VESDA DUCTS APPLICATION NOTE

October 2025
Doc. No. 35424_04

Preface

Xtralis has designed an air sampling smoke detection system specifically for use in ventilation ducts. The information contained in this document will assist you when designing VESDA systems for this type of application.

Note!

This system is not suitable for use in flexible ducts.

Related Products

The below products have been specially adapted for installation in ducts:

- VESDA-E VEP-A00-1P
- VESDA-E VEP-A00-1P-UL
- VESDA-E VEA-040-A00
- VESDA-E VEA-040-A10
- VESDA-E VEA-040-A00-UL
- VESDA-E VEA-040-A10-UL
- VESDA VLF-500-00-UL
- VESDA VLF-500-02-UL

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1.1.1 VESDA-E VEP-1P(-UL)

Small ducts are defined as those of width less than 1 m (3.28 ft). The figure below (Figure 1) shows a side view of a duct section with the insertion positions for the VESDA-E VEP-1P(-UL) detector inlet and exhaust pipes.

The detector inlet pipe should be installed in the middle of the duct at height H, where H is half of the duct diameter. The detector exhaust pipe should be inserted approximately 0.5 m (1.64 ft) downstream of the inlet pipe, at a quarter of the height of the duct.

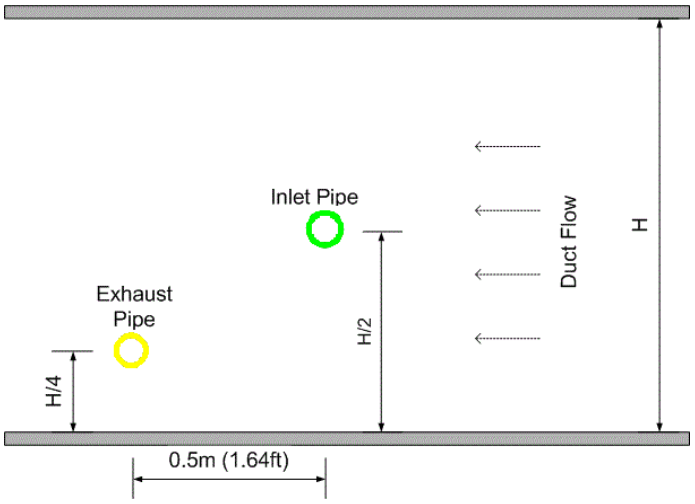

Figure 1: Side view of the inlet and exhaust pipe positions for a small ventilation duct.

A top view of the above installation is shown below (Figure 2). The number of inlet pipe sampling holes, their required size and spacing are listed in Table 1. Both sampling pipe and exhaust pipe holes have the same orientation with respect to the direction of the duct airflow.

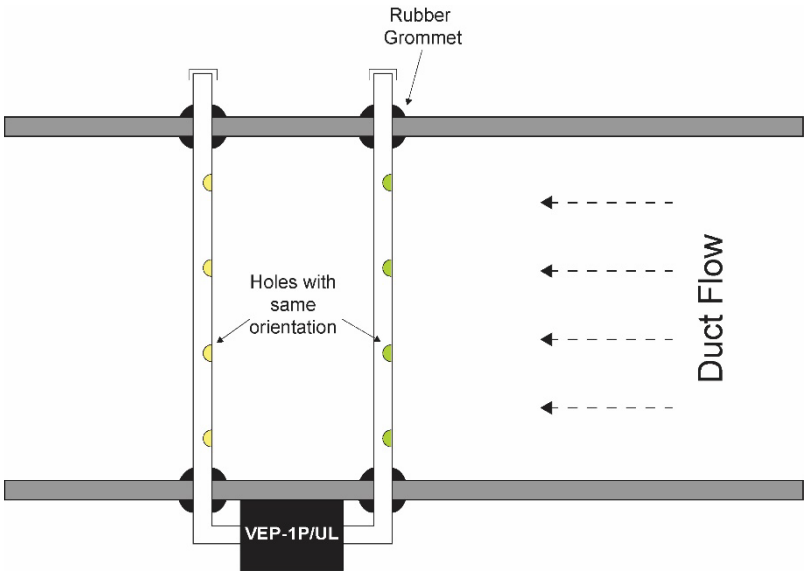

Figure 2: Top view of the inlet and exhaust pipe positions, including sampling hole location, for a small duct.

The sampling hole sizes, for the inlet pipe, are shown in Table 1. The exhaust pipe must have 4 × Ø10 mm (13/32 inch) holes, regardless of the width of the duct. These holes should be located in the middle of the duct width at least 50 mm (2 inches) from the side walls.

Table 1: Sampling hole requirements for a VESDA-E VEP-1P(-UL) detector with 5 m (16.4 ft.) inlet pipe and 2 m (6.56 ft.) exhaust pipe in small ducts.

