

3M Separation and Purification Sciences Division

# 3M™ LifeASSURE™ EPF Series Filter Cartridge Integrity Testing

## Introduction

Integrity testing is the end user's method of confirming the structural integrity of a membrane filter before and after use. It is a nondestructive testing that has been correlated to membrane retention and validates the performance of the filter cartridge.

The following procedures provide the instructions for integrity testing 3M™ LifeASSURE™ EPF Series 10" filter cartridges. Contact 3M Technical Service for details on how to integrity test other cartridge configurations.

## Background

According to *Fick's Law of Diffusion*, when a differential gas pressure exists across a wetted membrane, the gas molecules will "diffuse" through the wetting fluid filling the pores of the membrane. The rate of passage is proportional to the solubility of the gas in the wetting fluid, the surface tension of the wetting fluid, the differential pressure, the thickness of the membrane, and the surface area of the membrane.

Product	Test Pressure PSIG (bar)	Maximum Allowable Diffusion (cc/min)
EPF004	35 (2.41)	25
EPF020	35 (2.41)	51

### **WARNING**

- **To reduce the risk associated with personal injury due to system failure:**
  - **Depressurize** the system prior to installation and prior to removal.

### **CAUTION**

- **To reduce the risks associated with chemical exposure which, if not avoided, could result in minor or moderate injury:**
  - Always use appropriate personal protective equipment (PPE), including eye and face protection, protective gloves during filter change out and startup.
  - Do not use a cartridge that has been damaged or has damaged components.
  - Do not modify the cartridge or its components.
- **To reduce the risks associated with environmental contamination which, if not avoided, could result in minor or moderate injury:**
  - At the end of usable life, dispose of cartridge in accordance with applicable local, state, and federal regulations or laws.

# Test Method — Pressure Hold Test

## 1. Definition

A variation of the Forward Flow Integrity Test (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 decay of pressure in a closed volume on the upstream side of the membrane as the gas diffuses through the membrane. PHT values are dependent on the volume of the specific filter housing employed, less the volume of the installed cartridges. Therefore, they must be determined on a case by case basis. Please contact 3M Purification Inc. for assistance, if necessary.

The 3M™ 101 Series Automated Integrity Tester can be used to perform a PHT. When using the 3M 101 Series unit, follow the installation instructions for connecting the unit to the upstream valve as shown in Figure 1. Consult the appropriate 3M Purification Inc. literature for the test pressure and PHT value for the filter cartridge to be used or calculate the maximum allowable value using the following equation. Program these values into the 3M 101 Series Automated Integrity Tester when requested during the test set-up.

The following equation can be used to calculate the PHT value:

$$\Delta P = D(P_a)T/V_{hsg}$$

D = Manufacturer's maximum allowable diffusion rate for all the installed filters in cc/min (see FFIT specifications)

T = Time (typically 3 minutes)

P<sub>a</sub> = Atmospheric pressure

V<sub>hsg</sub> = Upstream housing volume (cc) less the volume occupied by the cartridge(s)

ΔP = Allowable pressure loss

## 2. Procedure (Manual Testing — Figure 1)

### ⚠ WARNING

- To reduce the risk associated with burn or system burst related injuries:
  - Do not exceed maximum operating pressure or temperature limits described on the vessel dataplate.

### ⚠ CAUTION

- To reduce the risk associated with exposure to contaminants:
  - Always use appropriate personal protective equipment (PPE) when installing, operating or changing the product as per your standard operating procedure.
  - Ensure that inlet/outlet valves are closed and all system pressure has been relieved prior to opening the system to atmosphere.

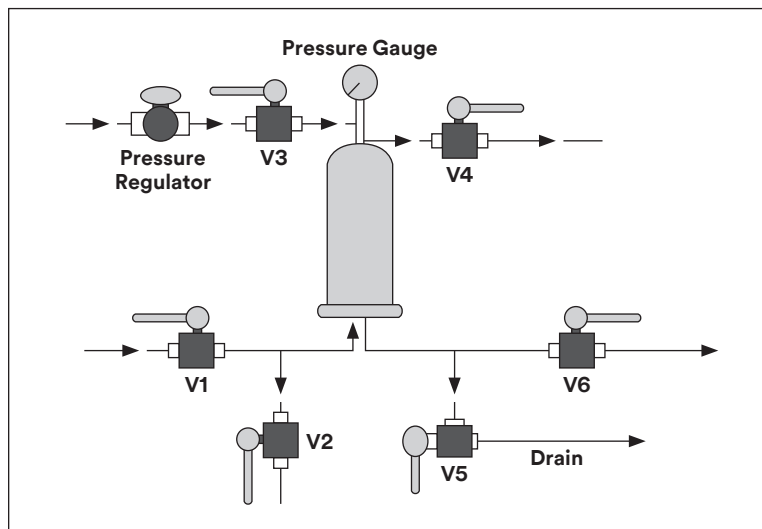


Figure 1. Schematic of the Manual PHT.

