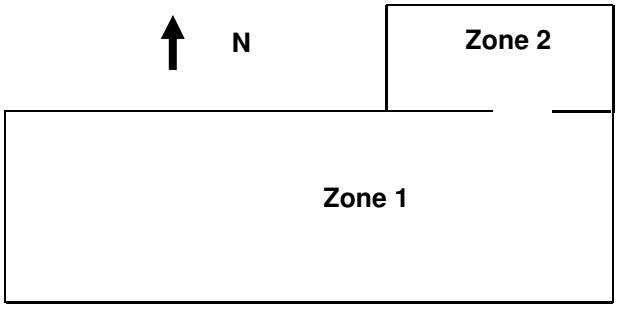
Example Multi-Fan Airtightness Test with TECLOG3
Setting up and Conducting a Test

Introduction:

This paper documents how TECLOG3 was used to conduct a multi-fan blower door airtightness test on a commercial building using the building envelope test protocol developed by the U.S. Army Corps of Engineers (Ver. 3). The building tested consists of one large (Zone 1 - offices) and one small (Zone 2 - warehouse) connected spaces. The two spaces are separated by a sheetrock wall which includes double doors allowing access between the office and warehouse spaces. The entire structure has an airtightness level that required 4 blower door fans to induce a change in building envelope pressure of approximately 75 Pascals.

Example Building



TECLOG3 is The Energy Conservatory's (TEC) data logging program. TECLOG3 is designed to work with up to 16 digital pressure gauges (DG-1000 or DG-700) to monitor and store data from differential pressure channels, and to provide computerized control of multiple Minneapolis Blower Door fans. The program provides easy control of data acquisition parameters and includes a feature to calculate multi-fan airtightness test results. TECLOG3 continuously records pressure and fan flow data during an entire airtightness test sequence, from beginning to end. The user selects time periods on the graph that will be used in the final airtightness test results.

Step 1: Document the Floor Plan, and the Locations of Blower Door Fans and Pressure Measurements.

For complicated buildings and especially when using TECLOG3 for the first time, it is helpful to fill in the TECLOG3 configuration worksheet before entering the configuration settings into the program. A blank copy of this worksheet is found under the TECLOG3 help menu.

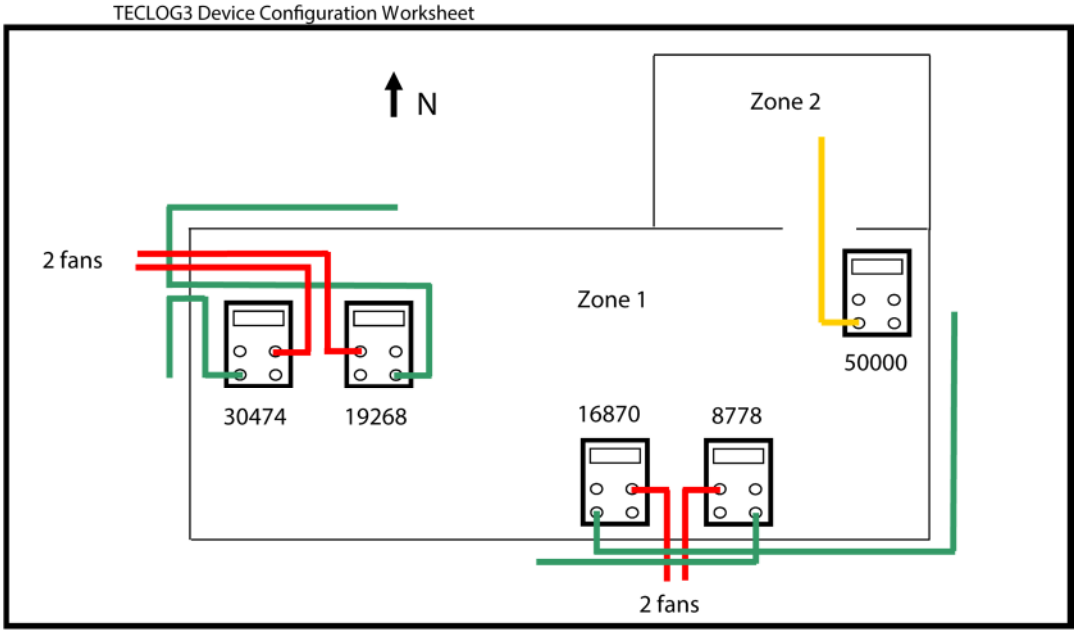
The top of the configuration worksheet contains space for a simple building floor plan. It is always helpful to mark down the approximate locations of fans and pressure gauges, as well as the tubing connections and outdoor terminations. For this test, we used a total of 4 blower door fans and 5 DG-700 gauges (10 total pressure channels). We installed two 2-fan blower door systems in exterior doors in the office space. The fans were initially set up to depressurize the building. We also measured the building envelope pressure with reference to (WRT) outside on all 4 sides of the building. TECLOG3 allows us to average the 4 building envelope pressure measurements into a single pressure reading. We have found that this technique greatly reduces envelope pressure fluctuations from wind. Finally, we measured the differential pressure between the office and the warehouse to check for pressure uniformity during the test. **Note:** For this test all 5 gauges were communicating wirelessly with TECLOG3 using TEC WiFi Links.

The bottom portion of the configuration worksheet is used to record the serial numbers of the DG-700 gauges being used, to document what each pressure channel is being used to measure (i.e. channel label), and to provide a label for each gauge (i.e. gauge label). In this test, a total of 9 pressure channels were used

(4 for fan flows, 4 for building envelope pressure WRT outside, and 1 for the pressure uniformity between the two building zones). One of the DG-700 pressure channels was left unused.

Completed Configuration Worksheet

TECLOG3 Device Configuration Worksheet

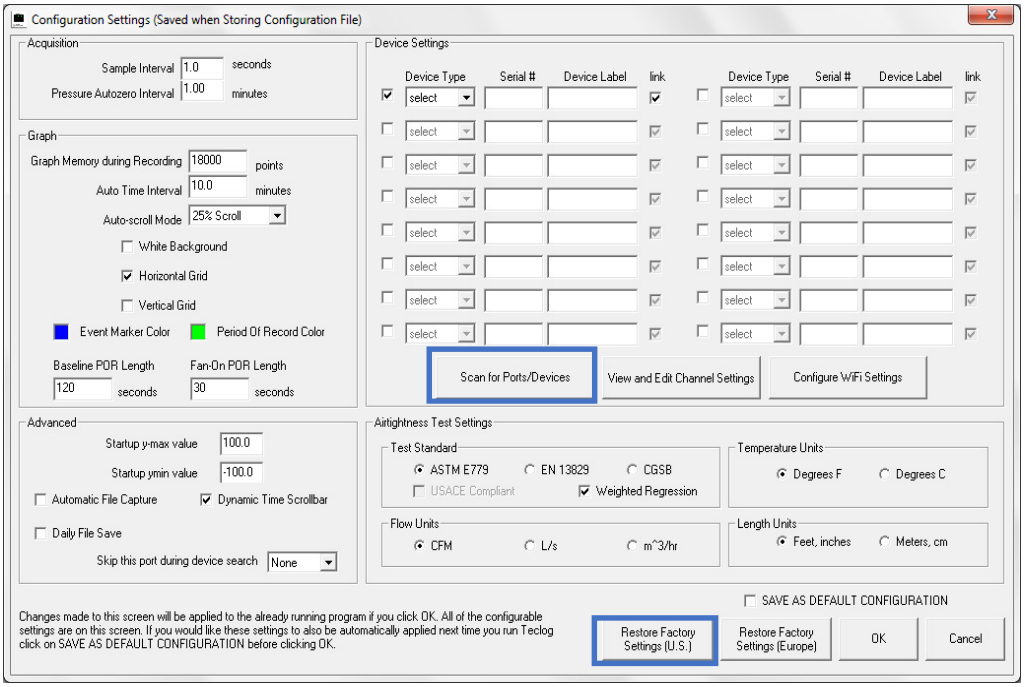


Serial	16870	Label	South 1	Serial		Label	
Chan A	East - Env	Chan B	Fan 1 - South	Chan A		Chan B	
Serial	8778	Label	South 2	Serial		Label	
Chan A	Fan 2 - South	Chan B	South - Env	Chan A		Chan B	
Serial	30474	Label	West 1	Serial		Label	
Chan A	West - Env	Chan B	Fan 1 - West	Chan A		Chan B	
Serial	19268	Label	West 2	Serial		Label	
Chan A	Fan 2 - West	Chan B	North - Env	Chan A		Chan B	
Serial	50000	Label	Interior	Serial		Label	
Chan A	Int Z1 to Z2	Chan B	unused	Chan A		Chan B	

Step 2: Edit the TECLOG3 Configuration Settings.

