OSPREY CORPORATION

Air System Diagnostics Kit Instructions

Rev. 0 - March 2016

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Introduction

Completing a system air survey is one of the most important steps in balancing a new air system, or in troubleshooting an existing system. During the survey, static pressure and air velocity readings are taken and recorded for each of the critical duct locations in the system. Balancing the air flows ensures proper performance of the system, reduces overall power consumption, and helps prevent dangerous buildup of dust inside the ducts.

The Osprey Corporation air system diagnostics kit provides all the tools needed to effectively complete a system air survey.

About the Air System Diagnostics Kit

To assist customers in taking these measurements, Osprey Corporation has assembled an air system diagnostics kit which contains all of the required tools. This kit is used by Osprey engineers and field service personnel when conducting field surveys for customers. Key features of the kit include:

Carrying Case

- Watertight, airtight, and dust-proof case with wheels and a retractable handle.
- Die-cut foam set that safely and securely organizes and holds the supplied measuring instruments.
- Meets current FAA requirements for carry-on luggage.

Air Measurement Tools

- Set of pitot tubes for insertion into conveying ducts; used for air velocity measurements.
- Set of Magnehelic gauges ranging from 0–0.498 kPa to 0–14.9 kPa (0–2 in. w.c. to 0–60 in. w.c.) for measuring differential pressure and air velocity.
- Digital gauge with electronic readout for measuring differential pressure and air velocity.
- Ammeter and tachometer for measuring the operating amperage and rpm of the fan motors.

Accessories

- Drill bits and matching plastic hole plugs for creating and sealing measurement points in the duct.
- Screwdriver, pliers, flashlight, and tape measure.
- Safety glasses, ear plugs, and dust masks for the technician’s safety.

For a complete list of the items contained in the air system diagnostics kit, refer to “Appendix A, Air System Diagnostics Kit Contents” on page 25.

Preparation for Air System Measurement

For the best system air survey results, create a flowchart of your system and review the formula for converting air velocity measurements to air volume, provided in this section.

Create an Air System Flowchart

Before actually taking any air pressure or velocity measurements, develop a flowchart of the entire air system being analyzed. An example flowchart of a typical drum filter system is shown below.

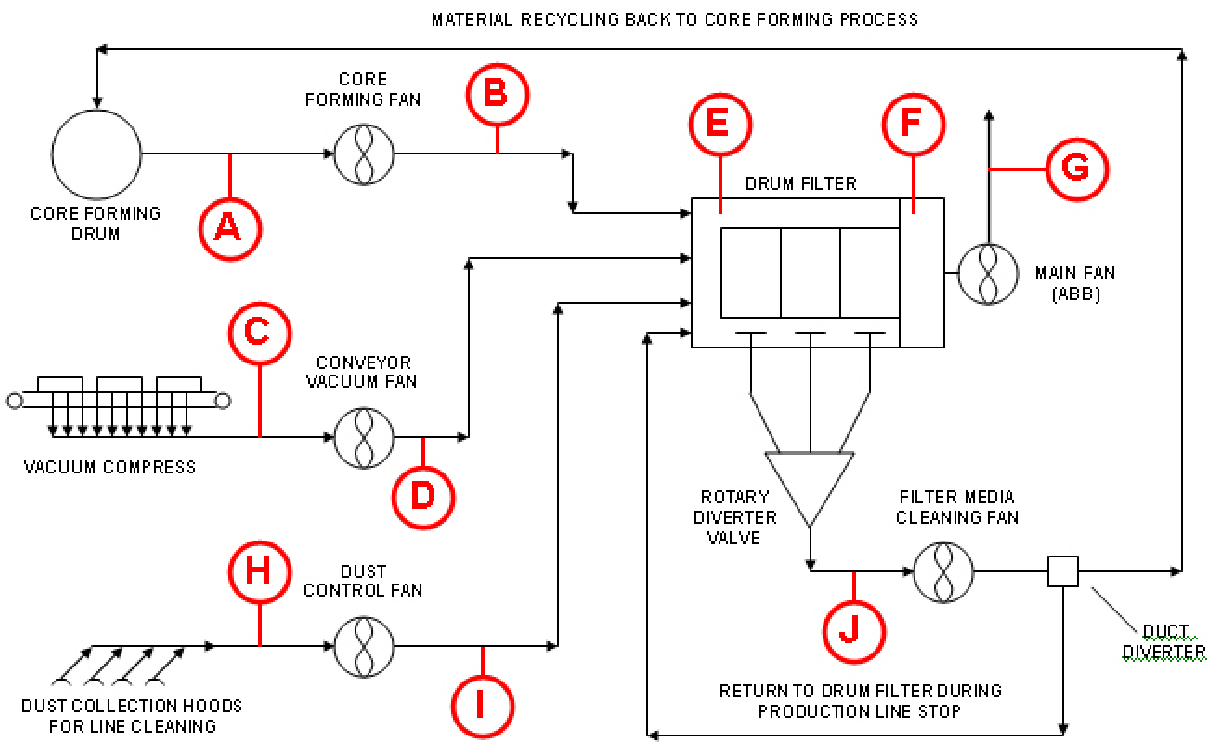


Figure 1 Example of an Air System Flowchart

Key points in the system are designated with a letter. Pressure and/or air velocity readings are taken at these locations and recorded. Spreadsheets work well for recording the readings. In addition to pressure and air velocity measurements, duct diameter, fan rpm, and fan amperage should be recorded (if applicable) at each location.

How to Convert Air Velocity to Air Volume

To convert air velocity (measured in meters per second [m/s] or feet per minute [ft/min]) into air volume (measured in cubic meters per hour [cm/hr] or cubic feet per minute [ft^3/min]), the air velocity must be multiplied by the cross-sectional area of the duct.

Q (air volume) = V (air velocity) × A (cross-sectional area of duct)

where

A (cross-sectional area of duct) = pi × (radius of duct)^2

Example—To determine the volume of air moving at 4,000 ft/min inside a 10-in. duct:

Find the area (A) of the 10-in. duct	**A = pi × (5 in.)^2 = 78.54 in.^{2}**
Convert the area of the duct from square inches to square feet by dividing by 144	**78.54 in.^{2} × 1 ft^2 ÷ 144 in.^{2} = 0.55 ft^2**
Insert the area of the duct in square feet into the air volume equation to determine total air volume	**Q = 4,000 ft/min × 0.55 ft^2** **Q = 2,200 ft^3/min**

NOTE

A Ductulator® is included with the air system diagnostics kit. The Ductulator provides a quick and easy way to convert air velocity into air volume without the need for manual calculation. Refer to "Appendix D, Ductulator® Operating Instructions" on page 35 for detailed information on using the Ductulator.

How to Take Air Measurements

Obtaining accurate data for the air pressure and the air velocity in ducting and around pieces of equipment such as fans, receivers, and separators is critical for effectively balancing any air system and troubleshooting air system problems. This section explains how to properly take air pressure and air velocity measurements.

Select and Prepare Measurement Locations

To obtain accurate results when using the equipment contained in the air system diagnostics kit, it is critical to take the measurements in the correct locations. Optimum locations for air pressure and air velocity measurements are typically not the same.

You will need the following items from the air system diagnostics kit:

- Tape measure
- Safety glasses, dust mask, and ear plugs
- Drill bits
- Hole plugs

For a complete list of the items contained in the air system diagnostics kit, refer to "Appendix A, Air System Diagnostics Kit Contents" on page 25.

Air Pressure Measurement Locations

The most common locations for static air pressure measurements include:

- Near the inlet and outlet of fans.
- Near the inlet and outlet of other receivers or separators in the system.

It is not advisable to take pressure measurements directly before or after any elbows or transitions in the duct. Doing so can result in inaccurate readings. See Figure 3 for a diagram of ideal static air pressure measurement locations.

1. Using the guidelines provided in this section, select two locations for air pressure measurements: one for inlet pressure and one for outlet pressure.
2. Prepare each selected air pressure measurement location as follows:
   - **For locations where pressure readings will be taken infrequently,** drill a 3 mm (1/8 in.) diameter hole in the duct at each location.
   - **For locations where pressure readings will be taken frequently,** install a static pressure fitting (see Figure 2).
3. Cap or plug the hole when it is not in use.

