Normative Annex 4
(formerly Annex D)

Test methods for the evaluation of valves and manufactured manifolds

NOTE — The test conditions specified in this Annex are not intended to represent recommended field use conditions.

N-4.1 Definitions

N-4.1.1 test section: The test piping according to Table N-4.1 within which the test specimen is mounted.

N-4.1.2 test specimen: Any valve or combination of valve, pipe reducer, and expander or other devices attached to the valve for which test data is requested.

N-4.2 Hydrostatic pressure test

N-4.2.1 Purpose

The purpose of this test is to ensure that a multiport valve, manufactured manifolds and components can withstand hydrostatic pressure 1.5 times the manufacturer's working pressure.

N-4.2.2 Apparatus / equipment

— pressure indicating devices meeting ANSI/ASME B40.100[6] Grade 1A specifications and sized to yield the measurement within 25% to 75% of scale;

— thermometer accurate to ± 1 °F (± 0.5 °C); and

— cyclic / hydrostatic pressure testing station.

N-4.2.3 Test waters

The test waters shall meet the following requirements:

	Swimming pool	Hot tub / spa
water temperature	75 ± 10 °F (24 ± 6 °C)	102 ± 5 °F (39 ± 3 °C)

Valves and manufactured manifolds except those labeled to be for swimming pools only, shall be tested at the hot tub / spa water temperature.

N-4.2.4 Test method

The following procedure shall be used for the valve and manufactured manifold hydrostatic pressure test:

a) Seal the valve's or manufactured manifold's filter inlet and outlet ports. Connect a pressure source from the hydrostatic testing station to the valve or manufactured manifold and place in the filter position.

b) Fill the valve or manufactured manifold with water conditioned to the temperature specified in Section N-4.1.3. Bleed off any remaining air.

c) Adjust the pressure regulator to apply hydrostatic pressure equal to 1.5 times the working pressure of the unit. Maintain the pressure for 300 ± 30 s. Slowly release the pressure and examine the valve or valve manifold and its integral components for evidence of a rupture, leak, burst, or other deformation that negatively impacts form, function, or performance.

d) Relieve the pressure and evaluate the valve or manufactured manifold according to Section N-4.2.5. Adjust the pressure regulator to apply a hydrostatic pressure of 30 ± 1 psi (207 ± 7 kPa) and maintain it for 2 ± 0.5 s. The pressurization rate shall not exceed 30 psi/s. Slowly release the pressure and maintain a hydrostatic pressure of 0 psi (0 kPa) for 2 ± 0.5 s. Automatic timers shall be used to ensure that the proper pressures are applied and maintained for the required intervals. Repeat this cycle 20,000 times and examine the valve and its integral components for evidence of a rupture, leak, burst, or other deformation that negatively impacts form, function, or performance.

e) After the cycle test in step d, adjust the pressure regulator so that the pressure applied on the valve or manufactured manifold increases steadily and reaches a hydrostatic pressure equal to twice the working pressure within 60 to 70 s. Slow release the pressure, drain the valve or manufactured manifold, and examine for evidence of a rupture, leak, burst, or other deformation that negatively impacts form, function, or performance.

f) If applicable, place the valve or manufactured manifold in the next port position and repeat steps in Section N-4.2.4 steps b and c.

N-4.2.5 Acceptance criteria

The valve or manufactured manifold and its integral components shall not rupture, leak, burst, or sustain other deformation that negatively impacts form, function, or performance.

N-4.3 Differential pressure / leakage test

N-4.3.1 Purpose

The purpose of this test is to determine the ability of a valve or the manufactured manifold to seal off ports not in use during normal operation.

NOTE— This test may be conducted on a valve mounted on the filter vessel. In which case the valve's filter inlet and outlet should remain unblocked when it is connected to the filter vessel.

N-4.3.2 Apparatus / equipment

— pressure indicating device meeting ANSI/ASME B40.100[6] Grade 1A specifications measurement within 25% to 75% of scale;

— pumping station;

— thermometer accurate to ± 1 °F (± 0.5 °C); and

— turbidity meter scaled in nephelometric turbidity units (NTU).

