Operating Instructions for Rhino Duct Leakage Tester (Metric)

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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 3.2 mm 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 (meters)**	**Wire Gauge**
VFD	230	1	3 to 15	10
			15 to 30	10
Slide Gate	230	3	3 to 15	14
			15 to 30	14
VFD	230	3	3 to 15	14
			15 to 30	14
Slide Gate	380	3	3 to 15	14
			15 to 30	14
VFD	380	3	3 to 15	14
			15 to 30	14
Slide Gate	460	3	3 to 15	14
			15 to 30	14
VFD	460	3	3 to 15	14
			15 to 30	14

Flex-Duct Length

Make sure you have enough flexible-duct with your tester for the job. Each tester includes 3.8 m, 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/programs). 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 2500 Pa pressure and the maximum allowable leakage is 283 L/s, you will need a 125 mm orifice plate since the 125 mm plate can be used for up to 380 L/s of leakage (see Table 7).

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 25 mm Orifice Plate

System Static Pressure (Pa)	Minimum Leakage* (L/s)	Maximum Leakage (L/s)
500	4	21
1000	4	19
1500	4	18
2000	4	17
2500	4	14
3000	4	12
3500	4	9
4000	4	6

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Determining Which Orifice Plate to Use (continued)

Table 4 – Tester Capacities using the **50 mm** Orifice Plate

System Static Pressure (Pa)	Minimum Leakage* (L/s)	Maximum Leakage (L/s)
500	17	87
1000	17	78
1500	17	73
2000	17	66
2500	17	57
3000	17	47
3500	17	35
4000	17	26

Table 5 – Tester Capacities using the **75 mm** Orifice Plate

System Static Pressure (Pa)	Minimum Leakage* (L/s)	Maximum Leakage (L/s)
500	40	195
1000	40	180
1500	40	165
2000	40	145
2500	40	130
3000	40	105
3500	40	80
4000	40	60

Table 6 – Tester Capacities using the **100 mm** Orifice Plate

System Static Pressure (Pa)	Minimum Leakage* (L/s)	Maximum Leakage (L/s)
500	75	370
1000	75	340
1500	75	310
2000	75	280
2500	75	245
3000	75	195
3500	75	155
4000	75	105

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Determining Which Orifice Plate to Use (continued)

Table 7 – Tester Capacities using the **125 mm** Orifice Plate

System Static Pressure (Pa)	Minimum Leakage* (L/s)	Maximum Leakage (L/s)
500	125	560
1000	125	520
1500	125	480
2000	125	430
2500	125	380
3000	125	310
3500	125	240
4000	125	175

Table 8 – Tester Capacities using the **159 mm** Orifice Plate

System Static Pressure (Pa)	Minimum Leakage* (L/s)	Maximum Leakage (L/s)
500	215	730
1000	215	670
1500	215	630
2000	215	560
2500	215	510
3000	215	425
3500	215	310
4000	215	230

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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

