Panther
Duct Leakage Tester
User Manual

Links to Online Help
(QR Code)

Video – Duct Leakage Testing

Online Technical Library

Online Max Leakage Calculator (SMACNA Leakage Class)

Online Max Leakage Calculator (% Allowable)

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Introduction

The PANTHER duct leakage tester is a powerful tester that can be used to test air handlers at 10 in.wg. as well as commercial duct systems. It is part of our line of the simplest to use testers on the market, backed by unparalleled customer service and technical support. Call us and find out. Thank you for your purchase.

The recommended recalibration interval for the plates is 5 years. Note the authority having jurisdiction may override this requirement, and if so, Oriflow has reasonable rates for re-calibrating orifice plates manufactured by Oriflow. Call us at 727-400-4881 to receive lead time and pricing for calibration. After you order the calibration, just ship the two orifice tube sections along with the Oriflow orifice plates to:

Oriflow Calibrations
2125 Range Rd., Suite B
Clearwater, Florida 33765

Safety Precautions

Before operating your tester, read the following safety precautions:

- ✓ **DO NOT** operate the tester outdoors, in the rain, or where it will get wet,
- ✓ **DO NOT** operate the tester while it is near or in water,
- ✓ **DO NOT** operate the tester with a damaged electrical cord or plug,
- ✓ **DO NOT** operate the tester without an inlet safety screen,
- ✓ **DO NOT** put fingers, hands or any object near inlet of blower while it is running,
- ✓ **DO NOT** touch the blower wheel when the unit is plugged in,
- ✓ **DO NOT** look into the discharge end of the tester when the unit is plugged in,
- ✓ **DO NOT** use the tester as a ladder or step stool,
- ✓ **DO NOT** allow children near the tester,

Things you SHOULD DO:

- ✓ Use an extension cord of the proper gauge (see *Table 3* on page 5),
- ✓ Make sure unit is electrically grounded,
- ✓ Use the proper voltage and phase listed on the Voltage/Phase/Hz label (front panel),
- ✓ Lock the casters when the tester is positioned horizontally,
- ✓ Use the tester on level ground,
- ✓ Secure the tester when transporting it,
- ✓ Wear proper hearing protection, safety glasses and work gloves,
- ✓ Seek assistance when lifting the tester (e.g., loading onto truck, going up or down stairs).

Prior to Testing

Are you Using the Correct Tester?

See Table 1 for the maximum capacity for each duct tester when using the largest orifice plate.

Table 1 – Duct Leakage Tester Capacities

Model	Maximum Leakage Capacity (cfm)*											
	System Test Pressure (in.wg.)											
	0.10	1	2	4	6	7	8	9	10	12	14	16
Cobra	680 cfm	650 cfm	645 cfm	600 cfm	465 cfm	405 cfm	350 cfm	250 cfm	—	—	—	—
Panther	1400 cfm	1350 cfm	1320 cfm	1210 cfm	1065 cfm	970 cfm	875 cfm	875 cfm	615 cfm	270 cfm	—	—
Rhino	1700 cfm	1630 cfm	1550 cfm	1420 cfm	1330 cfm	1255 cfm	1185 cfm	1185 cfm	1035 cfm	895 cfm	660 cfm	480 cfm

** Direct hookup (no flex) and using the largest sized orifice available for the model listed.*

System Preparation

Cap off all ends of system using clear plastic and duct tape or sheetmetal duct end caps. Make sure you test the part of the duct system that leakage testing is required. Usually, this is from the system fan up to, but not including, the VAV boxes (terminal units). Refer to the engineer's specifications and all applicable codes and test standards.

Power Requirements

Do you have an adequate power supply for your tester (see *Table 2*)?

Table 2 – Tester Amp Draw

Tester Model	Voltage	Flow Control Option	Full Load Amps
Panther	115	Slide Gate	< 30
Panther	230	VFD or Slide Gate	< 20

Extension Cord Requirements

If you need an extension cord, is it the proper gauge? See *Table 3* below for extension cord requirements. Note these are minimum requirements. Always error on the side of thicker wire.

Table 3 – Required Extension Cord Wire Gauge

Tester Model	Flow Control Option	Voltage	Extension Cord Length (feet)	Minimum Wire Gauge
Panther	Slide Gate	115	Up to 50	8
			50 to 100	6
Panther	VFD	230	Up to 50	10
			50 to 100	10
			100 to 150	8

Flex-Duct Length

Make sure you have enough flexible duct with your tester for the job. Each tester includes 12.5 feet, which is enough for most applications. Extra lengths of flexible-duct are available at https://oriflow.com/products/accessories/flexible-duct/.

Determining Maximum Allowable Leakage

To determine the maximum allowable leakage for the project, use ORIFLOW's **free online programs** to make these calculations (https://oriflow.com/software/).

In the U.S., calculations are done for either of the two typical specifications:

1. SMACNA Leakage Class, or
2. Percentage of system flow.

In Europe, Australia and other countries outside of the U.S., the following DW/143 specification is commonly used:

1. Pressure Classification (Class A, B, C or D)

If the specification uses SMACNA Leakage Class or Pressure Classification, you will need to calculate the total duct system surface area.