NOTE — In general a single differential pressure indicating device is more accurate than separate devices for measuring differences in pressure.

N-4.3.3 Test waters

The test waters shall meet the following requirements:

	Swimming pool	Hot tub / spa
water temperature	75 ± 10 °F (24 ± 6 °C)	102 ± 5 °F (39 ± 3 °C)
turbidity	≤ 15 NTU	≤ 15 NTU

Valves and manufactured manifolds, except those labeled to be for swimming pools only, shall be tested at the hot tub / spa water temperature.

N-4.3.4 Test methods

N-4.3.4.1 Filter system valve

The following procedure shall be used for the filter system valve, backwash position and manufactured manifold differential pressure/leakage test.

a) Make the following connections (while providing an adjustable valve between them):

1. Connect the test specimen without reducers or other attached devices in accordance with piping requirements in Table N-4.1 (see applicable Figures 7 and 9). The test specimen shall be in the full open position for each test.

2. Secure and make any additional connections that may be necessary to conform to any unique design features specified by the manufacturer.

b) Fill the system with water conditioned to the applicable temperatures specified in Section N-4.3.3, and bleed off any entrapped air.

c) Place the test specimen or manufactured manifold in the filter position and adjust the flow to the maximum design flow rate ± 1 GPM (± 3.8 LPM) and adjust valves V3 or equivalent until the pressure differential between the filter inlet port and outlet port is 24 ± 1 psi (165 ± 6.9 kPa). (See Figures 7 and 8.)

d) Observe and collect leakage from the waste port over a test period of 5 min ± 5 s.

e) Record and report the following:

— static pressure, psi (kPa);
— volume of leakage from waste port (mL);
— valve inlet port pressure (P1) psi (kPa);
— differential pressure – valve inlet to outlet ports (DPI); and
— differential pressure – at zero flow to account for elevation differences.

f) Move the following connections:

1. Move the pressure measurement device (DPI) from the filter system valve or manufactured manifold return-to-pool port to the waste port. Connect the test specimen without reducers or other attached devices in accordance with piping requirements in Table N-4.1 (see applicable Figures 8 and 10). The test specimen shall be in the full open position for each test.

2. Secure and make any additional connections that may be necessary to conform to any unique design features specified by the manufacturer.

g) Fill the valve with water conditioned to the applicable temperatures specified in Section N-4.3.3 and bleed off any entrapped air.

h) Place the test specimen in the backwash position and adjust the flow to the maximum design flow rate ± 1 GPM (± 3.8 LPM) and adjust valve V3 or equivalent until the pressure differential between the filter inlet port and waste port is 10 ± 1 psi (70 ± 6.9 kPa).

i) Observe and collect any leakage from the filter system valve return-to-pool port over a test period of 5 min ± 5 s.

j) Record and report the following:

— volume of leakage from return-to-pool port (mL);
— static pressures, psi (kPa);
— filter system valve inlet port pressure (P1);
— differential pressure, valve inlet to outlet ports (DP1);
— filter system valve waste port pressure (P2);
— elevations, feet (all from water tank or water level):

— Z1 at elevation of P1; and
— Z2 at elevation of P2.

N-4.3.4.1.1 Acceptance criteria

When tested in the filter position, the valve or manufactured manifold shall not leak in excess of 3 mL in the 5 min test from the waste port.

When the valve or manufactured manifold is tested in the backwash position, leakage from the return-to-pool port shall not leak in excess of 30 mL in the 5 min test.

