previously occupied.
e. Pressure to both inlet and pilot will then be slowly increased to the minimum level.
f. Compliance is judged satisfactory if all four valves perform their respective shifts or returns, and leakage does not occur from the exhaust ports in excess of that specified in 6.4.

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)	—	—	—	—	—	—	—	—
1-1/4	0	—	—	—	—	—	—	—	—
	3.28 (200)	—	—	—	—	—	—	—	—

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

6.4 Standby Leakage Rate—Valves in a new condition at room ambient temperature shall be leak tested at both their maximum rated pressure and at their minimum shift pressure, both energized and de-energized, as follows:

a. Determine the internal volume of each pressurized flow path (including pilot areas if they are pressurized from the flow path). Select an inlet chamber for use in testing that is between ten and fifteen times as large as the internal volume of the pressurized flow path. Install a pressure measuring device whose smallest marked increments are not greater than 14 kPa (2 psig). Assemble all items in a test circuit as shown in Figure 4 and determine the internal volume of the connecting plumbing. Add all volumes together to constitute a test volume.

b. For each pressurized flow path in the valve, admit the rated pressure from the inlet and allow a 2 min thermal stabilization time. Then close the shutoff valve and remove the inlet source to isolate the test circuit. Record the pressure in the test chamber at the time of inlet removal, and after a time interval of not less than 15 min.

During the time interval, check the inlet opening, the shutoff valve seal joints and all plumbing connections for leaks. The test is invalid if any occur.

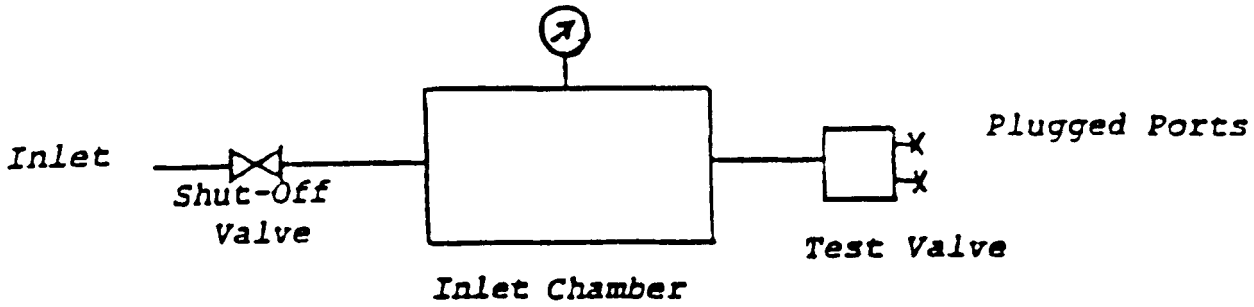


FIGURE 4—TEST CIRCUIT

c. Calculate the leakage rate of the test valve as follows:

$$Q = \frac{V}{t}\left[\frac{P_1 - P_2}{P_a}\right] \quad \text{(Eq. 1)}$$

where:

Q = leakage rate
V = test volume
t = time interval for test
P_1 = initial inlet pressure (absolute)
P_2 = final pressure at time "t" (absolute)
P_a = atmospheric pressure (absolute)

Leakage is judged acceptable if it does not exceed 0.06% of the rated flow of the valve at 621 kPa (90 lb/in^2) gage supply for each pressurized flow path. An example is a valve rated 47.2 dm^3/s ANR (100 SCFM) could have a 0.0283 dm^3/s ANR (3.6 SCFH) leakage rate.

d. Repeat the test at 241 kPa (35 psig), maintaining the same criteria and conditions as above.

6.5 Endurance Life

6.5.1 GENERAL REQUIREMENTS—Two single solenoid valves and two double solenoid valves of each base series shall be subjected to a 20 million cycle endurance test at 621 kPa (90 psig) valve inlet pressure and room ambient temperature using a moisture and rust laden air supply. The sample valves shall not receive any lubrication during the test but may begin the test prelubricated to the extent normally received during its assembly. The valves shall be installed in a test circuit with components as described.

