TESTING AT VERY LOW FLOWRATE

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Buildings are becoming tighter and tighter, leading to test at very small flowrate compared to the volume of the building. Airtightness testers sometimes experience difficulties to perform tests in such airtight buildings. Those difficulties are due to two issues:

- the pressure and/or flowrate are difficult to stabilize.
- the device used may not be able to measure at a small enough flowrate (for example when testing small shops or student dwellings)

This document explains the reasons behind those difficulties, gives advice to perform a test at very low flowrate and gives the flowrate limits of classical devices.

1 WHAT IS THE ISSUE WHEN TESTING A VERY AIRTIGHT BUILDING?

1.1 THE PRESSURE AND FLOW RATE ARE DIFFICULT TO STABILIZE

When a building is very airtight and very large, the flow rate needed to maintain the building at a constant pressure is very small compared to the volume. However, due to the compressibility of air, the amount of supplied air (in m^3) needed to reach 50 Pa is proportional to the volume. Therefore a large amount of air is needed but is provided by a small flow rate, so it may take time for the pressure to reach the required 50 Pa. This is like trying to inflate a car tire with a bicycle pump.

Furthermore, it could be necessary to adjust the parameters of the fan's control in order to take into account the specific conditions of very airtightness buildings, because it may take longer than to reach a stabilized pressure.

For example, in a very tight and very large building (200 000 m^3), up to 5 minutes were needed to reach a stable pressure at 50 Pa (100m^3 or 120kg air is needed). In a very airtight building it was also observed that it takes a long time to get back to the initial pressure when the test stops.

1.2 THE DEVICE IS NOT ABLE TO PERFORM THE MEASUREMENT AT SMALL FLOW RATE ACCORDING TO THE TECHNICAL SPECIFICATIONS STS-P71-3

In some cases the flow rate required to reach the low pressure point is below the range of the measuring device. This problem can be experienced when measuring a very small and airtight volume such as a small shop independent of the rest of the building on the ground floor, or student dwellings.

In this case the measurement device won't be able to perform the measurement at low pressure point or will but with a large uncertainty. Information is given in section 3 of this document to check the compatibility between measurement devices and the tested building.

2 PRACTICAL ADVICE TO PERFORM THE TEST

To ease a test in a very airtight/very large building the following recommendations can be followed:

- Not to use an automatic fan control
- Try to assure that the temperature inside the building stays as constant as possible during the test as heating or cooling the air causes it to expand or contract and this changes the pressure
- Cruise on the fan flow rather than on the pressure of the room

It is also important to notice that varying external parameters such as wind or other occupant behaviour (when testing a dwelling in a multi-family building) will further complicate the stabilization of the flow rate and pressure. Therefore those tests shall preferably be performed in no-wind conditions and occupants of adjoining apartments shall not open doors and windows during the test.

2.1 USE A SEMI-AUTOMATIC FAN CONTROL

When a test is performed on a very airtight building it is better not to use an automatic fan control, but to use software that shows the change in pressure and flow rates to determine when pressures are stable and you are ready to start sampling data.

It is better to increase the recording duration for each point in each pressure difference up to 60 or even 120 seconds.

2.1.1 WITH MINNEAPOLIS BLOWERDOOR

If the test is performed with TECLOG it is possible to see the building pressure evolution and start the recording when a plateau is reached.

If TECTITE Expresse is used then use a sample rate between 500 and 1000 data points per target pressure. The test takes slightly longer but the additional points are useful in order to reach a better uncertainty. Use the semi-automated test if it takes longer than 120 seconds to stabilize the pressure of the room; guidelines to perform such a test with Tectite are given in the Annex.

2.1.2 WITH RETROTECD

The automatic test mode on FanTestic will attempt to reach target pressure with a time-out of 240 s. Once timeout is reached the user will be prompted and can continue trying to reach pressure (without having the fans stop).

To improve the odds that automatic mode will work, increase the number of samples over which the average is taken when FanTestic is determining if the room pressure has been achieved (part of the “pressure target arrival criteria”). (see Annex for details on this)

In cases where the Automatic mode keeps timing out or is not able to stabilize on a target pressure, users can switch to using semi-auto at any time during a test.

Before an automatic test, use the Set Pressure option on the DM32 gauge and try for 50 Pa. If the DM32 has trouble stabilizing during Set Pressure, you know you will need to do a Semi-Auto test, and control fan speed directly.