Oriflow has a FREE Adobe test summary sheet that will calculate duct surface area, leakage factor, allowable leakage, actual leakage and Pass/Fail criteria. You can find this test summary sheet using the QR code to the right. It's an excellent tool that can be printed or emailed.

Determining Which Orifice Plate to Use

After determining the allowable leakage at the system test pressure, refer to the following tables for the capacities of each orifice plate.

The proper orifice plate is the smallest orifice where the specified allowable leakage falls between the minimum and maximum leakage at the system test pressure.

For example, if you are testing a system at 4 in.wg. pressure and the maximum allowable leakage is 600 cfm, you will need a 4-inch orifice since the 4-inch plate can test up to 740 cfm at a test pressure of 4 in.wg.

Table 3 – Tester Capacity using the 1-**inch** Orifice Plate

System Static Pressure (in.wg.)	Minimum Flow Rate* (cfm)	PANTHER Tester Maximum Flow Rate (cfm)
2	5	45
4	5	40
6	5	35
8	5	30
10	5	25
12	5	15

** If you need to measure lower flow rates, contact us about the 'low-flow' orifice plate.*
*** Minimum based on 0.40 in.wg. across orifice plate*

Table 4 – Tester Capacity using the 2-**inch** Orifice Plate

System Static Pressure (in.wg.)	Minimum Flow Rate* (cfm)	PANTHER Tester Maximum Flow Rate (cfm)
2	25	190
4	25	170
6	25	150
8	25	130
10	25	100
12	25	55

*** Minimum based on 0.40 in.wg. across orifice plate.*

Table 5 – Tester Capacity using the 3-**inch** Orifice Plate

System Static Pressure (in.wg.)	Minimum Flow Rate* (cfm)	PANTHER Tester Maximum Flow Rate (cfm)
2	50	390
4	50	350
6	50	310
8	50	265
10	50	205
12	50	120

*** Minimum based on 0.40 in.wg. across orifice plate.*

Determining Which Orifice Plate to Use (continued)

Table 6 – Tester Capacity using the 4-**inch** Orifice Plate

System Static Pressure (in.wg.)	Minimum Flow Rate* (cfm)	PANTHER Tester Maximum Flow Rate (cfm)
2	105	820
4	105	740
6	105	655
8	105	550
10	105	425
12	105	245

*** Minimum based on 0.40 in.wg. across orifice plate.*

Table 7 – Tester Capacity using the 5-**inch** Orifice Plate

System Static Pressure (in.wg.)	Minimum Flow Rate* (cfm)	PANTHER Tester Maximum Flow Rate (cfm)
2	190	1320
4	190	1210
6	190	1065
8	190	875
10	190	615
12	190	270

*** Minimum based on 0.40 in.wg. across orifice plate.*

Duct Leakage Test Setup and Procedure

Install Orifice Plate and Upper Tube Section

The orifice plate that was determined from the previous section should now be installed with the serial number facing upwards so the corresponding calibration certificate may be referenced after installation. Refer to *Figures 1* through *4*.

Figure 1 – Install Orifice Plate and then Rotate Clockwise

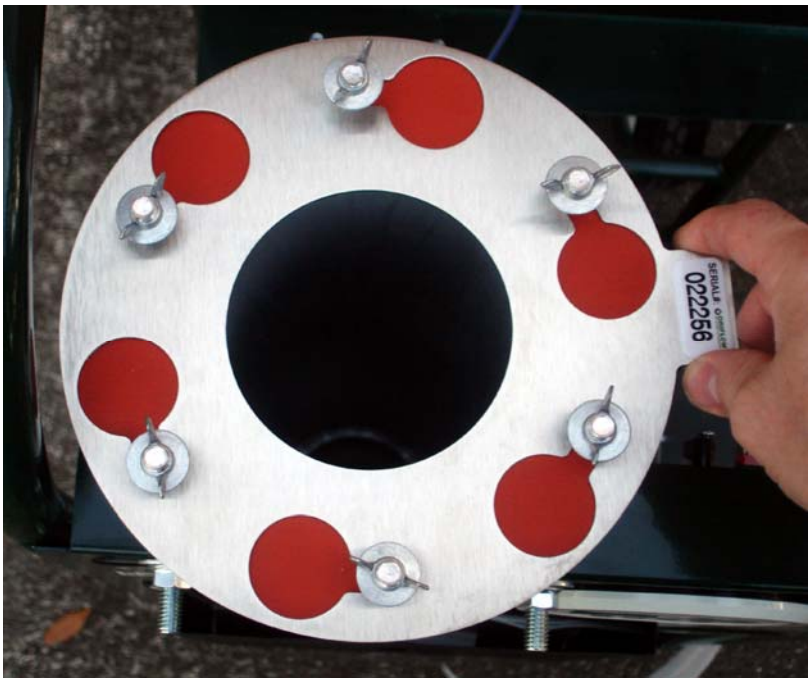

Figure 2 – Rotate Orifice Plate Clockwise until it Locks in Place

Install Orifice Plate and Upper Tube Section (continued)

After the orifice plate is locked in place, place the upper tube section over the bolt/wing nut set, rotate clockwise, and tighten wing nuts (Figures 3 and 4).