Duct width (m) {ft}	Number of Holes	Hole Ø (mm) {in}	Nominal Pipe Flow Rate (L/min) {cfm}
0.3 {1.0}	2	6 {15/64}	40.8 {1.43}
0.5 {1.7}	3	5 {13/64}	44.2 {1.56}
0.7 {2.3}	4	4 {5/32}	38.6 {1.36}
0.9 {3.0}	5	4 {5/32}	46.4 {1.64}

Note!

Nominal sampling hole spacing is 0.2 m (0.66 ft.).

1.1.2 VESDA-E VEA(-UL)

Return air sampling is achieved with microbore tubes for VEA system inserted in the return air duct behind the exhaust grill. it is recommended the tubes are installed facing perpendicular to the duct airflow (Figure 3). A specific sampling point, VSP-980-ST (No. 35295), must be used for VEA's duct sampling. It can be mounted on the duct by VEA Sampling Point Duct Bracket, part number VSP-1008.

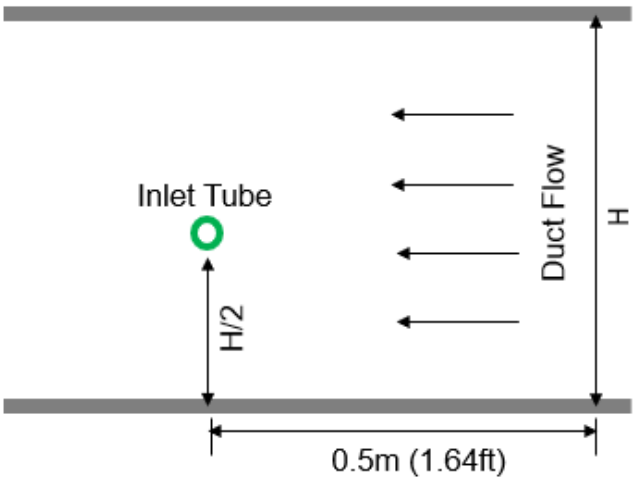

Figure 3: Side view of the inlet tube position for a small ventilation duct

The detector inlet tube should be installed in the middle of the duct at height H, where H is half of the duct diameter.

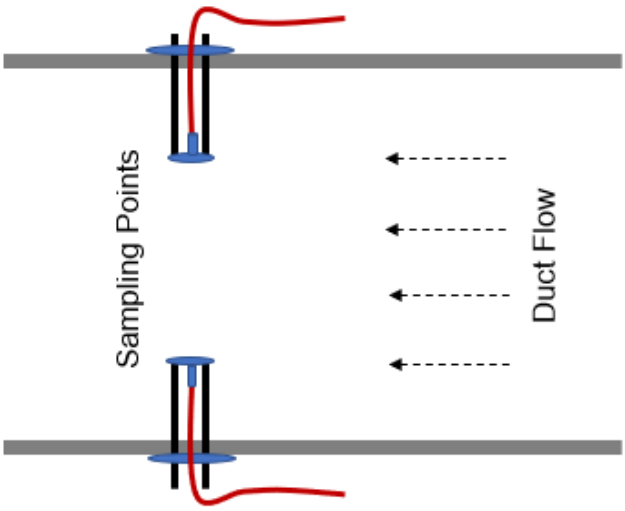

Figure 4: Top view of the inlet tubes positions, including duct mounting bracket for a small ventilation duct.

These sampling points should be located in the middle of the duct width at least 50 mm (2 inches) from the side walls.

Note!

Nominal sampling point spacing is 0.2 m (0.66 ft.).

1.1.3 VESDA VLF-500-UL

Small ducts are defined as those of width less than 1 m (3.28 ft). The figure below (Figure 5) shows a side view of a duct section with the insertion positions for the VESDA VLF-500-UL detector inlet and exhaust pipes.

The detector inlet pipe should be installed in the middle of the duct at height H, where H is half of the duct diameter. The detector exhaust pipe should be inserted approximately 0.5 m (1.64 ft) downstream of the inlet pipe, at a quarter of the height of the duct.

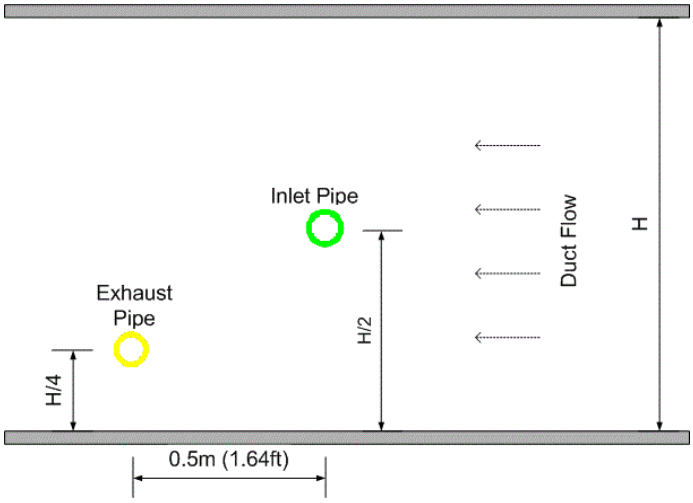

Figure 5: Side view of the inlet and exhaust pipe positions for a small ventilation duct.

