Operating Instructions for Rhino Duct Leakage Tester

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ORIFLOW
Air Leakage Test Equipment

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Introduction

These operating instructions are for ORIFLOW model RHINO air leakage tester. Take pride in knowing that you have purchased the best air leakage tester on the market. It is no secret that Oriflow manufactures the highest quality testers, and has unparalleled customer service and technical support.

The orifice plates available for your duct leakage tester are constructed from laser-cut 0.125-inch stainless steel and do not require recalibration for 10 years. Note the authority having jurisdiction may override this requirement, and if so, Oriflow has very reasonable rates for calibrating orifice plates manufactured by Oriflow.

Safety Precautions

Before operating your tester, read the following safety precautions:

- ✓ DO NOT operate the tester in the rain,
- ✓ 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 remove the inlet safety screen,
- ✓ 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,

- ✓ DO use an extension cord of the proper gauge (see *Table 2*),
- ✓ DO use the proper voltage and line frequency listed on the motor nameplate,
- ✓ DO lock the caster when the tester is positioned horizontally,
- ✓ DO use the tester on level ground,
- ✓ DO secure the tester when transporting it,
- ✓ DO wear proper hearing protection, safety glasses and work gloves,
- ✓ DO seek assistance when lifting the tester (e.g., loading onto truck, going up or down stairs).

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Prior to Testing

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 1*)?

Table 1 – Tester Amp Draw

Tester Model	Voltage	Flow Control Option	Phase	Full Load Amps
Rhino	208	Slide Gate	3	13
	208	VFD	3	14
	230	VFD	1	21
	230	Slide Gate	3	12
	230	VFD	3	13
	380	Slide Gate	3	7
	380	VFD	3	8
	460	Slide Gate	3	6
	460	VFD	3	7

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Extension Cord Requirements

If you need an extension cord, is it the proper gauge? See *Table 2* below for extension cord requirements.

Table 2 – Required Extension Cord Wire Gauge

Rhino Model				
Flow Control Option	**Voltage**	**Phase**	**Extension Cord Length (feet)**	**Wire Gauge**
VFD	230	1	10 to 50	10
			50 to 100	10
Slide Gate	230	3	10 to 50	14
			50 to 100	14
VFD	230	3	10 to 50	14
			50 to 100	14
Slide Gate	380	3	10 to 50	14
			50 to 100	14
VFD	380	3	10 to 50	14
			50 to 100	14
Slide Gate	460	3	10 to 50	14
			50 to 100	14
VFD	460	3	10 to 50	14
			50 to 100	14

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 www.oriflow.com/Products.

Determining Maximum Allowable Leakage

To determine the maximum allowable leakage for the project, use ORIFLOW's **free online programs** to make these calculations (www.oriflow.com/Technical). Calculations are done for either of the two typical specifications: percentage of system flow, or leakage class. If the specification uses leakage class, you will need to calculate the total duct system surface area. Oriflow has a free Adobe form available to our customers that will calculate duct surface area given the duct shape, dimensions and length.

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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 available for the **RHINO** model tester. Make sure you have an orifice plate that can measure the maximum allowable leakage. The proper plate is the one where the maximum allowable leakage falls between the minimum and maximum leakage at the system static pressure. For example, if you are testing a system at 10 in.wg. pressure and the maximum allowable leakage is 600 cfm, you will need a 5-inch orifice since the 5-inch plate can be used for up to 805 cfm of leakage.

It is a good idea to have the next larger orifice plate size since it is common for duct systems to leak more than the maximum allowable. Smaller diameter plates are use when leakage is relatively low.

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

System Static Pressure (in.wg.)	Minimum Leakage* (cfm)	Maximum Leakage (cfm)
2	9	45
4	9	41
6	9	38
8	9	35
10	9	30
14	9	19
16	9	13

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Determining Which Orifice Plate to Use (continued)

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

System Static Pressure (in.wg.)	Minimum Leakage* (cfm)	Maximum Leakage (cfm)
2	37	185
4	37	165
6	37	155
8	37	140
10	37	120
14	37	75
16	37	55

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

System Static Pressure (in.wg.)	Minimum Leakage* (cfm)	Maximum Leakage (cfm)
2	85	410
4	85	375
6	85	350
8	85	310
10	85	270
14	85	170
16	85	120