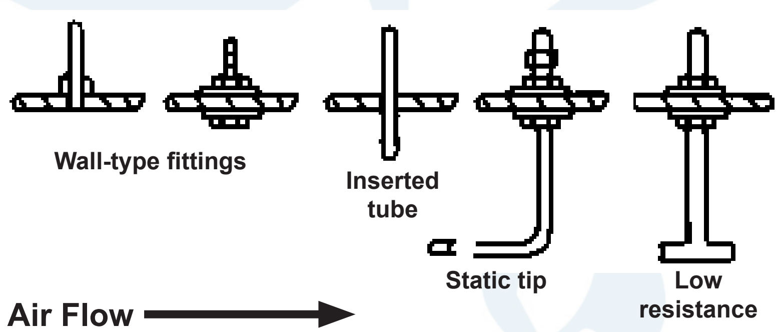


Figure 2 Types of Static Pressure Fittings

Air Pressure Measurement Locations (continued)

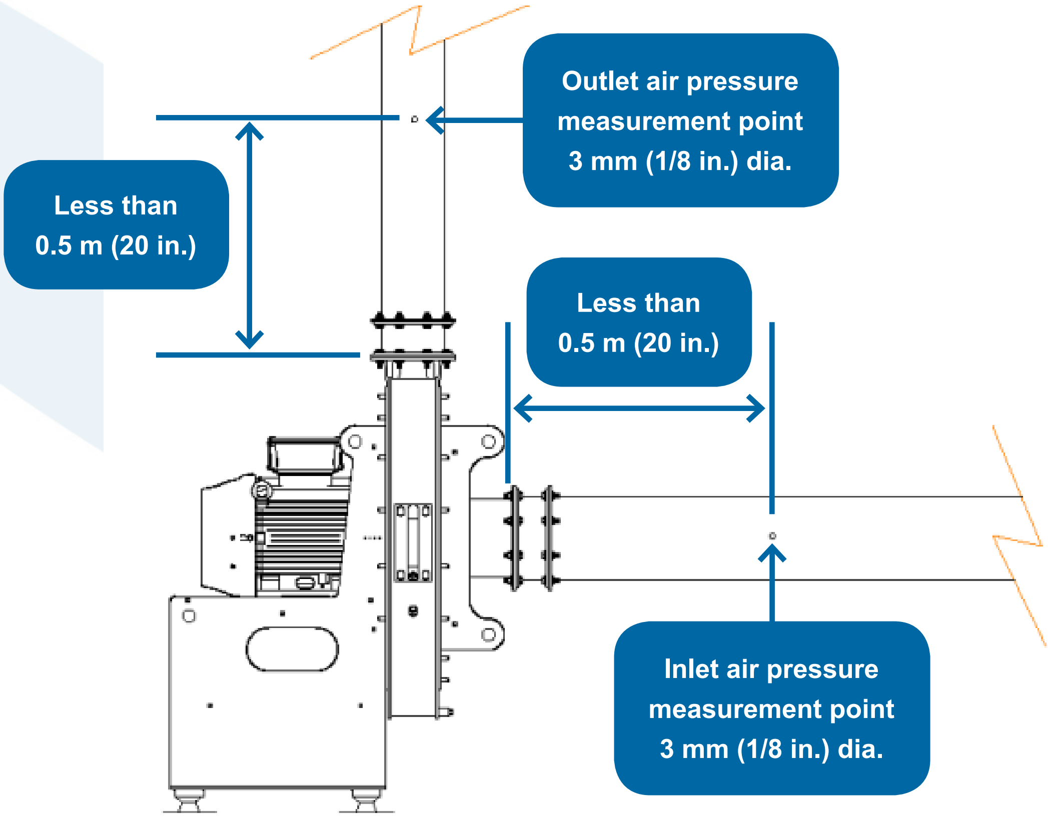


Figure 3 Ideal Static Air Pressure Measurement Locations

Air Velocity Measurement Location

The best location for an air velocity measurement is in a long straight section of duct. Ideally, the duct will be straight and free of elbows, transition, wyes, etc., for a length that is at least 10 times the duct diameter before and after the measurement location.

Air velocity measurement point 10 mm (3/8 in.) dia.

For example, a measurement location in the middle of a straight, 3-m-long (120 in.) section of 15-cm-diameter (6 in.) duct would be ideal. If an ideal measurement location is not available, select a measurement location in the middle of the longest straight section of duct.

It is not advisable to take air velocity measurements directly before or after fans, elbows, transitions, and other disturbances in the duct. Doing so can result in inaccurate readings.

1. Using the guidelines provided above, select a location for air velocity measurement.
2. Drill a 10 mm (3/8 in.) diameter hole in the duct.
3. Cap or plug the hole when it is not in use.

NOTE

In some cases, two measurement holes may be required. This is explained further under "Take Air Velocity Measurements" on page 10.

Not ideal: Too close to a fan inlet

Not ideal: Too close to a duct elbow

Not ideal: Too close to a duct branch

Take Air Pressure Measurements

Use the Magnehelic or digital pressure gauge from the air system diagnostics kit to take air pressure measurements. You will need the following items:

- Magnehelic gauges for analog measurements
- Digital pressure gauge for digital measurements
- Rubber hoses
- Clipboard and pen

For a complete list of the items contained in the air system diagnostics kit, refer to "Appendix A, Air System Diagnostics Kit Contents" on page 25.

Analog Air Pressure Measurement

1. Attach one end of a rubber hose to the appropriate fitting (+ or -) on the Magnehelic gauge. Use the positive fitting to measure positive pressure and the negative fitting to measure negative pressure.

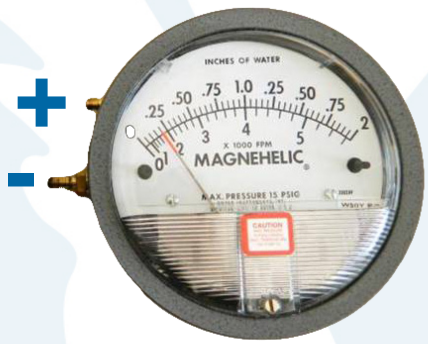


Figure 4 Magnehelic Gauge Positive and Negative Connections

2. Press the other end of the rubber hose against the duct where the 3 mm (1/8 in.) diameter measurement hole was drilled (or where the static pressure fitting is installed). The hole in the duct should line up with the hole in the rubber hose.
3. Hold the Magnehelic gauge vertically (perpendicular to the floor) and observe the air pressure reading. Take the following steps as needed:
   - If the needle on the Magnehelic gauge does not move, then the rubber hose is connected to the incorrect fitting on the gauge. Connect the rubber hose to the opposite fitting and record the pressure reading.
   - If the needle on the Magnehelic gauge moves a very small amount or moves beyond the last value on the gauge, then the gauge is scaled incorrectly for that particular pressure reading and a gauge a with a smaller or larger scale should be used. Switch to the correct gauge and record the pressure reading.

   When recording air pressure readings, note that:

   - If the rubber hose is connected to the positive fitting on the Magnehelic gauge, then the air pressure indicated on the gauge is positive.
   - If the rubber hose is connected to the negative fitting on the Magnehelic gauge, then the air pressure indicated on the gauge is negative.

NOTE

The Magnehelic gauge must be held vertically for the most accurate results.

Digital Air Pressure Measurement

1. Attach one end of a rubber hose to the positive fitting on the digital gauge.

Figure 5 Digital Gauge Positive and Negative Connections

2. Press PRESSURE to enter the Pressure mode. PRESSURE is highlighted on the digital gauge display.
3. With the rubber hose open to the ambient conditions, press and hold ZERO for 2 seconds.

NOTE

Refer to “Appendix B, Digital Gauge Operating Instructions” on page 27 for more detailed information as needed.

4. Press the open end of the rubber hose against the duct where the 3 mm (1/8 in.) measurement hole was drilled (or where the static pressure fitting is installed). The hole in the duct should line up with the hole in the rubber hose.
5. Record the air pressure reading shown on the screen of the digital gauge. Note that:
   - If the reading displayed on the digital gauge is negative, then the air pressure is negative.
   - If the reading displayed on the digital gauge is positive, then the air pressure is positive.

NOTE

The digital pressure gauge can only read pressure between -3.5 KPa (-14 in. w.c.) and +3.5 KPa (+14 in. w.c.). To read pressures outside of that range, use analog Magnehelic gauges.

Take Air Velocity Measurements

Use the Magnehelic or digital gauge from the air system diagnostics kit to take air velocity measurements. You will need the following items:

- Magnehelic gauge (with a 0–2 in. w.c. range and the velocity (ft/min) values shown under the pressure values) for analog measurements
- Digital pressure gauge for digital measurements
- Rubber hoses
- Pitot tube
- Tools and supplies for drilling a second measurement hole (if needed)
- Clipboard and pen

For a complete list of the items contained in the air system diagnostics kit, refer to “Appendix A, Air System Diagnostics Kit Contents” on page 25.

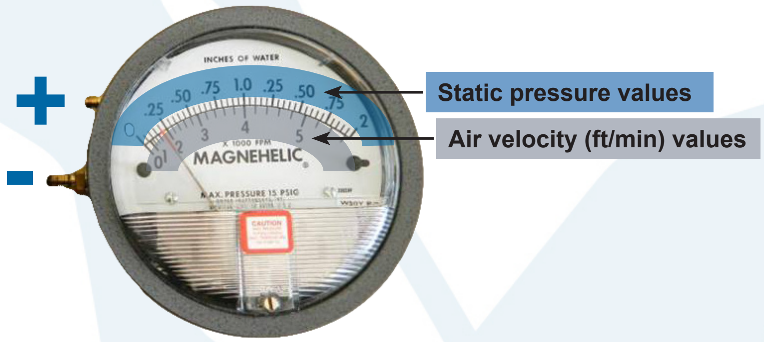


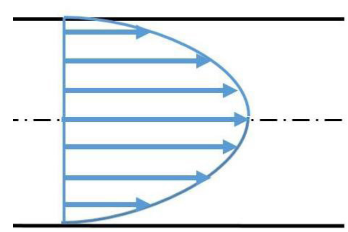
Figure 6 Magnehelic Gauge with ft/min Values

Analog Air Velocity Measurement

Depending on the stability of the air flow in a duct and the shape of a duct, air velocity measurements may need to be taken both horizontally and vertically across the duct. Follow these steps as applicable for your installation.