Once the configuration worksheet is completed, we are ready to enter the configuration settings into TECLOG3. Choose **Settings** from the **Configuration** menu at the top of the TECLOG3 screen.

If this is the first time you have used TECLOG3 on this particular building, it is a good idea to click on ***Restore Factory Settings (U.S.)***. This puts TECLOG3 into a known condition and provides a basis for the following discussion. The Factory Settings (U.S.) are shown in the screen below. **Note:** If you have tested this same building before and will be using the exact same equipment setup, you can load all of the configuration settings by loading a previously stored TECLOG3 data file, or by loading a previously saved TECLOG3 configuration file.

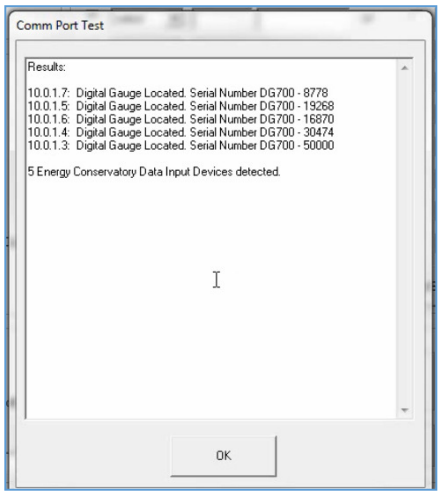


a. Device Settings.

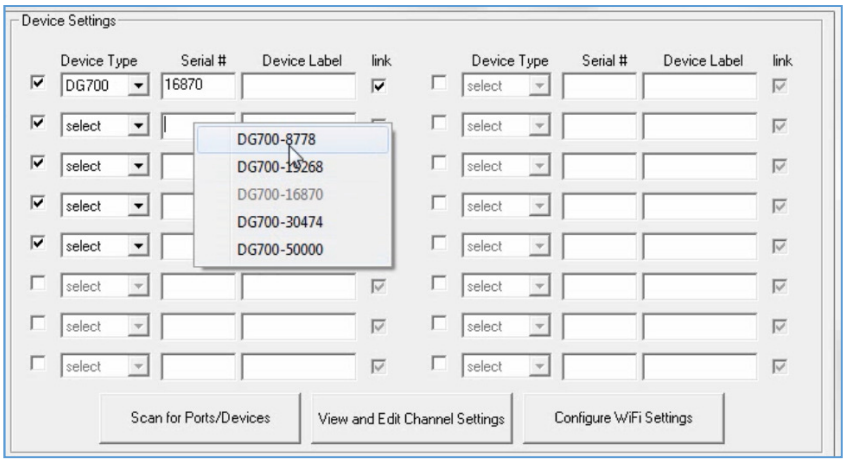
The first step is to enter the device settings for the gauges that will be used during the test (5 DG-700 gauges in this example). Before entering the devices it is often useful to click on the ***Scan for Ports/Devices*** button. The scan feature conducts a complete scan of all communication ports and available wireless networks, and provides a listing of all TEC devices and device serial numbers that are currently available to use. This confirms that TECLOG3 can establish a communication link with each device you are planning to use for the test. In addition, whenever a scan is undertaken, TECLOG3 stores a temporary table of serial number and device types that it finds, which makes completing the **Device Settings Table** easier.

Note: TECLOG3 can communicate with gauges through the computer's USB ports, Ethernet port (DG-1000 only), serial ports (DG-700 only) and wirelessly using the computer's wireless network adapter (requires a TEC WiFi Link if using DG-700 gauges)). All TEC devices must be properly connected to the computer and turned on in order to be detected during the scan.

Completed Scan for Ports/Devices



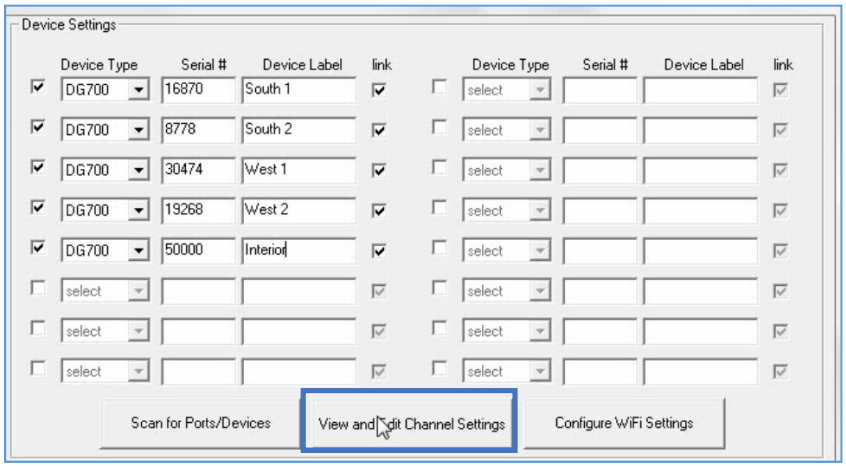
Each gauge (device) gets entered on a separate line in the **Device Settings Table** (the left check box must be checked in order to activate each line). Gauges can be entered manually by choosing the device type from the drop down list, and then entering the serial # and a device label of your choice. If you have performed a scan, you can simply double click in one of the activated serial number fields and a table will appear showing all of the gauges and serial numbers discovered during the most recent scan. Click on the gauge you wish to enter and the device type and serial number will be automatically entered into the **Device Settings Table**. Move down to the next activated row and repeat the process. Once all gauges have been entered, add an appropriate label for each gauge to document your test setup.



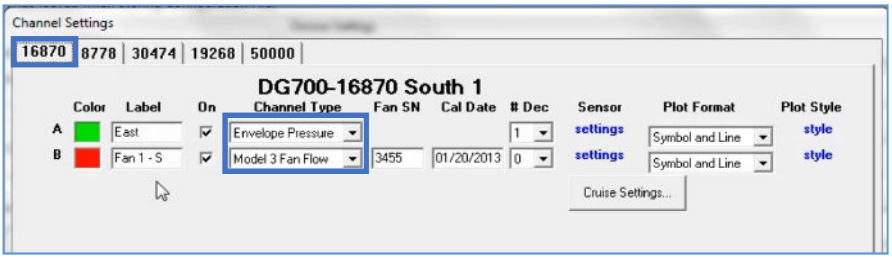
The **link** checkbox refers to the device's relationship to the **Master Fan Control Slider** and **Master Cruise Control** (see below). Selecting this option causes the devices fan control port to be linked to both of the Master Fan Controls. This linked or unlinked status can be changed during recording. For each device's fan control port that you want to be controlled by the Master Fan Controls, check **link**. For each device's fan control port that you would like to be under independent control (for example to facilitate the balance of interior pressures) uncheck **link**. **Note**: In this example we linked all 5 DG-700 gauges even though only two of the gauges were used to control fans - we did not use the fan control ports on the other 3 gauges.

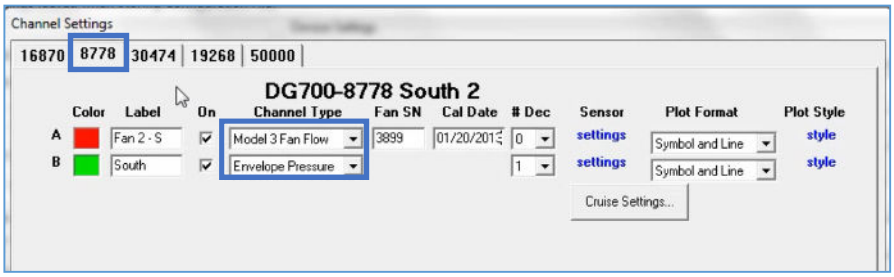
b. View and Edit Channel Settings

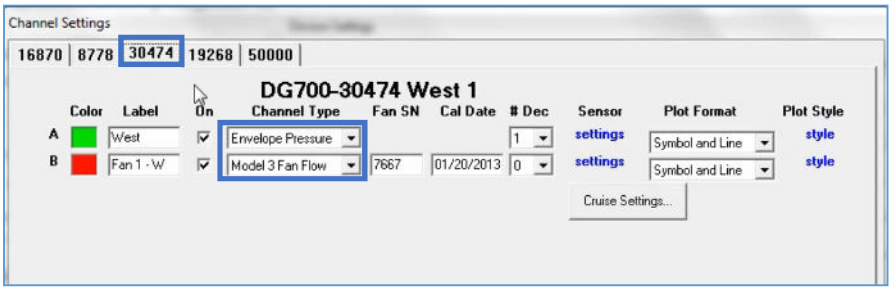
Once you have entered the device settings, you need to configure the channel settings for each of the gauges. Click on ***View and Edit Channel Settings***. The **Channel Settings Window** appears with tab(s) at the top of the window for each of the gauges entered. The figures below show the channel settings entered for each of the gauges used in the test.