N-4.3.4.2 Nonfilter system valve

N-4.3.4.2.1 Two port valves

N-4.3.4.2.1.1 Test method

The following procedure shall be used for two port valves:

a) Make the following connections:

1. Connect the test specimen without reducers or other attached devices in accordance with piping requirements in Table N-4.1. The test specimen shall be in the full closed position for each test; and

2. Secure and make any additional connections that may be necessary to conform to any unique design features specified by the manufacturer.

b) Fill the system with water conditioned to the applicable temperatures specified in Section N-4.3.3, and bleed off any entrapped air.

c) Adjust the pressure (PI) to 1.5 times the maximum working pressure ± 5 psi (34 kPa).

d) Observe and collect leakage from the nonpressurized port over a test period of 5 min ± 5 s.

e) Record and report the following:

— static pressures, psi (kPa);
— volume of leakage from the closed port (mL); and
— valve inlet port pressure (PI) psi (kPa).

f) Adjust the pressure (PI) to 3 ± 1 psi (21 ± 6.9 kPa).

g) Observe and collect leakage from the nonpressurized port over a test period of 5 min ± 5 s.

h) Record and report the following:

— static pressure psi (kPa);
— volume of leakage from the closed port (mL); and
— valve inlet port pressure (P1) psi (kPa).

N-4.3.4.2.1.2 Acceptance criteria

When tested the valve shall not leak in excess of 0.5 mL from the closed port in the 5 min test.

N-4.3.4.2.2 Three or more port valves

N-4.3.4.2.2.1 Test method

The following procedure shall be used for valves with three or more ports and manufactured manifold:

a) Make the following connections (while providing an adjustable valve between them):

1. Connect the test specimen without reducers or other attached devices in accordance with piping requirements in Table N-4.1 (see applicable Figures 5 and 6). The test specimen shall be in the full open position for each test.

2. Secure and make any additional connections that may be necessary to conform to any unique design features specified by the manufacturer.

b) Fill the system with water conditioned to the applicable temperatures specified in Section N-4.3.3 and bleed off any entrapped air.

c) Place the test specimen or manufactured manifold in the first operating position and adjust the flow to the maximum design flow rate ± 1 GPM (± 3.8 LPM) and adjust valve V2 until the pressure (PI) is 24 ± 1 psi (165 ± 6.9 kPa). (See Figures 5 and 6.)

d) Observe and collect leakage from the open port(s) over a test period of 5 min ± 5 s.

e) Record and report the following:

— static pressures, psi (kPa);
— volume of leakage from auxiliary port(s) (mL); and
— valve inlet port pressure (P1) psi (kPa).

f) Move the following connections:

1. Move the pressure measurement device (DPI) from the valve or manufactured manifold first port tested to the next port. Connect the test specimen without reducers or other attached devices in accordance with piping requirements in Table N-4.1 (see applicable Figures 5 and 6). The test specimen shall be in the full open position for each test.

2. Secure and make any additional connection that may be necessary to conform to any unique design features specified by the manufacturer.

g) Fill the valve with water conditioned to the applicable temperature specified in Section N-4.3.3, and bleed off any entrapped air.

h) Place the test specimen in the next operating position and adjust the flow to the maximum design flow rate ± 1 GPM (± 3.8 LPM) and adjust valve V2 until the pressure (P1) is 24 ± 1 psi (165 ± 6.9 kPa).

i) Observe and collect any leakage from the open port(s) over a test period of 5 min ± 5 s.

j) Record and report the following:

— volume of leakage from auxiliary port(s) (mL);
— static pressures, psi (kPa);
— valve inlet port pressure (P1) psi (kPa); and
— elevations, feet (all from water tank level): Z1 at elevation of P1.

k) Adjust the pressure (P1) to the maximum working pressure ± 5 psi (34 kPa).

l) Observe and collect leakage from the open port over a test period of 5 min ± 5 s.

m) Record and report the following:

— static pressures, psi (kPa);
— volume of leakage from the open port (mL); and
— valve inlet port pressure (P1) psi (kPa).

n) Adjust the pressure (P1) to 3 psi ± 1 psi (6.9 kPa).

o) Observe and collect leakage from the open port over a test period of 5 min ± 5 s.

p) Record and report the following:

— static pressure, psi (kPa);
— volume of leakage from the open port (mL); and
— valve inlet port pressure (P1) psi (kPa).

