Multiple-Fan

Blower Door Operation Manual

For Series 300, 5000, 6000 Systems

rev-2023-02-17

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Retrotec test fans, blower door systems, duct testing systems and gauges have been calibrated in our laboratory, which is accredited by the ANSI-ASQ National Accreditation Board to meet requirements of international standard ISO/IEC 17025:2005. All pressure and flow devices used in the calibration are traceable to the National Institute of Standards and Technology and themselves have ISO 17025 accreditation.

Retrotec equipment and software complies with the following standards:
ASTM E779-10, ASTM E-1554, ATTMA TSL1, ATTMA TSL2, CGSB 149.10, DW/143, Energy Star, EN12237, EN13829, EN15004, FD E51-767, ISO 9972-2015, ISO 14520-2006, NEN2686, NFPA 2001-2015, RESNET, SMACNA-2002, All USA State Energy Codes, Title 24 and USACE Protocol.

*Custom calibration available upon request

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1. Important equipment-related safeguards

When using electrical appliances, basic safety precautions should always be followed. If Retrotec equipment is used in a manner that does not follow the information provided in this manual, safety to the operator and equipment performance may be impaired.

Please read the following carefully before using your DucTester:

- Avoid contact with moving parts.
- Special attention should be made to keep children and pets away from the fan when it is operating.
- Do not insert anything into the fan casing while the fan is moving.
- Ensure that no debris is inside the fan casing before operating the fan.
- Keep hands, hair and clothing away from fan at all times.
- The fan can cause damage or injury if it were to fall on someone/something.
- Do not use equipment for other than its intended use.
- Do not stand on the fan, or use the fan to support the weight of another object.
- To protect against risk of electric shock, do not place this equipment or power cord in water or other liquid.
- Press the power plug firmly into the power receptacle on the fan. Failure to do so can cause over-heating of the power cord and damage the fan.
- Do not use ungrounded outlets or adapter plugs. Never remove or modify the grounding prong.
- Do not operate any device with a damaged electrical cord, or after an equipment malfunction.
- Use only the included power plug to operate the fan.
- Turn the unit off and unplug from any electrical outlet before moving and when not in use, or when making any adjustments to the fan motor or electrical components.
- For use under indoor conditions only.
- For use where there is no exposure to water or dusty substances or explosive materials or flammable materials.
- Ensure proper cooling of the fan motor.
- Equipment is intended for diagnostic testing and to be operated for brief periods under supervision by a qualified operator. Not to be used in a role as a household appliance for the purpose of moving air.
- Failure to follow these instructions carefully may result in bodily injury, damage to property and/or equipment failure. Failing to operate equipment as intended may void warranty and compliance with CE mark and other listings.

2. Important <u>occupant</u> safeguards during testing

Please read the following carefully before carrying out tests:

- If dust, pollen, mold spores, chemicals or other undesirable substances can get blown into living spaces, keep those susceptible to these substances away from the test area, and wear dust masks.
- Do not pressurize a duct system with air that is polluted or exposed to any toxic substances. For example, blowing air from a car-port into a house or duct system while a motor vehicle is running can quickly fill a house with toxic carbon monoxide.
- If combustion safety problems are found, tenants and building owners should be notified immediately and steps taken to correct the problem including notifying a professional heating contractor if basic remedial actions are not available.
- Air sealing duct work may change the pressure balance in a house and cause back drafting where it did not occur before. For example, a return leaking to outdoors may have pressurized a house but when corrected, leaky supplies may reverse that and cause depressurization which could result in back drafting hot water heaters, furnaces or fireplaces.
- Be aware of all possible sources of combustion. Ensure any appliances do not turn on during the test. Turn off power to the appliance, or set the appliance to the "Pilot" setting. It is possible for flames to be sucked out of a combustion air inlet (flame rollout) during a test, which is a fire hazard and can result in high carbon monoxide levels.
- If combustion safety problems are found, tenants and building owners should be notified immediately and steps taken to correct the problem (including notifying a professional heating contractor if basic remedial actions are not available). Remember, the presence of elevated levels of carbon monoxide in ambient building air or in combustion products is a potentially life threatening situation. Air sealing work should not be undertaken until existing combustion safety problems are resolved, or unless air sealing is itself being used as a remedial action.

3. When is more than one fan needed?

Multiple fans are required for testing an enclosure when the maximum flow generated by the power of one fan (running at 100% Speed with Open Range) is not enough to reach the desired test pressure. For example, you try to pressurize an enclosure to a target pressure of 75 Pa but even when the fan is running at 100% Speed with Open Range, you can only reach a pressure of 25 Pa. This problem occurs because there is too much leakage in the building to reach the target pressure. In this case, you will need additional fans.

A large enclosure area (greater than 10,000 cu ft) usually suggests a large amount of leakage, and you should investigate how many fans you'll need.

3.1 Maximum flow capacity of Retrotec fans

The maximum flows generated by Door Fans depend on which Range Configuration the fan has installed – a Range with a larger opening produces a higher maximum flow. They also depend on the induced pressures generated in the enclosure, known as the "backpressure" imposed on the fan – if the enclosure is being pressurized to a positive pressure, the higher the backpressure, the lower the flow capacity. The voltage/frequency of the fan's motor also affects the flow rate. Figure 1, Figure 2, and Figure 3 are flow charts for 6000, 5000, 300 series Retrotec fans respectively:
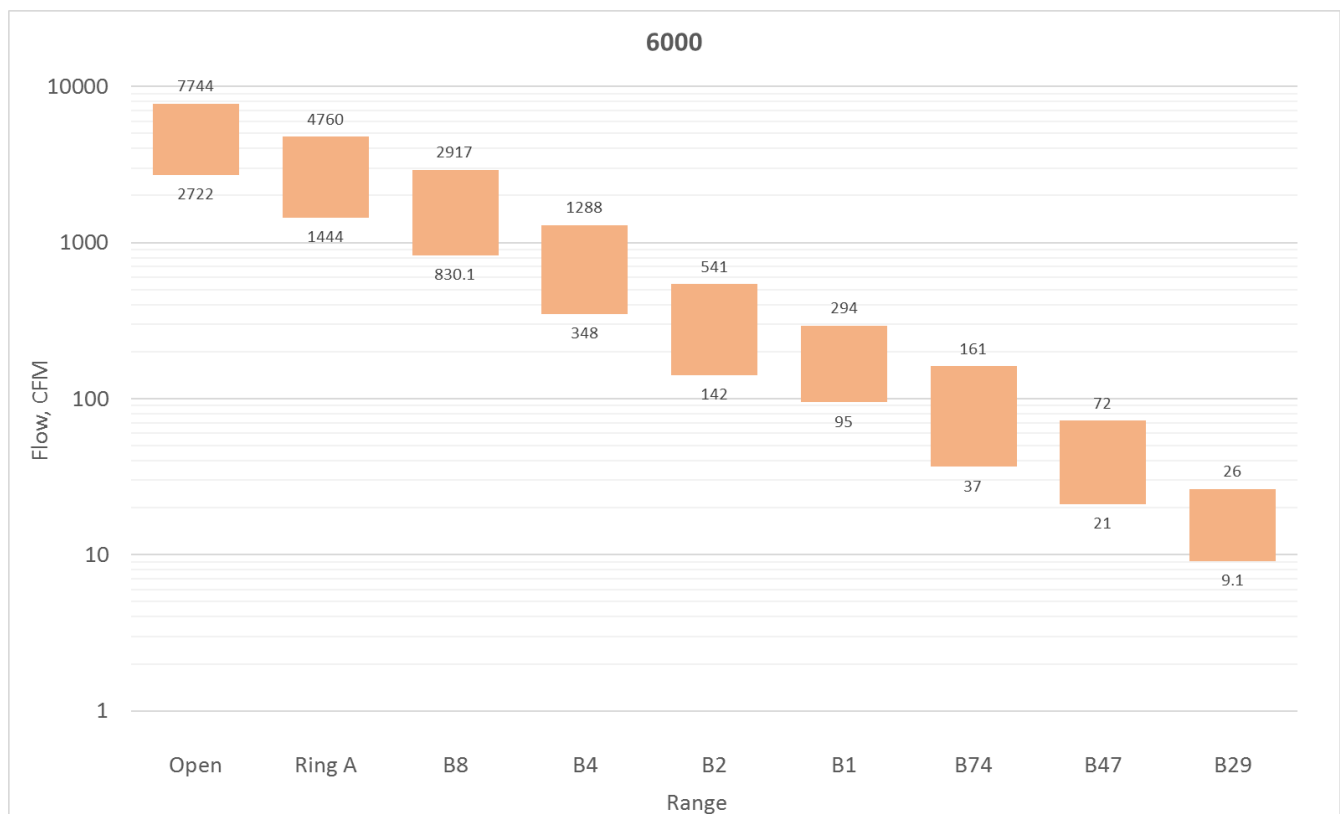

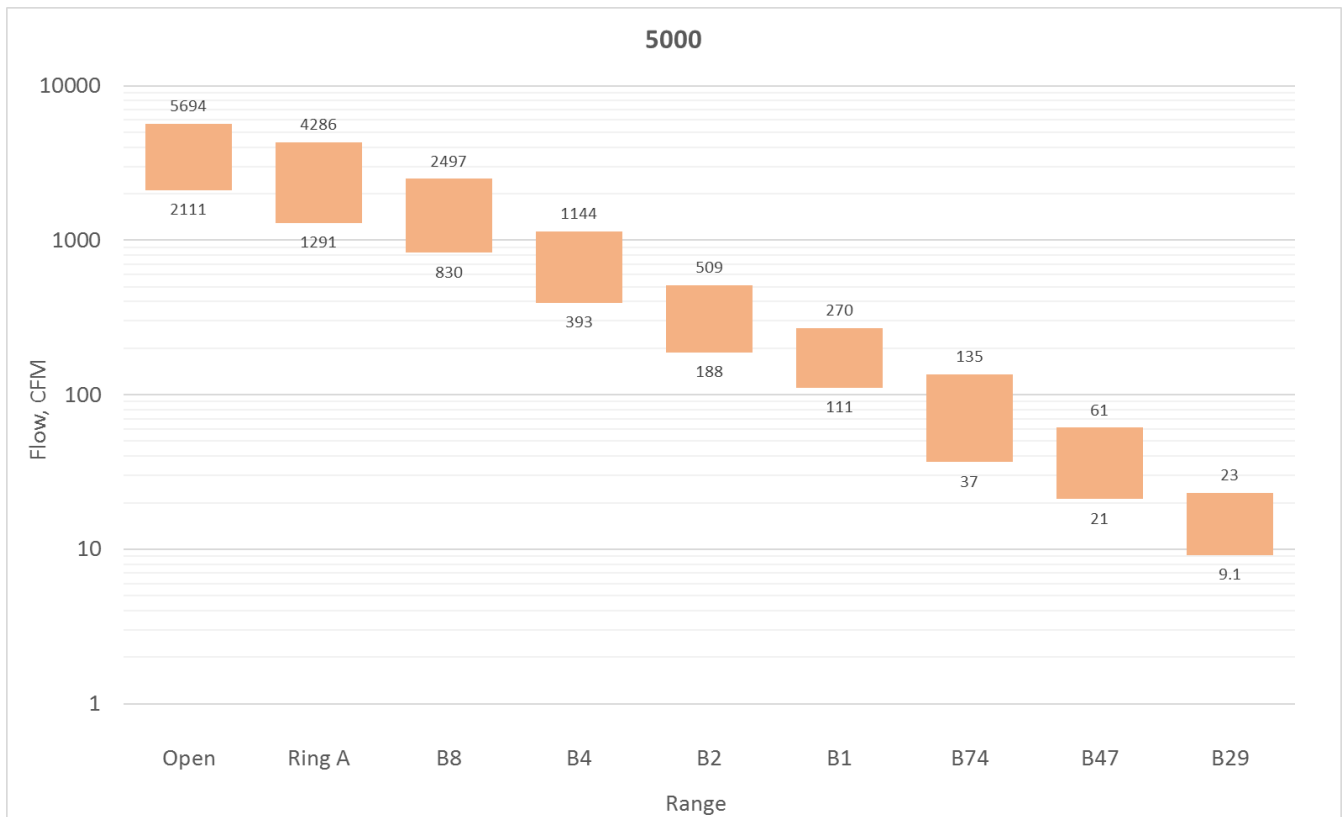**Figure 1: Minimum and Maximum Fan Flow per 6000 Range Configuration, at 50 Pa Backpressure**