A top view of the above installation is shown below (Figure 6). The number of inlet pipe sampling holes, their required size and spacing are listed in Table 2. Both sampling pipe and exhaust pipe holes have the same orientation with respect to the direction of the duct airflow.

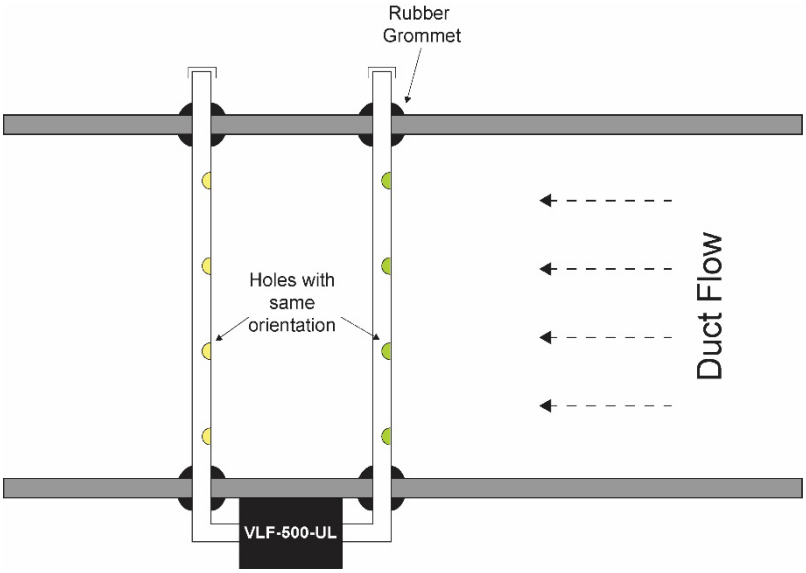

Figure 6: Top view of the inlet and exhaust pipe positions, including sampling hole location, for a small duct.

The sampling hole sizes, for the inlet pipe, are shown in Table 2. The exhaust pipe must have 4 × Ø10 mm (13/32 inch) holes, regardless of the width of the duct. These holes should be located in the middle of the duct width at least 50 mm (2 inches) from the side walls.

Table 2: Sampling hole requirements for a VESDA VLF-500-UL detector with 5 m (16.4 ft.) inlet pipe and 2 m (6.56 ft.) exhaust pipe in small ducts.

Duct width (m) {ft}	Number of Holes	Hole Ø (mm) {in}	Nominal Pipe Flow Rate (L/min) {cfm}
0.3 {1.0}	2	6 {15/64}	40.8 {1.43}
0.5 {1.7}	3	5 {13/64}	44.2 {1.56}
0.7 {2.3}	4	4 {5/32}	38.6 {1.36}
0.9 {3.0}	5	4 {5/32}	46.4 {1.64}

Note!

Nominal sampling hole spacing is 0.2 m (0.66 ft.).

1.2 Sampling Pipe Configuration in Large Ducts

1.2.1 VESDA-E VEP-1P(-UL)

Large ducts are defined as those with widths of 1 to 2 m (3.28 to 6.56 ft). For these ventilation ducts, it is recommended that the inlet pipe of the smoke detector be in two branches. The figure below (Figure 7) shows a side view of a duct section with the relative insertion points for the inlet and exhaust pipes. The two inlet branches are located at a quarter of the height (H) of the duct with the exhaust pipe inserted mid-height approximately 0.5 m (1.64 ft) downstream of the inlet pipes.

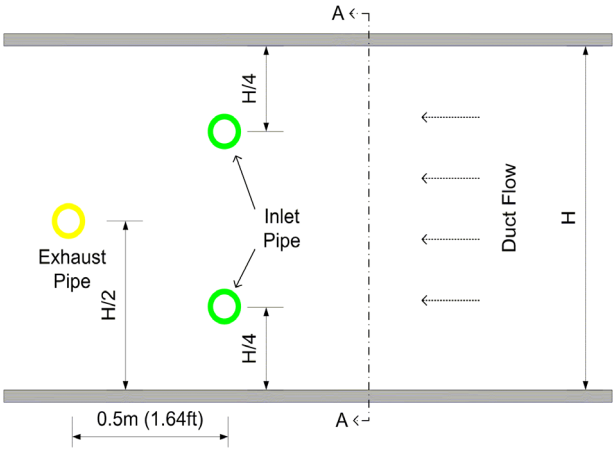

Figure 7: Side view of the inlet and exhaust pipe positions for a large duct.