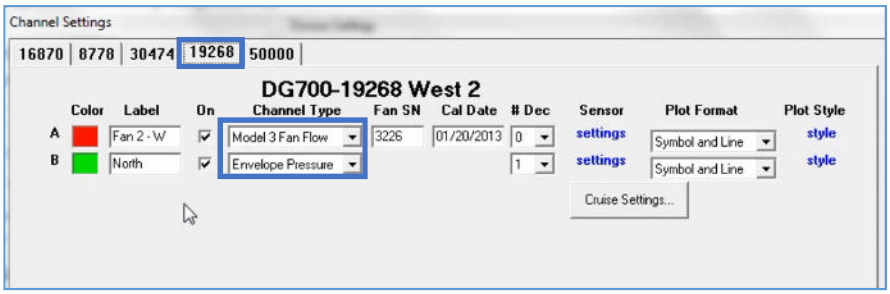


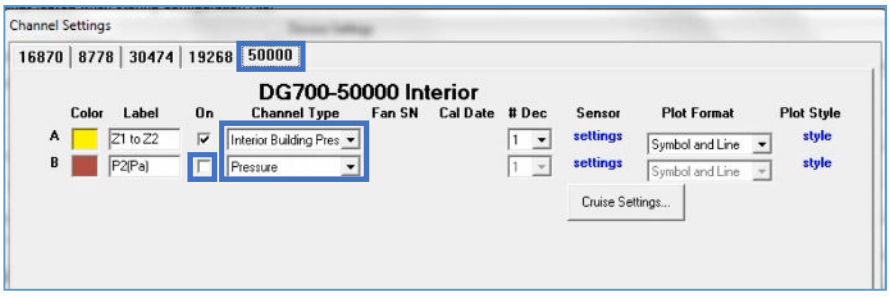
Channel Settings for Each Gauge











Color Convention: TECLOG3 defaults to the following recommended color convention; - ***Green*** for channel type set to Envelope Pressure, ***Red*** for channel type set to Model 3, Model 4 or Duct Blaster Fan Flow, and ***Yellow*** for Interior Building Pressure. You may choose other colors by clicking on the color box.

Channel Label: Enter the channel label from the configuration worksheet.

On: Check the ***On*** box to activate the channel (**Note:** one channel has not been activated in this example because we only need 9 total channels).

Channel Type: Select the appropriate channel type from the pull down menu.

Pressure: This is the default channel type and is a generic differential pressure channel.

Interior Building Pressure: When conducting an airtightness test, this channel type is used to measure pressures between various constricted zones in the building to monitor if there are unacceptably large pressure differences occurring during the test.

Envelope Pressure: When conducting an airtightness test, you must choose at least one channel to be your building envelope pressure channel. If you choose more than one, then the average of these channels will be used. The use of multiple building envelope pressure channels can help mitigate the effects of wind on the airtightness test results.

Model 3 Fan Flow, Model 4 Fan Flow and Duct Blaster Fan Flow: If you are conducting an airtightness test you need to have at least one of the channels set to be a fan flow. When one of these channel types is selected, the corresponding channel will be split into 3 channels on the main TECLOG3 readouts and graph (displaying fan pressure, fan ring and fan flow). If you select a fan flow channel type, you also have the ability to enter and record a fan serial number and calibration date.

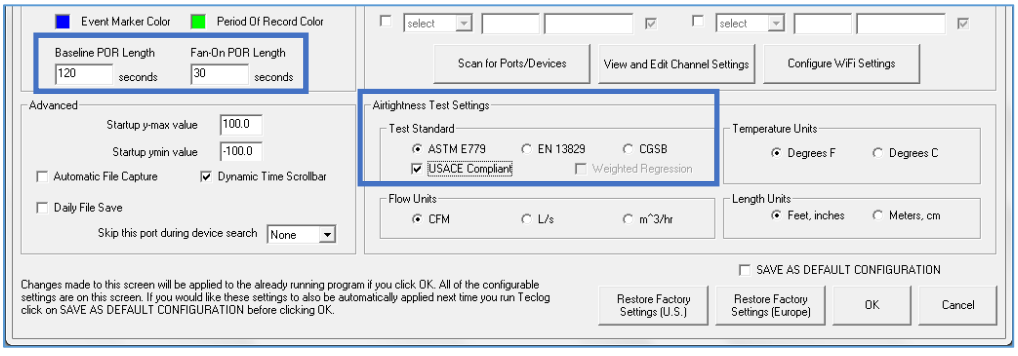
 # Dec: Select the number of decimal places you want displayed for each channel.

Sensor Settings: Do not change – leave factory defaults

Plot Format: Select a plot format, or leave factory defaults.

Plot Style: Select a plot style, or leave factory defaults.

When you have finished entering the channel settings, return to the main **Configuration** screen and click on ***USACE Compliant*** (in the **Airtightness Test Settings** section) because we are performing the test according to the US Army Corp of Engineers test standard. You can keep the default ***Baseline POR Length*** and ***Fan-On POR Length*** to 120 and 30 seconds respectively as these values comply with the current USACE standard. Press ***OK*** to return to main TECLOG3 screen.



Step 3. Connecting the DG-700's to Your Computer.

When conducting an airtightness test with TECLOG3, you will typically operate the program from a single laptop computer located in a central location in the building. The DG-700 gauges used in this example test are located throughout the building. The gauges associated with the blower door systems are generally attached to the adjustable aluminum frames, while the other gauges are located wherever they are needed to make the necessary pressure measurements**.** Always locate the gauges to minimize tubing lengths. Tubing runs over 100 feet should be avoided because of numerous problems associated with using long lengths of tubing when conducting airtightness tests.

The two most common ways to connect the DG-700 gauges to your laptop computer for a large building airtightness test include:

- Wirelessly connect multiple DG-700 gauges to your laptop using a wireless Router and TEC WiFi Link modules (***this is the method used in this example***).
- Run long lengths of CAT5 cable from the gauges to the laptop computer using sets of DB9 to CAT5 adapters and a DB9 to USB hub.

You can also use a combination of both wireless and wired connections. **Note:** DG-1000 gauges have other network connection options – see the DG-1000 manual for more information.

a. Wirelessly Connecting the Gauges to the Computer.

The TEC WiFi Link adapter attaches to the DG-700 gauge and creates a wireless network that can be directly accessed by any computer or mobile device with WiFi capability. In addition, the WiFi Link can be configured to search for a specific wireless access point (e.g. Router) and automatically connect to it. If multiple gauges with WiFi Links are configured to connect with the same Router, and the laptop computer is accessing that same Router, then TECLOG3 can communicate wirelessly with all the connected gauges.

Router and DG-700 Gauge with TEC WiFi Link

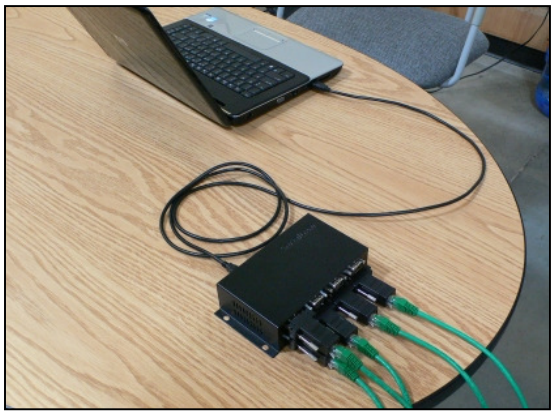
For this test we used an Apple Airport Express Router and 5 TEC WiFi Links, each attached to one of the DG-700 gauges. All 5 WiFi Links were configured to Router Mode and instructed to connect to the Airport Express Router (by entering the Router's SSID and Password into the Wi-Fi Link configuration). The WiFi Links were configured using the ***Configure WiFi Settings*** button in the **Device Settings** section of the Configuration screen (see pdf file *How to Configure Multiple TEC WiFi Links to Router Mode* in TECLOG3 Help menu).