Figure 3 – Install Upper Tube Section and Rotate Clockwise

Figure 4 – Tighten Wing Nuts after Rotation

Connect Flex-Duct to Orifice Tube

See Figure 5 below for securing the flexible duct to the orifice tube. Slide the flexible duct so that it overlaps the orifice tube 2 to 3 inches, and tighten clamp using a 5/16-inch nut driver.

Figure 5 – Installing Flex-Duct on Tube

Connect Flex-Duct and Static Pressure Tap to Duct System

Refer to Figures 6 and 7. Connect the other end of the flex-duct to the duct system. Find a convenient location on the duct system where the tester has easy access. Make sure the connection is a sturdy, tightly sealed connection. You don't want to create a leaky connection thereby adding to the system leakage.

To monitor the system static pressure, you need to drill a 5/16-inch diameter hole for the grey plastic static pressure tap to measure system static pressure (Figure 7).

If the static pressure tap is missing, locate the hole at least 3 feet away (farther is better) from flex-duct connection, and insert the pressure tubing from the DUCT SYSTEM gauge so that 6 to 12 inches of tubing is inside the duct system. [*Face the end of the pressure tubing away from the flex-duct connection so that air entering the system does not blow into the tubing, creating a false high system pressure reading*.] Using putty or duct tape, seal the connection. See *Figure 8*.

Connect Flex-Duct and Static Pressure Tap to Duct System (continued)

Figure 6 – Flex-duct Connection to Duct System

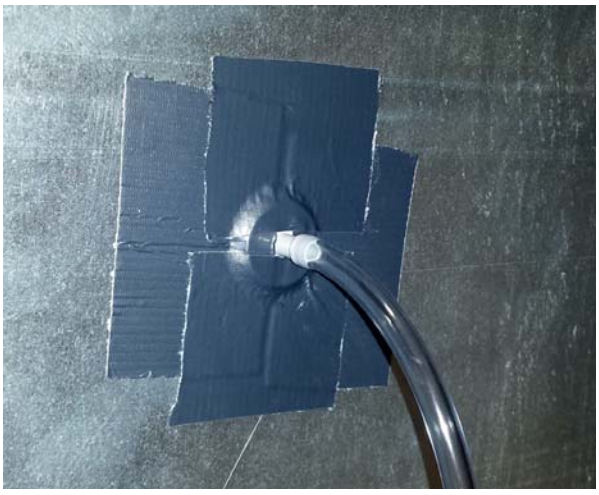

Figure 7 – Connection to Duct System using Static Pressure Tap

Duct Leakage Test Setup (SUPPLY)

See *Figure 8* for the test setup for SUPPLY duct system testing (positive pressure testing). On the backside of the DUCT SYSTEM pressure gauge, move the pressure tubing to the pressure port labeled SUPPLY SYSTEM.

