Integrity Testing LifeASSURE™ BDA020, BGA020 and BNA020 Series Filter Cartridges

EXPLANATION OF SIGNAL WORD CONSEQUENCES	
⚠ WARNING:	Indicates a potentially hazardous situation, which, if not avoided, could result in death or serious injury and/or property damage
⚠ CAUTION:	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury and/or property damage

⚠ WARNING:

To reduce the risk associated with system burst related injuries:

- Do not use if fluid pressure exceeds rating described on the pressure vessel data plate.
- Do not use with fluids at temperatures exceeding the rating described on the pressure vessel data plate.
- Do not use for continuous service with compressed gases.

⚠ CAUTION:

To reduce the risk associated with exposure to contaminants:

- Always use appropriate personal protective equipment (PPE) when installing or servicing the filtration system.
- Ensure that all system pressure has been relieved prior to opening the system to atmosphere.
- To reduce the risk associated with eye, skin, and respiratory and digestive tract injuries from chemical cleaners/sanitizers during system maintenance.
- Do not get chemical cleaners/sanitizers in eyes, on skin, or on clothing. Do not ingest or inhale.
- Wear appropriate PPE including eye and face protection, protective gloves, and an appropriate NIOSH-approved filter mask.

Introduction

The integrity test is a non-destructive method for the End User to confirm the structural integrity of a LifeASSURE™ BNA020, BGA020 or BDA020 series filter cartridge before and after use. An “in specification” result confirms the pore size of the filter cartridge membrane and that the cartridge is structurally integral. Three methods can be employed to integrity test hydrophilic (water wettable) LifeASSURE BNA020, BGA020 and BDA020 Series filter cartridges. These methods are:

1. Forward Flow Integrity Test (FFIT) - recommended for assemblies between one and three filter cartridges
2. Pressure Hold Test (PHT) - recommended for assemblies of any size
3. Bubble Point Test (BPT) - may be used for assemblies using one 10” filter cartridge

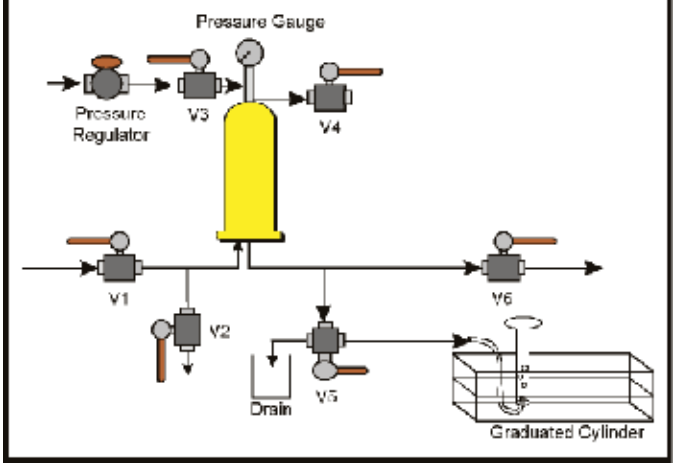
Although a Bubble Point Test can be performed on the LifeASSURE BNA020, BGA020 and BDA020 series filter cartridges, this integrity test is not the preferred method to evaluate filter cartridge integrity due to the structure of the highly asymmetric PES membranes used in the construction of these cartridges. The preferred integrity test methods are the Forward Flow Integrity and Pressure Hold Tests. This Technical Brief will present reasons for not recommending Bubble Point tests for integrity under the Bubble Point Test Section.

For more information about using the 3M™ 101 Series Integrity Test Device to perform an integrity test, refer to the 3M™ 101 Series Integrity Test Device Operator Manual (34-8719-8229-3).

Filter Cartridge Wet-Out (Refer to Figure 1)

Prior to performing an integrity test, the filter cartridge membrane must be thoroughly wet with clean, ambient temperature, filtered water. (NOTE: if the process requires wetting the filter cartridge with a fluid other than water, testing will be required to correlate water-wet integrity test values to test values obtained in the test fluid). Testing has shown that the LifeASSURE™ BNA020, BGA020 and BDA020 membranes are easily wet with water. Any of the following four methods may be used to ensure the cartridge membrane is thoroughly wet prior to the integrity test. Although any of the four wetting methods can be used, Methods 3 and 4 are the preferred and recommended procedures to ensure thorough wetting of the cartridge membrane.