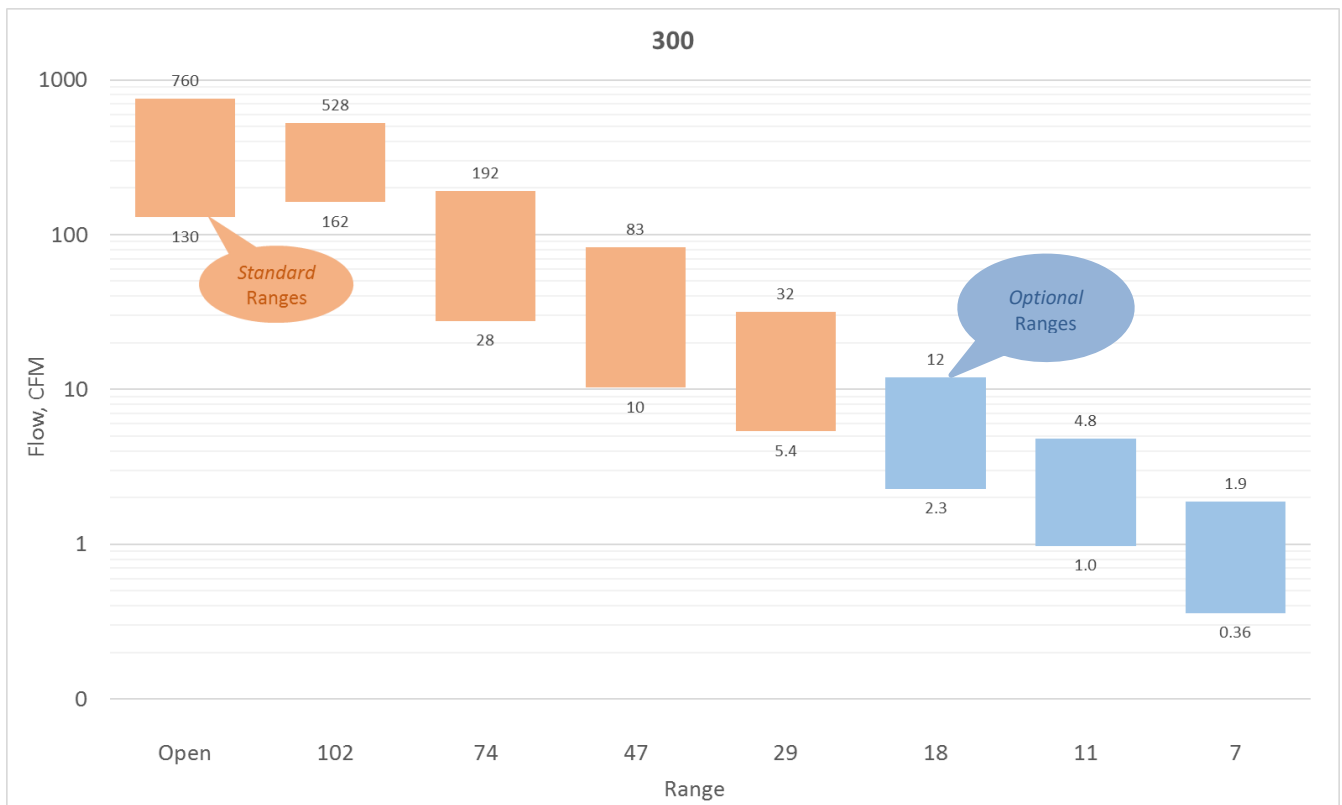**Figure 2: Minimum and Maximum Fan Flow per 5000 Range Configuration, at 50 Pa Backpressure**

Figure 3: Minimum and Maximum Fan Flow per 300 Range Configuration, at 50 Pa Backpressure

3.2　Calculate number of fans needed based on leakage requirement

Simply knowing the volume of the building is not enough information to estimate how many fans are needed, because for the same volume, an extremely leaky enclosure will require more fans to pressurize the enclosure than a very tight enclosure.

To more accurately estimate how many fans you need, you can perform a calculation based on enclosure area. This calculation can depend on the allowable leakage specified in the standard you are trying to comply with (e.g., ATTMA TSL1, ASTM E779 – 10, CGSB, USACE Protocol) or another leakage requirement that you are specifically trying to achieve (e.g., Air leakage, Permeability, Air Change rate). For typical leakage requirements around the world, refer to Table 2 in the Appendix (page 36).

To estimate how many fans you need, here's an example of the calculation to perform:

Let's assume you are testing a 70,000 sq ft enclosure area and the Standard you are trying to comply with requires that you can only allow a maximum permeability of 0.25 CFM/sq ft @ 75 Pa (compliance requirement for USACE).

$$Enclosure\ Area = 70,000\ sq\ ft$$

$$Permeability\ requirement = 0.25\frac{CFM}{sq\ ft}$$

Multiplying this permeability requirement by the enclosure area, you can estimate that you would need a total flow rate of 17,500 CFM to reach 75 Pa.

$$Flow\ required = Permeability\ requirement\ x\ enclosure\ area$$

$$Flow\ required = 0.25\frac{CFM}{sq\ ft}\ x\ 70,000 sq\ ft$$

$$Flow\ required = 17,500\ CFM$$

If you are using Retrotec's high output fans, they generate a maximum flow rate of approximately 7,000 CFM at 75 Pa (see Figure 1 for maximum flows of Retrotec fans), so you can divide the Flow required by the Flow capacity of the fan at 75 Pa to determine how many fans you need.

$$Number\ of\ fans\ required\ (at\ 75\ Pa) = \frac{Flow\ required}{Flow\ capacity\ of\ fan\ (at\ 75\ Pa)}$$

$$Number\ of\ fans\ required\ (at\ 75\ Pa) = \frac{17,500}{7,000}$$

$$Number\ of\ fans\ required\ (at\ 75\ Pa) = 2.5 = 3\ fans$$

In this example, the quotient is 2.5, meaning you would need at least 3 fans. (If the quotient is not a whole number, you would round it up to a whole number). In the event that you run a test using 3 fans and find that you cannot achieve a pressure of 75 Pa, you know that there is too much leakage in the building to comply with the permeability requirement for the standard (0.25 CFM/sq ft @ 75 Pa); hence, seal up some leakages and try the test again.

This example makes the assumption that the permeability requirement of the building is 0.25 CFM/sq ft to comply with USACE. If you are testing to a different standard, you are to use the requirement from the correct standard.

Keep in mind that the size of the building cannot tell you in advance what the permeability will be. If you need to determine what the permeability is, and are not doing sealing to make the enclosure comply, it is generally safer to calculate conservatively (assuming a higher permeability or leakage) to ensure you have enough fans to run your test.

3.3　Use Retrotec's 'Number of Fan Calculator' spreadsheet

Retrotec's 'Number of Fan Calculator' is an Excel spreadsheet that performs the calculations described above, for Retrotec fans. Instructions on how to use the spreadsheet are embedded within it. Click here to download a copy of this spreadsheet.

	retrotec					
		Inputs are green				
		Results are grey				
Units		imperial				
Frequency:		50Hz	▼			
	Option 1: Enter building dimensions					
Height		34	ft			
Width		38	ft			
Length		10	ft			
	Option 2: Enter area or volume directly					
Envelope area		35000	ft2			
Building volume			ft3			
Fan Capacity (cfm)		high power	standard power	duct tester		
50Pa		8200	4760	510		
75Pa		7700	3740	510		
	Standard airflow requirements					<====
Reference		**Airtightness**	**required flow**	**# fans required**		
Standard		**Spec**	**(cfm)**	**high power**	**standard power**	
USACE		.25 cfm/ft2 at 75Pa	8,750	2 fans	3 fans	
LEED ETS		1.25 in2 EfLA/100 ft2	7,961	1 fans	2 fans	
ATTMA TSL1		10 m3/h/m2 at 50Pa	19,138	3 fans	5 fans	duct tester
PassivHaus		0.6 ACH50	129	1 fans	1 fans	yes
	Generic requirements - Not specific to any standard					<====
		Airtightness	**required flow**	**# fans required**		
		Spec	**(cfm)**	**high power**	**standard power**	
ACH50		10	2,153	1 fans	1 fans	
Permeability @ 50 Pa		0.30 cfm/ft2	10,500	2 fans	3 fans	
Permeability @ 75 Pa		0.25 cfm/ft2	8,750	2 fans	3 fans	
Metric permeability @ 50 Pa		7.0 m3/h/m2	13,397	2 fans	3 fans	

Figure 4: Number of fans calculator based on allowable air leakage

3.4 Use Retrotec's 'Number of Fan Calculator' spreadsheet, for Enclosure Integrity Tests

Enclosure Integrity Tests for testing clean agent fire suppression systems don't have specific permeability requirements, but rather, they have Hold time requirements, which can be used to calculate how many fans are required to test an enclosure of a particular size. Click here to download a copy of this spreadsheet.

Figure 5: Number of fans calculator based on Hold Time for Enclosure Integrity Tests

4. Large Building Leakage Tests

There are two basic types of tests: Total Zone Leakage and Zone-to-Zone Leakage.

Total Zone Leakage is any test where the objective is to measure the total leakage of an enclosed volume. This enclosed volume could be anything from a one-bedroom apartment to a commercial office building.

Zone-to-Zone Leakage is any test where the objective is to measure the leakage of one zone into another zone. This includes a wide variety of measurements, such as the leakage from one floor to another, the leakage between two neighboring apartments, or the leakage from a house into an attic space.

Although the setup of the Door Fan systems is the same for both types of leakage tests, the actual test procedures for measuring leakage between multiple zones is different from that for measuring the total leakage of one zone.

Figure 6: Common Reference

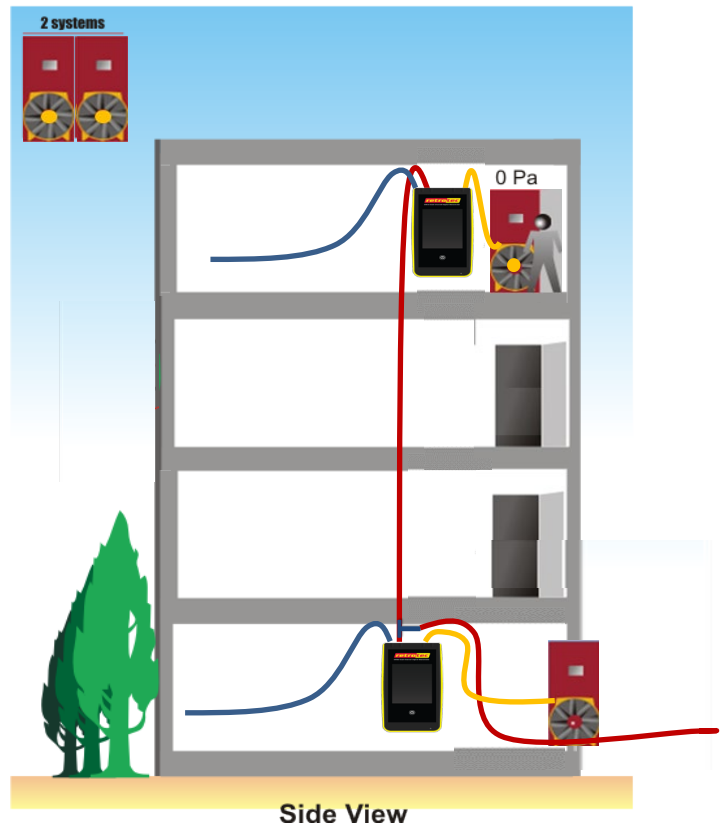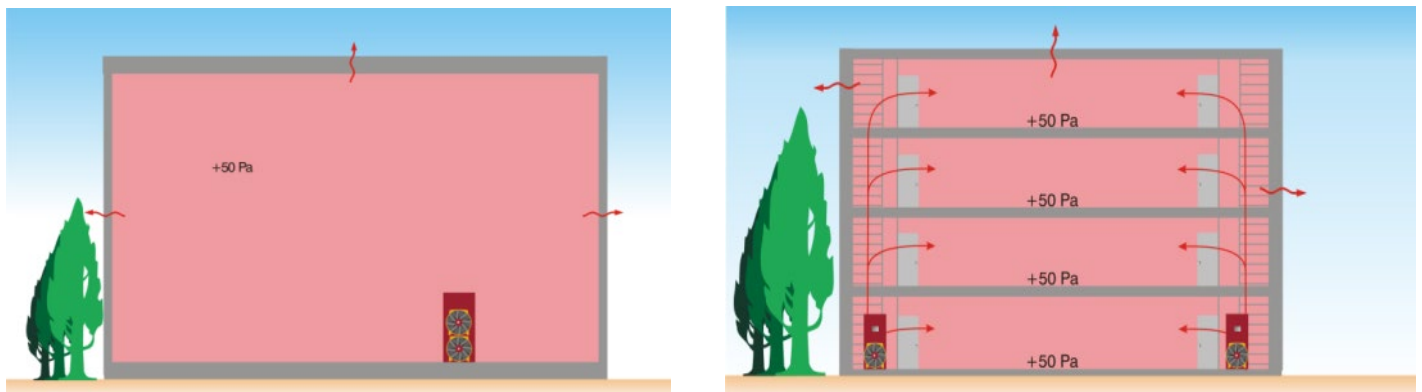## 4.1   Total Zone Leakage Test

In a Total Zone Leakage test, the entire zone is pressurized (or depressurized) to a uniform pressure and the leakage measured is the Total Zone Leakage.

In Figure 7, the Door Fans are pressurizing one zone, so they are measuring the total leakage of the entire zone or building.