The following figure (Figure 8) shows a cross-section view of the same duct with the positions of the inlet branches and exhaust pipe indicated. The number of inlet pipe sampling holes, recommended hole size and spacing are presented in Table 3.

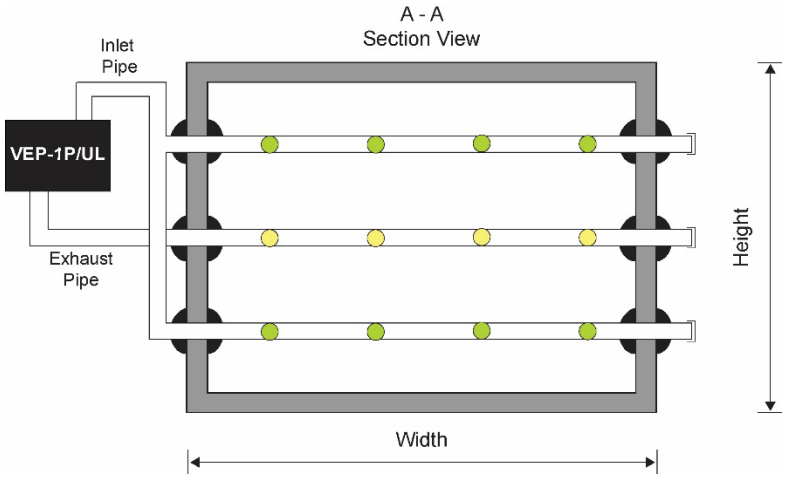

Figure 8: Cross-section view of the inlet pipe sampling hole setup and exhaust pipe in large ducts.

Table 3: Sampling hole requirements for a VESDA-E VEP-1P(-UL) detector with 5 m (16.4 ft) inlet pipes and 2 m (6.56 ft) exhaust pipe in a large duct.

Duct width (m) {ft}	Number of Holes	Hole Ø (mm) {in}	Nominal Pipe Flow Rate (L/min) {cfm}
1.0 {3.3}	6	3.5 {9/64}	45.8 {1.62}
1.5 {5.0}	8	3.0 {1/8}	47.8 {1.69}
2.0 {6.5}	10	3.0 {1/8}	57.0 {2.01}

Note!

Nominal sampling hole spacing is 0.4 m (1.3 ft).

The exhaust pipe must have 4 × Ø10 mm (13/32 inch) sampling holes, regardless of the width of the duct. These holes should be located in the middle of the duct width at least 50 mm (2 inches) from the side walls.

1.2.2 VESDA VLF-500-UL

Large ducts are defined as those with widths of 1 to 2 m (3.28 to 6.56 ft). For these ventilation ducts, it is recommended that the inlet pipe of the smoke detector be in two branches. The figure below (Figure 9) shows a side view of a duct section with the relative insertion points for the inlet and exhaust pipes. The two inlet branches are located at a quarter of the height (H) of the duct with the exhaust pipe inserted mid-height approximately 0.5 m (1.64 ft) downstream of the inlet pipes.

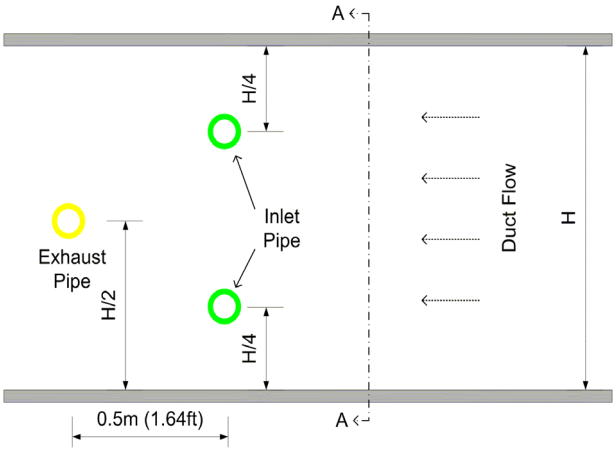

Figure 9: Side view of the inlet and exhaust pipe positions for a large duct.

The following figure (Figure 10) shows a cross-section view of the same duct with the positions of the inlet branches and exhaust pipe indicated. The number of inlet pipe sampling holes, recommended hole size and spacing are presented in Table 4.