2.2 TRY TO MAINTAIN THE TEMPERATURE IN THE BUILDING CONSTANT

Temperature variations induce pressure change, so heating or cooling the indoor air may induce pressure variation in the building. If the heating or cooling system is able to modulate its output quickly enough to maintain a constant heating or cooling rate, then it can be left running during the test. However, if the heating or cooling system is not able to maintain a constant temperature then it is better to turn it off and, if possible, to keep the building at the outdoor temperature during the test. It is better to avoid large temperature differences between inside and outside the building.

2.3 CRUISE ON THE FAN FLOW RATHER THAN ON THE PRESSURE OF THE ROOM

If the test is performed manually, the following procedure can be done:

- Increase the flow rate manually
- maintain the flow rate constant until the pressure is constant
- adjust the flow rate and wait until the pressure is constant (redo this step until the required pressure is obtained)

When the flow rate is constant and the pressure constant at the required pressure, record pressure and flow rate.

2.3.1 WITH MINNEAPOLIS BLOWERDOOR

In TECTITE Express it is possible to use the semi-auto mode (see annex) to perform the test this way. The user can control the fan by turning the knob of the speed controller. When the pressure and flowrate is constant, the user can press "start sampling". In this case, before starting the test, it is good to increase the samples per station to 500 to 1000 data points.

This process is easier and much more understable with TECLOG as it shows the graph of the pressure evolution. The tester can see and choose the optimal readings

2.3.2 WITH RETROTEC

In FanTestic the semi-auto mode (see Annex) is provided to control the speed of the fan from the software and capture the data when the user determines that the room pressure and flowrate are stable. The user can monitor the pressure in the room and the flowrate using FanTestic until the target has been reached and then press "Capture data". Each target point in the test can be performed this way.

In cases where the Automatic mode keeps timing out or is not able to stabilize on a target pressure, users can switch to using semi-auto at any time during a test. They can also add target points to an existing test, or delete bad captured target data and re-do the target point using semi-auto.

3 LIST OF DEVICES AND CORRESPONDING FLOWRATE /TESTABLE VOLUME/AIRTIGHTNESS

3.1 HOW TO MAKE SURE THAT YOUR DEVICE IS ABLE TO PERFORM THE TEST

According to the tested zone and the available device, the following calculation can be performed to estimate the minimum v_{50} ($v_{50;min}$, in m^3/h per m^2 envelope area) measurable.

Information needed:

- S : envelope area of your building (area used in the calculation of the v_{50}) in m^2

- n: flow rate coefficient, the average value is 2/3 but in very tight building with very small leakage it can reach almost 1, to perform a safe side calculation n=1 shall be used
- Q_{min}: minimum flow rate your device can test (see Table 1) in m³/h
- ΔP_{min}: minimum pressure difference to reach, in no wind conditions or temperature difference ΔP_{min}=10 Pa

$$v_{50;min} = \left(\frac{50}{\Delta P_{min}}\right)^{n} \frac{Q_{min}}{S}$$

For example for a Model 4 Minneapolis Blower Door (Q_{min}= 19 m³/h), in a dwelling with an envelope area of 100m², you may not be able to perform the test according to STS-P 71-3 if the dwelling is tighter than v_{50}=0.95 (the lowest target pressure of 10 Pa may not be reached).

For very tight buildings the leakage of the equipment used to test become very important and therefore additional taping may be needed.

3.2 MINIMUM FLOWRATE REACHABLE BY CLASSICAL DEVICES

The table below sums up the minimum flow rate reachable by classical devices in the market

Table 1: Minimum flow rate reachable by devices

Mineapolis Blowerdoor	Model 4	19 m³/h
	Minifan (Duct Blaster B)	5 m³/h
	Micro Leakage meter	0.17 m³/h
Retrotec	Model 5000 series	15.5m³/h
	Model 300 series	9.1m³/h

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Only two brands and products are mentioned, however it does not mean a value or quality judgement of these products and brands.

Retrotec and Blowerdoor Minneapolis have been involved in the writing of this document.