NOTE

The air flow inside a duct is not uniform: the air flow in the center of a duct is faster than the air flow at the edges of a duct. To account for this variation, air velocity measurements are taken at different locations across the duct, sometimes both horizontally and vertically, and the results averaged as described in this procedure.



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Analog Air Velocity Measurement (continued)

Preparing for Air Velocity Measurement

1. Attach one end of a rubber hose (1) to the positive fitting on the Magnehelic gauge and attach the other end to the short fitting (2) on the pitot tube that is perpendicular to the pitot tube tip.
2. Attach one end of the other rubber hose (3) to the negative fitting on the Magnehelic gauge and attach the other end to the long fitting (4) on the pitot tube that is parallel to the pitot tube tip.

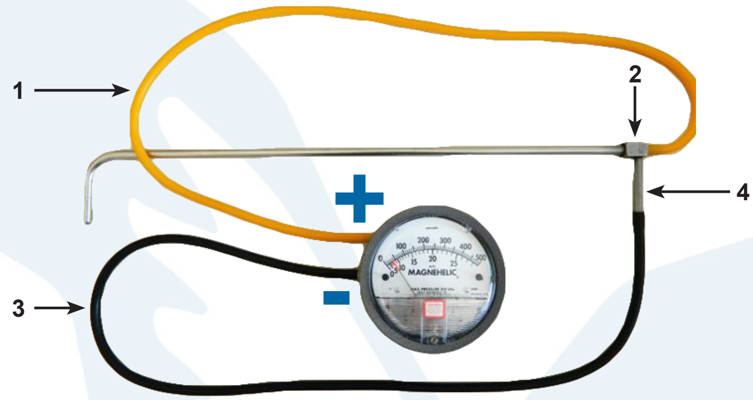


Figure 7 Rubber Hose Connections for Analog Air Velocity Measurement

3. Insert the pitot tube into the 10 mm (3/8 in.) hole that was previously drilled in the duct. When the pitot tube is inside the duct, rotate it so the tip is pointing into the air flow.

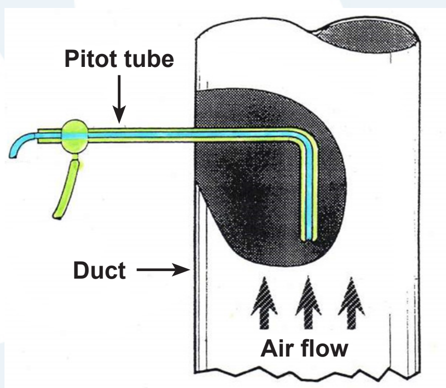


Figure 8 Correct Orientation of the Pitot Tube for Air Velocity Measurements

NOTE

The long fitting (see item 4 under step 2) on the pitot tube is parallel to the tip of the pitot tube; you can use this fitting to help orient the pitot tube correctly.

Analog Air Velocity Measurement (continued)

4. Verify that the Magnehelic gauge is reading properly by taking some initial readings across the duct and observing the gauge:
   - If the needle on the gauge does not move, then either the tip of the pitot tube is pointed in the wrong direction or the rubber hoses are connected to the incorrect fittings on the pitot tube.
   - First, rotate the tip of the pitot tube so it is facing the air flow. If the needle on the Magnehelic gauge still does not move, reverse the positions of the rubber hoses attached to the pitot tube and retake the air velocity reading.
   - If the air velocity readings vary greatly from one side of the duct to the other, then the measurement point is likely too close to an elbow or other flow disruption to obtain an accurate reading. Attempt additional readings further away from the disruption for accurate results. See Figure 9 for a diagram of an ideal air velocity measurement location.

   After you have confirmed that the gauge is reading properly and that the measurement location is ideal, continue with this procedure to take horizontal air velocity measurements and, if needed for your installation, vertical air velocity measurements and/or air velocity measurements for a rectangular duct.

NOTE

Measuring the air velocity in the center of a duct and taking 90% of that reading will usually provide a good approximation of the average air velocity in the duct. This method can be used when a quick velocity check is required or when transverse readings are not possible.

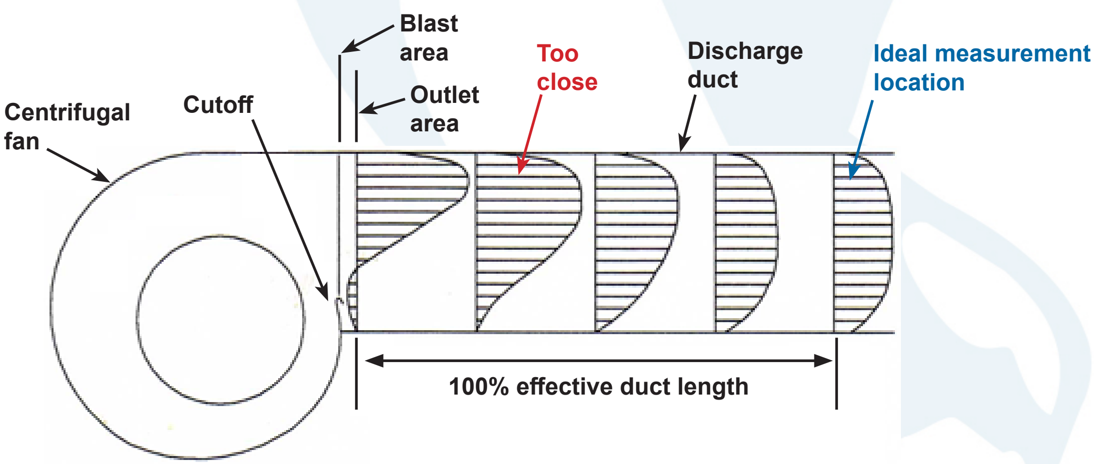


Figure 9 Air Flow at an Ideal Air Velocity Measurement Location

Analog Air Velocity Measurement (continued)

Taking Horizontal Air Velocity Measurements

5. Take an air velocity reading at the edge of the duct closest to you and record the reading, then move the pitot tube horizontally across the duct, taking measurements as described below and recording each of the readings:
   - For ducts 250 mm (10 in.) in diameter or less, take air velocity readings at 3 cm (1 in.) intervals across the width of the duct.
   - For ducts 300 mm (12 in.) in diameter or more, take air velocity readings at 5 cm (2 in.) intervals across the width of the duct.

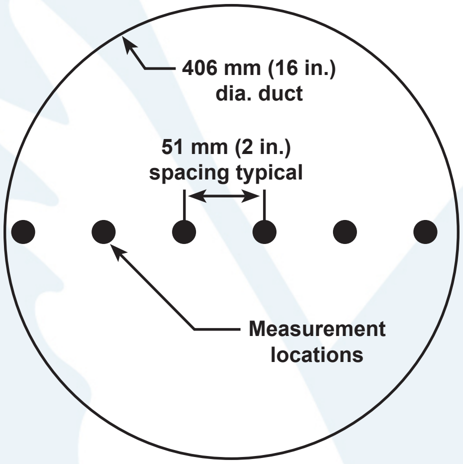


Figure 10 Locations to Take Air Velocity Readings Horizontally Across a Duct

NOTE

If the airflow is stable at the measurement point (10 or more duct diameters of length of straight duct on each side), then it is typically acceptable to measure the air velocity in only one direction as the velocity profile is the same regardless of measurement orientation.

Analog Air Velocity Measurement (continued)

Taking Vertical Air Velocity Measurements (If Needed)

6. If needed (see NOTE above), take air velocity readings vertically across the duct as follows to get a true average air velocity.
   a. Drill a second measurement hole 90 degrees from the first hole.
   b. Take air velocity readings vertically across the duct direction using the spacing shown in Figure 11 and record each reading.

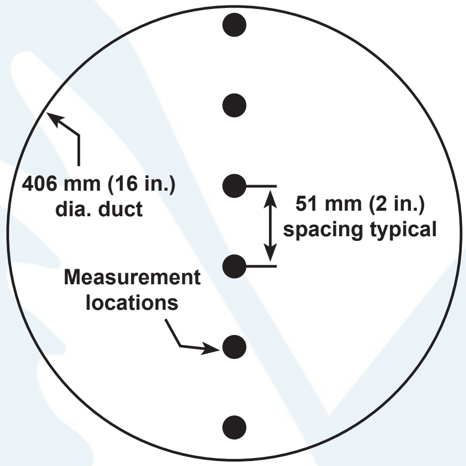


Figure 11 Locations to Take Air Velocity Readings Vertically Across a Duct

Taking Air Velocity Measurements for a Rectangular Duct (If Applicable)

7. If the duct is rectangular, take air velocity readings at multiple locations in both the horizontal and vertical directions as shown in Figure 12 and record each reading.