Figure 1 — Forward Flow Integrity Test (Manual Method)



Method 1

Close valves V2, V3 and place valve V5 in the closed position. With the housing vent valve V4 open and the downstream valve V6 slightly opened (or completely closed), open V1 and fill the housing with water.

1. When water begins to exit through the housing vent valve V4, close the vent valve V4, close the downstream valve V6 and stop the flow of water into the housing by closing V1.
2. Allow water to remain in the housing for approximately 10 minutes to statically wet the cartridge(s).
3. Open the vent valve V4, the housing drain valve V2 and the downstream valves V5 and V6 to drain the housing.
4. After the housing has completely drained close valves V1, V2, and V4. Close valve V6 and position valve V5 for air to flow downstream.
5. Perform the required integrity test. (NOTE: The drain port side of valve V5 should be of sufficient size to permit the cartridge core to completely drain under gravity when opened.)

Method 2

1. Close valves V2, V3, V6 and place valve V5 in the closed postion. Open valve V4. Fill the housing with water by opening valve V1.
2. When water begins to exit through the housing vent valve V4, close the vent valve V4 and slowly open valve V6 (if the rinse water is to be directed through the downstream system) or slowly open V5 to drain if rinse water is to be directed to the drain.
3. Adjust either the downstream valve V6 or the drain position of valve V5 to restrict the flow of water and apply a back pressure on the housing.
4. Flow water through the housing for approximately 5 minutes at 11.4 liters per minute (3 gpm) per 10” cartridge with 0.35 bar (5 psig) back pressure.
5. After flowing water through the cartridge(s) for 5 minutes, stop the flow by closing valve V1.
6. Open the vent valve V4, housing drain valves V2 and V5 to completely drain housing.
7. After the housing has completely drained close V1, V2 and V4. Close valve V6 and position valve V5 for air to flow downstream.
8. Perform the required integrity test.

If the integrity test result does not meet specifications when a back pressure of 0.35 bar (5 psig) has been applied during wetting of the cartridge(s), then proceed with Method 3.

Method 3

1. Close valves V2, V3, V6 and place valve V5 in the closed position. Open valve V4. Fill the housing with water by opening valve V1.
2. When water begins to exit through the housing vent valve V4, close the vent valve V4 and slowly open valve V6 (if the rinse water is to be directed through the downstream system) or slowly open V5 to drain if rinse water is to be directed to the drain.

3. Adjust either the downstream valve V6 or the drain valve V5 to restrict the flow of water and apply a back pressure on the housing.
4. Flow water through the housing for approximately 5 minutes at 11.4 liters per minute (3 gpm) per 10" cartridge with 1.7 bar (25 psig) back pressure.
5. After flowing water through the cartridge(s) for 5 minutes, stop the flow by closing valve V1. Open the vent valve V4, housing drain valves V2 and V5 to completely drain housing.
6. After the housing has completely drained close V1, V2 and V4. Close valve V6 and position valve V5 for air to flow downstream.
7. Perform the required integrity test.

Method 4

1. Close valves V2, V3 and place valve V5 in the closed position. With the housing vent valve V4 open and the downstream valve V6 slightly opened (or completely closed), open V1 and fill the housing with water.
2. When water begins to exit through the housing vent valve V4, close the vent valve V4, close the downstream valve V6 and stop the flow of water into the housing by closing V1.
3. Attach an air or nitrogen pressure source connected to a pressure regulator to the housing vent valve V4 that is capable of delivering at least 60 psig of pressure.
4. With water still in the housing, increase the air or nitrogen pressure to 50 psig and allow water to remain in the housing for 5 minutes under the 50 psig of pressure.
5. After 5 minutes, slowly and carefully decrease the air or nitrogen pressure and remove the pressure source from the vent valve V4.
6. With the housing vent valve V4 open, open drain valves V2 and V5 to completely drain housing. After the housing has completely drained, close V1, V2 and V4. Close valve V6 and position valve V5 for air to flow downstream.
7. Perform the required integrity test.