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

System Static Pressure (in.wg.)	Minimum Leakage* (cfm)	Maximum Leakage (cfm)
2	160	785
4	160	720
6	160	660
8	160	590
10	160	515
14	160	325
16	160	225

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Determining Which Orifice Plate to Use (continued)

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

System Static Pressure (in.wg.)	Minimum Leakage* (cfm)	Maximum Leakage (cfm)
2	260	1185
4	260	1100
6	260	1010
8	260	905
10	260	805
14	260	510
16	260	365

Table 8 – Tester Capacities using the **6-inch** Orifice Plate

System Static Pressure (in.wg.)	Minimum Leakage* (cfm)	Maximum Leakage (cfm)
2	455	1550
4	455	1420
6	455	1330
8	455	1185
10	455	1035
14	455	660
16	455	480

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Install Orifice Plate

The orifice plate that was determined from the previous section should now be installed. Install the orifice plate with the serial number facing upwards so the corresponding calibration certificate may be referenced after installation. Refer to *Figures 1* through *3*.

Figure 1 – Installing Orifice Plate

Figure 2 – Installing Top Tube Section

Figure 3 – Bolting Flange (hand tighten snuggly)

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Connect Flexible Duct to Orifice Tube

See the figures below for securing one end of the flexible duct to the orifice tube. Note that the worm-gear clamp should be slid over the flex-duct **before** connecting it to the orifice tube. Slide the flexible duct so that it overlaps the orifice tube1 to 2 inches, and tighten clamp using a 5/16-inch nut driver.

Figure 4 – Installing Flex-Duct on Tube

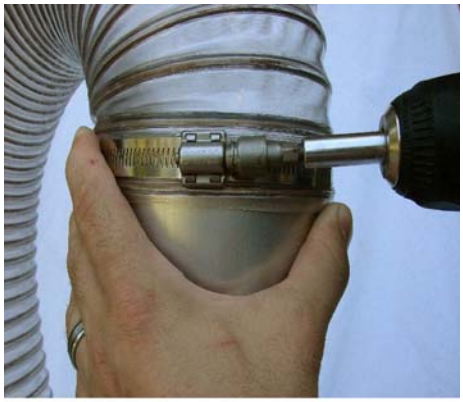

Figure 5 – Tightening Clamp

Connect Flex-Duct to Duct System

Find a convenient location in the duct system where the tester has easy access. Make sure that the connection where you connect the flexible duct is a sturdy, sealed tight connection. You don't want to create a leaky connection where the tester is supplying air into the system.

Figure 6 – Connection to Duct System

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System Test Pressure Connection

So that you can monitor the system static pressure, you need to drill a hole at least 3 feet away from the flex-duct connection. Drill a 5/16-inch diameter hole and insert the pressure tubing from the "DUCT SYSTEM" gauge so that 6 to 12 inches of tubing is inside the duct system. Using putty or duct tape, seal the connection. If your pressure tubing has a plastic static pressure tap at the end of the pressure tubing, insert the tap in the hole and seal it to the duct wall using duct tape. See *Figure 4* below.