Once the WiFi Links were configured properly, the laptop computer was set to access the wireless network being broadcast by the Airport Express Router. The Router was placed in a central building location so that it could easily communicate with both the laptop computer and the WiFi Links.

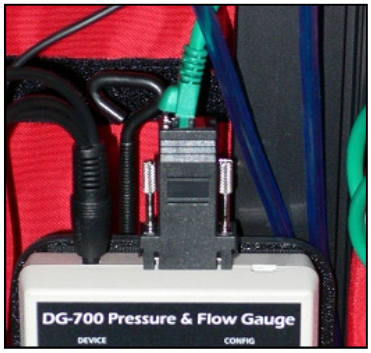
b. Using Wired CAT5 Connections Between the Gauges and the Computer.

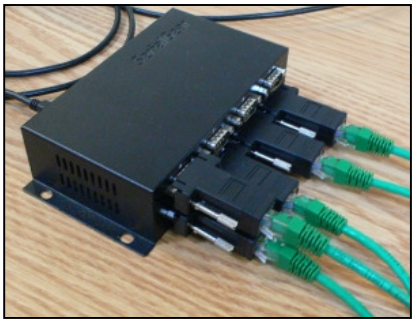
In order to create wired connections between the 5 DG-700 gauges to the laptop computer, we would typically use the following hardware option.

- 1 Eight-Port DB-9 RS232 to USB Adapter Hub (available from TEC). This device provides 8 separate RS232 communication ports through a single USB connection to the laptop. While the DG-700 gauge has both USB and RS232 communication ports, we choose to use the RS232 ports on the gauges because RS232 communication allows for much longer cable lengths (we have successfully used cables up to 4,000 feet in length). This is very useful in large buildings.



- Sets of DB9 to CAT5 Adapters (a set includes one male and one female adapter – available from TEC). These adapters allow the use of standard CAT5 cable between the gauge and the serial ports, rather than using a long serial cable. CAT5 cable is readily available in many lengths, and 2 lengths of cable can be easily connected together with a CAT5 coupler. The male DB9 to CAT5 adapter is plugged into the DG-700 gauge (pictured at right) while the female DB9 to CAT5 adapter is plugged into the hub (pictured below). CAT5 cable is then plugged into the top of the adapters.





Step 4. Method of Fan Control.

Two common fan control methods are described below, along with advantages and disadvantages of each. There are certainly other ways of performing the tests, but a thorough understanding of these two will help you decide how you should conduct your particular tests.

a. Computer Control Using Master Fan Slider and Master Cruise Control.

When using the computer control method, each blower door fan speed controller should be connected to a fan control port on a DG-700 gauge (using a fan control cable) so that all fans can be controlled using the **Master Fan Control Slider**, or the **Master Cruise Control**. It is possible to connect multiple (up to 3) fan speed controllers to a single DG-700 gauge fan control port. The **Master Cruise Control** feature controls the fans to get the average building envelope pressure to the targets which you specify. **This is the fan control method used in this test example.**

Advantages

Easier to get the building envelope pressure to precisely the targets you choose. You may be working with requirements to precisely hit the targets, in which case this may be important to you. (Technically speaking it is not very important precisely which pressures are achieved, as long as the range and even distribution of pressures is adequate and there are enough points to give you the resolution you need.)

Very easy to stop and restart the fans due to an interruption such as someone needing to enter or leave the building, even when many fans are in use.

Disadvantages

More data is gathered with fans running at less than full speed. This reduces the precision of the flow measurements to some degree. This is really only a problem for positive pressure (pressurization) testing on windy days.

Running the fans at partial speed also leads to higher motor current draw.

- For each of the 2-fan blower door systems installed for this test, we used the fan control port on a single DG-700 to control both fans. When using this setup, the two fans are controlled together and cannot be independently adjusted (this works well for large building testing). This setup is accomplished by plugging the single 3.5 mm plug on the commercial fan control cable into a DG-700 fan control port. The remaining plugs on the commercial fan control cable are plugged into communication ports on the side of the fan speed controllers (for a 2-fan system, one of the plugs is left unused). The order in which they are connected does not matter.

b. Manual Control of Fans

With this method, you start up each fan manually, one at a time. When many fans are being used (leakier buildings) you may be running each fan full speed right away. You essentially get one new pressure level for each fan you turn on. You may choose to adjust one fan speed to fine tune the building envelope pressure.

Advantages

Fans are typically running at or near full speed. This leads to lower current draw and somewhat better flow precision. Using this method, it is possible to run two fans off of a single 20 Amp circuit if you avoid running both of them at partial speed at the same time. However it is recommended to have each fan on its own circuit.

You do not need to connect fan speed control cables from the DG-700 gauges to the fan controllers.

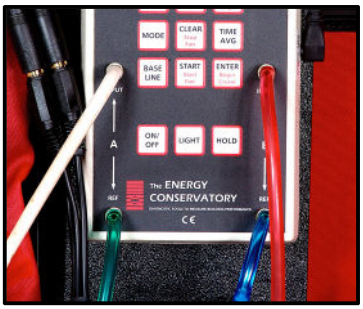
Disadvantages

It is harder (or tedious, at least) to hit specific pressure targets.

Interruptions may be harder to deal with.

Note: When Using a 2 or 3 Fan Blower Door System

- For 2 and 3-fan blower door systems, we recommend that all ports on the DG-700 gauges have tubing connected at all times to protect from noisy readings caused by air currents. For example, the gauge pictured to the right is being used to measure one building envelope pressure (Channel A Reference Tap), and one fan flow (Channel B Input Tap). The white tubing connected on the Channel A Input tap is simply run to an inside location near the blower door system that is away from turbulent air flows. For a depressurization test, the blue tubing connected to the Channel B Reference Tap is also run to an inside location to protect from turbulent air flows. When the system is pressurizing the building, the blue tubing will be run to the outside to provide the appropriate reference pressure for the fans.



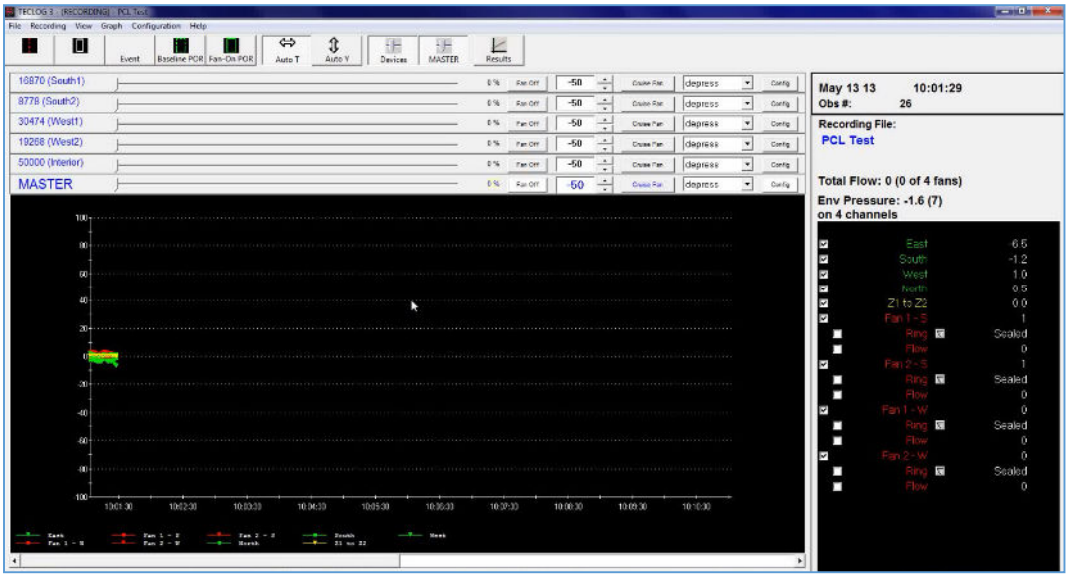
Step 5: Start Data Recording.