Forward Flow Integrity Test (Refer to Figure 1)

Definition

According to Fick's Law of Diffusion, when a differential gas pressure exists across a wetted membrane, the gas molecules will dissolve into the water and "diffuse" from one side of the membrane to the other. The rate of passage is proportional to the solubility of the gas in the wetting fluid, the differential pressure, the thickness of the membrane, the porosity, and the surface area of the membrane. The diffusion rate is measured at a pressure below the membrane bubble point pressure. If there are defects or large pores in the membrane, then there will be an additional bulk flow above the expected diffusional flow. The integrity test examines the total flow of the cartridge under a specific set of test conditions, and compares that to the expected diffusion flow if no defect existed. A flow limit is established that takes into account the typical flow of a cartridge due to diffusion, but excludes the higher flow response of cartridges with defects. The Forward Flow Integrity Test (FFIT) may be employed with a multi-cartridge housing.

Table 1. FFIT Specifications

Grade ID	FFIT Pressure	FFIT Limits
BNA020	35 psig / 2.4 bar	< 51.0 cc/min @ 25 °C
BDA020	40 psig / 2.76 bar	< 33 cc/min @ 25 °C
BGA020	40 psig / 2.76 bar	< 33 cc/min @ 25 °C

Procedure 1. Forward Flow Integrity Test (Manual Method)

(NOTE: Because this method requires opening the sterile/sanitized side of the filter cartridge system, take appropriate steps to prevent contamination.)

A. Configure the system as shown in Figure 1. Connect a pressure regulator to a clean and dry compressed air source **(Do Not Use CO_2)*** capable of delivering a minimum of 0.7 bar (10 psig) more than the required test pressure. (Refer to the FFIT specifications in Table 1). Connect a length of clear flexible tubing (3-6 mm I.D.) to the outlet port of drain valve V5. Fill the reservoir to a depth of approximately 5 cm (2 inches) with clean filtered water. Fill a graduated cylinder or burette of an appropriate size with clean filtered water, invert and submerse the open end 1.2 cm (0.5 inch) under the clean filtered water.

B. Install filter cartridge(s) into housing and thoroughly wet with clean, ambient temperature, filtered water using one of the two preferred and recommended wetting procedures previously described in "Filter Cartridge Wet-Out" Section, Page 2.

* Use of CO_2 in the integrity test will result in a false reading.

C. Ensure all water has been drained from both upstream and downstream sides of the filter cartridge and valves V1, V2, V4 and V6 are closed.

D. Position V5 to direct flow to the water reservoir. (NOTE: ensure that the open end of the tubing is NOT under the inverted graduated cylinder/burette at this time).

E. Open V3 and slowly adjust the pressure regulator to pressurize the system (approximately 2-3 psig/sec [150 - 200 mb/sec]) to the specified FFIT test pressure (see FFIT specifications in Table 1). Allow the system to equilibrate for a minimum of one minute, or until steady bubbling is observed from the submersed end of the tubing.

F. Record the starting level of the water in the inverted graduated cylinder (or burette). Simultaneously, place the end of the tubing under the submersed end of the inverted graduated cylinder (or burette) and start a timer.

G. After 5 minutes, remove tubing from under the inverted graduated cylinder (or burette) and record the water level in the graduated cylinder. Determine the water volume displaced and calculate the air diffusion rate in cc/minute.