Figure 7: Buildings pressurized as a single zone to measure Total Zone Leakage

4.2 Zone-to-Zone Leakage Test

Zone-to-Zone Leakage tests are the only way to measure the leakage through a particular surface, such as a partition wall between two apartments, or the leakage from a hallway into an apartment.

Zone to zone leakage is more complicated than total zone leakage – it involves pressure neutralization between two zones. How to set up your fans is based on the fundamental concept of Pressure Neutralization, described in the next section.

4.2.1. Pressure Neutralization

Flow is caused by a pressure differential across a hole. The idea behind Pressure Neutralization (sometimes confusingly called "guarded testing" even though nothing is actually guarded) is that if you pressurize both sides of any hole to the same pressure, there will be no flow (hence, no leakage measured) through the hole since there is no pressure differential. The magnitude of this pressure can be large or small, but as long as the pressure on both sides is the same, there will be no flow.

4.2.2. Measure Leakage between floors using pressure neutralization

The procedure below describes how leakage between floors of a high rise building is measured by Pressure Neutralization.

<table>
<tr>
<td>

To measure the leakage between the 10th floor and the 9th floor, you would set up Door Fans on both floors.

1. Pressurizing only the 10th floor, the gauge on the 10th floor will be measuring the flow (or leakage) across all barriers of that floor.

   In Figure 8, 1000 CFM is measured as the flow across all barriers of the 10th floor.

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<td>

Figure 8: Measure the flow across all barriers on the top floor

</td>
</tr>
<tr>
<td>

2. Pressurizing both 10th and 9th floors, the gauge on the 10th floor will now be measuring the flow (or leakage) across all barriers except the slab between floors - there is no flow between the 10th and 9th floor due to Pressure Neutralization.

   In Figure 9, 800 CFM was measured as the flow; This means that the flow between the 10th and 9th floor must be 200 CFM, by subtraction from the result of step 1.

   1000 CFM – 800 CFM = 200 CFM

</td>
<td>

Figure 9: Measure the flow from the top floors combined

</td>
</tr>
</table>
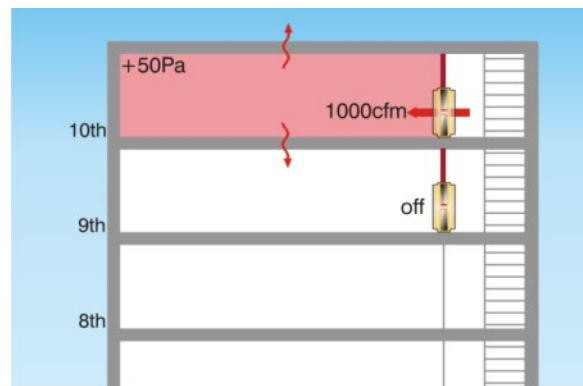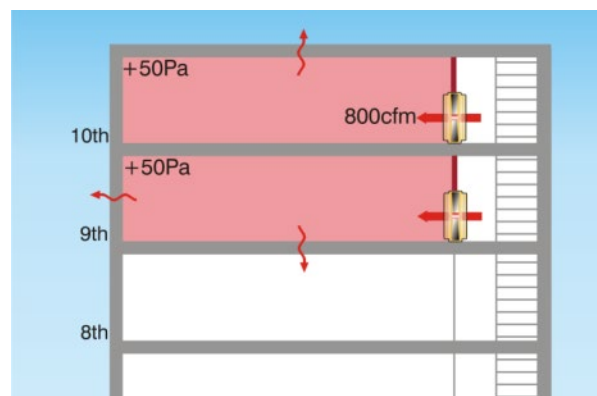
The order of steps 1 and 2 can be interchanged. To test the leakage of the other floors, you would move the Door Fan from the 10th floor to the 8th floor and repeat the procedure.

4.2.3. Measure Leakage between rooms using pressure neutralization

The procedure below describes how leakage between rooms or apartments is measured by Pressure Neutralization.

1. Initially, the first Door Fan pressurizes a room, and its gauge will measure the flow (or leakage) across **all barriers** of a room. Record the flow, and keep the Door Fan On for the following steps.	**Figure 10: Pressurize the first room to measure flow from the room**
2. A second Door Fan pressurizes the hallway, but now the room gauge will be measuring the flow (or leakage) across all its barriers **except its wall between the hallway** – since there is no flow between this wall due to Pressure Neutralization. The drop in flow rate (from step 1), on the room gauge, indicates the flow or leakage across the room's wall between the hallway	**Figure 11: Use a second Door Fan to pressurize the hallway**
3. The door of an adjacent room is opened so that it is pressurized as well. Now the gauge of the originally pressured room will be measuring the flow (or leakage) across all its barriers **except its wall between the hallway and its wall to the other room**. The drop in flow rate (from step 2), on the room gauge, now indicates the flow or leakage across the wall between the two rooms.	**Figure 12: Open a door to the adjacent room to determine flow between the rooms**
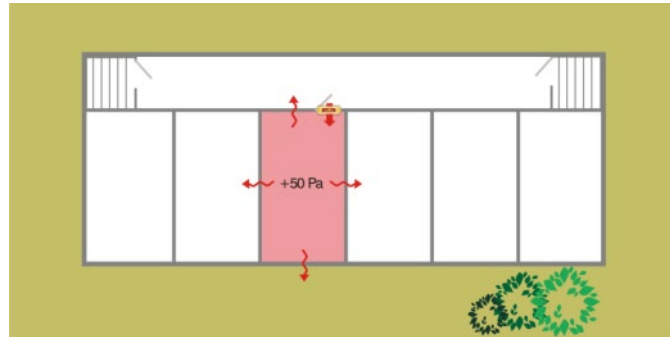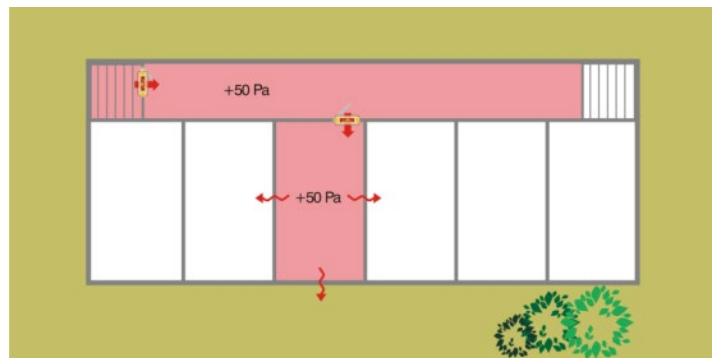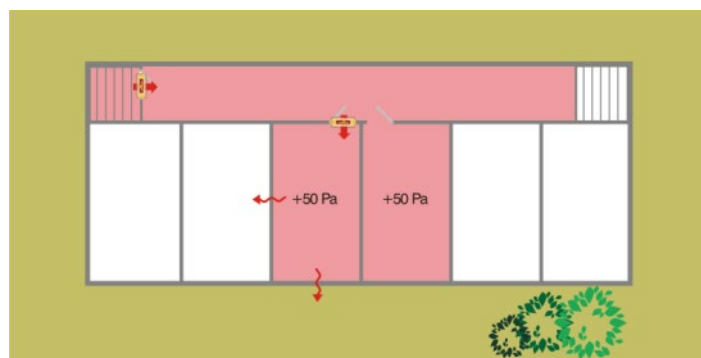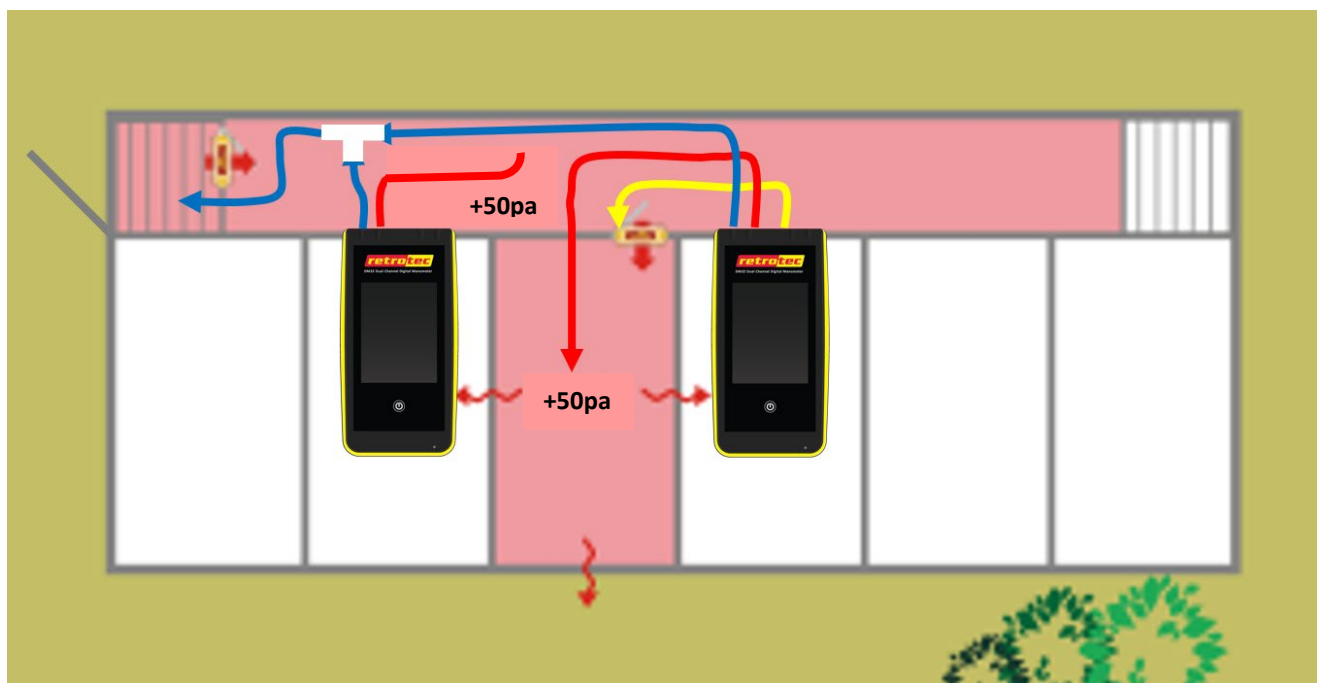
Figure 13. Pressure tube configuration for pressure neutralization. Both gauges should be in the hallway.

All pressures are referenced to a common Blue tube which is connected to outdoors via the stairwell where at least one door should be open to outdoors. The Red tubes are measuring pressure in the hallway and the apartment respectively.

Before the hallway blower door is turned on, the **total apartment leakage** is being measured by the blower door in the apartment doorway. Then the hallway blower door is turned on.

The Left gauge and blower door establish a pressure at 50 Pa between outdoors and the hallway in this example.

The apartment blower door will have to slow down to maintan a pressure at 50 Pa between outdoors and the apartment. The pressure between the apartment and hallway wall is zero and has been neutralized. The leakage across this boundary has also been neutralized forcing the blower door mounted in the apartment doorway to read a reduced flow rate. This reduction represents the hallway to apartment portion of the previous **total apartment leakage**.

This procedure is sometimes oddly called "guarded" blower door tests which is not a technical term even though it's sees common usage in the USA. Pressure neutralization or pressure nulling is truly the terminology of what this method depicts.

5. Options for controlling the speed of multiple fans

There are two methods of speed control for your multi-fan setup. You can either control the speed of all fans with one gauge (Common set point), or let each fan's speed be controlled with different gauges (Individual set point). There are advantages and disadvantages for each of the fan speed control methods you choose. Reasons for choosing one over the other are described in the scenarios of section 7 using FanTestic software, which provides either Common set point or Individual set point control of the fans.

5.1 Common set point control

One gauge called the "Primary gauge" controls all fans. Common set point control can be accomplished by one of two methods, either manually with gauges only or using FanTestic software to control the gauges:

5.1.1. Without FanTestic software

Use a Speed Control Splitter to connect the "Primary Gauge" Speed Control Cable to multiple fans (part number: FN280 – see section 9.3)

Daisy chain fans together (possible if Fan Tops have two Control ports – see Figure 18) so their Speed Control ports can all be connected to the single "Primary Gauge".

5.1.2. With FanTestic software:

Select "Common" Gauge Control in FanTestic:

Gauge Control: ● Common ○ Individual

5.2 Individual set point control

Each fan has an associated gauge that is used to control that fan: one gauge controls one fan, another gauge controls another fan. Individual set point can be accomplished by one of two methods:

5.2.1. Without FanTestic software:

Connect Speed Control Cables (Ethernet style) from each gauge to each fan directly (i.e., Not using a Speed Control Splitter and not daisy chaining fans together)

5.2.2. With FanTestic software:

Select "Individual" Gauge Control in FanTestic:

Gauge Control: ○ Common ● Individual

6. Options to set up test parameters and collect test data

For multi-fan tests, you can choose to collect data using FanTestic software or not, however it is highly recommended to do so (see section 5).