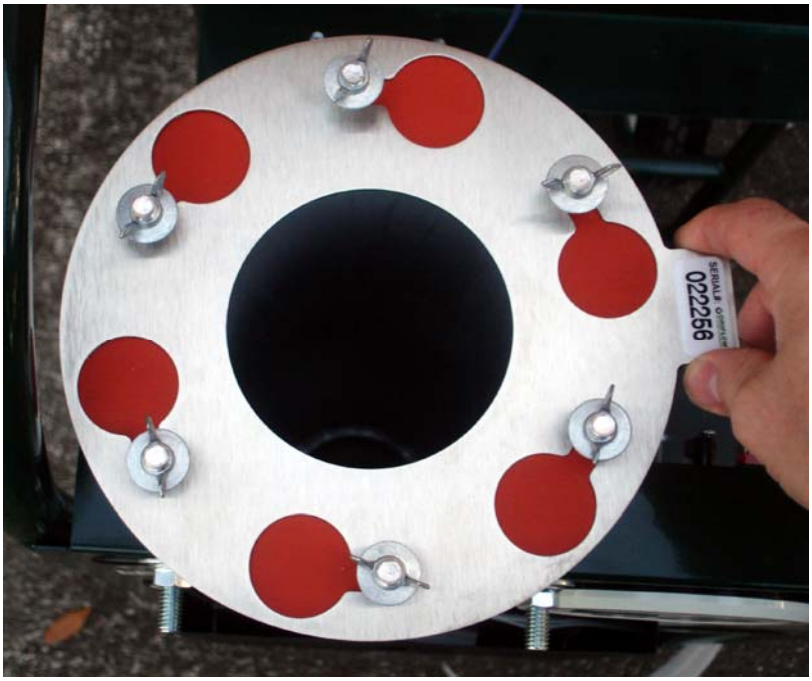

Figure 2 – Rotate Orifice Plate Clockwise until it Locks in Place

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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

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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 tube 25 to 50 mm, and tighten clamp using a 8 mm nut driver.

Figure 5 – Installing Flex-Duct on Tube

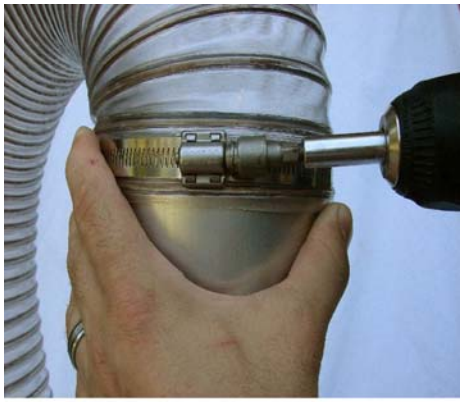

Figure 6 – Tightening Clamp

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 7 – 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 1 meter away from the flex-duct connection. Drill a 8 mm diameter hole and insert the pressure tubing from the "DUCT SYSTEM" gauge so that 150 to 300 mm 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 8* below.