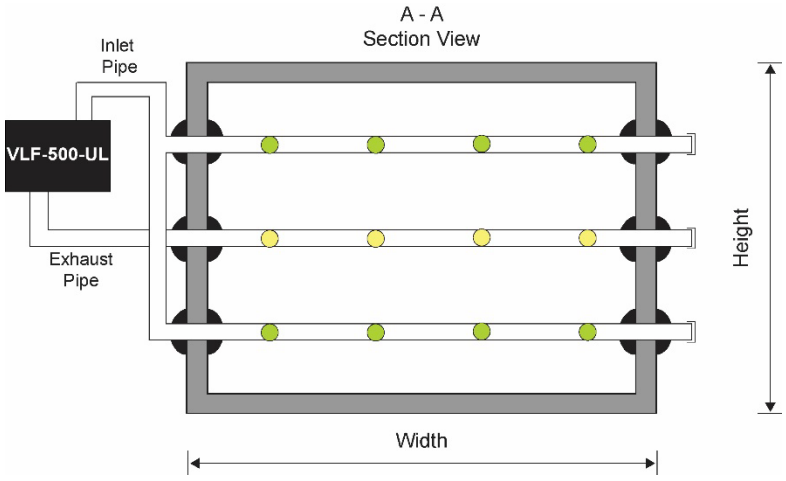

Figure 10: Cross-section view of the inlet pipe sampling hole setup and exhaust pipe in large ducts.

Table 4: Sampling hole requirements for a VESDA VLF-500-UL detector with 5 m (16.4 ft) inlet pipes and 2 m (6.56 ft) exhaust pipe in a large duct.

Duct width (m) {ft}	Number of Holes	Hole Ø (mm) {in}	Nominal Pipe Flow Rate (L/min) {cfm}
1.0 {3.3}	6	3.5 {9/64}	45.8 {1.62}
1.5 {5.0}	8	3.0 {1/8}	47.8 {1.69}
2.0 {6.5}	10	3.0 {1/8}	57.0 {2.01}

Note!

Nominal sampling hole spacing is 0.4 m (1.3 ft).

The exhaust pipe must have 4 × Ø10 mm (13/32 inch) sampling holes, regardless of the width of the duct. These holes should be located in the middle of the duct width at least 50 mm (2 inches) from the side walls.

Note!

Calculations, performed with the ASPIRE pipe design software tool and shown in Tables 1, 2, 3 and 4, apply to a 5 m (16.4 ft) inlet pipe and a 2 m (6.56 ft) exhaust pipe. These calculations are suitable for an inlet pipe length of 1 to 10 m (3.28 to 32.8 ft) and an exhaust pipe length of < 2 m (6.56 ft), provided that corresponding pipe flow rate adjustments are made. Always refer to local codes and standards for hole size and spacing requirements.

1.3 Key Design Considerations

1.3.1 VESDA-E VEP-1P(-UL)

The following should be considered when designing a VESDA-E VEP-1P(-UL) for duct protection:

- All inlet and exhaust pipes must be sealed at their far end with an end-cap.
- The holes on the inlet and exhaust pipes should be facing the airflow as shown in the above figures. Holes with the same orientation eliminate unwanted flow faults associated with cyclical operation, maintenance or power failure of the duct system. However, in some industrial applications, where the quality of air inside the duct is poor, it is recommended that all holes on the inlet and exhaust pipes face downstream, that is, 180° to the incoming airflow).
- The pipes should always be held in position at the duct walls with fittings such as rubber grommets. Silicon is recommended, to ensure an airtight seal.
- Regardless of duct width, the exhaust pipe must have 4 × Ø10 mm (13/32 inches) holes.
- Never simultaneously sample from multiple ducts or ambient environments with the same the detector.

1.3.2 VESDA-E VEA(-UL)

The following should be considered when designing a VESDA-E VEA for duct protection:

- Sampling points install in duct pressures within -30Pa to +30Pa.
- Maximum differential pressure (DP) of 30Pa between sampling points on same VEA unit.
- The exhaust of the VEA unit must be within a pressure range -30Pa to +30Pa.

1.3.3 VESDA VLF-500-UL

The following should be considered when designing a VESDA VLF-500-UL for duct protection:

- All inlet and exhaust pipes must be sealed at their far end with an end-cap.
- The holes on the inlet and exhaust pipes should be facing the airflow as shown in the above figures. Holes with the same orientation eliminate unwanted flow faults associated with cyclical operation, maintenance or power failure of the duct system. However, in some industrial applications, where the quality of air inside the duct is poor, it is recommended that all holes on the inlet and exhaust pipes face downstream, that is, 180° to the incoming airflow).
- The pipes should always be held in position at the duct walls with fittings such as rubber grommets. Silicon is recommended, to ensure an airtight seal.
- Regardless of duct width, the exhaust pipe must have 4 × Ø10 mm (13/32 inches) holes.
- Never simultaneously sample from multiple ducts or ambient environments with the same the detector.