FanTestic software is developed by Retrotec to communicate directly with Retrotec Door Fan and DucTester systems for Automatic Control. It also serves the purpose of calculating results, from Automatic Tests or data entered manually, in compliance with the most recent edition of various domestic and international Standards. Target pressures and test parameters can be changed for each Automatic Test, however parameters for compliance with the Standard selected are implemented by default. For further detail on how to operate FanTestic software, please refer to *Manual-FanTestic*.

6.1   Manual Data Collection without using FanTestic

If you choose not to use FanTestic, this would be a Manual Test where you set the target pressures on each individual gauge directly – this is when you do not connect gauges to a computer. If you wanted Common set point control in this case, you will need either a Speed Control Splitter or fans with dual Speed Control (Ethernet-style) ports, or a combination of the two if fans of different series are connected. More details on this are illustrated in section 9.

6.2   Automatic Data Collection Using FanTestic

Using FanTestic in a multi-fan setup allows all the data to be collected and results calculated during an Automatic Test. If you choose to use FanTestic, you must connect your gauges to your computer.

The Individual Control function in FanTestic determines the manner in which the fans in a multi-fan setup are controlled by software. If you have ever used a Speed Control Splitter or used the daisy chaining method to connect fans together, Individual Control in FanTestic essentially simulates the same setup for the fans' speed control, without the use of a Speed Control Splitter or Fan Tops with dual-Control ports.

To configure Individual Control in FanTestic, click Settings →Advanced → Basics tab.
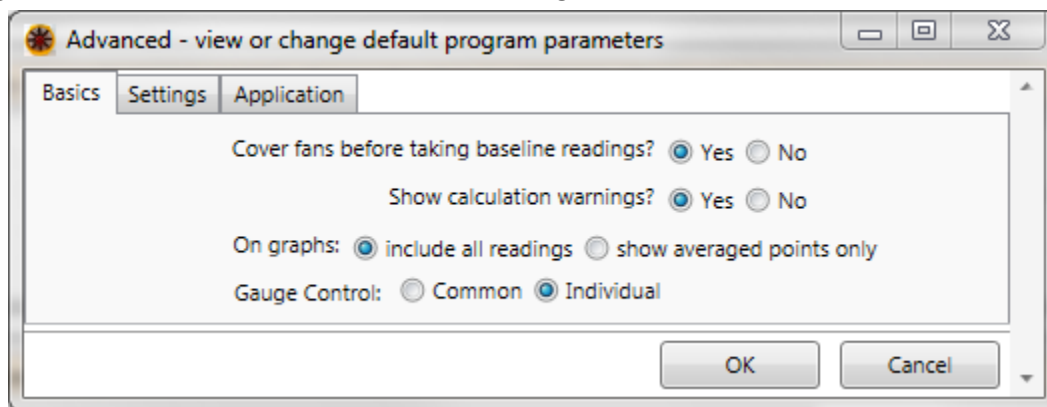
Figure 14: Select Individual Control in the Advanced Window

6.2.1. How to set "Individual Control" with FanTestic Software

Individual Control Gauge Control: ○ Common ● Individual is the default setting.

When attempting to create an Induced pressure, FanTestic will tell each gauge separately (i.e. send different speed signals to each gauge) to reach that pressure target. This would be the same as a user manually using the [Set Pressure] function on each gauge separately.

Using "Individual Control", in the same way as setting pressure manually on multiple gauges, may result in "dueling" fans where one fan takes over and runs up to a speed of 100%, while the other fan(s) decrease to 0% speed.

6.2.2. How to set "Common Control" with FanTestic Software

Common Control Gauge Control: ● Common ○ Individual .

This will set the #1 gauge in FanTestic as a "Primary gauge". The primary gauge can be switched by the user.

When attempting to create an Induced pressure, FanTestic will tell the primary gauge to seek that target pressure. FanTestic will then read the fan speed % from the Primary gauge, and tell all other gauges to go to that speed. This effectively turns all fans into one big fan that is controlled by the pressure on Channel A of the Primary gauge. This will eliminate any "dueling" between fans, however different pressures between different zones tested may result.

Note: Running Automatic Tests in FanTestic with multiple fans requires a FanTestic Pro license.

Version	Max Fans*	Standards**	Customizable Reports in MS Word	Exportable Data to MS Excel
FanTestic Lite	1	1	X	X
FanTestic Pro	2	1	✓	✓
FanTestic Pro 6	6	All	✓	✓
FanTestic Pro 24	24	All	✓	✓

Figure 15: How many fans can you run with FanTestic?

7. Multiple Fan Testing Scenarios

The following are different scenarios that illustrate multiple-fan testing problems. Solutions are to wire control cables correctly and/or to change to the Individual Control setting if using FanTestic software. The same solutions apply when using Set Pressure from the gauge, when running fans semi-automatically or fully automatically in FanTestic Software. All software in separate computers will "talk" to the gauge by telling it to "Set Pressure" to a required value, which is 50 Pa in the ongoing example.

Diagrams show the control cable going directly from the Dm32X/DM32 gauge to the fan for simplicity. Model 3000 & 6000 fans actually have this control going directly to the variable frequency drive, which is then connected to the Fan with another cable.

 Also note that the diagrams show a Control Cable connected from the gauge directly to the fan for simplicity, however if the fan is a high output fan (Retrotec 3000/6000 series), the Control Cable will actually be connected to the Drive of the fan instead.

7.1   Multiple Fans blowing into one zone:

Typically, two or more fans will all be installed in the same doorway on the ground floor. Upper floors or other zones in the building will often receive less pressure. A typical example could be a three-story building where we must measure pressure on the ground and third floor to ensure readings are within 10% of the average.

Problem #1: Fans "fighting each other" until one slows down or stops

The Target Set Pressure is 50 Pa on both gauges. The upper Fan continues to increase in speed until the pressure on the 3rd floor is 50 Pa. Since the pressure on the 1st floor is greater, the lower fan will continue to slow down since 50 Pa was already achieved. If the upper fan has enough power to pressurize the whole building, the lower fan might even stop altogether. Air might even pass through the lower fan backwards causing the blades to spin and fooling the operator into thinking it was working correctly. Fortunately, the software is designed to notice this and may issue a warning.
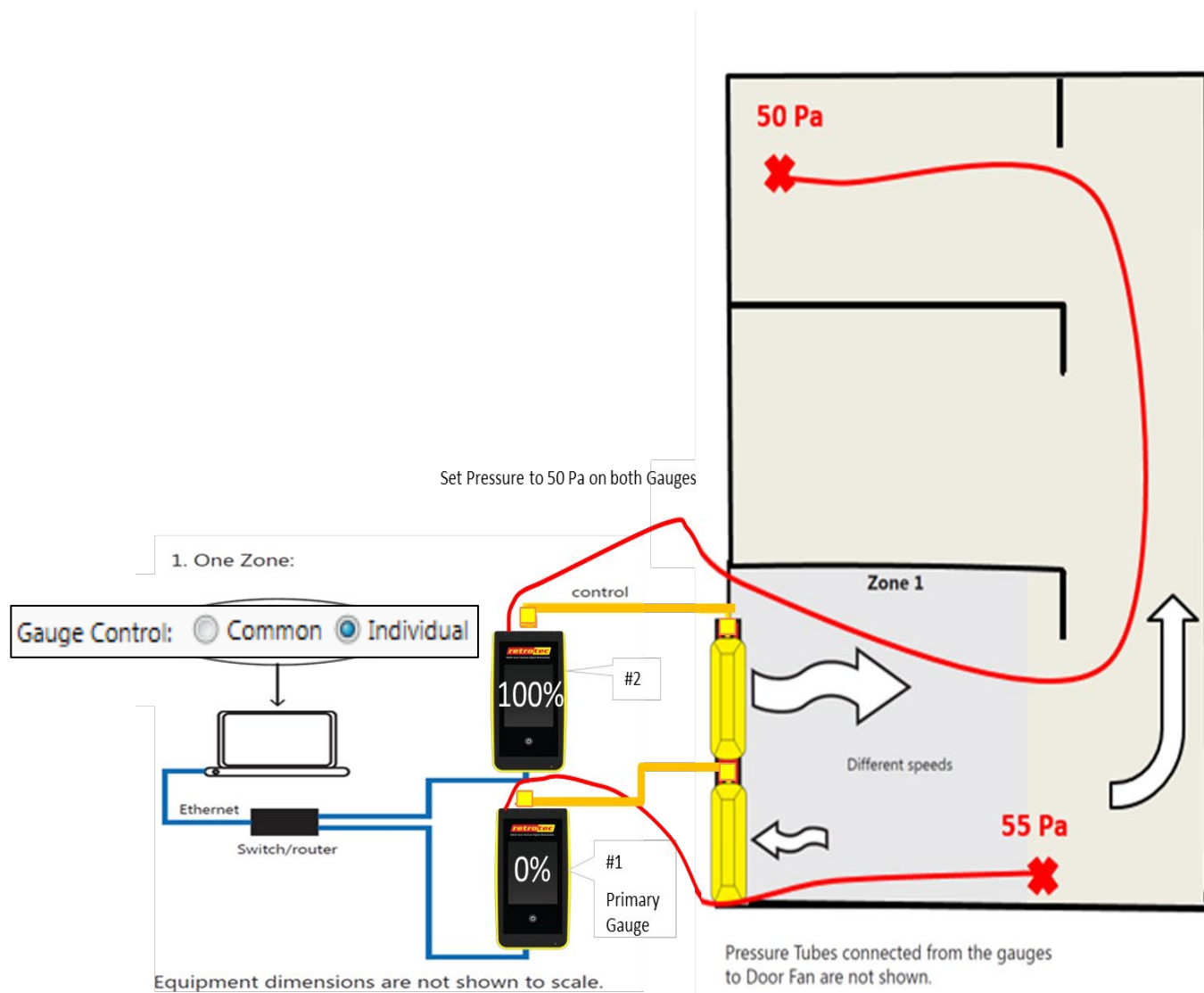
Figure 16. Problem #1 - Imbalanced test fan flow caused by the lower fan being controlled by the higher pressure.

Solution for Problem #1, Option A:

An option in FanTestic software is to select "Common" Control, which will cause all fans to receive the same speed control signal. To perform this, click Settings → Advanced → Basics tab → Select "Common" control

Common Control has the same effect as daisy chaining the fans together or using a Speed Control Splitter. The primary gauge will receive a pressure target from FanTestic, and all other gauges will mimic the speed control signal of the primary gauge, as shown in Figure 17.
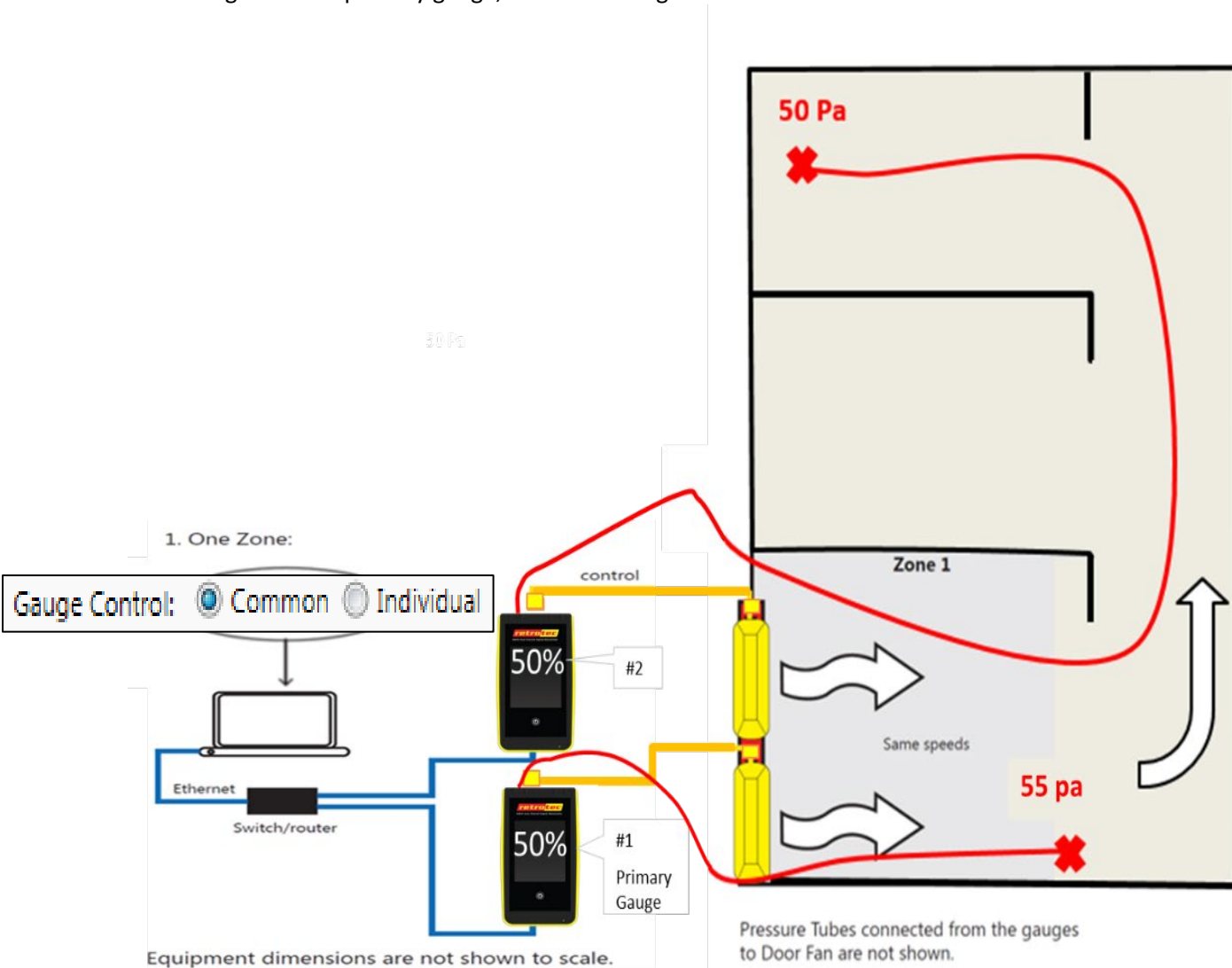
Figure 17: Solution for Problem #1, Option B - Use Common set point control from FanTestic software to balance output from fan

Option A is the preferred solution over Option B because it is easier to set up without the need for extra Speed Control Cables, and to toggle between Control settings.