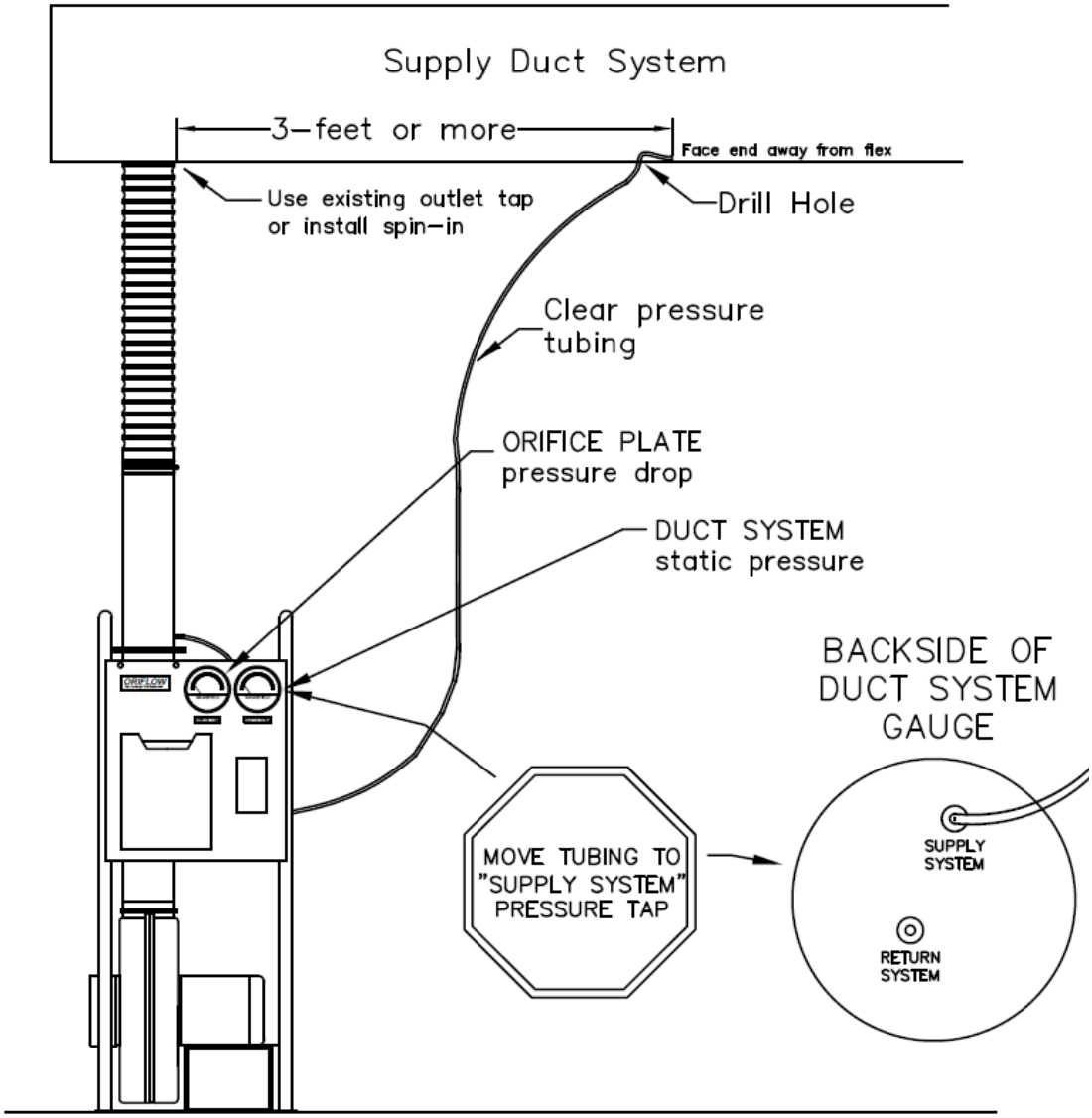

Figure 8 – Duct Leakage Test Setup for a SUPPLY System

Duct Leakage Test Setup (RETURN/EXHAUST)

Refer to *Figure 9* for the test setup required to measure air leakage of a RETURN/EXHAUST system (negative pressure testing). On the backside of the DUCT SYSTEM pressure gauge, move the pressure tubing to the pressure port labeled RETURN SYSTEM.

Connect the 6-inch end of the flex-duct to the inlet of the blower so that air from the system is drawn into the blower. You will determine the leakage of the system since the air drawn from the blower is discharged through the orifice plate.