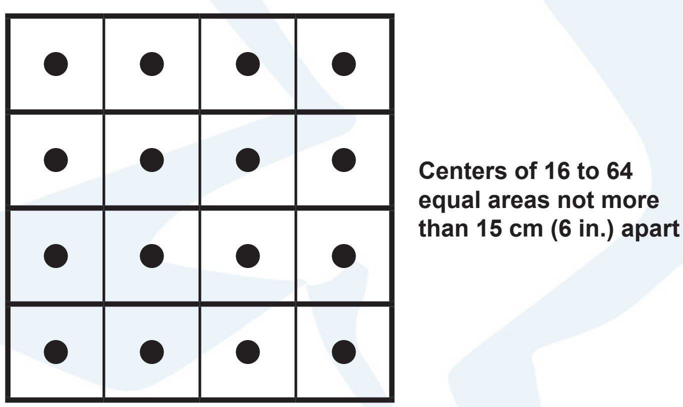


Figure 12 Locations to Take Air Velocity Readings for a Rectangular Duct

Analog Air Velocity Measurement (continued)

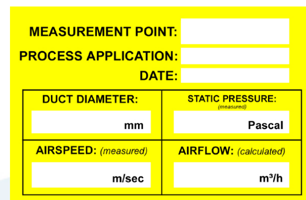
Analyzing the Recorded Air Velocity Readings

8. When all readings have been recorded, average them. If the air velocity measurements were taken (1) at an altitude of 600 m (2,000 ft) or greater or (2) at a temperature of 38 °C (100 °F) or greater, include a correction factor in the air velocity calculation to account for the low density of the air. Refer to “Appendix C, Air Volume Calculation Correction Factor for High Altitudes and Temperatures” on page 34.

   The result is the air velocity measurement for the duct.

NOTE

Air measurement stickers are included with the kit. These stickers are intended to be placed on the duct at the measurement locations. Measurement data can then be recorded on the stickers for historical reference. Use if desired.



Digital Air Velocity Measurement

NOTE

The digital gauge can automatically convert air velocity into air volume and can also calculate the average air velocity, eliminating the need for manual calculation. Refer to “Appendix B, Digital Gauge Operating Instructions” on page 27 for detailed information.

1. Attach one end of a rubber hose (1) to the positive fitting on the digital gauge and attach the other end of the hose to the short fitting (2) on the pitot tube that is perpendicular to the pitot tube tip.
2. Attach one end of the other rubber hose (3) to the negative fitting on the digital gauge and attach the other end of the hose to the long fitting (4) on the pitot tube that is parallel to the pitot tube tip.

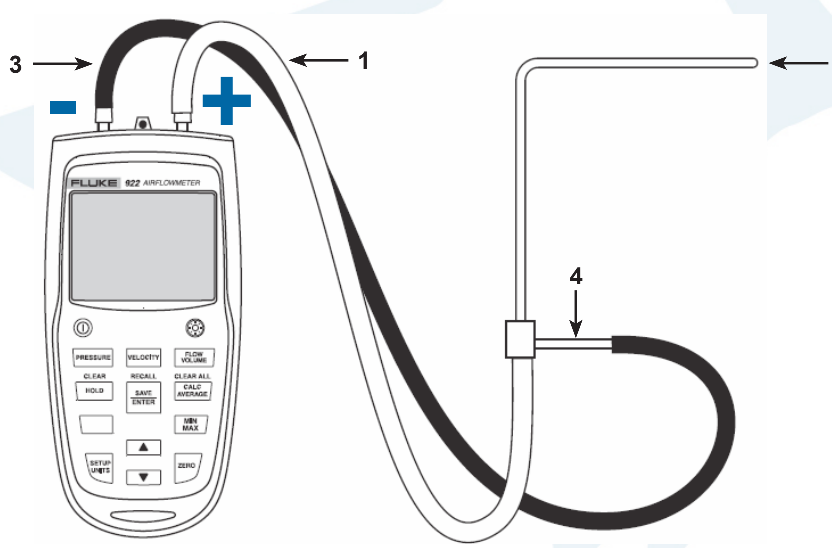


Figure 13 Digital Gauge and Pitot Tube Connections

Digital Air Velocity Measurement (continued)

3. Press VELOCITY to enter the Velocity mode. VELOCITY is highlighted on the digital gauge display.
4. With the pitot tube open to the ambient conditions, press and hold ZERO for 2 seconds.
5. Insert the pitot tube into the 10 mm (3/8 in.) hole that was previously drilled in the duct. When the pitot tube is inside the duct, rotate it so the tip is pointing into the air flow.

NOTE

Refer to “Appendix B, Digital Gauge Operating Instructions” on page 27 for more detailed information as needed.

6. Verify that the digital gauge is reading properly by taking some initial readings across the duct and observing the gauge:
   - If a very low air velocity reading (less than 500 ft/min) is shown on the digital gauge, then the tip of the pitot tube is pointed in the wrong direction or there is no air flow in the duct. Rotate the tip of the pitot tube so it is facing the air flow.
   - If a negative air velocity reading is shown on the digital gauge, then the rubber hoses are connected to the incorrect fittings on the pitot tube. Reverse the positions of the rubber hoses attached to the pitot tube and retake the air velocity reading.
   - If the air velocity readings vary greatly from one side of the duct to the other, then the measurement point is likely too close to an elbow or other flow disruption to obtain an accurate reading. Attempt additional readings further away from the disruption for accurate results. See Figure 12 for a diagram of an ideal air velocity measurement location.

   After you have confirmed that the gauge is reading properly and that the measurement location is ideal, continue with this procedure to take horizontal air velocity measurements and, if needed for your installation, vertical air velocity measurements and/or air velocity measurements for a rectangular duct.

NOTE

Measuring the air velocity in the center of a duct and taking 90% of that reading will usually provide a good approximation of the average air velocity in the duct. This method can be used when a quick velocity check is required or when transverse readings are not possible.

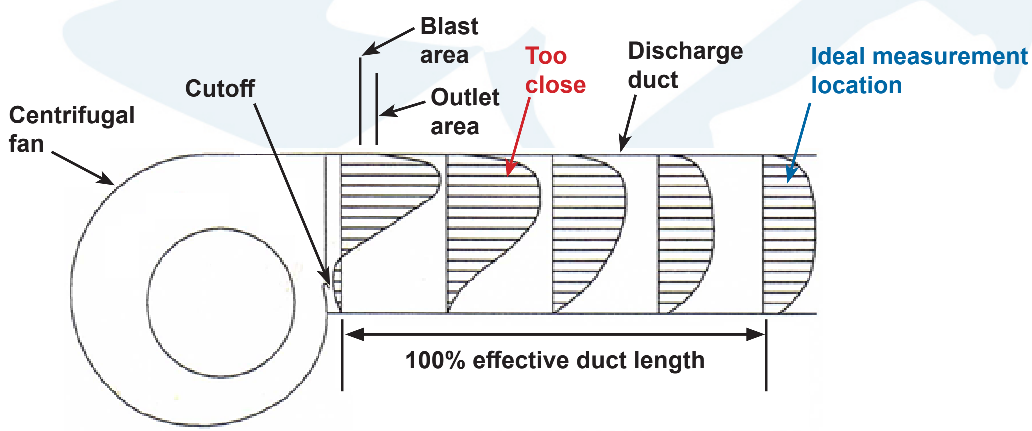


Figure 14 Air Flow at an Ideal Air Velocity Measurement Location

Digital Air Velocity Measurement (continued)

Taking Horizontal Air Velocity Measurements

7. Take an air velocity reading at the edge of the duct closest to you and record the reading, then move the pitot tube horizontally across the duct, taking measurements as described below and recording each of the readings:
   - For ducts 250 mm (10 in.) in diameter or less, take air velocity readings at 3 cm (1 in.) intervals across the width of the duct.
   - For ducts 300 mm (12 in.) in diameter or more, take air velocity readings at 5 cm (2 in.) intervals across the width of the duct.

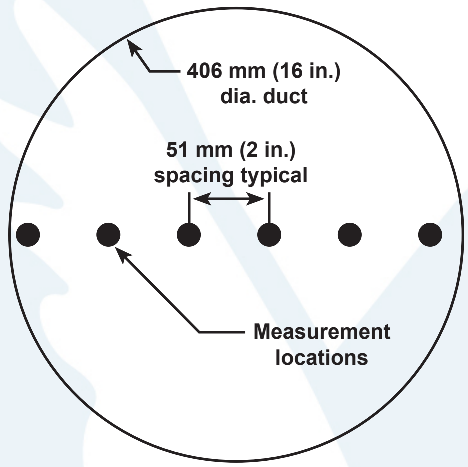


Figure 15 Locations to Take Air Velocity Readings Horizontally Across a Duct

NOTE

If the airflow is stable at the measurement point (10 or more duct diameters of length of straight duct on each side), then it is typically acceptable to measure the air velocity in only one direction as the velocity profile is the same regardless of measurement orientation.

Digital Air Velocity Measurement (continued)

Taking Vertical Air Velocity Measurements (If Needed)

8. If needed (see NOTE above), take air velocity readings vertically across the duct as follows to get a true average air velocity.
   a. Drill a second measurement hole 90 degrees from the first hole.
   b. Take air velocity readings vertically across the duct direction using the spacing shown in Figure 16 and record each reading.