N-4.3.4.2.2.2 Acceptance criteria

When tested in each operating position, the valve or manufactured manifold shall not leak in excess of 0.5 mL from any port in the 5 min test.

N-4.4 Head loss curve test

N-4.4.1 Purpose

The purpose of this test is to compare a head loss curve of a valve or manufactured manifold to the manufacturer's published head loss curve(s) for all manufacturer specified operating positions.

N-4.4.2 Apparatus / equipment

— pressure indicating device meeting ANSI/ASME B40.100[6] Grade 1A specifications measurement within 25% to 75% of scale;

— pumping station; and

— temperature-indicating device accurate to ± 1 °F (± 0.5 °C).

N-4.4.3 Test waters

The test waters shall meet the following requirements:

	Swimming pool	Hot tub / spa
water temperature	75 ± 10 °F (24 ± 6 °C)	102 ± 5 °F (39 ± 3 °C)

All valves and manufactured manifolds, except those labeled to be for swimming pools only, shall be tested at the hot tub / spa water temperature.

N-4.4.4 Test methods

N-4.4.4.1 The following procedure shall be used for the valve or manufactured manifold head loss curve test (see Figures 4 through 6):

a) Make the following connections:

1. Connect the test specimen without reducers or other attached devices in accordance with piping requirements in Table N-4.1. The test specimen shall be at 100% of rated travel.

2. Make any additional connections that may be necessary to conform to any unique design features specified by the manufacturer.

b) Fill the valve with water conditioned to the applicable temperature specified in Section N-4.4.3, and bleed off any entrapped air.

c) Start the pump and set the flow rate through the test specimen to 10% of the maximum design flow rate (± 1 GPM [±3.8 LPM]).

d) Record the following:

— static pressures, psi (kPa);
— valve inlet port pressure (P1);
— differential pressure, valve inlet to outlet ports (DP1); and
— elevations, feet (all from water tank or water level):

  — Z1, at elevation of P1; and
  — Z2, at elevation DP1.

e) Using the data generated according to Section N-4.4, steps b through d, calculate the head loss due to the valve or manufactured manifold at each flow rate: record the differential pressure at DP1 and static pressure at P1 at 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% and 100% of the maximum design flow rate (± 1 GPM [± 3.8 LPM]).

f) Using the data generated according to Section N-4.4.4.1, steps b through d, calculate the head loss due to the valve or manufactured manifold at each flow rate:

— for each of the static pressures recorded in Section N-4.4.4.1, step e, convert pressures to feet of water:

— P (ft) = P (psi) × 2.307
— P (ft) = P (kPa) / 2.989

— calculate the total head loss due to the valve or manufactured manifold:

$HLV_{1\text{-}2}$ = DP1 + (Z1 – Z2)

where:

HLV = total head loss due to valve or manufactured manifold.

NOTE — This analysis assumes that inlet and outlet piping are of the same size, material, and general condition. If this is not the case, these factors shall be taken into account.

g) When applicable, move the pressure indicating device from the valve or manufactured manifold outlet port to the valve or manufactured manifold auxiliary port(s). Repeat Section N-4.4.4.1, steps b through f for each operational position with a head loss curve published by the manufacturer.

h) Record the following:

— static pressures, psi (kPa);
— valve inlet port pressure (P1);
— differential pressure, valve inlet to outlet ports (DP1); and
— elevations, feet (all from same reference line): Z1 at elevation of DP1.

i) Record the differential pressures at DP1 and pressures at P1, at 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% and 100% of the maximum design flow rate (± 1 GPM [± 3.8 LPM]).

j) Using the data generated according to Section N-4.4.4.1, steps g through i, calculate the head loss due to the valve or manufactured manifold at each flow rate according to the equation in step f.

N-4.4.4.2 Acceptance criteria

The measured head loss through a valve or manufactured manifold itself shall not exceed the manufacturer's published head loss by more than 5% for each published valve operating position(s).

N-4.5 Waste port leakage test for filter system valves

N-4.5.1 Purpose

The purpose of this test is to determine the valve or manufactured manifold waste port leakage.