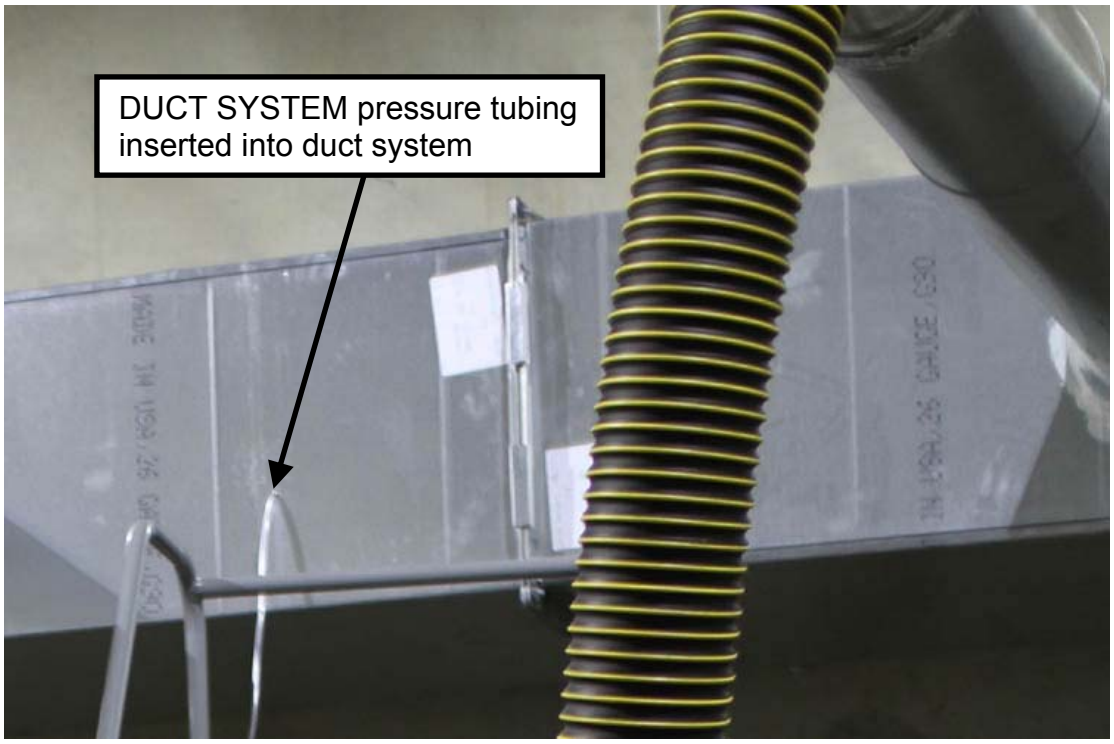

Figure 7 - Static Pressure Tubing Connection

See *Figure 8* showing the test setup for SUPPLY system testing. Refer to *Figure 9* for the test setup required to measure air leakage of a RETURN/EXHAUST system. Note you will need an inlet transition to attach to the blower inlet when performing a return/exhaust test. The dimensions of the transition required depends on whether you have a Rhino model with an inlet slide gate or VFD for flow control. See *Figure 10* and *11* for inlet transition dimensions required.

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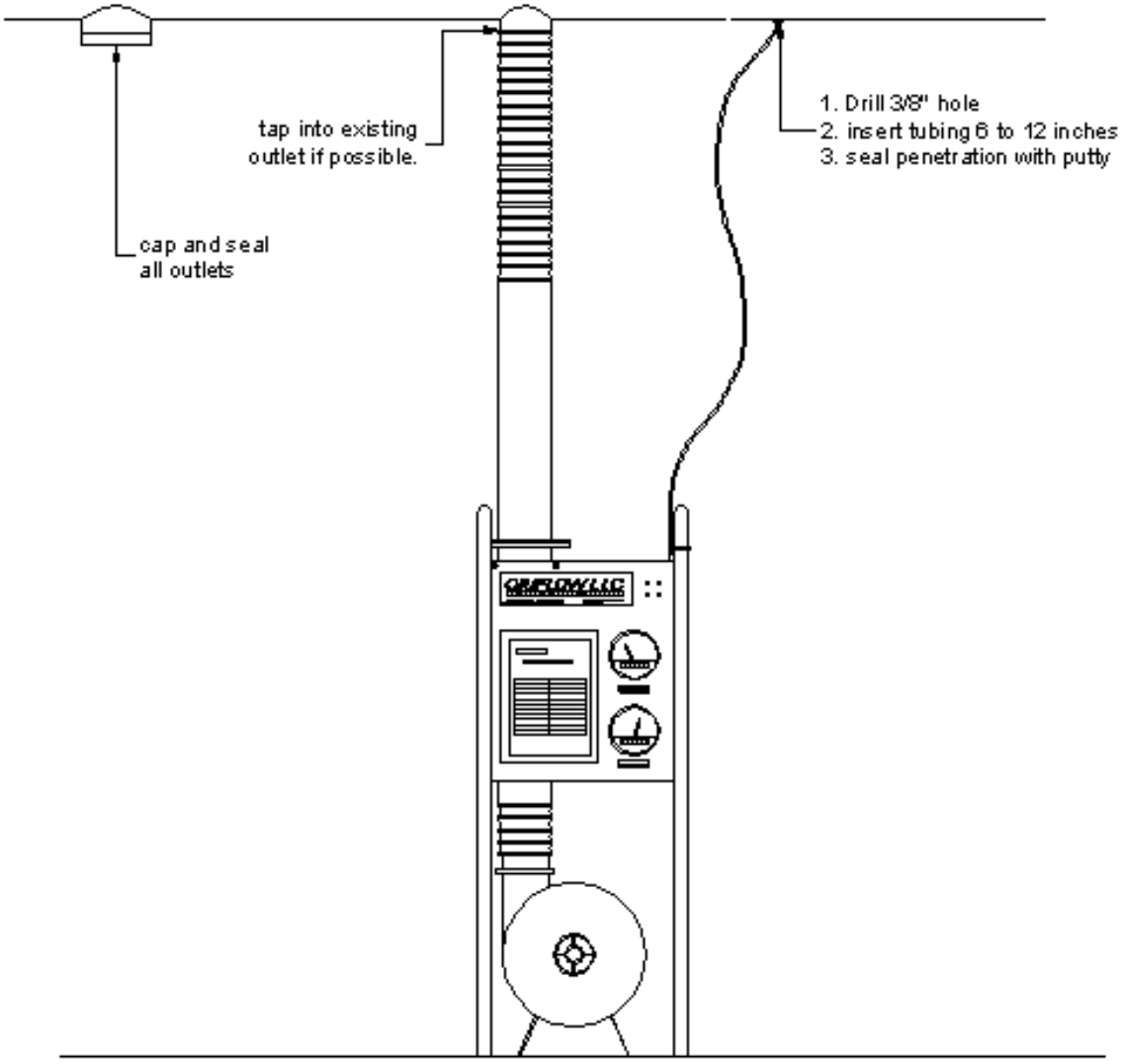