2 VESDA System Installation

2.1 Environmental Conditions

2.1.1 VESDA-E VEP-1P(-UL)

You will need equipment to measure the following environmental conditions when installing a VESDA-E system in a duct:

- Temperature.
- Humidity.
- Static Pressure – the pressure generated by the fan to deliver a specific flow-rate in the duct. This pressure is a function of the flow-rate and impedance of the duct system.
- Air Pressure.
- In air-return ducts, the smoke detector must be installed where the static pressure is above −500 Pa and the air velocity in the duct is below 20 m/s or, converted to volumetric flow rate (m3/hr) = velocity × duct area.
- Always vent the exhaust pipe back into the ventilation duct, even when the duct pressure is sometimes < 20 Pa, because the duct system operation may change in the future.

Condensation may occur when the dew point temperature of the air in the ventilation duct is at or above the ambient temperature of the area where the smoke detector is installed. This usually occurs when the temperature of the humid air in the duct is higher than the ambient temperature of the air outside the duct, where the detector is to be installed, and the temperature of the air inside the sampling pipes of the detector.

You should measure the temperature and humidity both inside the duct and in the area where the detector will be installed. If the results indicate that condensation may be a problem, refer to the ‘Duct Sampling and Condensation’ section of the Pipe Network Installation Manual for advice on how to modify the design. The Pipe Network Installation Manual (Doc. No. 10255) forms part of the VESDA-E System Design Manual.

One solution for combating condensation is to use an inverted mount so water does not enter the detector. (Figure 11). This can be combined with a water trap so that condensation can be released at intervals.

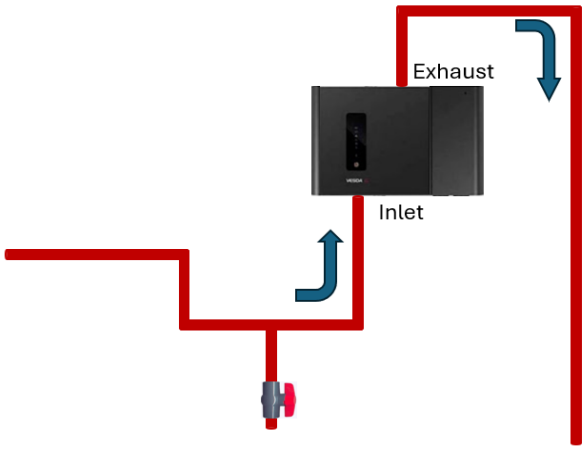

Figure 11: VESDA-E VEP-1P(-UL) detector invert mounting solution, to combat condensation.

The sampling pipe should be removed from the detector regularly for inspection, especially during winter, to determine whether any condensation is forming inside the pipes.

Smoke tests should be conducted regularly during the first two months following installation. If the smoke tests fail, condensation may have affected the air filter in the detector. Replace the air filter and re-test. The condensation problem will need to be addressed by following the methods described above.

If you have any doubts about the installation, seek support from your local Xtralis office or VESDA distributor.

2.1.2 VESDA-E VEA(-UL)

Ensure duct environmental conditions do not lead to water condensation inside the tube.

2.1.3 VESDA VLF-500-UL

You will need equipment to measure the following environmental conditions when installing a VESDA system in a duct:

- Temperature.
- Humidity.
- Static Pressure – the pressure generated by the fan to deliver a specific flow-rate in the duct. This pressure is a function of the flow-rate and impedance of the duct system.
- Air Pressure.
- In air-return ducts, the smoke detector must be installed where the static pressure is above −500 Pa and the air velocity in the duct is below 20 m/s or, converted to volumetric flow rate (m3/hr) = velocity × duct area.
- Always vent the exhaust pipe back into the ventilation duct, even when the duct pressure is sometimes < 20 Pa, because the duct system operation may change in the future.

Condensation may occur when the dew point temperature of the air in the ventilation duct is at or above the ambient temperature of the area where the smoke detector is installed. This usually occurs when the temperature of the humid air in the duct is higher than the ambient temperature of the air outside the duct, where the detector is to be installed, and the temperature of the air inside the sampling pipes of the detector.

You should measure the temperature and humidity both inside the duct and in the area where the detector will be installed. If the results indicate that condensation may be a problem, refer to the ‘Duct Sampling and Condensation’ section of the Pipe Network Installation Manual for advice on how to modify the design. The Pipe Network Installation Manual (Document Number 10255) forms part of the VESDA System Design Manual.

One solution for combating condensation is to use an inverted mount so water does not enter the detector. (Figure 12). This can be combined with a water trap so that condensation can be released at intervals.

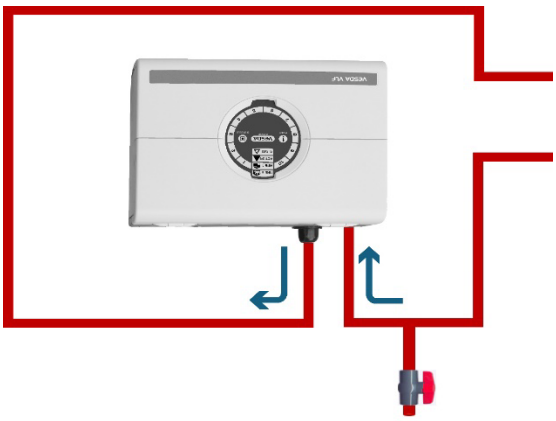

Figure 12: VESDA VLF-500-UL detector invert mounting solution, to combat condensation.