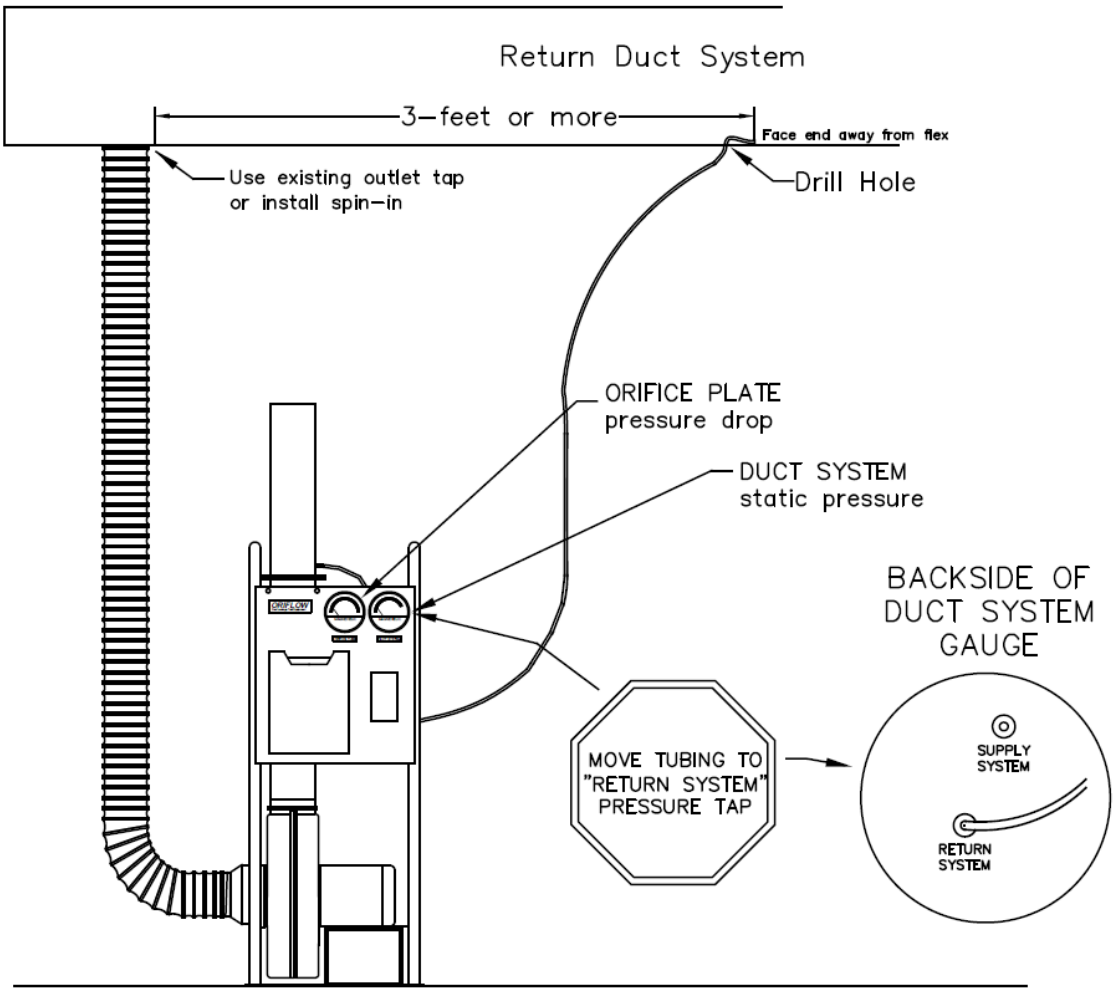

Figure 9 – Duct Leakage Test Setup for a RETURN/EXHAUST System

Zeroing Pressure Gauges

Before turning on the tester, make sure both gauges have been zeroed.

Zeroing **Analog** Gauges

Using a small slotted screwdriver, turn the zero-adjustment screw on the gauge until the needle is aligned with the zero reading unless the calibration certificate for the pressure gauge shows a different set value for true zero. Turning the screw clockwise increases the pressure reading; turning it counterclockwise decreases the reading. See *Figure 10*.

Figure 10 – Zeroing Analog Gauges

Zeroing **Digital** Gauges

If gauges do not turn on automatically (VFD tester models), turn on both gauges by pressing the black (or red) button located on the backside of each gauge.

Use the following steps to zero each digital gauge:

1. Press **MENU** button once.
2. Press ▼ arrow button until Adu shows on screen.
3. Press **E** button once to go into auto-zero mode
4. Press **E** button again and AUTO will be blinking on screen
5. Press **E** button a third time to complete the zeroing process.
6. Press **MENU** button two times to get back to the pressure reading.
7. Pressure should be reading zero or within +/- 0.02 in.wg. If not, repeat steps.

Avoiding Over-Pressurization

Prior to starting the blower, shut the inlet slide gate on models without the speed controller option. For models with the VFD speed controller, rotate speed control knob counter-clockwise until the readout shows 10.00 (the lowest speed setting). See Figures 11.

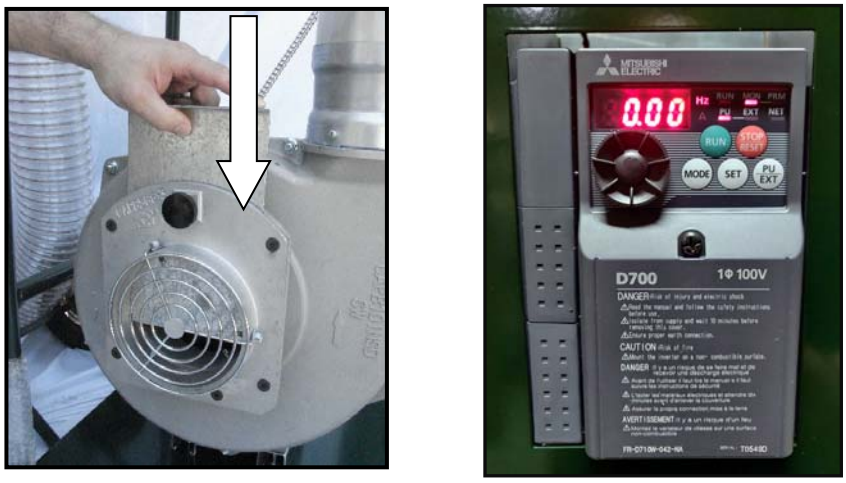

Figure 11 – Avoid Over-Pressurizing by Minimizing Air Delivery upon Startup (inlet slide model on left, VFD speed control model on right)

Obtaining System Test Pressure

Turn the blower on and slowly open the inlet slide gate if your tester has an inlet slide gate. If your tester has the VFD speed controller, press the RUN button, and then rotate the speed control knob clockwise to increase fan speed which will increase test pressure. The faster you rotate the knob, the more quickly the speed will increase. See Figures 12.

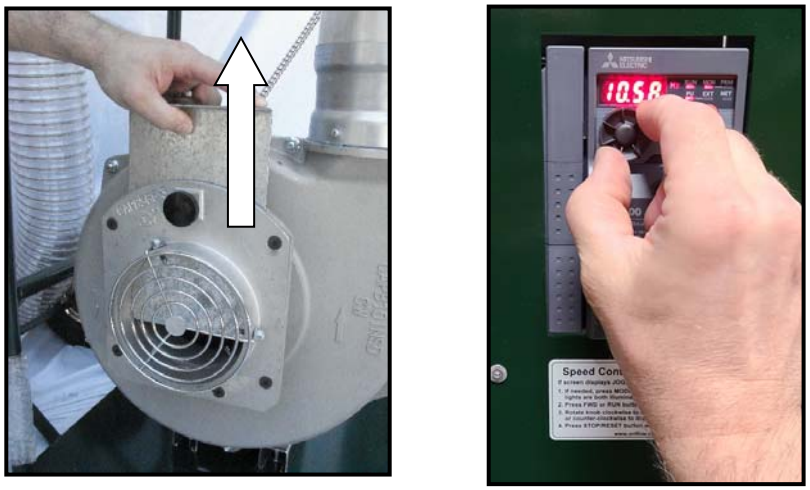

Figure 12 – Obtaining System Test Pressure (inlet slide model on left, VFD speed control model on right)

Obtaining System Test Pressure (continued)

Pay attention to the DUCT SYSTEM gauge while increasing airflow (Figures 13). When you have reached the required system static pressure, tighten the setscrew on the inlet damper (or STOP rotating the speed control knob).