6.5.2 TEST CIRCUIT—Install components as shown in Figure 5, using 3/4 in schedule 40 black pipe with close fitting nipples. Purge the system with clean dry air before starting each new test. The oil indicator (see Appendix A) must be tested before beginning the endurance test to assure that it is sensitive to lubricants used in the compressor(s) that provide supply air. This may be accomplished by admitting a drop of lubricant into the bottom of the indicator tube and observing for a reaction. If none occurs, the compressor lubricant must be changed for this test.

6.5.2.1 *Water Injector*—The water injector shall be a commercially available airline lubricator or other device using deionized or distilled water. It shall be sized to deliver not less than the amount specified in Table 5 for each valve, over a cyclic period as described in Step g of 6.5.3.

TABLE 5—WATER INJECTION SPECIFICATIONS

Series Auto	Series ISO	Water[1] Injection	Minimum Test Chamber cc (in^3)
075	1	12	16.4 (1)
125	2	36	49.2 (3)
250	3	48	98.3 (6)
500	4	72	196.6 (12)
1000		84	327.7 (20)

1. cc per valve in a cycle per 5.5.3 g

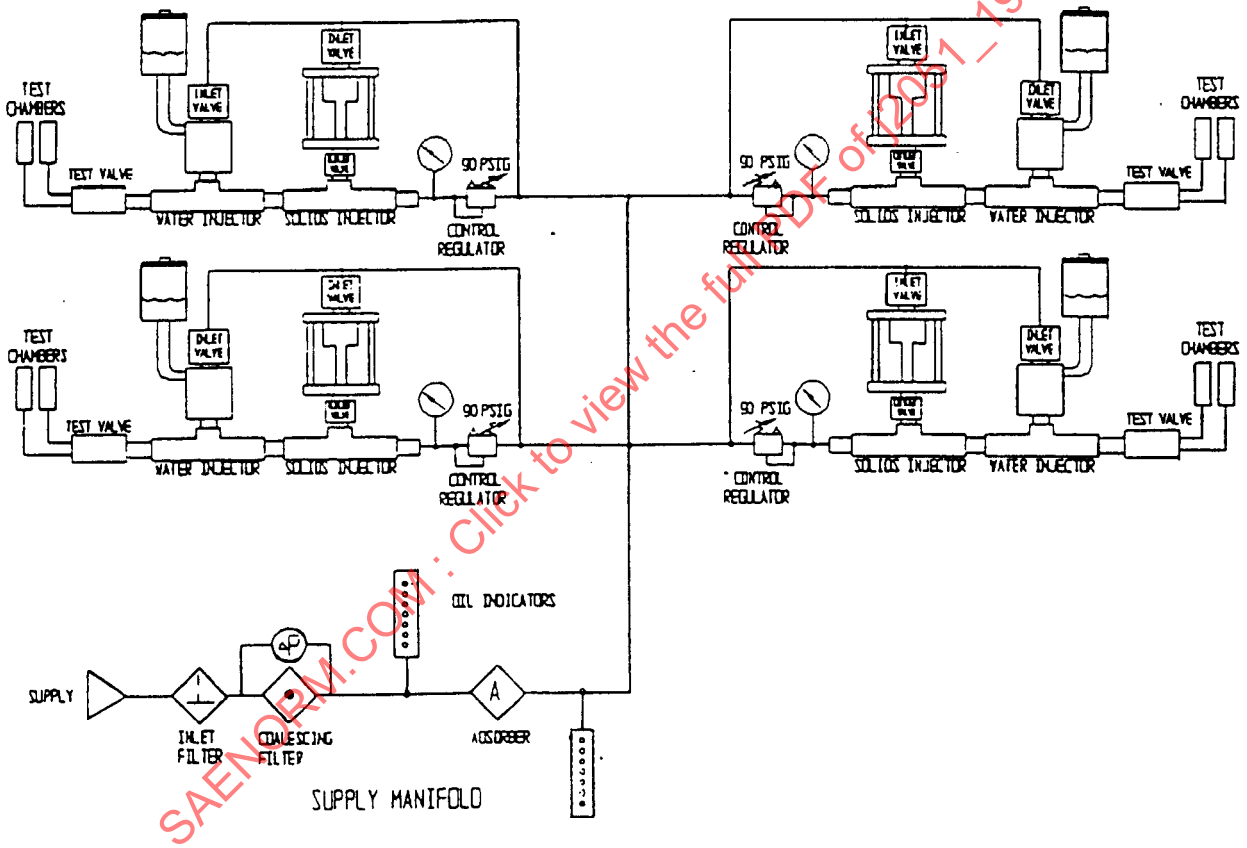
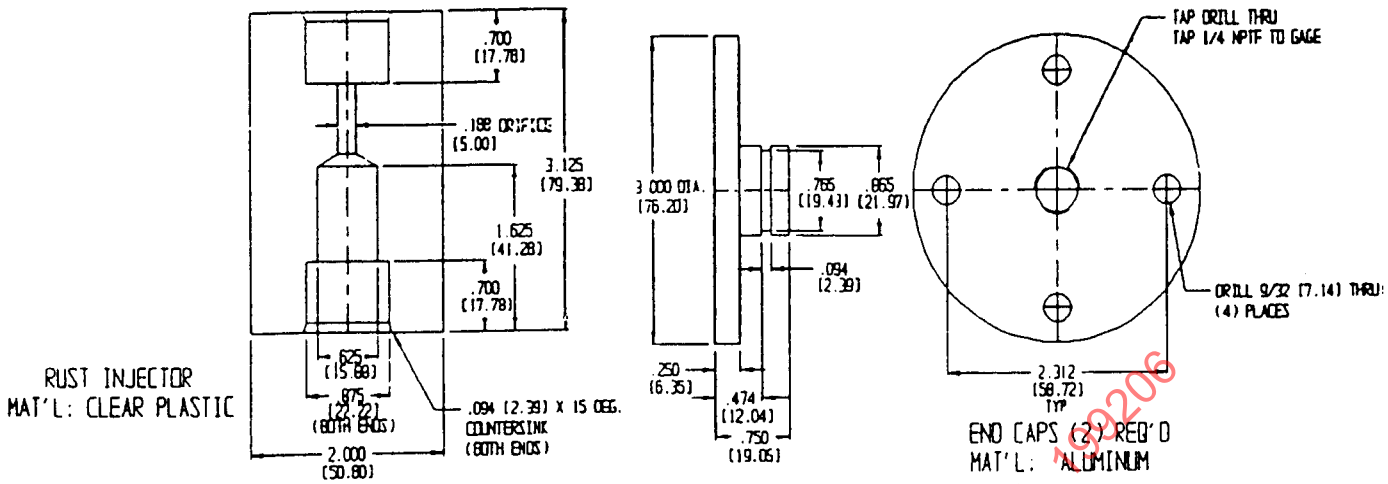