Solution for Problem #1, Option B:

An option is to connect the fans by daisy chaining the control signal on the CAT5 cable from Fan 1 to all other fans in series. Like Option A, this will cause all the fans to run the same speed. This works whether data is being taken with or without a computer. Notice the control cables for the bottom two fans are not connected to the gauge. Here, the top gauge in this illustration is the "Primary Gauge" controlling the speed of all three fans.
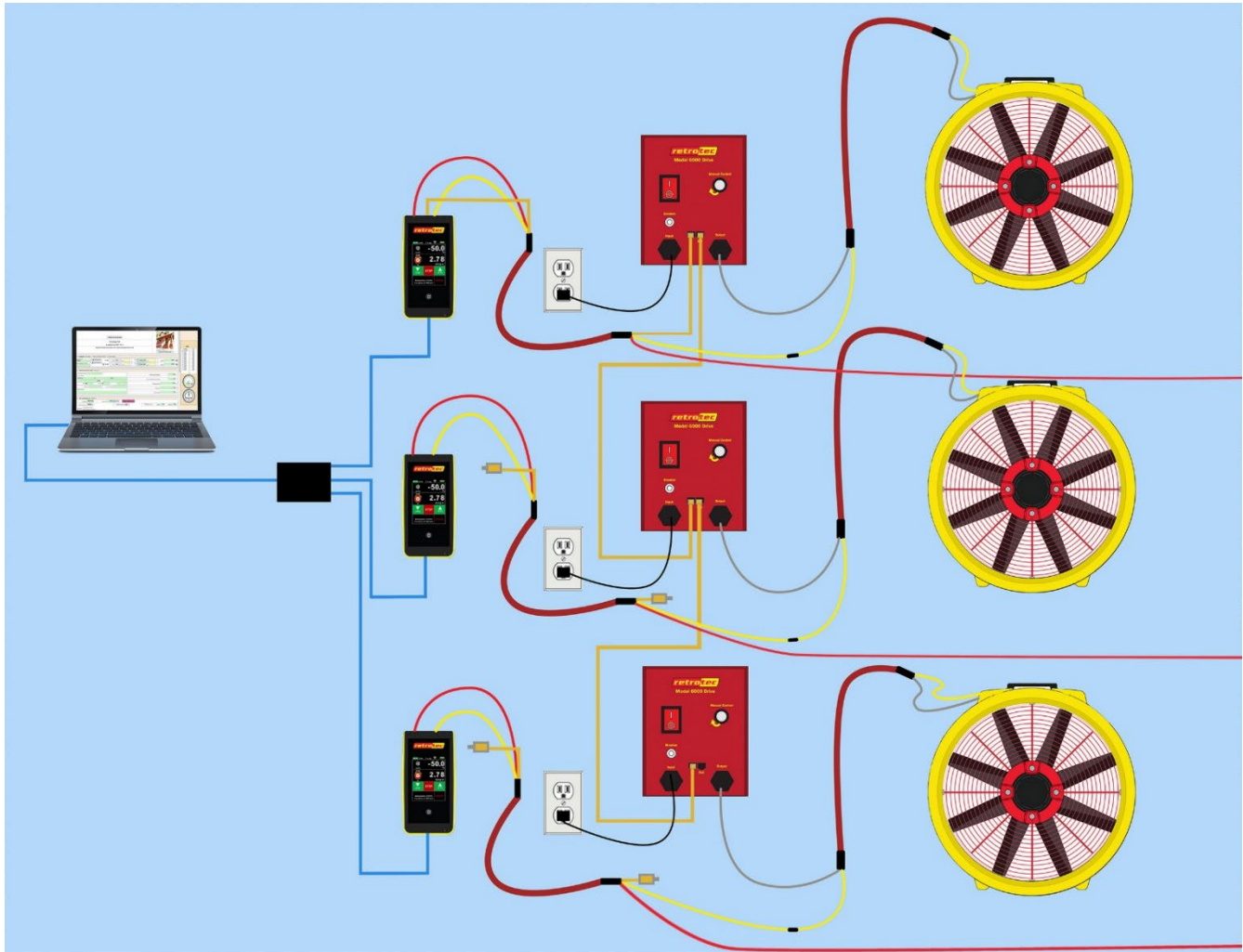
Figure 18: Solution for Problem #1, Option A - Use one control cable from one gauge ("Primary Gauge") daisy chained in series to control all fans with the same speed signal.

7.2   Multiple Fans blowing into multiple zones:

Testing multiple zones can require one fan on each separate zone. These zones can be adjacent rooms or separate floors.

Problem #2: Uneven building test pressures between zones can be caused by a Common set point control as shown in Figure 19. The same control signal can create uneven pressures in unconnected zones. This happens when one zone is leakier than the other.
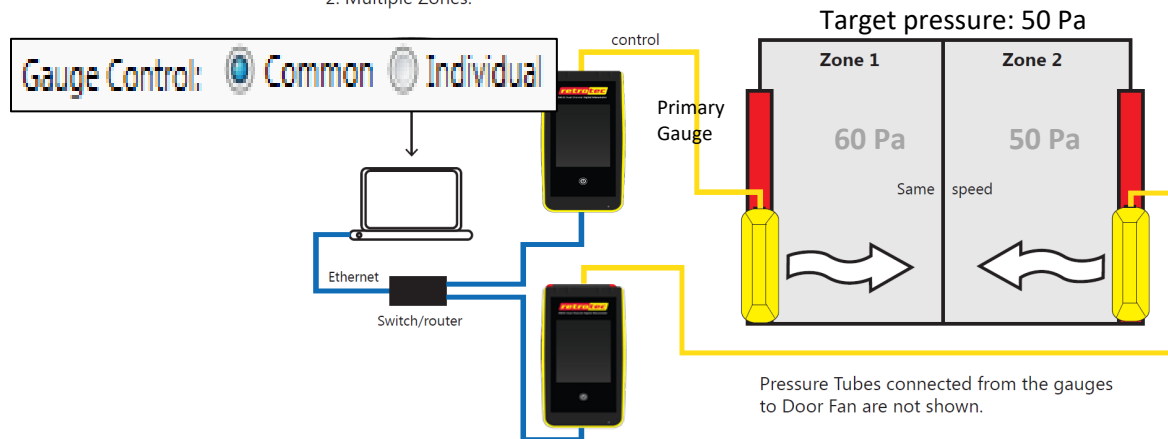
Figure 19: Problem #2 - Uneven pressures between zones caused by Common set point control

Solution for Problem #2: Use Individual set point control ("Individual Control" turned On).

Eliminate the problem of being unable to reach the same pressure in separate zones by controlling each fan individually with its own gauge. The solution is depicted in igure 20.
To perform this with FanTestic, click Tools →Advanced Options → Settings tab → check "Individual Control" ☑ Individual Control?
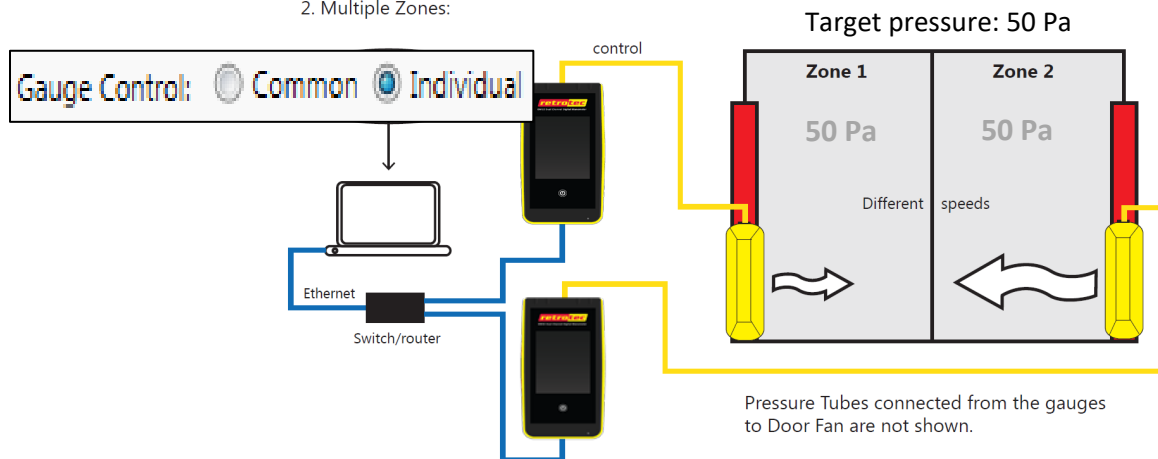
igure 20: Solution for Problem #2: Keep pressures even between zones with Individual set point control

7.3   Multiple Zones (Leaky), multiple fans per zone

Testing multiple zones can require multiple fans on each separate zone. These zones can be adjacent rooms or separate floors.

Problem #3A: Uneven building test pressures between floors can be caused by a common set point as shown in Figure 21. The same control signal can create uneven pressures in different zones. This happens when one zone is leakier than the other. In this scenario all 6 fans are going the same speed.
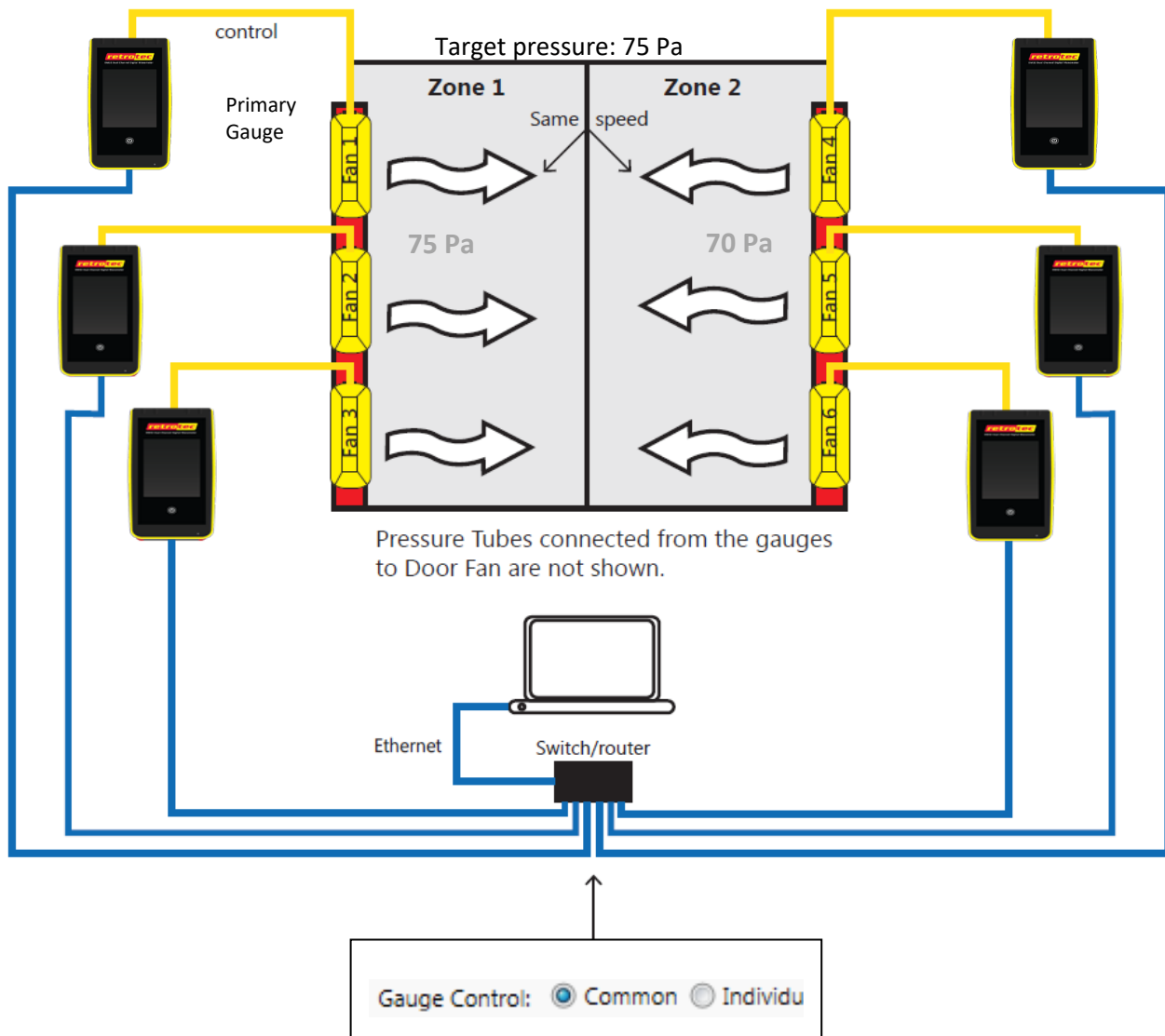
Figure 21: Problem #3A - Uneven test pressures between zones caused by Common set point control of multiple fans per zone