N-4.5.2 Apparatus / equipment

— pressure source;

— pressure indicating device meeting ANSI/ASME B40.100[6] Grade 1A specifications measurement within 25% to 75% of scale;

— sight glass assembly;

— thermometer accurate to ± 1 °F (± 0.5 °C); and

— turbidity meter scaled in nephelometric turbidity units (NTU).

N-4.5.3 Test waters

The test waters shall meet the following requirements:

	Swimming pool	Hot tub / spa
water temperature	75 ± 10 °F (24 ± 6 °C)	102 ± 5 °F (39 ± 3 °C)
turbidity	≤ 15 NTU	≤ 15 NTU

Valves and manufactured manifolds, except those labeled to be for swimming pools only, shall be tested at the hot tub / spa temperature.

N-4.5.4 Waste port leakage test method

a) The following procedure shall be used for the valve or manufactured manifold waste port leakage test.

b) Connect the pressure source to the return-to-pool port. Place the valve or manufactured manifold in the filter position.

c) Seal the filter inlet and outlet ports and the valve or manufactured manifold inlet port.

d) Fill the valve or manufactured manifold with water at the applicable temperature specified in Section N-4.5.3, and bleed off any remaining air.

e) Set the level in the sight glass approximately 2 in (51 mm) above the valve or manufactured manifold center line and record the height.

f) Apply a pressure of 10 ± 0.5 psi (69 ± 3.4 kPa) at a rate of 2 psi/min (13.8 kPa/min) to the return-to-pool port and hold for no less than 5 min ± 5 s. Observe the valve for leakage.

N-4.5.5 Acceptance criteria

Leakage through the waste port up to 10 psi (70 kPa) or during the 5 min static test shall not exceed 3 mL.

Table N-4.1
Piping requirements

A	B	C	D
At least 18 nominal pipe diameters of straight pipe	6 nominal pipe diameters of straight pipe	6 nominal pipe diameters of straight pipe	At least 1 nominal pipe diameter of straight pipe