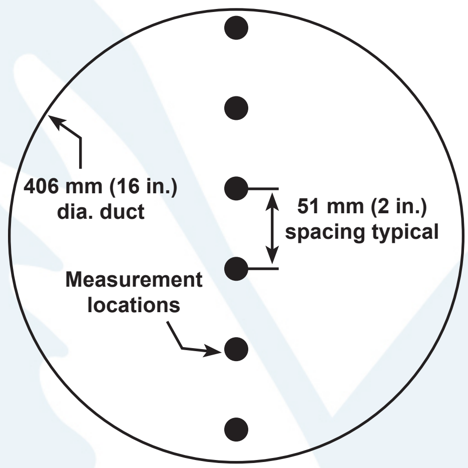


Figure 16 Locations to Take Air Velocity Readings Vertically Across a Duct

Taking Air Velocity Measurements for a Rectangular Duct (If Applicable)

9. If the duct is rectangular, take air velocity readings at multiple locations in both the horizontal and vertical directions as shown in Figure 17 and record each reading.

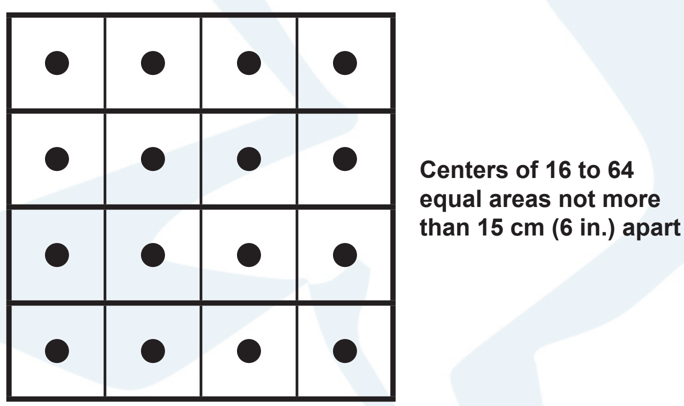


Figure 17 Locations to Take Air Velocity Readings for a Rectangular Duct

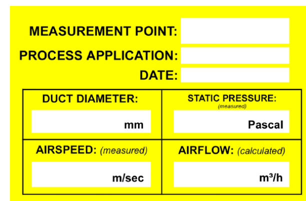
Digital Air Velocity Measurement (continued)

10. When all readings have been recorded, average them. If the air velocity measurements were taken (1) at an altitude of 600 m (2,000 ft) or greater or (2) at a temperature of 38 °C (100 °F) or greater, include a correction factor in the air velocity calculation to account for the low density of the air. Refer to “Appendix C, Air Volume Calculation Correction Factor for High Altitudes and Temperatures” on page 34.

    The result is the air velocity measurement for the duct.

NOTE

Air measurement stickers are included with the kit. These stickers are intended to be placed on the duct at the measurement locations. Measurement data can then be recorded on the stickers for historical reference. Use if desired.



Take Air Volume Measurements Using the Digital Gauge (Optional)

In addition to measuring air velocity, the digital gauge can also directly measure air volume (air flow).

1. Press [FLOW VOLUME] to enter the Flow mode. FLOW is highlighted on the digital gauge display.
2. Enter the duct information as prompted by the gauge.
3. With the pitot tube open to the ambient conditions, press and hold [ZERO] for 2 seconds. The air volume (flow) measurement appears on the display.

NOTE

Refer to “Appendix B, Digital Gauge Operating Instructions” on page 27 for more detailed information as needed.

Optimal System Design

To ensure the efficient operation of any air handling system, proper system design is essential. Designing a system properly will ensure adequate conveying velocities with minimal pressure loss, resulting in less downtime due to material blockages, less housekeeping time to deal with dust, and less energy being used by system fans.

Air Velocity

The ideal speed for conveying the light dust and trim material typical of the hygiene industry is 17.5 m/s–22.5 m/s (3,500–4,500 ft/min). This range strikes the best balance between conveying velocity and pressure loss due to friction.

Using air velocities much lower than 17.5 m/s (3,500 ft/min) can lead to material fallout and accumulation in the duct.

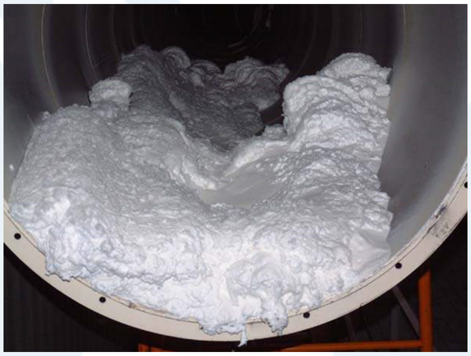


Figure 18 Material Accumulation Inside a Duct Due to Low Air Velocity

Using air velocities much higher than 22.5 m/s (4,500 ft/min) creates an unnecessarily high amount of pressure loss due to friction. This high amount of friction must be overcome by the system fans and thus results in high energy consumption by the system fan motors.

Duct Sizing

When designing an air system, duct should be sized to induce an air velocity within the range of 17.5 m/s–22.5 m/s (3,500–4,500 ft/min), as noted above. To calculate the proper duct size, air volume is divided by the desired air velocity. This value represents the cross-sectional area of the duct and can then be converted to duct diameter.

A (cross-sectional area of duct) = Q (air volume) ÷ V (air velocity)

where

A (cross sectional area of duct) = pi × (radius of duct)^2

Example—To determine the proper duct size for 2,200 ft^3/min of air:

Divide the air volume by the desired air velocity (4,000 ft/min in this case):	**A = (2,200 ft^3/min) ÷ (4,000 ft/min)** **A = 0.55 ft^2**
Convert the area of the duct to duct radius and the duct diameter	**Sqrt (0.55 ft^2 ÷ pi) = radius** **0.418 ft = radius** **2 × radius = diameter** **0.836 ft = diameter**
Convert the duct diameter to inches	**0.836 ft × (12 in ÷ 1 ft) = 10 in.**

So, in this example, a 10-in. duct should be used to induce an air velocity of 4,000 ft/min.

Pressure Loss

Pressure loss in an air system is due to friction caused by the air moving through the duct. Pressure loss increases as air velocity increases. When designing an air system, try to keep pressure loss to a minimum while still maintaining adequate conveying velocity.

The following examples show poor system design practices that increase pressure loss and should be avoided.

- An unnecessarily large number of elbows

- Ducts joining near an elbow

- Ducts joining at 90 degrees

- Short radius elbows

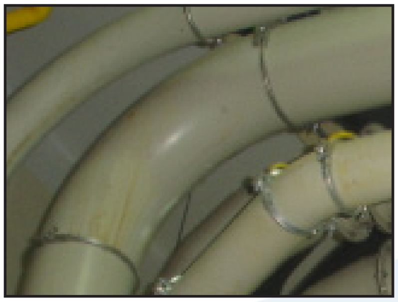
- Elbows on the inlet or outlet of fans

Pressure Loss (continued)

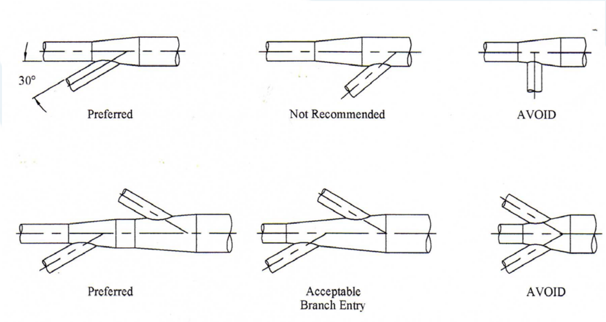
The following examples show good system design practices that keep pressure loss to a minimum.

- Using as few elbows as possible

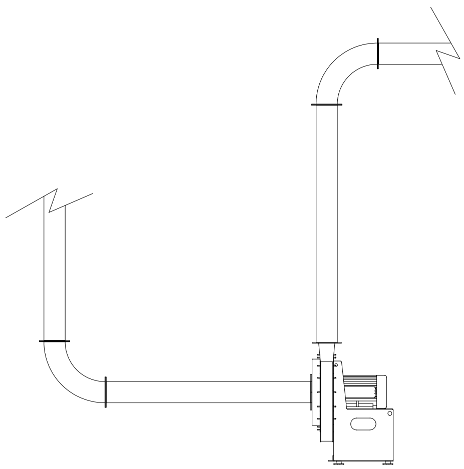
- Using large-radius elbows (the radius should be at least 2.5 times the diameter)



- Joining ducts at angles of 30 degrees or less



- Using straight sections of duct on the inlet and outlet of fans



Duct Construction

Quality duct construction is critical for the efficiency, cleanliness, and functionality of an air system. Ducts should be fabricated and installed by skilled personnel.

Osprey Corporation's recommendations for duct construction and installation are as follows:

- All ducts should be of smooth-type construction (no spiral or riveted duct) with flanged ends.
- All ducts should be constructed of 14-gauge steel.
- All welded joints should be continuous-seam and leak-free. Welds inside of ducts should be de-burred.
- All mating surfaces should be sealed with silicone caulk or gasket tape before assembly.
- Ducts should be independently supported.
- Clean-outs should be installed periodically.
- Slide gates should be installed in the duct around each piece of equipment to facilitate system balancing.