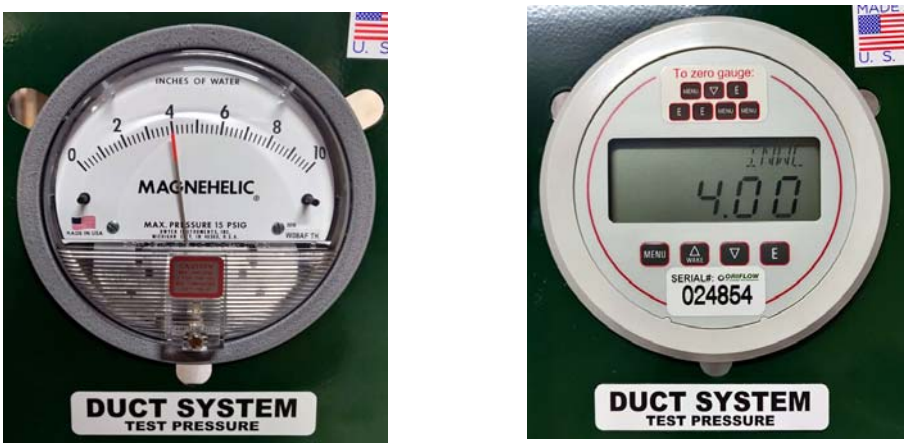

Figure 13 – Duct System Test Pressure (analog on left, digital on right)

Determining the Leakage Rate

Now that you have obtained the system test pressure, note the pressure drop of the ORIFICE PLATE gauge (*Figures 14*). [*Note: Ideally, the pressure drop across the orifice plate should be over 1.0 in.wg. to reduce the amount of error introduced into the reported leakage rate*. Use next smaller orifice plate so the pressure drop reading will increase for a given leakage rate.]

Refer to your calibration certificate to determine the leakage rate that corresponds to the gauge reading. An example of a calibration certificate is shown in *Figure 15*; it is for informational purposes only and used in the example shown on the next page. **Always refer to the calibration certificate(s) that came with your calibrated orifice plate(s).**

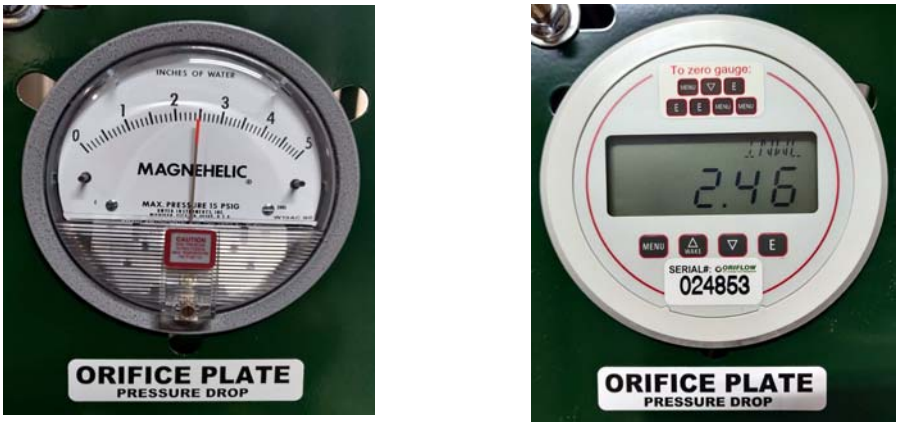

Figure 14 – Orifice Plate Pressure Drop (analog on left, digital on right)

SAMPLE CALIBRATION CERTIFICATE
USE YOUR CERTIFICATE

Issue Date:	01/29/17	Orifice Size:	**3 inch**	Material:	Alum
Reference Meter:	50MC2-4	Orifice Serial #:	021553	Tube Diameter:	5 inches

Standard Temperature and Pressure (70 °F and 29.92 in.Hg.)