Figure 8 – Duct Leakage Test Setup for a SUPPLY System

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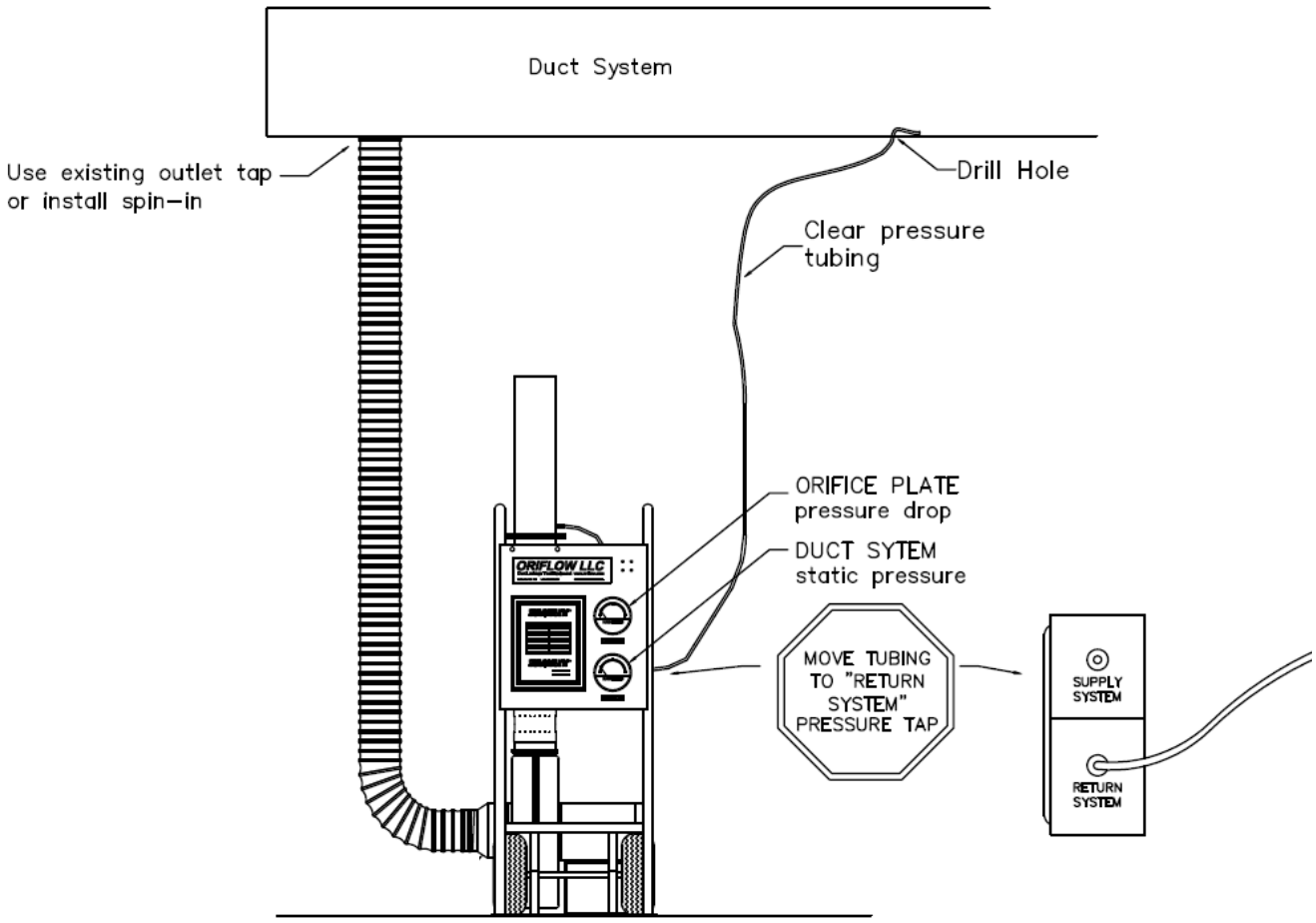