FIGURE 5—ENDURANCE TEST CIRCUIT

6.5.2.2 *Rust Injector*—The rust injector shall be constructed as described in Figures 6 and 7. Ferric(ous) oxide #I-119 will be loaded into the injector in an amount as specified in Table 6 and delivered all at once during each cyclic period as described in Step g of 6.5.3.

6.5.2.3 *Test Chambers*—An individual test chamber shall be attached to each cylinder port of all four test valves. The volume of the test chamber shall be as specified in Table 5.



NOTE—For this figure only, direct dimensions in inches, parenthesis are mm.

FIGURE 6—RUST INJECTOR DETAILS

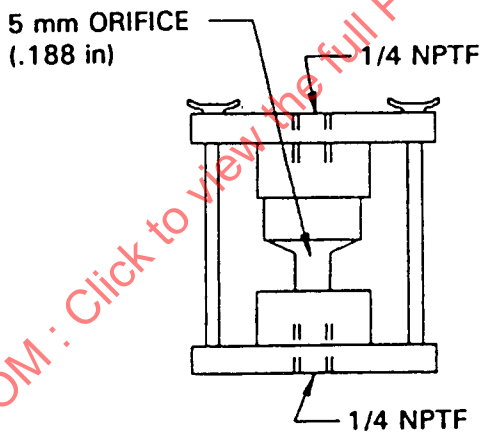


FIGURE 7—RUST INJECTOR ASSEMBLY

6.5.3 OPERATING PROCEDURES

a. Pressurize the test valves to 621 kPa (90 psig) in a static state. Record any leakage from all exhaust ports and pilot valve exhaust passages in both the energized and de-energized positions. Leakage should not exceed 0.06% of its rated flow at 621 kPa (90 psig) supply pressure at start of testing or at any point thereafter.

b. Maintain all four valves in a static pressurized condition at 621 kPa (90 psig) for at least 65 h; one of the single solenoid valves shall be maintained energized during this period.

c. At the end of the 65 h from step b, perform a response time test in accordance with ANSI/(NFPA) standard T3.21.8-1990, except use an inlet pressure of 621 kPa (90 psig). Use the test chambers attached to the valve and perform the test only for the existing state of the valve position. It is important that this test be performed without any valve motion or pressure change during the 65 h period. The time between solenoid signal change, and the point at which the pressure changes by 10% of its range, shall not exceed 100 ms. Step "c" is performed only at the beginning, middle, and end of the endurance life program. Step "d" is not performed afterwards—skip to Step "e".

TABLE 6—RUST INJECTION SPECIFICATIONS

Series Auto	Series ISO	Capacity cc
075	1	0.12
125	2	0.25
250	3	0.50
500	4	0.75
1000		1.25

NOTE: Equivalent orifice area of outlet valve must equal or exceed delivery orifice.

d. Do this step after performing the static test described in Step "b". Reduce pressure on the test valves to 241 kPa (35 psig) (without disturbing the valve elements) and record if the valves shift and return within 1/2 s after being energized and de-energized. Record if they also function by manual override at 241 kPa (35 psig).

e. Fill reservoir of rust injector with specified amount of rust media. Fill reservoir of water injector with specified amount of deionized or distilled water.

f. Begin cyclic operation at 300 CPM. Maintain inlet pressure to the test valves at 621 kPa (90 psig) during the operation.

g. Adjust delivery of water injector so that the appropriate volume of water described in Table 5 is injected as uniformly as possible, but in no less than the first 144 000 cycles of each 864 000 cycles. After 432 000 cycles, open inlet and outlet valves on rust injector for a minimum of 10 cycles or until rust has completely exited the injector reservoir. Refill water and rust injector reservoirs and repeat this procedure every 864 000 cycles.

h. Record cycle count, inlet pressure, and any other operating conditions that may affect the test conduct every 432 000 cycles for the first 2 160 000 cycles; thereafter, record them only every 2 160 000 cycles but monitor them every 432 000 cycles.

i. Replace the coalescing filter if the pressure drop exceeds the manufacturer's recommended operating conditions and replace the inlet filter element as required.

j. Observe the upright oil indicator downstream of the coalescer for presence of oil carryover (see Appendix A). If the carryover exceeds 0.10 PPM (w/w), record the cycle count and perform a system inspection/clean-up. Continue the testing and oil indicator recordings. If the recordings continue to show an oil carryover in excess of 0.10 PPM (w/w), stop the operation and perform such system maintenance as necessary to reduce the carryover before resuming testing. If the downward facing oil indicator (on the downstream side of the adsorber) demonstrates a sudden rate of increase, also stop the operation and perform a system clean-up; including replacement of coalescing and adsorber elements.

k. After every 2 to 3 million cycles, depressurize the system and repeat steps a, b, and d before continuing cyclic operation. Step c should be repeated at 10 million and 20 million cycles.

l. During the test program, if any valve stops cycling or fails to start up after a 65 h dwell period, an attempt should be made to operate it by manual override at 621 kPa (90 psig). If this is successful, the event shall be recorded and the test continued. Failure to restart will necessitate removal of the valve for disassembly examination. If it is found that a condition not related to the test valve caused the stoppage, this may be corrected and the valves returned to testing. No more than three combinations of manual restart or disassembly or both may occur among the four valves during this test.

m. Continue this procedure for 20 million cycles. At the end of that time, perform the standby leakage test as described in steps b and d, for both shift directions.