"ORIFICE PLATE" Gauge Reading (in.wg.)	Leakage Rate (cfm)	"ORIFICE PLATE" Gauge Reading (in.wg.)	Leakage Rate (cfm)	"ORIFICE PLATE" Gauge Reading (in.wg.)	Leakage Rate (cfm)
0.0	0.0	1.7	175.3	3.4	247.9
0.1	42.5	1.8	180.3	3.5	251.5
0.2	60.1	1.9	185.3	3.6	255.0
0.3	73.6	2.0	190.1	3.7	258.6
0.4	85.0	2.1	194.8	3.8	262.0
0.5	95.0	2.2	199.4	3.9	265.5
0.6	104.1	2.3	203.9	4.0	268.8
0.7	112.5	2.4	208.2	4.1	272.2
0.8	120.2	2.5	212.5	4.2	275.5
0.9	127.5	2.6	216.7	4.3	278.7
1.0	134.4	2.7	220.9	4.4	282.0
1.1	141.0	2.8	224.9	4.5	285.1
1.2	147.2	2.9	228.9	4.6	288.3
1.3	153.3	3.0	232.8	4.7	291.4
1.4	159.0	3.1	236.7	4.8	294.5
1.5	164.6	3.2	240.5	4.9	297.6
1.6	170.0	3.3	244.2	5.0	300.6

You may use a calculator to calculate leakage using the "ORIFICE PLATE" gauge reading and the following equation:

Leakage (cfm) = 134.420 x $\sqrt{\text{ORIFICE PLATE Gauge Reading}}$

Figure 15 – **Example Calibration Certificate**. Use the calibration certificate that came with your orifice plate

Example (refer to Figures 14 and 15)

For an ORIFICE PLATE pressure drop (gauge reading) of 2.46 in.wg. (Figure 14), the leakage rate is approximately 210 cfm using the calibration certificate shown in Figure 15.

For an exact value, use the equation that comes with every calibration certificate. For the certificate shown in Figure 15:

$$Leakage = 134.42 \times \sqrt{\text{ORIFICE PLATE Gauge Reading}}$$

*where the value of "134.42" is the "Leakage Coefficient" and will be specific to the orifice plate used (**every plate has its own value; yours will be different**).*

*Using a calculator, take the square root of the ORIFICE PLATE gauge reading first, and then multiply by the constant for your orifice plate (for this example, the constant is "134.42"). The exact leakage is 134.42 x (square root of 2.46) = 210.8 cfm. Better yet, **download Oriflow's test summary sheet described on the bottom of page 5 of this manual.***

Troubleshooting

Can't obtain system test pressure (DUCT PRESSURE TOO LOW)

This typically happens when the system is leaking too much air. Make sure all outlets are sealed. Check corners of rectangular duct for excessive leakage. Inspect all duct and fitting joints for leakage. Make sure you seal all suspect joints and allow to cure 24 to 48 hours. Always refer to duct sealant manufacturer's instructions.

Perform troubleshooting steps in the order shown in the *Table 8* below.

Table 8 –Troubleshooting steps when DUCT SYSTEM test pressure is too low

Step	Scenario	What to do
1	Allowable Leakage is greater than capacity of tester.	Refer to top of page 4, "Are you using the correct tester."
2	Inlet damper was left shut, cutting off air to the system.	Open inlet damper slowly.
3	Pressure tubing connected to gauge incorrectly	Look at the P1 and P2 stickers that are located on the orifice tube (airflow meter) and gauges. Make sure tubing from P1 tap is connected to the P1 tap on the ORIFICE PLATE gauge.
4	Plugged pressure port on orifice tube	Remove pressure tubing from the P1 and P2 ports on the ORIFICE PLATE gauge. Blow through each tubing end. You should be able to blow air freely through both ports. If plugged, use paper clip or 1/16" drill bit to clear hole.
5	Malfunctioning gauge.	Attach pressure tubing to the port labeled "SUPPLY SYSTEM." Gently blow through other end of pressure tubing. The pressure reading should increase.
6	System is leaking too much air.	Check for these other sources of leakage: • Rectangular duct joints (check and seal corners), • Fire or smoke dampers, • Duct joints (pay particular attention to flex-duct joints if they are part of the leak test), • VAV boxes (pay particular attention to parallel box back draft dampers), • Built-up air handlers, • Plenums, • Uncured duct sealant blow-thru (follow manufacturer instructions for cure time), • Improperly sealed or un-sealed joints, • Hot water coils and electric heaters, • Open duct end that was supposed to be sealed/capped-off for the leak test.

A non-toxic smoke machine is an excellent tool for locating significant sources of leakage. Call ORIFLOW at 727-400-4881 or to our website at www.oriflow.com for more information.

Can't obtain system test pressure (DUCT PRESSURE TOO HIGH)

This typically happens on small or tight systems when using a duct tester without the VFD speed controller. Testers equipped with the inlet slide gate damper always run at about 3600 rpm and are so powerful, air pressure is generated even with the inlet damper is completely shut and sealed.

- Use a smaller orifice plate. If using the 1-inch plate, install the ½-inch plate which is used to measure flow rates from 1 to 10 cfm.
- Remove the end of the flex-duct where it connects to the duct system (typically, a 6-inch round tap). Using duct tape, completely cover the tap, and then poke a hole(s) in it with a screwdriver or pen. Then install the flex-duct as usual. This will act as an outlet damper or restriction. Now you can use the inlet damper to regulate flow.