Problem #3B: Imbalanced flow can also be caused by individual set points as shown in Figure 22. When more than one fan are individually set to control to the same pressure, the balance of flow between the fans can shift so that some fans speed up which can cause others to slow down or stop altogether. To utilize the flow capacities of all fans, a different method of fan control must then be used to ensure the flow rates between the fans are balanced. In this scenario all 6 fans are going different speeds.
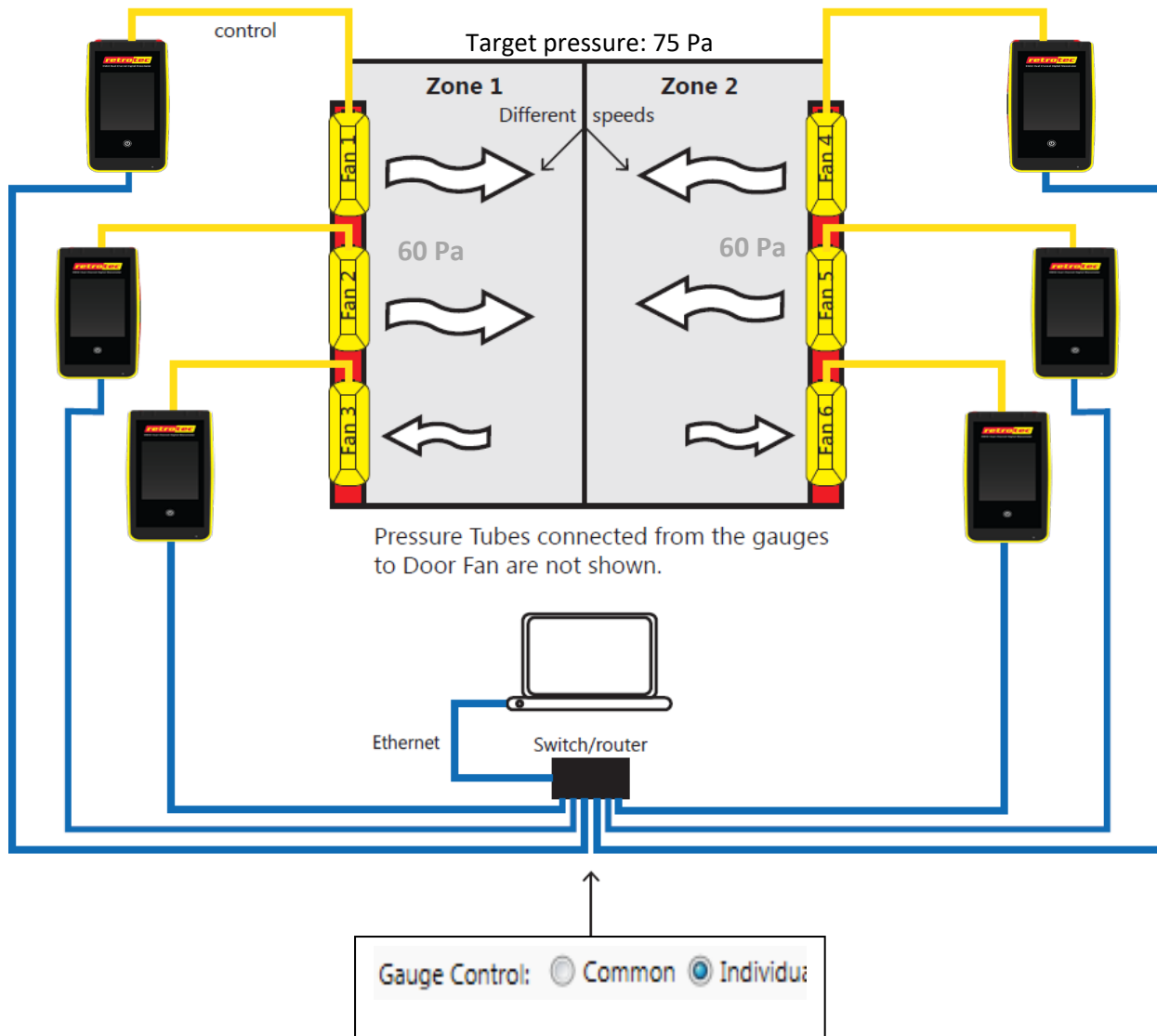
Figure 22: Problem #3B - Unbalanced flow caused by Individual set point control of multiple fans per zone

In Figure 22, Fans 1, 2, 4 and 5 were close to running at 100% speed, but Fans 3 and 6 are running at 5% speed because air is flowing backwards through them. As a result, the target pressure of 75 Pa could not be reached since the full output of Fan 3 and 6 are not utilized. Imbalanced flow is often a problem for multi-point tests.

Solution to Problem #3A and #3B: Individual set point control **between** zones ("Individual Control" turned On), and Common set point control **within** a zone, as shown in Figure 23.

1. Fans within the same zone must run at the same speed.
2. To perform this, fans in an enclosure are connected using a Speed Control Splitter or by daisy-chaining them together. There will only be one Control Cable that connects from one of the gauges to one of the fans – This gauge is called the 'Primary Gauge' and the other gauges have no Control Cables to their fans.
3. Fans between zones can run at different speeds.

To perform this with FanTestic, click settings →Advanced → Basics tab →select "Individual" Control

Gauge Control: ○ Common ⦿ Individual

In the example below, fans 1-3 are all running at one speed and fans 4-6 are all running at another speed.
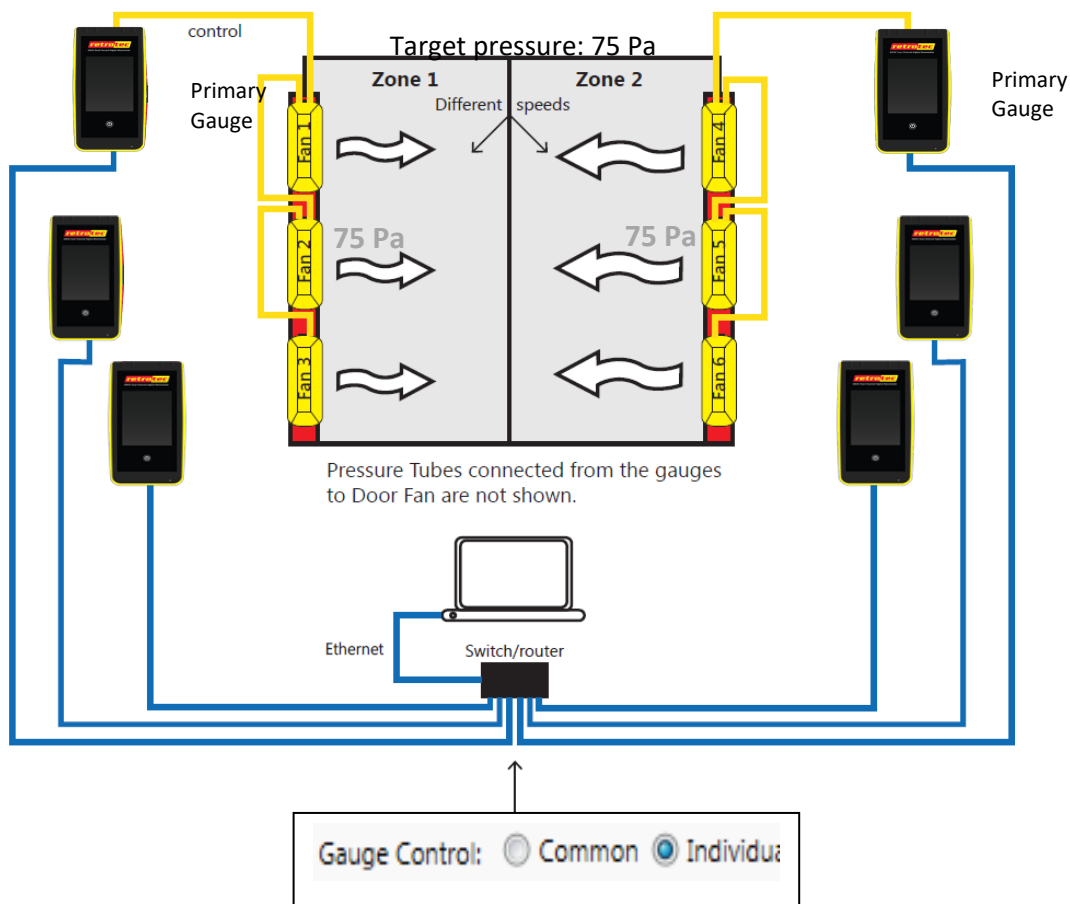
Figure 23: Solution for Problem #3A and #3B: Balanced flow for fans within a zone, balanced pressure between zones

Note: For each zone, this diagram shows one method to control fans to the same speed by daisy chaining the fans together. An alternative method is to connect all the fans in a zone to one side of a Speed Control Splitter (FN280), and the "Primary gauge" to the other side. For detailed schematics on how fans can be controlled by a "Primary gauge", refer to diagrams in section 9 for connections that work best.

8. Routers and switches

Routers and switches are different kinds of networking equipment, and are not interchangeable.

A switch will for the most part just pass the traffic through. Switches can be used for multiplexing so you can get multiple inputs onto one output. They can also be used as signal boosters so you can extend the length of your data connection.

A router will dynamically generate IP addresses for devices connected to it. The router will also multiplex and boost signal.

When networking, it is important to understand what piece of equipment is in charge of generating the IP address for each device. If there is a router anywhere in the network to which you are connecting gauges, that router will provide the IP addresses.

Gauges connected to a network containing a router must be set to DHCP for their IP address generation, because these gauges expect the router to tell them what IP address they will use. You have to set DHCP on the gauge itself (network settings screen>>"Mode") then the gauge will wait for the router to tell it what IP address to use.

Gauges connected to a network containing only switches must be set to Static and have a UNIQUE IP address entered, because the gauge itself will need to know its IP address in advance of connecting to the network. You have to set both of these things yourself on each gauge (network settings screen>>"Mode" and "IP Address").

For ease of configuration, it is best to use one router connected to the control computer and set all the gauges to DHCP. I then use switches if I need to gang gauges together at a location. For instance if we have two banks of fans at separate locations in the building, it is advised to use a switch at each bank, and then feed one cable from each bank to the router.

It is best to use the computer you are taking to the jobsite, and use the network equipment you are taking to the jobsite to set up and test your network before you go.

Most computers are configured so that they will operate either on a network with a router (DHCP mode), or on a network where devices need to know their own IP address (Static mode) without the user having to change any settings on the computer. Be careful when plugging the devices into ports on a router. Most ports will be labeled for LAN and one will be labeled differently (WAN or Internet). Be sure to plug your control computer and devices only into LAN ports, never the Internet/WAN ports or there may be routing issues.

9. Control Cable configurations that work best

The difference between the following multi-fan configurations is how you connect the Speed Control Cables and FanTestic software settings. The configuration of your multi-fan setup depends on whether you want Individual or Common Control (see section 5).

9.1   Connecting 6000 fans

Most commonly, multi-fan setups use high output fans, so connections involving only 6000 series Retrotec fans will primarily be illustrated in this section. Figure 26 and Figure 27 illustrate how to configure connections for Common set point or Individual set point control.

Figure 24A. Model 6000 fan drive.