H. When the test is complete compare the results to the filter cartridge FFIT specifications in Table 1.

I. After the test is completed, drain any residual water from the housing and place the filter cartridge into service.

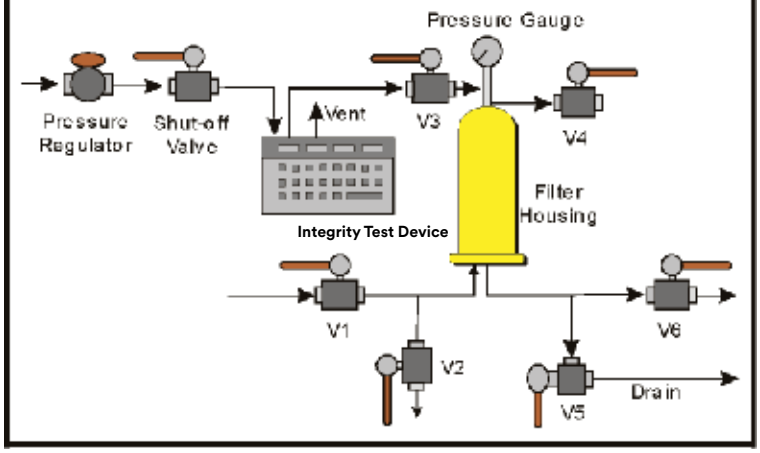
J. If the diffusion rate is higher than the specification, consider the following questions and re-test if necessary. (Rewet the filter cartridge with Methods 3 or 4 described in the “Filter Cartridge Wet-Out” Section, Page 2, and retest.):

- Was the filter cartridge completely wetted out?
- Was the correct pore size filter cartridge installed?
- Was the temperature of the water and filter cartridge ambient?
- Was the stabilization time adequate?
- Was the test time adequate?
- Was the filter cartridge seated correctly in the housing and were the o-rings undamaged?

Procedure 2. Forward Flow Integrity Test (Automated Method)

A. Configure the system as shown in Figure 2. Connect a pressure regulator to a clean and dry compressed air source **(Do Not Use CO_2)*** capable of delivering a minimum of 0.7 bar (10 psig) more than the required test pressure. FFIT test pressure (Refer to the FFIT specifications in Table 1.)

Figure 2 — Forward Flow Integrity Test (Automated Method)



B. Install filter cartridge(s) into housing and thoroughly wetted with clean, ambient temperature, filtered water using one of the two preferred and recommended wetting procedures previously described in the “Filter Cartridge Wet-Out” Section, Page 2.

C. Ensure all water has been drained from both upstream and downstream sides of the filter cartridge and valves V1, V2 and V4 are closed. Open valve V5 and/or V6 if not already open.

D. Connect the Integrity Test Device Tester to valve V3. Adjust the pressure regulator to deliver a minimum of 3.5 bar (50 psig) to the Integrity Test Device. Open valve V3.

E. Initiate the appropriate automated Forward Flow Integrity Test program.

F. When the test is complete, close valve V3. The Integrity Test Device will indicate a pass or failed test on the printout.

G. After the test is complete and system pressure has been vented, drain any residual water from the housing by opening V2 and V4 before placing the cartridge in service.

H. Disconnect the Integrity Test Device from the housing.

I. If the FFIT value is higher than the specification, consider the following questions and retest if necessary. (Rewet the filter cartridge with Methods 3 or 4 described in the “Filter Cartridge Wet-Out” Section, Page 2, and retest).

* Use of CO_2 in the integrity test will result in a false reading.

- Is the Integrity Test Device programming correct for the filter cartridge being tested?
- Was the filter cartridge completely wetted out?
- Was the correct pore size filter cartridge installed?
- Was the temperature of the water and filter cartridge ambient?
- Was the stabilization time adequate?
- Was the test time adequate?
- Was the filter cartridge seated correctly in the housing and were the o-rings undamaged?
- Are there any leaks on the upstream side of the filter cartridge?

Pressure Hold Test

Definition

A variation of the FFIT is the Pressure Hold Test (PHT). Instead of measuring the diffusion rate of gas across the membrane, the PHT uses a sensitive pressure gauge to measure the pressure decay of a precisely known closed and fixed volume on the upstream side of the membrane as the gas diffuses through the wetted membrane. The pressure measuring device used must be capable of accurately measuring a pressure change of 10 mbar (0.15 psig). The PHT value is dependent on the total upstream volume of the filter cartridge system being tested. Typically, PHT values are based on valve V1 being connected directly to the housing inlet port. In systems where V1 is not directly connected to the housing inlet port, calculate the additional volume between the inlet port and V1 add that volume to the known upstream volume for the assembly to be tested. Recalculate the maximum allowable pressure loss using Equation 1. Contact 3M for assistance if necessary. The 3M™ 101 Series Integrity Test Device can be used to perform a PHT. When using the 3M™ 101 Series Integrity Test Device, follow the installation instructions for connecting the unit to the upstream valve as shown in Figure 4. Consult 3M for the appropriate PHT value for your filter cartridge housing. Program these values into the 3M™ 101 Series Integrity Test Device tester when prompted during test programming.