Contact Osprey for more information on recommended duct construction.

Technical Support

Contact Osprey Corporation engineering for additional information or questions on air readings and system design. Osprey can also provide a field service technician to complete a full air survey for your system. Refer to "Contact Information" on page 25.

Appendix A, Air System Diagnostics Kit Contents

The complete air system diagnostics kit part number is ASDK0001. The kit may be ordered from the Parts Department at Osprey Corporation by either phone or fax.

When ordering parts, have the following information available.

- Part number
- Complete description of part
- Equipment model number
- Equipment serial number (if applicable)
- Quantity needed
- Shipping address and method
- Customer order number

Contact Information

Osprey Corporation

1835 Briarwood Road, NE

Atlanta, GA 30329

Tel: 404-321-7776

Fax: 404-634-1401

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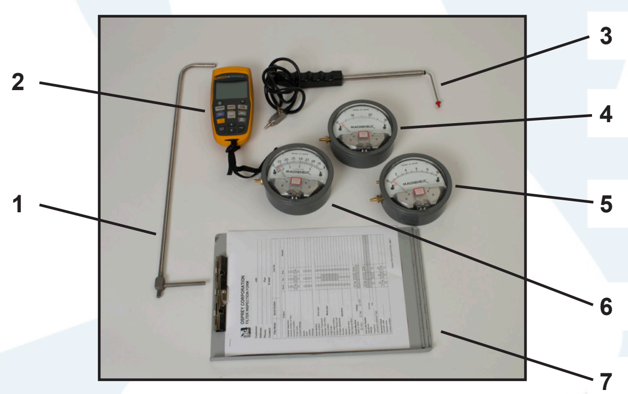
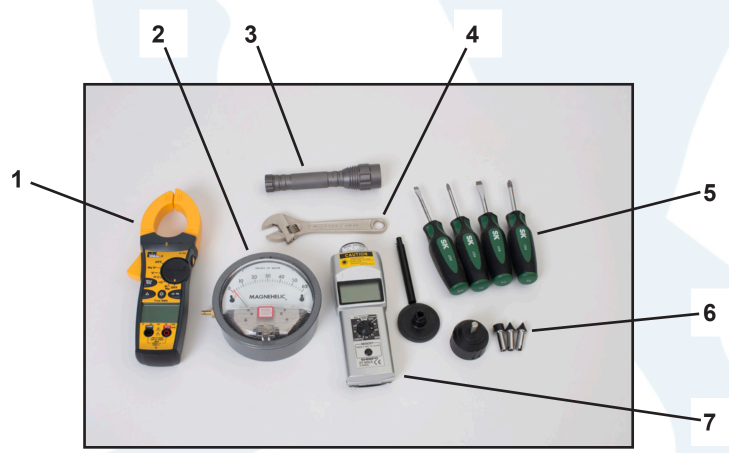


No.	Item	Qty.	Note
1	Pitot tube, 17 in., PNUMSC23287	1	Used to measure air velocity and pressure inside ducts
2	Fluke air meter (digital air velocity and pressure gauge)	1	Displays low differential pressure between -14 and +14 inH_2O and air velocity when used in conjunction with a pitot tube
3	Pitot tube, extendable	1	For large ducts or tight spaces, used in place of a conventional pitot tube
4	Magnehelic gauge, 0-30	1	Displays differential pressure up to 30 inH_2O
5	Magnehelic gauge, 0-10	1	Displays differential pressure up to 10 inH_2O
6	Magnehelic gauge, 0-2 with ft/min values		Displays air velocity when used in conjunction with a pitot tube
7	Clipboard and pen	1	

Appendix A, Air System Diagnostics Kit Contents (continued)

Item	Qty.
Rubber hose, 6 mm (1/4 in.) diameter, 0.6 m (24 in.) long	1
Air measurement labels, 5 cm (2 in.) diameter	50
Needle-nose pliers	1
Spare batteries, AA, AAA, 9V	8, 4, 1
Calculator	1
Ductulator	1
Laser pointer	1
Safety glasses	1
Ear plugs (100 per package)	5
Dust mask (50 per package)	3
Tape measure, 30–812 ft	1



No.	Item	Qty.	Note
1	Ammeter, clamp on	1	Displays current draw, voltage, and other electrical information for electric motors
2	Magnehelic gauge, 0-60	1	Displays differential pressure up to 60 inH_2O
3	Flashlight, LED	1	
4	Crescent wrench, 6 in.	1	
5	Screwdriver set, 4 piece	1	
6	Drill bit, 1/8 in. diameter	1	Used with a tachometer to measure rpm for rotating machinery
	Drill bit, 3/8 in. diameter	1	
	Hole plug, 1/8 in. diameter	100	
	Hole plug, 3/8 in. diameter	100	
7	Tachometer	1	Uses multiple measuring methods to display revolutions per minute (rpm) for rotating machinery

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Appendix B, Digital Gauge Operating Instructions

Use these procedures as needed to operate the Fluke digital gauge.

NOTE

The information in this Appendix was excerpted and adapted from the "Fluke 922 Air Meter Users Manual" and is provided for convenient reference. Refer to the Fluke User's Manual for all other information related to the Fluke digital gauge. Refer to "Fluke User's Manual Citation" on page 33 for a full source citation.

Digital Gauge Push Buttons

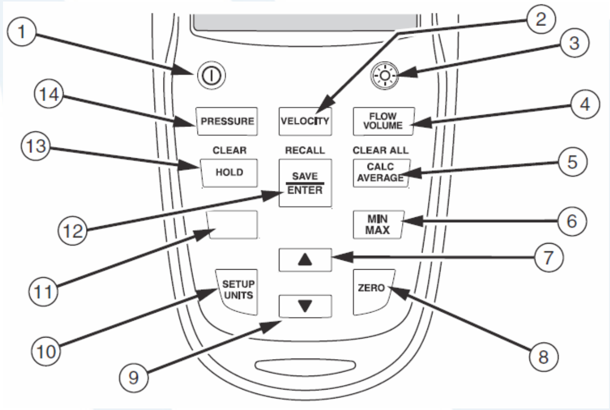

Figure 19 Digital Gauge Push Buttons

1	Power	Turns the digital gauge on or off. Hold for 5 seconds to display the firmware version.
2	VELOCITY	Activates the velocity mode. Refer to "Measuring Velocity" on page 31.
3	Backlight	Turns the backlight on or off.
4	FLOW VOLUME	Activates the flow (volume) mode. Refer to "Measuring Flow (Volume)" on page 32.
5	CALC AVERAGE	Calculates the average of stored values.
6	MIN MAX	Activates the live Min Max Avg functions. Refer to "Min Max Avg" on page 30.
7	Up arrow	Increases manual inputs, scrolls through memory, and navigates through the Setup menu.
8	ZERO	Resets the display. Press and hold 2 seconds to zero-out the display before taking measurements.
9	Down arrow	Decreases manual inputs, scrolls through memory, and navigates through the Setup menu.
10	SETUP UNITS	Opens the Setup menu. Refer to "Setup Menu" on page 32.
11	Blank	Accesses the secondary functions (CLEAR, RECALL, CLEAR ALL) shown in yellow letters on the front of the digital gauge.
12	SAVE / ENTER	Stores data and accepts changes to setup menu and flow parameters.
13	HOLD	Holds the present reading.
14	PRESSURE	Activates the pressure mode. Refer to "Measuring Differential Pressure" on page 30.

Digital Gauge Display

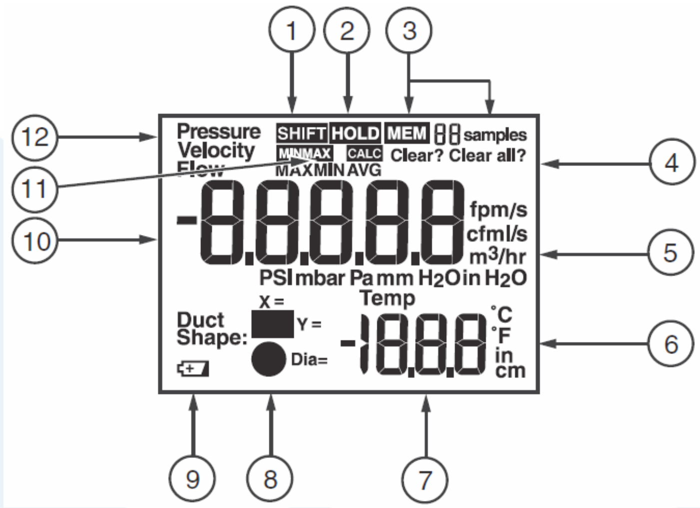

Figure 20 Digital Gauge Display

1	Shift key is in use and secondary menu functionality is engaged
2	Hold is engaged
3	Annunciators showing that sample memory is being accessed and the number of samples
4	Indicates that a stored sample (or all samples) is about to be deleted from memory
5	Units of pressure, velocity, and flow (volume)
6	Units of length and temperature
7	Digits for temperature and setup parameters
8	Duct shape choices
9	Low battery indicator. Replace the battery as soon as the low battery indicator appears.
10	Digits for main measurements of pressure, velocity, and flow (volume)
11	Min Max and Hold indicators
12	Pressure, Velocity, or Flow (volume) mode is active

Using the Digital Gauge

Power

To turn the digital gauge power on or off, press ⏻. The power is provided by four AA batteries. To replace the batteries (and for other maintenance or service information), refer to the Fluke air flow meter user's manual.