- A. Configure the system as shown in Figure 1.
- B. Install the filter in the housing and flow wetting fluid (25% / 75% TBA — Tertiary butyl alcohol / water, or 60%/40% IPA (v/v) @ 20 °C through the filter at a rate of approximately 1 gpm/10" cartridge for a minimum of 2 minutes.
- C. Close inlet V1 and outlet valve V6 to isolate the housing. Drain all the wetting fluid from the upstream side of the filter by positioning V5 to direct flow to drain. Adjust the pressure regulator to deliver 3–5 psig of air or nitrogen (DO NOT USE CO2). Slowly open V3. Close V3 when wetting fluid discharge is no longer evident.
- D. Disconnect the wetting fluid supply line and allow the wetting fluid to drain from the housing. Leave V5 or V6 open to atmosphere.
- E. Open V3 and slowly adjust the pressure regulator to pressurize the system to the specified PHT pressure value and allow the system to equilibrate for a maximum of two minutes.
- F. Using a stopwatch, measure the pressure decay for 3 minutes. Calculate the pressure decay over the 3 minute period in psi/min.
- G. When the test is complete, compare the measured Pressure Hold value against the acceptable pressure hold value for the filter cartridge under test.
- H. After the test is complete, flush the wetting fluid from the assembly with clean, filtered water and drain the wetting fluid from the housing or adjust the pressure regulator to deliver 3–5 psig of air or nitrogen. Slowly open V3. Close V3 when wetting fluid discharge is no longer evident. Dry the cartridge before placing the cartridge in service.
- I. If the pressure decay is higher than the specification, consider the following questions and re-test if necessary:
  - Was the filter completely wetted?
  - Was the correct pore size filter installed?
  - Was the temperature of the wetting fluid and filter ambient?
  - Was the stabilization time adequate?
  - Was the test time adequate?
  - Was the filter seated correctly in the housing and were the O-rings undamaged?
  - Are there any leaks on the upstream side of the filter?

### 3. Procedure (Automated Test — Figure 2)

#### **⚠ WARNING**

- **To reduce the risk associated with burn or system burst related injuries:**
  - Do not exceed maximum operating pressure or temperature limits described on the vessel dataplate.

#### **⚠ CAUTION**

- **To reduce the risk associated with exposure to contaminants:**
  - Always use appropriate personal protective equipment (PPE) when installing, operating or changing the product as per your standard operating procedure.
  - Ensure that inlet/outlet valves are closed and all system pressure has been relieved prior to opening the system to atmosphere.

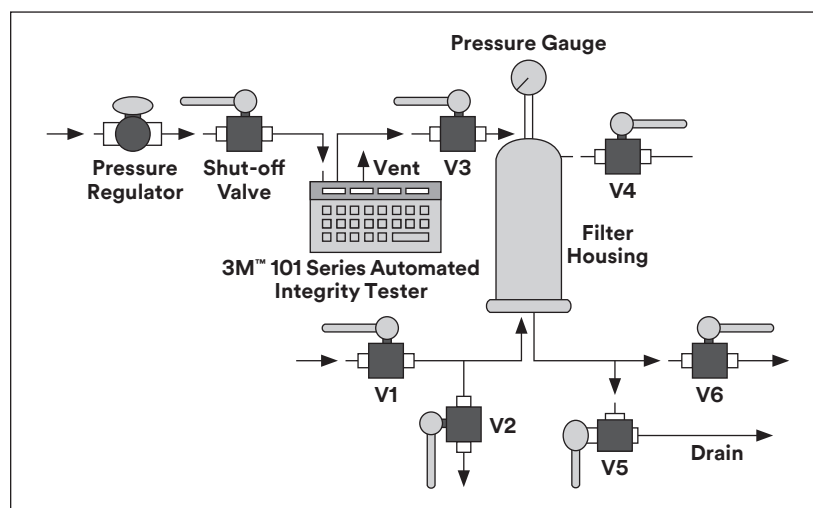


Figure 2. PHT (Automated Method).

- A. Configure the system as shown in Figure 2.
- B. Install the filter in the housing, close all valves except V1, V4, and V6, and flow wetting fluid (25% / 75% TBA — Tertiary butyl alcohol/water, or 60% / 40% IPA (v/v) @ 20 °C) through the filter at a rate of approximately 1 gpm/10" cartridge for a minimum of 2 minutes. Initially, leave V4 partially open until the housing is completely vented out by observing bubble free liquid discharge then close V4 until the flow is complete.
- C. Close inlet V1 and outlet valve V6 to isolate the housing. Drain all the wetting fluid from the upstream side of the filter by positioning V5 to direct flow to drain. Adjust the pressure regulator to deliver 3–5 psig of air or nitrogen (DO NOT USE CO2). Slowly open V3. Close V3 when wetting fluid discharge is no longer evident.
- D. Disconnect the wetting fluid supply line and allow the wetting fluid to drain from the housing. Leave V5 or V6 open to atmosphere.
- E. Close V1 and connect the 3M™ 101 Series Automated Integrity Tester at V3 and initiate the PHT protocol. Close the housing inlet valve V1 and connect the 3M 101 Series Automated Integrity Tester at V3 and initiate the automated FFIT protocol. When prompted, program a stabilization time of 2 minutes and a test time of 3 minutes.
- F. When the test is complete, compare the measured Pressure Hold value against the acceptable limit for the filter cartridge under test.
- G. After the test is complete, flush the wetting fluid from the assembly with clean, filtered water and drain the water from the housing. Slowly open V3. Close V3 when wetting fluid discharge is no longer evident. Dry the cartridge before placing the cartridge in service.
- H. Disconnect the 3M 101 Series Automated Integrity Tester from the housing.
- I. If the pressure decay is higher than the specification, consider the following questions and re-test if necessary:
- Was the filter completely wetted?
  - Was the correct pore size filter installed?
  - Was the temperature of the wetting fluid and filter ambient?
  - Was the stabilization time adequate?
  - Was the test time adequate?
  - Was the filter seated correctly in the housing and were the O-rings undamaged?
  - Are there any leaks on the upstream side of the filter?

<b>Technical Information</b>
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