Equation 1:

$$\frac{\Delta P}{T} = \frac{K(PA)}{Vhsg}$$

Pa =Manufacturer's maximum allowable diffusion rate for all the installed filter cartridges in cc/min (see Forward Flow Integrity specifications).
T = Time (typically 5 minutes).
K = Atmospheric pressure, 14.7 psig (1.01 bar).
Vhsg = Upstream housing volume (cc) less the volume occupied by the cartridge(s). See note in Table 2.
ΔP = Allowable pressure loss (Pi – Pf).

Procedure 3. Pressure Hold Test (Manual Method)

A. Configure the system as shown in Figure 3. Connect a pressure regulator to a clean and dry compressed air source **(Do Not Use CO^2)*** capable of delivering a minimum of 0.7 bar (10 psig) more than the required test pressure. The PHT test pressure is the same test pressure as used to perform a FFIT (see FFIT specifications in Table 1).

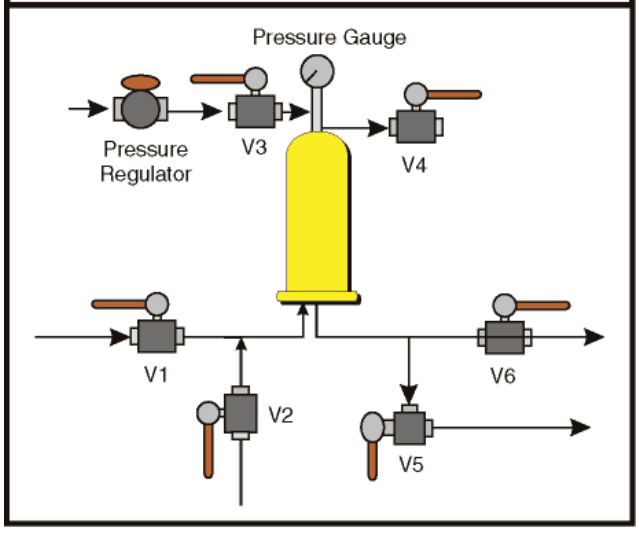
B. Install filter cartridge(s) into housing and thoroughly wet with clean, ambient temperature, filtered water using one of the two preferred and recommended wetting procedures previously described in the "Filter Cartridge Wet-Out" Section, Page 2.

C. Ensure all water has been drained from both upstream and downstream sides of the filter cartridge and valves V1, V2 and V4 are closed. Open valve V5 or V6 if not already open.

D. With V5 or V6 open to atmosphere, open V3 and slowly adjust the pressure regulator to pressurize the system, raising the pressure approximately 1.4 bar (20 psig) per minute. Allow the system to equilibrate for a minimum of two minutes.

E. At the end of the two minute equilibration record the pressure as the initial pressure (Pi). Close V3 and immediately start a timer. After 5 minutes, record the pressure as the final pressure (Pf). (NOTE: if the pressure decay is less than the capability of the pressure measuring device, then increase the test time to 10 or 15 minutes). Determine the pressure decay by subtracting Pf from Pi; divide this value by the number of minutes in the test to obtain the pressure decay per minute.

Figure 3 — Pressure Hold Test (Manual Method)



* Use of CO_2 in the integrity test will result in a false reading.

F. When the test is complete, compare the result to the specified PHT provided by 3M Purification.

G. After the test is complete, drain any residual water from the housing and place the cartridge back in service.

H. Disconnect the 3M™ 101 Series Integrity Test Device from the housing.

I. If the pressure decay is higher than the PHT specification, consider the following questions and re-test if necessary.

(Rewet the filter cartridge with Methods 3 or 4 described in the "Filter Cartridge Wet-Out" Section, Page 2, and retest).