Measurement Units

The digital gauge supports both metric and US measurement units. Select the desired measurement unit using the Setup menu. Refer to "Setup Menu" on page 32.

NOTE

If any measured value of any parameter is above the specified range, the digital gauge shows **OL***.*

Backlight

Press ☼ to turn on the backlight. The backlight automatically turns off after 2 minutes.

Automatic Power Off

To conserve battery power, the digital gauge changes to sleep mode after 20 minutes of inactivity. To turn the digital gauge back on, press ⏻. To disable automatic power off, turn the digital gauge on while simultaneously holding ⏻ and ☼ until the display shows **APO OFF**. Repeat this procedure to re-enable this feature. The display shows **APO ON**.

Temperature

Ambient temperature is displayed on the digital gauge as a reference. The temperature can be displayed in either °C or °F. Refer to "Setup Menu" on page 32.

Secondary Menu Modes

Use [ ] with other select pushbuttons to shift to secondary menu modes and functions:

- Press [ ] and then HOLD to access the Clear functions. Refer to "Clearing Sample Data" on page 33.
- Press [ ] and then SAVE/ENTER to access the Recall menu. Refer to "Recall" on page 33.
- Press [ ] and then CALC/AVERAGE access the Clear All function. Refer to "Clearing Sample Data" on page 33.

Zero

To reset differential pressure, velocity, or flow (volume) to zero (0), have both pressure ports open to ambient conditions, then press and hold [ZERO] for 2 seconds. Upon zeroing, the digital gauge beeps.

Min Max Avg

The Min Max mode stores live minimum (MIN) and maximum (MAX) input values. When the input drops below the stored minimum value or above the stored maximum value, the digital gauge beeps and stores the new value. Min Max mode also calculates an average (AVG) of all readings taken since the mode was activated. This mode can be used to capture intermittent readings and to record maximum and minimum readings while you are away or when you cannot watch the digital gauge.

To use Min Max mode, press [MIN MAX]. The maximum reading appears first. Each subsequent press of [MIN MAX] steps through the minimum, average, and live readings, and then back to the maximum reading.

To exit Min Max mode, press and hold [MIN MAX] for approximately two seconds. When in Min Max mode, the Auto-off feature is automatically disabled.

Hold

Pressing [HOLD] captures the current reading and holds it on the display. If [HOLD] is pressed while in Min Max mode, the reading is held on the display and Min Max mode continues to store minimum and maximum values.

Saving Samples

The digital gauge saves various samples in its three major modes. To save a sample, do the following:

1. When taking a sample, press [SAVE ENTER] to store the sample. The digital gauge can save up to 99 samples in each of its three modes.
2. Once the samples are taken, press [CALC AVERAGE] to view the average of all the samples.
3. Press [CALC AVERAGE], [PRESSURE], [VELOCITY], or [FLOW VOLUME] to exit the Calculate mode. If the memory is full (99 samples have been stored), more samples cannot be stored. If you attempts to store another sample, the display flashes “Full” and does not save new readings.

Measuring Differential Pressure

To measure differential pressure do the following:

1. Press [PRESSURE] to enter the Pressure mode.
2. Connect a single hose to the “Input (+)” port, leaving the “Ref (-)” port unconnected.
3. With the hose open to ambient conditions, press and hold [ZERO] for 2 seconds.
4. Place the input hose in a different zone than the digital gauge. The digital gauge displays the differential pressure of the input zone with respect to the reference zone. For instance, a positive reading means that the input zone is positively pressured with respect to the digital gauge location or its reference zone.

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Measuring Velocity

The digital gauge uses standard ambient conditions (temperature = 21.1 °C (70 °F), barometric pressure = 14.7 psia (1,013 mbar) to approximate actual velocity and flow (volume).

To measure velocity, do the following:

1. Press VELOCITY to enter the Velocity mode.
2. Connect the hoses to the pitot tube and to the digital gauge. The “Input (+)” pressure port on the digital gauge connects to the yellow hose from the total pressure connection of the pitot tube. The “Ref (-)” pressure port on the digital gauge connects to the black hose from the static pressure connection of the pitot tube. See Figure 21.

NOTE

If velocity measures negative on the display, check to make sure that the hoses are attached to the correct ports on the digital gauge and the pitot tube.

3. With the pitot tube open to ambient conditions, press and hold ZERO for 2 seconds.

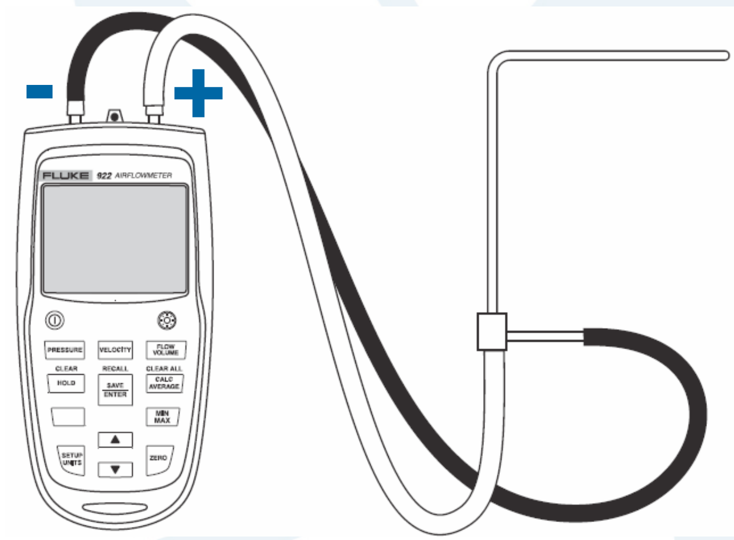

Figure 21 Digital Gauge and Pitot Tube Connections

Measuring Flow (Volume)

1. Press [FLOW VOLUME].
2. The digital gauge requests the duct shape and size. The digital gauge stores the last duct shape and size that was entered. If the duct is different than the stored version, press [▼] or [▲] to find the proper duct type for the measurement (rectangular or round).
3. Press [SAVE ENTER] to select the duct type.
4. If the duct is rectangular, use [▼] or [▲] to select the X dimension and press [SAVE ENTER] to store it. Use [▼] or [▲] to select the Y dimension. Hold [▼] or [▲] to increase the rate of change. Press [SAVE ENTER] to store it.
5. If the duct is round, use [▼] or [▲] to select the duct diameter and press [SAVE ENTER] to store it.
6. To measure flow (volume), complete Steps 2–3 under "Measuring Velocity" on page 31.

NOTE

If velocity measures negative on the display, make sure the hoses are attached to the correct ports on the digital gauge and the pitot tube.

NOTES

HOLD, SAVE, CALCULATE, SHIFT, MIN MAX, ZERO, and SETUP UNITS can be used when measuring pressure, velocity, and flow (volume).

If [PRESSURE] or [VELOCITY] is pressed before pressing [SAVE ENTER] for the final time, the digital gauge will exit the flow (volume) setup process and will not save any of the selections made or values entered.

Setup Menu

Use the Setup menu to change the following digital gauge parameters:

- Pressure units
- Velocity units
- Flow (Volume) units
- Temperature units
- Duct dimension units

To modify the digital gauge setup parameters:

1. From any screen, press [SETUP UNITS] to enter Setup menu editing mode.
2. Use [▼] or [▲] to change the measurement units. Hold down [▼] or [▲] to increase the rate of change.
3. Press [SAVE ENTER] to store the change. The digital gauge beeps to signal that the change has been stored. With each press of [SAVE ENTER], the menu moves to the next parameter. To exit the Setup menu without changing subsequent parameters, press [PRESSURE], [VELOCITY], or [FLOW VOLUME].

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Clearing Sample Data

The digital gauge stores data that periodically will need to be cleared. Individual samples or the entire data memory can be cleared. When the memory is full (99 samples), the display shows "Full" when [SAVE ENTER] is pressed and the gauge emits short beeps and will not save any value until some samples are cleared.

To clear individual sample data, do the following:

1. Press [PRESSURE], [VELOCITY], or [FLOW VOLUME] to clear samples for that mode.
2. Press [ ].
3. Press [HOLD] (CLEAR).
4. Use [▼] or [▲] to select the desired sample number. The last measurement saved appears first.
5. Press [SAVE ENTER] to clear the sample. Note that the number of samples displayed is reduced.

To clear all sample data, do the following:

1. Press [ ].
2. Press [CALC AVERAGE] (CLEAR ALL).
3. Press [SAVE ENTER] to clear all samples. The digital gauge beeps and the display shows 0 samples.
4. To exit (CLEAR) or (CLEAR ALL) without deleting samples, press [PRESSURE], [VELOCITY], or [FLOW VOLUME] before pressing [SAVE ENTER].