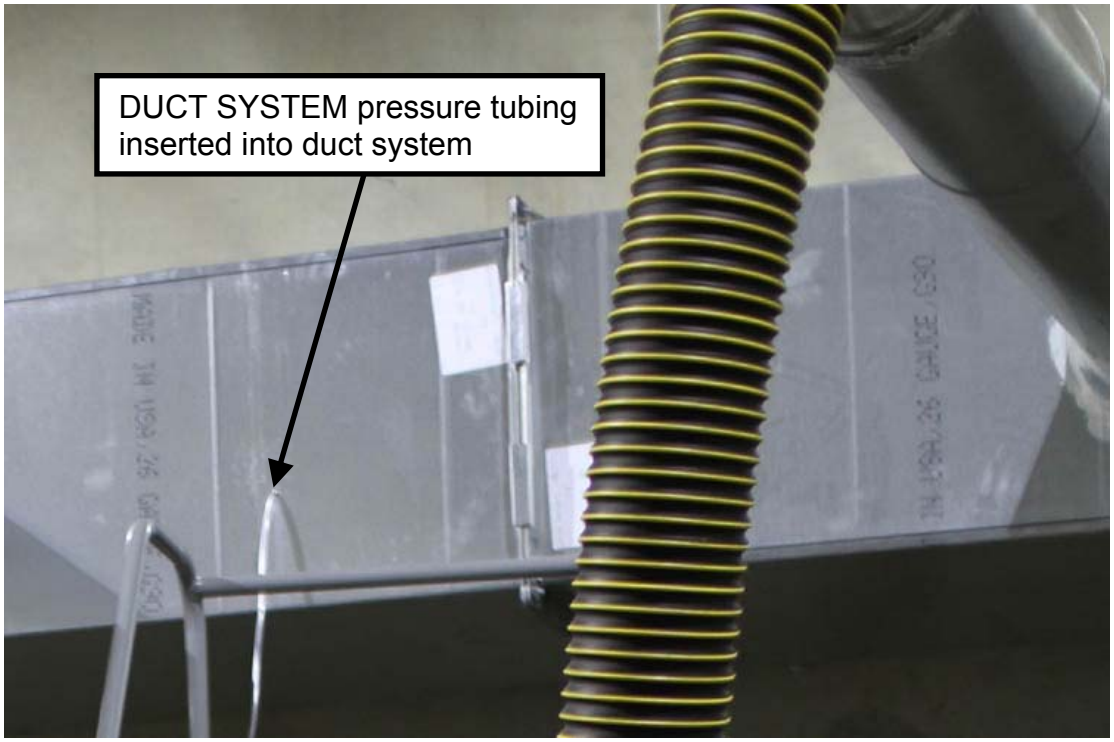

Figure 8 - Static Pressure Tubing Connection

See *Figure 9* showing the test setup for SUPPLY system testing. Refer to *Figure 10* 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 11* and *12* for inlet transition dimensions required.

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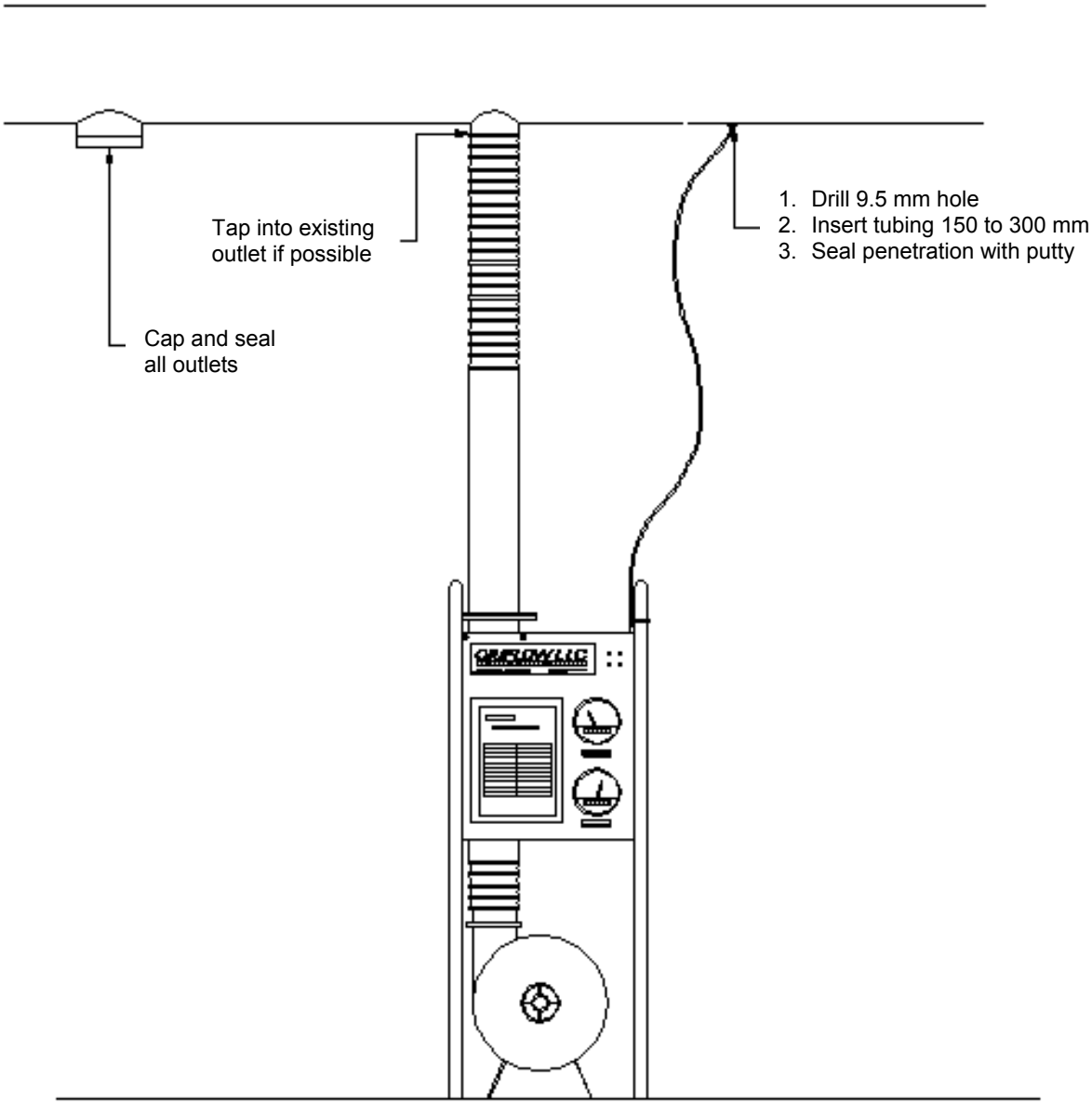