Control multiple fans using one primary gauge

Controlling multiple Door Fans using a Speed Control Splitter

1. Set up Door Fans in doorway(s)

2. Connect Drives to Door Fans using the Drives' Umbilical

3. Connect yellow tubes from the gauge to each fan or Drive

4. Connect Control Cables from each Drive to another in a daisy chaining fashion (Figure 26), or all to a the Speed Control Splitter (Model: FN280)

5. Connect a Control Cable from the Speed Control Splitter to one gauge ("Primary Gauge")

6. T-connect the red tubing from each of the gauges together

7. Pass the red tube through the port in the panel and toss away from the Door Fans' airstream

8. Use [Set Speed] or [Set Pressure] function on the Primary Gauge to control the same speed on all Door Fans
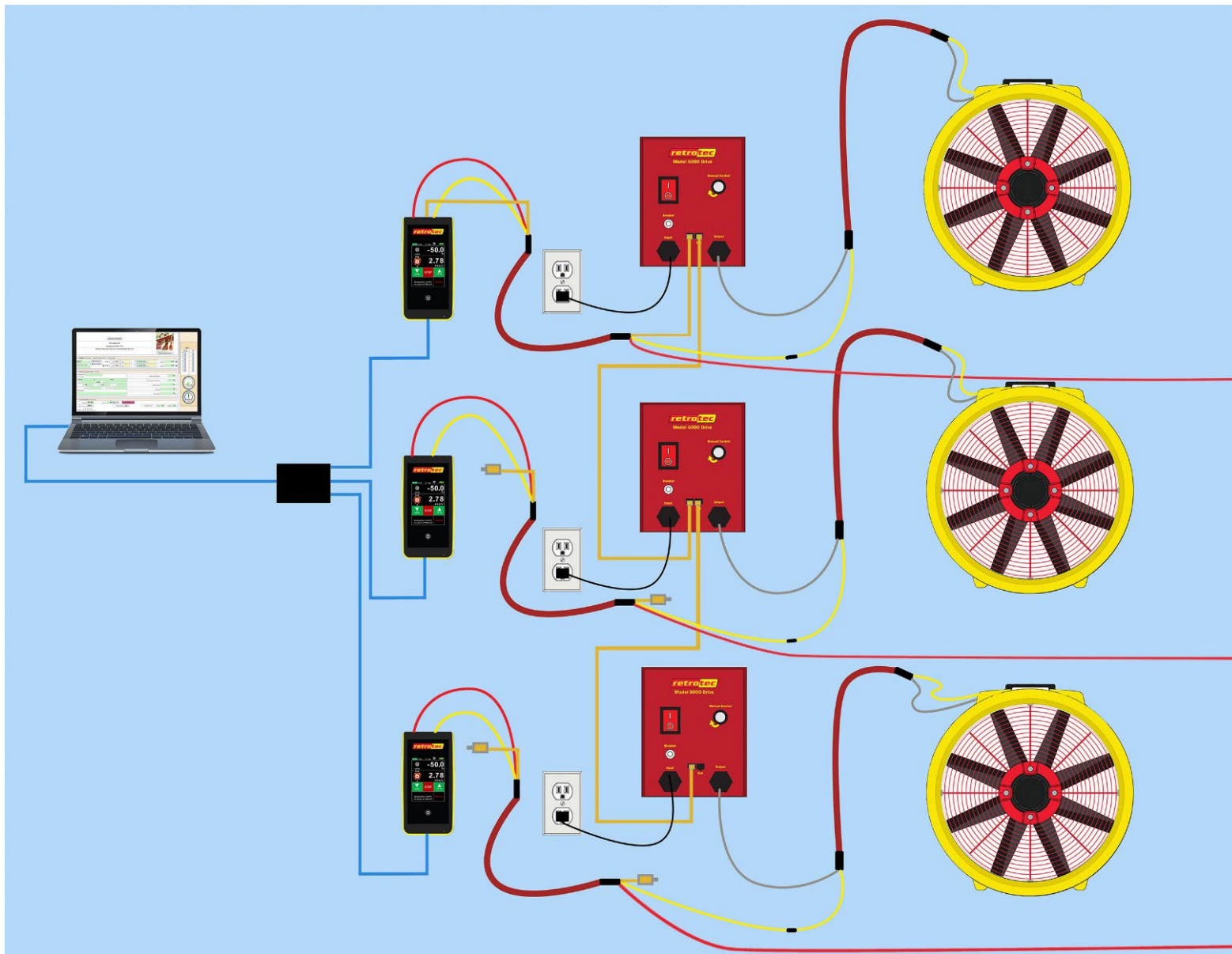
Figure 25. Connections for **Common control.**   Fans get the same control signal that daisy chained from the top fan down to the second and third fan so they'll all run at the same speed.

Only the top gauge's control signal is being used. Notice the control cables from the bottom two gauges are disconnected.
Fan drives with DM32 gauges are not shown to scale.

9.2   Control multiple fans automatically with gauge and FanTestic software

The setup is similar to the procedure in Figure 25 except control cables are required from each gauge to the PC running FanTestic software. For the DM32X, the control connection can be via Wired Ethernet, WiFi, or Bluetooth®. For the DM32, the control connection can be via Wired Ethernet or WiFi. For the DM-2 the control connection can only be via USB.

1. Go to http://retrotec.com to download and install a free trial version of FanTestic Pro 24

2. Connect the primary gauge to the Speed Control Splitter via Control cable

3. Connect each gauge to a computer (with FanTestic Pro software installed)

4. Start FanTestic Pro, create a new test, Find Gauges, and perform an Auto-Test:

5. For detailed instructions on how to run an Auto-Test, please refer to FanTestic Manuals on Retrotec's website

6. Retrotec also features many step-by-step instructional videos on how to run automatic Door Fan tests with FanTestic, which can be found on YouTube: https://www.youtube.com/user/RetrotecEnergy
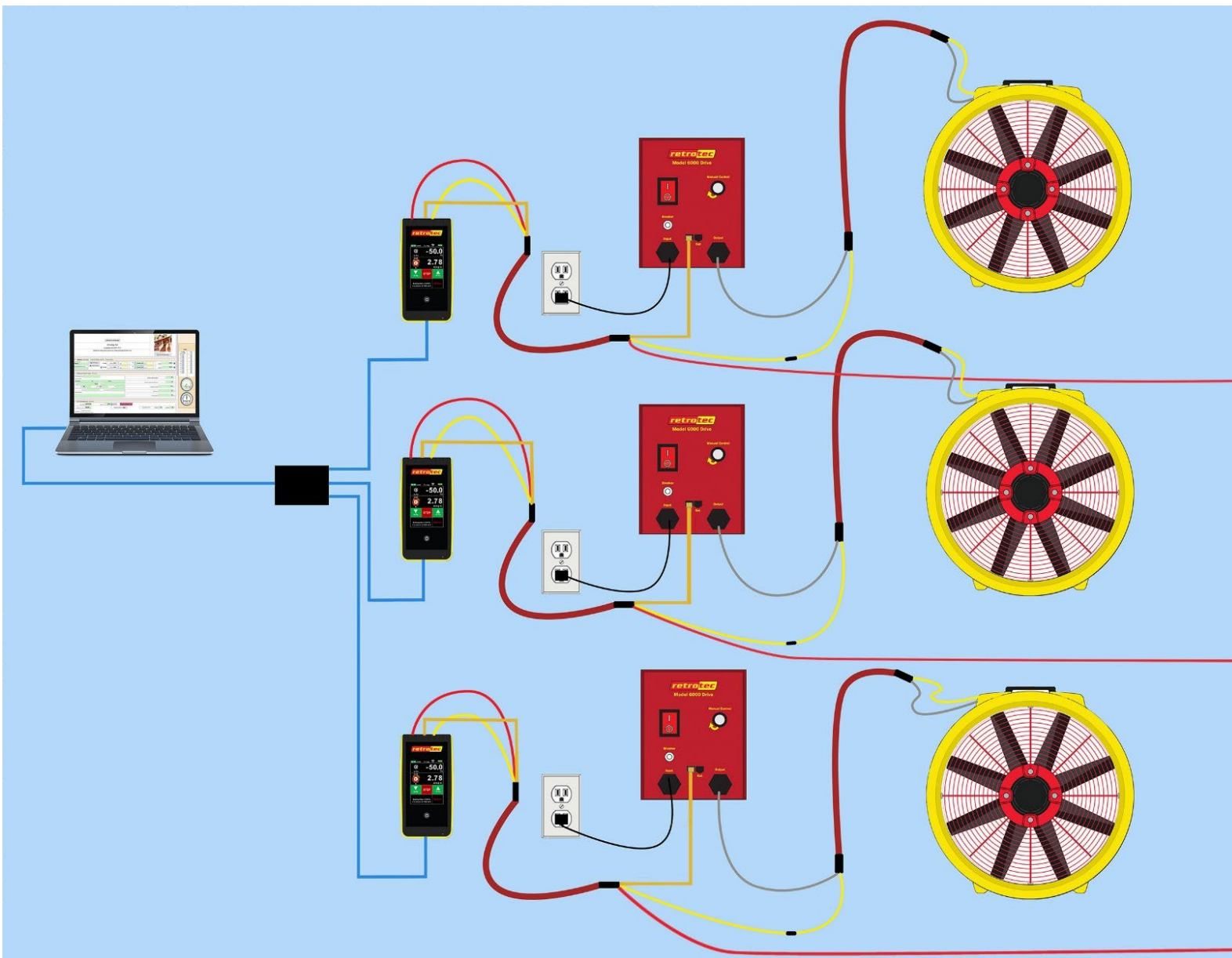
Figure 26. Connections for **Individual control**. Fans get a control signal from each gauge which could cause some fans to slow down and stop.

Get around this by choosing "Common" under "Gauge Control" in the software or by daisy chaining the control cables from the Primary gauge to all the other gauges.

6000 fan drives with DM32 gauges are not shown to scale.

9.3　Use a Speed Control Splitter to control multiple fans

Instead of Daisy Chaining control cables to get each fan to run at the same speed and alternative is to use Speed Control Splitter is used to allow a single gauge to control the fan speed of multiple fans. This is a useful tool when trying to test very large, open, enclosures. Testing time can be significantly reduced by simplifying fan speed adjustment. It also means that automatic control to a test pressure is still possible, even with multiple fans.

The Speed Control Splitter connects to the gauge with the included Speed Control Cable. Additional lengths of Control Cable are used to connect up to seven fans to the Speed Control Splitter. It does not matter which Control Port the fans or gauge are connected to on the Speed Control Splitter.

Model 300, 5000, 6000 Fan Tops include a second Control Port on the Fan Top, which can be used to link multiple fans together, and eliminates the need for the Speed Control Splitter in most circumstances.

While the gauge connected to the Speed Control Splitter will control the fan speed of all connected fans, it can only measure the Fan Pressure from one fan.

Flow and/or Fan Pressure will still need to be measured simultaneously from each fan to get accurate airflow results. Do not add the measured Fan Pressure from each fan. Instead, convert the Fan Pressure to CFM (flow) (or adjust the gauge to display Flow in CFM), then add the numbers for flow together.

Figure 27: Do NOT use this older Speed Control Splitter with a computer connected to the gauges since the interconnectivity may cause damage to your computer. (Part number FN242) works in some configurations. See the Multi-Fan Manual for instructions.

Figure 28: Current Speed Control Splitter (Part number FN280) works in all configurations.

9.4 Connecting older fan drives: Model 3300 and 3350

Model 3350 fan drives were manufactured after February 2012 and also featured the convenience of "In" and "Out" Control Cable CAT5 connectors to daisy chain fans together.

Some earlier units display "for 3000 fans" on the front, but the "3350" label on the back plus the above identifies it as a Model 3350.

Figure 29: Cable ports on Model 3350 fan drives from 2012 and later.

If it is desired to Daisy chain 3300 or 3350 drives, only a FN280 splitter with Red connection ports can be used. Do not daisy chain with Splitters that have yellow connection ports.

WARNING: Connect Model 3300 and Model 3350 Drives together ONLY with the Model FN280 splitter or risk damage to your computer and drives.
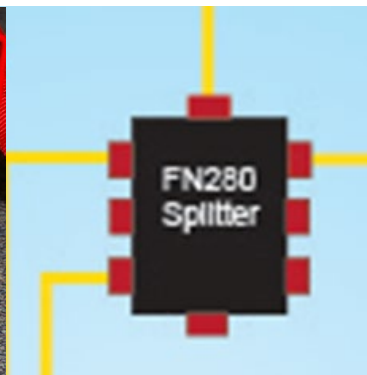
DO NOT use a splitter with Yellow connectors and DO NOT daisy chain a 3300 to a 3350.