The sampling pipe should be removed from the detector regularly for inspection, especially during winter, to determine whether any condensation is forming inside the pipes.

Smoke tests should be conducted regularly during the first two months following installation. If the smoke tests fail, condensation may have affected the air filter in the detector. Replace the air filter and re-test. The condensation problem will need to be addressed by following the methods described above.

If you have any doubts about the installation, seek support from your local Xtralis office or VESDA distributor.

2.2 Key Installation Considerations

You must consider the following when installing a VESDA system for duct protection:

- For air-return (negative pressure) ducts, smoke sampling must occur:
  - Upstream and away from any fans.
  - Upstream of humidifiers, heating coils and filters.
  - Upstream of fresh air intakes.
- For a smoke detector mounted on the duct, ensure there are no tangible vibrations when the duct system is in full operation. If there are vibrations, insert visco-elastic foam between the smoke detector's mounting bracket and the external surface of the duct.
- The inlet pipe/tube of the VESDA detector must be inserted at a distance of six to ten duct widths or diameters from any flow disturbance caused by sharp bends, plenums, nozzles, branch connections etc. Hence this system is not suitable for flexible ducts.
- Make sure that sampling holes/points are at least 50 mm (2 inches) away from the duct walls.

3 VESDA System Commissioning

3.1 Hole Orientation Adjustment

3.1.1 VESDA-E VEP-1P(-UL) and VESDA VLF-500-UL

The differential pressure across the inlet and exhaust pipes must be kept within ±20 Pa to ensure the normal operation of the smoke detector. Differential pressure is created by the orientation of the holes on both pipes in relation to the duct flow. There are three methods for adjusting hole orientation. Your choice of method will depend on what equipment is available to you.

1. Method 1 takes about 5 to 15 minutes, not including air flow normalization. No special equipment required.

Step	Action
1	Ensure that the ventilation duct system is operating, and airflow is present in the duct.
2	Drill holes in the inlet and exhaust smoke detector pipes as required.
3	Connect the inlet and exhaust pipes to the detector while the pipes are outside the duct.
4	Normalize the airflow to the smoke detector and then record the %Flow.
5	Insert the inlet and exhaust smoke detector pipes in the duct with the holes facing the airflow and record %Flow at the smoke detector.
6	Slightly rotate the pipes so that the %Flow is within 5% of the original reading.
7	Mark the position of the pipes' orientation on the duct and pipes. This will make re-positioning the pipes easy after maintenance checks in the future.
8	Secure the pipe installation.

2. Method 2 requires no connection to the smoke detector. Inlet and exhaust pipes are installed inside the duct. A manometer, for instance, Model 8702 DP-CALC Micromanometers from www.tsi.com will be required.

Step	Action
1	Connect the ends of the inlet and exhaust smoke detector pipes to a pressure manometer as shown (Figure 13), ensuring that all connections are airtight.
2	Face the holes of both pipes to the airflow and slightly rotate the pipes so that the pressure reading is within ±20 Pa.
3	Mark the position of the pipes' orientation on the duct and pipes. This will make re-positioning the pipes easy after maintenance checks in the future.
4	Connect the detector after securing the pipe network.

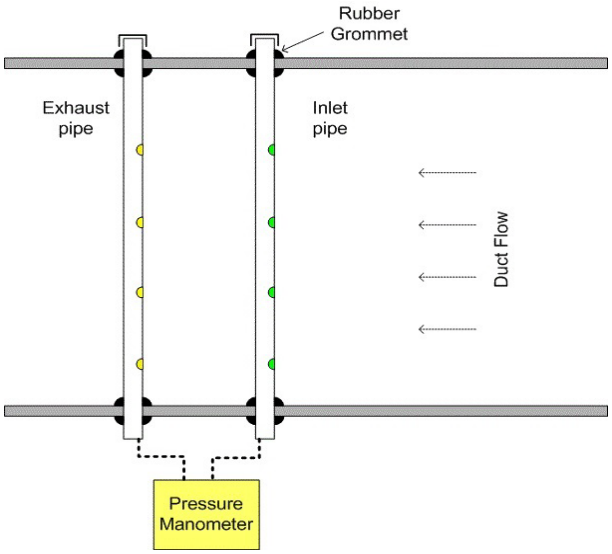

Figure 13: Manometer set-up for hole orientation adjustment

3. Method 3 is the same as Method 2, except that it does not require the manometer but uses a clear, flexible U-tube.

Step	Action
1	Instead of a manometer, connect the ends of inlet and exhaust pipes to a clear U-shaped flexible tube containing water as shown (Figure 14), ensuring all connections are airtight.
2	Face the holes on both the inlet and exhaust pipes to the airflow. Slightly rotate the pipes so that the water level on both sides of the flexible tube is the same.
3	Mark the position of the pipes' orientation on the duct and pipes. This will make re-positioning the pipes easy after maintenance checks in the future.
4	Connect the detector after securing the pipe network.