- Was the filter cartridge completely wetted out?
- Was the correct pore size filter cartridge installed?
- Was the stabilization time adequate?
- Was the test time adequate?
- Was the filter cartridge seated correctly in the housing and were the o-rings undamaged?
- Are there any leaks on the upstream side of the filter cartridge?

Procedure 4. Pressure Hold Test (Automated Method)

(NOTE: Automated PHT with the 3M™ 101 Series Integrity Test Device can only be performed on filter cartridge assemblies containing five 20" filter cartridge or less. Larger assemblies must be tested manually.)

A. Configure the system as shown in Figure 4. Connect a pressure regulator to a clean and dry compressed air source **(Do Not Use CO2)*** capable of delivering a minimum of 0.7 bar (10 psig) more than the required test pressure. The PHT test pressure is the same test pressure as used to perform a FFIT (see FFIT specifications in Table 1).

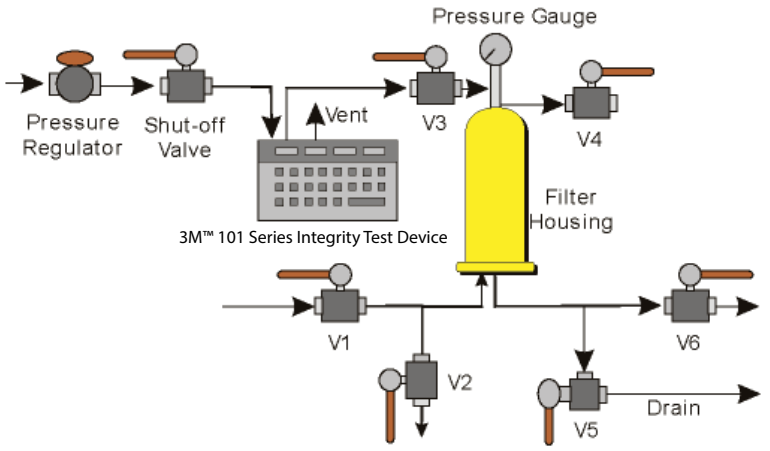
B. Install filter cartridge(s) into housing and thoroughly wet with clean, ambient temperature, filtered water using one of the two preferred and recommended wetting procedures previously described in the "Filter Cartridge Wet-Out" Section, Page 2.

C. Ensure all water has been drained from both upstream and downstream sides of the filter cartridge and valves V1, V2, and V4 are closed. Open valve V5 or V6 if not already open.

D. Connect the 3M™ 101 Series Integrity Test Device to valve V3. Adjust the pressure regulator to deliver a minimum of 3.5 bar (50 psig) to the 3M 101 Series Integrity Test Device. Open valve V3.

E. Select the 3M™ 101 Series Integrity Test Device program that uses the appropriate upstream housing volume or the calculated housing volume and the specified PHT test pressure.

Figure 4 — Pressure Hold Test (Automated Method)



F. Initiate the automated Pressure Hold Integrity Test program.

G. When the test is complete, the 3M™ 101 Series Integrity Test Device will indicate a pass or fail on the printout.

H. After the test is complete, drain residual water from the housing and place the cartridge back in service.

I. Disconnect the 3M™ 101 Series Integrity Test Device from the housing.

J. If the pressure decay is higher than the PHT specification, consider the following questions and re-test if necessary. (Rewet the filter cartridge with Methods 3 or 4 described in the "Filter Cartridge Wet-Out" Section, Page 2, and retest).

- Was the filter cartridge completely wetted out?
- Was the correct pore size filter cartridge installed?
- Was the stabilization time adequate?
- Was the test time adequate?
- Was the filter cartridge seated correctly in the housing and were the o-rings undamaged?
- Are there any leaks on the upstream side of the filter cartridge?

* Use of CO_2 in the integrity test will result in a false reading.

Table 2.