To start data recording, click on **Start Recording** from the main **Recording** menu item. At this point, TECLOG3 will search through all available COM ports and wireless networks on the computer to try and find the devices with the specific serial numbers entered into the **Device Settings Table**. If any of your specified devices are not found, recording will not begin and the **Configuration Settings** screen will appear. If any extra devices are found that you have not specified, then you will be warned and given the option to cancel.

Note: If you are having trouble creating a communication link with all of the devices, click on the ***Scan for Ports/Devices*** button in the **Configuration Settings** screen. The scan feature conducts a complete scan of COM ports and wireless network connections, and provides a listing of all connected TEC devices (the devices must be on to be detected.)

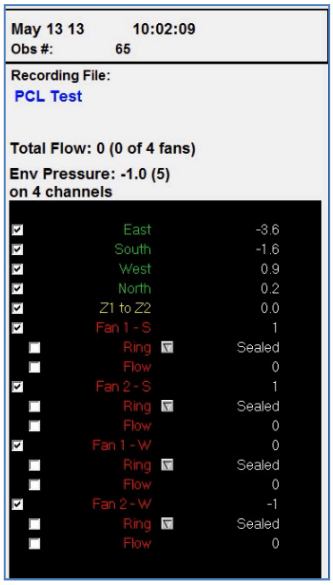
Once a communication link has been established with all the listed devices, you will be prompted to enter a filename for the data that will be recorded. After the filename is entered, the TECLOG3 data recording screen appears.

TECLOG3 Data Recording Screen



The most prominent feature of the data recording screen is the graph displaying the data as it is acquired. The rate at which data points (or observations) for each active channel are added to the graph is determined by the ***Sample Interval*** from the **Configuration Settings** screen (in this example we used the default setting of 1 second averages). The initial width of the x-axis (time) is determined by the ***Auto Time Interval***, and the y-axis limits are determined by the ***Startup y max*** and ***Startup y min*** settings, all located in the **Configuration Settings** screen. A time scroll bar, located at the bottom of the screen, allows the user to scroll back and look at data that has scrolled off the screen. **Note:** After using the time scroll bar, click on the ***Auto T*** button to reset the x-axis scale and display data currently being acquired.

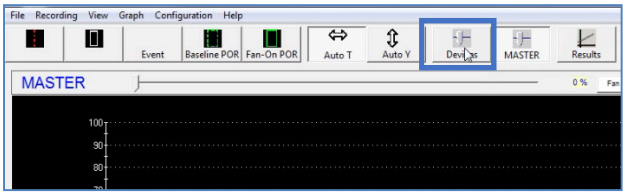
The right side of the data recording screen shows the current date and time (taken from your computer's internal clock), the observation number for the most recent sample interval, and the channel label and channel readouts (corresponding to the current observation number) for all active channels (in this case we have 9 active channels). Channels can be temporarily removed from the graph by clicking on the display button to the left of each channel label. Data for all active channels are stored to the data file even if the display button is turned off. For active channels where the Channel Type has been set to a fan flow, the fan configuration (Ring) and the fan flow are also displayed in addition to the fan pressure and the fans are automatically marked as "Sealed".



The channel readouts are automatically sorted by Channel Type, with all envelope pressures listed first, then interior building pressures, then fan flows and finally generic differential pressure channels.

a. Hiding Device Fan Controls

At the top of the graph are 6 **Fan Control Interfaces** (1 for each DG-700 plus 1 Master control). Because we will be using the **Master Fan Control** interface to control all fans, we can hide the 5 individual fan controls by clicking on the **Devices** button in the Toolbar menu.



b. Periods of Record (POR)

TECLOG3 is continuously recording pressure and fan flow data for each active channel throughout the entire airtightness test sequence. Periods of Record (POR) are a critical part of conducting airtightness tests with TECLOG3 because they define the time intervals from the test graph which will actually be used in the airtightness calculations.

There are two ways to create a POR for an airtightness test:

1. The most efficient way to create an airtightness test POR is to use the ***Baseline POR*** and ***Fan-On POR*** graph control buttons. During **Data Recording** mode, the POR is started at the exact time that the POR button was clicked (assuming the Measurement Line is off). When using the graph control buttons, the length of time for the POR is pre-set in the **Configuration Settings** screen (default of 120 seconds for a Baseline POR and 30 seconds for a Fan-On POR).

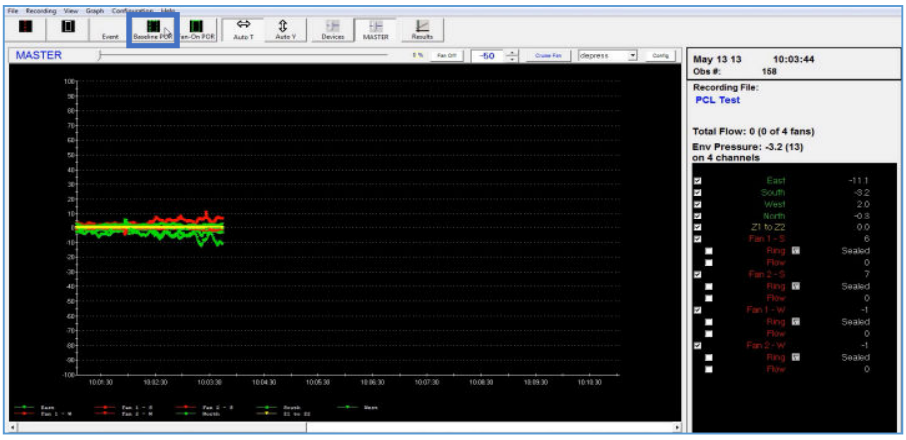
2. A POR can also be manually created:

   - Activate the ***Region Select Tool***,
   - Drag a rectangle containing the time interval to be included,
   - Right-clicking inside the selected time interval and choosing ***Create Period of Record***

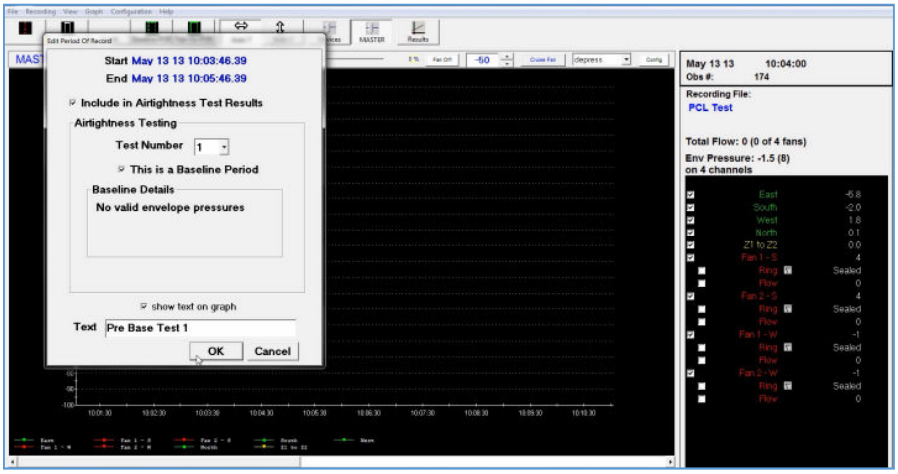
TECLOG3 can be used to create POR's for two different airtightness tests within the same TECLOG3 data file. When creating the POR's, you will indicate whether a particular POR is part of Test 1 or Test 2.

c. Creating the Pre-Test Baseline POR for Test 1 (Depressurization Test)

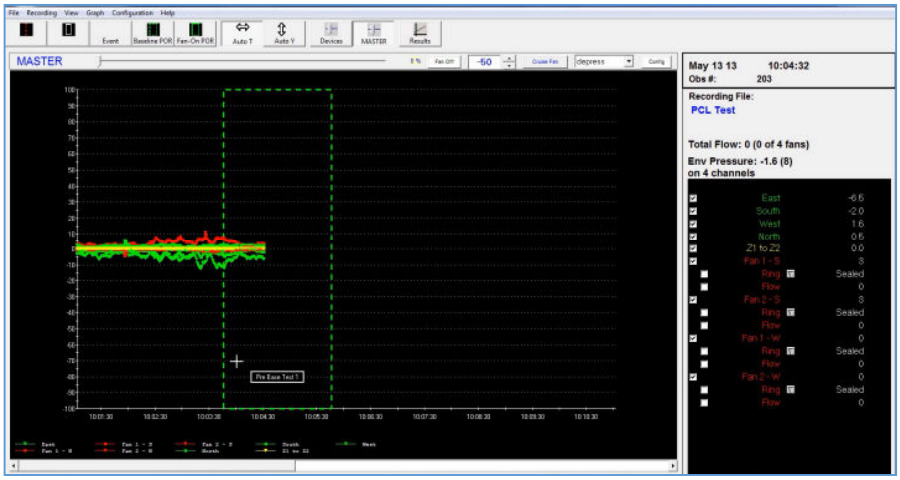
The first POR you will be creating is the pre-test baseline POR for Test 1. With all the fans off and sealed, TECLOG3 is displaying pre-test baseline data. Click on the ***Baseline POR*** graph control button to create a baseline POR.