Recall

1. Press [PRESSURE], [VELOCITY], or [FLOW VOLUME] to recall samples for that mode.
2. Press [ ].
3. Press [SAVE ENTER] (RECALL) to recall samples. Use [▼] or [▲] to locate the desired sample. Hold [▼] or [▲] to increase the rate of change.
4. Press [PRESSURE], [VELOCITY], or [FLOW VOLUME] to exit the Recall menu.

Fluke User's Manual Citation

Fluke Corporation (2007). *Fluke 922 Air Meter Users Manual*. Taiwan: Fluke Corporation. PN 2683880; November 2006; Rev.1, 12/07.

Appendix C, Air Volume Calculation Correction Factor for High Altitudes and Temperatures

When taking air velocity measurements at altitudes of 610 m (2,000 ft) or greater OR at air temperatures of 38 °C (100 °F) or greater, apply a correction factor to compensate for extreme altitudes or temperatures. Use the following formula to calculate the correction factor.

[1 – (0.000035 x D)] × [530 ÷ (460 + T)

where

D is the altitude (elevation in feet above sea level)

and

T is the temperature in Fahrenheit

After determining the correction factor, divide the air velocity reading shown on the analog or digital gauge by the square root of the correction factor to determine the actual air velocity, as shown in the example below.

Example—To apply a correction factor to an air velocity reading of 4,000 ft/min taken at an altitude of 6,000 ft and with a duct air temperature of 125 °F.

Determine the correction factor when the altitude (D) = 6,000 and the temperature (T) inside the duct = 125	**[1 – (0.000035 x 6,000)] × [530 ÷ (460 + 125)] = 0.72**
The correction factor equals 0.72.	**0.72**
Apply the correction factor to the air velocity reading of 4,000 ft/min	**4,000 ft/min ÷ sqrt[0.72] = 4,714 ft/min**
Actual air velocity	**4,714 ft/min**

Appendix D, Ductulator® Operating Instructions

The Ductulator included in the air system diagnostics kit provides a quick and easy way to convert air velocity into air volume without the need for the manual calculation described under “How to Convert Air Velocity to Air Volume” on page 4. The Ductulator can quickly determine air velocity and pressure loss for a known amount of air in a particular size of duct. It can also be used during system design to quickly size ducting. Metric units are on one side of the Ductulator and English units are on the other.

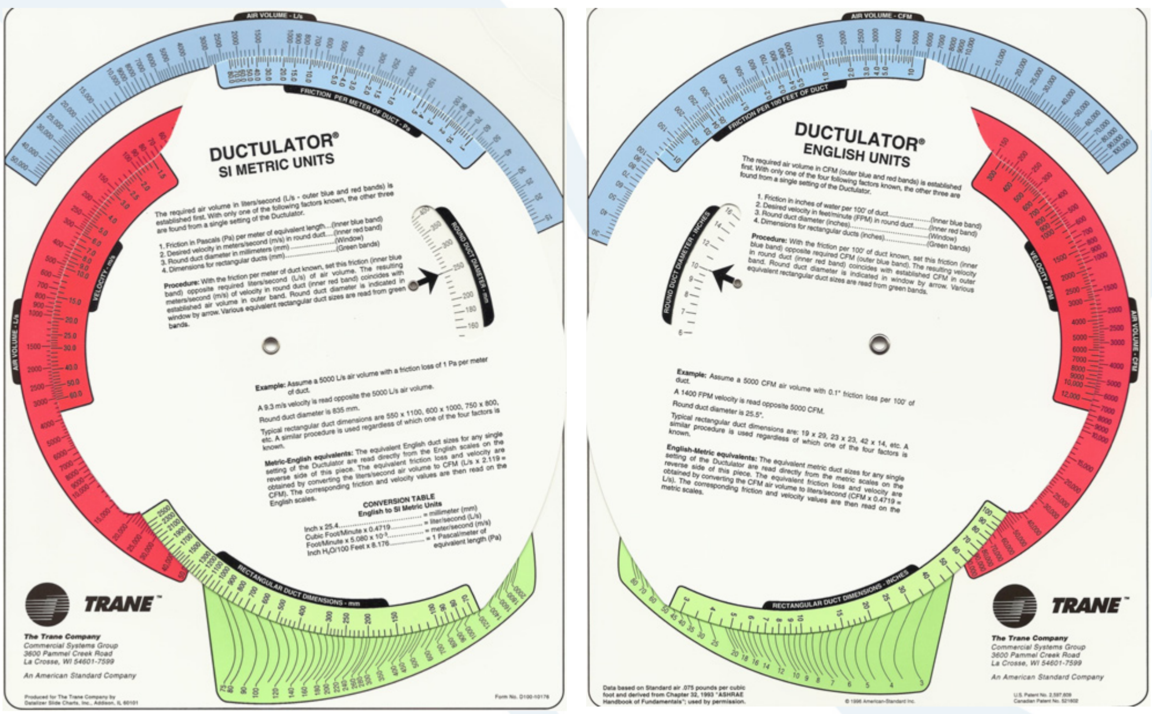

Figure 22 Metric and English Units on the Ductulator

Appendix D, Ductulator® Operating Instructions (continued)

Using the Ductulator to Determine Air Velocity

You must know the duct size and air volume to perform this procedure. As an example, a 10 in. duct size and a 2,200 ft^3/min air volume measurement will be used in this procedure.

1. Align the black arrow on the left of the Ductulator to the correct duct size (in this example, 10 in.).

Figure 23 A 10 in. Duct Size Selected on the English Units Side of the Ductulator

2. Find the AIR VOLUME value on the right side of the Ductulator (in this example, 2200 ft^3/min).

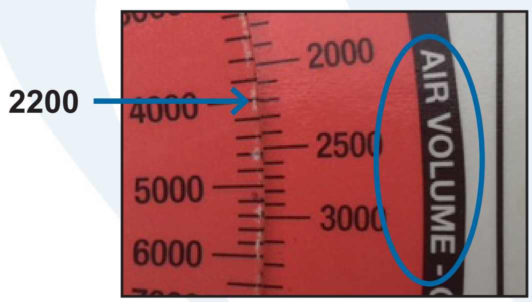

Figure 24 A 2200 ft^3/min Value Selected on the AIR VOLUME Units Side

The number in the VELOCITY section that is directly adjacent to the AIR VOLUME value is the velocity of the air. In this example, about 4,000 ft/min.

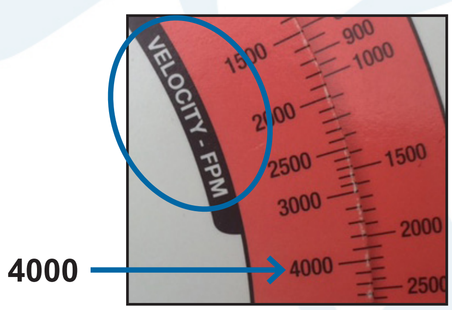

Figure 25 The Corresponding 4000 ft/min Value on the VELOCITY Side

Appendix D, Ductulator® Operating Instructions (continued)

Using the Ductulator to Determine Pressure Loss (or Friction Loss)

You must know the duct size and air volume to perform this procedure. As an example, a 10 in. duct size and a 2,200 ft^3/min air volume measurement will be used in this procedure.

1. Align the Ductulator as described under "Using the Ductulator to Determine Air Velocity" on page 36 with a known duct size and air volume.
2. Find the AIR VOLUME value in the in blue FRICTION section of Ductulator, near the top (in this example, 2200 ft^3/min).

Figure 26 A 2200 ft^3/min Value Selected on the AIR VOLUME Units Side

The number in the FRICTION section that is directly adjacent to the air volume value is the amount of pressure loss per 100 ft of straight duct. In this example, about 2.2 in. w.c./100 ft.

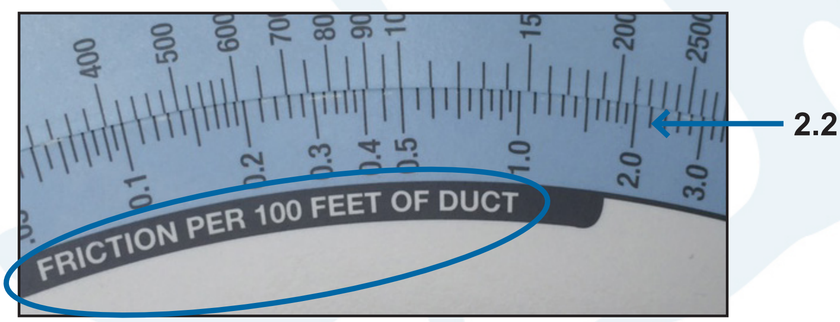

Figure 27 The Corresponding 2.2 in. w.c./100 ft Value on the FRICTION Side

Appendix D, Ductulator® Operating Instructions (continued)

Using the Ductulator During Air System Design

You can use the Ductulator during system design to properly size ducting. To do so, align the AIR VOLUME value with the desired air VELOCITY (typically around 4,000 ft/min), and find the duct diameter next to the black arrow. If the duct diameter shown is not commercially available (for example, 9.5 in. diameter duct), the desired air velocity may have to be adjusted slightly up or down so a commercially available duct size can be used. If you have to adjust the duct size, be sure to stay in the optimum air velocity range of 17.5 m/s–22.5 m/s (3,500–4,500 ft/min).

NOTES