6.5.4 TEST CRITERIA—The valves shall be judged satisfactory if the following conditions are satisfied on all surviving samples at the end of the endurance test:

a. Mechanical breakdown or loosening of fastened parts did not occur.
b. Leakage of each valve did not exceed 0.06% of its rated flow at 621 kPa (90 psig) supply pressure.
c. The minimum shift pressure did not exceed 241 kPa (35 psig).
d. The response time as described in step "c" did not exceed 100 ms during each of its three tests.
e. All valves shifted back and forth at 241 kPa (35 psig) when tested.

7. Valve Operating and Standby Cost—Appendix B is provided for information only.

PREPARED BY THE SAE PNEUMATIC VALVE SUBCOMMITTEE OF THE SAE
INDUSTRIAL FLUID POWER COMPONENTS COMMITTEE

APPENDIX A

A-4000 OIL INDICATOR—

The A-4000 oil indicator is a calibrated measuring instrument used to detect aerosol-mist levels of oil entrainment that may be present in compressed air systems. Sensitivity of the indicator is limited only by the total number of hours it is allowed to remain on the air supply system. The indicator is sensitive enough to measure a concentration of oil entrainment as low as 0.01 PPM (0.012 mg/m^3) in a compressed air system. It can be used in systems with line pressures between 70 and 875 kPa (10 and 125 psig).

A.1 ***Application—***Oil entrainment in the control air supply to the pressure reducing valve may eventually have an adverse effect on the control system performance. Since some oil entrainment is inherent to lubricated compressors, all oil lubricated compressor installations must include factory approved oil filters to be reliably acceptable. The indicator can be used in two ways. Either it can be used to check for oil carryover from the compressor or it can be used to check out any filtered air supply source before connecting it to the system and also every few months after the system becomes operative. Once the needle valve of the oil indicator has been opened, one continuous uninterrupted exposure is recommended for greatest accuracy.

A.2 ***Operation—***When the needle valve of the oil indicator is open, less than 0.08 mL/s/kPa (2 scim/psig) will flow through the calibrated plastic tube. Any oil present in the air will then carry a red oil soluble dye up the tube, coloring a white material in the tube. The rate of color travel will be proportional to the amount of oil present. The parts per million (PPM) value of oil entrained in the air can be determined using the conversion chart included with the instrument. After use, the needle valve should be closed and left in the line and the cartridge removed. At the time of the next test, a replacement cartridge will need to be installed on the needle valve fitting.

A.3 ***Installation—***In order for the oil indicator to properly measure a given oil entrainment, sufficient exposure time is required. The length of exposure time is inversely proportional to the pressure at the point of installation. When using the indicator to check for oil carryover from the compressor, it should be installed at the discharge of the tank. When using the indicator to measure oil entrainment in the air supply system, it should be installed between the oil filter and the pressure reducing valve (PRV). At this point, dry high pressure air will be present, resulting in the best accuracy and fastest indication.

NOTE—In humid air, moisture may wash traces of dye up the tube, creating a light pink area above the dark red area. When calculating oil entrainment, measure only to the top of the dark red column. Locations involving excessive moisture, temperature, or velocity should be avoided. The indicator valve should remain closed except during the measuring period. For pressures above 875 kPa (125 psig) or below 70 kPa (10 psig), consult the factory.

WARNING: If the pressure exceeds 875 kPa (125 psig) or the retaining nut is loosened, the oil indicator tube could blow out of the compression fitting, creating a hazardous condition.

The indicator must be mounted within 45 degrees of an upright position for best possible performance. Fittings (1/8 in N.P.T.) are provided on both high and low pressure sides of all A-4000 series filter and reducing station assemblies. Any other mounting location will require a 1/8 in N.P.T. mounting tee as shown in Figure A1.