After pressing the button, an **Edit Period of Record** window appears. Because this POR is a baseline period, the box labeled ***This is a Baseline Period*** is automatically checked. Also, because we will be using this POR in our airtightness test results, the box labeled ***Include in Airtightness Test Results*** is also checked. The text box at the bottom of the window can be filled out identifying the POR that is being created. Click ***OK*** to finish creating your pre-test baseline POR.



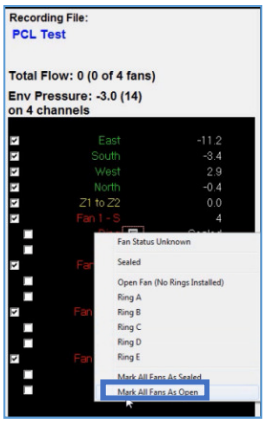
The pre-test baseline POR appears on the graph as a green dashed rectangular box with a default time width of 120 seconds. The POR starting time is the exact time that the ***Baseline POR*** button was pressed. Simply let TECLOG3 collect enough data to completely fill the width of the baseline POR. **Note**: A POR can be edited or deleted by first clicking within the POR region (this causes the POR box to turn from green to white), then right-clicking within the white box and selecting ***Edit Period of Record***, or ***Delete Period of Record***.

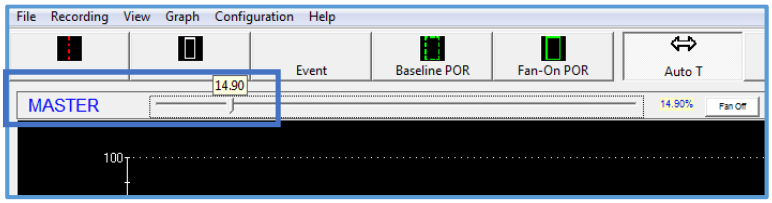


d. Preliminary "Fan-On" Test Using the Master Fan Control Slider.

Before beginning the "fan-on" portion of the airtightness test, it is always a good idea to slowly turn up the installed blower door fans to be sure that the fans and frames are installed properly, and that there is adequate pressure uniformity within the building (by observing the interior building pressure readings). In addition, this allows us to easily determine if we have installed enough fans to achieve the highest desired target building envelope pressure. Because we are using computer control for the fans in this example, the preliminary test is done using the **Master Fan Control** slider. **Note:** For this building we will conduct a depressurization test first, so be sure the fans are initially installed to blow air out of the building.

With the fans remaining sealed and the speed controllers in the off position, click on any of the fan ring pull-down menus and select ***Mark All Fans as Open***. Initially after marking the fans as open, the fan channel readouts will be flashing red to indicate low fan pressure (this is normal because the fans have not been turned on). Directly above the graph, find the **Master Fan Control** interface. Manually drag the **Master Fan Control** slider to the right until the slider is calling for approximately 15% to 20% fan speed





At this point the fans are not spinning because all of the speed control knobs are turned off, even though TECLOG3 is requesting the fans to run. Now go around and for each fan, turn the fan speed control knob to the "just-on" position, and once the blades begin to turn rapidly, unseal the fan (by removing the red fan cover and <u>all</u> flow rings). **Note:** Waiting to unseal the fans until the blades begin turning prevents the fans from spinning backwards due to baseline pressure differences between inside and outside the building.

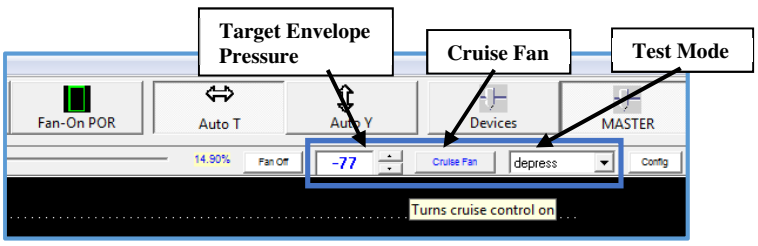
Do this for each fan – all fans should be running slowly once you have turned on all the controllers and unsealed the fans. **Note:** For a Model 3 fan, the "just-on" position means that the controller knob is turned clockwise from the off position only until you feel the click and no further. If the controller knob is turned up more than the "just on" position, TECLOG3 will not be able to control the fan speed.

Once all the fans are unsealed, you can manually drag the slider further to the right and confirm that you will be able to achieve the desired target building pressure, and that there is adequate pressure uniformity within the building. Once you are satisfied, return the slider to the 15% to 20% position (<u>all fans should remain unsealed and running slowly</u>).

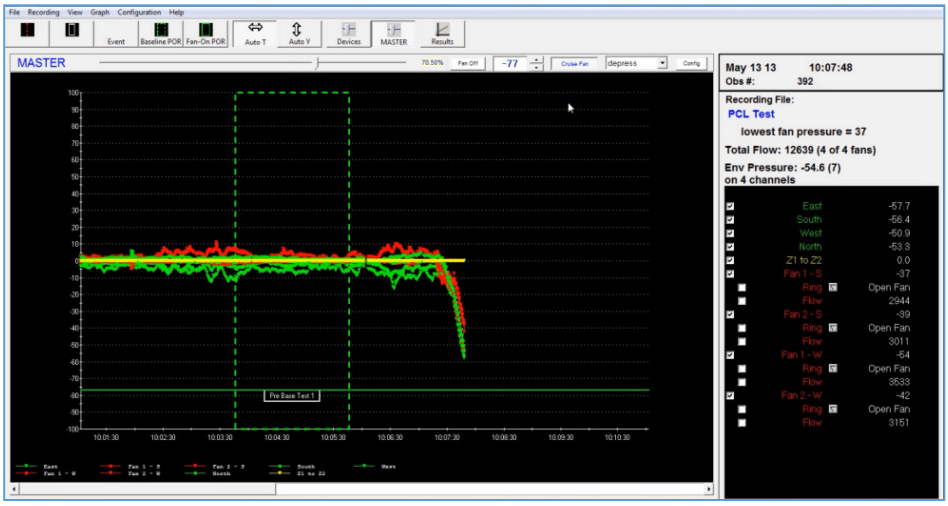
e. "Fan-On" Depressurization Test Using the Master Fan Cruise.

For the "fan-on" test, we will operate all fans in the open configuration, and then when necessary turn one of the fans off and seal it. Use the smallest number of fans that can reach the target building envelope pressure (in this example we needed 4 fans to hit our largest target induced pressure of approximately -75 Pa). In the target envelope pressure box input your first target envelope pressure (in this case we entered -77 Pa rather than -75 Pa in order to account for the initial baseline building pressure of about -2 Pa – we want to change the building envelope pressure by -75 Pa from its initial starting point).

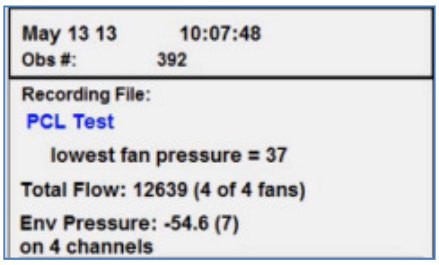
Click on the ***Cruise Fan*** button and cruise control will begin. All the fans will now begin speeding up at the same time in order to depressurize the building to -77 Pa.



Once the fans turn on high enough to accurately measure flow, the red flashing in the fan channel readouts will go away. A solid green horizontal line represents the target building envelope pressure. **Note:** You can quickly shut down all fans by either clicking on the ***Fan Off*** button on the **Master Fan Control** interface, or by simply pressing the ***Esc*** key on your keyboard.