ORIFICE PLATE gauge reading maxed out

- *Scenario 1*: The system is leaking too much air. Make sure all outlets are sealed. Check corners of rectangular duct for excessive leakage. Inspect all duct and fitting joints for leakage. Make sure you seal all suspect joints and allow curing time of 24 to 48 hours. Always refer to duct sealant manufacturer's instructions.
- *Scenario 2*: orifice plate bore could be too small, causing a high pressure-drop at low to moderate flows. Use the next larger sized orifice.

GFI/GFCI trips

This happens when using a duct leakage tester with the variable speed option. The supply wiring has ground wired to neutral which causes the GFI to activate when the tester is operating.

Possible solutions:

1) Utilize a correctly wired GFI outlet that has separate neutral and true ground,
2) Use a non-GFI outlet to power the tester,
3) Use a non-VFD model tester.

Error Codes

Error Code	Description	What to do
	Undervoltage error. Too much voltage-drop between power source and duct leakage tester.	Use power cord with thicker gauge wire. See Table 2 for power requirements and Table 3 for minimum wire gauge for extension cords.
	Undervoltage error. Too much voltage-drop between power source and duct leakage tester.	Use power cord with thicker gauge wire. See Table 2 for power requirements and Table 3 for minimum wire gauge for extension cords.

Zero or very small reading on ORIFICE PLATE gauge

If the gauge reading is zero, perform troubleshooting steps in the order shown in *Table 9* below.

Table 9 –Troubleshooting steps when ORIFICE PLATE gauge is zero

Step	Scenario	What to do
1	Plugged pressure taps.	Remove pressure tubing from the P1 and P2 ports on the ORIFICE PLATE gauge. Blow through each tubing end. You should be able to blow air freely through both ports. If plugged, use paper clip or 1/16" drill bit to clear hole.
2	Orifice plate too large for application.	If you are using a 4-inch ID orifice plate, and the system is leaking 40 cfm, you probably won't even notice the gauge needle moving. This can happen to other orifice plates too. Use an orifice plate with a smaller bore diameter so that a small amount of airflow/leakage will result in a bigger pressure drop.
3	System is leaking very little air.	You will know if this is true if the fan inlet is almost shut. Not likely unless system is small and well-sealed. Use an orifice plate with a smaller bore diameter so that a small amount of airflow/leakage will result in a bigger pressure drop.
4	Pressure tubing connected incorrectly.	Look at the P1 and P2 stickers that are located on the orifice tube sections and the ORIFICE PLATE gauge. Make sure they match.
5	Malfunctioning gauge.	Remove the clear pressure tubing from the lower pressure tap on the orifice tube and blow through the end of the tubing. The needle should move in response. If not, the gauge is faulty.
		Use other test gauge to see if you get same reading.
6	Not sure	The best way to make sure that your tester is working properly is to disconnect the flex duct from the system and turn the blower on, and slowly open the inlet damper. If you feel a lot of air coming out of the tube end, you should see a pressure reading on the gauge ORIFICE PLATE.

DUCT SYSTEM Gauge (Digital) Displays UFL or OFL

Refer to *Table 10* below:

Table 10 –Troubleshooting steps when DUCT SYSTEM Gauge (Digital) Displays UFL or OFL

Scenario	What to do
UFL/OFL displays when TESTER is OFF	Disconnect pressure tubing from rear of gauge and re-zero gauge (page 14). Did this fix it? **YES**: re-connect the tubing. If error returns (UFL or OFL on display) after reconnecting tubing, check pressure tubing for blockage. **NO**:. If UFL or OFL still displays, gauge is most likely faulty. Call Oriflow for pricing or replacement (warranty period 12 months from date of purchase).
UFL/OFL displays when TESTER is ON	Testing Supply System? Make sure pressure tubing from the duct system is connected to the gauge port labeled “SUPPLY SYSTEM” Testing Return or Exhaust System? Make sure pressure tubing from the duct system is connected to the gauge port labeled “RETURN SYSTEM”

ORIFICE PLATE Gauge (Digital) Displays UFL or OFL

Refer to *Table 11* below:

Table 11 –Troubleshooting steps when ORIFICE PLATE Gauge (Digital) Displays UFL or OFL

Scenario	What to do
UFL/OFL displays when TESTER is OFF (no airflow through orifice tube)	Disconnect pressure tubing from rear of gauge (both ports) and re-zero gauge (page 14). Did this fix it? **YES**: re-connect the tubing paying attention that P1 goes to P1, P2 to P2 (from orifice tube ports to gauge ports. If error returns (UFL or OFL on display) after reconnecting tubing, one of the ports on the orifice tube may be plugged. Blow through both pressure ports on orifice tube or use paper clip or wire (≤ 1/16” diameter) to verify holes in both ports are clear of debris **NO**:. If UFL or OFL still displays, gauge is most likely faulty. Call Oriflow for pricing or replacement (warranty period 12 months from date of purchase).
UFL/OFL displays when TESTER is ON (airflow through orifice tube)	Make sure P1 from orifice tube (lower pressure port) is connected to P1 port on ORIFICE PLATE gauge, and P2 from orifice tube (lower pressure port) is connected to P2 port on ORIFICE PLATE gauge.
	Are you using another blower in series with the tester? The digital gauges used on the tester can read up to about 11 in.wg. maximum.

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