10. Setting up the Tubes

10.1 Connecting tubes

The graphic below show the correct way to hook up tubes for 5000 or 6000 Fans when inside the building.
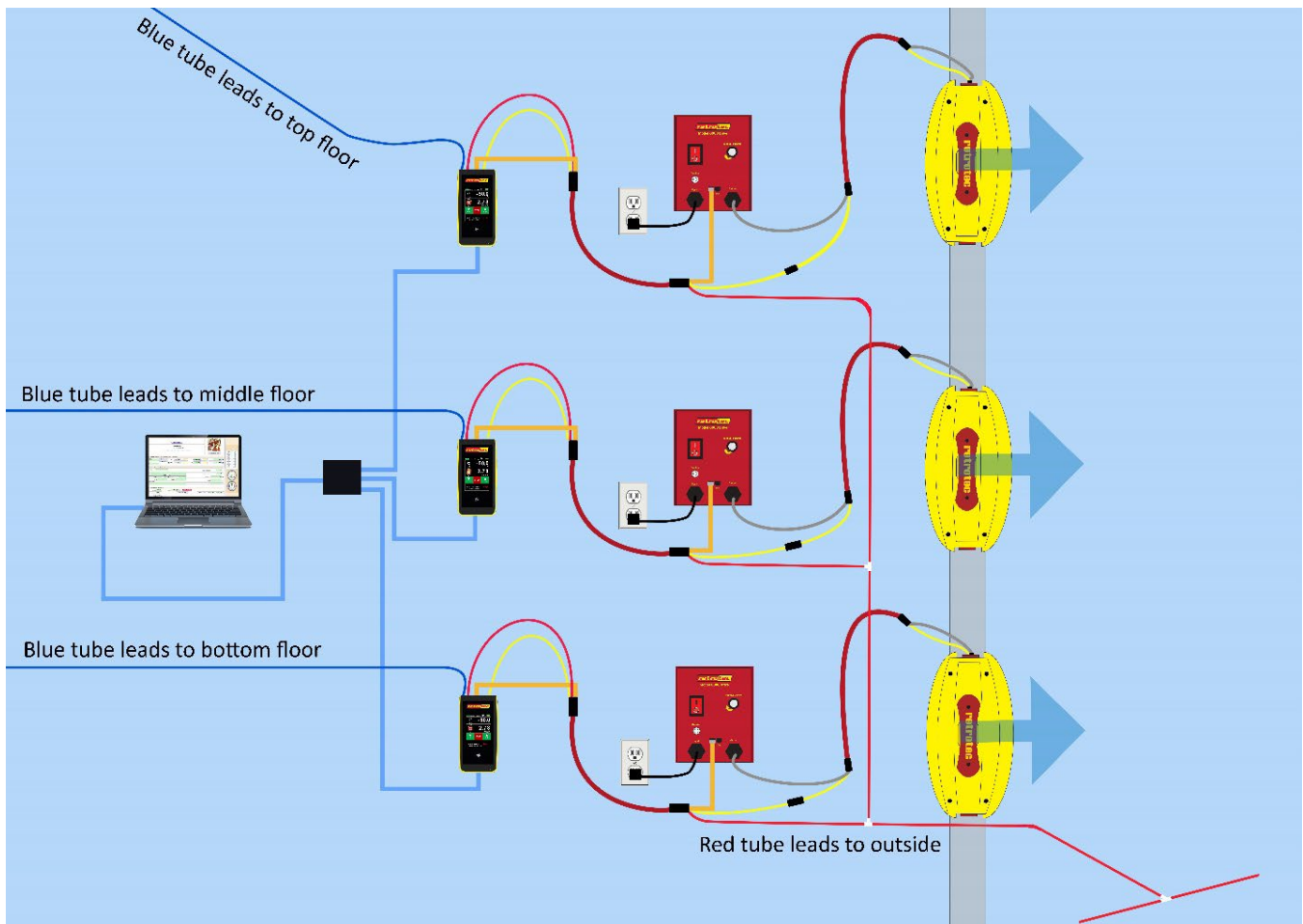
10.1.1. When operator (and gauges) are inside the building being tested

The **red** tube must go from every gauge to **out**doors. Simply T the **red** tubes at the gauge or at the end of the umbilical as shown. Only one tube will exit the panel which goes outdoors and may be T'd to two or four equal length tubes for windy conditions. The point here is that each gauge must see the same outdoor reference pressure so that each indoor pressure is being measured from the same base.

The blue tubes will now give indoor differential pressures relative to the same reference pressure.

10.1.2. When operator (and gauges) are outside the building being tested

The **blue** tube must go from every gauge to **out**doors. Simply T the **blue** tubes at the gauge. The red tubes must now pass through the panels and will now give indoor differential pressures relative to the same reference pressure.

10.1.3. When fans are turned around and blow towards the operator

This configuration will work perfectly; no matter which way the fans are turned around.
Normally, a second tube had to be connected from Channel B in order to get the correct flow reading; if this tube was forgotten, readings would be 20% high. BUT Retrotec gauges and software are smart enough to subtract the test pressure making this tubing change unnecessary.

When using DM32X's or DM32s and FanTestic software, this arrangement will always work regardless of the make of fan as long at the correct fans is selected. For Retrotec Fan Models 1000, 3000, 5000 and 6000 the Test Pressure will be deducted from the Room Pressure in each case

10.1.4. Controlling multiple fan speeds

The graphic shows control cables going from each gauge to one fan. This is individual control from a cable standpoint unless in the software you choose "Common Control" where all fans will run the same speed. Alternatively, you could daisy chain the control cables together so only one gauge controls all fans which will also force them all to run at the same speed which is what is needed here.

10.2 Exterior tube locations

Various standards have different recommended locations for pressure pickups, and under specific situations. The following table lists these recommendations:

Table 1: Recommended locations for exterior pressure pickups

Exterior pressure pick-up locations from Standards	
ASTM	1 tube across the middle of each façade (NOT at corners of the building)
	Manifold and average all pressure readings using a manifold (averaged ver 10s)
	If > 3 stories, measured at more than 1 height
ATTMA	Measured at the lowest floor level of the building
	Located "some distance away" from the building envelope, out of the way of fan airflow and sheltered from wind
CGSB	Calm conditions - 1 pressure measurement outside the building is ok
	Windy - min of 4 measurements on each façade, manifold
	Gusty winds - use wind damping kit (capillary tubes, averaged over 5s)
EN13829-FR	Measure at the bottom floor level, but if tall building, measure at the top as well
	Keep exterior pressure taps out of the sun, and fitted to a T-pipe or connected to a perforated box to protect from wind
USACE	Min 1 exterior pressure tap required, but if bias pressures high, use more
	Interior pressure gauge references tied together in a manifold to read 1 pressure reading

Appendix – Airtightness Requirements

Table 2: Large Building airtightness requirements based on a 4 story building, 120 x 110 x 8 ft, n=0.65

Standard	Region	Comments		Requirement		ACH50 n_{50}	CFM75 /sq ft	(m³/hr 50)/m²
North America								
ASHRAE 90.1	USA	Average		0.30	CFM75/sq ft	3.9	0.30	4.2
		Leaky		0.60	CFM75/sq ft	7.9	0.60	8.4
		Tight		0.10	CFM75/sq ft	1.3	0.10	1.4
LEED	USA	All 6 surfaces enclosing an apartment.		0.23	CFM50/sq ft	2.2	0.17	2.4
				1.17	(L/s 50)/m²	3.9	0.30	4.2
USACE	USA	Large Buildings		0.25	CFM75/sq ft	3.3	0.25	3.5
		Large Buildings (proposed)		0.15	CFM75/sq ft	2.0	0.15	2.1
Washington State, Seattle Code	USA	WA Energy Code, 4 storeys or more. Positive induced pressure or both.		0.40	CFM75/sq ft	5.3	0.40	5.6
Europe								
Passivhaus	Europe			0.60	ACH50	0.60	0.050	0.64
	Austria	Naturally ventilated		3.0	ACH50	3.0	0.23	3.2
		Mechanically ventilated		1.5	ACH50	1.5	0.11	1.6
	Belgium			12	(m³/h 50)/m²	11	0.85	12
	Czech Republic	Common Buildings maximum		4.5	ACH50	4.5	0.34	4.8
		Low energy buildings		1.5	ACH50	1.5	0.11	1.6
		Passive houses		0.6	ACH50	0.6	0.046	0.64
		Mechanically ventilated buildings without heat recovery		1.5	ACH50	1.5	0.11	1.6
		Mechanically ventilated buildings with heat recovery		1.0	ACH50	1.0	0.076	1.1
	Denmark (current regulation)	Normal	New building	1.5	(L/s 50)/m²	5.1	0.38	5.4
			Low energy building	1.0	(L/s 50)/m²	3.4	0.26	3.6
		Building with high ceiling	New building	0.5	(L/s 50)/m²	1.7	0.13	1.8
			Low energy building	0.3	(L/s 50)/m²	1.0	0.08	1.1
	Denmark (new regulations: 2020)	Normal	New building	0.5	(L/s 50)/m²	1.7	0.13	1.8
		Building with high ceiling		0.15	(L/s 50)/m²	0.50	0.04	0.54
	Estonia	Small buildings, new		6.0	(m³/h 50)/m²	-	-	-
		Small buildings, existing		9.0	(m³/h 50)/m²	-	-	-
		Large buildings, new		3.0	(m³/h 50)/m²	-	-	-
		Large buildings, existing		6.0	(m³/h 50)/m²	-	-	-
	Finland	Building heat loss reference		2.0	ACH50	2.0	0.15	2.1
		Energy Performance Certificate (EPC)		4.0	ACH50	4.0	0.30	4.3
	France	Offices, hotels, educational and health care buildings		1.2	(m³/h 4)/m²	5.8	0.44	6.2
		Other buildings		2.5	(m³/h 4)/m²	12	0.92	12.9
DIN 4108-7	Germany	Naturally ventilated		3.0	(m³/h 50)/m²	2.8	0.21	3.0
		Mechanically ventilated		1.5	ACH50	1.5	0.11	1.6

Standard	Region	Comments		Requirement		ACH50 n_{50}	CFM75 /sq ft	(m³/hr 50)/m²
	Lithuania	Naturally ventilated		3.0	ACH50	3.0	0.23	3.2
		Mechanically ventilated		1.5	ACH50	1.5	0.11	1.6
	Latvia	Public and Industrial buildings		4.0	ACH50	4.0	0.30	4.3
		Ventilated Buildings		3.0	ACH50	3.0	0.23	3.2
	Norway			3.0	ACH50	3.0	0.23	3.2
	Slovenia	Naturally ventilated		3.0	ACH50	3.0	0.23	3.2
		Mechanically ventilated		2.0	ACH50	2.0	0.15	2.1
	Scotland	Current regulation		5.0	(m³/h 50)/m²	4.7	0.36	5.0
		New regulation		1.0	(m³/h 50)/m²	0.93	0.07	1.0
	Slovakia			2.0	ACH50	2.0	0.15	2.1
ATTMA TSL2	UK	Best Practice	Office – Natural Ventilation	3.0	(m³/h 50)/m²	2.8	0.21	3.0
			Office – Mixed Ventilation	2.5	(m³/h 50)/m²	2.3	0.18	2.5
			Office – AC/low energy	2.0	(m³/h 50)/m²	3.3	0.21	2.0
			Factories/ warehouses	2.0	(m³/h 50)/m²	3.3	0.21	2.0
			Supermarkets	1.0	(m³/h 50)/m²	0.93	0.07	1.0
			Schools	3.0	(m³/h 50)/m²	2.8	0.21	3.0
			Hospitals	5.0	(m³/h 50)/m²	4.7	0.36	5.0
			Museums / archives	1.0	(m³/h 50)/m²	0.93	0.07	1.0
			Cold stores	0.2	(m³/h 50)/m²	0.19	0.01	0.2
		Normal Practice	Office – Natural Ventilation	7.0	(m³/h 50)/m²	6.5	0.50	7.0
			Office – Mixed Ventilation	5.0	(m³/h 50)/m²	4.7	0.36	5.0
			Office – AC/low energy	5.0	(m³/h 50)/m²	4.7	0.36	5.0
			Factories/ warehouses	6.0	(m³/h 50)/m²	5.6	0.42	6.0
			Superstores	5.0	(m³/h 50)/m²	4.7	0.36	5.0
			Schools	9.0	(m³/h 50)/m²	8.4	0.64	9.0
			Hospitals	9.0	(m³/h 50)/m²	8.4	0.64	9.0
			Museums / archives	1.5	(m³/h 50)/m²	1.4	0.11	1.5
			Cold stores	0.35	(m³/h 50)/m²	0.33	0.03	0.35
	UK (current regulation)	New Building		10	(m³/h 50)/m²	11	0.55	10
		Small Building (less than 500 m³)		15	(m³/h 50)/m²	16	0.82	15
		Large Building		5	(m³/h 50)/m²	4.7	0.36	5.0
	UK (new regulations)	With cooling requirement		3	(m³/h 50)/m²	2.8	0.21	3.0
		Without cooling requirement		5	(m³/h 50)/m²	4.7	0.36	5.0
Other regions								
Abu Dhabi Building Code (IECC)	Abu Dhabi, UAE	Commercial building test		2.0	(L/s 75)/m²	5.2	0.39	5.5
Green Building Regulations	Dubai, UAE			10	(m³/h 50)/m²	9.4	0.71	10
IECC	Global			5.6	(m³/h 50)/m²	5.3	0.40	5.6
Energy Conservation Building Code	India			0.4	CFM75/sq ft	5.3	0.40	5.6
	Japan	Level A		7.5	ACH50	7.5	0.57	8.0

Standard	Region	Comments	Requirement		ACH50 n_{50}	CFM75 /sq ft	(m³/hr 50)/m²
		Level B	3.0	ACH50	3.0	0.23	3.2
		Level C	1.5	ACH50	1.5	0.11	1.6
QSAS	Qatar	Low	0.6	(m³/h 4)/m²	2.9	0.22	3.1
		Med	1.1	(m³/h 4)/m²	5.3	0.40	5.7
		High	2.2	(m³/h 4)/m²	11	0.81	11.4