A key display element is the box in the upper-right corner of the channel readouts. This is where you can see:



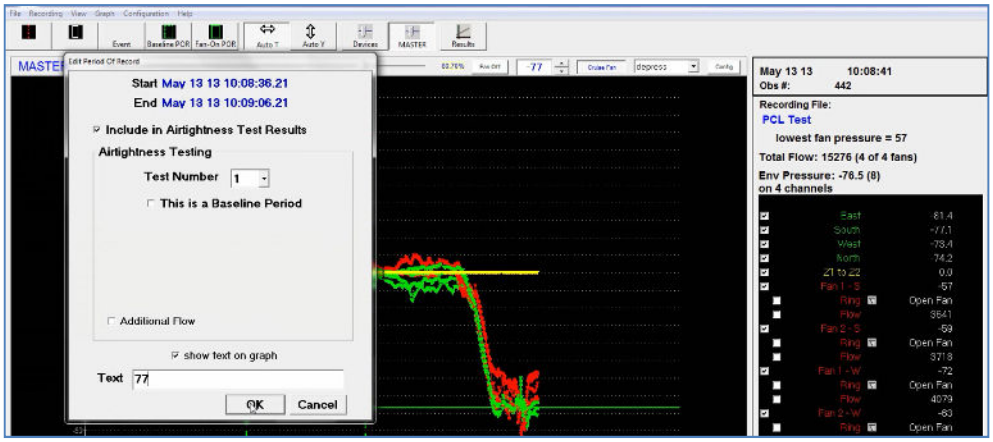
- The lowest fan pressure of all of the four unsealed fans (37 Pa). If any of the fan pressures are below the recommended minimum, this line will turn red.
- The total flow rate for the four fans (12,639 cfm)
- The average of all 4 four exterior building envelope pressures (-54.6 Pa). This is the building envelope pressure value that is used by the **Master Cruise Control** interface.
- The difference between the highest and lowest of the four building envelope pressures (7 Pa) – this gives you an idea of the uniformity in the 4 building envelope pressure readings. This test was conducted a fairly windy day causing a difference in building envelope pressures between the four sides of the building.

If you need to rescale the y-axis in order to show all of the data displayed on the graph, click on the ***Auto Y*** button. In addition, if you ever need to rescale the x-axis (time axis) to show the currently collected data, click on ***Auto T***.

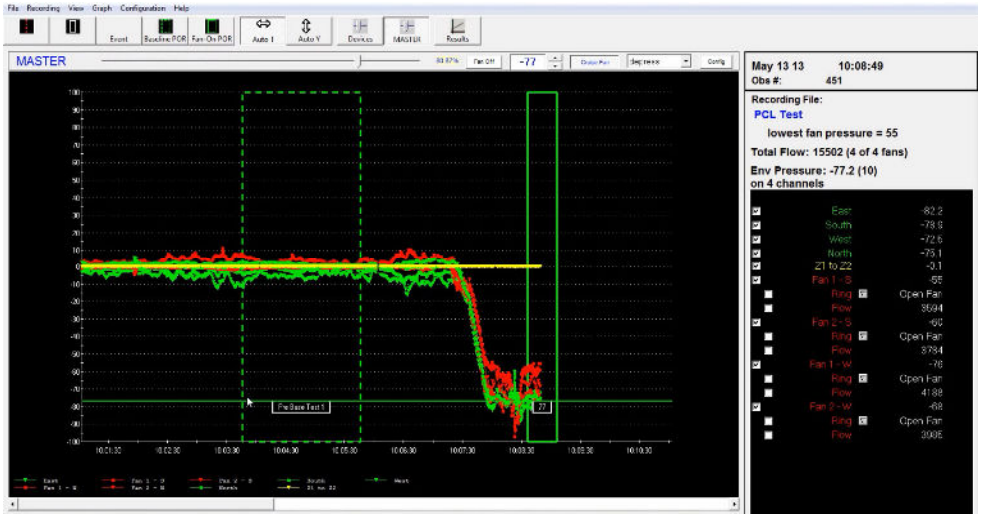
f. Creating Fan-On POR's for Test 1.

Once the average envelope pressure is close to the first target (-77 Pa), click on the ***Fan-On POR*** graph control button to create the first fan-on POR for Test 1.

After pressing the button, another **Edit Period of Record** window appears. Because this POR is a fan-on period, the box labeled ***This is a Baseline Period*** is automatically unchecked. Also, because we will be using this POR in our airtightness test results, the box labeled ***Include in Airtightness Test Results*** is checked. The text box at the bottom of the window can be filled out identifying the POR that is being created. Click ***OK*** to complete creating your first fan-on POR.



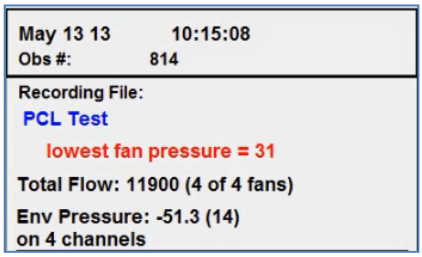
The fan-on POR appears on the graph as a green solid rectangular box with a default time width of 30 seconds. The POR starting time is the exact time that the ***Fan-On POR*** button was pressed. Simply let TECLOG3 collect enough data to completely fill the width of the fan-on POR



After the first fan-on POR is filled with data, we want to reduce the target envelope pressure by about 5 Pa so that we can create a second fan-on POR at a different building envelope pressure. For this depressurization test, we want to record a total of 12 different envelope pressures (the current U.S. Army Corp Test standard requires 12 target pressures). To easily change the target envelope pressure by 5 Pa, click on the up arrow just to the right of the target pressure field in the **Master Fan Control** interface. **Note:** If you want the target pressure to changes by something other than 5 Pa, then edit the target pressure field manually.

After you have changed the target envelope pressure, the fans will slowly ramp down to achieve the new target pressure. Once the average envelope pressure is close to the new target pressure, click on the ***Fan-On POR*** button again and create your second fan-on POR.

g. Continue Creating Fan-On POR's - What if you see a red low fan pressure warning?



Continue stepping down through your target pressures, and creating fan-on POR's. Keep an eye on your lowest fan pressure. This label will turn red and start flashing when any operating fan is below a minimum acceptable fan pressure level (it turns red and starts flashing when a fan pressure drops below 35 Pa).

If you see a red low fan pressure warning, follow these steps:

- Seal off one the blower door fans and physically turn off the speed controller for the sealed fan.
- In the channel readout for the sealed fan, mark that fan as ***Sealed*** using the ring pull-down menu.
- If desired, create an Event Marker that indicates you have turned off the fan.
- Be sure the target pressure field in the **Master Fan Control** interface is set to the next target envelope pressure you wish to achieve.

h. Creating the Post-Test Baseline POR for Test 1.

When you have completed all of your fan-on POR's for the depressurization test, turn off all the fans by clicking on the ***Fan Off*** button on the **Master Fan Control** interface. Physically seal off all of the blower door fans, and turn the fan speed controllers to the off position. In TECLOG3, use one of the channel ring pull-down menus to select ***Mark All Fans as Sealed***.

Click on the ***Baseline POR*** button to create your post-test baseline POR. Let TECLOG3 completely fill the width of the post-test baseline POR.

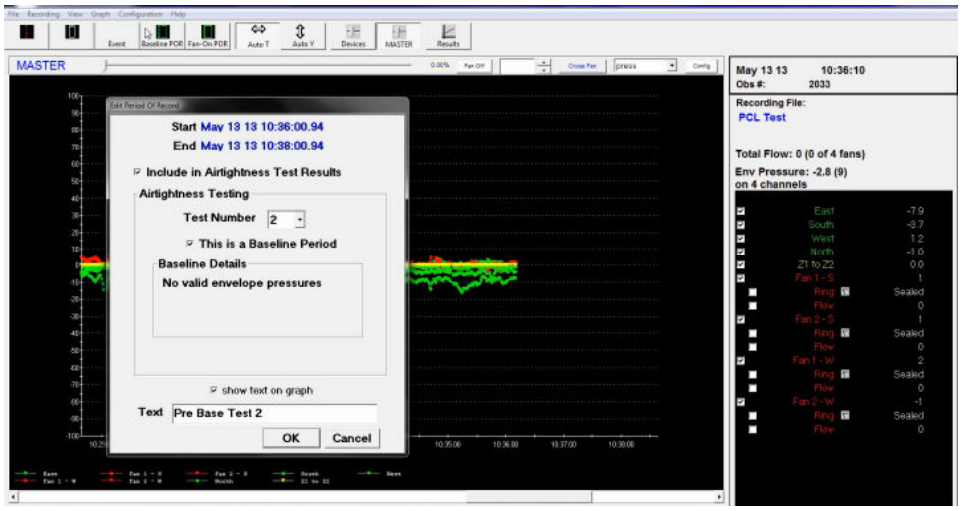
i. Prepare the Fans and Tubing for a Pressurization Test.