3M Filter Cartridge cartridge Housing	# EQSL†	Forward Flow Integrity Test Maximum Acceptance Value (cc/min)		Upstream Housing Volume†† (cc)	Pressure Hold Test psig/min (bar/min)	
		BNA020	BDA020/BGA020		BNA020	BDA020/ BGA020
1ZVS1	1	51	33	1,987	0.38 (0.026)	0.24 (0.017)
1ZVS2	2	102	65	3,188	0.47 (0.032)	0.30 (0.021)
1ZVS3	3	153	98	4,373	0.51 (0.035)	0.33 (0.023)
1ZVS4	4	204	130	5,557	0.54 (0.037)	0.34 (0.024)
1ZMS1	1	51	33	2,119	0.35 (0.024)	0.23 (0.016)
1ZMS2	2	102	65	3,319	0.45 (0.031)	0.29 (0.020)
1ZMS3	3	153	98	4,504	0.50 (0.034)	0.32 (0.022)
1ZMS4	4	204	130	5,705	0.53 (0.036)	0.34 (0.023)
4ZWC1	4	204	130	11,200	0.27 (0.018)	0.17 (0.012)
4ZWC2	8	408	261	14,400	0.42 (0.029)	0.27 (0.018)
4ZWC3	12	612	391	19,600	0.46 (0.032)	0.29 (0.020)
4ZWC4	16	816	522	24,800	0.48 (0.033)	0.31 (0.021)
8ZWC1	8	408	261	20,400	0.29 (0.020)	0.19 (0.013)
8ZWC2	16	816	522	28,800	0.42 (0.029)	0.27 (0.018)
8ZWC3	24	1,224	782	37,200	0.48 (0.033)	0.31 (0.021)
8ZWC4	32	1,632	1,043	45,600	0.53 (0.036)	0.34 (0.023)
11ZWC1	11	561	359	27,300	0.30 (0.021)	0.19 (0.013)
11ZWC2	22	1,122	717	42,600	0.39 (0.027)	0.25 (0.017)
11ZWC3	33	1,683	1,076	54,900	0.45 (0.031)	0.29 (0.020)
11ZWC4	44	2,244	1,434	67,200	0.49 (0.034)	0.31 (0.022)
21ZWC1	21	1,071	685	65,300	0.24 (0.017)	0.15 (0.011)
21ZWC2	42	2,142	1,369	80,600	0.39 (0.027)	0.25 (0.017)
21ZWC3	63	3,213	2,054	100,900	0.47 (0.032)	0.30 (0.021)
21ZWC4	84	4,284	2,738	136,200	0.46 (0.032)	0.30 (0.020)

†EQSL = (Equivalent Single Length) The number of standard 10 inch filter cartridge lengths.

††Upstream housing volumes assume that the inlet valve is directly connected to the housing inlet. If the inlet valve is not connected directly to the housing inlet then the upstream housing volume column must be adjusted to include the volume between the valve and housing inlet.

Bubble Point Test

Definition

The bubble point is the minimum gas pressure required to overcome the surface tension holding water in a membrane filter cartridge's pores. The bubble point pressure measurement is only recommended for single 10-inch filter cartridges. When more filter cartridge area is online, it can become difficult to distinguish diffusional flow from the true bulk flow which occurs at the bubble point pressure. (**NOTE:** For systems with more than one 10-inch equivalent filter cartridges, the Pressure Hold test is only recommended.) Prior to conducting a bubble point test, the filter cartridge must be fully wet using one of the two preferred and recommended methods (see "Filter Cartridge Wet Out" Section, Page 2). When using the Integrity Test Device, follow the installation instructions for connecting the unit to the upstream valve as shown in Figure 6. The minimum Bubble Point values are presented in Table 3.

When performing bubble point test on asymmetric membranes, the wetting fluid in the pores does not clear suddenly when a critical pressure is applied as would be the case for uniform pore diameter membranes. As upstream pressure increases, fluid gradually evacuates through the pore structure. Two things occur: 1.) As fluid is pushed through the pores, the upstream volume expands and the displaced fluid pushes gas downstream. Both responses trigger automated integrity test systems even though the pores are not clear of the wetting fluid. (The automated integrity tester senses that the bubble point has been reached) and 2.) As the liquid layer thins, the diffusion of the gas through the wetting fluid increases. This response also triggers automated integrity to sense that the bubble point has been reached. Therefore, the flow response of an integral asymmetric membrane looks just like the flow response of a broad pore size distribution symmetric membrane. The difference is that the asymmetric membrane responds to BPT testing in this way by design.