5 ANNEX

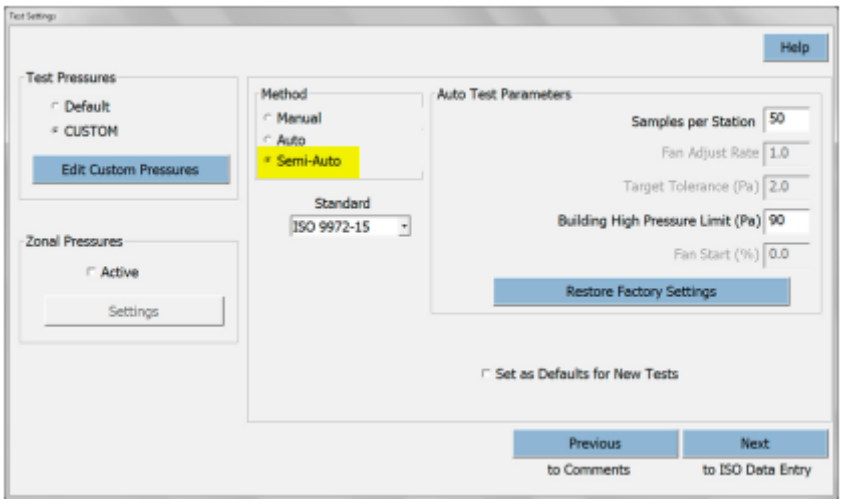
5.1 HOW TO PERFORM A TEST WITH TECTITE EXPRESS IN VERY AIRTIGHT BUILDINGS

5.1.1 WITH VERSION 4.1 AND 5.1

Starting with the update of TECTITE Express to version 4.1 and in the current version 5.1 the software gets an extra method “Semi- Auto” in order to do a semi-automated test. The semi-automated test is used for buildings or dwellings if it is not possible to do an automated test because of:

- a very good / excellent airtightness
- unsteady wind
- adjoining building parts with disturbing pressure fluctuations

or a combination of these points.



The difference between an automated and semi-automated test are

- during the **automated test** the **software controls the fan speed** up and down
- and in the **semi-automated** test the **tester controls the fan speed** up and down.

5.1.1.1 TRY TO ADJUST THE SETTINGS IN AN AUTOMATED TEST

During a fully automated airtightness test, the computer is in charge of adjusting the fan to reach the desired (or target) building pressures. In the **automated test** the software jumps after finishing data sampling for one target pressure to the next target pressure. Then the fine-tuning starts in order to get as near as possible to the target pressure . If the pressure fluctuation is too large and it isn’t possible to get a stable (constant) building pressure within 120 seconds, the software stops the fan and shows the message “excessive building fluctuation” and the user has the possibility to change settings of the automated control.

One of the settings is the "fan adjust rate". The fan adjust rate determines how quickly the fan speed changes as the computer tries to achieve the target building pressure. For most cases, the default fan adjust rate of 1.0 will work fine. In some cases it may be necessary **to reduce the fan adjust rate** to **prevent the fan from responding too quickly**. In a tight building, the fan adjust rate can be reduced to 0.2 so that the fan adjusts slowly enough to help complete the test. Note that the test will take longer.

If it is still not possible to get a stable building pressure with that setting, this is a reasonable sign for the tester to switch to the semi-automated test.

5.1.1.2 THEN SWITCH TO A THE SEMI-AUTOMATED TEST

The advantage of the **semi-automated** test is that the user has **unlimited** time to adjust the fan and that the tester decides to start sampling data points for each target pressure.

More information on the semi-automated test is available on the Reference guide BlowerDoor Standard or Reference guide BlowerDoor MiniFan (https://www.blowerdoor.com/en/services/downloads/reference-guides/It is also recommended to increase the number of samples per target pressure (station) up to 500 – 1000.

5.2 USE RETROTEC FANTESTIC TO TEST TIGHT ENCLOSURES

Retrotec FanTestic has always had a Semi-automatic mode to allow users to have control over the fans but still allow them to capture data in an automatic way. In cases where the Automatic mode keeps timing out or is not able to stabilize on a target pressure, use semi-auto. You can switch to using semi-auto at any time during a test, and can add points to an existing test (as long as you are using the same gauge/fan combination(s)). If you are in the midst of an automatic test, click Stop Test, and then use the “Begin Semi-Auto” button.