Figure 9 – Duct Leakage Test Setup for a SUPPLY System

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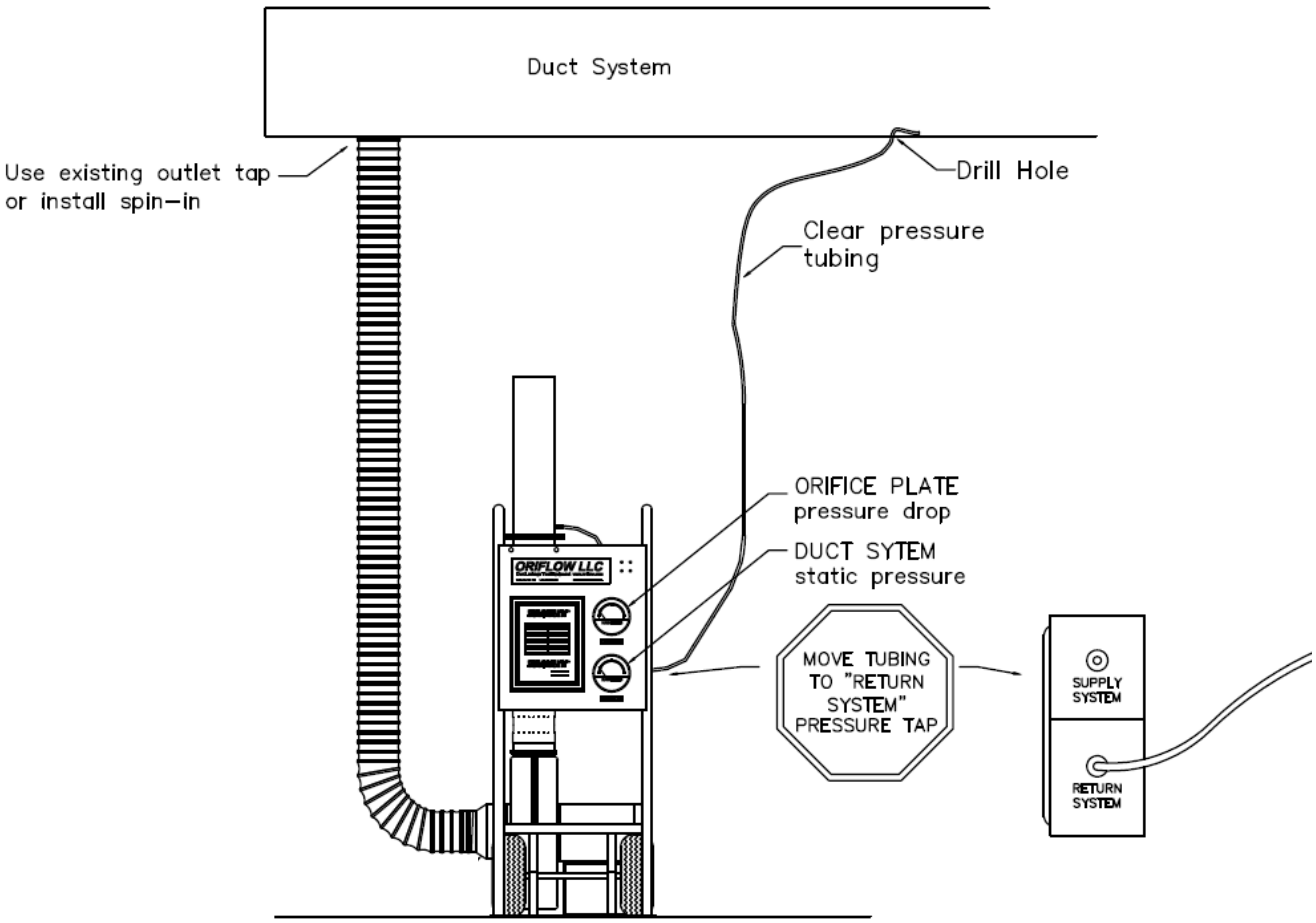