Table 3. Bubble Point Specifications

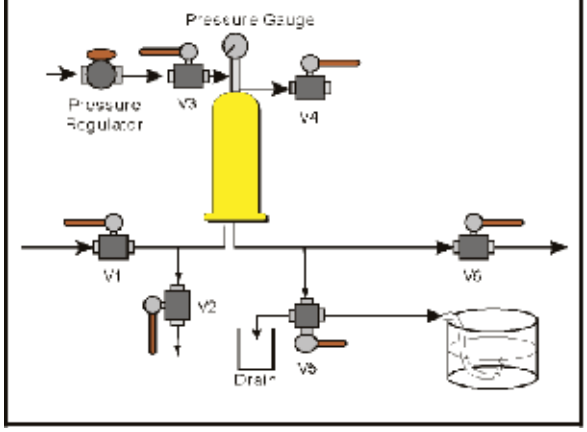
Grade ID	Minimum Bubble point
BNA020	≥ 40.0 psi (2.76 bar)
BDA020	≥ 45.0 psi (3.1 bar)
BGA020	≥ 45.0 psi (3.1 bar)

Procedure 5. Bubble Point Test (Manual Method)

(NOTE: Because this method requires opening the sterile/sanitized side of the filter cartridge system, take appropriate steps to prevent contamination.)

A. Configure the system as shown in Figure 5. Connect a pressure regulator to a clean and dry compressed air source (Do Not Use CO_2)* capable of delivering a minimum of 1.4 bar (20 psig) more than the required test pressure. Fill the reservoir to a depth of approximately 5 cm (2 inches) with clean filtered water. Connect a length of clear flexible tubing (3-6 mm I.D.) to the outlet port of drain valve V5 and place the other end into the reservoir under the clean filtered water.

Figure 5 — Bubble Point Test (Manual Method)



B. Install the filter cartridge(s) in the housing and thoroughly wet with clean, ambient temperature, filtered water using one of the two preferred and recommended wetting procedures previously described in the “Filter Cartridge Weted-Out” Section, Page 2.

C. Ensure all water has been drained from both upstream and downstream sides of the filter cartridge and valves V1, V2, V4 and V6 are closed.

D. Position valve V5 to direct flow to the water reservoir.

E. Open V3. Using the pressure regulator, slowly pressurize the system with air (DO NOT USE CO_2), raising the pressure approximately 0.35 bar (5 psig) per minute. As the pressure is being increased observe the submersed end of the tube for a vigorous steady stream of bubbles which would be indicative of either a damaged filter cartridge device or inadequate filter cartridge wetting (Rewet the filter cartridge with Methods 3 or 4 described in the “Filter Cartridge Wet-Out” Section, Page 2, and retest). When within 0.35 bar (5 psig) of the specified bubble point pressure (presented in the BPT specifications in Table 2), make only very gradual 0.07 bar (1 psig) increases allowing 10 - 15 seconds between pressure increases to observe evidence of bubbling.

F. Observe air flow from the tube connected to the downstream port. A modest flow of small bubbles is diffusional flow only. When a vigorous continuous stream of bubbles appears, the filter cartridge’s bubble point has been reached.

G. When the test is complete, compare the measured bubble point value against the acceptable limit presented in the BPT specifications in Table 3 for the filter cartridge under test.

H. After the test is complete, drain any residual water from the housing and place the cartridge back in service.

I. If the bubble point is less than the BPT specification, consider the following questions and re-test if necessary. (Rewet the filter cartridge with Methods 3 or 4 described in the “Filter Cartridge Wet-Out” Section, Page 2, and retest.):

- Was the filter cartridge completely wetted out?
- Was the correct pore size filter cartridge installed?
- Was the temperature of the water and filter cartridge ambient?
- Was the stabilization time adequate?
- Was the test time adequate?
- Was the filter cartridge seated correctly in the housing and were the o-rings undamaged?
- Are there any leaks in the system?

* Use of CO_2 in the integrity test will result in a false reading.

Technical Information:

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