Figure 9 – Duct Leakage Test Setup for a RETURN/EXHAUST System

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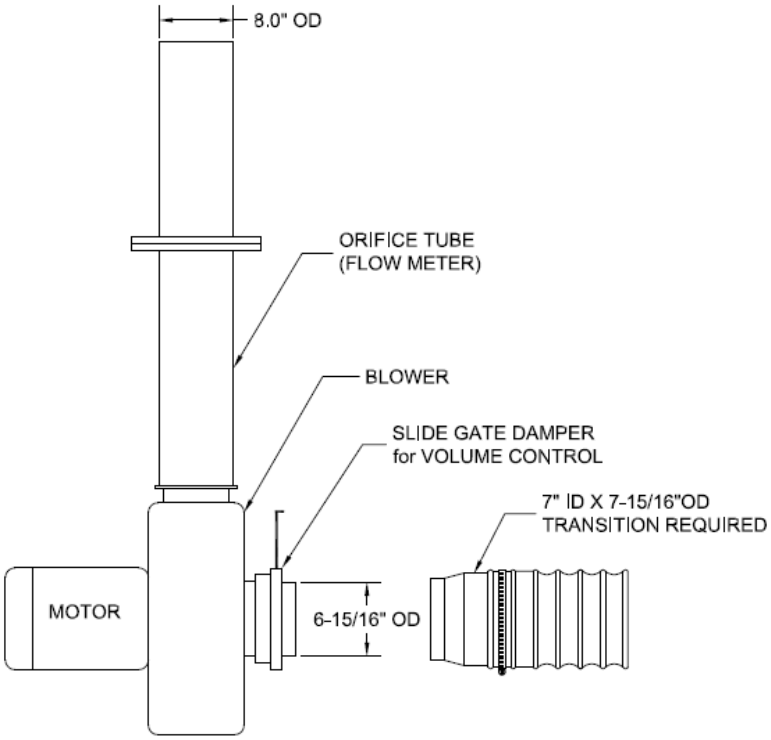