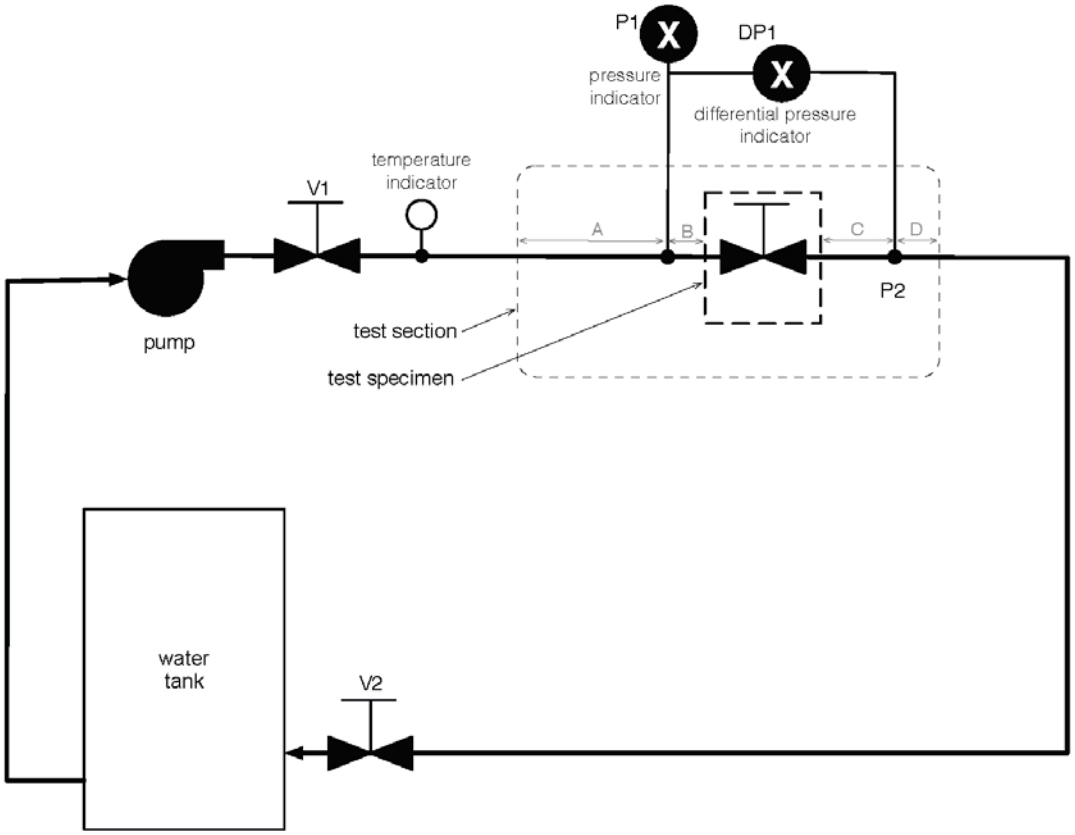

Figure 4
Valve differential pressure test

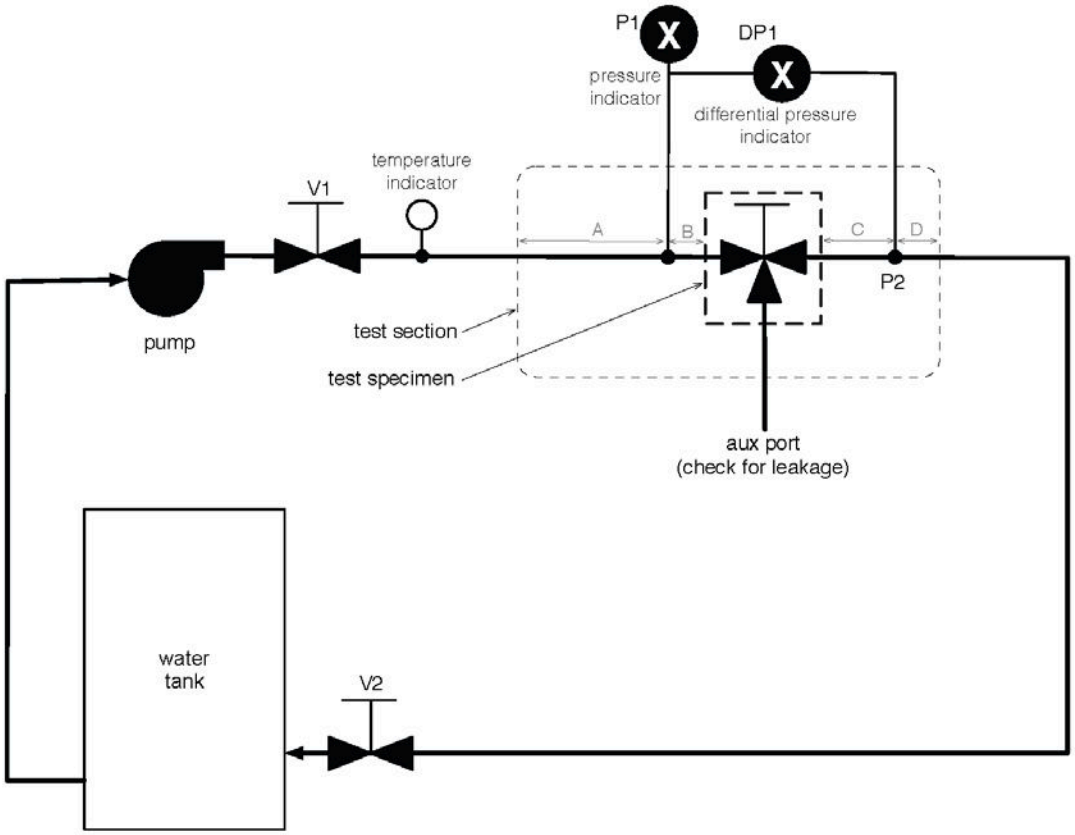

Figure 5
3-way valve differential pressure / leakage test