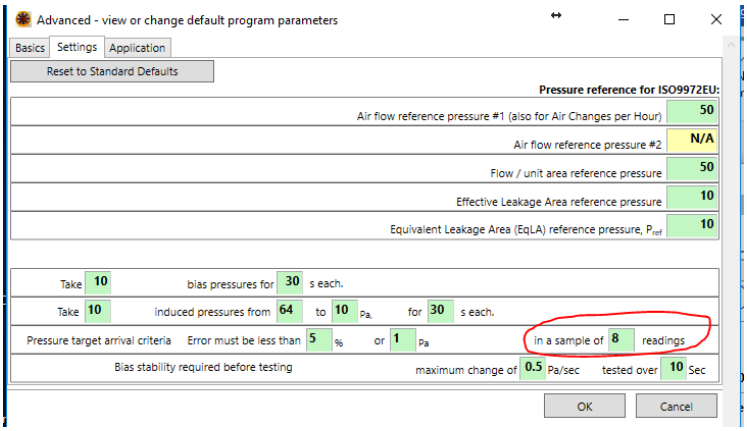
Before starting a test, Retrotec recommends doing a check of the building with the fan(s) using just the gauge – tap the Set Speed on the gauge and set it to 50% to see how the building responds, and try other speeds to characterize the building before the automatic test.

Stop the fan and then tap Set Pressure on the gauge and try for 50 Pa (or the maximum required for your test). With this you can determine if the range is set correctly (if you get fan pressure too low warning, change to a more restrictive one, if you reach 100% speed, go to a larger range). This way you can get your fan set up with the best range for the highest pressure before the test starts, and in many cases there will not be a range change required. You can also check your minimum required target pressure to see if a range change will be required.

If the gauge itself has trouble stabilizing during Set Pressure, you know you will need to use a Semi-Auto test, and control fan speed directly.

5.2.1 TRY AUTOMATIC MODE

To improve the odds that automatic mode will work, increase the number of samples over which the average is taken when FanTestic is determining if the room pressure has been achieved (part of the “pressure target arrival criteria”). Open Settings>>Advanced Options>>Settings Tab . Set this number to be 30-50, but remember to change it back if your tests are reaching pressure more easily in a different building and FanTestic is waiting too long to start capturing data. After you change this setting you must start a new test.