Before installing a replacement cartridge, first check that the needle valve on the existing installation is closed all the way by making sure that the needle valve handle Figure A2 is fully rotated in a clockwise direction. Install the replacement cartridge Figure A3 by tightening the lower 1/8 in nut in place.

NOTE—Do not disturb the factory adjusted torque on the upper 3/16 in retaining nut that holds the plastic tube in place. Also make sure that the indicator scale can be conveniently viewed before tightening the cartridge in place.

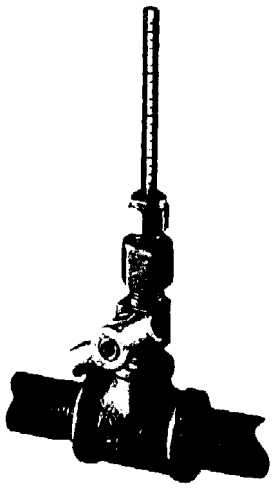


FIGURE A1—A-4000 OIL INDICATOR INSTALLED IN AIR LINE

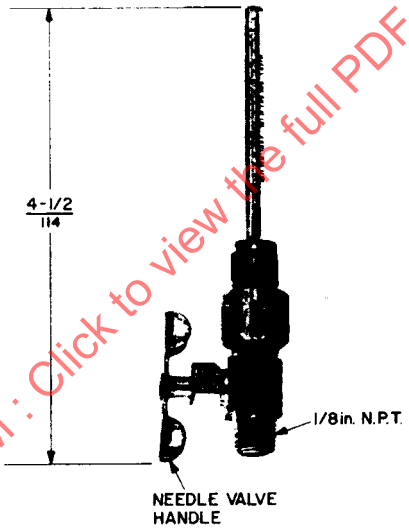


FIGURE A2—DIMENSIONS IN/MM

A.4 Readings and Measurements

A.4.1 Before taking a measurement, fill out the record tag furnished with the oil indicator. Record the line pressure or the average pressure (if it varies at the point of installation).

A.4.2 Fully rotate the needle valve handle Figure A2 counterclockwise to open it and record the time that the needle valve was opened on the record tag. Slide the record tag over the oil indicator to avoid misplacing it.

A.4.3 At the following times and locations, visual inspections of the oil indicators should be made:

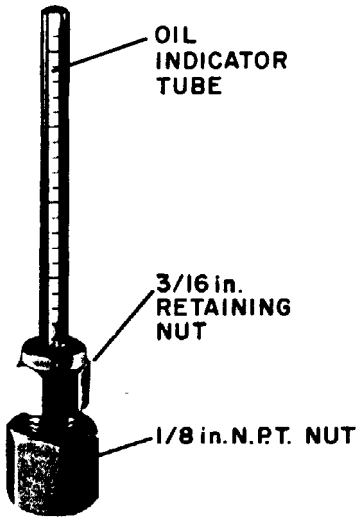


FIGURE A3—A-4000-121 REPLACEMENT CARTRIDGE

TABLE A1—SPECIFICATIONS

Product	A-4000-120 Oil Indictor and Needle Valve Assembly
Air Consumption	0.07 mL/s/kPa (1.9 SCIM/PSIG)
Maximum Temperature	49 °C (120 °F) Internal and Ambient
Pressure Range	70 to 875 kPa (10 to 125 psig)
Oil Concentration Range (W/W (1))	0 to 25 PPM By Weight at 20 °C (68 °F) 0 to 3 oz/100 000 SCF 0 to 30 mg/m^3
Accessory (order separately)	A-4000-121 Oil Indicator Replacement Cartridge
Shipping Weight	0.2 lb

1. W/W = Weight of oil per weight of air

a. When checking for compressor oil carryover, inspection should be made after 4 h at the compressor discharge.
b. When checking for oil entrainment in the air supply, inspection should be made after 40 h between the oil filter and the PRV.

A.4.4 Judging from the rate of color travel established at the time of the first inspection, schedule the final reading of the indicator (and needle valve shut-off) at approximately 1 unit (marked "1.0" on the scale), and preferably not more than 1-1/2 units (marked "1.5" on the scale).