Figure 10 - Inlet Transition Required for Rhino with Inlet Slide Gate

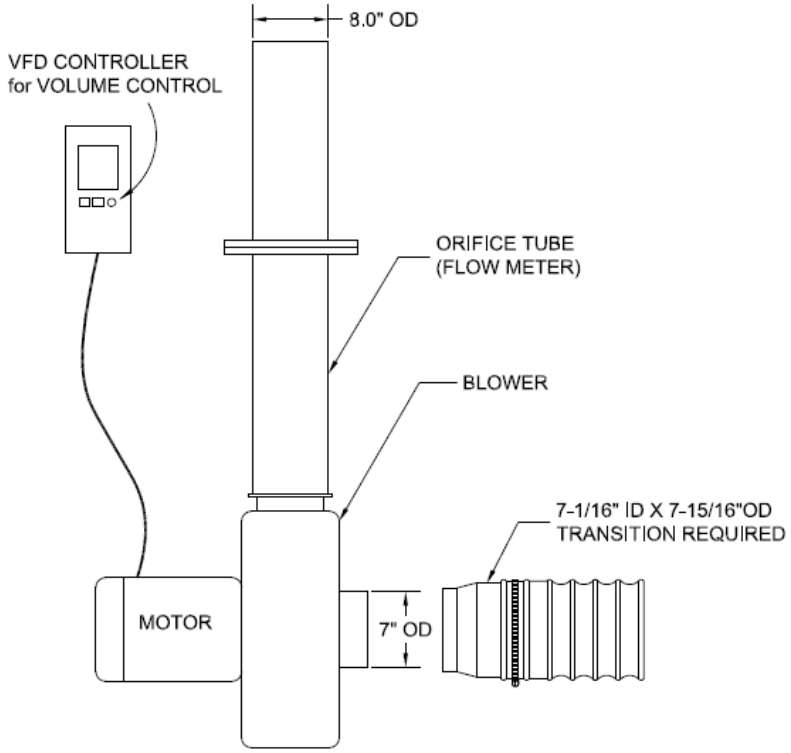

Figure 11 - Inlet Transition Required for Rhino with VFD Speed Controller

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Zeroing Pressure Gauges
Before you run the tester, make sure both gauges have been zeroed.

Zeroing Analog Gauges
Using a very small screwdriver, turn the zero-adjustment screw on the gauge until the needle is aligned with the zero reading. Turning the screw clockwise increases the pressure reading; turning it counterclockwise, decreases the reading. See *Figure 12*.

Figure 12 – Zeroing Analog Gauges
(zero BOTH gauges before testing)

Zeroing Digital Gauges
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.

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Avoid 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 the speed control knob completely counter-clockwise.

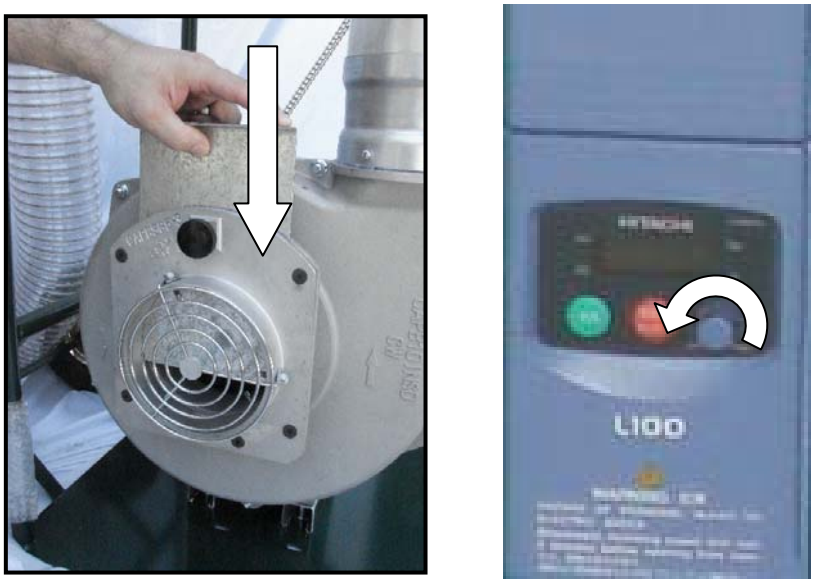

Figure 13 – Avoid Over-Pressurizing by Minimizing Air Delivery upon Startup

Obtaining System Test Pressure

Turn the blower on and slowly open the inlet slide gate for models without the speed control option. If your tester has the VFD speed controller, rotate speed control knob slowly clockwise to obtain system test pressure.

Figure 14 – Obtaining System Test Pressure

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Regardless of tester model used, pay attention to the “DUCT SYSTEM” gauge while increasing airflow. When you have reached the required system static pressure, tighten the set-screw on the inlet damper (or stop rotating the speed control knob).