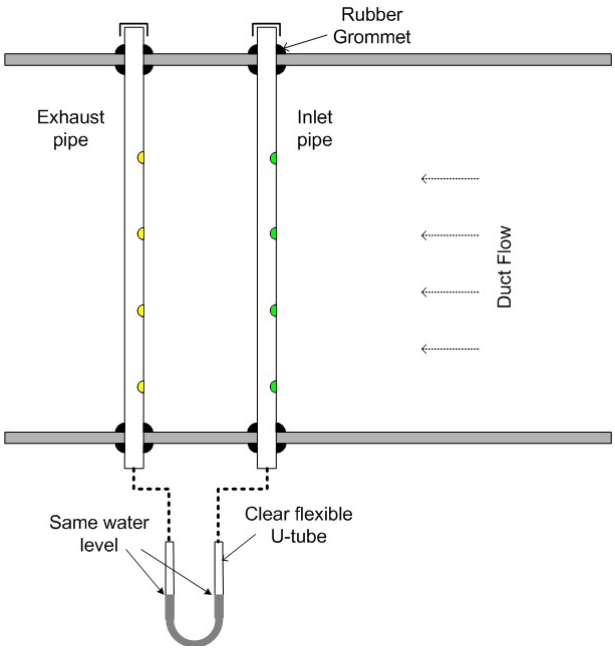

Figure 14: Flexible U-tube set-up for hole orientation adjustment

3.2 System Performance Verification

Verify system performance, with the Air Handling Unit (AHU) in its normal operating mode, by following the steps below.

Step	Action
1	Connect to the smoke detector using the VESDA System Configurator (VSC) software or a hand-held programmer. Record the initial background reading from the detector.
2	Conduct two smoke tests inside the duct using a small amount of smoke, from a smoke cartridge (i.e. approximately 3 g), with known characteristics.
3	Record the peak smoke reading and the time taken to reach the peak.
4	To test air leakage into the smoke detector, remove the front cover of the detector. Cover the electronics during this test with a sheet of paper.
5	Introduce smoke inside the detector's interior housing using a smoke can.
6	Place the smoke can's nozzle 0.5 m (1.5 ft) away from the detector and spray for no more than 1 second. Note the peak smoke reading from the detector.
7	Repeat the smoke test twice more, after the background returns to ambient, noting the peak smoke reading each time.
8	If all the peak smoke readings were < initial background reading + 0.05%, proceed to Step 10. If any of the peak smoke readings were > initial background reading + 0.05%, there is possibly leakage in the system that must be corrected. Proceed to Step 9.
9	Check all pipe connections and repeat Steps 5-8. If necessary, contact your local distributor or Xtralis office.
10	Complete any additional tests required to verify compliance with local codes and standards.

4 System Maintenance

4.1 Local Codes and Standards

Note!

The maintenance requirements of all local codes and standards must be adhered to.

4.2 First Year Requirements

Repeat the procedure for Performance Verification, as described in section 3 VESDA System Commissioning , at least once every six months. Compare readings with previous records and investigate any discrepancies.

4.3 On-Board Filter Replacement

The smoke detector will indicate when its filter needs to be replaced. Replace the filter and repeat the procedure for Performance Verification as described in section 3 VESDA System Commissioning.

4.4 Site Visit Requirements

During each site visit, at a frequency specified by local codes and standards, the following procedure must be carried out.

Step	Action
1	Check flow readings at the smoke detector(s). Differences in flow readings from those of previous site visits require further investigation such as inspection of the pipes/sampling tubes integrity for fatigue and creep, or for hole blockage.
2	Check for condensation in the pipes/sampling tubes and address the problem as described in System Installation under Environment.
3	VEP-1P, check the original hole orientation marks to ensure that they have not been moved since the last inspection. If the hole orientation has changed, refer to Hole Orientation Adjustment and readjust.

In addition to the above, the following procedure needs to be carried out during each site visit for pipe maintenance.

Step	Action (VESDA-E VEP-1P(-UL) and VLF-500-UL)
1	Disconnect inlet and exhaust pipes from the smoke detector.
2	Remove the end caps from the inlet and exhaust pipes. Back-flush with compressed air.
3	Ensure all pipes are returned to their original configuration.
4	Check overall system performance.

Disclaimer On the Provision of General System Design Recommendations

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