Once the depressurization test is completed, let TECLOG3 continue to run while you prepare the fans and tubing for the pressurization test. This will require turning the fans around in the nylon panels so that they are setup to blow air into the building rather than exhausting air from the building. Keep the fans sealed after turning them around. In addition, for all gauge channels being used to measure fan flow, you will need to connect the Channel B reference tap to the outside so that the fan flow channels are properly referenced to the outside space near where the fans are installed. **Note:** If you have an older Model 3 blower door fan with a fan direction switch, do not use the direction switch in lieu of turning the blower door fans around. The fan can only measure airflow in one direction – air must exhausting through the metal exhaust guard in order to measure airflow.

After the fans and tubing are prepared, return to TECLOG3 and change the ***Mode*** setting in the **Master Fan Control** interface from ***depress*** to ***press***.

j. Creating the Pre-Test Baseline POR for Test 2 (Pressurization Test).

With the fans sealed, TECLOG3 is ready to record the baseline building envelope pressure. Click on the ***Baseline POR*** button to begin creating the pre-test baseline POR for Test 2.



TECLOG3 will automatically recognize that this is the second test for this file and will fill in the Test Number for this POR and all subsequent POR's with a "**2**".

k. Create Fan-On POR's for Test 2.

Edit the target envelope pressure field in the **Master Fan Control** interface for your first fan-on POR (approximately 75 Pa, adjusted for the building baseline pressure). Mark the fans as ***Open*** in TECLOG3 and drag the **Master Fan Control** slider to the right until the slider is calling for approximately 15% to 20% fan speed. Now go around and for each fan, turn the speed controller to the "just on" position and once the blades begin to spin rapidly, unseal the fan (by removing the red fan cover and all flow rings).

After all fans are running slowly and unsealed, click on the ***Cruise Fan*** button to begin the fan-on pressurization test. Create 12 fan-on POR's at 12 different envelope pressures just like the depressurization test.

l. Create a Post-Test Baseline POR for the Pressurization Test.

When you have completed all of your fan-On POR's for the pressurization test, turn off all the fans by clicking on the ***Off*** button on the Master Fan Control interface, and then manually turn off the speed controllers. Physically seal off all of the Blower Door fans. In TECLOG3, use one of the channel ring pull-down menus to select ***Mark All Fans as Sealed***.

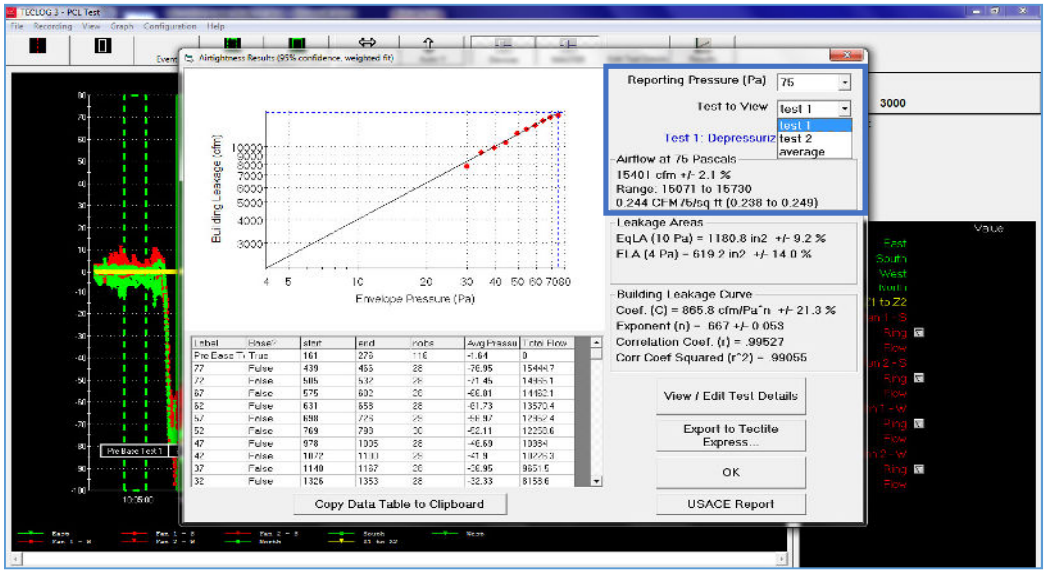
Click on the ***Baseline POR*** button to create your post-test baseline POR for Test 2. Let TECLOG3 completely fill the width of the post-test baseline POR.

m. Ending the Recording.

Once the testing is completed, it is good practice to view the results of the test (see next section below) to verify that the test results are satisfactory. After you have verified that the results are satisfactory, you can end the recording session using the **Recording….Stop Recording** menu item. TECLOG3 will ask: ***Would you like to load the file you just created?*** Answer ***Yes*** to load the complete data file. **Note:** Stored data files can also be loaded using the **File….Load Data File** menu item.

Step 6: Viewing the Results.

While the data file is displayed on the graph, you can view your airtightness test results by clicking on the ***Results*** button in the toolbar. **Note**: You can also click on the ***Results*** button during the middle of an airtightness test to see the partial test data.



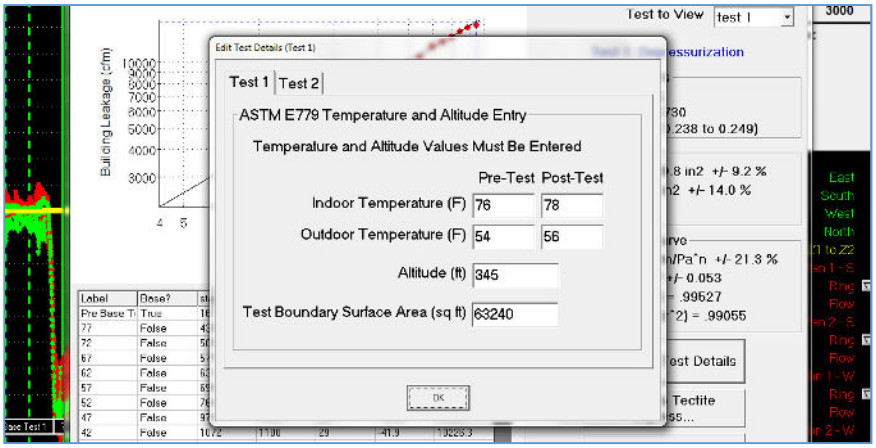
a. Airtightness Results Window.

There are several things to notice in the Airtightness Results window. First, in the ***Test to View*** field (upper right hand corner) you can choose to see the results of Test 1, Test 2 or the Average of both Test 1 and Test 2. Secondly, a pull-down menu in the upper right hand corner can be used to select the reporting building envelope pressure in Pa (75 Pa in this example). Third, the airflow is reported at the selected reporting pressure along with its 95% precision confidence interval, expressed as a +/- percentage (in this case 2.1) and also as low to high limits (15,071 to 15,730). Finally, if you have input a test boundary surface area in the **Edit Test Details** window (see below), TECLOG3 will report the airflow per square foot of surface area (permeability).

Below the airflow results are the fitted parameters, also with 95% confidence interval information and the correlation coefficient (r) and its square, commonly referred to as the R-Squared.

b. View/Editing Test Details

Test Details including inside and outside temperatures, building site altitude and test boundary surface area can be viewed and edited by clicking on the ***View/Edit Test Details*** button in the Airtightness Results window. The temperature and altitude data is used to perform airflow density and viscosity corrections, while the test boundary surface area is used to calculate the measured envelope permeability (CFMXX/ft^2).



c. Export Options.

There are two ways to export the summarized airtightness test data.

Copy Data Table to Clipboard will place on the Windows clipboard a copy of the selected results, with one row for each period of record plus a header row. This is in a format that can be easily pasted into a spreadsheet or other program for analysis or into an email.

Export to TECTITE Express will store the selected results in a file which can be loaded by TECTITE Express 4.0 or newer.

d. US Army Corp Report

A test report designed to meet the requirements of the US Army Corp of Engineers test protocol is available by clicking on the USACE Report button at the bottom of the Airtightness Results window.