Figure 10 – Duct Leakage Test Setup for a RETURN/EXHAUST System

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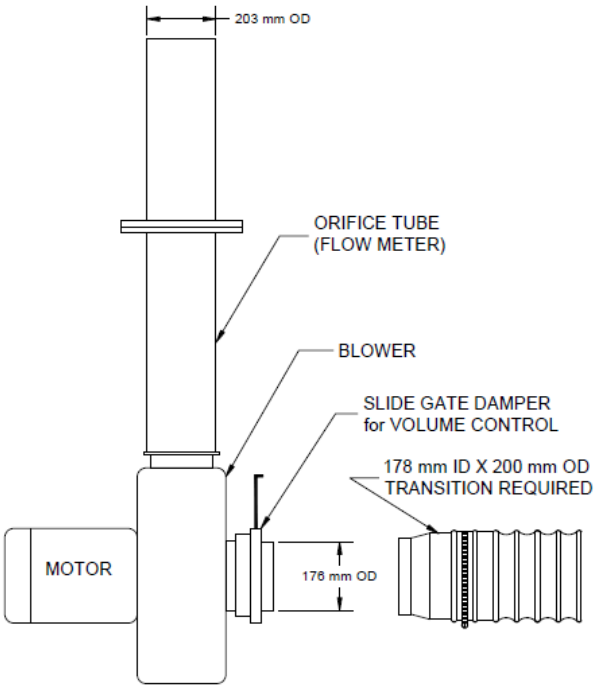

Figure 11 - Inlet Transition Required for Rhino with Inlet Slide Gate

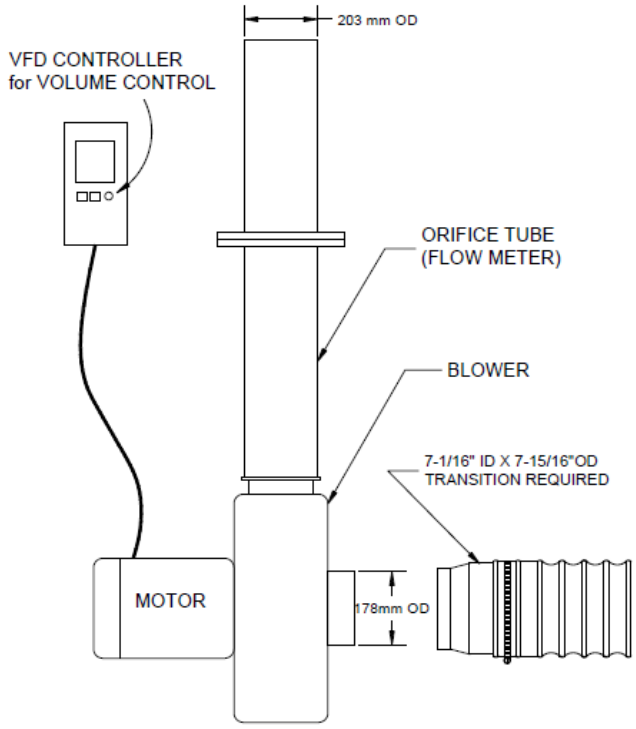

Figure 12 - Inlet Transition Required for Rhino with VFD Speed Controller

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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 13*.