Figure 15 – Duct System Gauge Pressure Reading

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Determining the Leakage Rate

Now that you have obtained the system test pressure and have the inlet damper locked in position, note the pressure reading of the ORIFICE TUBE gauge (*Figure 16*). 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 17*; it is for informational purposes only and used in the example shown on the next page. **Always refer to the calibration certificate that came with your calibrated orifice plate.**

Figure 16 –ORIFICE TUBE reading

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SAMPLE CALIBRATION CERTIFICATE TABLE FOR EXAMPLE ONLY
USE YOUR CERTIFICATE

"ORIFICE TUBE" Gauge Reading (in.wg.)	Leakage Rate (cfm)
0.0	0.0
0.1	42.2
0.2	59.7
0.3	73.2
0.4	84.5
0.5	94.4
0.6	103.5
0.7	111.8
0.8	119.5
0.9	126.7
1.0	133.6
1.1	140.1
1.2	146.3
1.3	152.3
1.4	158.0
1.5	163.6
1.6	169.0

"ORIFICE TUBE" Gauge Reading (in.wg.)	Leakage Rate (cfm)
1.7	174.2
1.8	179.2
1.9	184.1
2.0	188.9
2.1	193.6
2.2	198.1
2.3	202.6
2.4	206.9
2.5	211.2
2.6	215.4
2.7	219.5
2.8	223.5
2.9	227.5
3.0	231.4
3.1	235.2
3.2	238.9
3.3	242.6

"ORIFICE TUBE" Gauge Reading (in.wg.)	Leakage Rate (cfm)
3.4	246.3
3.5	249.9
3.6	253.4
3.7	256.9
3.8	260.4
3.9	263.8
4.0	267.1
4.1	270.5
4.2	273.7
4.3	277.0
4.4	280.2
4.5	283.3
4.6	286.5
4.7	289.6
4.8	292.6
4.9	295.7
5.0	298.7

Figure 17 – Tables from a Sample Calibration Certificate. Every calibration chart has an equation located below the table (not shown here)

Example (refer to Figure 16)

For an ORIFICE TUBE gauge reading of 1.15 in.wg., the leakage rate appears to be approximately 143 cfm.

For an exact value, use the equation that comes with every calibration certificate. For the example shown in Figure 17:

$$Leakage = 133.6 \times \sqrt{\text{ORIFICE TUBE Gauge Reading}},$$

*where the value of "133.6" is a constant 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 gauge reading first, and then multiply by the constant for your orifice plate (for this example, the constant is "133.6"). The exact leakage is 133.6 x (square root of 1.15) = 143.3 cfm. In most cases, reporting the leakage as 143 cfm is acceptable.

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Troubleshooting

Zero reading on "DUCT SYSTEM" gauge

If the gauge reading is zero, refer to the table below to fix this problem. Perform troubleshooting steps in the order shown in the *Table 9* below.

Table 9 –Troubleshooting steps when "DUCT SYSTEM" gauge is zero

Step	Scenario	What to do
1	Inlet damper was left shut, cutting off air to the system.	Open inlet damper slowly.
2	Pressure tubing connected to gauge incorrectly	Look at the P1 and P2 stickers that are located on the orifice tube and gauges. Make sure tubing from P1 tap matches the P1 tap on the "ORIFICE TUBE" gauge.
3	Plugged fitting or malfunctioning gauge.	Gently blow through other end of pressure tubing from "DUCT SYSTEM" gauge, and watch needle increase pressure reading.
4	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.

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Zero reading on "ORIFICE TUBE" gauge

If the gauge reading is zero, refer to the table below to fix this problem. Perform troubleshooting steps in the order shown in *Table 10* below.

Table 10 –Troubleshooting steps when "ORIFICE TUBE" gauge is zero

Step	Scenario	What to do
1	Inlet damper was left shut, cutting off air to the system.	Open inlet damper slowly.
2	Plugged pressure taps.	Remove pressure tubing from "ORIFICE TUBE" gauge, and blow through each end to make sure the pressure taps on the orifice tube are clear.
3	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. You need to purchase an orifice plate with a smaller bore diameter so that a small amount of airflow/leakage will result in a bigger pressure drop.
4	System is leaking very little air.	You'll know if this is true if the fan inlet is almost shut. Not likely unless system is small. Fix is to use plate with smaller bore.
4	Pressure tubing connected incorrectly.	Look at the P1 and P2 stickers that are located on the orifice tube and gauges. 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.
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 TUBE".

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Can't obtain system test pressure

This 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.

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 online at www.oriflow.com for more information.

"ORIFICE TUBE" 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. You need an orifice plate with a larger bore.

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