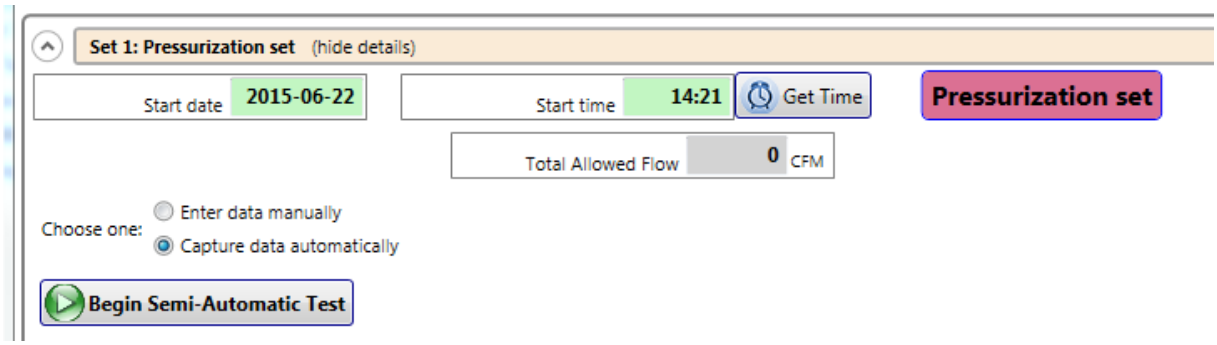


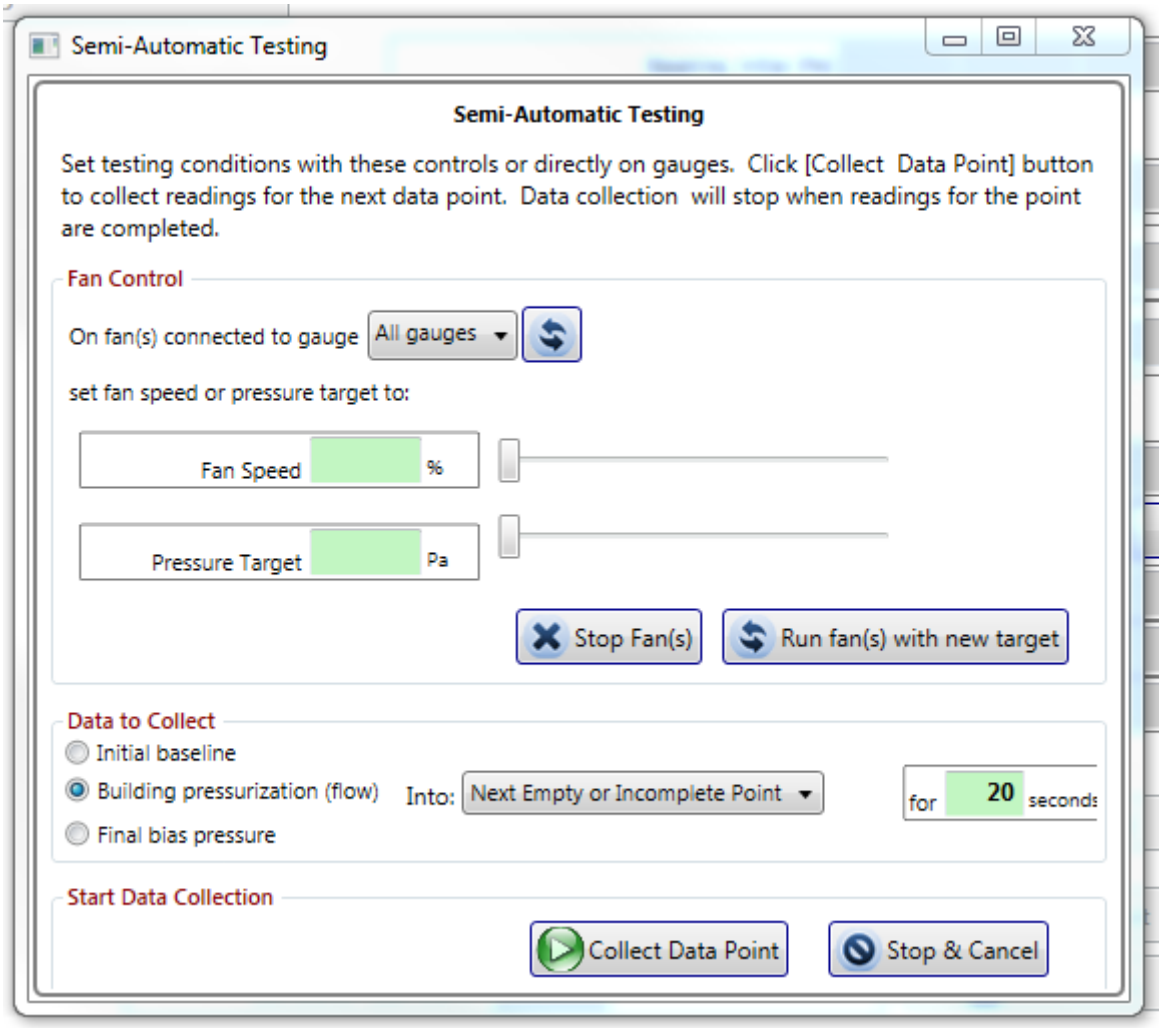
You can switch to using semi-auto at any time during an automatic test. You can also add points to an existing test (as long as you are using the same gauge/fan combination(s)). If you are in the midst of an automatic test, click Stop Test, and then use the "Begin Semi-Auto" button.

5.2.2 USE SEMI-AUTOMATIC MODE

If the gauge itself has trouble stabilizing during Set Pressure, you know you will need to use a Semi-Auto test, and control fan speed directly.

Use the "Begin Semi-Auto" button to open the Semi-Auto Window:





Choose which gauge you want to control (or all at the same time) and set the fan speed to a value. Click on "Run fan(s) with new target". When the room pressure and flowrate are stable, click on "Collect Data Point". You can choose which target point to save the data into, and you can choose how long to capture data for on each target point.

The saved data shows up in the main screen of FanTestic, just as an automatic captured target point would.

More information on using the semi-automatic mode is provided in the FanTestic User Manuals provided in the Help menu of FanTestic (so you always have access) or at the following download link:

https://retrotec.com/manuals-guides