Figure 13 – 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 +/- 5 Pa 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.

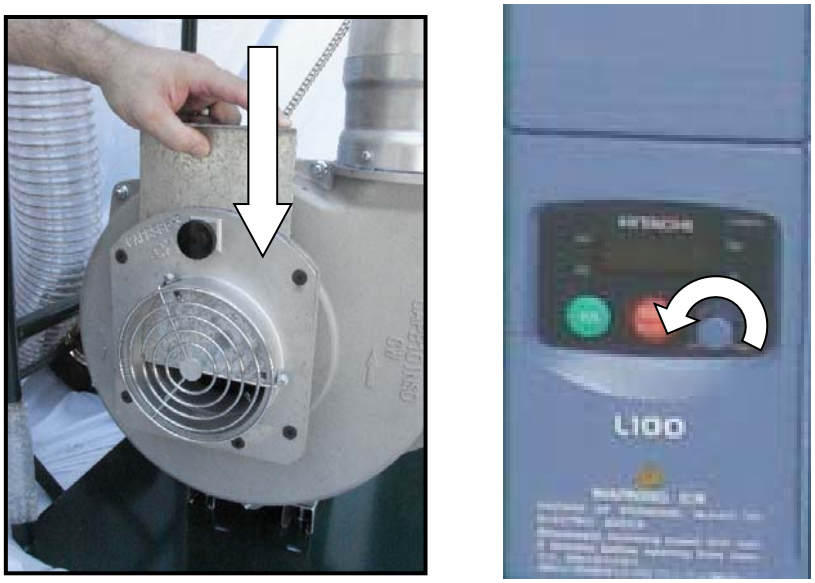

Figure 14 – Avoid Over-Pressurizing by Minimizing Air Delivery upon Startup

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 15 – Obtaining System Test Pressure

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Obtaining System Test Pressure (continued)

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 speed control knob).

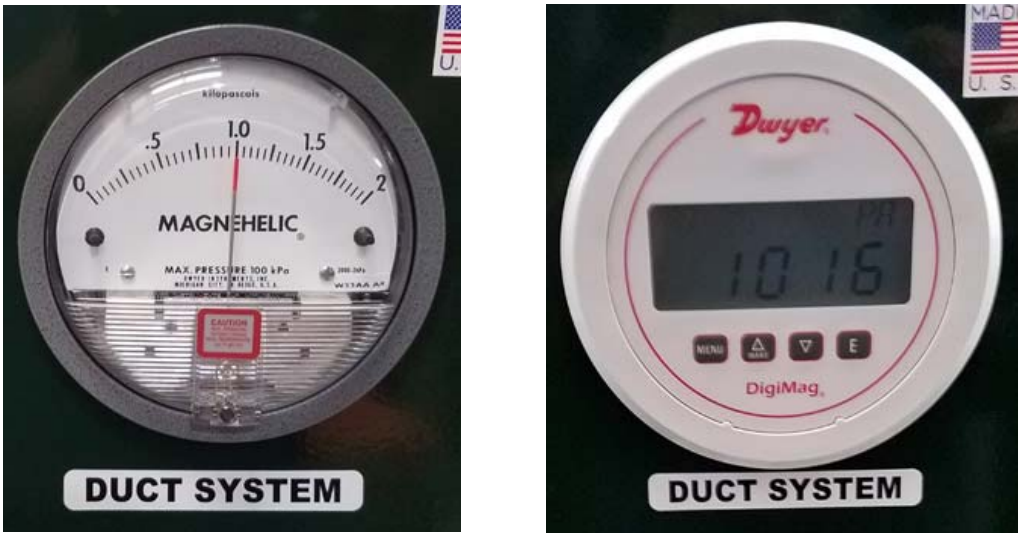

Figure 16 – Duct System Gauge Reading (analog on left, digital on right)

Determining the Leakage Rate

Now that you have obtained the system test pressure, note the pressure reading of the ORIFICE PLATE gauge (*Figure 17*). 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 18*; 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 17 –ORIFICE PLATE Gauge Reading (analog on left, digital on right)

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Determining the Leakage Rate (continued)

SAMPLE CALIBRATION CERTIFICATE
USE YOUR CERTIFICATE

Calibration Certificate for Plate No. 023294

Customer orifice plate was calibrated using ORIFLOW's proprietary internal test procedure OTP-TM-1105. The ORIFLOW laboratory follows applicable test procedures contained in ANSI/ASHRAE 41.1, 41.2 and 41.3. Calibration equipment is traceable to NIST. Estimated uncertainty of orifice plate flow reading is +/- 2%.

Issue Date:	06/20/17	Orifice Size:	**101.6 mm**	Material:	304 SS
Reference Meter:	Z50MC2-8	Orifice Serial #:	023294	Tube Diameter:	203.2 mm

Standard Temperature and Pressure (22.1 °C and 101.3 kPa)

"ORIFICE PLATE" Gauge Reading (Pa)	Leakage Rate (L/s)	"ORIFICE PLATE" Gauge Reading (Pa)	Leakage Rate (L/s)	"ORIFICE PLATE" Gauge Reading (Pa)	Leakage Rate (L/s)
0	0.0	423	148.3	846	209.7
25	36.0	448	152.6	871	212.8
50	50.9	473	156.8	896	215.8
75	62.3	498	160.8	921	218.8
100	71.9	523	164.8	946	221.7
124	80.4	548	168.7	971	224.6
149	88.1	572	172.5	996	227.5
174	95.2	597	176.2	1021	230.3
199	101.7	622	179.8	1045	233.1
224	107.9	647	183.4	1070	235.8
249	113.7	672	186.9	1095	238.6
274	119.3	697	190.3	1120	241.3
299	124.6	722	193.7	1145	243.9
324	129.7	747	197.0	1170	246.6
348	134.6	772	200.3	1195	249.2
373	139.3	797	203.5	1220	251.8
398	143.9	821	206.6	1245	254.3

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

Leakage (L/s) = 7.206 x $\sqrt{\text{ORIFICE PLATE Gauge Reading}}$

Figure 18 – **Example Calibration Certificate**. Use the calibration certificate that came with your orifice plate

Example (refer to Figures 17 and 18)

For an ORIFICE PLATE gauge reading of 725 Pa (Figure 16), the leakage rate is approximately 194 L/s using the calibration certificate shown in Figure 18 (see arrow).

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

Leakage = 7.206 x $\sqrt{\text{ORIFICE PLATE Gauge Reading}}$

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Determining the Leakage Rate (continued)

*where the value of "7.206" 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 "7.206"). The exact leakage is 7.206 x (square root of 725) = 194.0 L/s.*

Oriflow has FREE Adobe forms available that will calculate the leakage, leakage factor, allowable leakage, Pass/Fail criteria and duct surface area among other variables (www.oriflow.com/freeform).

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 PLATE" 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 PLATE” 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 PLATE” 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 PLATE” 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 100 mm ID orifice plate, and the system is leaking 20 L/s, you probably won’t even notice the gauge needle moving. This can happen to other orifice plates too. You need to 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	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. Solution is to use a smaller ID plate.
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 PLATE”.

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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 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*: The 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.

ORIFLOW LLC
www.oriflow.com
2125 Range Rd., Suite B
Clearwater, Florida 33765

727-400-4881 (phone) 8am to 5pm PST
877-420-7091 (fax)
sales@oriflow.com
engineering@oriflow.com

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